

Geologic Characterization of the South Georgia Rift Basin for Source Proximal CO₂ Storage

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University of South Carolina - Columbia



Carbon Storage Program Infrastructure Annual Review Meeting

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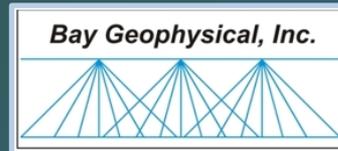
Research Team



John Shafer and Michael Waddell



James Knapp and Camelia Knapp



Lee Kurtzweil and Phil VanHollebeke



C.W. "Bill" Clendenin



Richard Berg

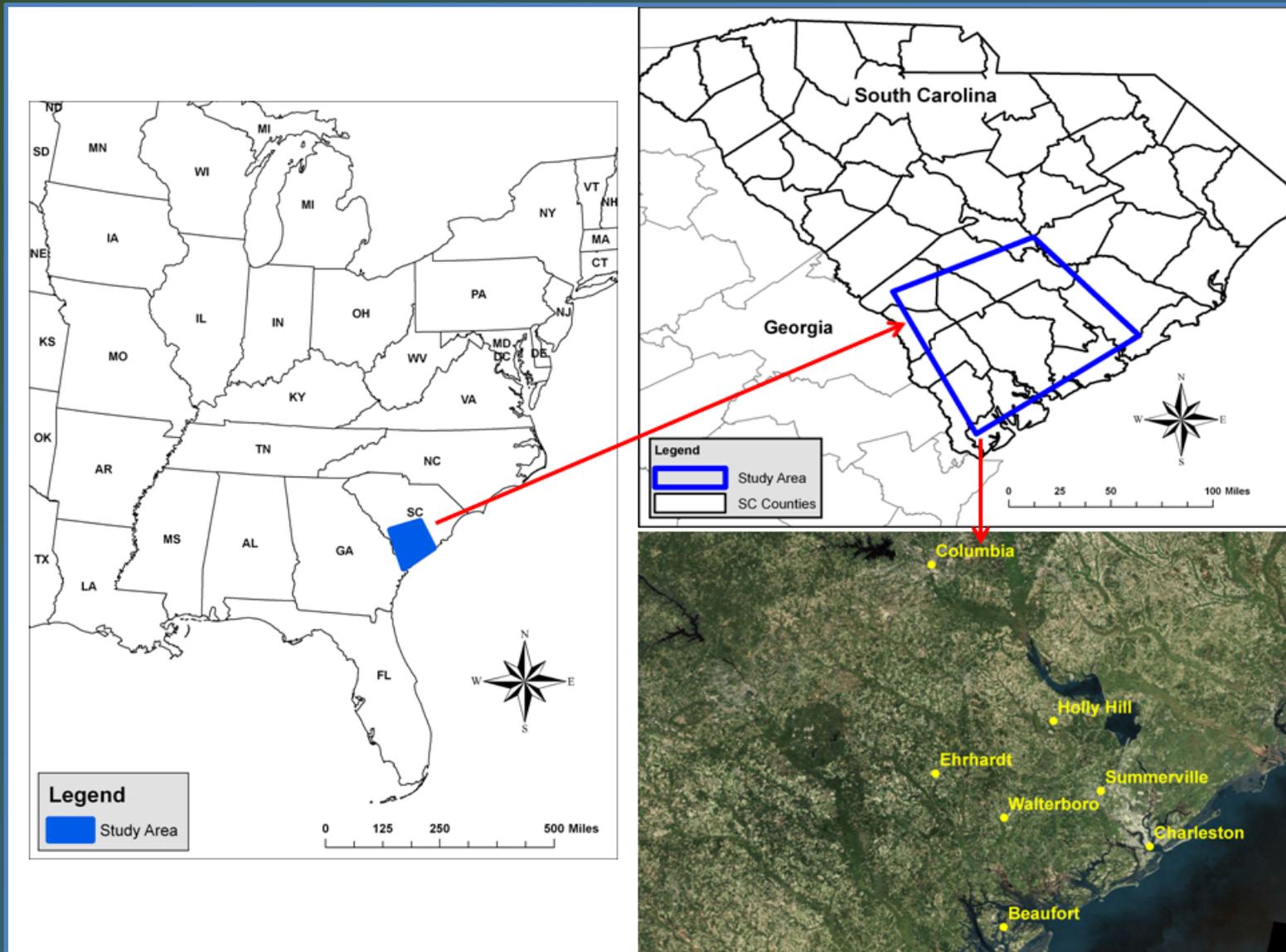


James Rine

Integrated Services Contract for Drilling/Coring/Logging – TBD

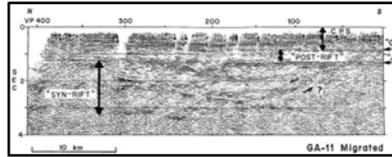


Study Area



Project Work Flow (Year 1)

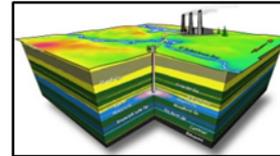
**Gather and Assess Existing
Geologic/Geophysical Data**



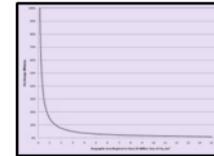
**Determine Structural Controls on
Mesozoic Reservoirs with Known Analogs**



**Identify Favorable Injection Zones
and Containment Effectiveness**



Estimate CO₂ Storage Capacity

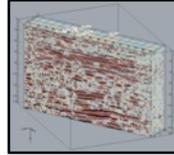


“Go/No Go” Decision

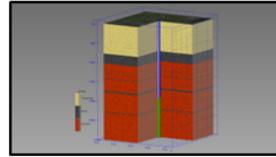


Project Work Flow (Year 2)

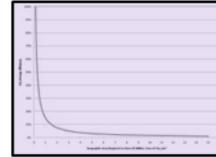
**Integrate New Seismic Data
with Phase 1 Existing Data**



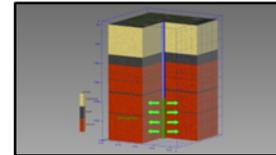
Refine Solid Earth Model



Update CO₂ Capacity Estimates



Simulate Injectivity into Formation



“Go/No Go” Decision



Project Work Flow (Year 3)

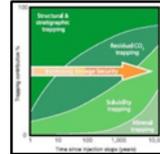
Drill/Log/Core Test Hole



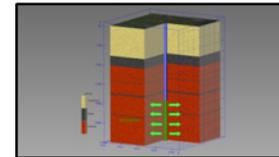
Assess Caprock and Storage Formation Properties and Brine Interaction



Evaluate Leakage Pathways



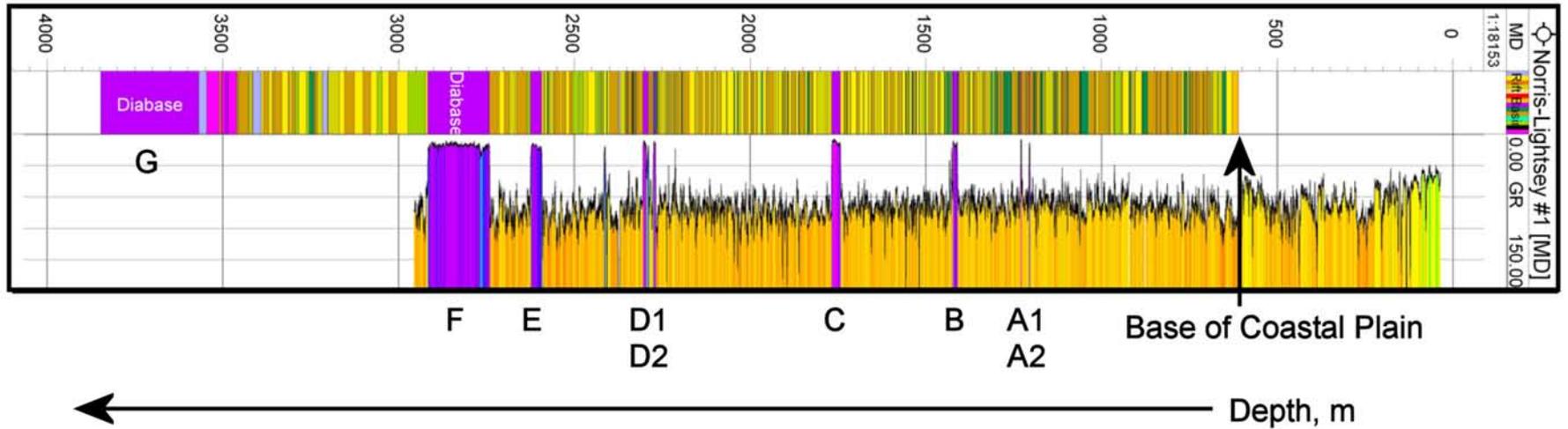
Finalize Conceptual Model of SGR and Simulate Injection



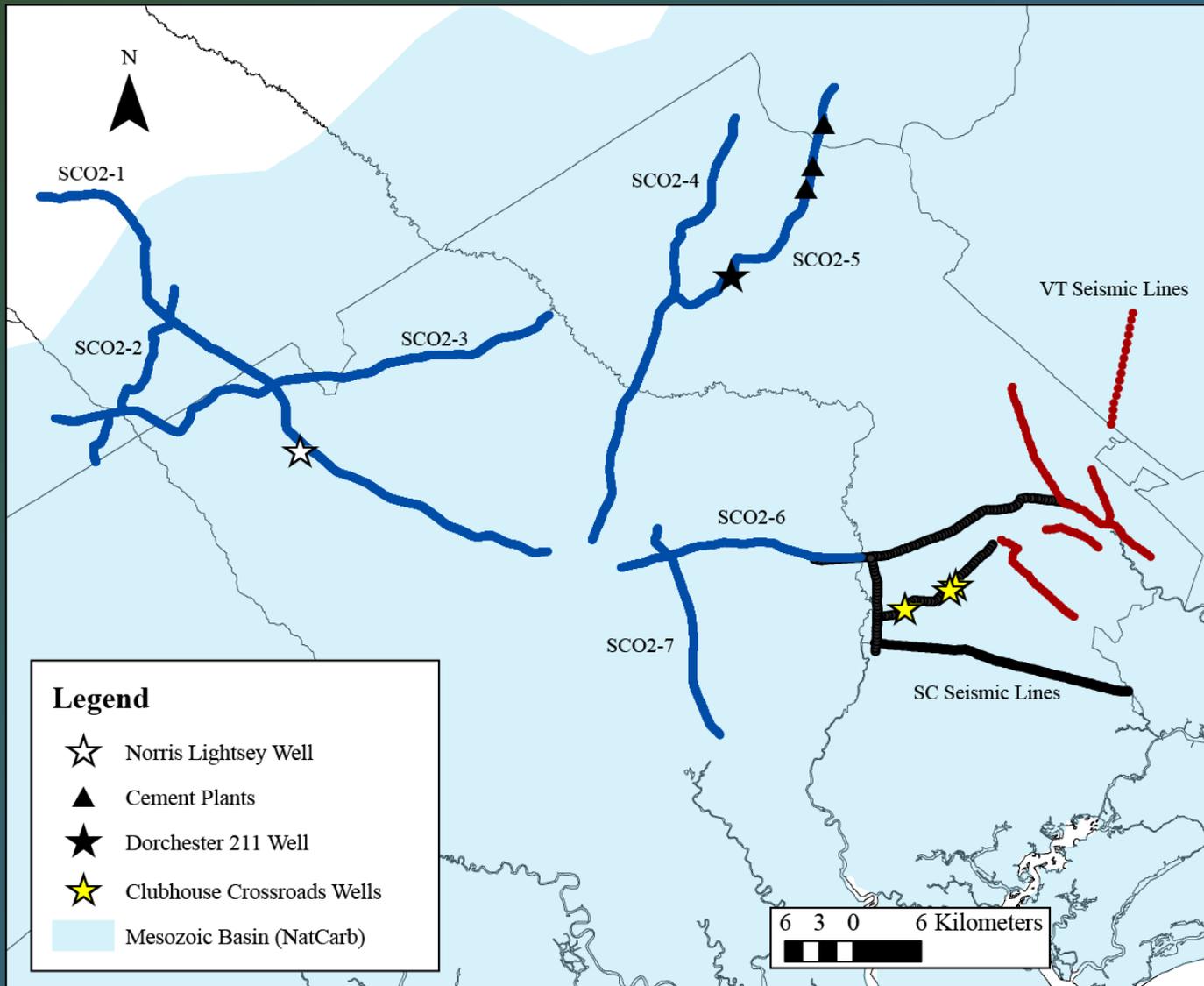
Identify Site Attributes that Pose Risks to Operations



