Project OASIS (DE-FE0032267) – Project Closeout Meeting

September 3, 2025

PI: Kenneth Nemeth
Co-PIs: Kimberly Sams-Gray; Ben Wernette, PhD

Speakers: Ben Wernette, PhD (SSEB); John Koster (ARI); Gabe Casanova (ARI); David King, PhD (AU); and Jack Pashin, PhD (OSU)

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NATIONAL ENERGY TECHNOLOGY LABORATORY

Transcending Boundaries

Agenda

- Project Motivation
- Location
- Geology
- Organization, Objectives, Task Description
- Activities
  - Project Management – SSEB
  - Community Benefits – SSEB
  - Site Specific Characterization – ARI, AU, OSU
  - Infrastructure Needs - SSEB
  - CarbonSAFE Phase III Readiness – ARI
  - Risk – ARI
  - Commercialization – SSEB, CRI
- Conclusions

Themes

- Responded to broad industry appetite
- Technical success that resulted in robust lessons learned
- Extensive opportunity for knowledge transfer
- Cashflow models suggest an uneconomic site, though technology development or further characterization may improve viability

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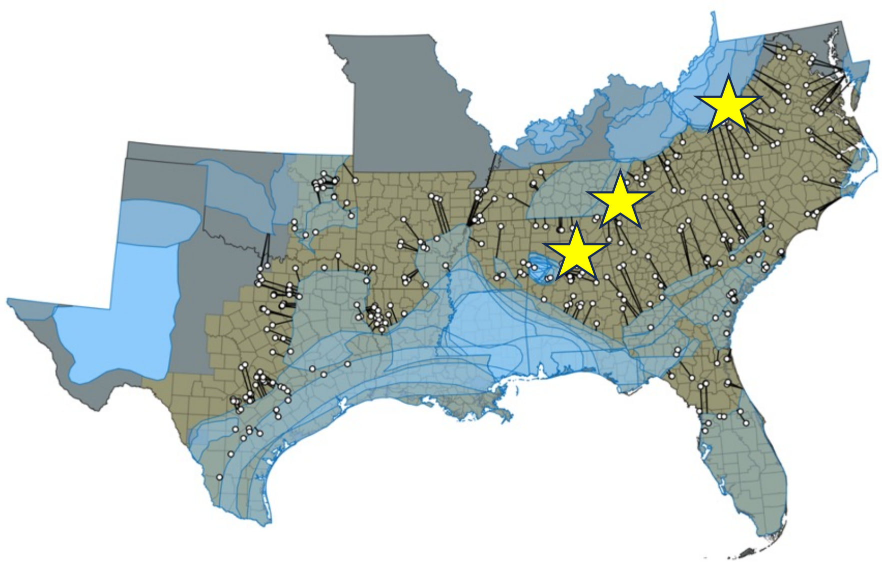
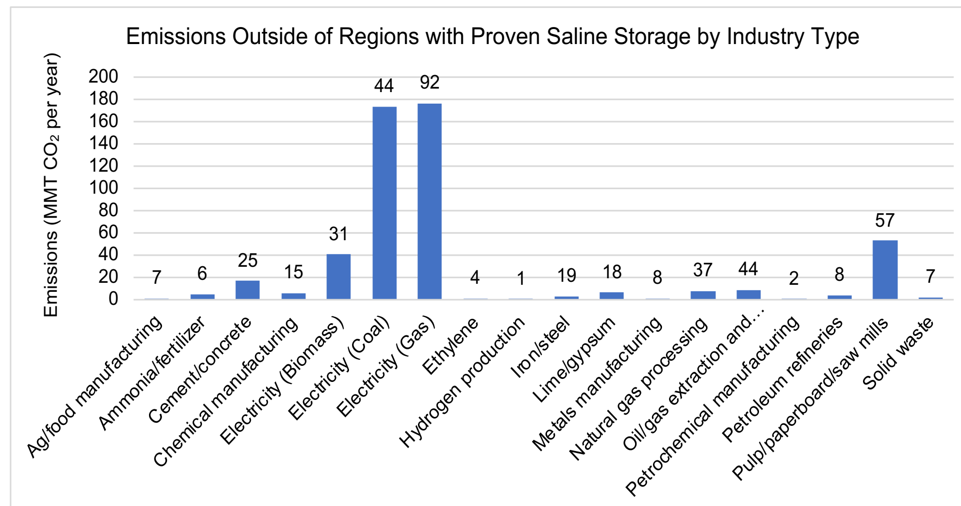
Project Motivation - Stranded Emissions

- In total, 425 facilities fall outside of areas with proven saline storage, representing annual emissions of nearly 509 million metric tons of CO_2 (identified as part of SECARB-USA, DE-FE0031830)
- Lengthy infrastructure required, or investment in proximal exploration
- Motivated project partners with assets in these areas (Southern Company, Titan)



Location of SECARB-USA regional facilities (white dots) located outside of proven saline storage areas (blue polygons). Also shown is least distance path to from each facility to saline polygons as a proxy for required pipeline length. Facility data is from the EPA GHGRP while saline polygons are from the US DOE NATCARB Atlas.



Distribution of facilities outside of areas with proven saline storage in the SECARB-USA region by industry type, number, and annual CO_2 emissions.

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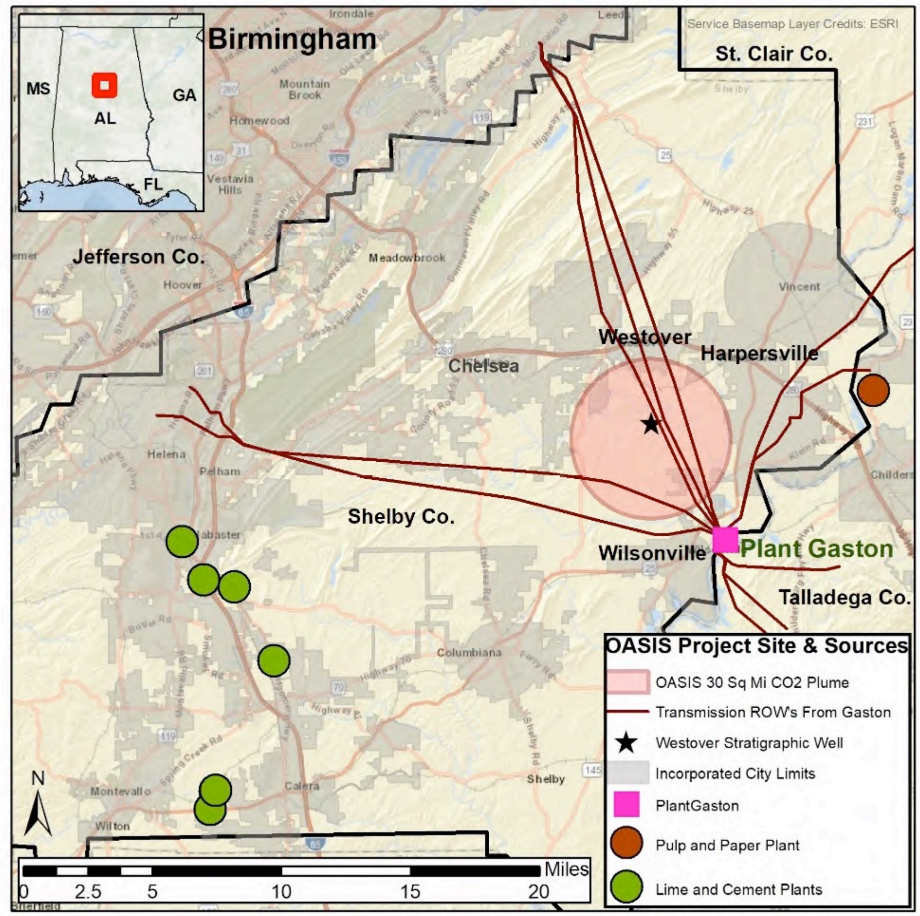
Project Motivation (continued)

- Establish the foundation for a commercial-scale geologic storage complex for CO_2 captured from Plant Gaston **(home to the National Carbon Capture Center)** and surrounding industrial sources of CO_2 located in Shelby County, Alabama
  1. Demonstrate that the subsurface saline formations at the storage complex can store commercial volumes of CO_2 safely and permanently;
  2. Develop a comprehensive Stakeholder Engagement Plan;
  3. Develop the infrastructure framework for a CO_2 storage hub;
  4. Develop a rigorous risk registry and conduct a comprehensive risk assessment;
  5. Develop a monitoring plan;
  6. Develop a comprehensive site characterization plan to support an Underground Injection Control Class VI Permit in Phase III; and
  7. Evaluate project commerciality

Location

- The proposed storage complex site is located 30 miles southeast of Birmingham
- The complex will provide storage for the CO_2 emissions captured from Alabama Power's Plant Gaston and is the site of the DOE's National Carbon Capture Center (NCCC) in Wilsonville, Alabama
- The proposed storage site could also serve as a central CO_2 storage hub for the seven large cement plants and a major pulp and paper plant located in the area



Map illustrating the location of Project OASIS and regional emitters.

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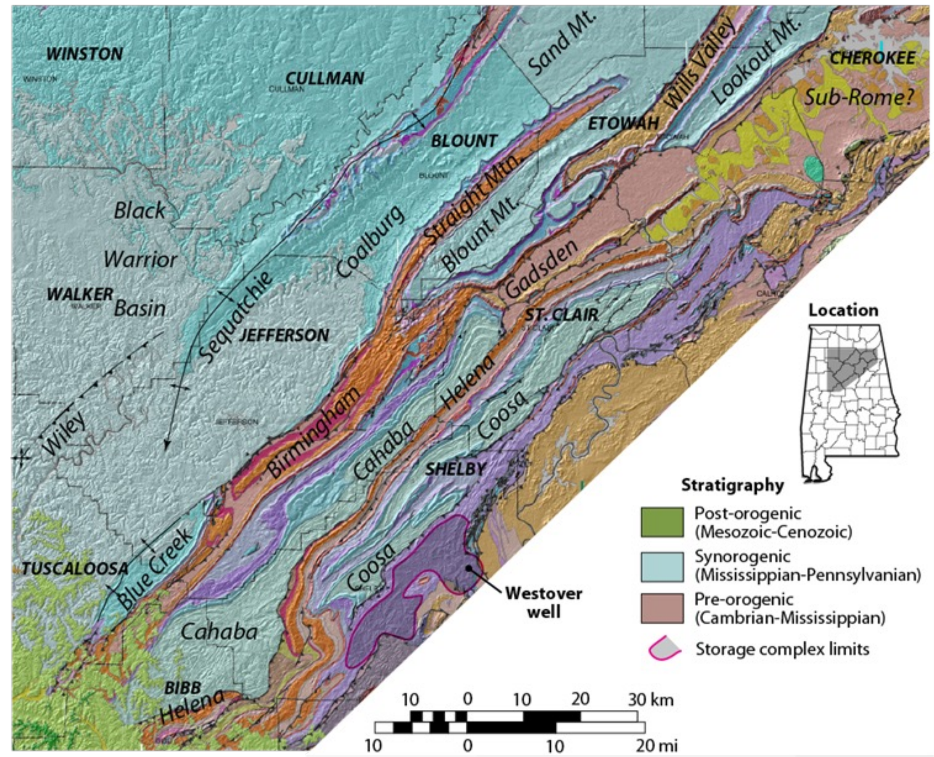
Geology

- Located in the Alabama fold and thrust belt
- Relatively flat lying structural panels between thrust faults may serve as regional storage complexes
- Cambro-Ordovician carbonates and Cambrian clastic units offer multiple storage intervals
- Shales, including the tectonically thickened Floyd-Parkwood, provide containment
- Opportunity for knowledge transfer throughout the Southeast



Geologic map illustrating the location of Project OASIS within the Alabama Valley and Ridge province.

