

**CLASS VI PERMIT APPLICATION NARRATIVE****Magnolia Sequestration Project**

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**1.0 Project Background and Contact Information**

Facility name: Magnolia Sequestration Project  
Magnolia CCS 1, Magnolia CCS 2, Magnolia CCS 3, and Magnolia CCS 4 Wells

Facility contact: Kelly Watson, Project Manager  
5 Greenway Plaza Houston, TX 77046  
713-552-8613 kelly\_watson@oxy.com

Well location: Allen Parish, Louisiana  
Magnolia CCS 1  
30° 40' 56.2474" N, 092° 50' 1.2244" W (NAD 27)  
30° 40' 56.9387" N, 092° 50' 1.7707" W (NAD 83)  
Magnolia CCS 2  
30° 41' 40.1623"N, 092° 50' 23.1767"W (NAD 27)  
30° 41' 40.8527" N, 092° 50' 23.7241" W (NAD 83)  
Magnolia CCS 3  
30° 41' 6.1794" N, 092° 50' 24.1145" W (NAD 27)  
30° 41' 6.8705" N, 092° 50' 24.6617" W (NAD 83)  
Magnolia CCS 4  
30° 41' 38.4597" N, 092° 50' 23.1814" W (NAD 27)  
30° 40' 39.1501" N, 092° 50' 23.7288" W (NAD 83)

The CCS wells in the Magnolia Sequestration Project are part of the Magnolia Sequestration Hub, LLC, objective to demonstrate technical feasibility of Carbon Capture and Storage (CCS), utilizing CO<sub>2</sub> from industrial emitters along the Louisiana Gulf Coast. The advancement of CCS technology is critically important in addressing CO<sub>2</sub> emissions and global climate change concerns. The Magnolia Sequestration Project is designed to demonstrate utility-scale integration of transport and permanent storage of captured CO<sub>2</sub> into a deep geologic formation (i.e., geologic sequestration). A commercial-scale CCS system will be designed, built, and operated with the capability of storing CO<sub>2</sub> gas. The Magnolia Sequestration Project will display that the geologic sequestration process can be done safely, ensuring that the injected CO<sub>2</sub> will be retained within the intended storage reservoir.

The CO<sub>2</sub> will be transported to the storage site located in Allen Parish, Louisiana via safe and proven pipeline technology. The source CO<sub>2</sub> for the pipeline will be industrial emitters along with Louisiana Gulf Coast. At this time, Magnolia Sequestration Hub, LLC, has ongoing discussions and negotiations with multiple entities for offtake agreements and/or transportation services. Obtaining Class VI well permits is a critical element to facilitate the ongoing negotiations to commercialize the Magnolia Sequestration Project as a Hub for carbon sequestration.

At the Magnolia Hub, the CO<sub>2</sub> will be injected into the Frio formation at a proposed rate of 2 million metric tons (MMT) of CO<sub>2</sub> per well each year for a planned duration of 15 years. Injection depth or aquifer exemptions will not be submitted for the project.

The proposed Area of Review (AOR) has no known critical cultural sites or sites of archaeological significance. There is one known place of worship and one known cemetery within a 1-mile buffer zone surrounding the AOR. There are no known schools, hospitals, or nursing homes within the AOR or buffer zone surrounding the AOR. An Environmental Justice analysis is submitted as part of the project documentation.

#### **GSDT Submission - Project Background and Contact Information**

**GSDT Module:** Project Information Tracking

**Tab(s):** General Information tab; Facility Information and Owner/Operator Information tab

Please use the checkbox(es) to verify the following information was submitted to the GSDT:

☒ Required project and facility details *[LAC 43:XVII.3607(B)]*

## **2.0 Site Characterization**

A detailed geologic evaluation was conducted both regionally and locally for the area pertaining to the Magnolia Sequestration Project site using geologic, geophysics, and petrophysics data obtained from public literature and Oxy-licensed data. Additionally, a stratigraphic test well, the YAMS MLR 004 (SN 975950) was drilled November 1, 2022 to calibrate petrophysical, geochemical, and geomechanical inputs. See Figure NAR-1 for site overview and site characterization data.

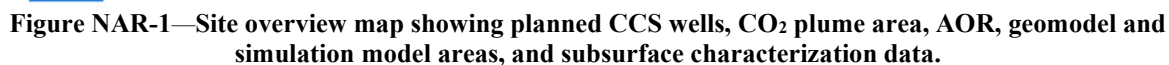
The Magnolia Sequestration Project targets sands of the Oligocene Frio formation for injection with overlying intermediate and confining zones in the Anahuac and Lower Miocene formations respectively. These units constitute the Storage Complex for the site. The site is located in a region where no natural seismicity is present, and no impactful faulting is present within or above the Storage Complex. Strata within the Storage Complex is structurally characterized by homoclinal dip of approximately 1.5 degrees and is at depths well within the supercritical range for CO<sub>2</sub>. Fresh water aquifers that are present above the Storage Complex have been well characterized, and no producing fields are present within the Storage Complex (Figure NAR-2).

The gross thickness of the Frio Injection Zone is approximately 2,000 ft and ranges in depth from 2,880 ft to 7,565 ft across the site with general monoclinical dip of 1.25 to 1.35 degrees. The Frio Injection Zone is broken up into 7 mappable sub zones where each zone is composed of a shaley base (intra-Frio confining units) deposited during a transgressive systems tract that coarsens up into a sandy top (injection zones). Average porosities for the injection zones range from 29-33% and average horizontal permeabilities range from 1,920-2,852 mD. Intra-Frio confining units have significantly lower average porosities (18-25%) and average horizontal permeabilities (0.8 - 2.2 mD) than the injection zones and act as vertical baffles to CO<sub>2</sub> migration. Porosities and permeability values from well logs are calibrated to measurements from whole core plugs taken in the YAMS MLR-04 (SN 975950) well. The Anahuac Intermediate Zone and Lower Miocene Confining Zone stratigraphically overlay the Frio Injection Zone. The shale-rich Lower Miocene Confining Zone is mapped as approximately 500 ft thick across the site and exhibits properties more than sufficient to contain CO<sub>2</sub> within the



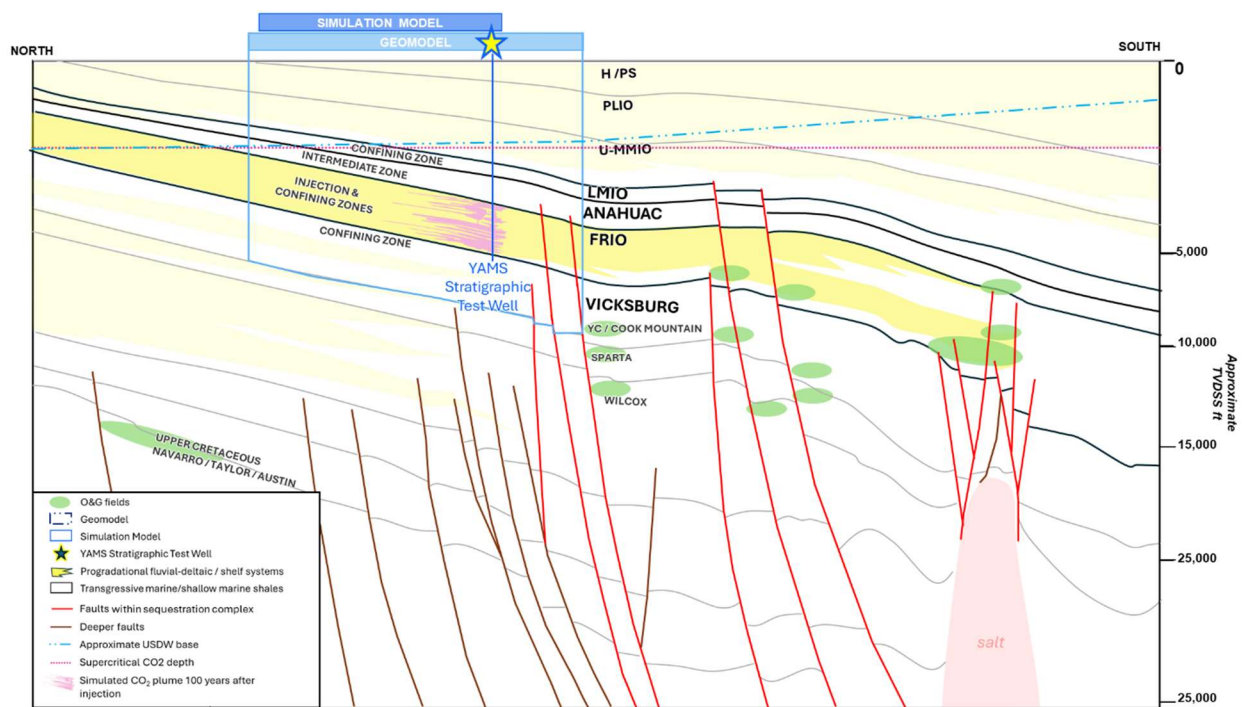
Storage Complex. Net Shale thickness over this zone ranges from 240 – 460 feet thick, averaging 346 ft. Figure NAR-74 shows net shale thickness for the Lower Miocene zone.

Modeling and simulation results are presented in the AOR\_CA Section 3.0; a map view of the planned injection wells and resulting CO<sub>2</sub> plume and AOR is shown in Figure NAR-1. The Frio Injection Zone is divided into two completions targets, where the Upper Frio Injection Zone consists of the Frio 1-4 sands, and the Lower Frio Injection Zone consists of the Frio 5-7 sands (Figure NAR-3). The presented injection scenario supports a project designed to inject rates of 2 million tonnes per year (MMTPA) in each of 4 wells (2 Upper Frio Injection Zone, 2 Lower Frio Injection Zone) for 15 years for a total of 120 million tonnes (MMT) storage capacity.



## Narrative for Magnolia Sequestration Project

LA C&amp;E Permit No. 45027, 45028, 45756, and 45757



**Figure NAR-2—Regional N-S dip line schematic through Magnolia Sequestration Hub shows regional stratigraphy and dip relative to supercritical CO<sub>2</sub> depth and base USDW. Interpreted from 2D seismic and published well tops.**

|                                                        | Zones         | Sub Zonation                   |                                                                            |
|--------------------------------------------------------|---------------|--------------------------------|----------------------------------------------------------------------------|
| Top of Model ~3747 ft.                                 |               |                                |                                                                            |
| <b>Confining Zone</b>                                  | Lower Miocene | Lower Miocene<br>3747' – 4262' | Ave. Porosity = 29%<br>Ave. Perm = 2.4 mD                                  |
| <b>Intermediate Zone</b>                               | Anahuac       | Anahuac<br>4262' – 4662'       | Ave. Porosity = 34%<br>Ave. Perm = 2192 mD<br>Ave. Net Reservoir = 209 ft. |
|                                                        |               | Anahuac<br>4662' – 4958'       | Ave. Porosity = 30%<br>Ave. Perm = 1424 mD<br>Ave. Net Reservoir = 157 ft. |
| Top of Injection Zone ~4982 ft.                        |               |                                |                                                                            |
| <b>Upper Frio Injection Zone<br/>CCS-3 &amp; CCS-4</b> | Frio          | Frio<br>4982' – 5474'          | Ave. Porosity = 33%<br>Ave. Perm = 2569 mD<br>Ave. Net Reservoir = 400 ft. |
|                                                        |               | Frio 2<br>5488' – 5763'        | Ave. Porosity = 33%<br>Ave. Perm = 2831 mD<br>Ave. Net Reservoir = 118 ft. |
|                                                        |               | Frio 3<br>5792' – 5924'        | Ave. Porosity = 29%<br>Ave. Perm = 1920 mD<br>Ave. Net Reservoir = 62 ft.  |
|                                                        |               | Frio 4<br>5945' – 6173'        | Ave. Porosity = 30%<br>Ave. Perm = 2217 mD<br>Ave. Net Reservoir = 190 ft. |
|                                                        |               | Frio 5<br>6194' – 6444'        | Ave. Porosity = 30%<br>Ave. Perm = 2396 mD<br>Ave. Net Reservoir = 206 ft. |
|                                                        |               | Frio 6<br>6477' – 6614'        | Ave. Porosity = 30%<br>Ave. Perm = 2852 mD<br>Ave. Net Reservoir = 114 ft. |
|                                                        |               | Frio 7<br>6630' – 6984'        | Ave. Porosity = 29%<br>Ave. Perm = 2327 mD<br>Ave. Net Reservoir = 264 ft. |
| <b>Lower Frio Injection Zone<br/>CCS-1 &amp; CCS-2</b> | Vicksburg     | Vicksburg                      | Ave. Porosity = 14%<br>Ave. Perm = 1 mD                                    |
|                                                        |               |                                |                                                                            |
| Base of Injection Zone ~6994 ft.                       |               |                                |                                                                            |

**Figure NAR-3—Injection, Intermediate, and confining zonation with individual subzones with averages of porosity, permeability, and net reservoir thickness based on log analysis, along with approximate depth intervals at stratigraphic test well YAMS MLR 004 (SN 975950). Note that depths given here are in reference to the YAMS MLR 004 well.**

### 2.1.1 Regional Geology

The Paleogene and Neogene progradational wedge of sediment targeted for CO<sub>2</sub> sequestration at the Magnolia Hub is underlain by Mesozoic geology, a brief summary of which ensues. Following episodes of Triassic then Jurassic through earliest Cretaceous failed rifting, the region began its long history of thermal subsidence and basin infill (Figure NAR-4, Galloway 2008, Snedden and Galloway, 2019). Syn-rift sedimentation was followed by intermittent isolation of the proto Gulf of Mexico from global seas, which caused evaporation and buildup of tens of kilometers of salt during the middle Jurassic. Subsequent movement of the Louann salt due to loading and/or gravitational forces underpins most of the prolific oil and gas fields along the Gulf Coast and Gulf of Mexico, creating structural closures, faulting, and controls on sedimentation. The position of the Magnolia Hub on the edge of the Louann Salt basin means that the dramatic structuring often associated with salt evacuation, diapirism, faulting, etc. is minimal.