Norris Lightsey #1



2D Seismic Survey



Seismic Acquisition Parameters

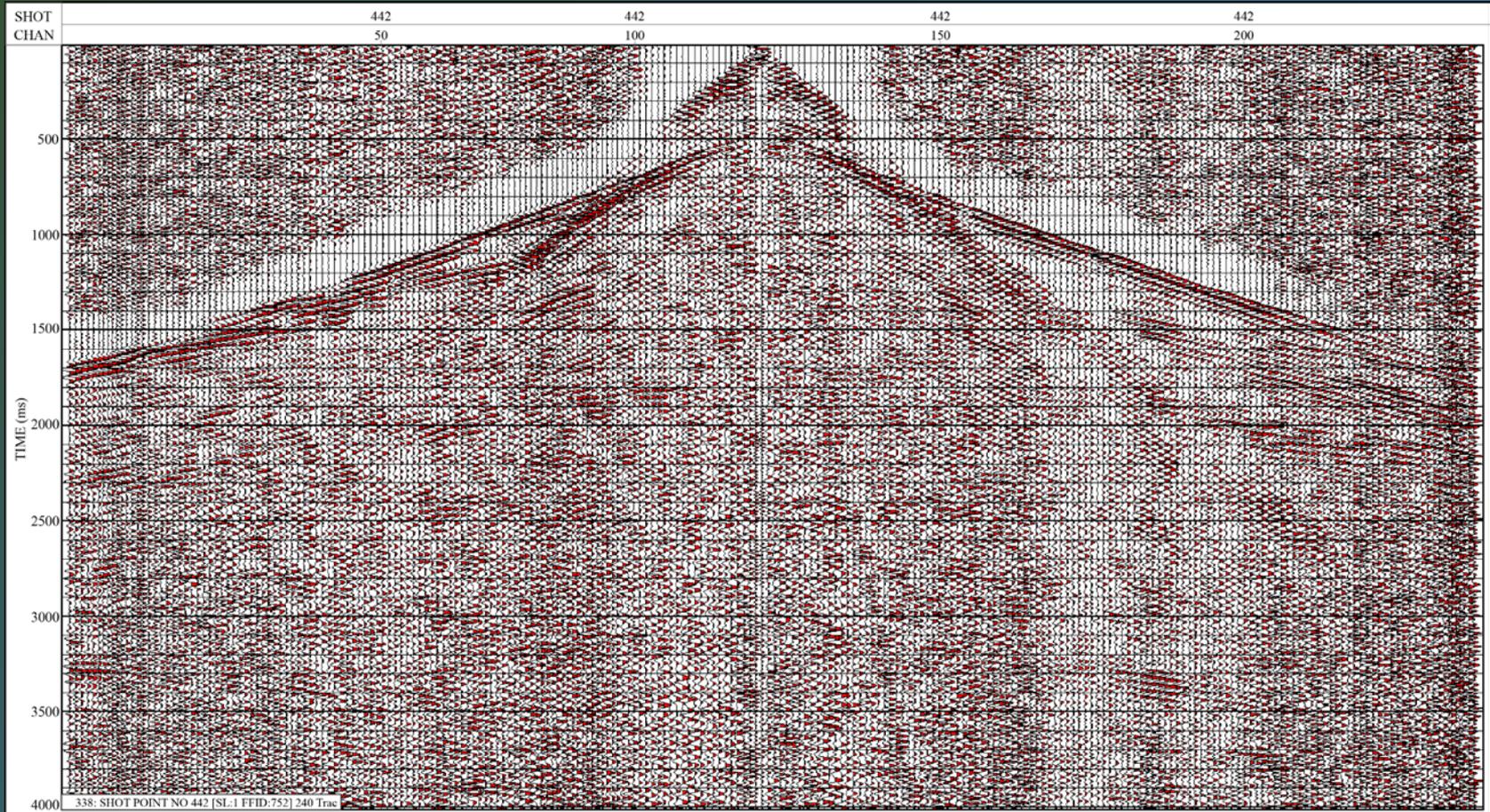
| | |
|--------------------|---|
| Number of Channels | 240 channels |
| Group Interval | 52 meters |
| Source Interval | 52 meters |
| Spread | Symmetrical Split Spread Maximum offset 6,240 meters |
| Source | 3 IVI Litton 315 System Vibrators (42,000 force lbs with advance torque amp control system) |
| Sweep Parameters | 10 Hz to 72 Hz, 8 each-8 second sweeps |
| Record Length | 6 seconds |
| Sample Rate | 2 ms |
| Geophone Array | 12 (each) Oyo GeoSpace Geophones-10 Hz over 52 meters |