Transcending Boundaries

OASIS Organization Chart

U.S. Department of Energy (DOE)
National Energy Technology Laboratory (NETL)

Southern States Energy Board (SSEB)
Lead PI: Kenneth Nemeth
Co-PI/Project Coordinator: Kimberly Sams-Gray, Ben Wernette, PhD
Key Team Member: Patricia Berry, Nicholas Kaylor, PhD
Tasks: 1, 2, 6, 7, 8

Advanced Resources International (ARI)
Lead PI: George Koperna
Co-PI: Dave Riestenberg
Tasks: 2, 3, 4, 5, 6, 7, 8

Auburn University (AU)
Lead PI: David King, PhD
Co-PI: Ashraf Uddin, PhD
Task: 4

Alabama A&M University (AAMU)
Lead PI: Phil Bording, PhD
Task: 2

Crescent Resource Innovation (CRI)
Lead PI: Brian Hill
Tasks: 1, 5, 6, 7, 8

Oklahoma State University (OSU)
Lead PI: Jack Pashin, PhD
Task: 4

Stakeholder Network
Community
City of Birmingham
Industry
Alabama Power Company
Southern Company
Westervelt
Shelby Co. Lime & Cement Companies

Vendor Arrangements
ARI → Baker Hughes (Task 3)
ARI → Loudon Technical Services (Task 3)

Project Objectives

Site specific characterization and assessment of the CO_2 storage complex via stratigraphic test well drilling, formation testing, and geologic data collection

A project risk assessment with mitigation and management plans

A plan for subsequent detailed site characterization and UIC Class VI permitting

A project technical and economic feasibility assessment, including conceptual level design study for CO_2 transport

A robust stakeholder engagement plan

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Tasks

Task 1 – Project Management and Planning

Task 2 – Community Benefits Plan

Task 3 – Site Specific Characterization and Assessment of the CO_2 Storage Complex

Task 4 – Geologic Data Analysis

Task 5 – Infrastructure Assessment

Task 6 – CarbonSAFE Phase III Readiness

Task 7 – Risk Assessment

Task 8 - Commercialization Plan

Task 1 – Management

As Awarded
Federal Spend: $7,944,918.00
Cost Share: $1,993,412.00
Overall: $9,938,330.00

→

As of July 2025
Federal Spend: $6,221,677.50
Cost Share: $1,462,416.24
Overall: $7,684,093.74

- Project OASIS team members participated in recurring project management calls to track progress towards deliverables and milestones
  - Outputs were call memos detailing progress and action items
  - Cadence variable, responding to needs of the project
- Recurring update calls with OASIS Federal Project Manager
- SSEB staff tracked invoicing to monitor spend and cost-share

Project OASIS Timeline	D = Deliverable, M = Milestone		Budget Period 1																							
			Year 1												Year 2											
			Project Month																							
Task Description	**Start Date**	**End Date**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
Task 1.0 - Project Management and Planning	10/1/23	9/30/25																								
Deliverable: Project Management Plan (D1)	10/31/23	10/31/23	D*																							
Subtask 1.1 - Project Coordination	10/1/23	9/30/25																								
Subtask 1.2 - Contractual and Regulatory Requirements	10/1/23	9/30/25																								
Milestone: Participate in NETL Project Kick-Off Meeting	12/31/23	12/31/23			M*																					
Task 2.0 - Community Benefits Plan	10/1/23	9/30/25																								
Subtask 2.1 - Community and Labor Engagement	10/1/23	9/30/25																								
Milestone: Host a community and stakeholder engagement event to include a public presentation on CBP work (CBP Commitment B2)	2/28/25	2/28/25																	M							
Subtask 2.2 - Investing in Job Quality and a Skilled Workforce	10/1/23	9/30/25																								
Subtask 2.3 - Diversity, Equity, Inclusion and Accessibility (DEIA)	10/1/23	9/30/25																								
Milestone: Identify at least one point of contact and hold at least one introductory meeting with faculty representing at least two Alabama Historically Black College and Universities (HBCUs) not represented on the Project Team (CBP Commitment D3)	3/31/24	3/31/24						M*																		
Milestone: Host at least one event to communicate STEM-related CCUS job opportunities to underrepresented groups and students at an Alabama HBCU campus (CBP Commitment D4)	2/28/25	2/28/25																	M							
Subtask 2.4 - Justice40 (J40)	10/1/23	9/30/25																								
Task 3.0 - Site Specific Characterization and Assessment of the CO_2 Storage Complex	10/1/23	1/31/24																								
Milestone: Site Specific Drilling Report	1/31/24	1/31/24				M*																				
Subtask 3.1 - Well Site Selection	10/1/24	10/31/24																								
Subtask 3.2 - Permitting and Site Surveys	10/1/24	10/31/24																								
Subtask 3.3 - Well Design	10/1/24	11/30/24																								
Subtask 3.4 - Wellbore Hydraulic Design	10/1/24	11/30/24																								
Milestone: Complete Well Design and Drilling Plan	11/30/24	11/30/24		M*																						
Subtask 3.5 - Well Drilling and Geologic Data Collection	11/1/24	1/31/24																								
Deliverable: Stratigraphic Test Well Drilling Report (D2)	1/31/24	1/31/24				D*																				
Subtask 3.6 - Wireline Well Testing	1/1/24	1/31/24																								
Task 4.0 - Geologic Data Analysis	2/1/24	9/30/25																								
Subtask 4.1 - Core Analysis	2/1/24	9/30/25																								
Subtask 4.2 - Refined Geologic Model	8/1/24	9/30/25																								
Milestone: Host Team Meeting to Review Geologic Data to Inform Model Development	10/31/24	10/31/24													M*											
Subtask 4.3 - Reservoir Modeling	11/1/24	9/30/25																								
Deliverable: Geologic Analysis - Core Analysis, Refined Geologic Model, and Reservoir Model (D3)	9/1/25	9/1/25																								D
Task 5.0 - Infrastructure Assessment	2/1/24	4/30/25																								
Subtask 5.1 - Potential CO_2 Source Screening and Selection	2/1/24	5/31/24																								
Subtask 5.2 - CO_2 Pipeline Infrastructure	6/1/24	10/31/24																								
Subtask 5.3 - Pore/Surface Rights and Right of Way Requirements	6/1/24	10/31/24																								
Deliverable: Infrastructure Assessment Report (D4)	10/31/24	10/31/24													D*											
Task 6.0 - CarbonSAFE Phase III Readiness	8/1/24	9/30/25																								
Subtask 6.1 - Class VI Readiness	8/1/24	10/31/24																								
Milestone: Evaluation of Class VI Readiness	10/31/24	10/31/24													M*											
Subtask 6.2 - Injection Well Design, and Initial MVA	11/1/24	12/31/24																								
Subtask 6.3 - Public Engagement Plan to Support Class VI Permit	12/1/24	3/31/25																								
Deliverable: CarbonSAFE Phase III Readiness Report (D5)	9/1/25	9/1/25																								D
Task 7.0 - Risk Assessment	10/1/23	9/30/25																								
Deliverable: Social and Environmental Risk Assessment Report (D6)	9/1/25	9/1/25																								D
Task 8.0 - Commercialization Plan	10/1/24	9/30/25																								
Subtask 8.1 - Technical and Economic Feasibility Assessment	10/1/24	9/30/25																								
Subtask 8.2 - Conceptual-Level Design Study for CO_2 Transport	10/1/24	9/30/25																								
Deliverable: Commercialization Plan (D7)	9/1/25	9/1/25																								D

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Project Milestones

Task	Milestone Title & Description	Planned Completion Date	Actual Completion Date	Verification Method
1.0	Participate in NETL Kickoff Meeting	12/31/2023	11/30/2023	Presentation File to DOE
2.3	Identify at least one point of contact and hold at least one introductory meeting with faculty representing at least two Alabama Historically Black College and Universities (HBCUs) not represented on the Project Team (CBP Commitment D3)	3/31/2024	3/31/2024	Letter Report
2.1	~~Host a community and stakeholder engagement event to include a public presentation on CBP work (CBP Commitment B2)~~ WORK STOPPED	~~10/31/2024~~		~~Letter Report~~
2.3	~~Host at least one event to communicate STEM-related CCUS job opportunities to underrepresented groups and students at an Alabama HBCU campus (CBP Commitment D4).~~ WORK STOPPED	~~12/28/2025~~		~~Letter Report~~
3.0	Site Specific Drilling Report	1/31/2024	1/25/2024	Letter Report
3.4	Complete Well Design and Drilling Plan	11/30/2023	10/31/2023	Letter Report, Deliverable 3.0
4.2	Host Team Meeting to Review Geologic Data to Inform Model Development	10/31/2024	10/31/2024	Letter Report
6.1	Evaluation of Class VI Readiness	10/31/2024	11/01/2024	Letter Report

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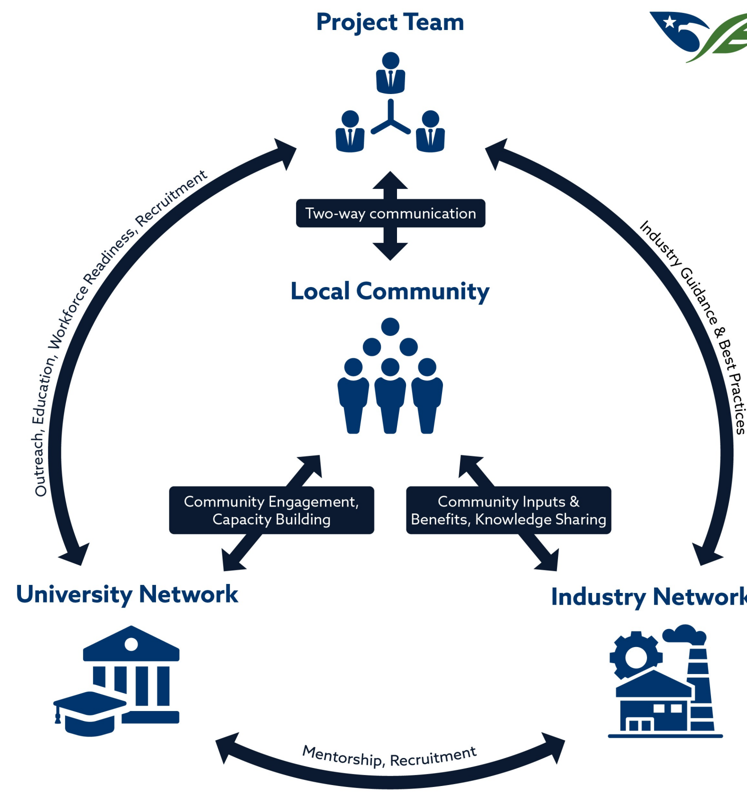
Project Deliverables

Task/ Subtask Number	Deliverable Title	Due Date
1.0	Project Management Plan (D1)	Update due 30 days after award. Revisions to the PMP shall be submitted as requested by the NETL Project Manager.
3.0	Stratigraphic Test Well Drilling Report (D2)	To be completed after drilling operations.
4.0	Geologic Analysis Report – Core Analysis, Refined Geologic Model, and Reservoir Modeling (D3)	30 Days Prior to End of Performance Period.
5.0	Infrastructure Assessment Report (D4)	30 Days into Year 2 of Performance Period.
6.0	CarbonSAFE Phase III Readiness Report (D5)	30 Days Prior to End of Performance Period.
7.0	Social and Environmental Risk Assessment Report (D6)	30 Days Prior to End of Performance Period.
8.0	Commercialization Plan (D7)	30 Days Prior to End of Performance Period.

