Project OASIS (DE-FE0032267)

Optimizing Alabama's CO_2 Storage in Shelby County

Presented at:
2024 FECM/NETL Carbon Management Research Project Review Meeting
Carbon Transport and Storage Breakout Session 3: CarbonSAFE PHII (Southeast)
5-9 August 2024, Pittsburgh, PA

Presented by:
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on behalf of the Project OASIS Team

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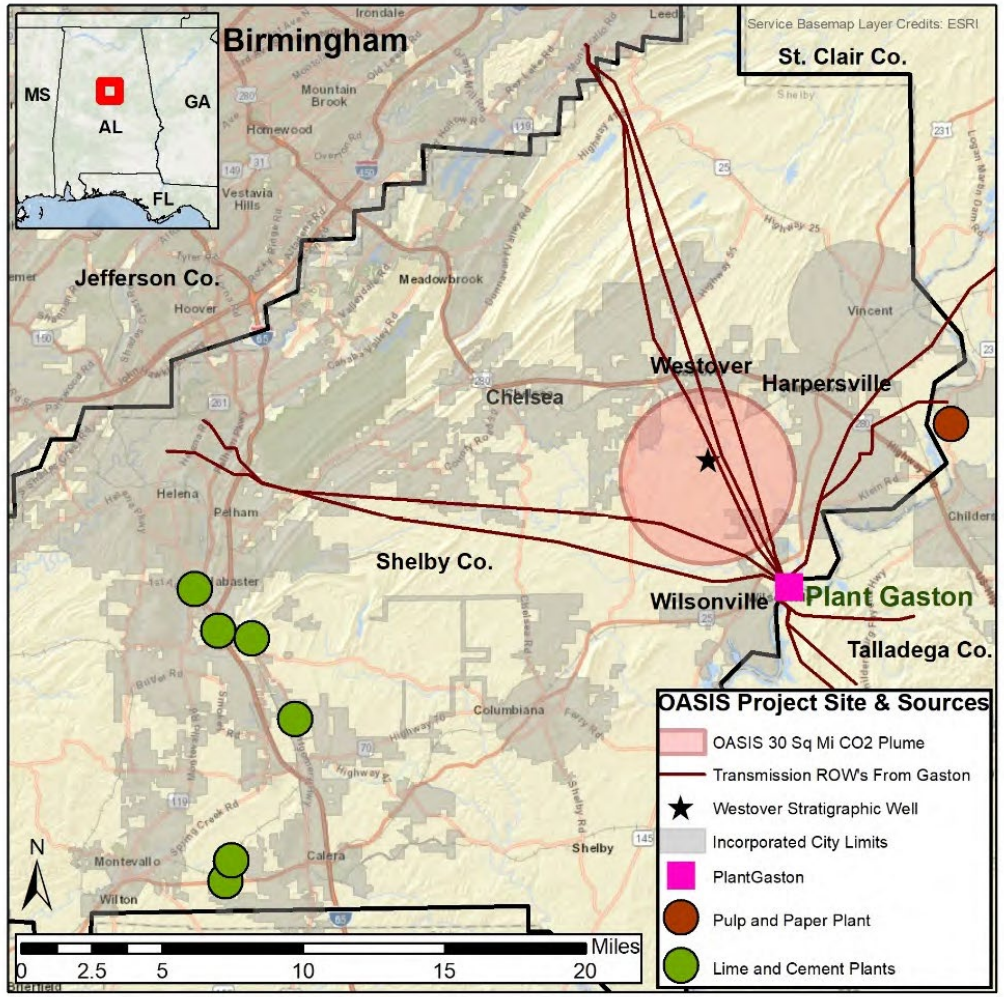
Location

- The proposed storage complex site is located 30 miles southeast of Birmingham, Alabama
- The complex could 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 site could also serve as a central CO_2 storage hub for seven large cement plants and a major pulp and paper plant located in the area



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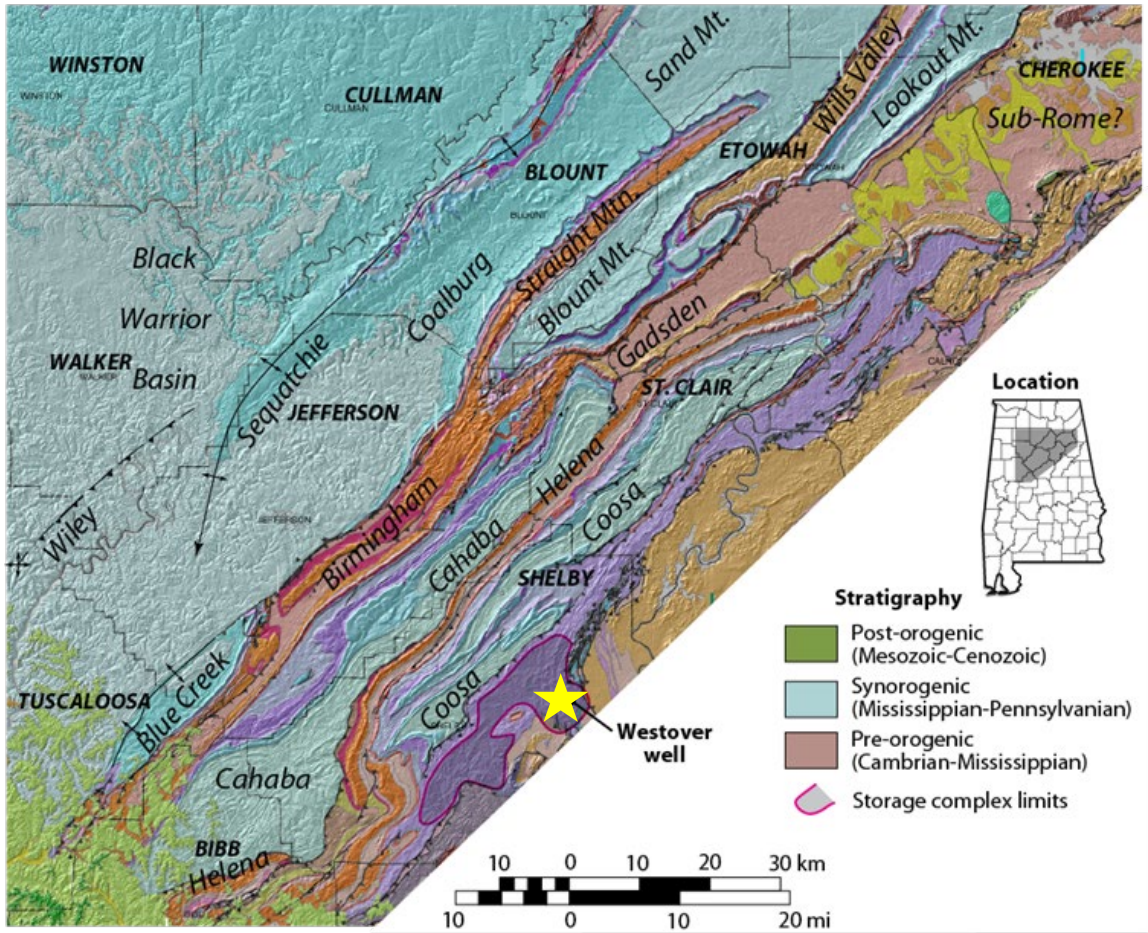
This Site is Geologically Complicated