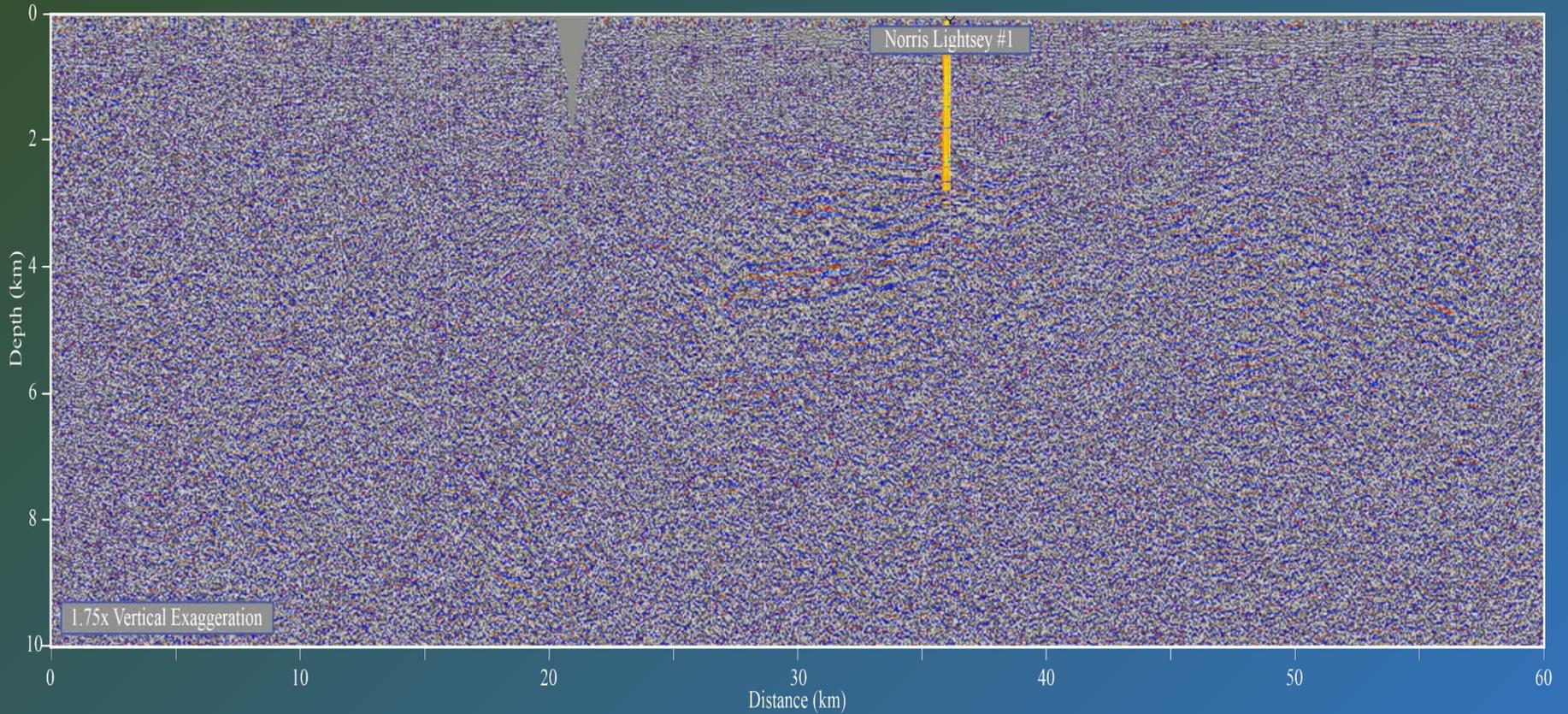
Seismic Source



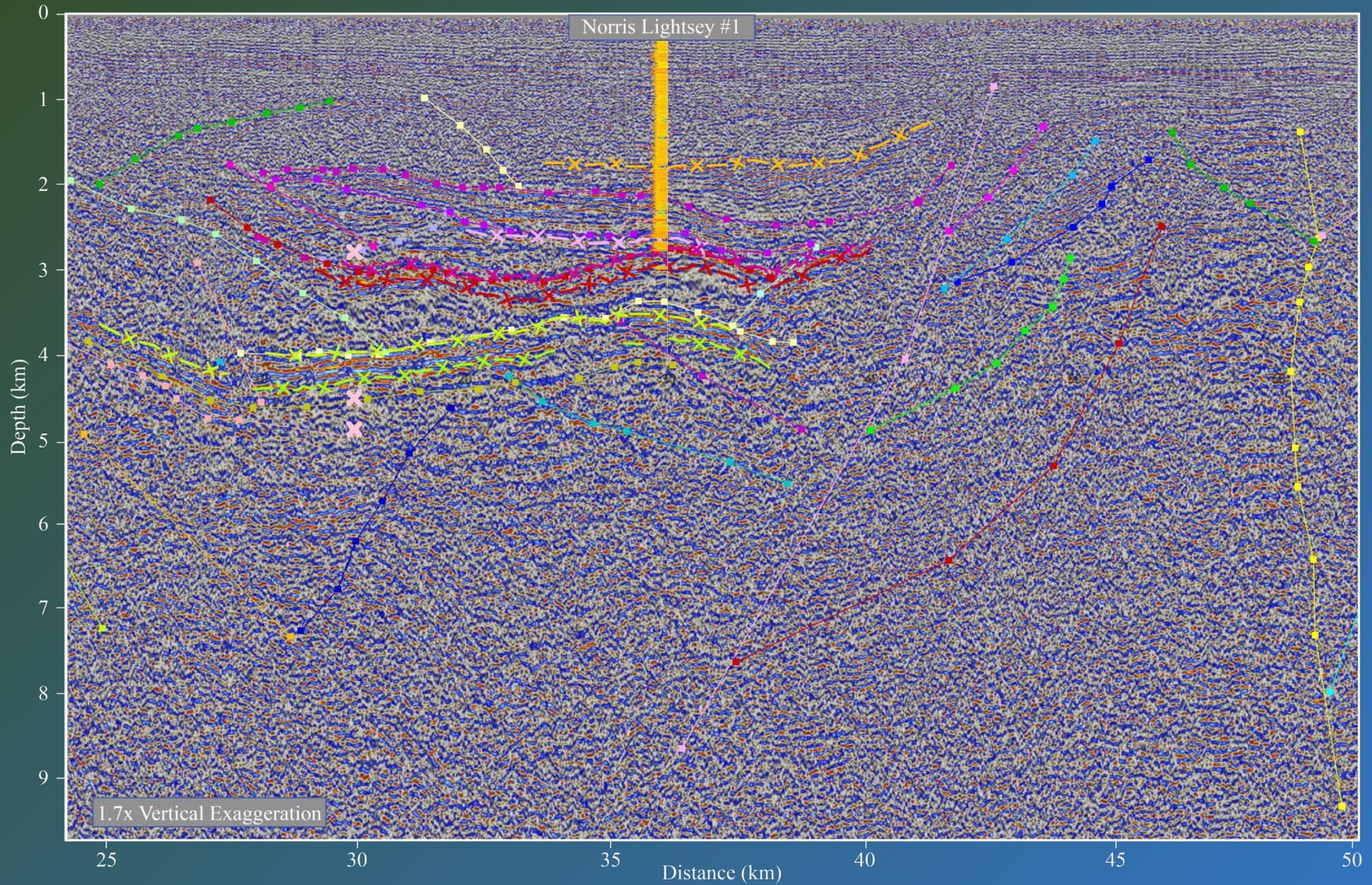
Typical Field Record



Seismic Line SCO2-1



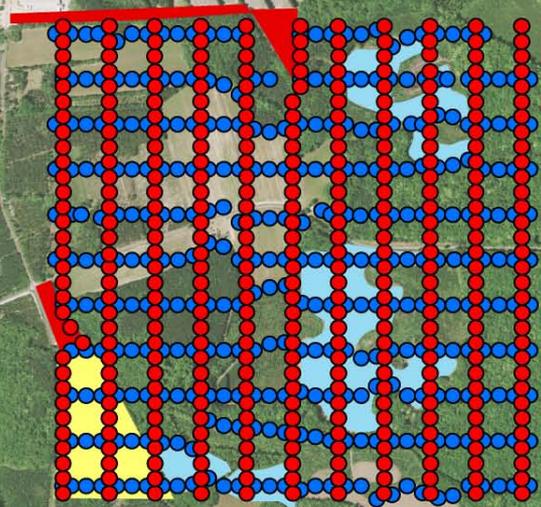
Seismic Line SCO2-1



Collecton County, South Carolina SCO2 3D, Rizer Property

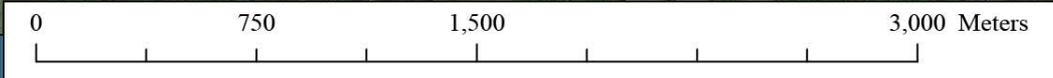


52 x 156 osd
 Receivers Summary: Blue (North-South)
 Total # of Included Receivers = 352
 Total Area of Included Receivers = 2.515 sq km
 Receiver Density = 139.976 per sq km
 Shots Summary: Red (East-West)
 Total # of Included Shots = 361
 Total Area of Included Shots = 2.476 sq km
 Shot Density = 145.782 per sq km
 Rx/Sx Interval 52 m

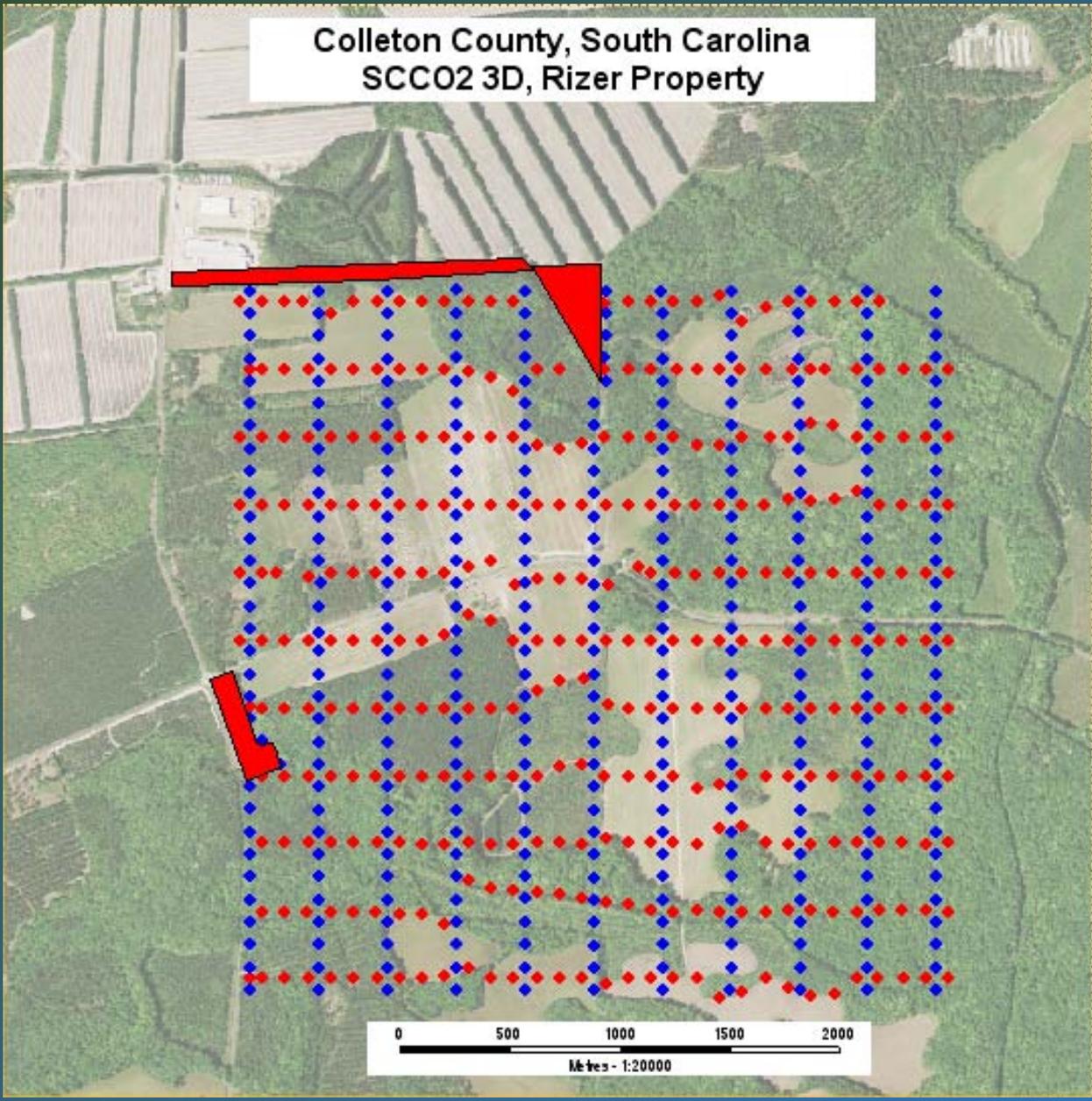


Legend

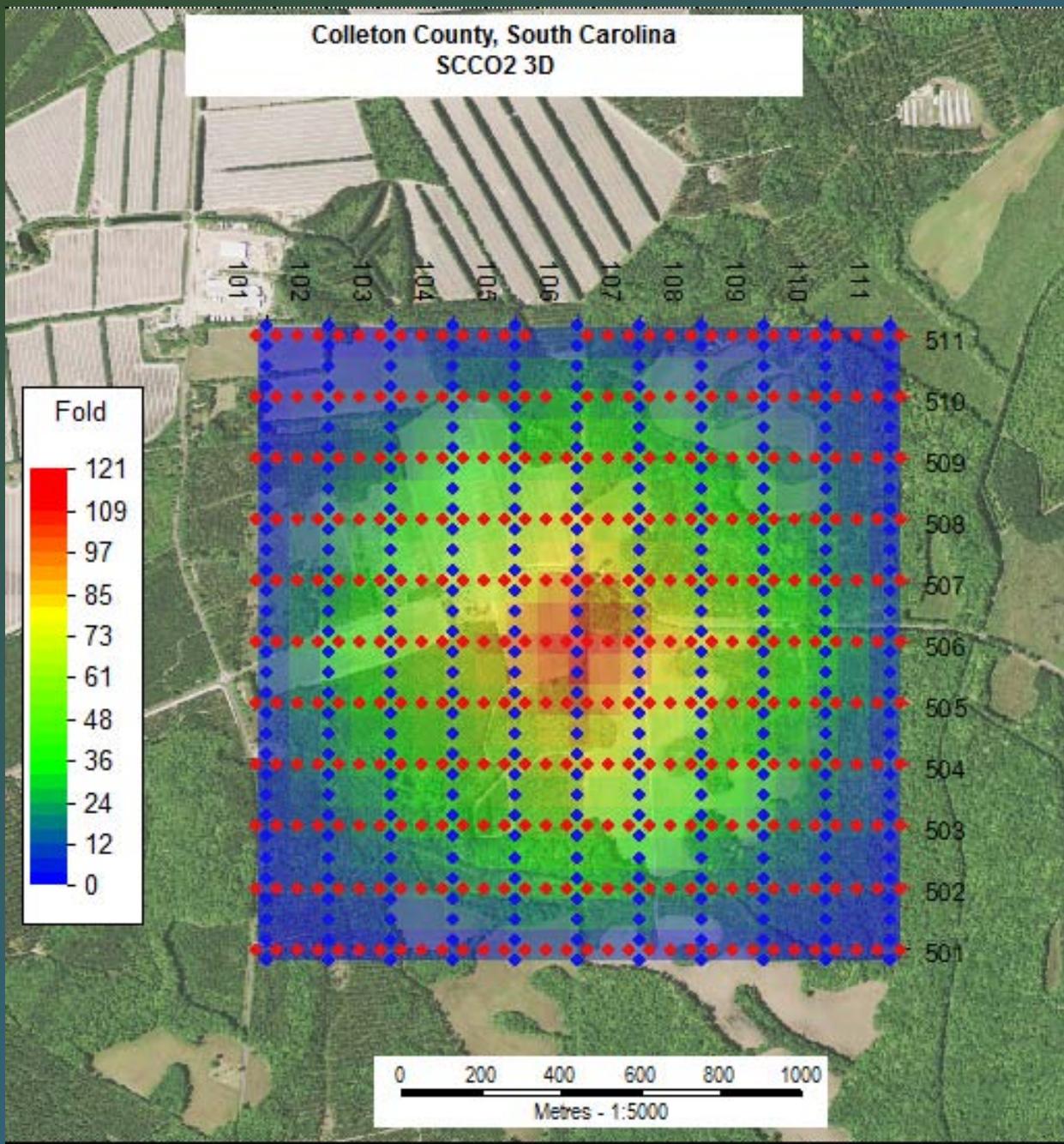
- ☆ Norris Lightsey #1 Well
- Post Receiver
- Post Source
- SCO2-ICDPs
- Hunting Weekends
- No Permits
- Soybeans