Task 2 – Community Benefits

- High-level objectives
  - Community engagement and involvement in long-term decision making
  - Support educational and career opportunities by working with participating academic institutions
    - Training (Baker Hughes' JewelSuite)
    - Networking
  - Engage with regional industry interested in decarbonization
  - Communicate project progress with regulators and other stakeholders
- Questions around CBP expectations and what is reasonable given status of project



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Task 2 – Community and Labor Engagement

- Coordinated an open house with Southern Company and the NCCC on November 3, 2023
  - Over 30 individuals in attendance
  - Designed to provide students and industry with an overview of the carbon capture and storage value chain
- April 19, 2024, open house with students from Alabama A&M at NCCC
- Critical activity for educating stakeholders and establishing next generation workforce
- Engagement with Governor Ivey and Alabama Legislators
- September 11, 2025, Alabama CCS Workshop

Left: screen shot of participants in the Alabama Mineralogical society virtual trip. Below: photograph of participants in the November 3, 2023, open house.


PROJECT OASIS

SOUTHERN STATES ENERGY BOARD
Transcending Boundaries

Optimizing Alabama's CO_2 Storage in Shelby County (Project OASIS)

Goal: Drill a deep stratigraphic test well to better understand the subsurface geology

Location: Privately held land in Shelby County, Alabama **Timeline:** 1.5 to 2 months

Impact: May cause an increase in traffic and noise around the field location. No long-term impacts are anticipated. The location will be returned to its original state upon project completion.

The passage of the Bipartisan Infrastructure Law (P.L. 117-58) allocated $2.25 billion in funding towards Carbon Storage Assurance Facility Enterprise (CarbonSAFE) projects. These projects include the development of new and expanded commercial-scale carbon storage projects and carbon transport infrastructure. Optimizing Alabama's CO_2 Storage in Shelby County (Project OASIS) is a new project to support the U.S. Department of Energy's CarbonSAFE Phase II Program goals of reducing project risks and costs for future carbon dioxide (CO_2) capture, utilization, and storage (CCUS) projects, bringing more storage resources into commercial classifications that support business and financial decisions, and encouraging more rapid growth of a vibrant, geographically widespread industry for geologic carbon storage.

The ultimate objective is to establish the foundation for a commercial-scale geologic storage complex for CO_2 captured from power generation facilities and surrounding industrial sources of CO_2 located within Shelby County.

Establishing a storage facility in Shelby County will provide significant support for the decarbonization of multiple industries while facilitating economic growth within the region. While some risks are present due to the complexity of the sub-surface in the region, the Project Team includes a diverse group possessing the experience and expertise to mitigate any potential issues while safely moving the project forward. The drilling and characterization methods utilized by the team are routine and common practice in other portions of the US. It is expected that the well site will be reclaimed following the conclusion of the field activities and that there will be no long-term impact on surrounding communities.

www.sseb.org (770) 242-7712

Above: photograph of participants in the April 18, 2024, open house.

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Task 2 – Investing in a Skilled Workforce

- Building capacities in subsurface image processing and working with industry standard software
  - Partnering with Baker Hughes and Alabama A&M University to train students in utilizing software
  - Student outcomes to be reported
- Alabama A&M has created 20 paid internships focusing on small geophysics related research
- Create student engagement opportunities with participating industry partners
- Students gave presentations as part of the April 19, 2024, open house at the NCCC

Computer stations donated to Alabama A&M to support student interns.

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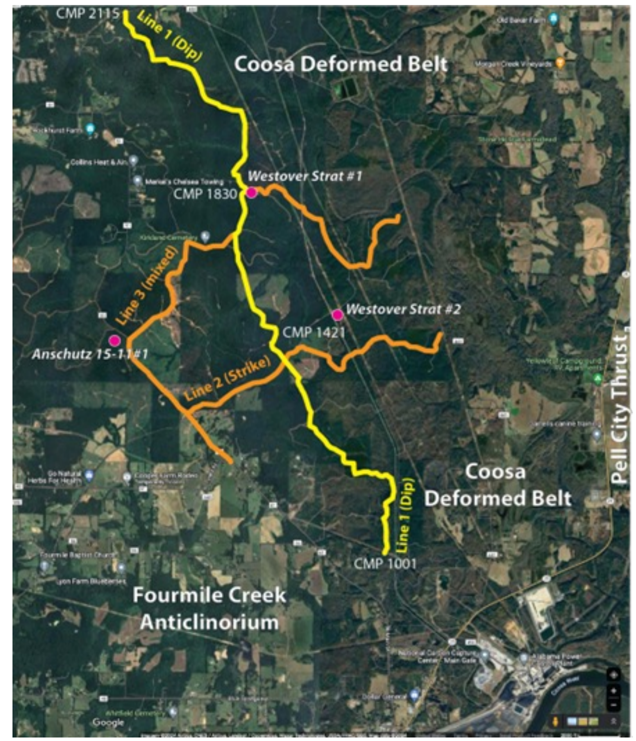
Task 3 – Site Specific Characterization and Assessment of the CO_2 Storage Complex

Pre-Drilling Optimization of Westover #2

- Location, Location, Location
  - Selected a new site based on 2D seismic stratigraphy
  - Minimized the thickness of Floyd-Parkwood Shale - “MUSHWAD” to drill through
- Wellbore Stability is Key in Valley and Ridge
  - Increased Mud Weight to control formation
  - Utilized directional drilling tools to maintain vertical wellbore and reduce tortuosity



Map illustrating the location of new 2D seismic data that was acquired to support OASIS, and the location of Westover No.1 and No. 2

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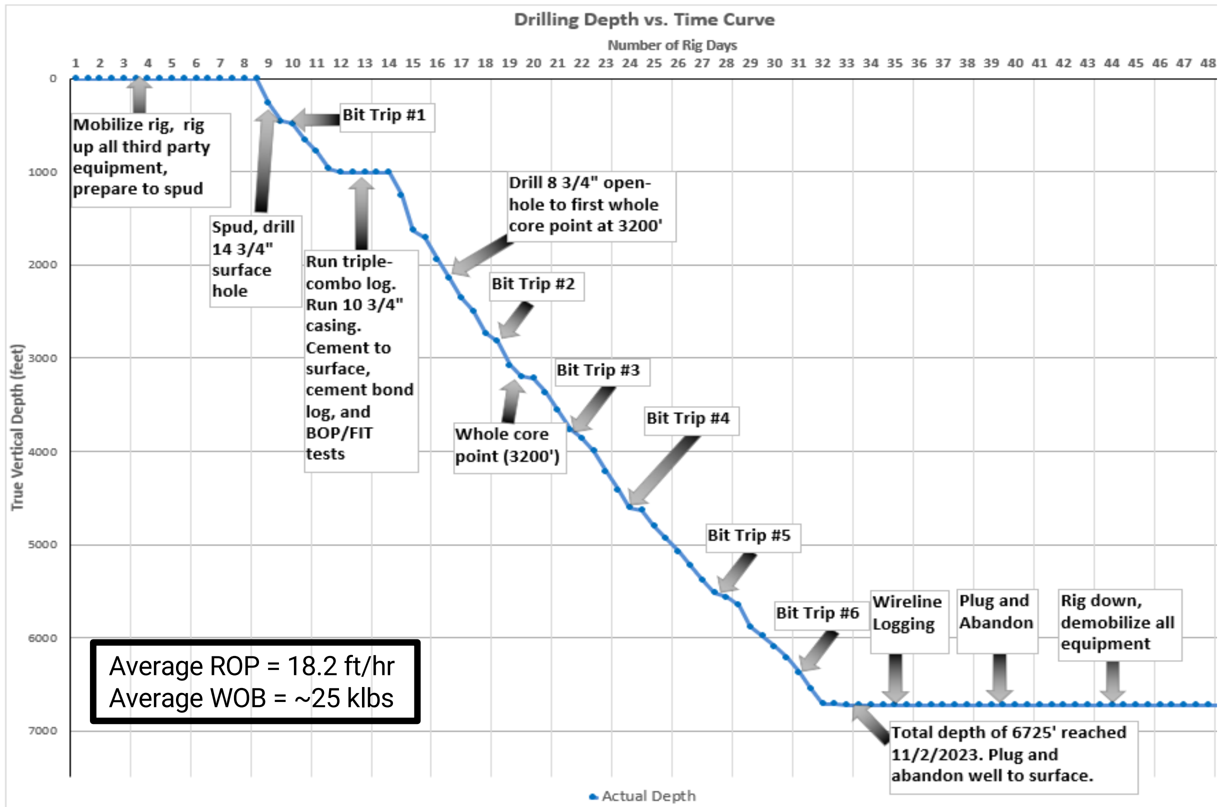
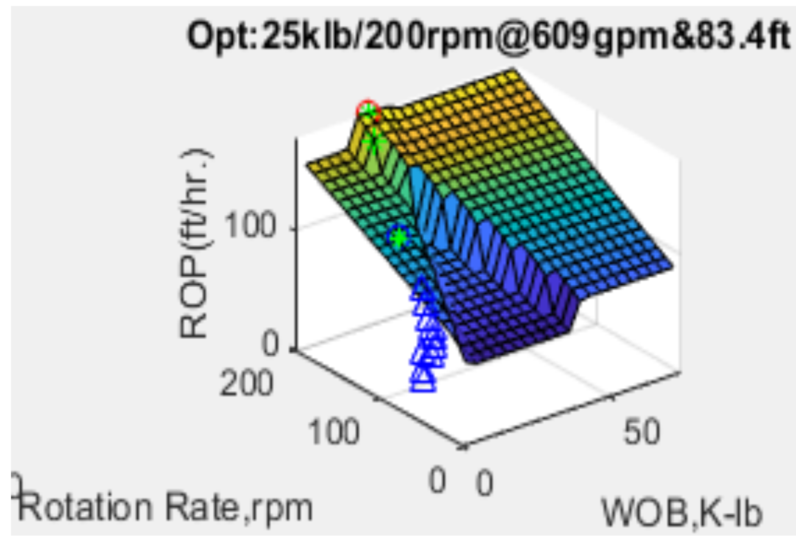
Task 3 - Drilling Westover #2

- The optimized site selection reduced drilling time
  - ✓ Westover #1 achieved 6,500ft in 29 days
  - ✓ Westover #2 achieved 6,725 ft in 25 days
- However, lower than expected rate of penetration (ROP) precluded depth target (~10,000ft)
- Repeat section helped sample "all" intervals of interest



Task 3 – Post Drilling Optimization

- NETL - Drilling Parameter Optimization Software (DROPS)
  - Conducted by Wu Zhang under the direction of Mark McCoy
  - Utilized rig data and bit performance from Westover #2 drilling operations simulates real-time drilling conditions to identify potential efficiency improvements, including predicting bit wear
- Results
  - Lack of top drive rotary torque data prevented a comprehensive determination of mechanical specific energy (MSE).
  - Limited data input (one well)



NETL 3D Representation of How Weight on Bit (WOB) and Rotations Per Minute (RPM) effect Rate of Penetration (ROP) in Westover #2