- Located in the Alabama fold and thrust belt
- Relatively flat lying structural panels between thrust faults may serve as non-conventional storage complexes
- Cambro-Ordovician carbonates and Cambrian clastic units offer multiple potential storage intervals
- Shales, including the tectonically thickened Floyd-Parkwood, provide containment



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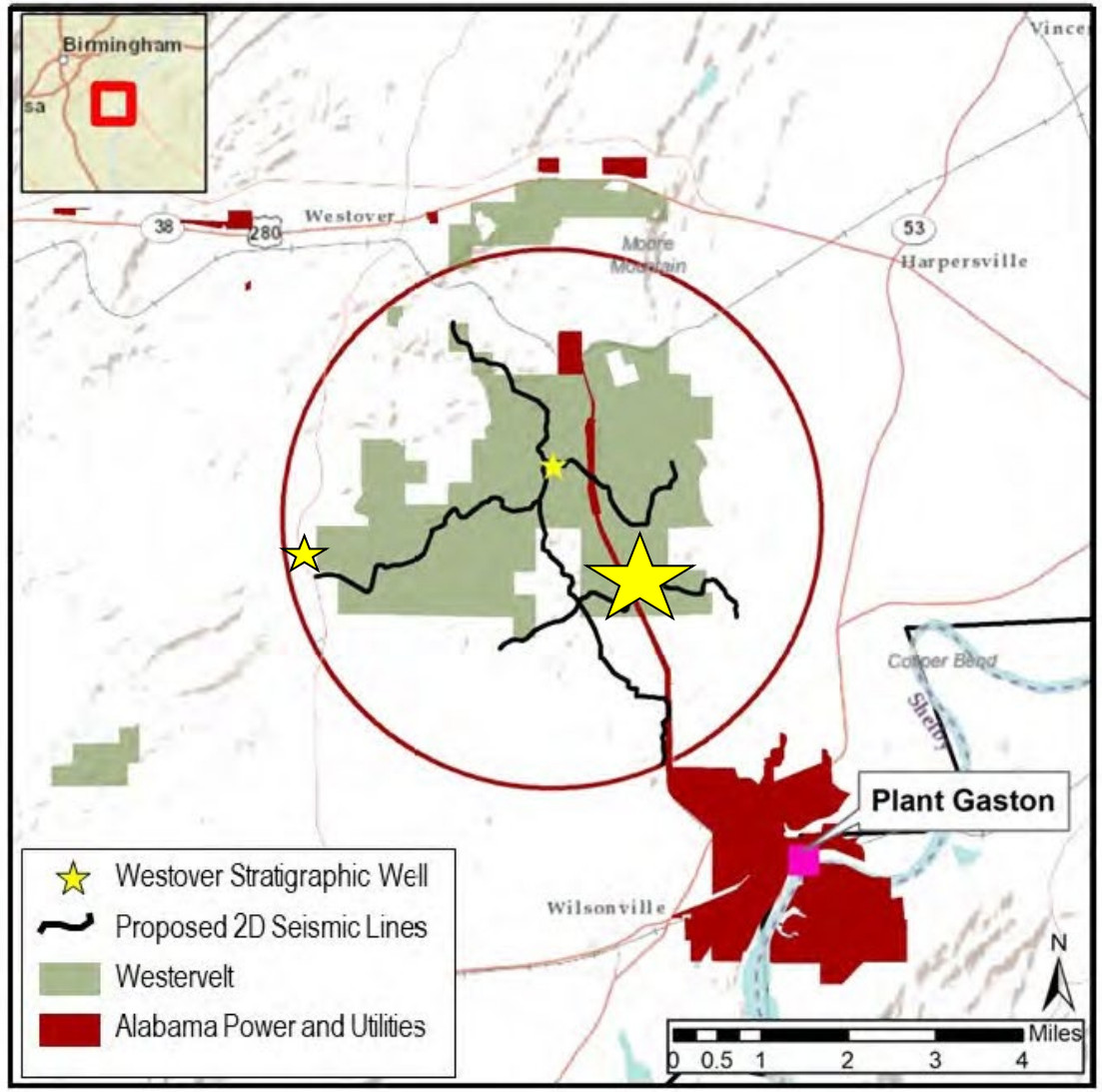
Knowledge-Base

- Vintage (1984) deep well with SP/RES/DEN logs as well as core/cuttings.
- In early 2022, a wildcat stratigraphic test was drilled to characterize storage.
  - Based on regional structural trends, the Cambrian-Ordivician (OCk) storage formations were thought to occur at 5,000-6,000 ft and overlain by the Floyd Shale/Parkwood MUSHWAD.
  - Directional drilling was used to maintain verticality, but a 6,500 ft test did not reach the storage interval.
- In November (2022), a multi-2D seismic survey was collected across the area of interest to better site the new test well.



MUSHWAD: Malleable Unctuous SHale, Weak-layer Accretion in a Ductile complex

Project Objectives

- Site specific characterization of a CO_2 storage complex via 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, and
- A robust Community and Stakeholder engagement plan.