Colleton County, South Carolina
SCCO2 3D, Rizer Property

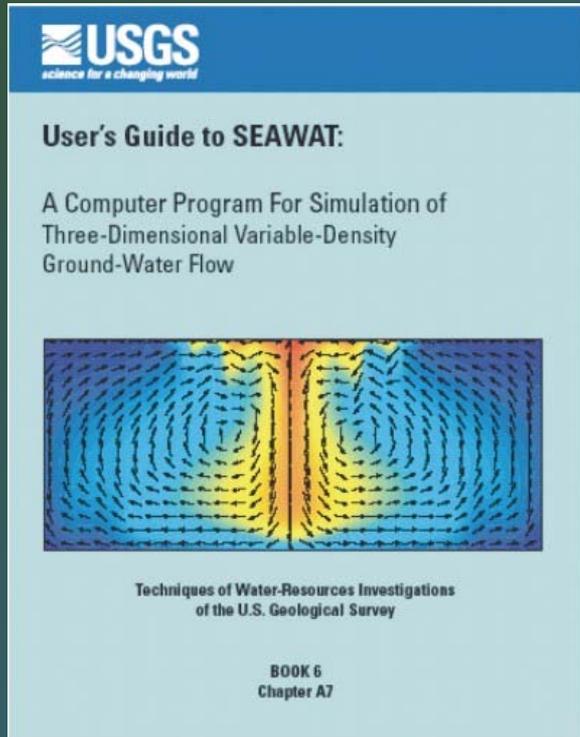


Colleton County, South Carolina
SCCO2 3D

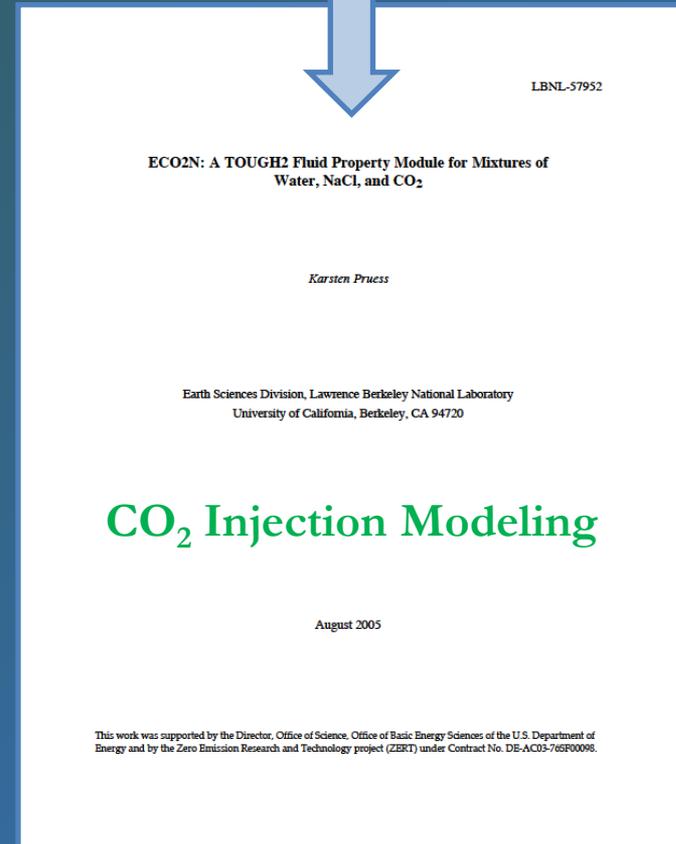


CO₂ Injection Simulation Approach

High spatial resolution
equilibrium modeling
(No CO₂)