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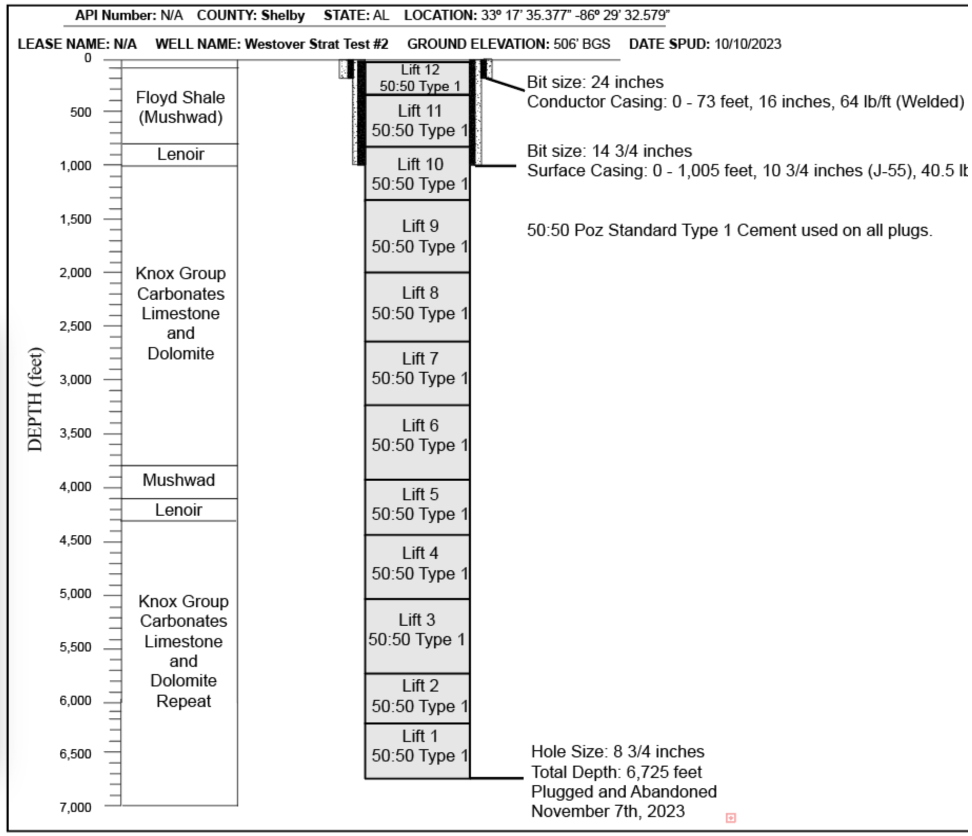
Task 3 - Plugging and Abandonment

Advanced Resources International, Inc.

- Wellbore fully cemented from TD to surface on 12-19-23
- Both Westover sites reclaimed to site host (Westervelt) satisfaction



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Task 4 – Geologic Data Analysis

Advanced Resources International, Inc.

Data Gathered From Westover #2

Open Hole Logging:

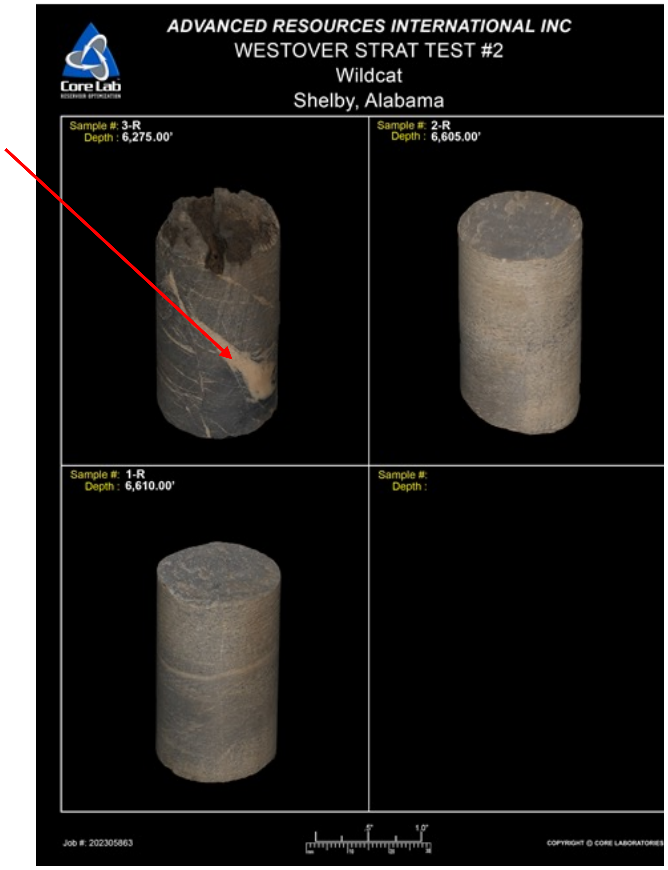
- 94 – 6,725 ft
  - "Triple Combo" (GR, Neutron Density, Resistivity)
- 1,004 – 6,725 ft
  - Dipole Sonic – mechanical properties
  - NMR – Fluid saturations, formation porosity, pore size
  - FMI – 3D Wellbore Image, fractures, bedding, formation dips

Rotary Sidewall Coring:

- 39 plugs recovered between 3,452 – 6,610 ft
- 30 plugs sufficient size and integrity to be analyzed
- Avg. porosity and permeability were 5.0% and <1.0 mD

17 feet of Whole Core

Calcite filled fractures



Project OASIS sidewall core example images.

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Task 4 – Geologic Data Analysis

- Auburn University provided detailed petrographic studies of available core and side-wall core samples
  - Goal: evaluate mineralogy, porosity, and characterize fractures
- Includes material from the nearby Arco/Anshutz No. 1 well in addition to the Westover No. 2 well
- The image (right) shows a portion of the whole core taken from Westover No. 2
- The core consists of very light grey, finely crystalline dolomite with calcite-filled veins throughout. The veins range from a maximum of 3 millimeters (1/8 inch) to less than 1 millimeter. The calcite is fine crystalline, white, and exhibits a general northeast orientation within the fracture network.

Image: Westover No. 2 whole core from 977 to 979 meters (3,205–3,211 feet). The box scale is 0.6 meters (2 feet) per column, totaling 1.8 meters (6 feet). The core width is 10 centimeters (4 inches). Image courtesy of Bryce Hall.

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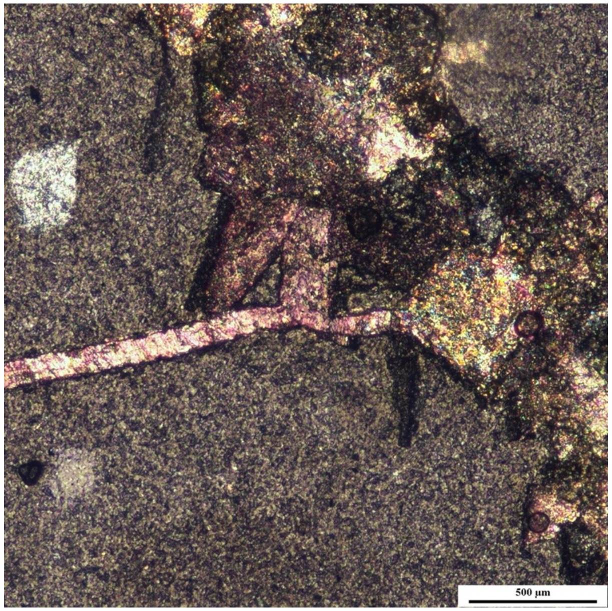
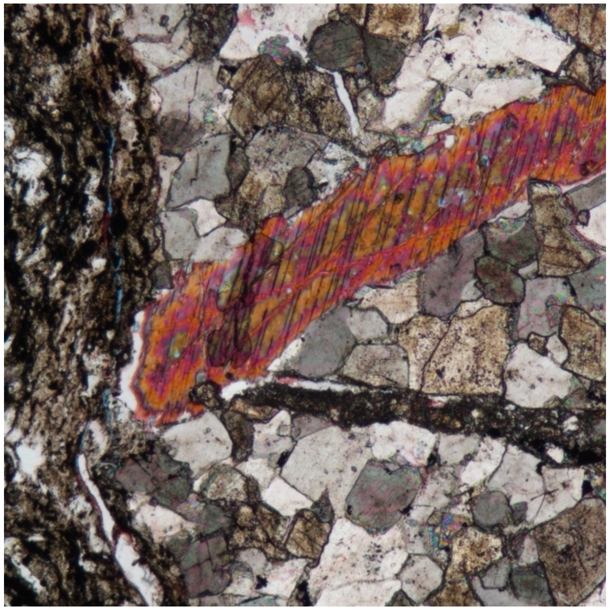
Task 4 – Geologic Data Analysis

Whole Core Samples from Arco/Anshutz No. 1



Knox Group - Thin section image from sample B-2, located at 2,160 meters (7,088 feet) in the adjacent ARCO/Anschutz #1 well. The image shows a fine dolomitic matrix with coarse calcite within the fracture filling. Taken at 4x magnification under cross-polarized light, with a scale of 500 micrometers. Image courtesy of Bryce Hall.

Whole Core Samples from Westover No. 2



Knox Group - Core sample from the Westover #2 well, taken from a depth of 980 meters (3,212 feet). The image was captured at 4x magnification under cross-polarized light, with a scale of 500 micrometers. Calcite fracture filling is highlighted by Alizarin Red S staining. Medium, subhedral crystalline dolomite surrounds the calcite vein in the thin section. Image courtesy of Bryce Hall.

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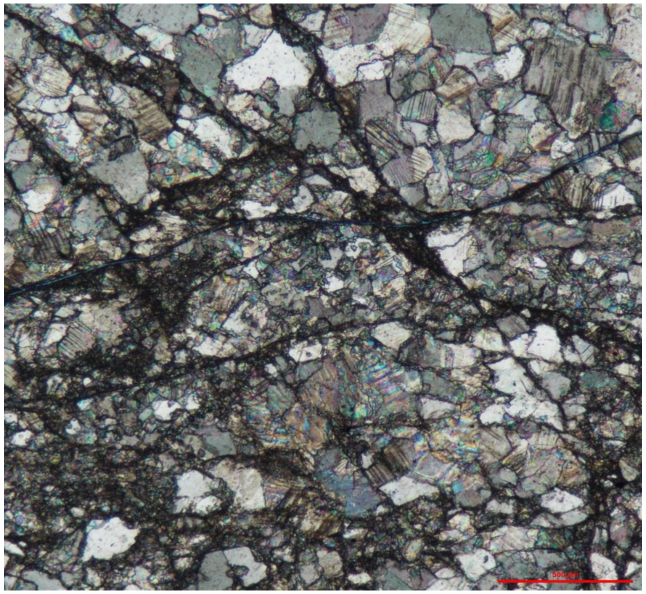
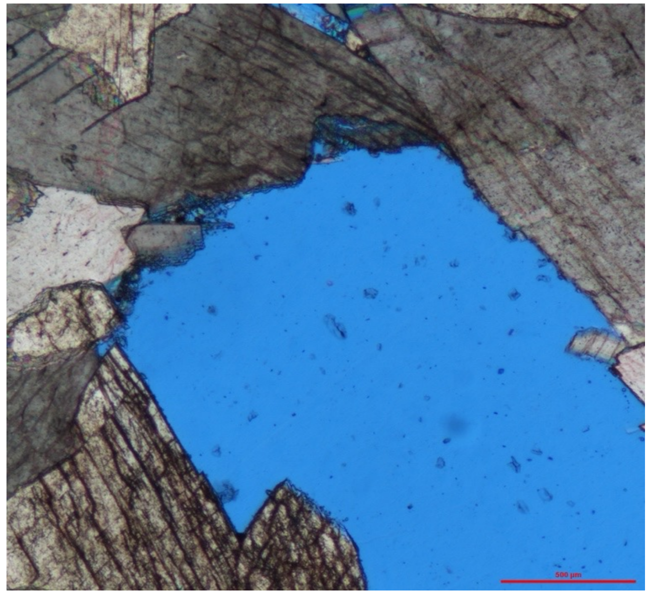
Task 4 – Geologic Data Analysis