Roles and Responsibilities

SSEB
- Project Management
- Community Benefits
- Risk

ARI
- Field Program
- Class VI Readiness
- Community Benefits

AL A&MU
- Community Benefits
- Workforce Development

AU
- Subsurface data evaluation

CRI
- Risk
- Infrastructure
- Commercial Plans

OSU
- Subsurface data evaluation

SOUTHERN CO
- Technical Assistance
- Industry Lead

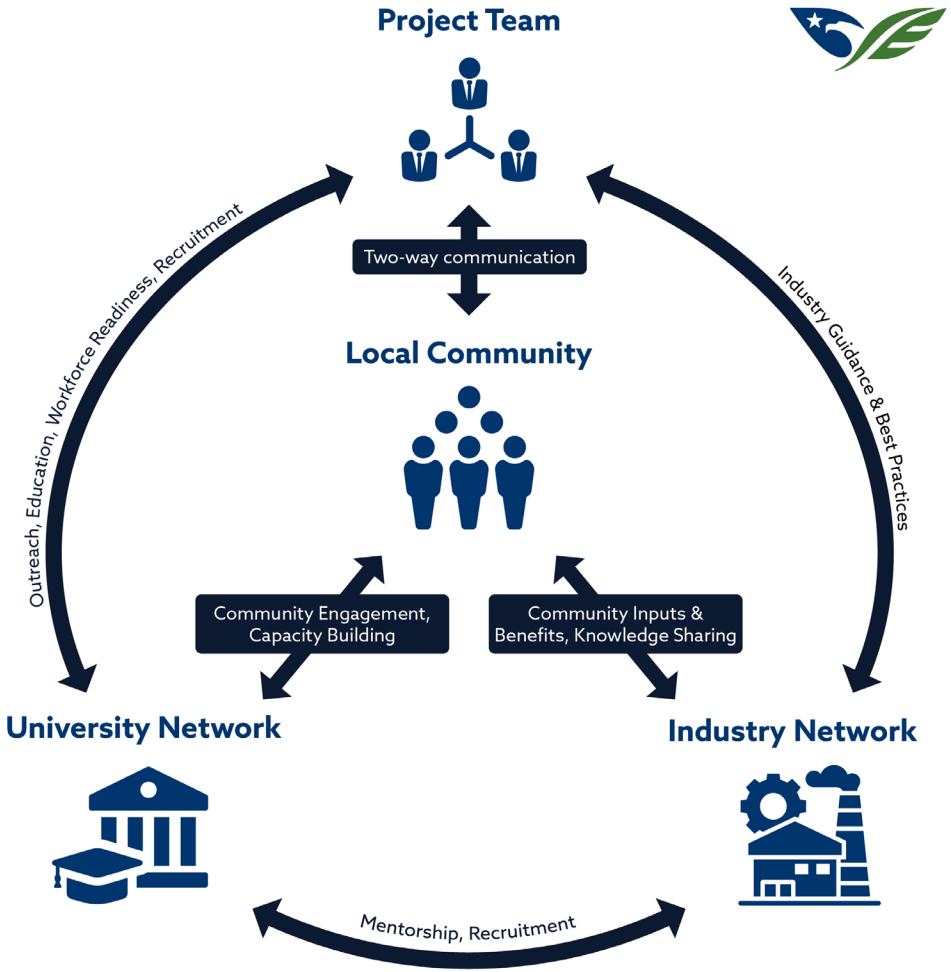
WESTERVELT
- Site Host

Tasks and Deliverables

Task 1 – Project Management and Planning	**Deliverable 1**-Project Management Plan ✓
Task 2 – Community Benefits Plan	
Task 3 – Site Specific Characterization/ Assessment of CO_2 Storage Complex	**Deliverable 2**-Stratigraphic Test Well Drilling Report ✓
Task 4 – Geologic Data Analysis	**Deliverable 3**-Geologic Report, Core Analysis, Refined Geologic and Reservoir Model
Task 5 – Infrastructure Assessment	**Deliverable 4**-Infrastructure Assessment Report
Task 6 – CarbonSAFE Phase III Readiness	**Deliverable 5**-CarbonSAFE Phase III Readiness Report
Task 7– Risk Assessment	**Deliverable 6**-Social and Environmental Risk Assessment Report
Task 8 – Commercialization Plan	**Deliverable 7**-Commercialization Plan

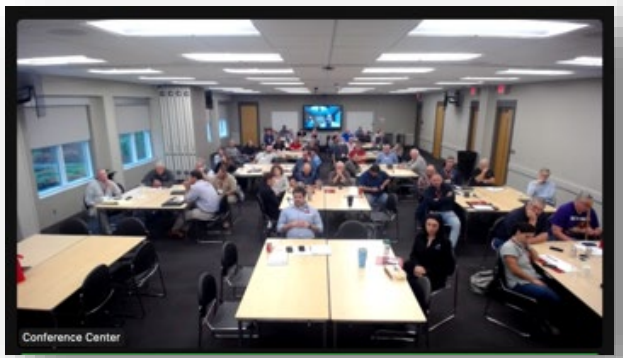
Task 2 – Community Benefits Plan

- 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



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
  - Included well site visit
- April 19, 2024, open house with students from Alabama A&M at NCCC
- Critical activity for educating stakeholders and establishing next generation workforce



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

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

Investing in Job Quality and A Skilled Workforce

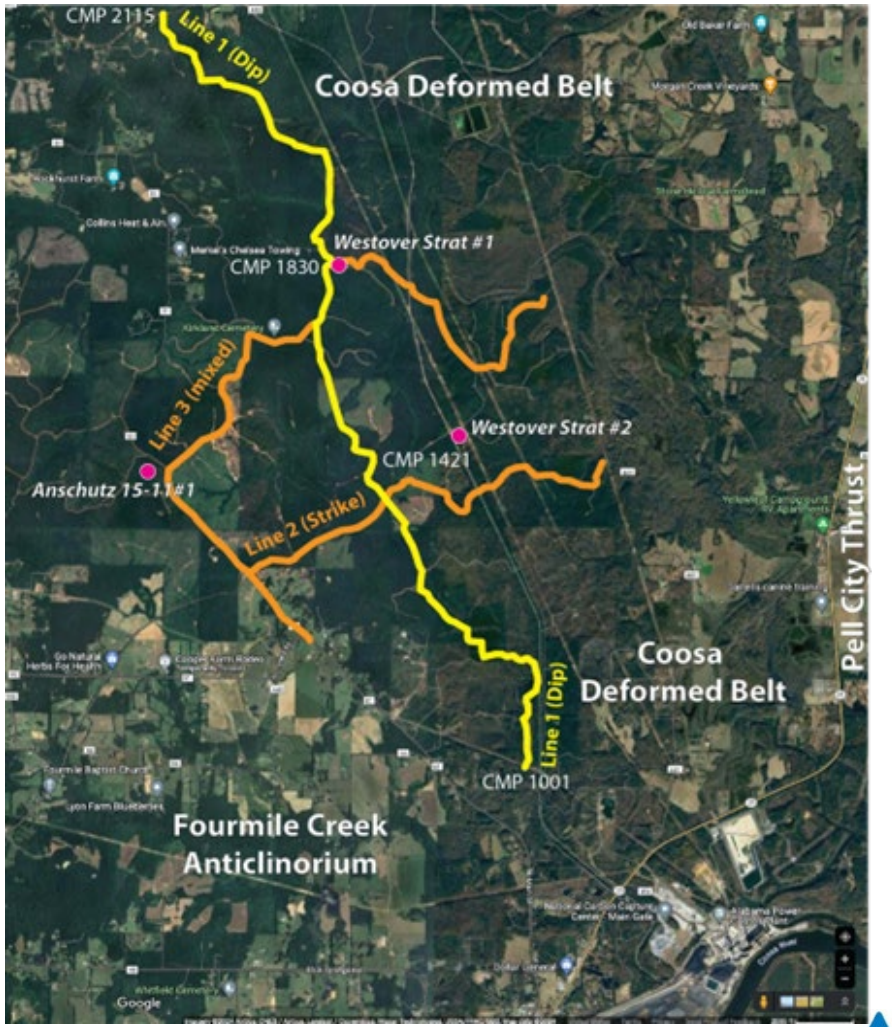
- Building capacities in subsurface image processing and working with industry standard software
  - Partnering with Baker Hughes and Alabama A&M University to train students in utilizing software
  - Student outcomes to be reported
- Alabama A&M has created 10 paid internships focusing on small geophysics 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.

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

Drilling Lessons Learned from Westover #1

- Location, Location, Location
  - Selected a new site based on 2D seismic stratigraphy. Minimized the thickness of Floyd-Parkwood Shale - "MUSHWAD" to drill through
  - Repeat section (double the "pay", double the chert)
- 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