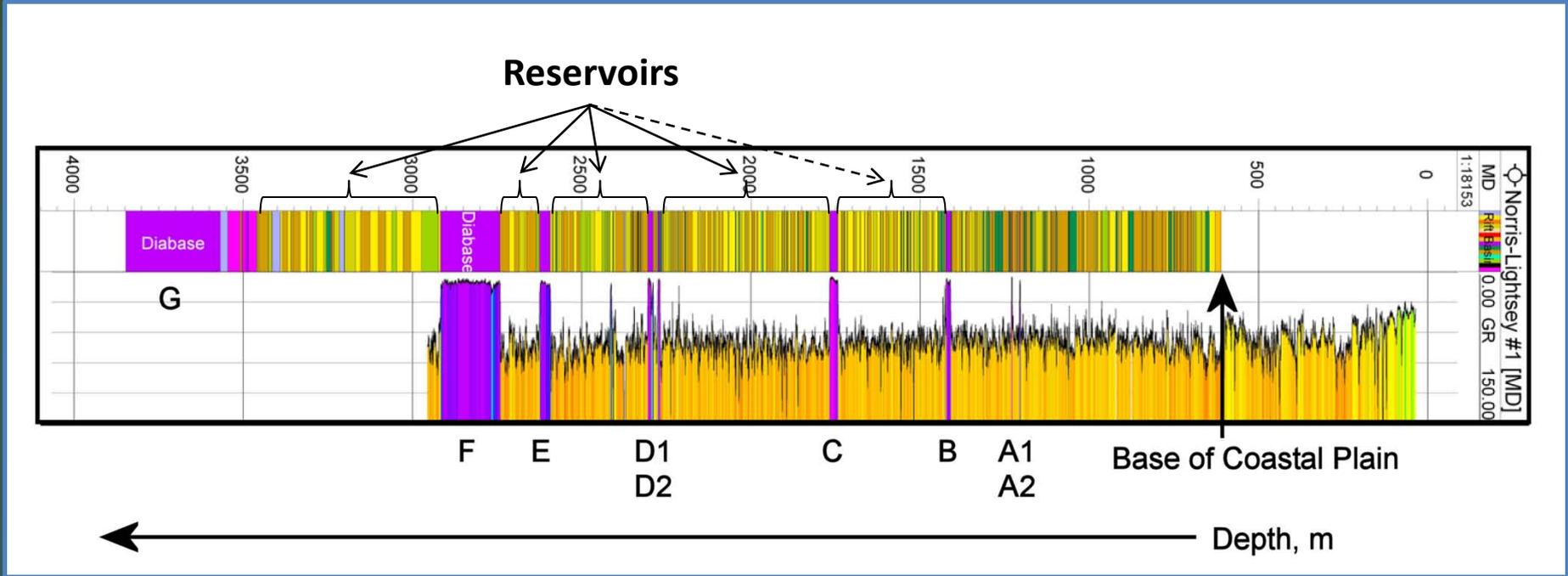


Internally consistent
initial conditions



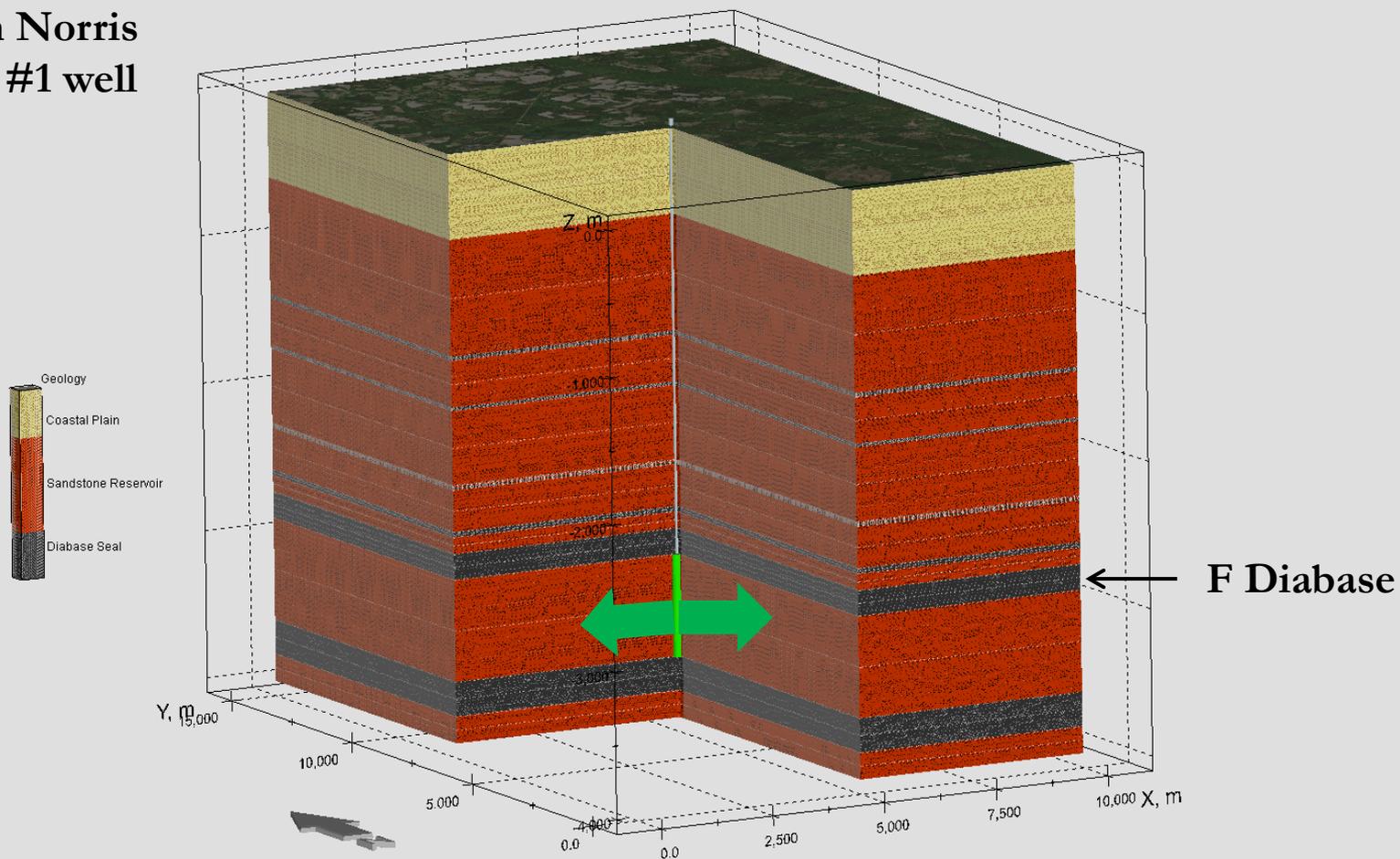
SGR Stacked Storage Concept

Norris Lightsey #1 Well

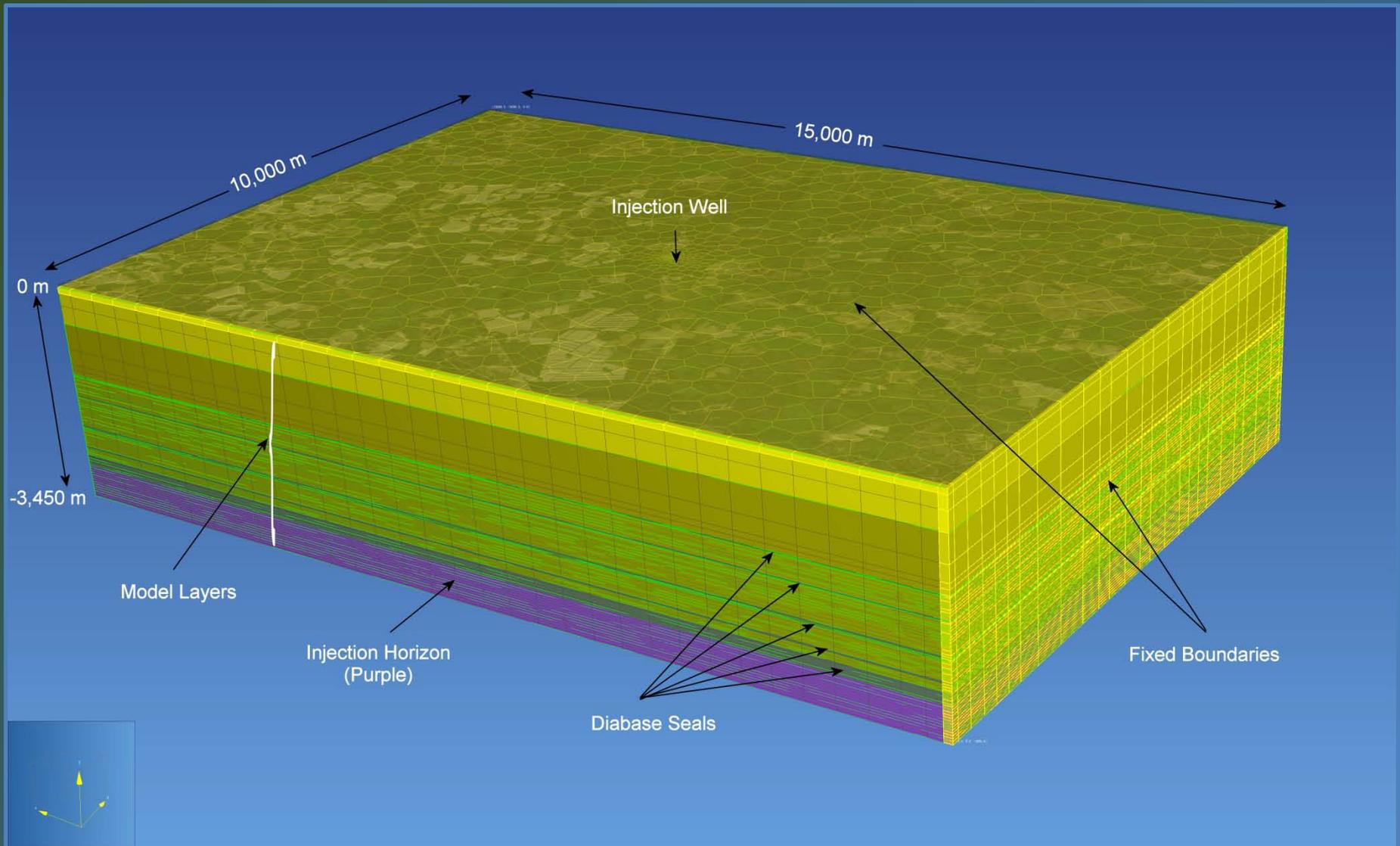


Conceptual 3D Geology for CO₂ Injection Simulation

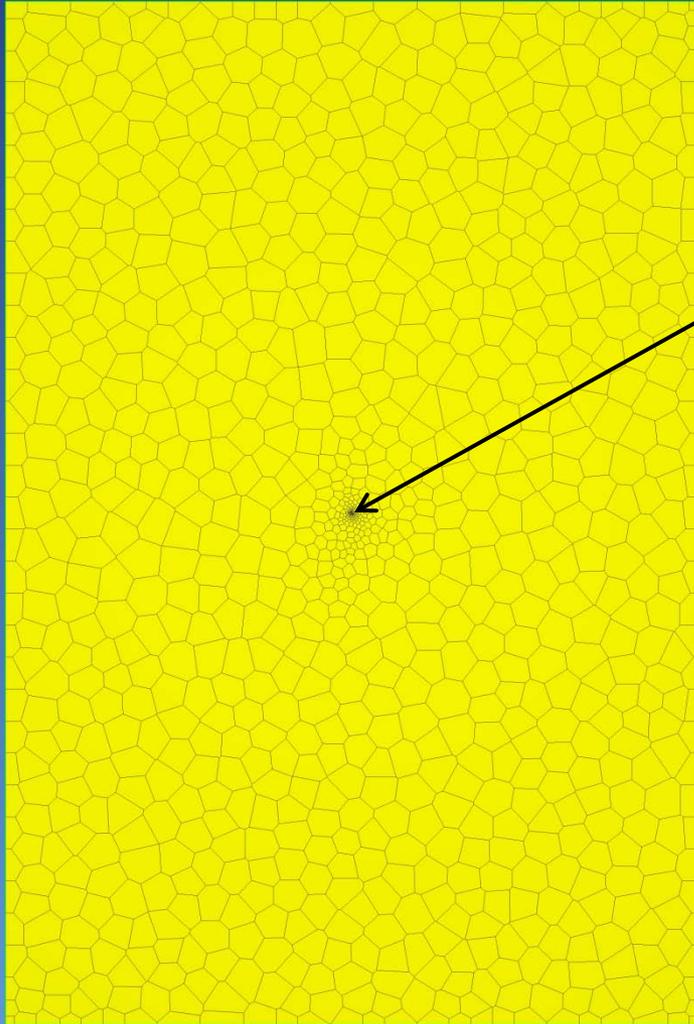
Based on Norris
Lightsey #1 well



TOUGH2/ECO2N Model Domain



CO₂ Injection Model Specifications



- X by Y by Z = 10,000 m by 15,000 m by 3,450 m
- 67,628 polygonal cells (Voronoi)
- 58 model layers
- Injection cell cross-sectional area < 1 m²
- North, east, and west boundaries are closed
- South boundary is open
- Bottom boundary – constant temperature, no flow
- Three material types:
 - Coastal Plain
 - Reservoir
 - Seal
- Inject 1M metric tons per year for 30 years - continue simulation for 170 years for total simulation time = 200 years

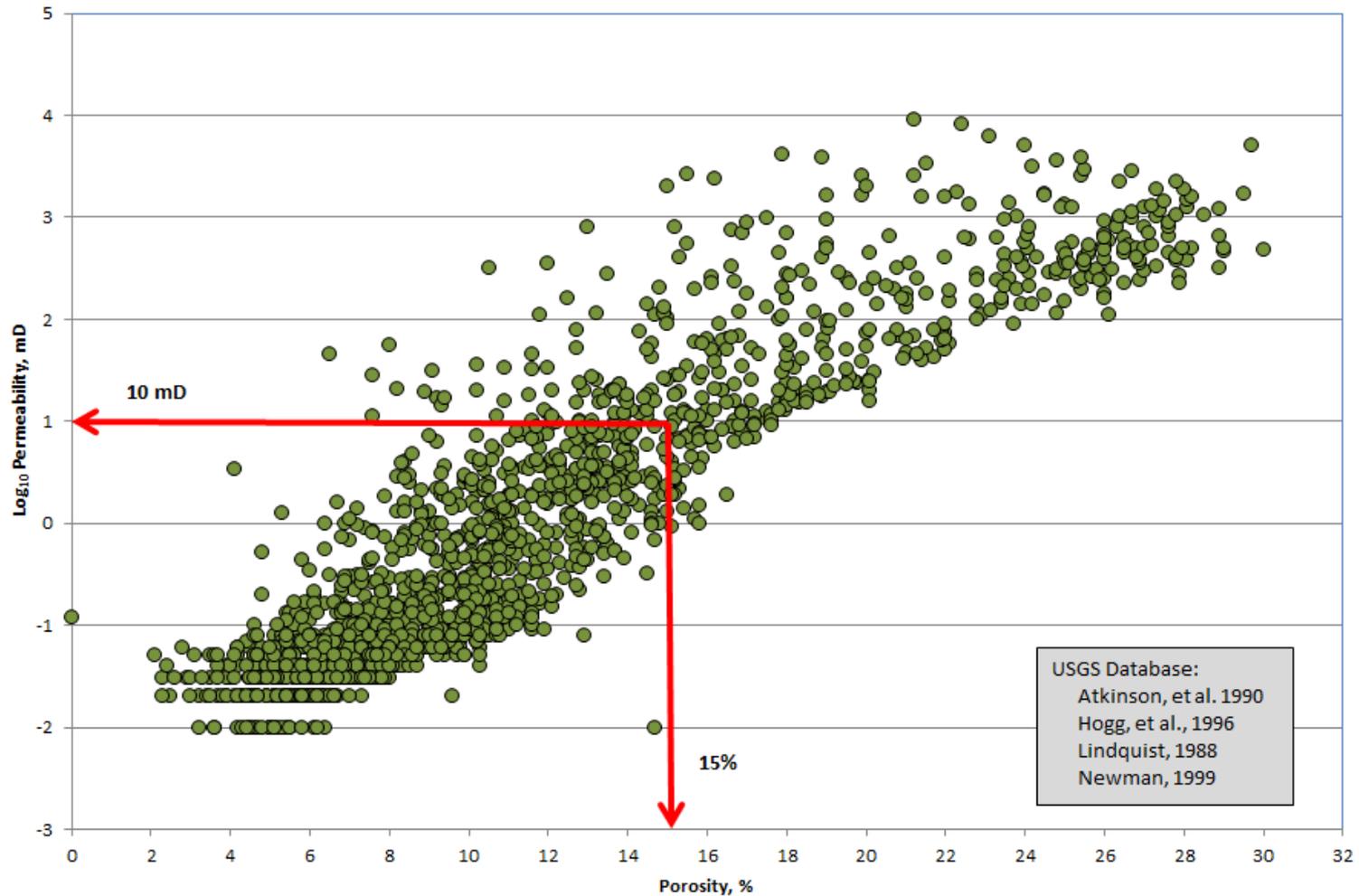
Simulation Material Properties

| Property | Units | Coastal Plain | Reservoir | Seal |
|-------------------------------|--------------------|---------------|-------------|------------------|
| XY Permeability | m ² /mD | 3.60e-12/3650 | 9.87e-15/10 | 1.00e-20/1.00e-5 |
| Z Permeability | m ² /mD | 3.60e-13/365 | 9.87e-15/10 | 1.00e-20/1.00e-5 |
| Porosity | % | 20 | 15 | 0.1 |
| Rock Density | kg/m ³ | 2,400 | 2,700 | 2,933 |
| Corey S _{gr} | – | 0.05 | 0.05 | 0.05 |
| Corey S _{lr} | – | 0.17 | 0.15 | 0.20 |
| van Genuchten P _o | kPa | 2.1 | 1.5 | 337.0 |
| van Genuchten λ | – | 0.457 | 0.457 | 0.457 |
| van Genuchten S _{lr} | – | .17 | 0.15 | 0.20 |