Knox Group – Side-wall core no. 11



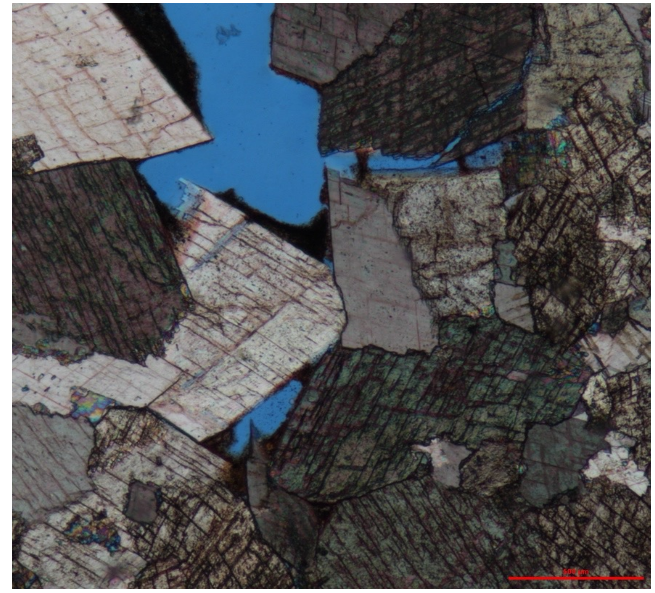
Showing fractured dolomite obtained at a depth of 1,700 meters (5,577 feet). Extensive dark-filled fractures (microbreccia) are visible throughout the small to medium crystalline dolomite. Image captured at 4x magnification under cross-polarized light, with a scale of 500 micrometers. Image shows micro-porosity only, and has very little open space, which is most common. Image courtesy of Bryce Hall.

Knox Group – Side-wall core no. 14



From the Westover #2 well, collected at a depth of 1,524 meters (5,000 feet) in the Knox Group. Blue epoxy highlights the open channel porosity. The primary lithology in this sample is grey to white, subhedral crystalline dolomite. The image was captured at 4x magnification under cross-polarized light, with a scale of 500 micrometers. Shows some relatively uncommon open porosity. Image courtesy of Bryce Hall.

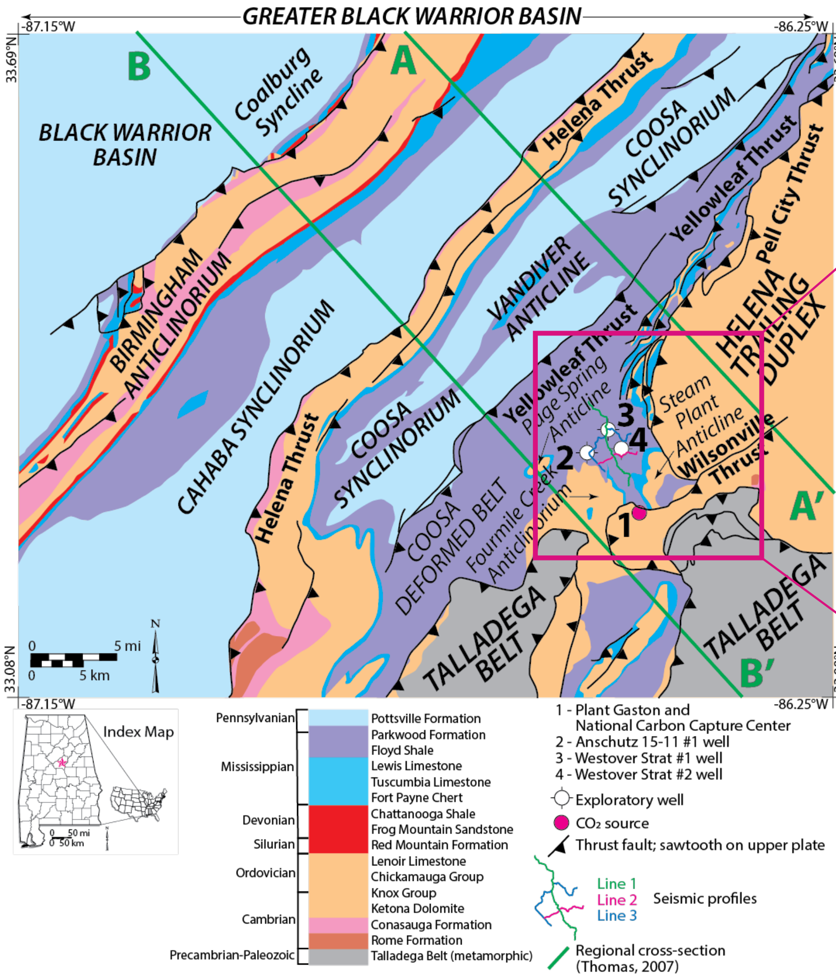
Ft. Payne Chert – Side-wall core no. 31

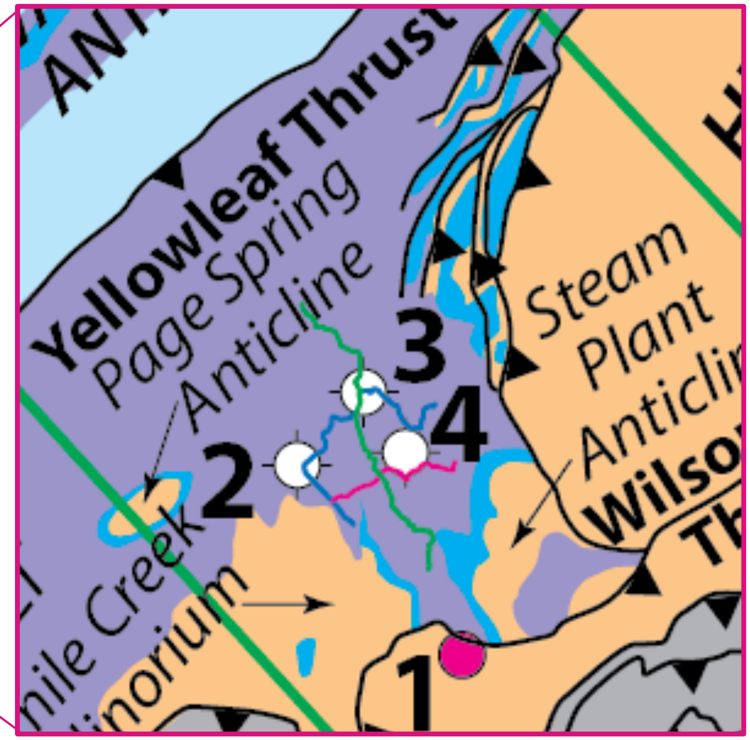


From Westover #2, taken at a depth of 1,240 meters (4,067 feet), shows vuggy porosity highlighted by the blue epoxy. These voids are classified as vugs due to the size of the voids within the dissolute dolomite. This fractured, medium to large crystalline dolomite lacks permeability, but the vugs contribute to increased porosity. The image was made at 4x magnification under cross-polarized light, with a scale of 500 micrometers. Shows finer scale open space.

Transcending Boundaries

Task 4 – Geologic Data Analysis



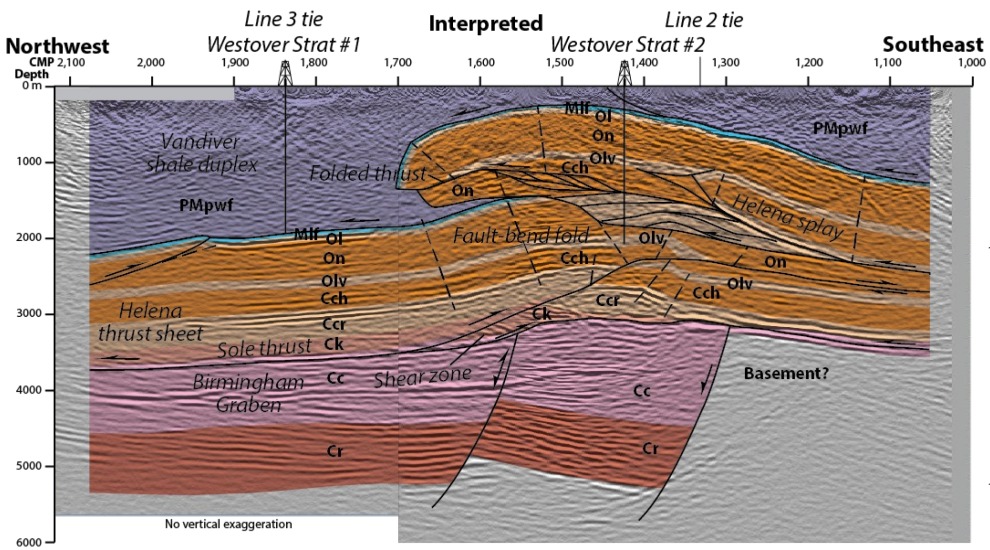


Transcending Boundaries

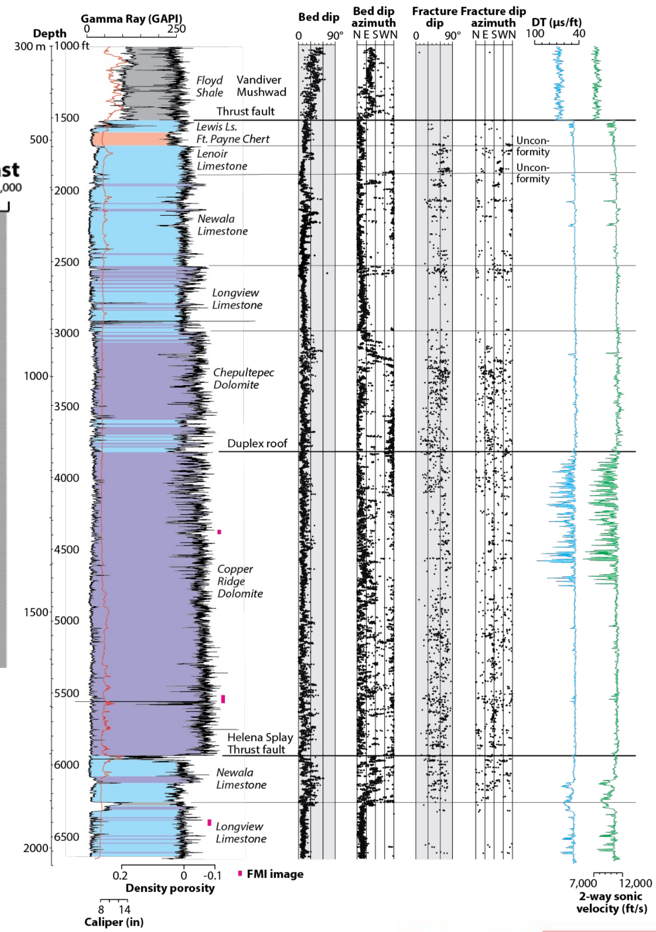
Task 4 – Geologic Data Analysis

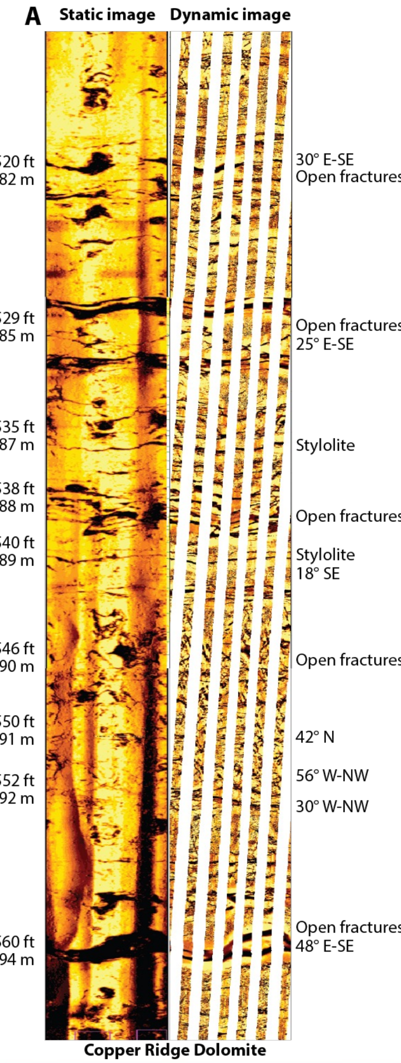
Westover Strat #2 well

OASIS Anticline



Dip line showing triangle zone with back-thrusted fault-bend fold, Copper Ridge duplex, and OASIS anticline developed above inverted graben margin.