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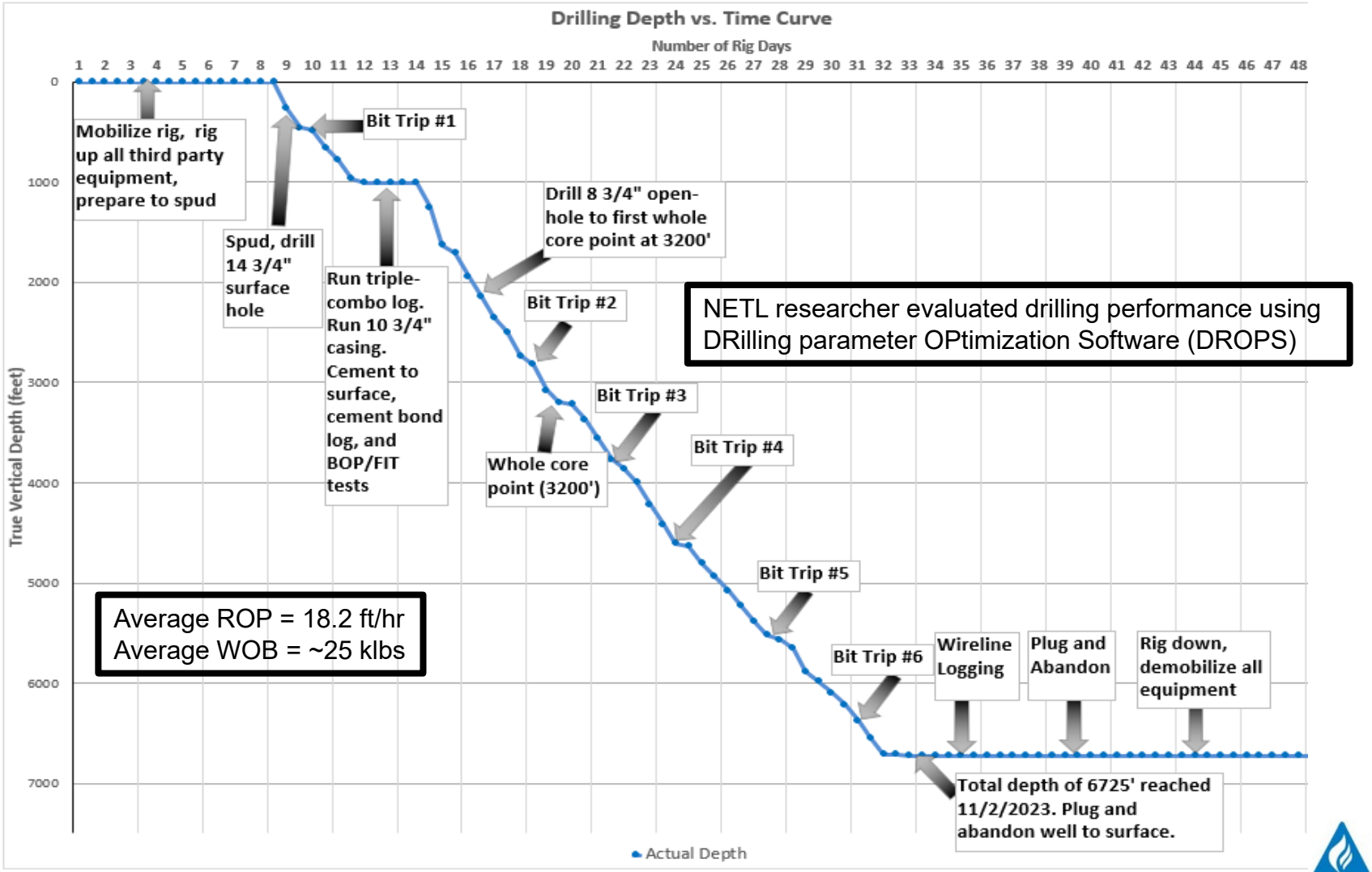
Drilling Westover #2

- 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 avg ROP precluded depth target (~10,000ft)
- Repeat section helped us see "all" the intervals



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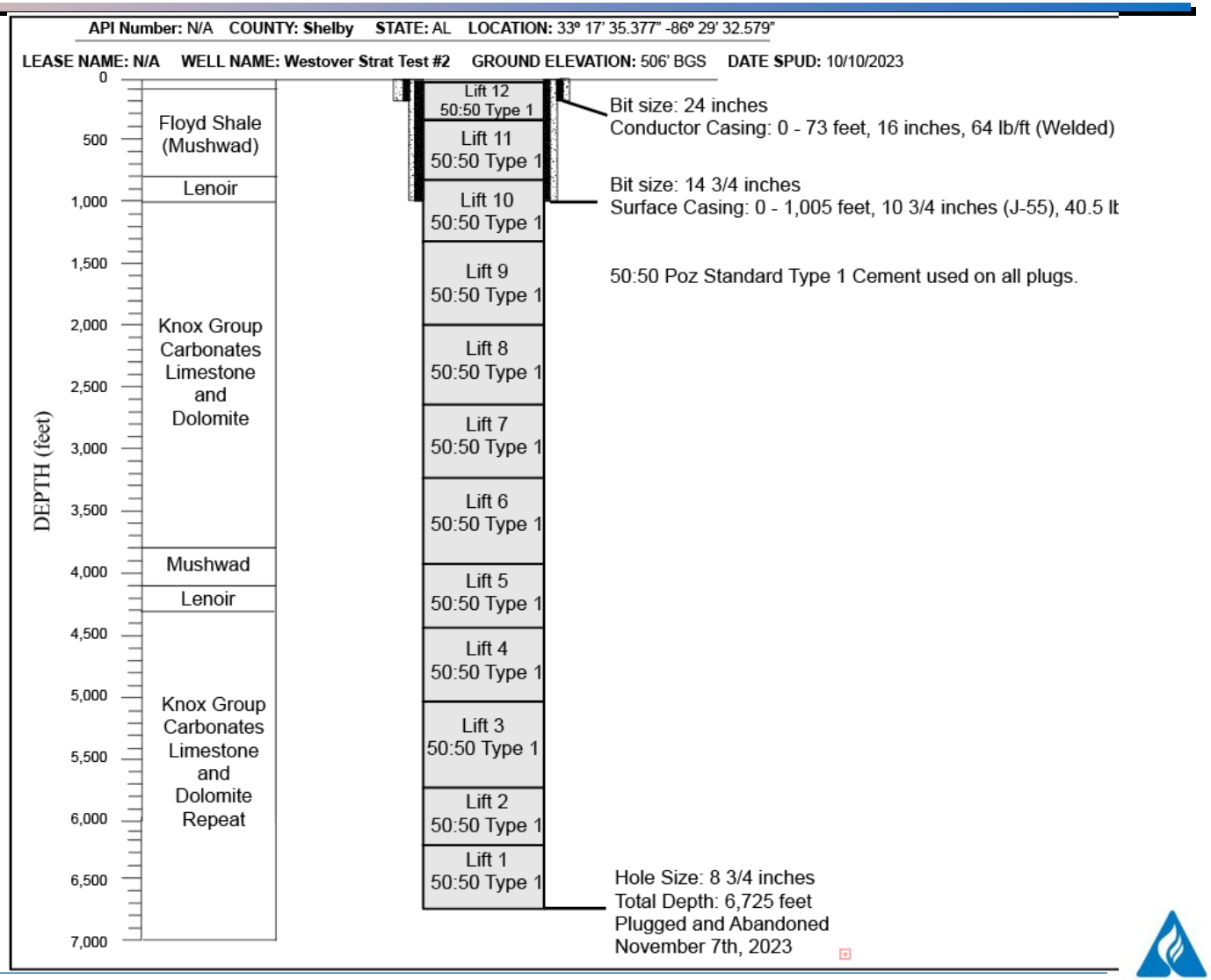
Plugging and Abandonment