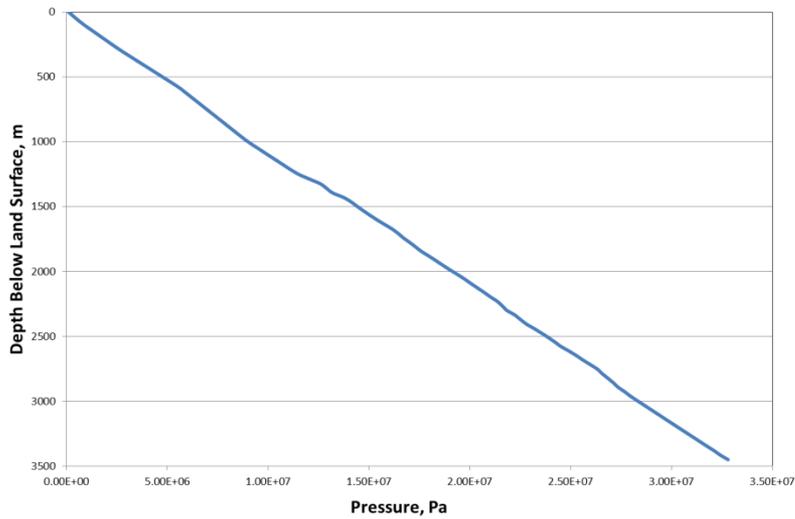
Porosity and Permeability

Porosity vs. Permeability - Triassic Sediments

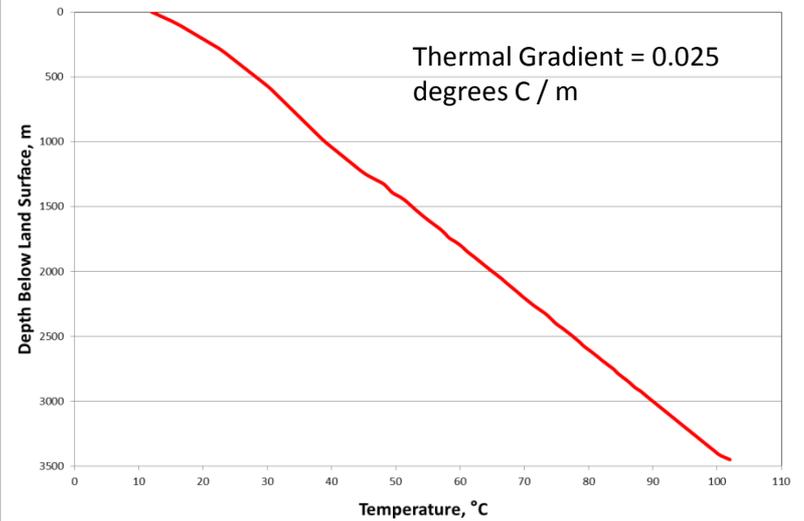


Initial Conditions

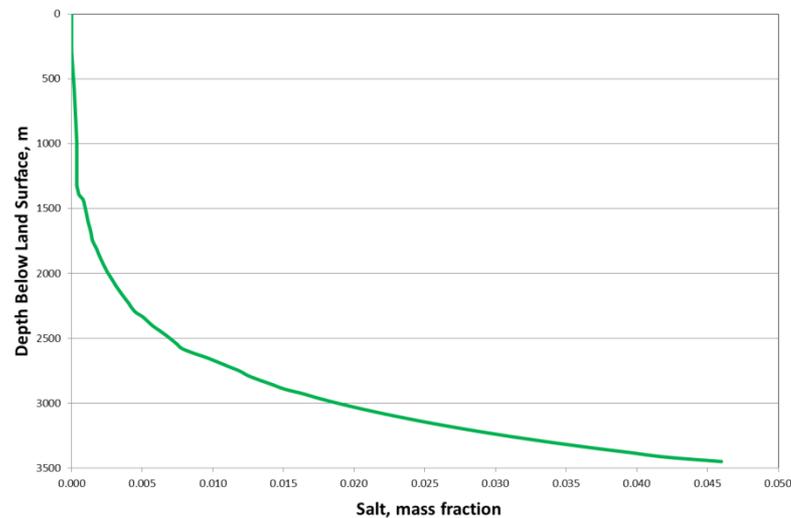
Pressure



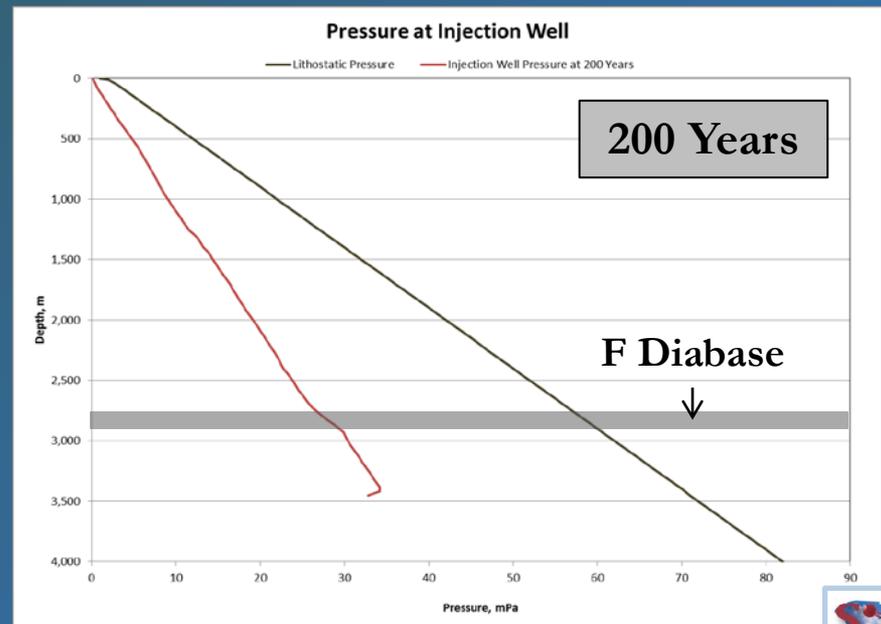
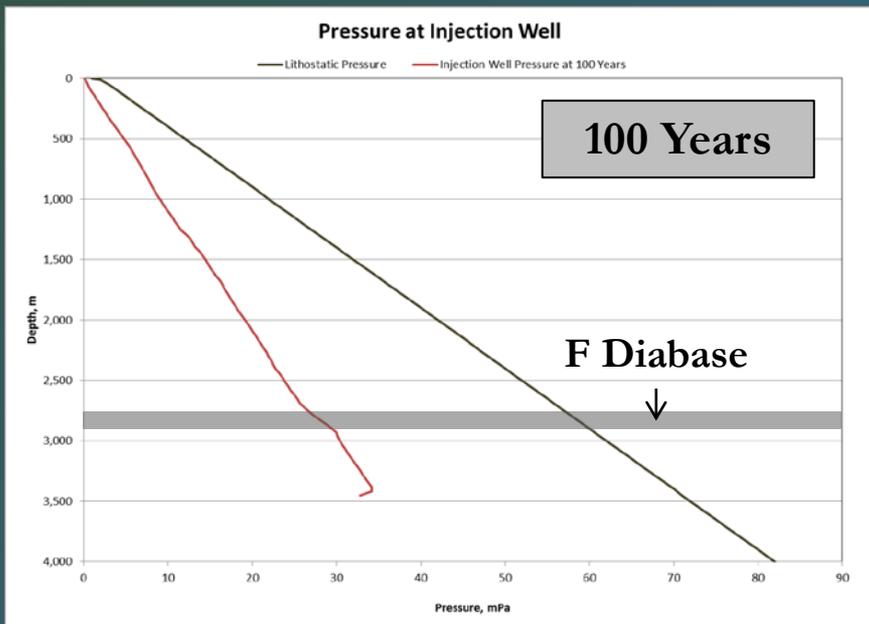
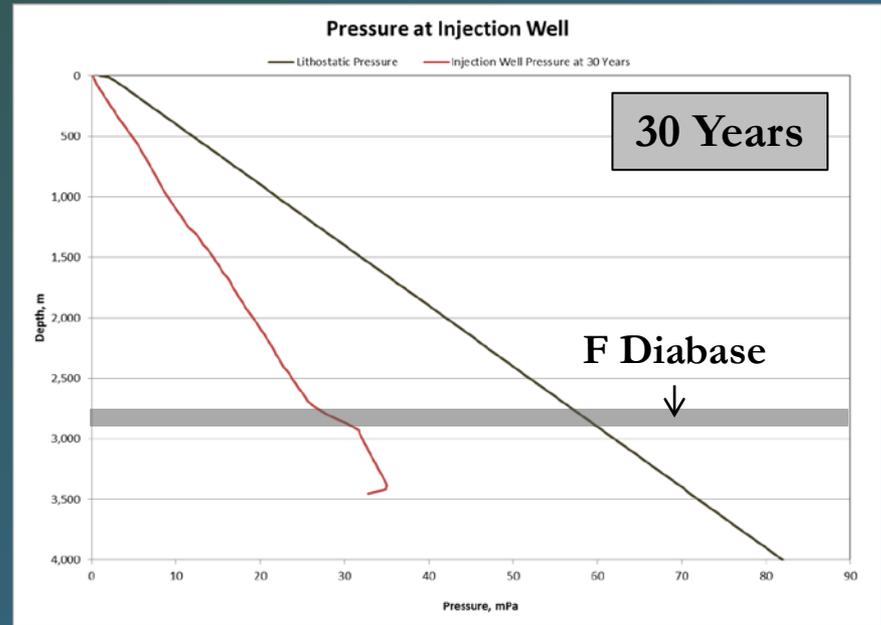
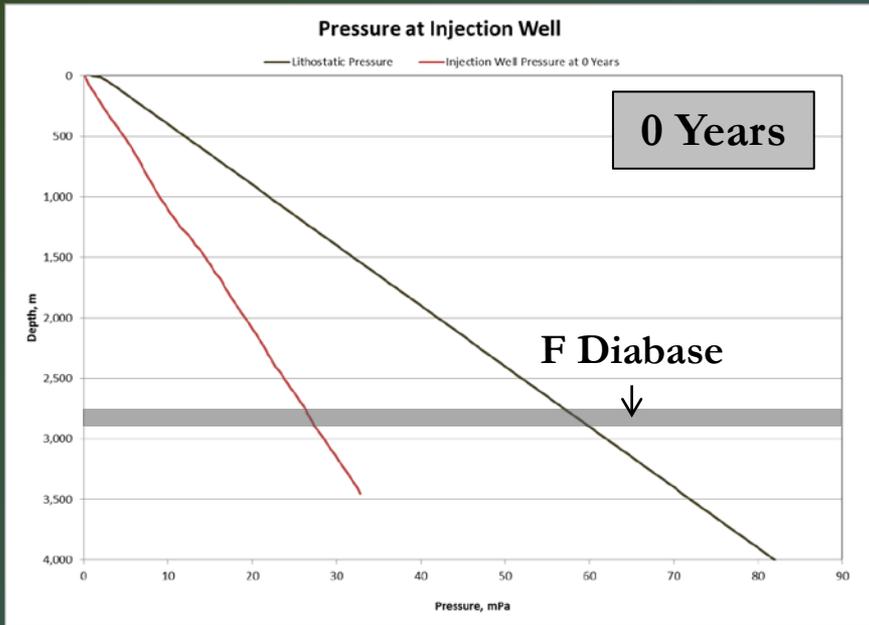
Temperature