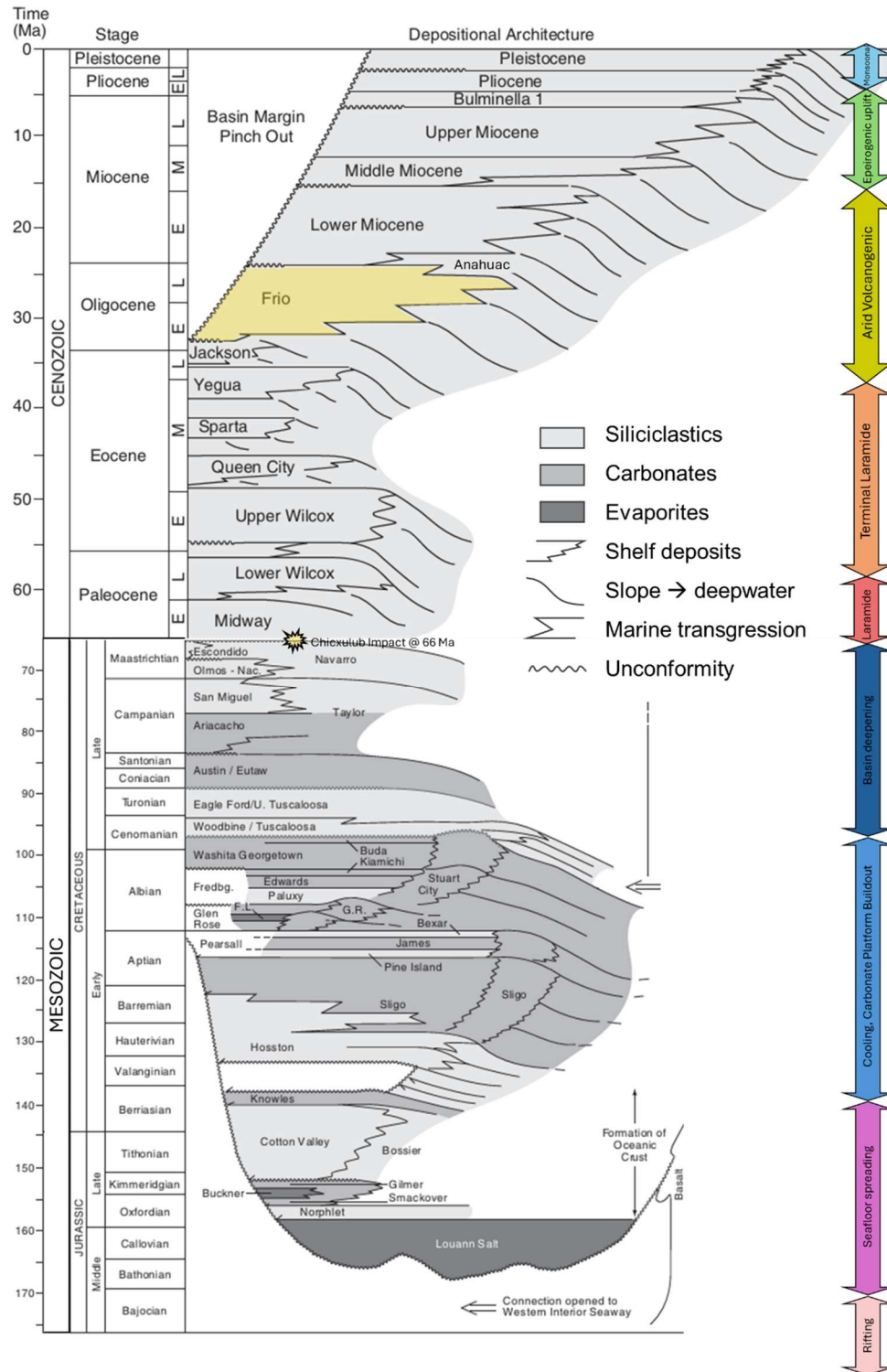
Mesozoic sedimentation above the Louann salt in the project area occurred in the arid environment of the Middle to Late Jurassic, then basin-margin to deepwater carbonates and siliciclastics through the Cretaceous. These include the middle-upper Cretaceous Eagle Ford shale and overlying Austin Chalk, which comprise the petroleum system elements of the prolific oil fields just north of the Magnolia site. Late Cretaceous through Eocene Laramide orogeny long-wavelength compression of the interior North American continent created source terrain for paleo river systems draining to

the Gulf of Mexico. This compression also activated the Sabine and Monroe uplifts and La Salle Arch basement highs to the north, where movement occurred along pre-existing zones of weakness inherited from the earlier Ouachita orogeny. These basement highs bracketed the course of the paleo Mississippi's lower reaches so the delta's position along strike was relatively fixed, focusing repeated depositional episodes as vast continental-scale river systems delivered sediment from the rapidly uplifting and eroding Rocky Mountains (Figure NAR-5).

The Frio formation injection target at the Magnolia Hub was deposited as part of the Mississippi paleo river delta and shoreface system during the mid Oligocene from ~34-23 Ma (Figure NAR-6; Galloway et al., 2011). Sediment derived from the northern Rocky Mountains and Great Plains was delivered to the coast via the paleo Mississippi drainage systems (Figure NAR-6). Long drainage systems plumbing mature sediment provenance areas resulted in the deposition of thousands of feet of relatively mature sediment composition at the Magnolia Hub, where point count data from the YAMS MLR 004 (SN 975950) stratigraphic test well show sublitharenite to subarkosic classification. (Figure NAR-6, Galloway et al., 2014; Loucks et al., 1984).

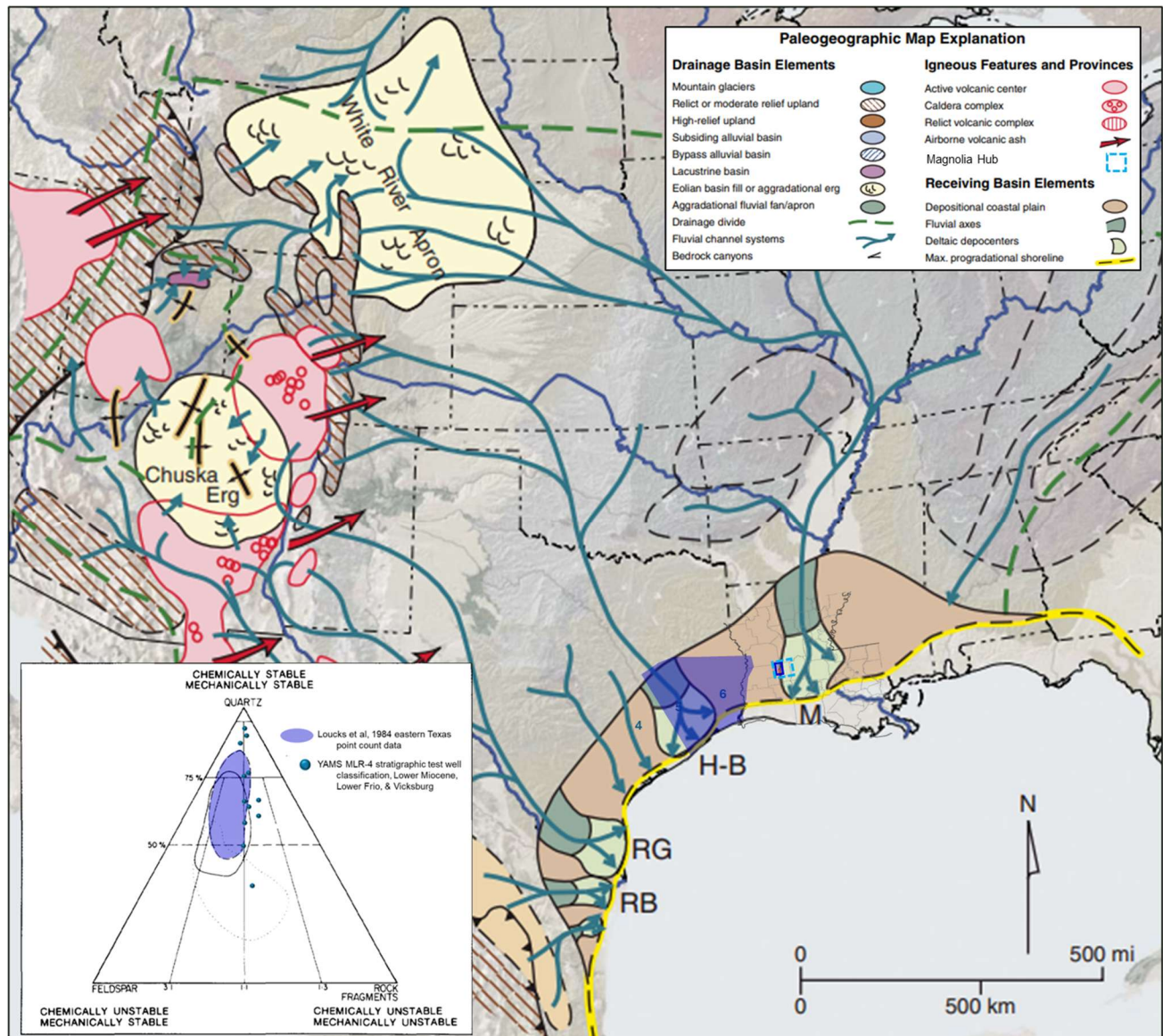
As Paleogene-Neogene continental sedimentation built out deltas and the shelf, it was periodically inundated by rising sea levels. The resulting marine shales provide excellent regional seals for both traditional oil and gas as well as CO<sub>2</sub> sequestration projects. Figures NAR-7 and AOR-4 [from Area of Review and Corrective Action Plan (AOR\_CA)] show published regional cross sections through the project area annotated with storage complex elements.

Careful correlation of GR, SP, and RES log character and understanding of the regional geologic context supported the recognition of stacked coarsening-up cycles within the Frio, Anahuac, and Lower Miocene stratigraphy. These are interpreted to be 3<sup>rd</sup> order parasequence sets in a proximal fluvial deltaic/shoreface setting. Each set is composed of a shaley base deposited during a transgressive systems tract, which coarsens up into a sandy top. Zones are numbered Frio 1-7 with the basal shales having a “\_B” suffix (e.g. Frio1 is the upper sand-dominated highstand systems tract deposit and Frio1\_B is the shaley base). Figure NAR-8 shows how the parasequence model compares with coarsening-upward cycles in a partial type log.



**Figure NAR-4—Mesozoic and Cenozoic stratigraphic diagram for Northern Gulf of Mexico showing timescale on left, depositional architecture in middle, and major tectonic stages on right. Magnolia Hub targets the progradational Eocene, Oligocene, and Lower Miocene strata composed of the Jackson/Vicksburg transgressive shale, Oligocene Frio progradational shelf, and Anahuac-Lower Miocene transgressive system. (Galloway 2008, Snedden and Galloway, 2019)**





**Figure NAR-5 — Oligocene Frio paleogeography after Galloway et al. 2011. Ternary diagram in lower left of figure shows YAMS MLR 004 (SN 975950) point count data (N=12) overlaid on grain composition from point count data from eastern Texas regions 5 & 6 published in Loucks et al., 1984.**

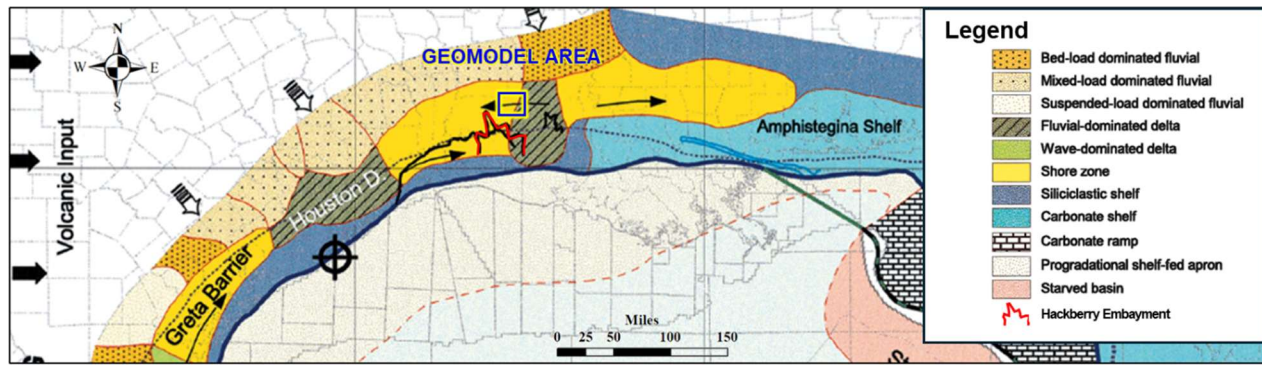


Figure NAR-6—Paleogeographic map of the modeled area at Magnolia Hub during mid-late Oligocene time, after Galloway, 2000. The site is situated at the western edge of the paleo Mississippi fluvially-dominated delta in the transition to the shore zone, where wave energy processes influence patterns of sand distribution.