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



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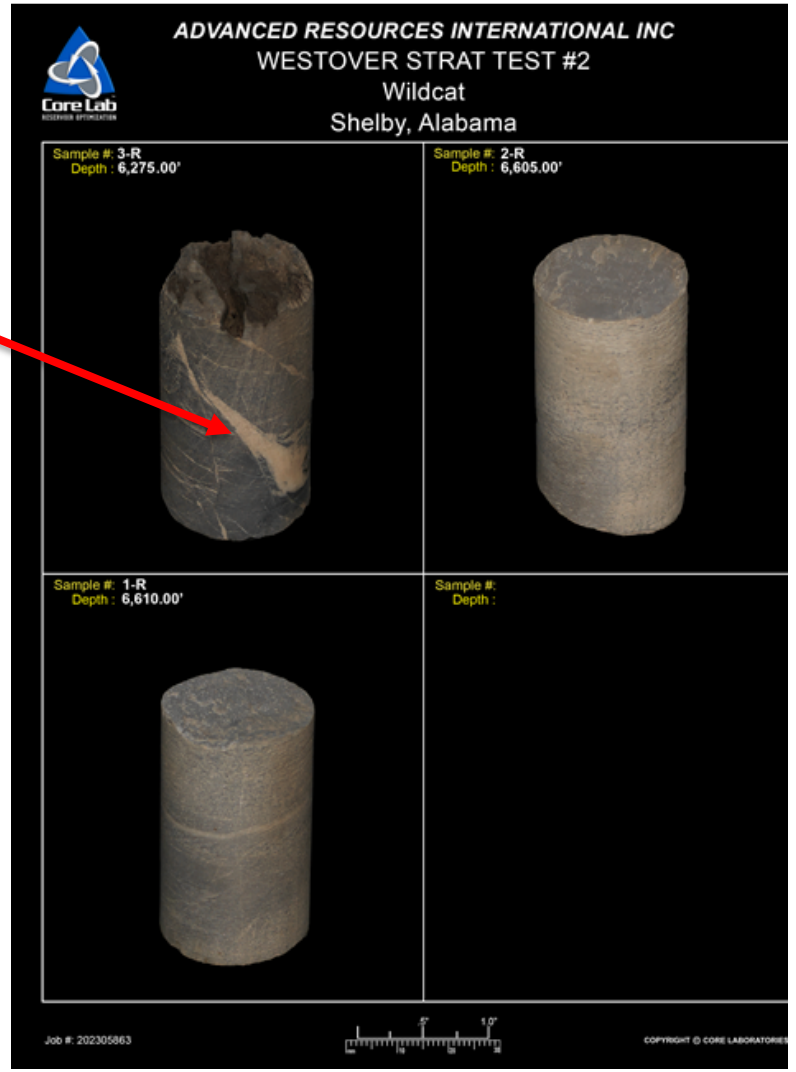
Task 4 – Geologic Data Analysis

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



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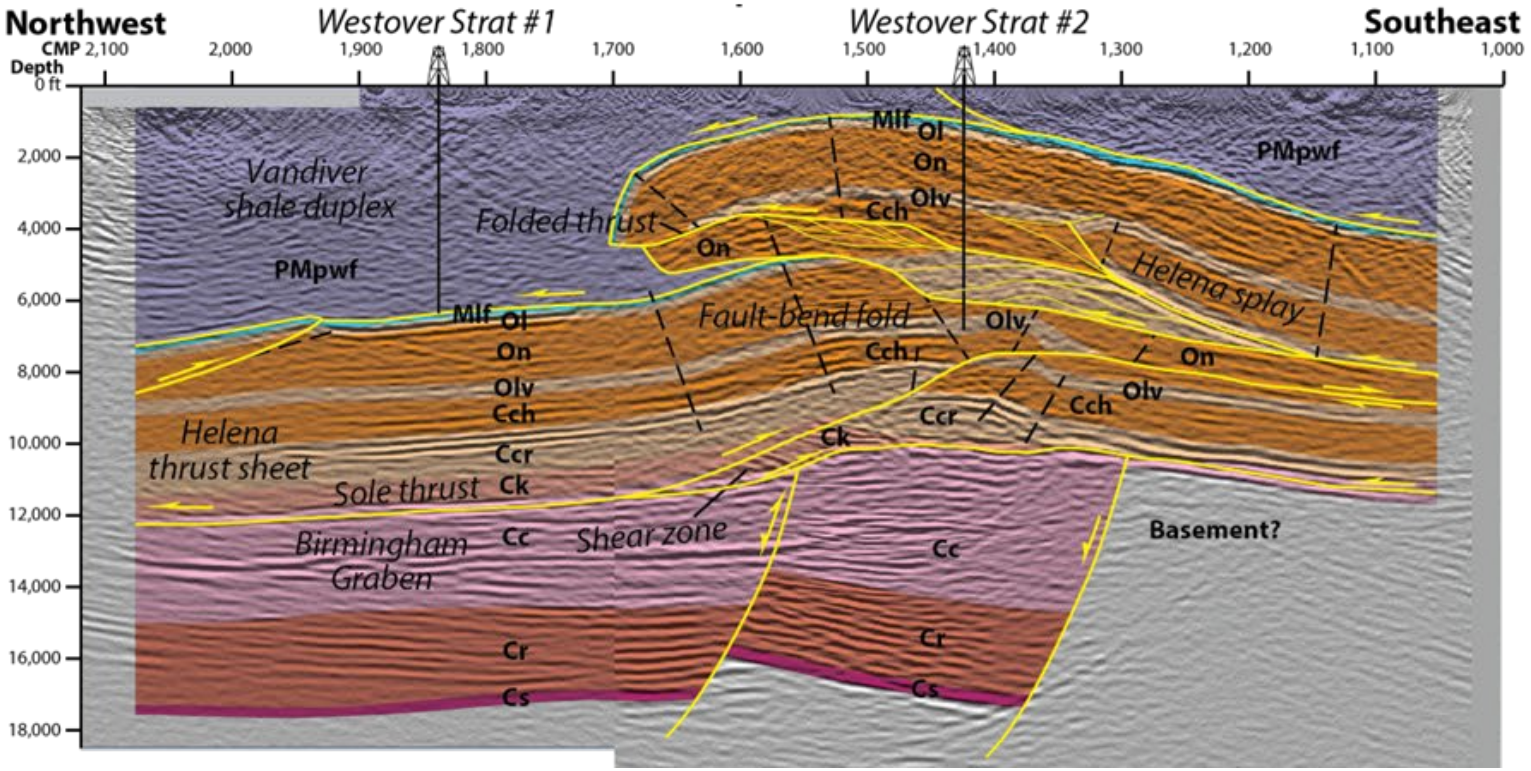
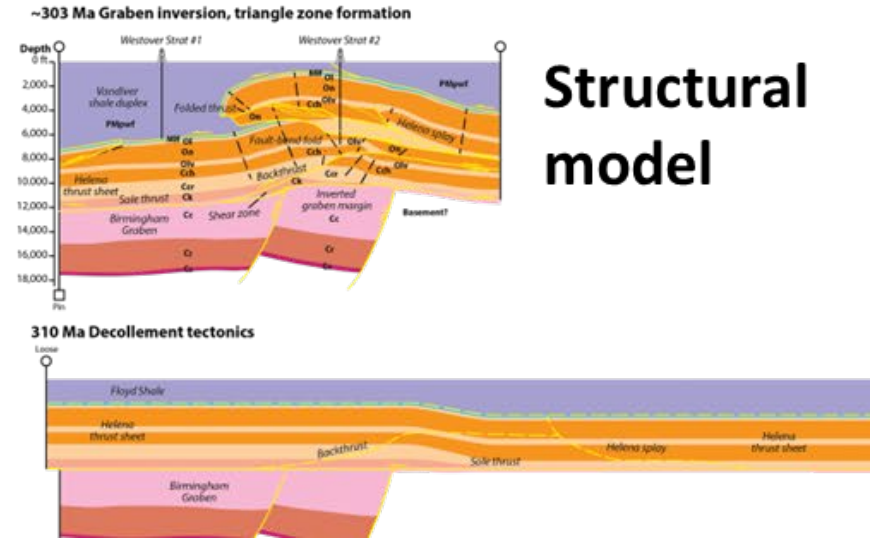
Oklahoma State University