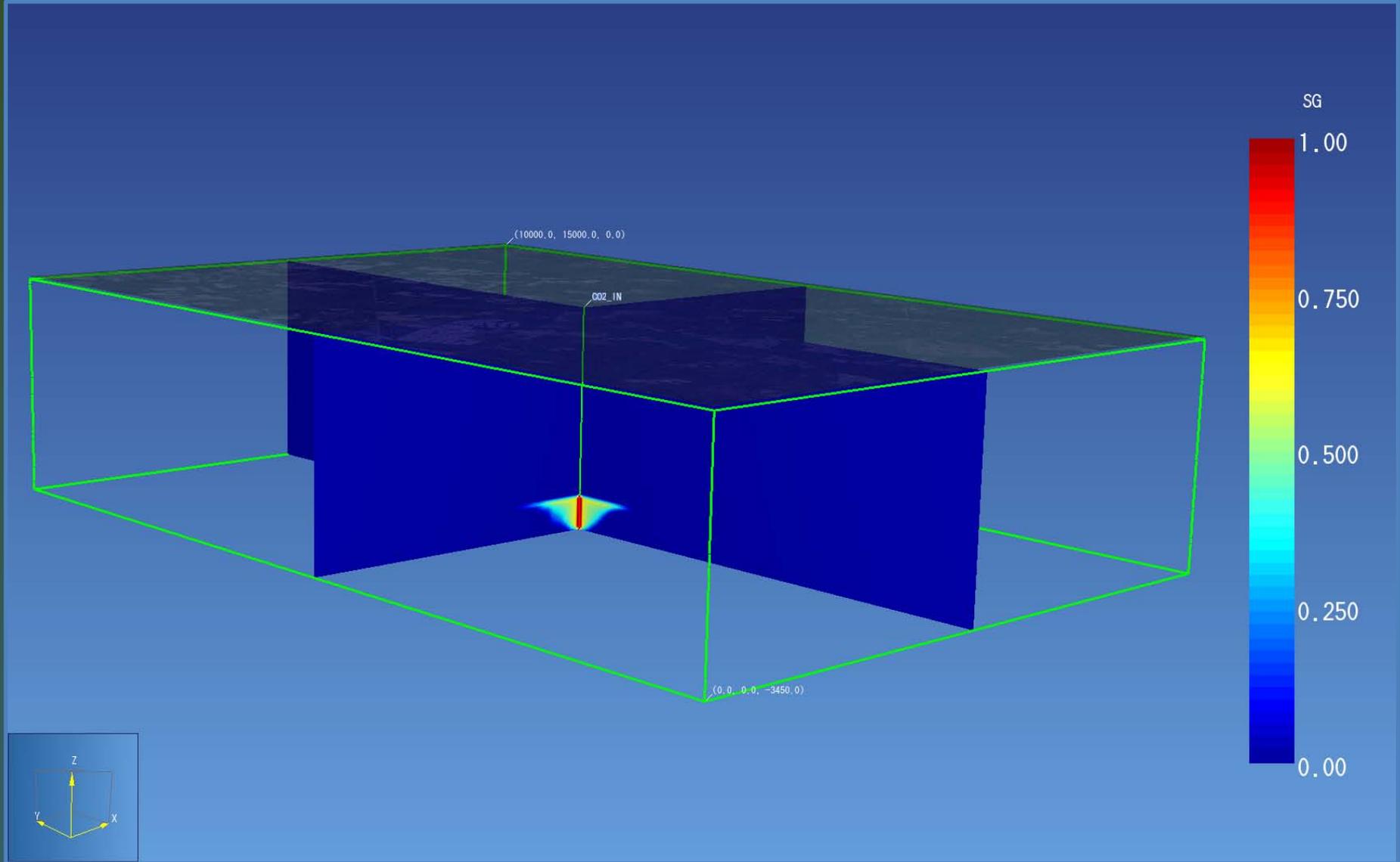
Salt



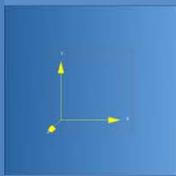
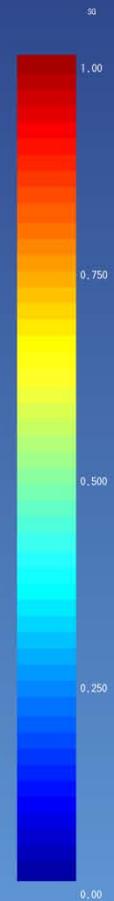
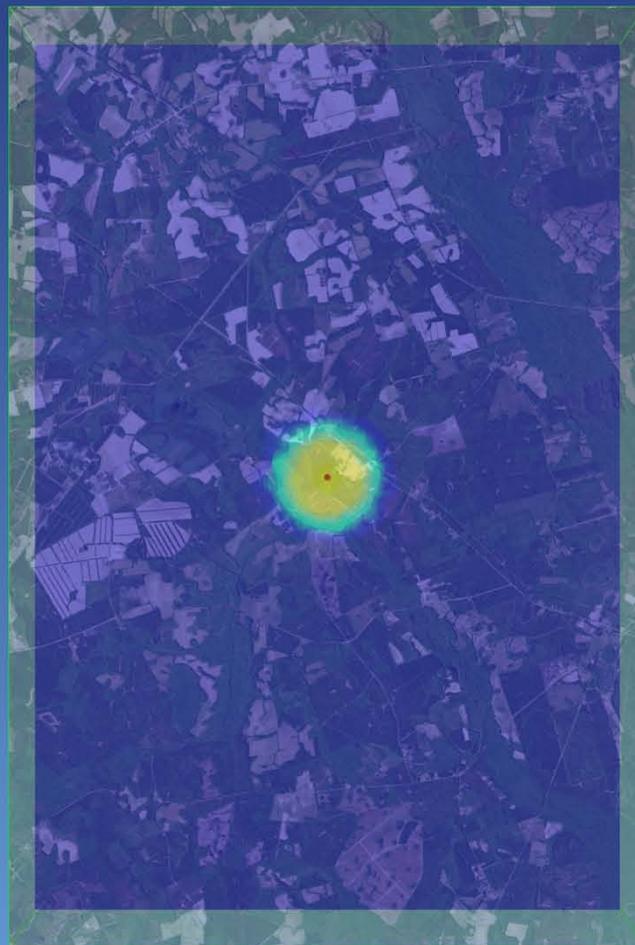
Fluid Pressure Results



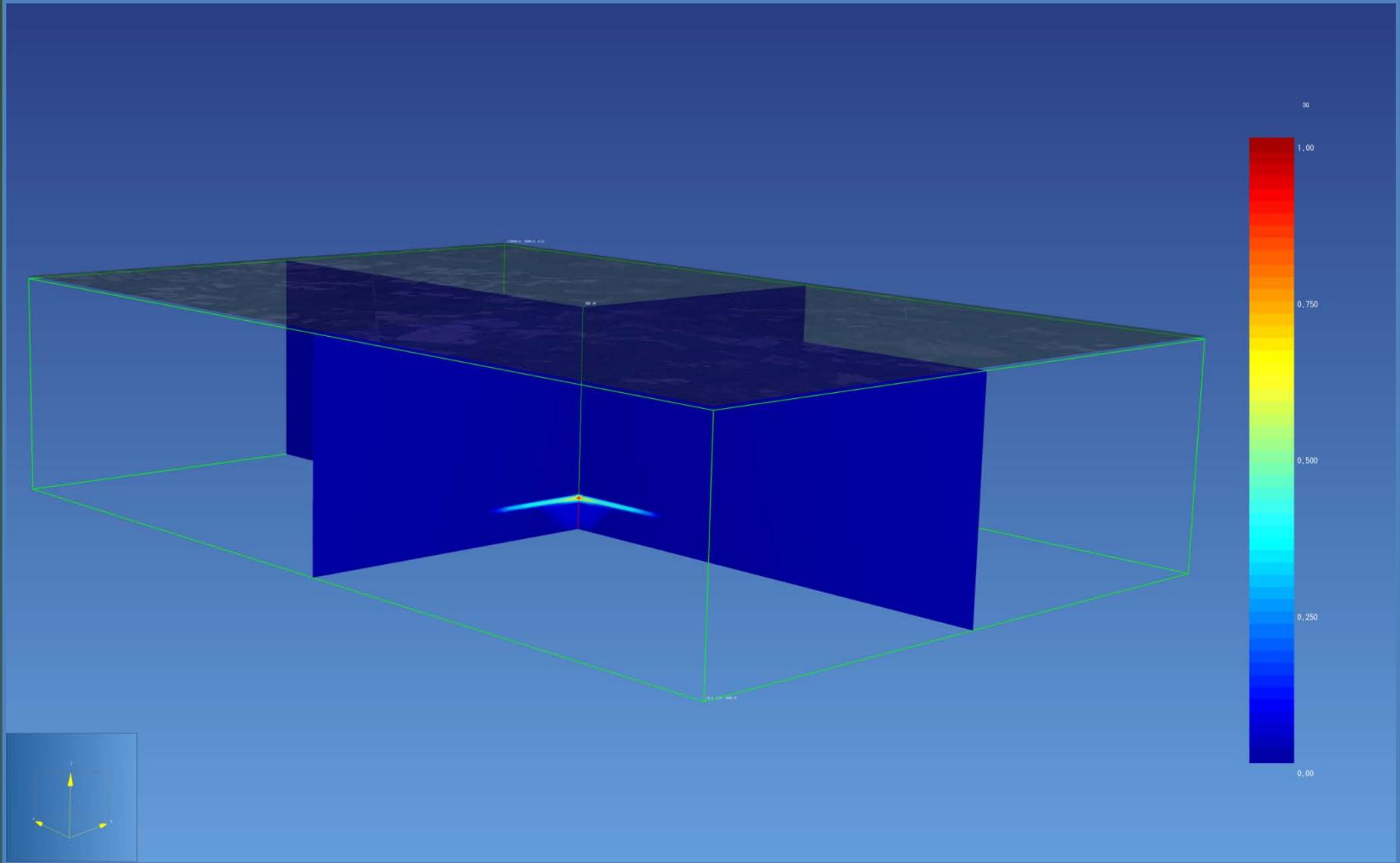
CO₂ Injection Results After 30 Years



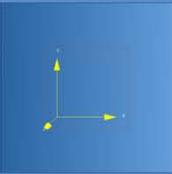
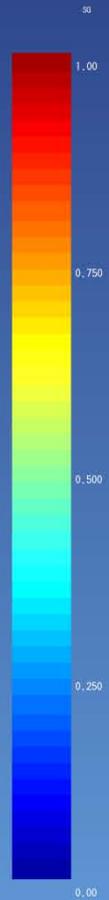
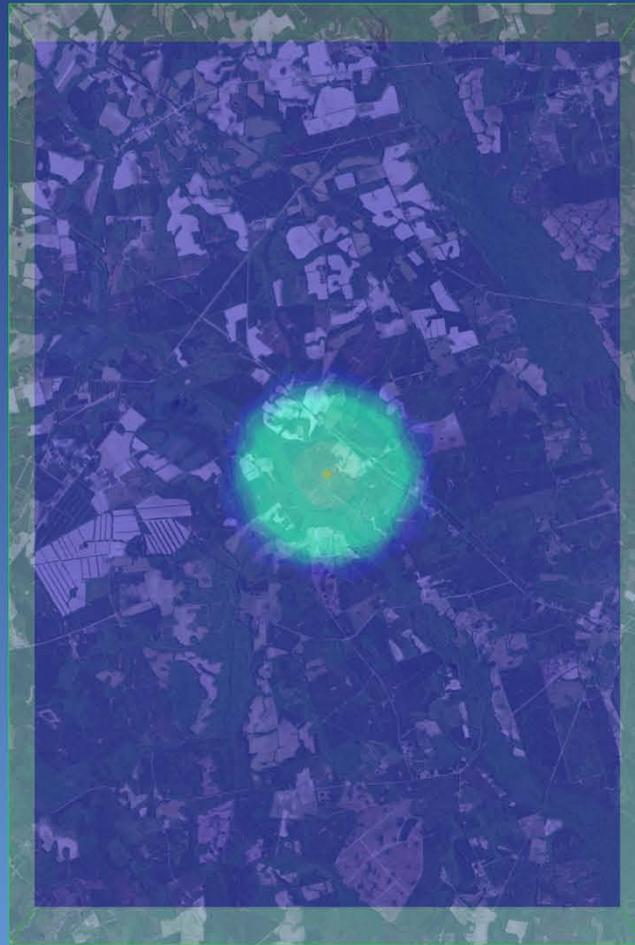
CO₂ Injection Results After 30 Years