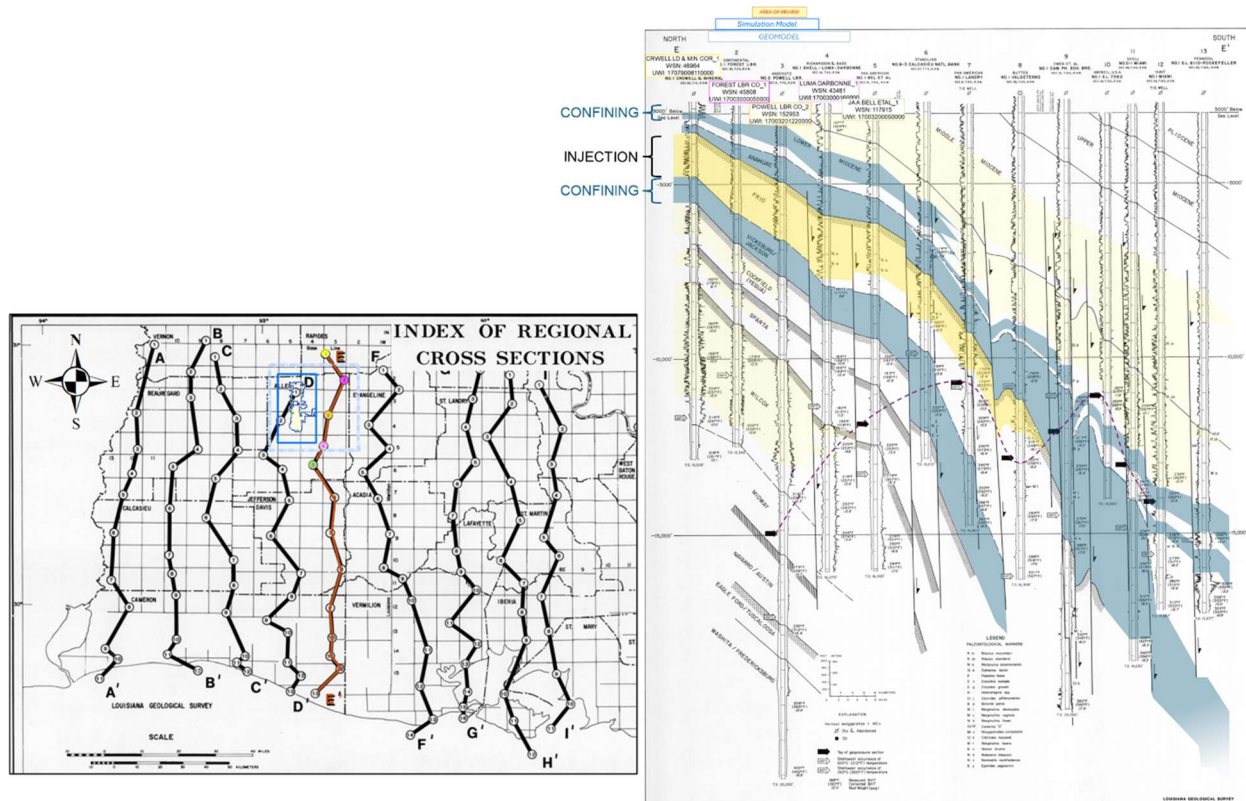
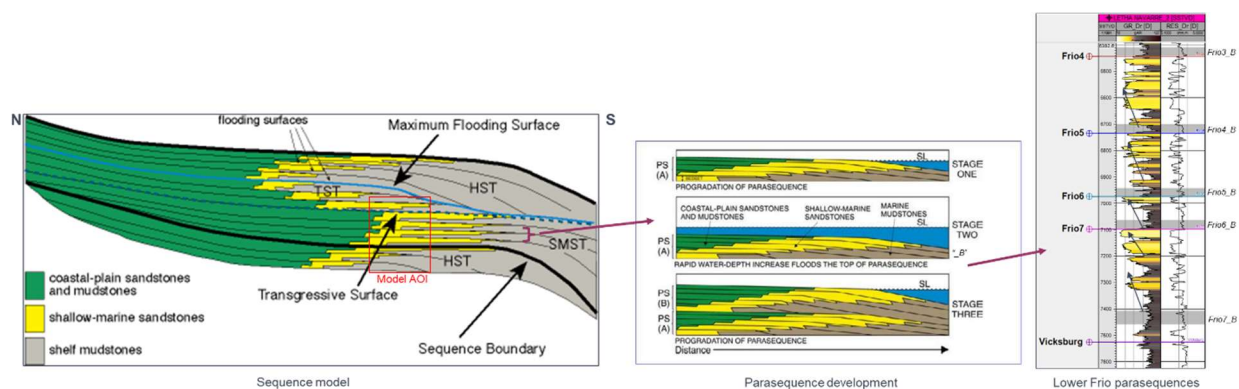


Figure NAR-7—Regional N-S cross section (E-E') from Bebout & Gutierrez, 1982, annotated with storage complex elements, gross lithologies, and geomodel, simulation model, and Area of Review intersections. Line is located to east of Magnolia Hub, but shows regional context of targeted Vicksburg, Frio, Anahuac, and Lower Miocene formations that comprise the storage complex. Datum is 3,000 ft total vertical depth subsurface (TVDSS).

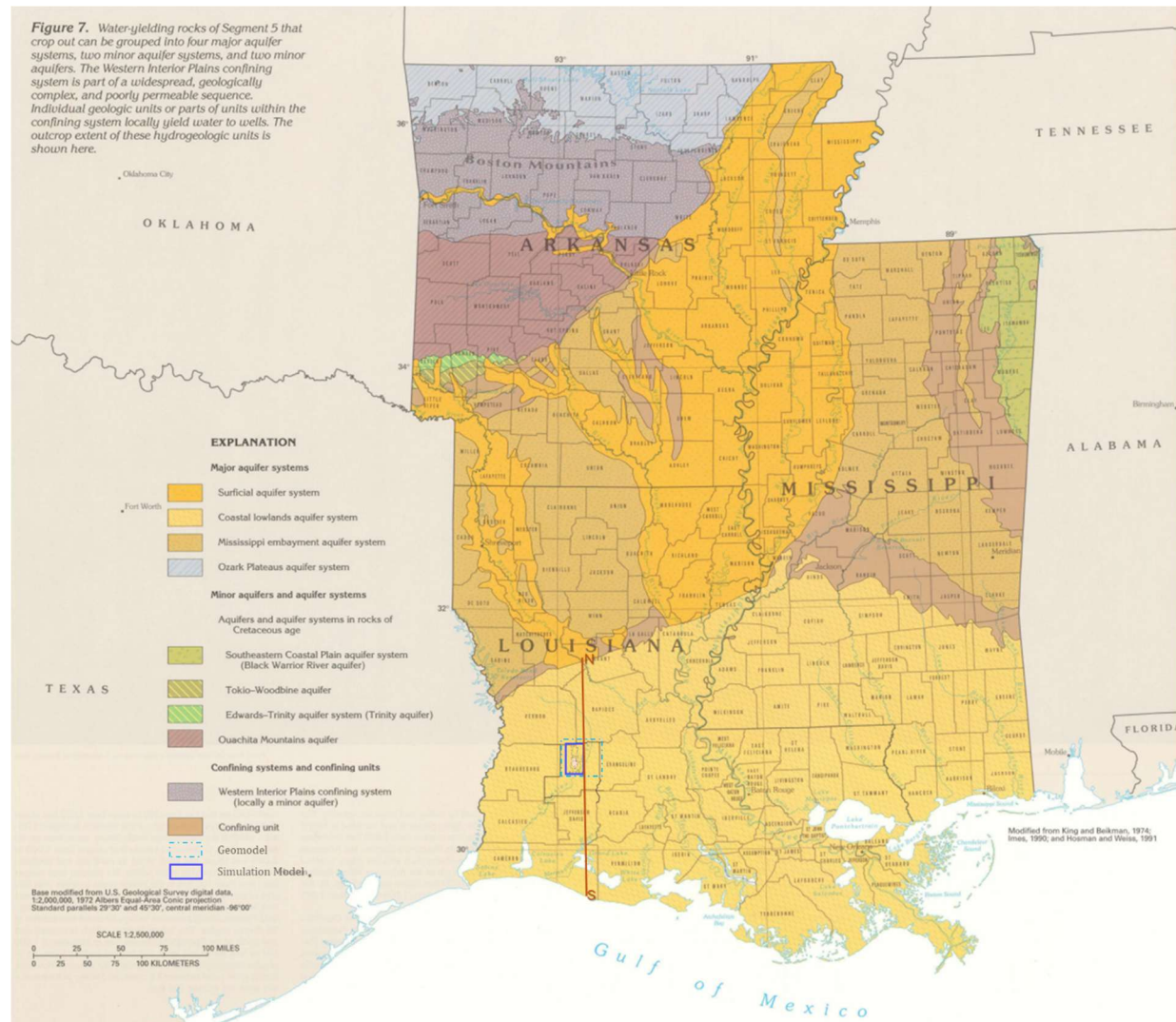




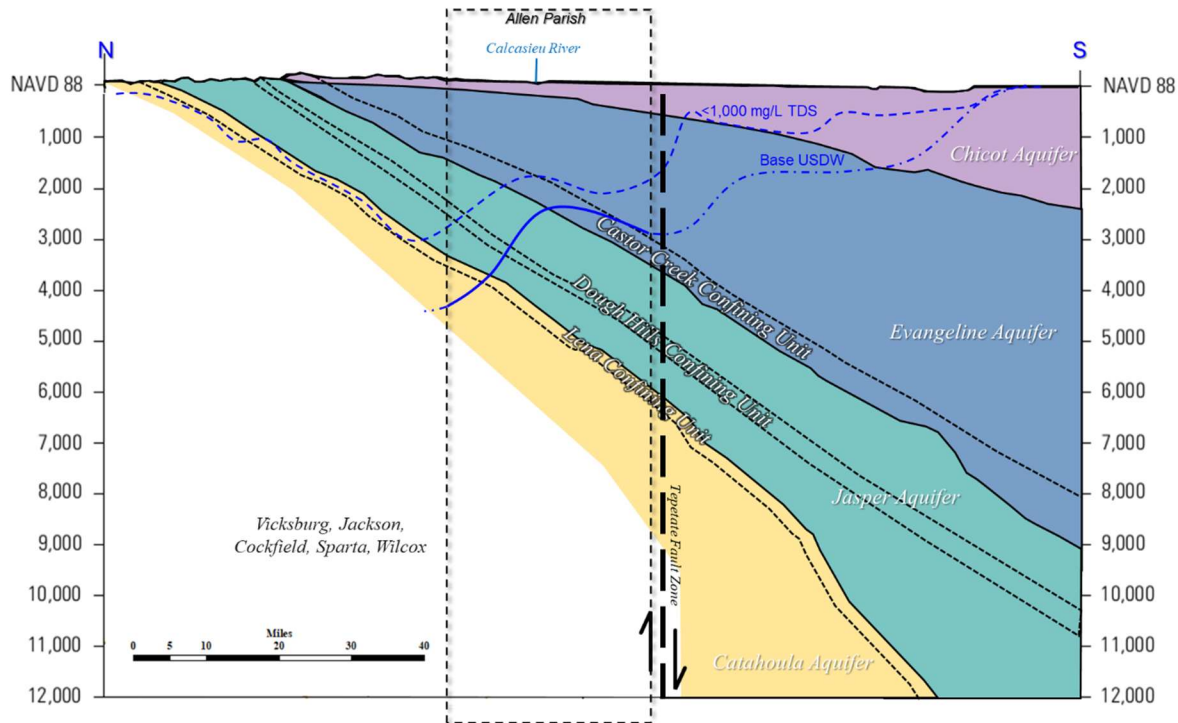
**Figure NAR-8 —Left: Progradational sequence stratigraphy diagram after Van Wagoner et al. (1990). Middle zooms in to parasequence set development to show how coarsening-up cycles accumulate. Shaley bases occur due to relative sea level rise, which results in subregional extent despite relatively low thickness. Right: An example of parasequence set identification from electrofacies in the Letha Navarre 2 (SN 196649) well.**

### 2.1.2 Hydrogeology

The Magnolia Sequestration Site overlies the Coastal Lowlands Aquifer System (Figure NAR-9) which is composed of the Chicot, Evangeline, and Jasper Aquifers (Smoot, 1988; Renkin, 1998; Lindaman, 2023). Figure NAR-10 illustrates the gently south-southeast sloping nature of the aquifer system towards the Gulf of Mexico.