Seismic profile



Look for a poster covering this ongoing work later today



Structural model

Structural restoration of the Westover thrust fault ramp and fold architecture

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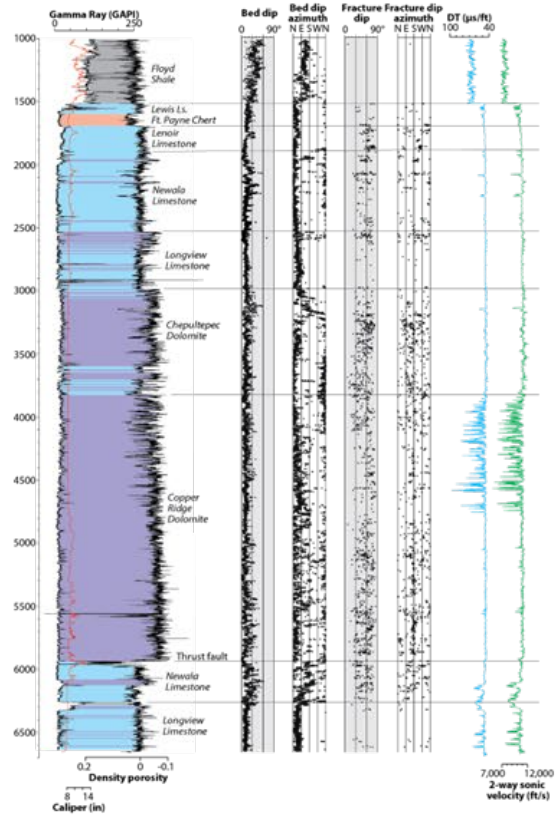
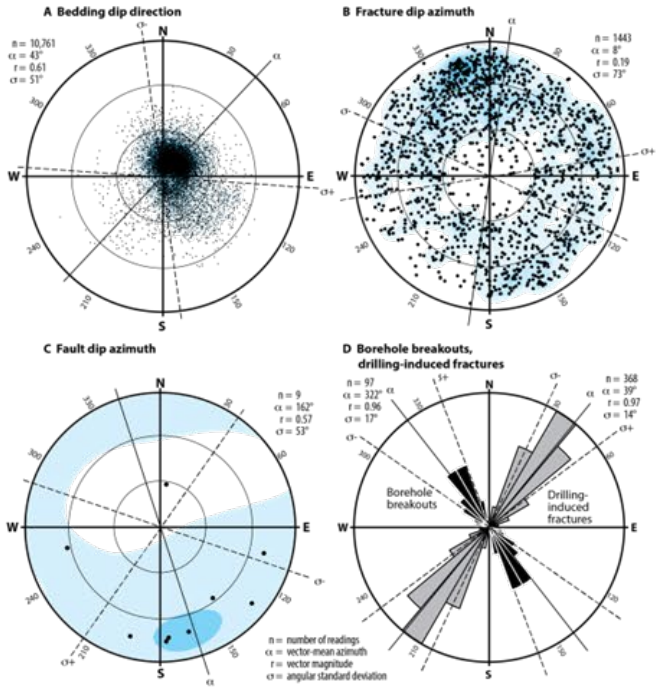
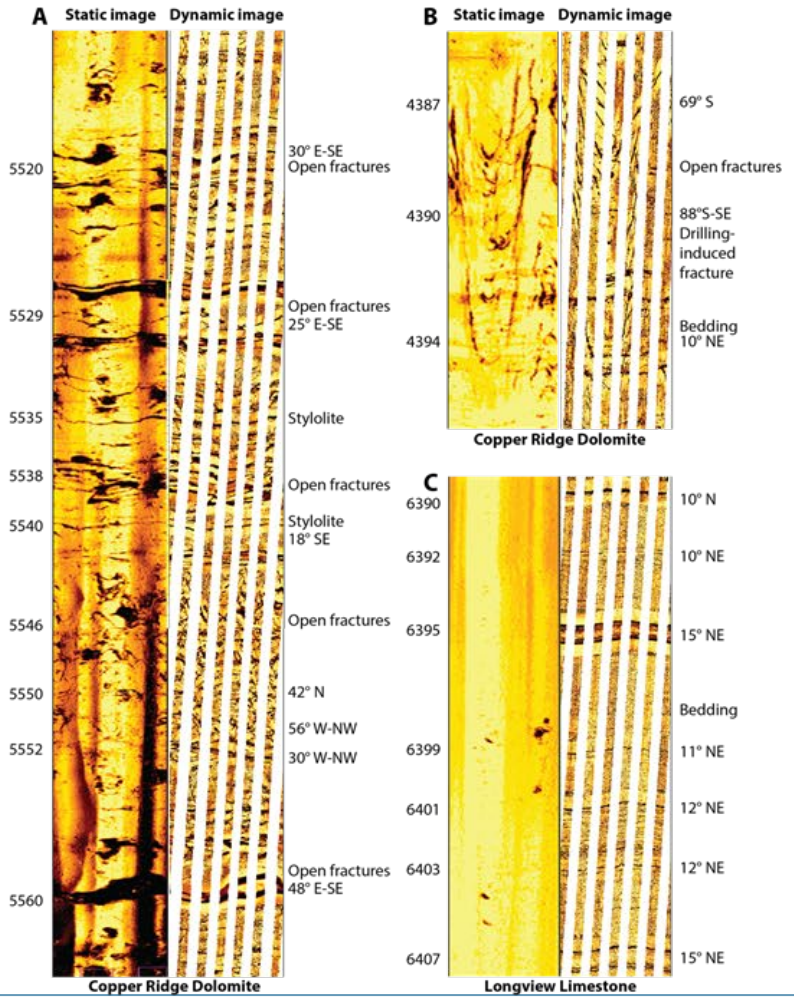
Geophysical logs