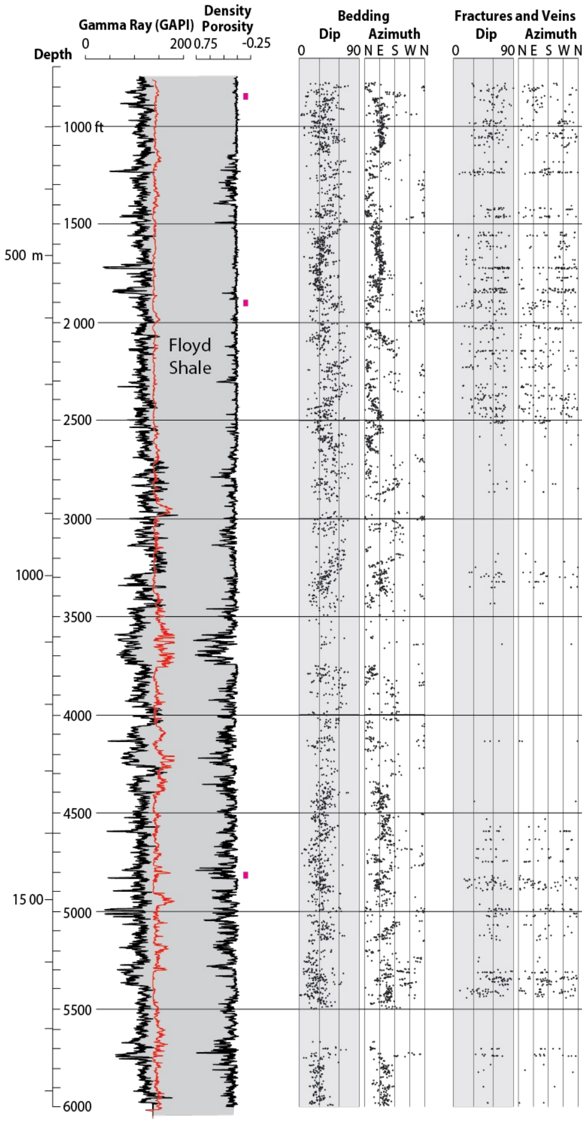




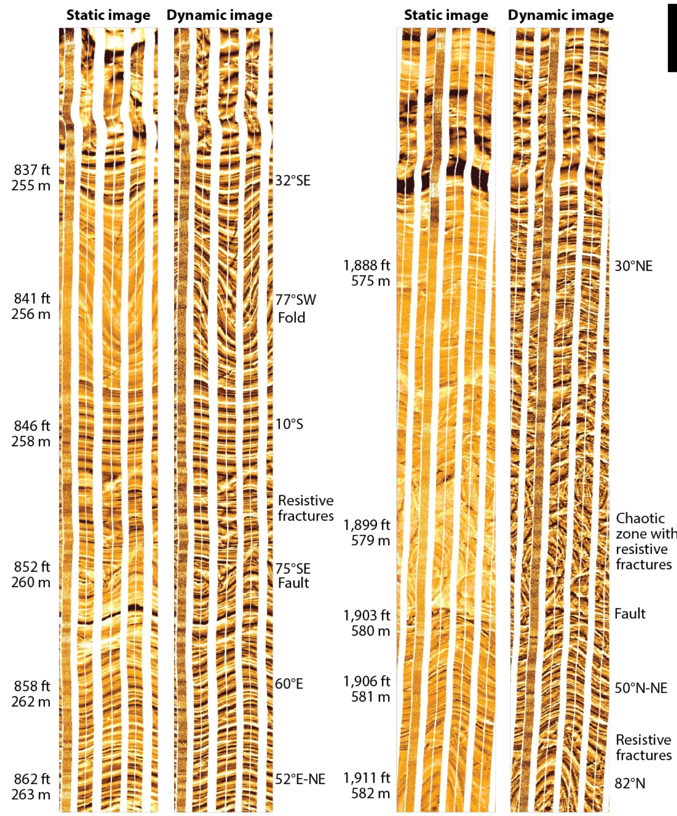
Transcending Boundaries

Task 4 – Geologic Data Analysis

Westover Strat #1 well

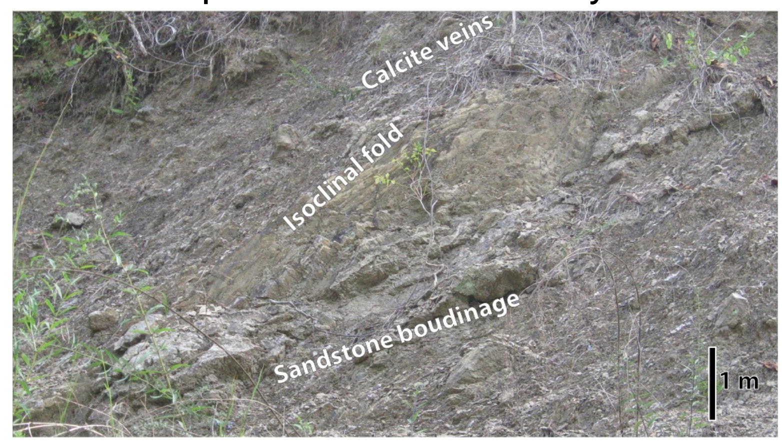


FMI Images



Complexly folded shale with abundant veining in Floyd-Parkwood shale of the Vandiver Mushwad

Outcrop in footwall of Pell City thrust

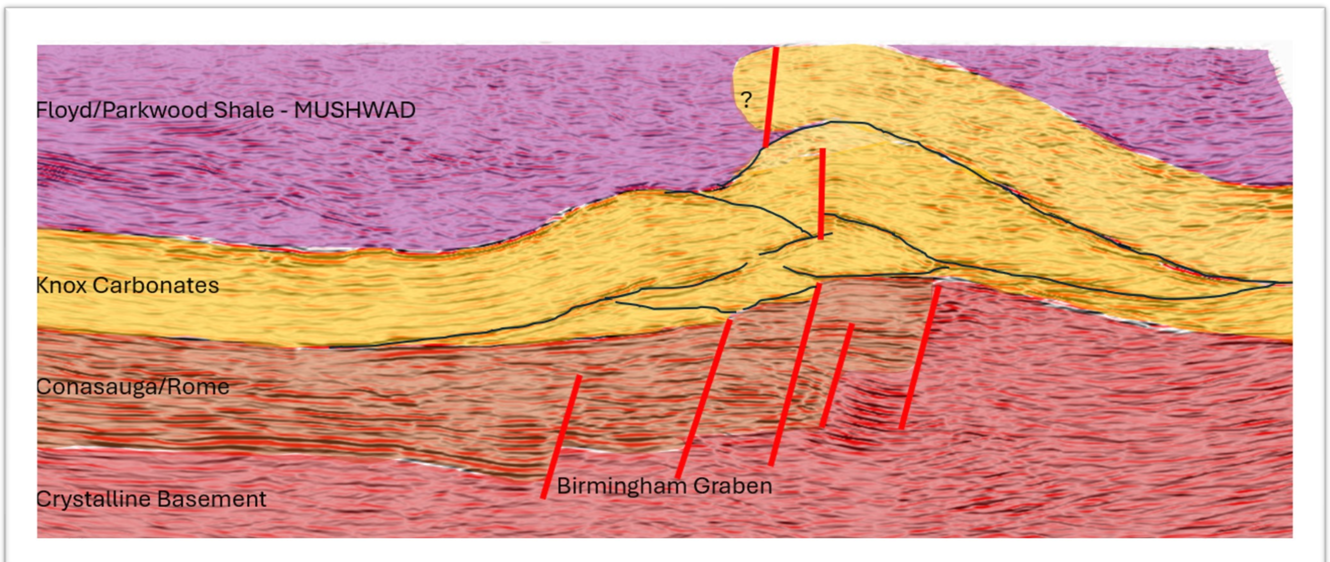


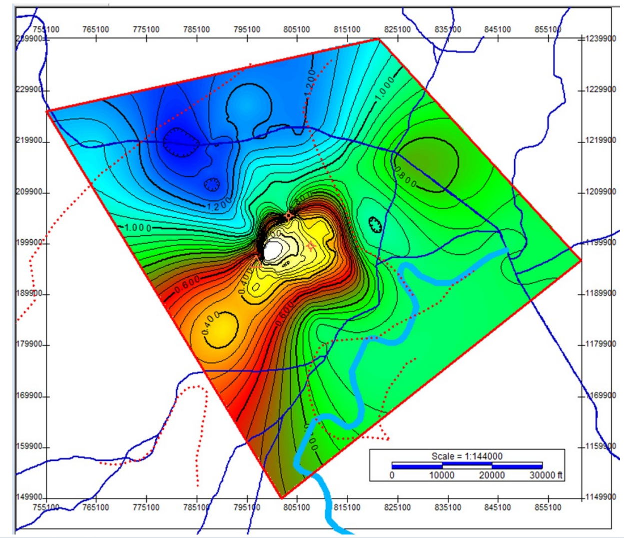
Transcending Boundaries

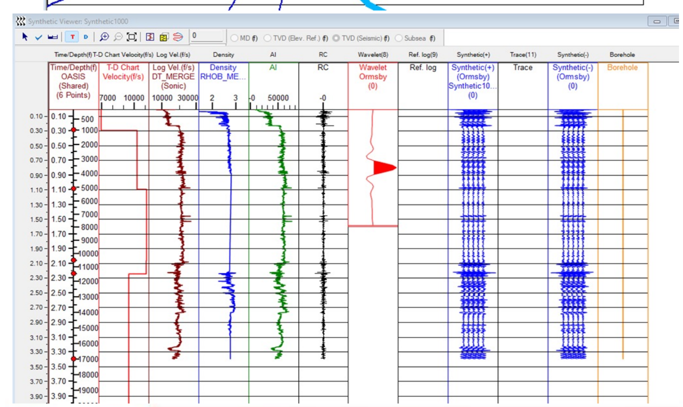
Task 4 – Geologic Data Analysis

Advanced Resources International, Inc.

- Bring together regional work, petrographic observations
- Secondary "regional" seismic licensing for geologic framework
- Expands model domain or area from existing wells to 180+ square miles.