**Figure NAR-9—Magnolia CCS Site is located in the coastal lowlands aquifer system. The coastal lowlands aquifer system consists of interbedded sands and shales, and is Holocene to upper Pleistocene deposits at the Magnolia site (Renken, 1998). N-S line is shown in Figure AOR-10.**



**Figure NAR-10—Regional hydrostratigraphy through Magnolia Hub, after USGS, 2023. The Magnolia Hub storage elements Lena Confining Zone, Anahuac Intermediate Zone, and Frio Injection Zone comprise the Catahoula Aquifer. The published depth to fresh water is shown in dashed blue line; solid blue line in Allen Parish is based on local base USDW mapping.**

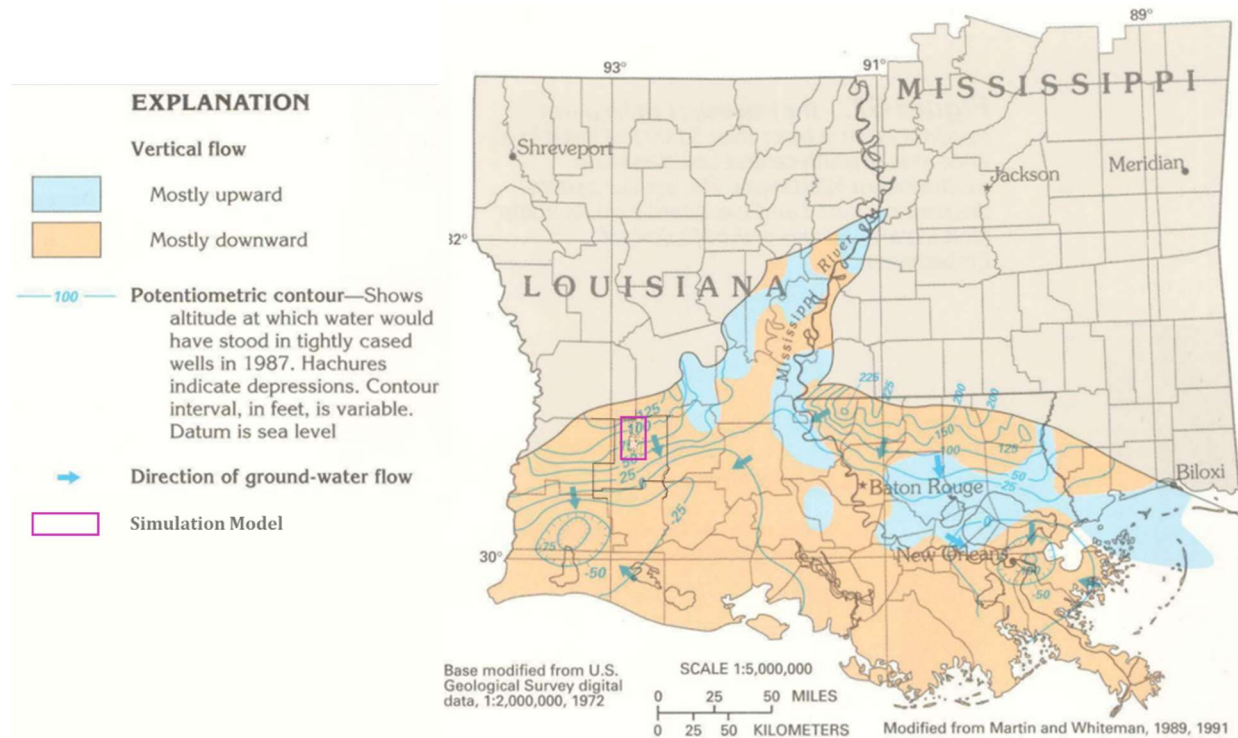
Groundwater production for agricultural and municipal use in Allen Parish is primarily sourced from the Chicot Aquifer, the shallowest of three primary aquifers that make up the overall Coastal Lowlands Aquifer System. The Chicot Aquifer consists of Pleistocene- to Holocene-aged sands with confining clay units at the surface and deeper undifferentiated sands (Figure NAR-10).

Precipitation recharges the Coastal Lowlands Aquifer Systems in mostly landward, interstream areas (Figure NAR-9). Under natural conditions groundwater flow is gravity driven and largely influenced by topography. Regional groundwater flow directions are predominately south-southeast toward to the Gulf of Mexico. However, more than 90 years of groundwater withdrawals from the Coastal Lowlands Aquifer have influenced groundwater flow directions in Southwestern and Southeastern Louisiana. These large groundwater withdrawals, primarily from agricultural use, have resulted in local and regional depressions in the potentiometric surface causing a change in groundwater flow directions towards areas with high volumes of groundwater extraction. Publicly available data of potentiometric surfaces in Chicot Aquifer suggest groundwater withdrawals in Lake Charles to the southwest of Allen Parish likely have or will eventually influence shallow groundwater flow directions in Allen Parish (Renken, 1998; Figure NAR-11).

The Evangeline Aquifer underlying the Chicot Aquifer is separated from the Chicot Aquifer by subregional sequences of shaly confining units. The Evangeline Aquifer is a confined aquifer comprising fine- to medium-grained sandstones interbedded with siltstones and clays.

The Jasper Aquifer underlies the Evangeline aquifer, separated by the regional Castor Creek confining unit predominately composed of shales. The Jasper aquifer system includes three major

geologic units: Williamson Creek Aquifer, Dough Hills confining unit, and Carnahan Bayou Aquifer (Prakken et al., 2012; Lindaman, 2023).



**Figure NAR-11—Large withdrawals at major pumping centers have resulted in decline of the potentiometric surface and have formed a large cone of depression in southwestern Louisiana, southeast of the Magnolia Hub.**

### 2.1.3 Structural Geology

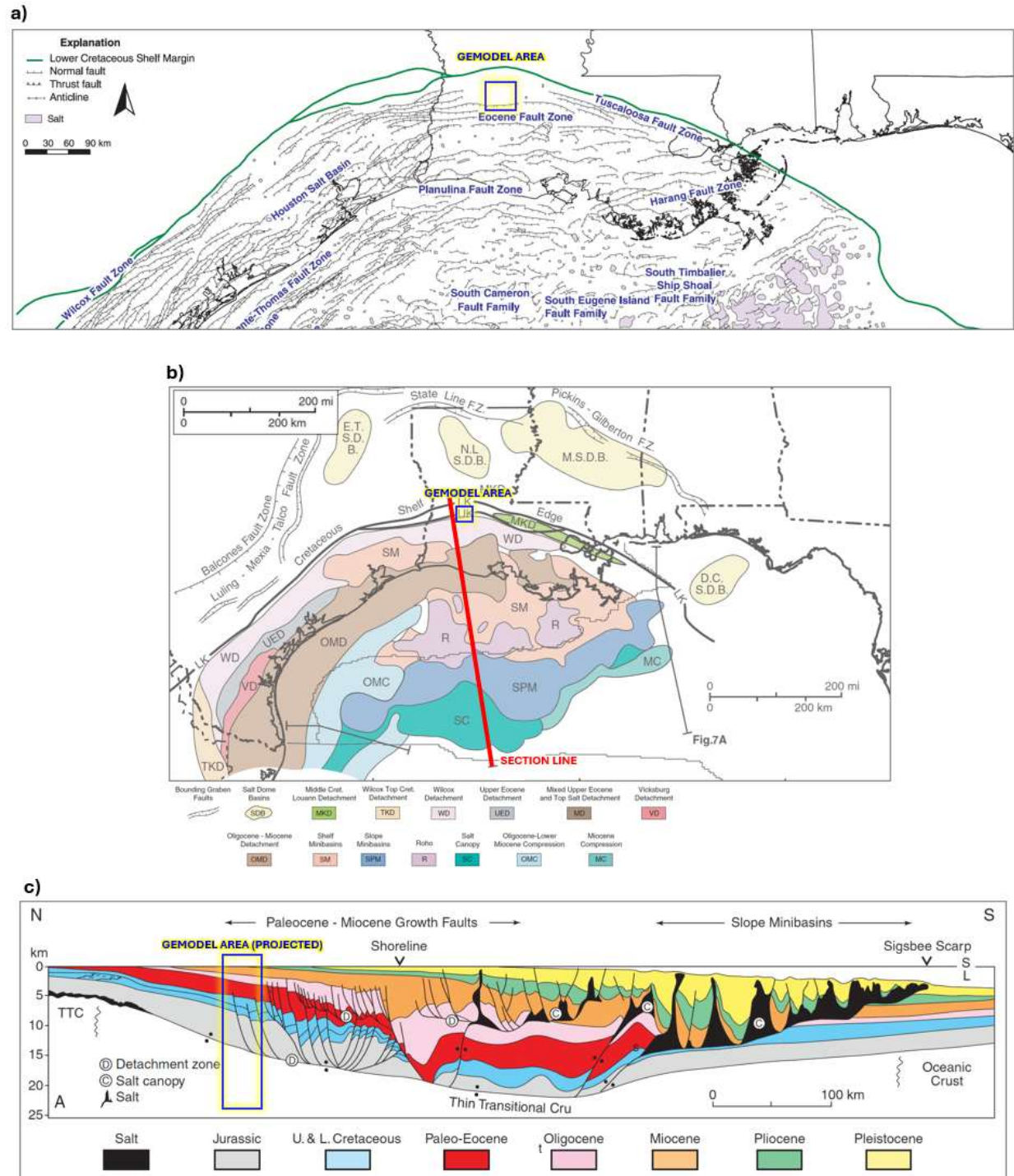
The Magnolia project site is located south of the regional Lower Cretaceous Shelf Margin (Figure NAR-12a) within the Paleocene-Eocene Wilcox Cretaceous Shelf Edge (figure NAR-12b). The project area is north of a regional Eocene aged fault zone, sometimes referred to as a zone of Wilcox detachment (Figure NAR-12b). The dominant structural style in the region is coast-parallel listric growth faulting of various ages resulting from progradational sediment loading. This progradational loading and resulting growth faulting results in mapped growth structures that decrease in age geographically towards the Gulf of Mexico Basin (Figure NAR-12c). This relationship is apparent in Figure NAR-12c where faulting in the project Geomodel area was active in the Cretaceous while later Paleocene-Eocene active faulting developed south of the Geomodel area.

A synthesis of regional faulting data along with local Lidar data is shown in Figure NAR-13. While age information is not provided for GEOMAP faults (GEOMAP is a commercial database to which Oxy subscribes), GBDS (Gulf Basin Depositional Synthesis Consortium) fault are age differentiated and agree with the regionally recognized development of a Paleocene-Eocene aged fault zone south of the CO<sub>2</sub> plume and at the distal edge of the AOR as defined by the Threshold Pressure Front.

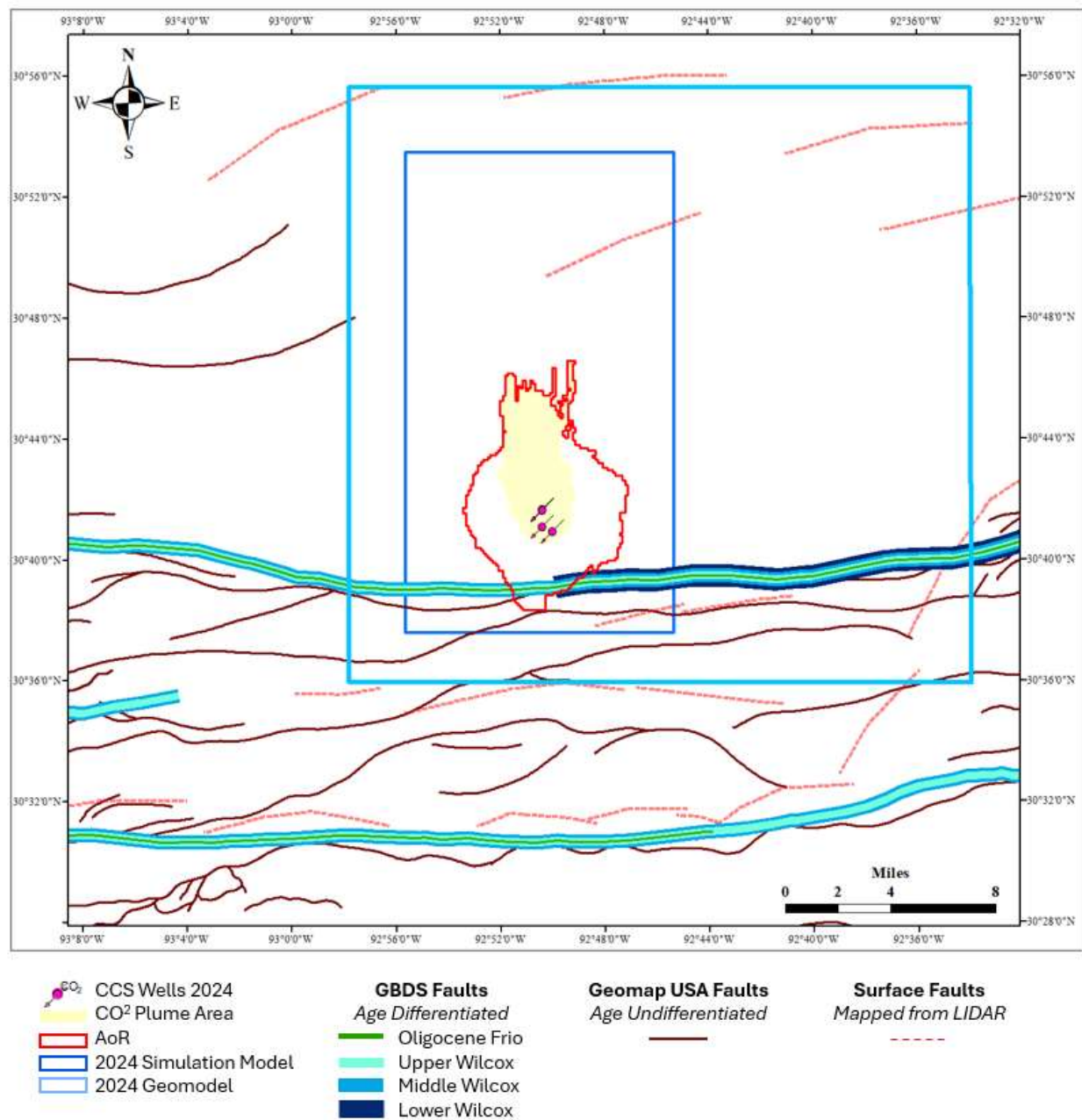
High-resolution LIDAR data was evaluated to identify potential surface faults. LIDAR-interpreted faults are included in Figure NAR-14. Faults were interpreted where the LIDAR indicated approximately coast-parallel linear features indicating potential linear fault offset. Variable gaining of the LIDAR data was required to highlight faulting in different areas as shown in Figure NAR-14b and c.