Structural analysis



FMI images



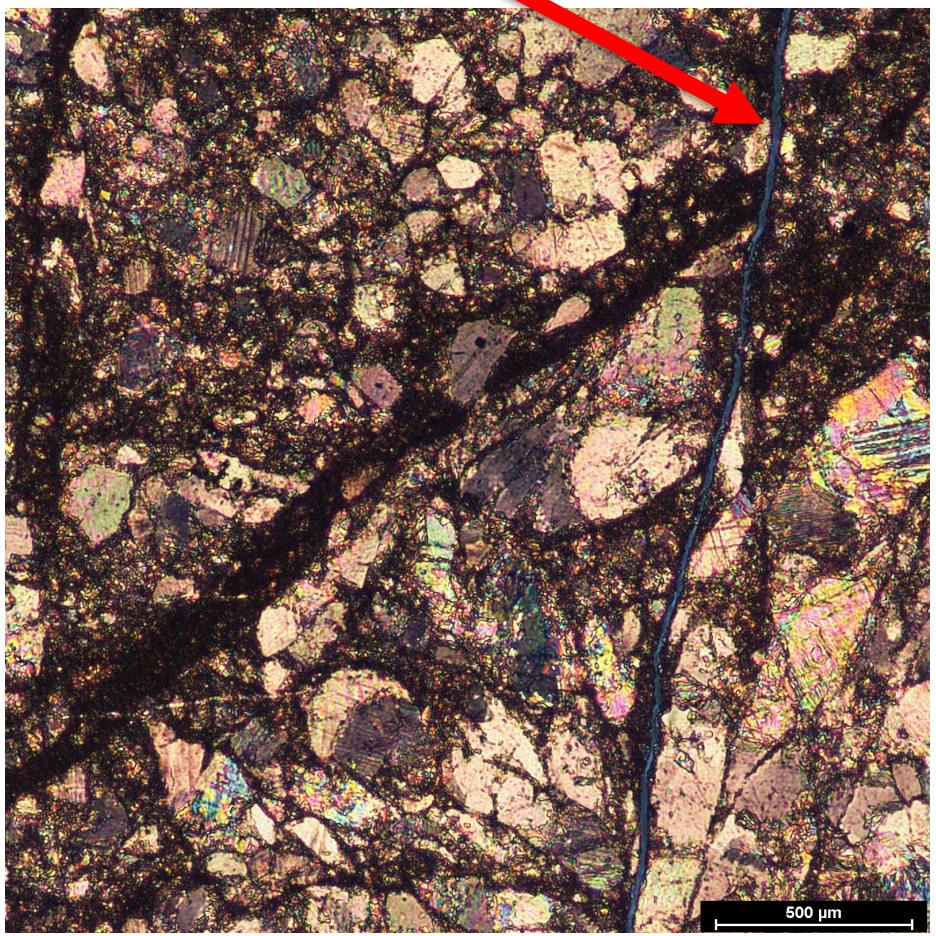
Dr. Jack Pashin – manuscript submitted to GSA Dr. Bill Thomas Memorial Session. *In Review*

Auburn University

Students: Bryce Hall & James Mayes; Advisors: Dr. David King Jr. & Dr. Ashraf Uddin

- **Updates:**
  - Received thin sections
  - Submission of abstracts to GSA
  - Initial petrographic analysis
- **Findings:**
  - Composition is largely consistent, featuring crystalline carbonate with high degree of fracturing
    - Fractures are mostly infilled with precipitate materials (carbonate & chert)
  - Carbonate mud makes up most of non-crystalline material
- **Upcoming:**
  - **<u>GSA poster presentations (September)</u>**
  - Methods to be done:
    - X-ray diffraction
    - Scanning Electron Microscope
    - Cathodoluminescence

Open Fracture Porosity

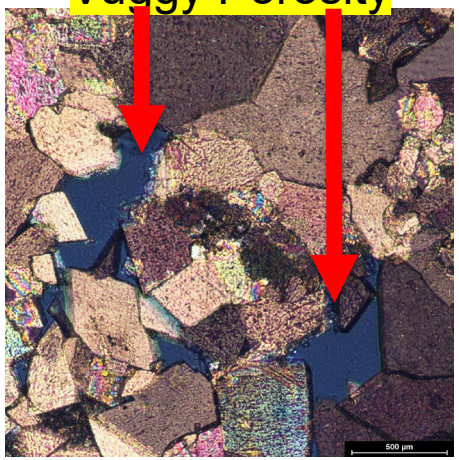


SWC 11-5,577ft (Knox Group)

Chert Vein Infill

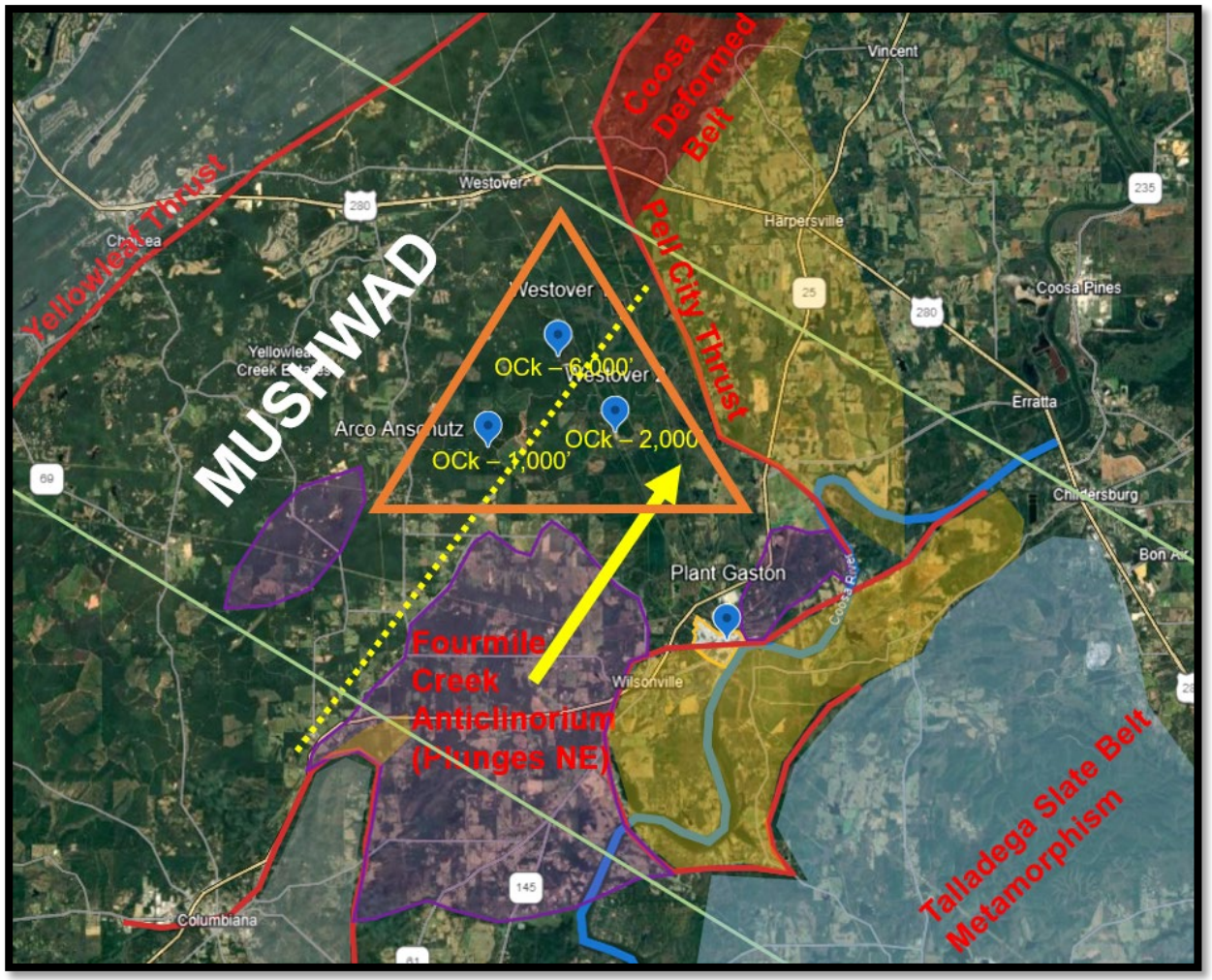
SWC 46-3,491ft (Knox Group)