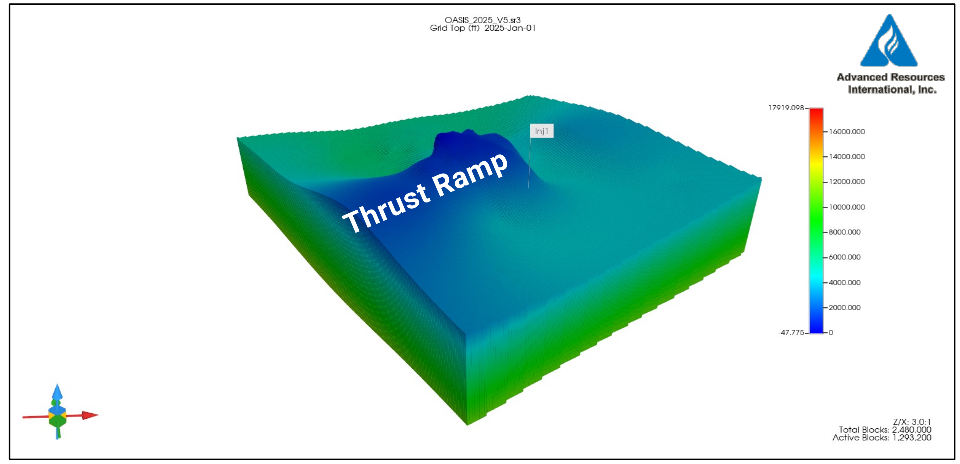




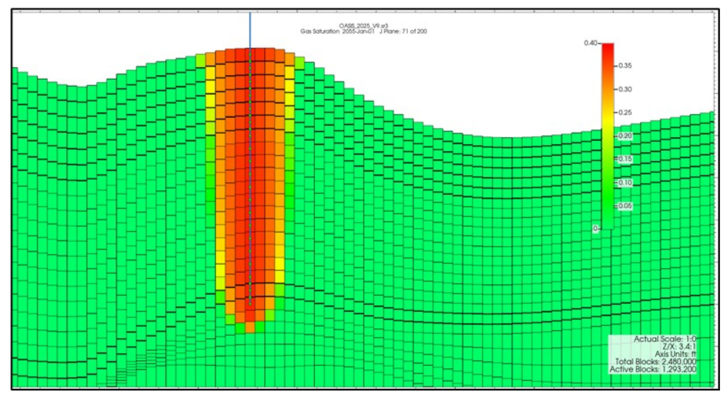
Transcending Boundaries

Task 4 – Geologic Data Analysis

- The reservoir model was constructed using the geologic input data supplied from 2D seismic surveys, well logs, and regional mapping across the study area.
- Using this data, the geologic model, including surface maps, was constructed.
- The 3D image in this slide and cross-sectional image in the following slide show the preliminary reservoir model.
- The modeled panel is 182 mi^2 including the thrust ramp structure(46.5 mi^2) illustrated in blue and labeled to the right.



Side View of CO2 Plume at End of Injection



Transcending Boundaries

Task 4 – Geologic Data Analysis

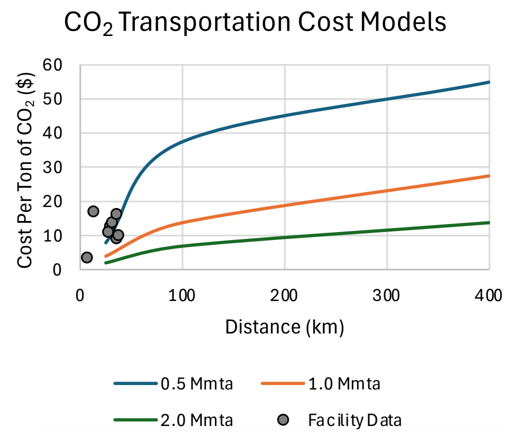
- The table to the right summarizes the result of sensitivity analysis – changing the injection scenario to explore how changing parameters affects injectivity.
- Overall, the Knox shows upside for low rate or multi-well projects, while the Rome shows high potential injectivity with limited data.

Numerical Modeling Results		
Injection Scenario	**Stabilized CO_2 Injection Rate per Year (million tonnes/year)**	**Wells to Reach 50 million tonnes of CO_2 over 30 Years***
Knox Fracture Zone	0.02	84
Knox Fracture Zone – Perforate Entire Knox Section	0.06	28
Rome Injection-(Theoretical)	1.33	2

*Note: Numbers based on stabilized injection rates

Task 5 - Infrastructure Assessment

- A total of 7,223,773 Mmta CO_2 is emitted within 25 miles of the Project OASIS location
- Injection and monitoring well requirements identified by ARI as part of dynamic simulations
  - AFEs were developed for accurate representation of capital costs
- Examined pipeline rights of way to identify least distance path to OASIS for regional emitters
- Established CarbonSAFE base case to determine cashflow and ROI



Cashflow Base Case Scenario

Cement and Limestone Industry	CO_2 Emissions	Latitude	Longitude	Distance to OASIS Site
ARGOS Cement LLC	1,054,894	33.104	-86.799	22
Carmeuse Lime & Stone Inc.	516,089	33.219	-86.786	18
Cheney Lime and Cement Company	493,165	33.223	-86.807	19
Mississippi Lime Co	462,637	33.094	-86.795	22
Lhoist North America - O'Neal Plant	600,146	33.177	-86.759	17
Lhoist North America - Montevallo Plant	974,682	33.093	-86.802	23
Power Generation	**CO_2 Emissions**	**Latitude**	**Longitude**	
E C Gaston	2,978,599	33.244	-86.457	4
Pulp and Paper	**CO_2 Emissions**	**Latitude**	**Longitude**	
Resolute Forest Product - Coosa Pines Operation	153,567	33.327	-86.358	8

Task 6 – CarbonSAFE Phase III Readiness

- **USWD**

  No USWD or water zone was identified at Westover #1 or #2. Regional water wells could be monitored as an alternative method.

- **Confining Zone**

  The Floyd-Parkwood Shale is thick and laterally extensive and could serve as a regional seal, however it is difficult to drill and increases well cost when drilled through.

  The upper Knox consist mainly of massive dolomite and could also serve as a confining zone

- **Characterized Injection Zone (Knox)**

  The Knox injection zone is approximately 3,700 ft thick, contains 2-5% porosity, 0.2-2mD permeability as well as fractures. Single well injectivity estimates are 60,000 tonnes/year near the Westover #2 site.

- **Theoretical Injection Zone (Deep Rome)**

  The deep Rome (below 14,000ft) theoretical injectivity estimates are based on Arco Anshutz #1 well logs and indicate a possible 2-10% porosity and 1-10 mD permeability. Single well injectivity if estimations are proven accurate would be 1,330,000 tonnes/year.

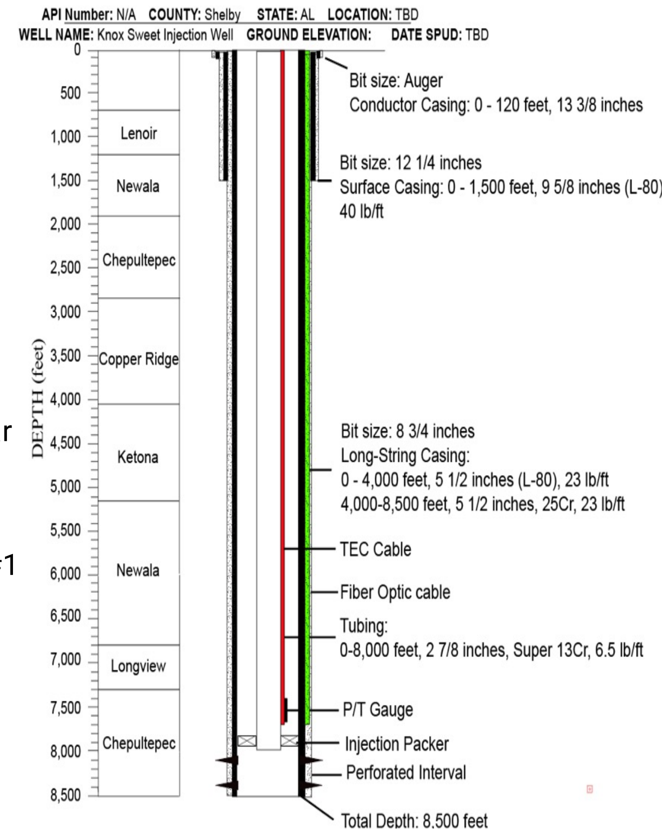
- **Well Cost**

  Knox Injector = $8.2MM

  Knox In-Zone Monitor = $7.9MM

  Deep Rome Injector = $17.68MM

  Deep Rome In-Zone Monitor = $13.1MM



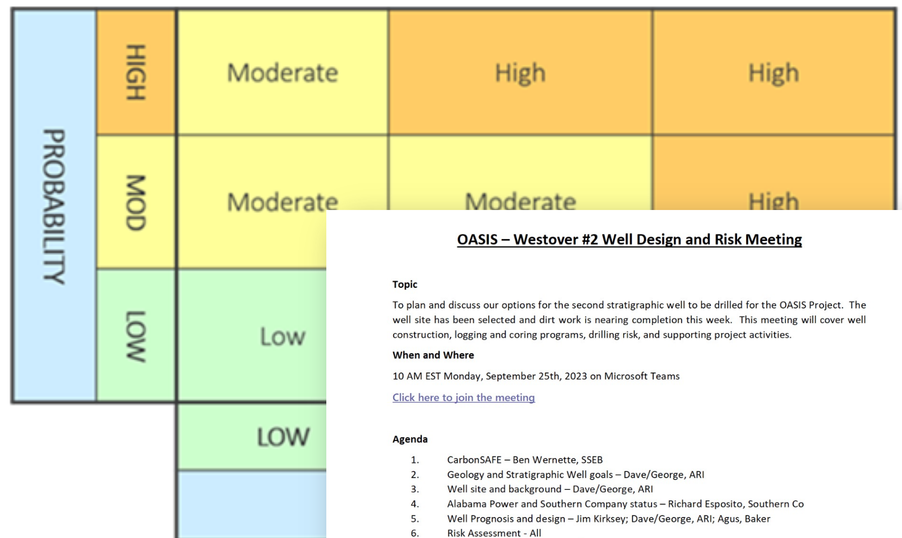
Knox Injection Well Diagram

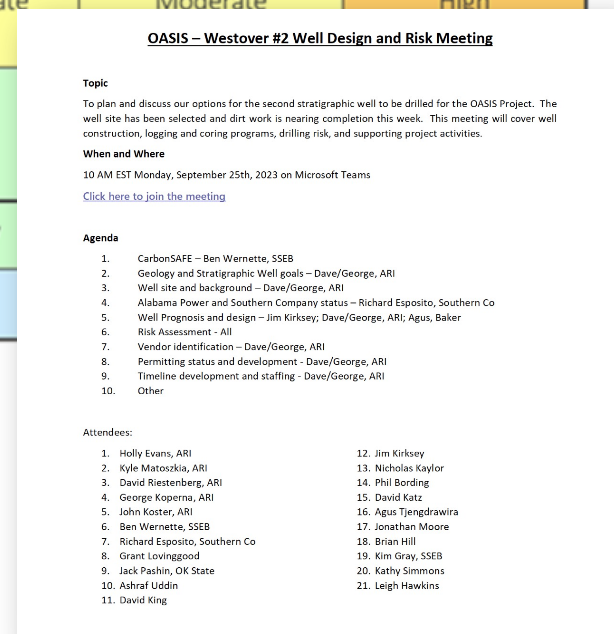
Transcending Boundaries

Task 7 – Risk Assessment

- Multi step process to address project risks, impact and mitigation strategies included
  - Initial risk assessment in PMP
  - Drilling risk workshop held on September 25, 2023, prior to drilling stratigraphic well
  - Project risk workshop held on April 29, 2025, to close out risks and identify additional risks that may impact future phases and/or commercialization efforts
- Team focused on the likelihood that a specific risk may happen and the potential impact to the project if that specific risk were to occur
  - The team identified potential mitigation strategies to reduce the likelihood of occurrence and/or reduce the potential impact if there was an occurrence

Semi-Quantitative Risk Assessment Matrix





OASIS – Westover #2 Well Design and Risk Meeting

Topic

To plan and discuss our options for the second stratigraphic well to be drilled for the OASIS Project. The well site has been selected and dirt work is nearing completion this week. This meeting will cover well construction, logging and coring programs, drilling risk, and supporting project activities.