Movement on faulting to the south of the CO<sub>2</sub> plume is dated from Lower Wilcox to Oligocene Frio in timing. Age-undifferentiated faulting is indicated to the northwest of the AOR, but is shown to terminate laterally more than 5 miles west of the AOR. Most interpreted surface faults align with known fault trends to the south of the AOR, however some surface faults are interpreted north of the AOR where regional data for faulting is absent.

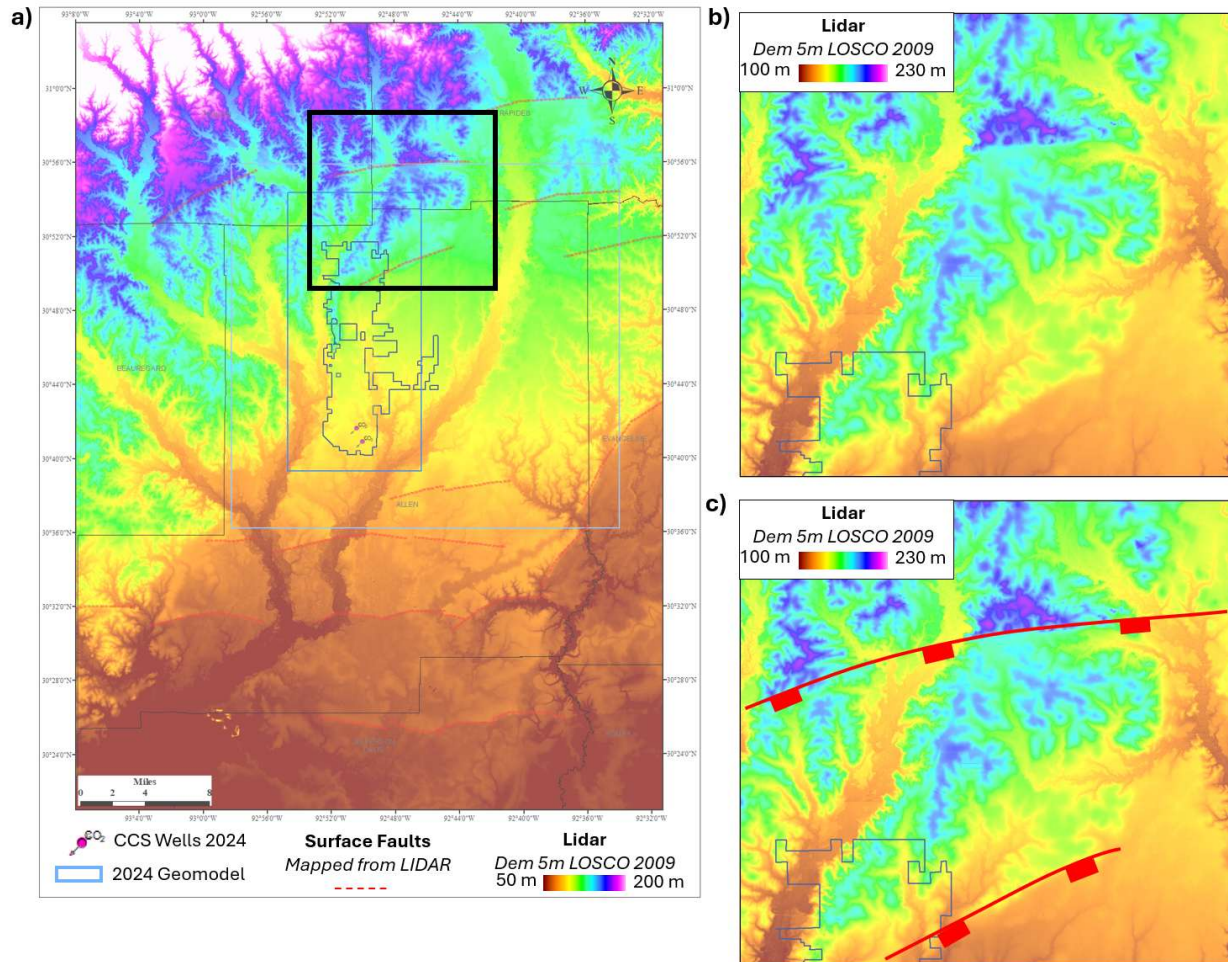




**Figure NAR-12—Compilation of regional interpretations from Galloway, 2008. a) Structural features of the northern Gulf of Mexico. b) Structural domains of the northern Gulf of Mexico. c) North-south (dip) cross section of the northern Gulf of Mexico continental margin**



**Figure NAR-13— Map showing all regional faulting data utilized for characterization.**



**Figure NAR 14—**a) Map showing surface LIDAR over regional area including 2024 Geomodel area with interpreted surface faults. b) Zoom area example indicated by black box in (a) with LIDAR gained to show local discontinuities used to interpret surface faults without fault interpretation and c) with surface fault interpretation.

## 2.2 AOR Overview

### 2.2.1 Maps and Cross Sections of the AOR

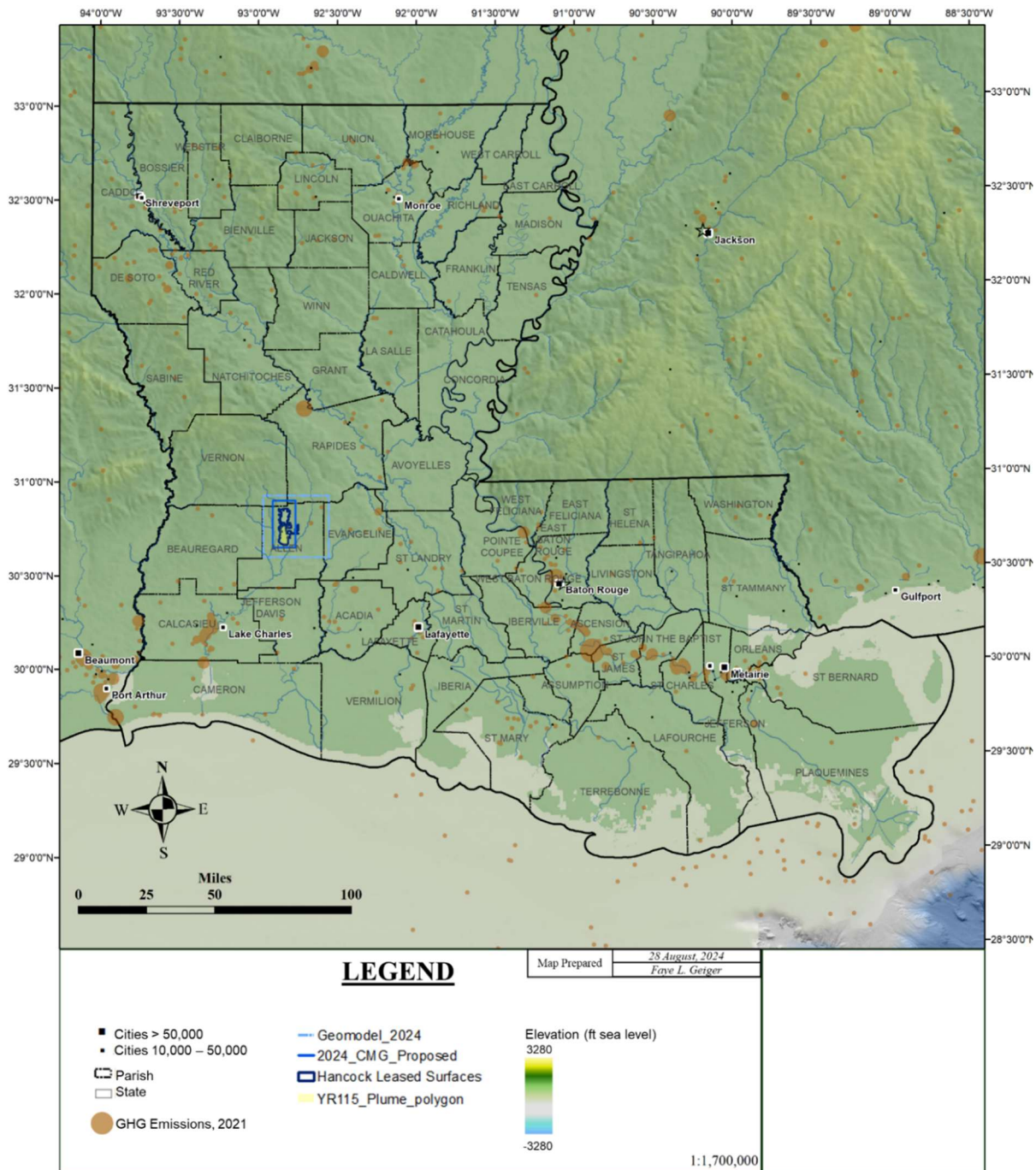
The Magnolia Sequestration Project site, located in northern Allen Parish in southwestern Louisiana, (Figure NAR-15) was selected due to its position between several large GHG emitters and favorable subsurface geology. The surface leasehold is positioned in between Tenmile Creek on the west and the Calcasieu River to the east (Figures NAR-15 and NAR-16). Land use is primarily sustainable forestry, evidenced by the patchwork colors in Figure NAR-16 that show harvested and unharvested portions of the property. There are no springs, surface and subsurface mines, quarries, structures intentent for human occupancy, or state, tribal, or territorial boundaries occur within the plume plus a 2-mile buffer. Figure AOR-8 (from AOR\_CA) shows surface hydrology and the Area of Review (coincident with LAC 43:XVII.3615(B)) and defined by the CO<sub>2</sub> plume extent 100 years post-injection and maximum threshold pressure front in section 4.2



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of the AOR\_CA. The legacy oil/gas wells and water wells within the AOR and are discussed in detail in AOR\_CA Section 5.0.

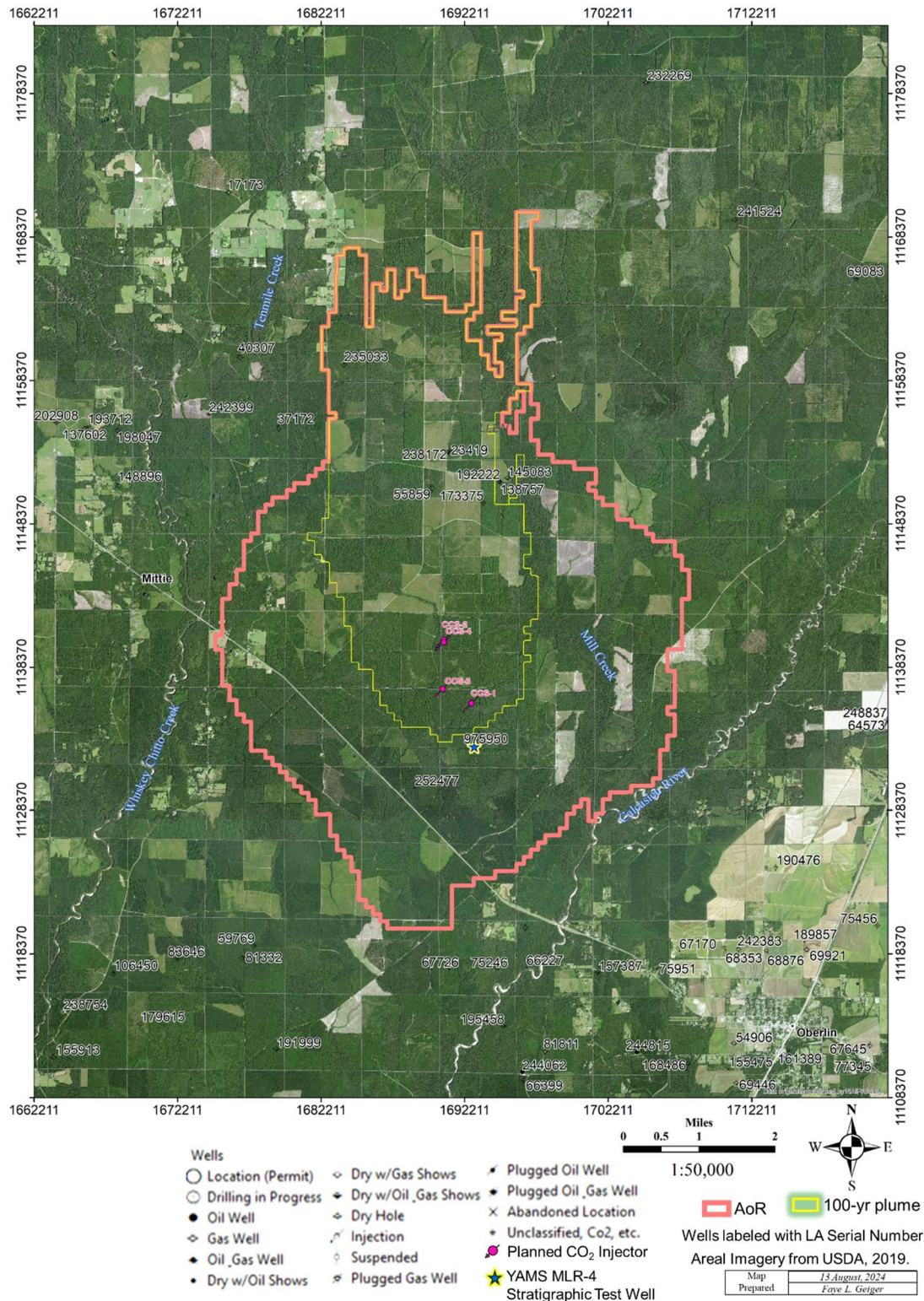


**Figure NAR-15—Magnolia Sequestration Hub is located on the Gulf Coastal Plain in northern Allen Parish, southwestern Louisiana, 30-40 miles from major green house gas emitters and major population centers. Green House Gas emission sources from EPA Flight database (2021).**