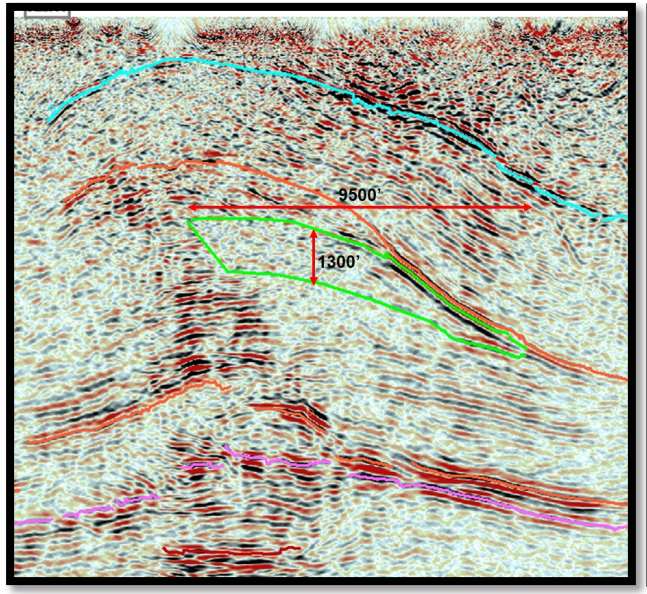
Vuggy Porosity

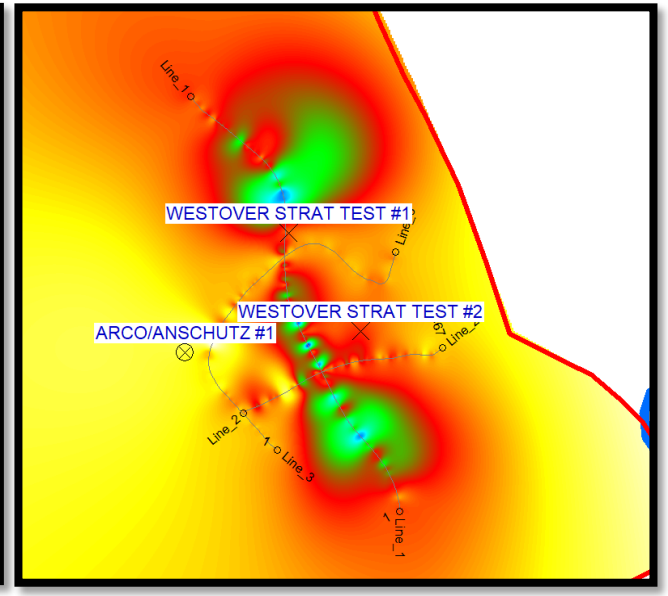


SWC 14-5,500ft (Knox Group)

Geologic Modelling







Based on the logs from Westover #2, the Copper Ridge member of the Knox Group is being modelled as a fractured reservoir for CCS. Seismic interpretation allows for extrapolation of the area (in progress – although initial results show strong sensitivity to max injection pressure).

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Next Steps for Project OASIS

- Finalize refinement of the reservoir injection potential,
- Refine assumptions around injectivity (partner with DOE?),
- Use the reservoir models to inform project commercial bounds and infrastructure scenarios,
- Integrate the results of this work into the project risk assessment, and
- Continue to work with University partners on student engagement and project activities.

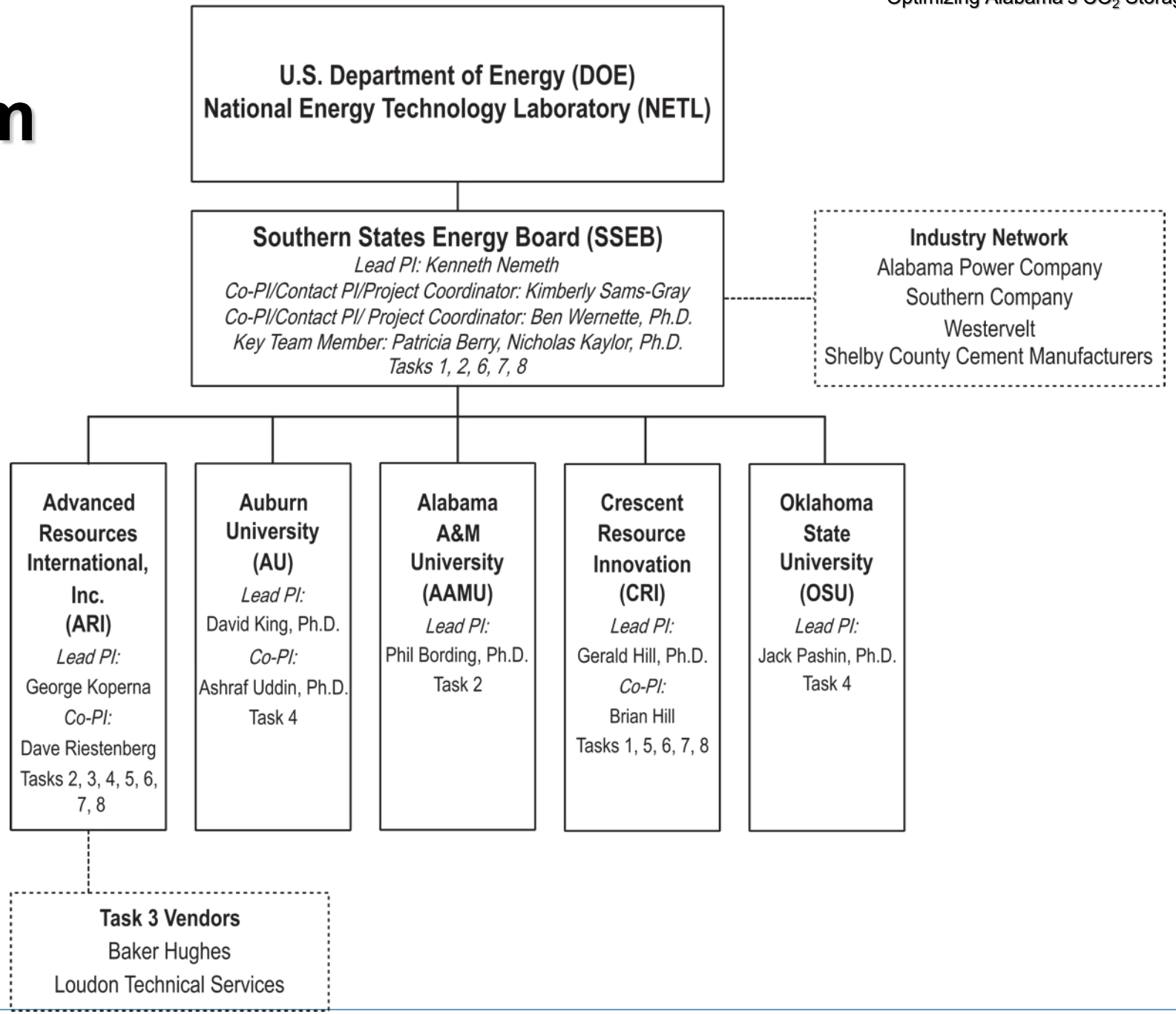
Photograph of the OASIS well site after reclamation and the well head fully plugged prior to burial

OASIS Team

FPM: Johnathan Moore

CS: Caitlin Lecker

CO: Susan Miltenberger



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