CO₂ Injection Results After 200 Years

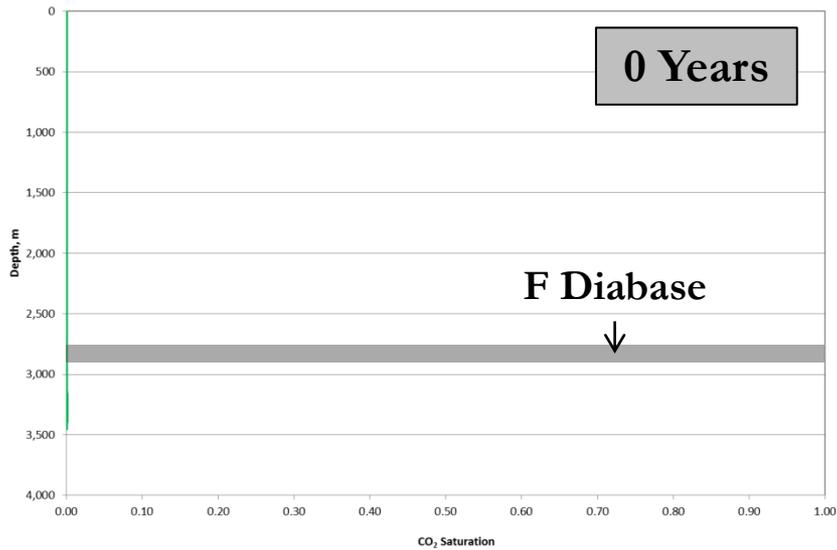


CO₂ Injection Results After 200 Years

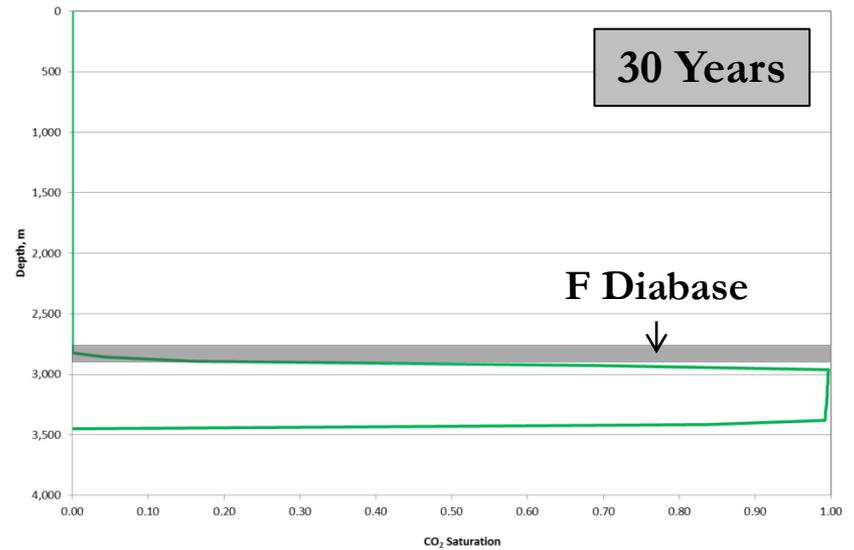


CO₂ Injection Results

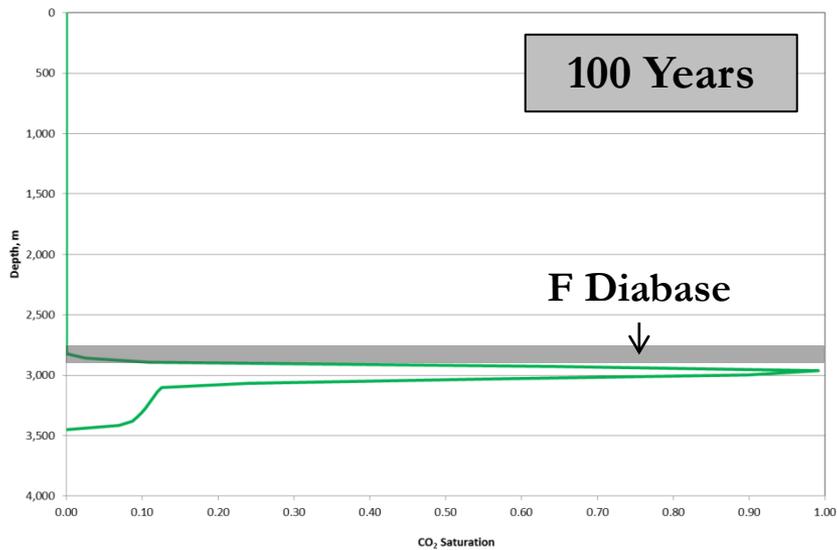
CO₂ Saturation at Injection Well



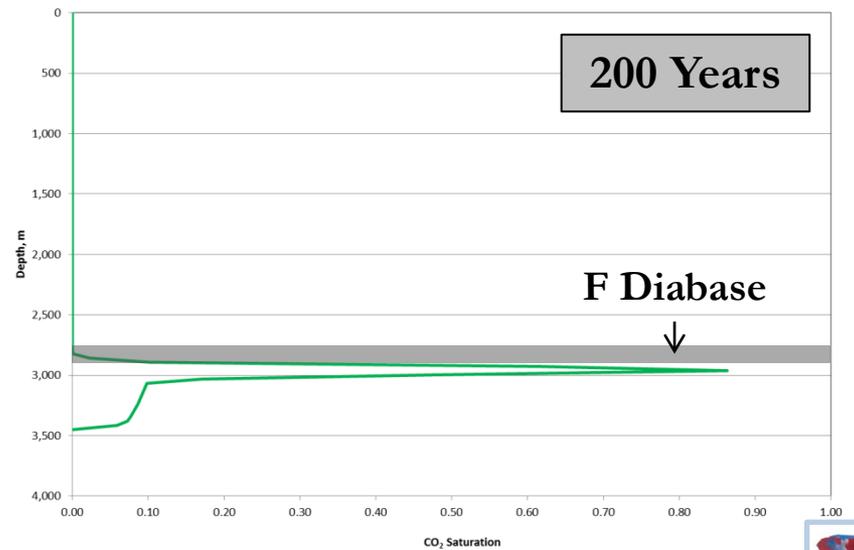
CO₂ Saturation at Injection Well



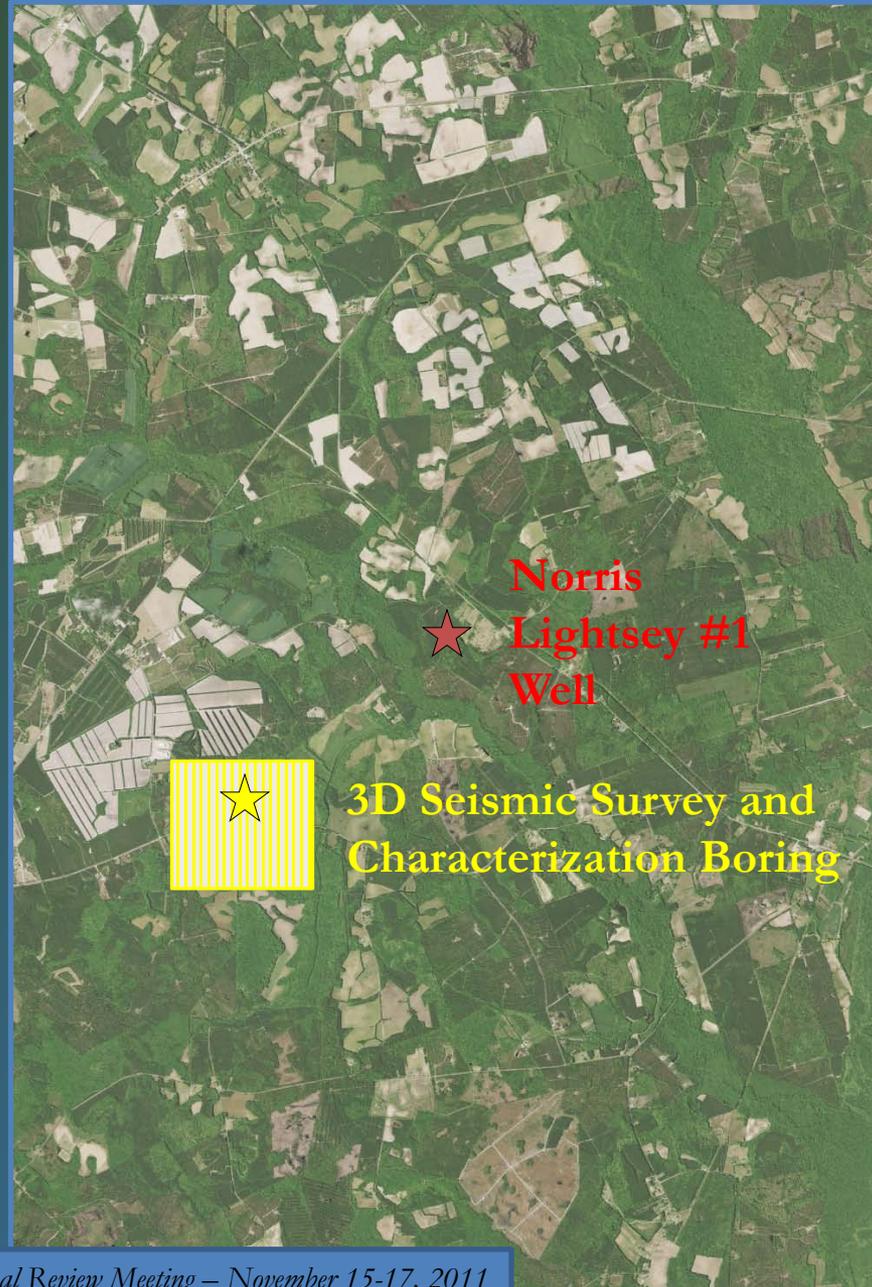
CO₂ Saturation at Injection Well



CO₂ Saturation at Injection Well



Tying It Together



2D Seismic
Coverage

3D Seismic Survey and
Characterization Boring

Norris
Lightsey #1
Well

Acknowledgment & Disclaimer

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