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**Figure NAR-16—Location Area of Review, 100-year CO<sub>2</sub> plume footprint, and proposed injector wells over aerial photography from USGS The National Map, August, 2023**

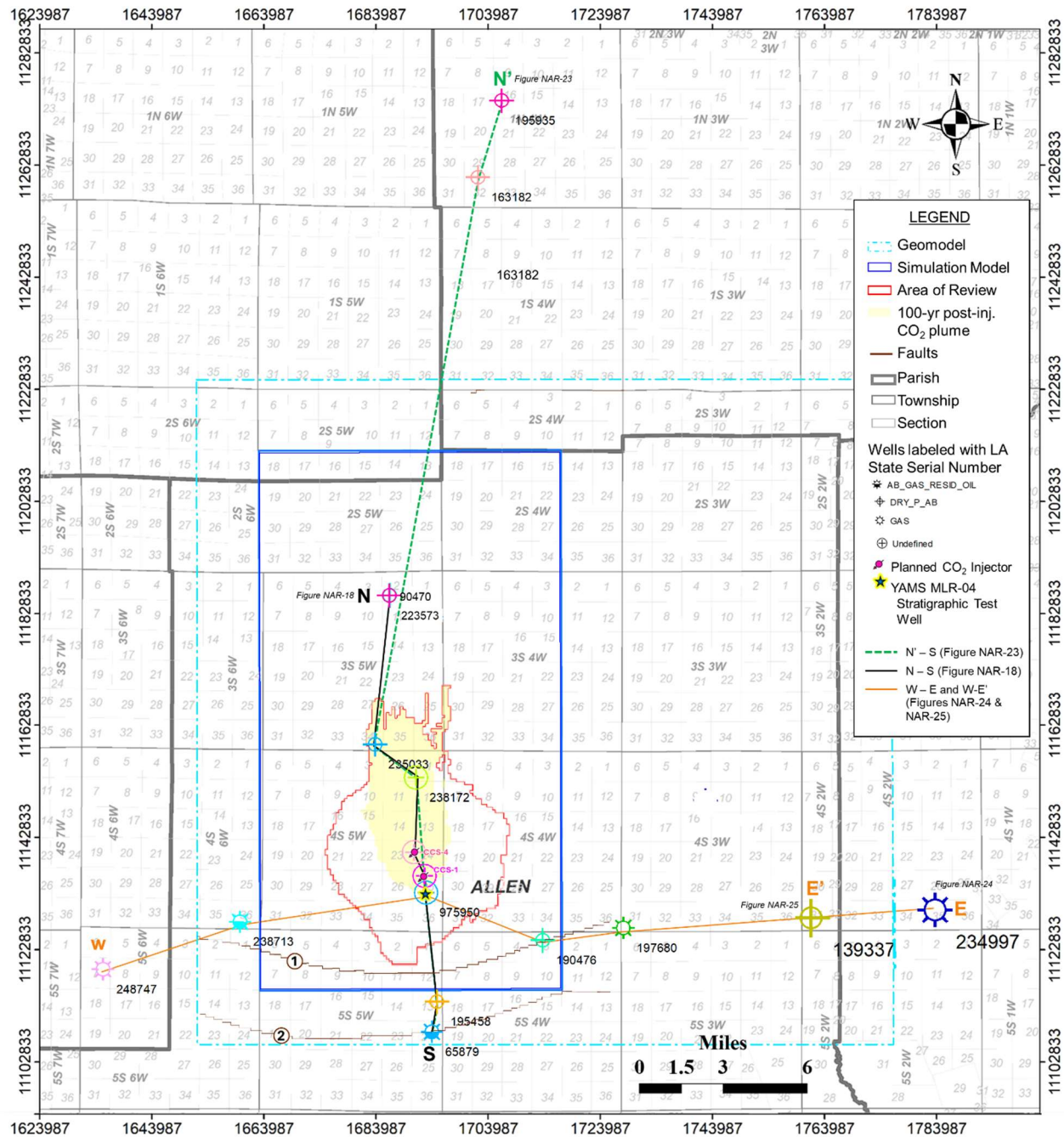


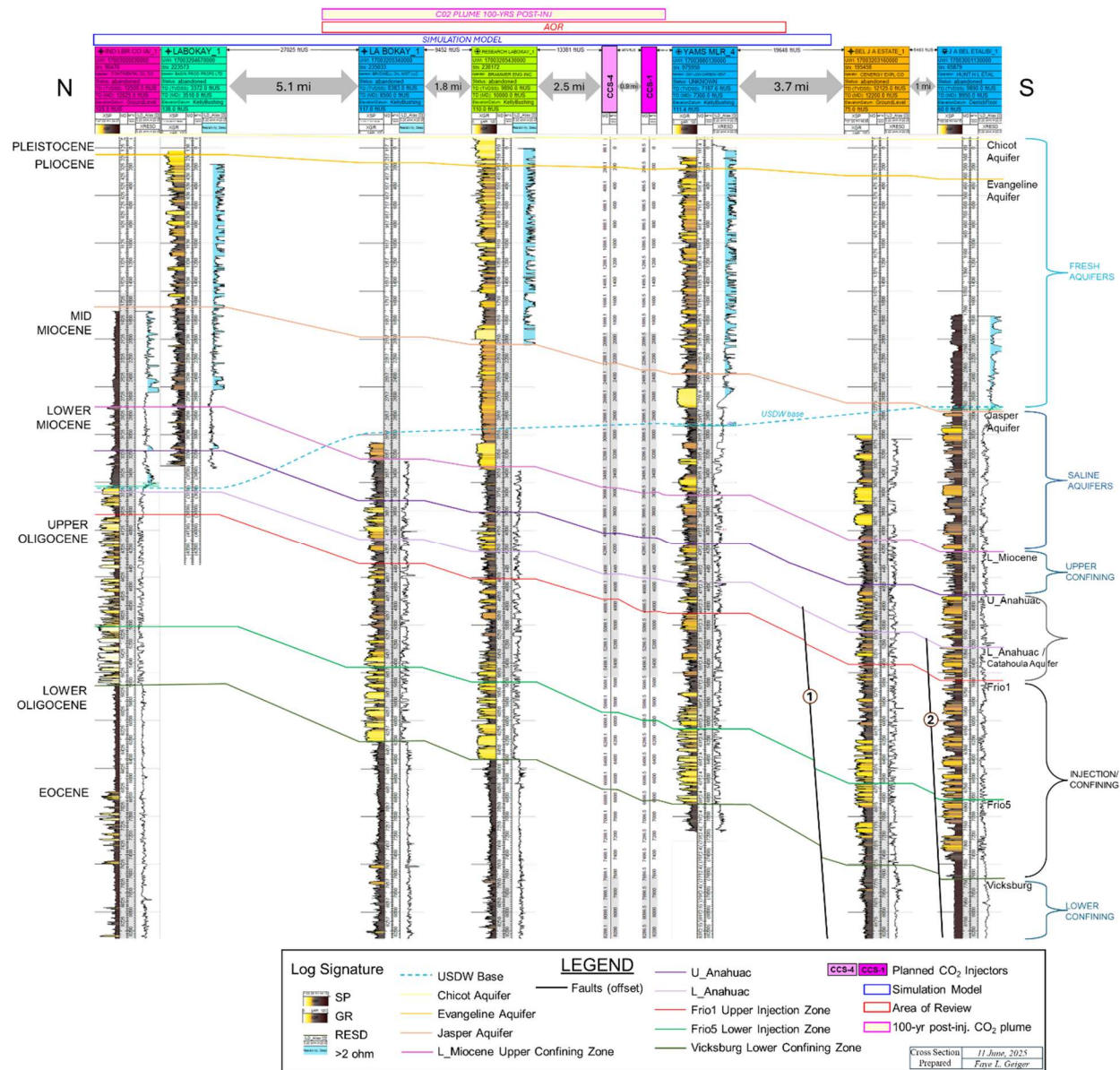
The Magnolia Site is positioned just north of major Oligocene faulting within the stable Frio shelf environment. Figure NAR-17 shows the position of the N-S cross section shown in Figure NAR-18, which is a structural N-S cross section through the entire area with storage complex elements annotated. The base of the lowermost underground source of drinking water (USDW) shown on the figure is discussed in greater detail in section NAR 2.2.9; it is separated from the Frio Injection Zone by the Lower Miocene upper confining system and the Anahuac Intermediate Zone. The two faults shown on the southern end of the line in Figure NAR-18 are discussed in detail in the next section; both are outside of the modeled CO<sub>2</sub> plume and Fault 1 (F1) intersects the edge of the threshold pressure front. Figures NAR-19, 20, 21, 22, and 22 show 238 shows depth structure maps of the top Lower Miocene Upper Confining Zone, top Anahuac Intermediate Zone, top Frio1 upper injection zone, top Frio5 lower injection zone and top Vicksburg Lower Confining Zone. These maps show homoclinal dip down to the south, no structural traps, and how Faults 1 and 2 (F1, F2) are modeled to match observations from seismic lines: the Vicksburg Lower Confining Zone has offset, and there is some offset through the Frio Injection Zone. By the Anahuac, there is no observable offset on these faults.

Parasequence-scale sand packages are laterally continuous across the site, though individual architectural elements may pinch out or be compensationally stacked. Here the paleo-Mississippi delta deposited sand as mouth bars, delta lobes, point bar deposits, and barrier bars; and shales in off-axis, bayfill, backbay, lower shoreface, and prodelta environments. Local cross sections through the area show how sands and shales were deposited within parasequences, and that sands tend to be associated with highstand systems, while basal transgressive systems tracts are shalier. Figure NAR-19 shows the same N-S cross section as Figure NAR-17, but stratigraphically hung on the Frio3 and annotated with systems tract interpretation, subregional shale units, and geomodel, simulation model, and AOR intersections. Figure NAR-20 is a W-E oriented stratigraphic cross section with the Frio3 pick as its datum and the YAMS MLR 004 (SN 975950) well as the tie well between Figures NAR-19 and NAR-20. Possible sequence boundaries or transgressive surfaces are annotated in red along with the systems tract interpretation.