When and Where

10 AM EST Monday, September 25th, 2023 on Microsoft Teams

Click here to join the meeting

Agenda

1. CarbonSAFE – Ben Wernette, SSEB
2. Geology and Stratigraphic Well goals – Dave/George, ARI
3. Well site and background – Dave/George, ARI
4. Alabama Power and Southern Company status – Richard Esposito, Southern Co
5. Well Prognosis and design – Jim Kirksey; Dave/George, ARI; Agus, Baker
6. Risk Assessment - All
7. Vendor identification – Dave/George, ARI
8. Permitting status and development - Dave/George, ARI
9. Timeline development and staffing - Dave/George, ARI
10. Other

Attendees:

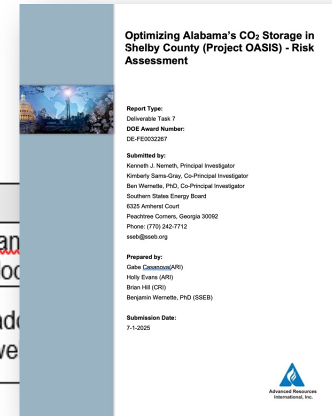
1. Holly Evans, ARI
2. Kyle Matoszkia, ARI
3. David Riestenberg, ARI
4. George Koperna, ARI
5. John Koster, ARI
6. Ben Wernette, SSEB
7. Richard Esposito, Southern Co
8. Grant Lovinggood
9. Jack Pashin, OK State
10. Ashraf Uddin
11. David King
12. Jim Kirksey
13. Nicholas Kaylor
14. Phil Bording
15. David Katz
16. Agus Tjengdrawira
17. Jonathan Moore
18. Brian Hill
19. Kim Gray, SSEB
20. Kathy Simmons
21. Leigh Hawkins

Task 7 – Risk Assessment

- Risk Assessment Workshop meeting held on April 29, 2025
- Semi-Quantitative Approach
- Formalized and closed out risks
  - Project Management
  - Drilling
  - Future Phases of Development
  - 102 risks were identified with mitigation strategies

Geologic Risk:				
Confining unit does not provide adequate seal	Medium	High	High	Update geomechan characterization, loc
Fracture pressure lower than expected reducing maximum injection pressure and injection rate	Medium	High	High	Stress testing in ad characterization we
Insufficient lateral continuity (or spatial distribution) of the reservoir properties, limiting overall storage capacity	High	High	High	Exploration program, multiple wells drilled throughout the region
USDW deeper than expected causing redesign of project	Medium	High	High	Site characterization, logging data and fluid sampling data to determine salinity
New or Existing Wellbore Risk:				
CO_2 leaks through a fault or fracture impacting a USDW or reaching the atmosphere	Medium	High	High	Determine maximum injection pressure based on stress state modeling. Collect seismic data. Monitoring.
Operations - Capture/Transport Risk:				
Public opposition to pipeline construction	High	High	High	Early Outreach and education
Legal and Logistical Risk:				
Class VI Permit takes longer to acquire than expected	High	High	High	early submittal, respond to RAIs quickly
Site Host or other major partner pulls out of Project	Medium	High	High	Diversify project partner portfolio, alternative funding sources

High Risk Categories Identified During the April 29 Workshop


Optimizing Alabama's CO_2 Storage in Shelby County (Project OASIS) - Risk Assessment

Report Type:
Deliverable Task 7
DOE Award Number:
DE-FE0032267

Submitted by:
Kenneth J. Nemeth, Principal Investigator
Kimberly Sams-Gray, Co-Principal Investigator
Ben Wernette, PhD, Co-Principal Investigator
Southern States Energy Board
6325 Amherst Court
Peachtree Corners, Georgia 30092
Phone: (770) 242-7712
sseb@sseb.org

Prepared by:
Gabe Casanova(ARI)
Holly Evans (ARI)
Brian Hill (CRI)
Benjamin Wernette, PhD (SSEB)

Submission Date:
7-1-2025

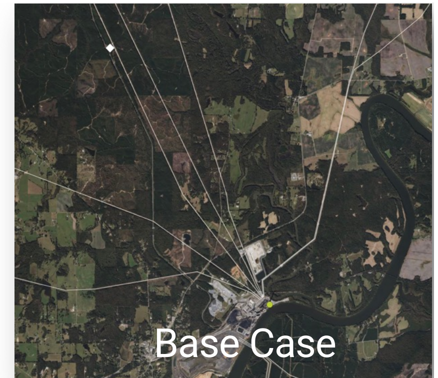
Advanced Resources International, Inc.

Task 8 – Commercialization

- Capital challenges for CarbonSAFE contextualized

Note that scenario improves if Rome injection scenario is realized (1.3 Mmta per annum per well) – Total Net Cashflow (30 yrs) is positive in Scenario 1

Note: the Rome is likely at depths > 14,000 ft and has not been sampled directly at the OASIS site



CarbonSAFE Development Costs and Assumptions

Parameter	Scenario 1	Scenario 2	Assumption
Capture Island CAPEX, $M	845.00	1,322.00	Scenario 1 is a 650 MW NGCC retrofit[1]; Scenario 2 is a 557 MW NGCC retrofit[2]
Pipeline CAPEX, $M	7.50	7.50	4-mile, 8-inch diameter[3]
Injection Wells CAPEX, $M	221.40	221.40	27 total wells at 0.06 Mmta[4]
Monitoring Wells CAPEX, $M	110.60	110.60	14 total wells[4]
Total CAPEX, $M	1,184.50	1,661.50	
Total O&M (over 30 yrs), $M	236.9	332.3	20% of total capital
Annual CO_2 injection	1.6 Mmta	1.6 Mmta	Held constant for simplification
45Q Credit	$85/t	$85/t	IRS Section 45Q Tax Credit for saline storage, 12-year window
Project Life	30 yrs	30 yrs	

[1]OCED Porfolio Insights: Carbon Capture in the Power Sector: https://www.energy.gov/sites/default/files/2024-04/OCED_Portfolio_Insights_CC_part_i_FINAL.pdf; used for the low-end capture island capital estimate

[2]Stoles, J., 2024, Retrofittable Advanced Combined Cycle Integration for Flexible Decarbonized Generation (557 MW NCCC retrofit); used for the high-end capture island capital estimate

[3]National Energy Technology Laboratory, FECM/NETL CO_2 Transport Cost Model (2023)

[4]OASIS AFEs developed by ARI

Note that in-field pipe is not included in this scenario

Net Cashflow Model

Metric	Scenario 1	Scenario 2
CAPEX, $M	1,184.50	1,661.50
OPEX (30 yrs total), $M	236.9	332.3
Annual OPEX, $M	7.9	11.08
Annual Debt Payment (5%, 12 yrs)[1], $M	133.8	187.6
Total Debt Repayment (12 yrs), $M	1,606.00	2,251.10
Annual Net Cashflow (Years 1 – 12)[2], $M	–5.73	–62.67
Annual Net Cashflow (Years 13 – 30)[3], $M	–7.90	–11.08
Total Net Cashflow (30 yrs), $M	–211.0	–951.5

[1]Assumes 100% debt financing of CAPEX at 5% APR

[2]Annual net cashflow = IRS Section 45Q revenue - OPEX - debt service; debt is fully paid in 12 years

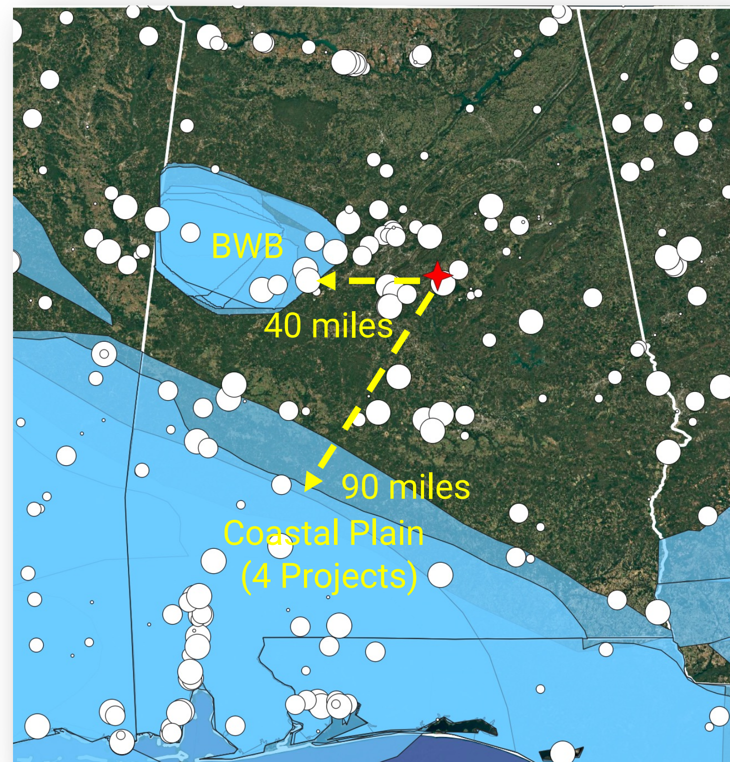
[3]Annual net cashflow for Years 13 through 30 represents OPEX only

Note that discount rates and PISC are not included in these calculations

Transcending Boundaries

Task 8 – Commercialization (continued)

- Strong regional appetite to understand local CO_2 storage opportunities
- Challenges include regulatory challenges and capital requirements
  - Highly fractured reservoir, depth of USDW difficult to ascertain
  - OASIS results suggest capture island capital requirements and injectivity drive economics
  - In the absence of suitable geology, low cost to capture facilities *may* work
  - **Nth-of-a-kind improvements to capture technologies and an understanding of the Rome Formation may improve viability**
- As part of SECARB-USA, ARI is evaluating utilization (EOR, EGR) and storage opportunities in the nearby Black Warrior Basin



Map illustrating the location of OASIS (red star), regional emitters (white), and distance to known saline storage opportunities of the Black Warrior Basin (BWB) and the Coastal Plain

Conclusions

Responded to demand for a better understanding of CO_2 storage potential in the Valley and Ridge Province of Alabama

Successful and safe field program that resulted in materials that can be shared with other projects exploring similar terrain

Supported over 20 paid internships at AAMU, two graduate students at Auburn University, and one graduate student at Oklahoma State University

Collaborative Task 3.0 that generated an abundance of data at both the micro and macro scale, responding to data need for the area

Generated a robust risk evaluation for current and future phases of development

Reservoir modelling reveals the extensive infrastructure needed to achieve CarbonSAFE objectives (28 wells in some scenarios!); cashflow models suggest a project that is currently uneconomic

N^{th} of kind improvements to capture technologies and an understanding of the Rome Formation may improve viability

Thanks!

Contact

Ben Wernette, PhD

Principal Scientist and Strategic Partnerships Lead

Southern States Energy Board

Wernette@sseb.org

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The Project OASIS team is acknowledged for their contributions to this presentation. Southern Company is recognized for their support throughout the execution of this initiative. Westervelt is thanked for their willingness to support this project as site host. Insightful discussions with OASIS Federal Project Manager Johnathan Moore enhanced both the content of this presentation and the overall direction of OASIS. The U.S. Department of Energy is also recognized for their financial support of OASIS through award number DE-FE0032267.

Transcending Boundaries