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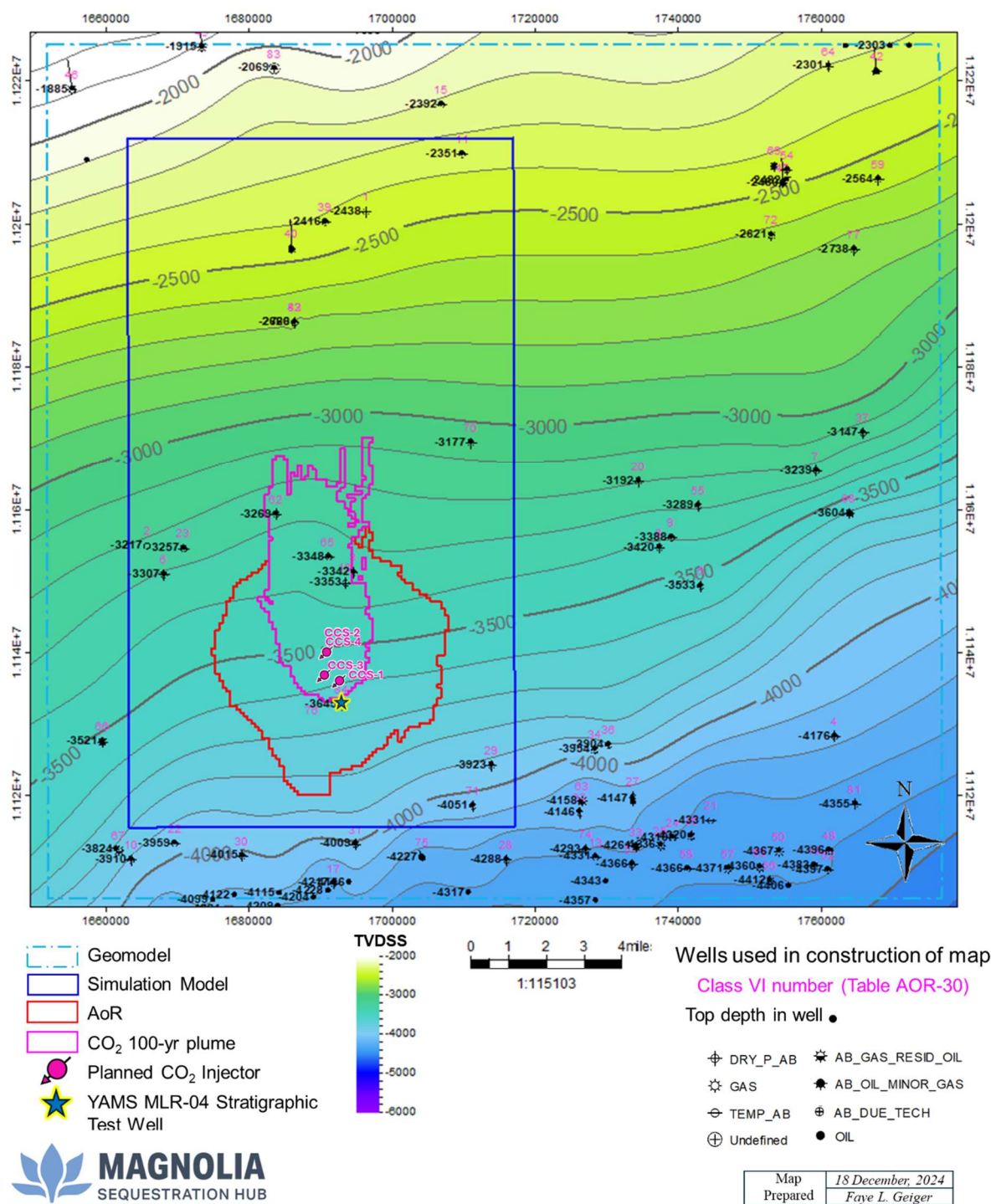
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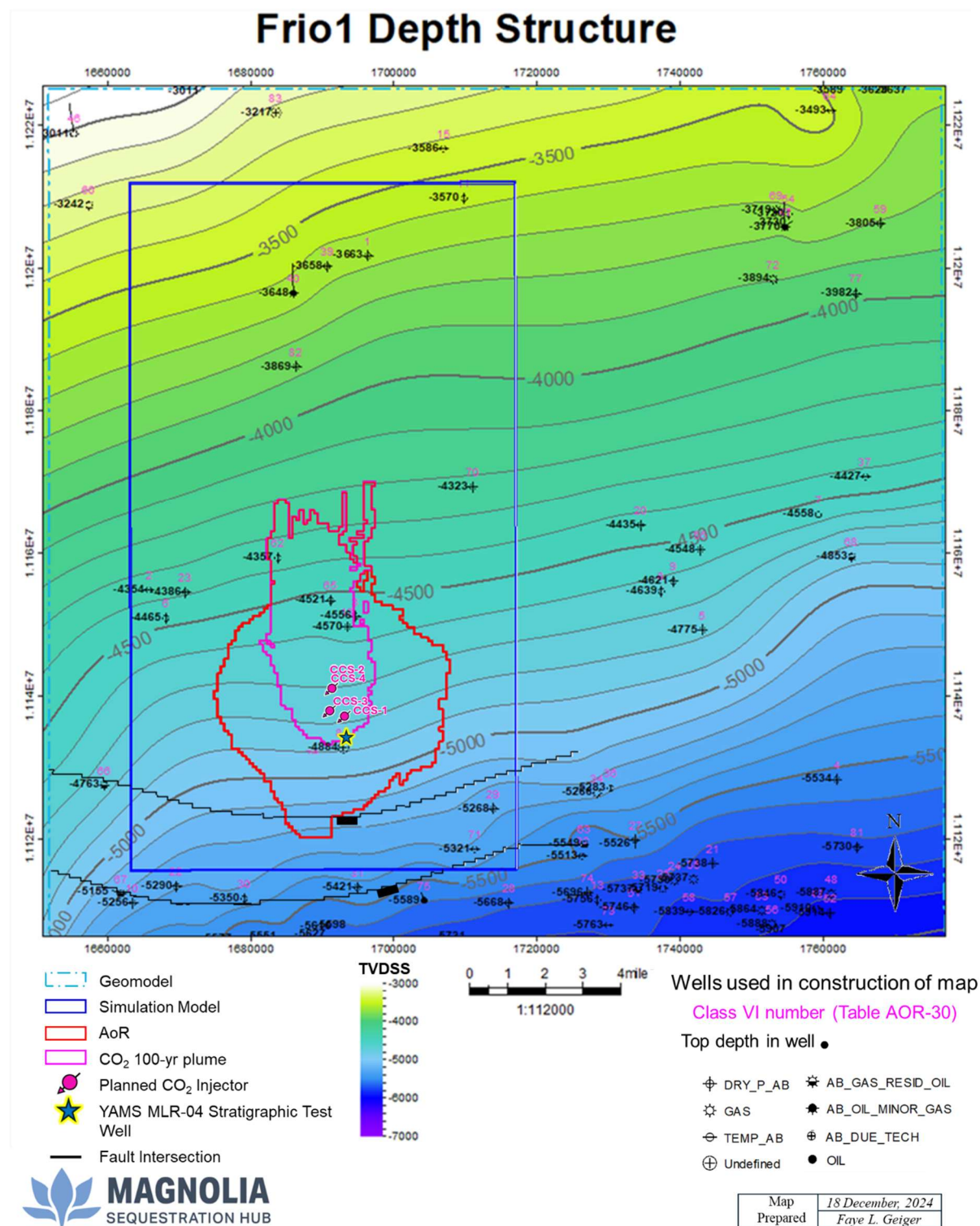


## L\_Miocene Depth Structure

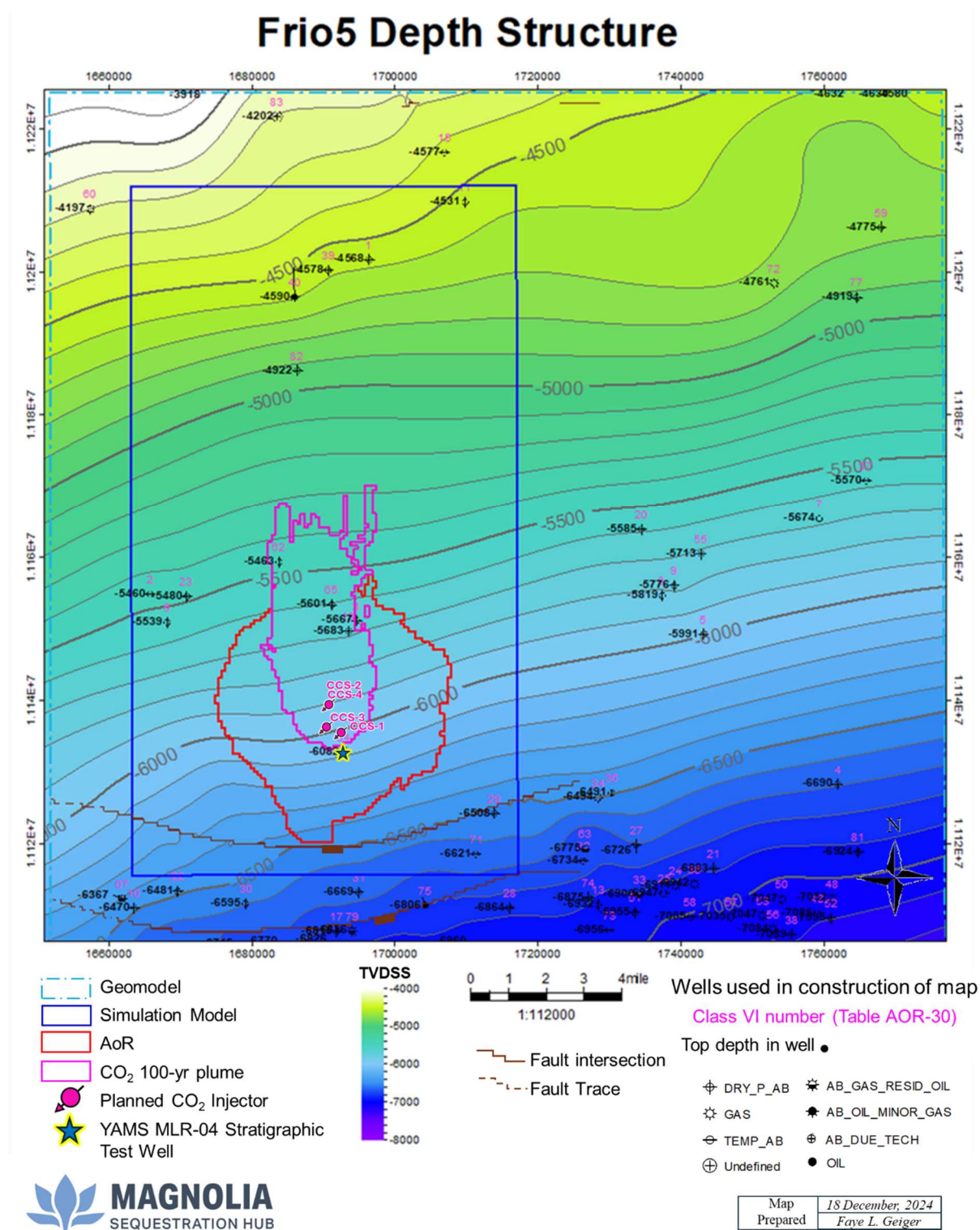


**Figure NAR-19—Depth structure maps over the modeled area on the top Upper Confining Zone, the Lower Miocene. Contour interval is 100 ft. Wells with tops used in the construction of the structure map are labeled with arbitrary Class VI number (catalogued in Table AOR-30) in pink and top depth in TVDSS in black. Faults 1 and 2 at southern end of project are not modeled to have offset at this level.**





**Figure NAR- 20—Depth structure maps over the modeled area on the top Frio Injection Zone at the Frio1. Contour interval is 100 ft. Wells with tops used in the construction of the structure map are labeled with arbitrary Class VI number (catalogued in Table AOR-30) in pink and top depth in TVDSS in black.**



**Figure NAR-21 – Depth structure maps over the modeled area on the top Frio5, which is the top of the lower part of the Frio targeted for injection. Contour interval is 100 ft. Wells with tops used in the construction of the structure map are labeled with arbitrary Class VI number (catalogued in Table AOR-30) in pink and top depth in TVDSS in black.**



## Vicksburg Depth Structure

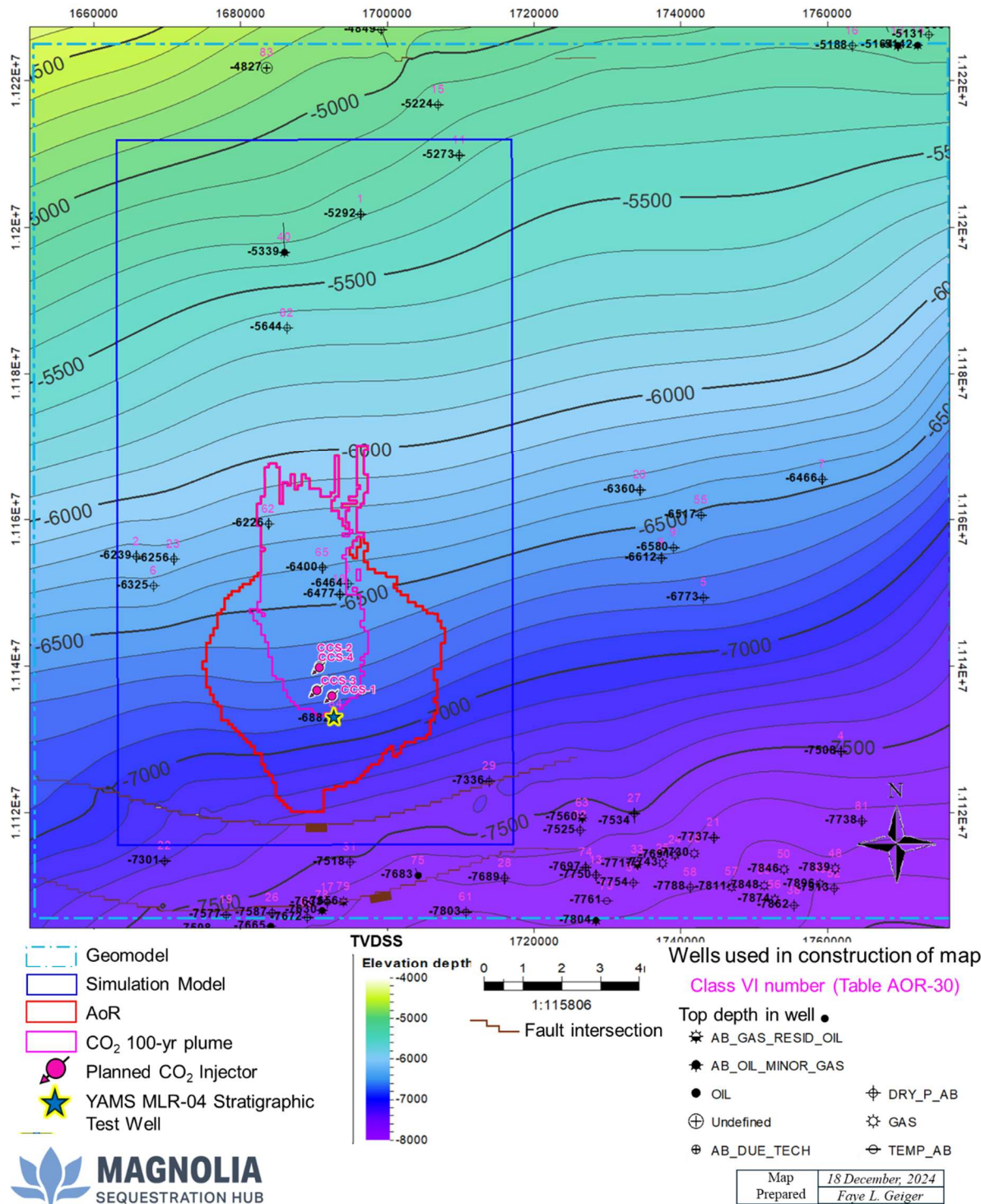
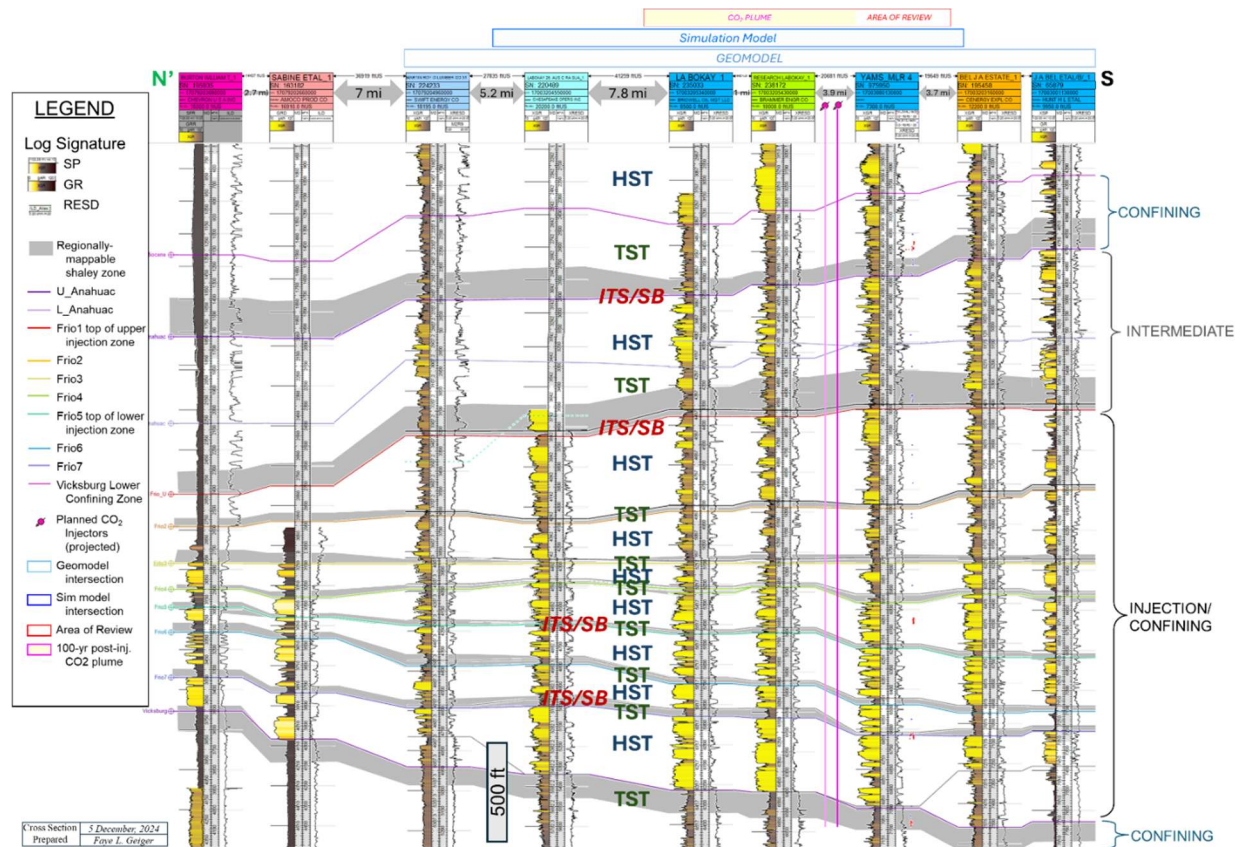


Figure NAR-22—Depth structure maps over the modeled area on the top Lower Confining Zone, the Vicksburg. Contour interval is 100 ft. Wells with tops used in the construction of the structure map are labeled with arbitrary Class VI number (catalogued in Table AOR-30) in pink and top depth in TVDSS in black.

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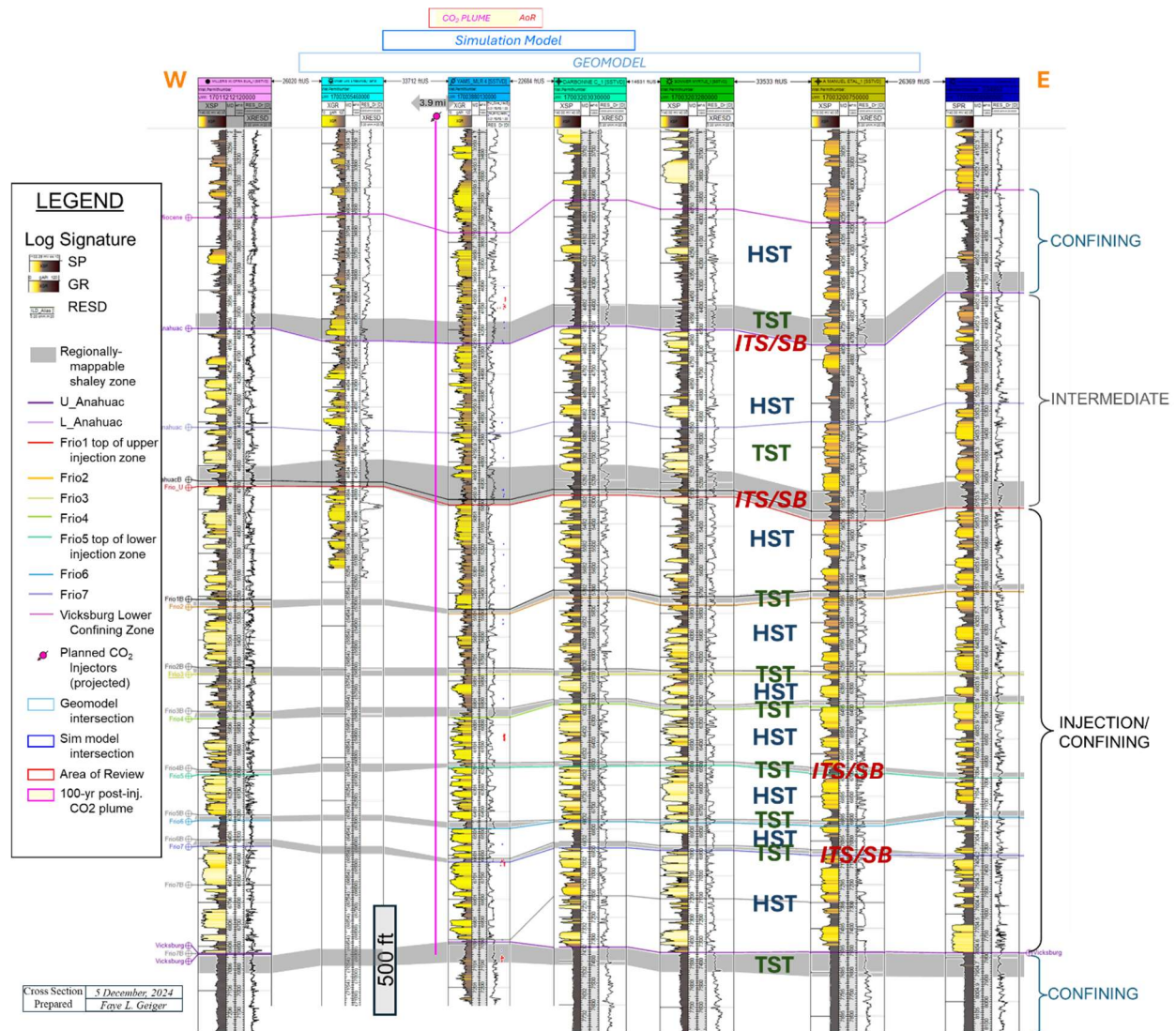


**Figure NAR-23– Stratigraphic N'-S cross section through the modeled area flattened on the Frio3. Storage complex elements labeled on right; interpreted tops that correspond to geomodel zones annotated on the left of the section. Annotated shales correlate regionally through geomodel area. CCS-1 and CCS-4 wells projected onto section.**

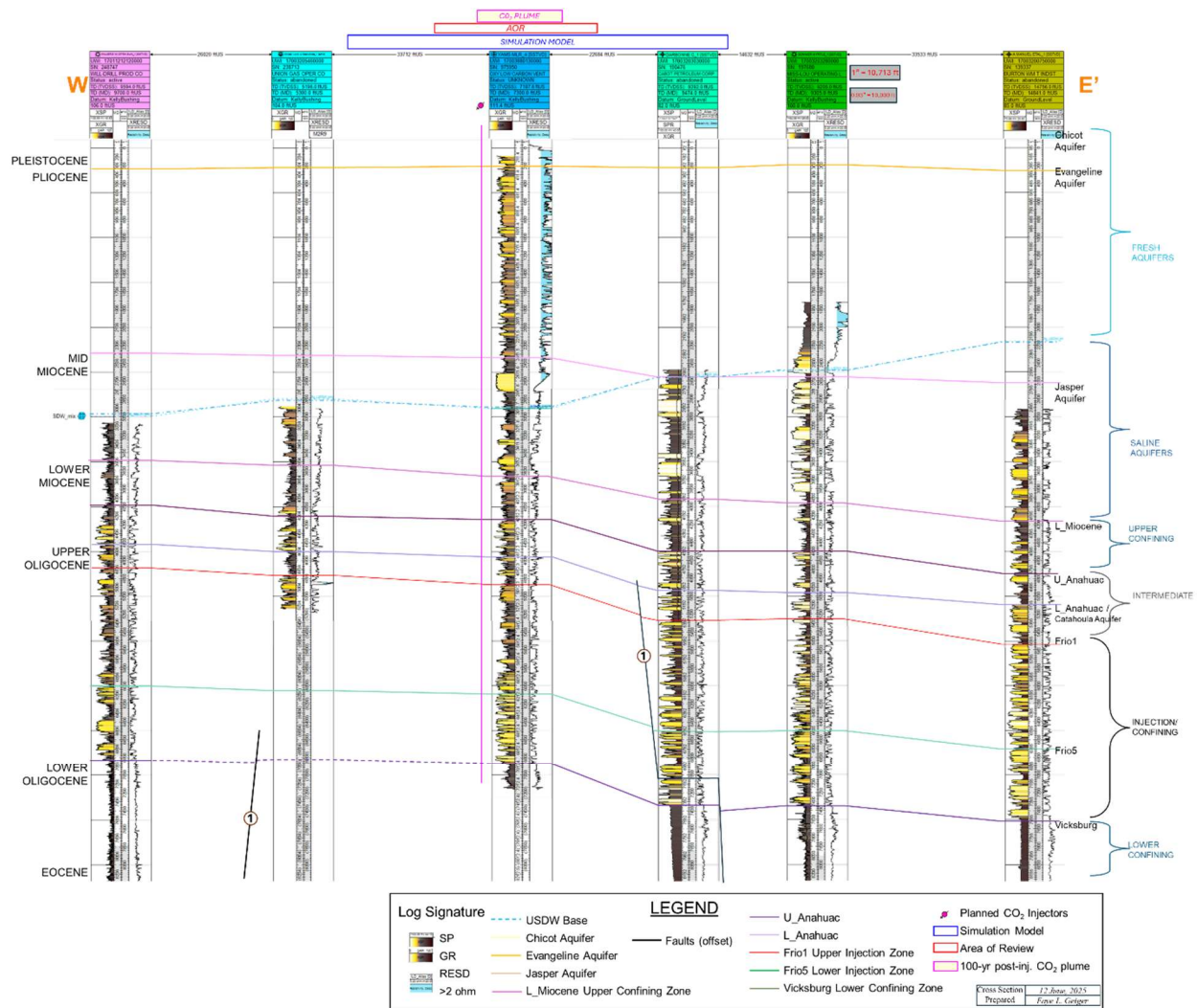


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**Figure NAR-24—Stratigraphic W-E cross section through the modeled area flattened on the Frio3 at same scale as Figure NAR-23. Storage complex elements labeled on right; interpreted tops that correspond to geomodel zones annotated on the left of the section. Annotated shales correlate regionally through geomodel area.**



**Figure NAR-25—Structural W-E' cross section through the modeled at same scale as Figure NAR-18. Storage complex elements and interpreted tops that correspond to geomodel zones annotated on the right of the section.**

### 2.2.1.1 Faults

In summary, a synthesis of regional and local data demonstrates that no through-going or transmissible faults are present within the storage complex across the calculated CO<sub>2</sub> plume extent, and effects resulting from the interaction between the distal southern extent of the pressure front and a fault that extends vertically into the Frio Injection Zone, but terminates below the Lower Miocene Confining Zone are negligible and pose no tangible risk to the project.

Licensed 2D seismic data further underpins this observation. Figure NAR-26 shows 2D seismic data sets used for the construction of the Geomodel ('Licensed 2D Seismic Data Pre 2024') along with additional 2D seismic licensed at a later date ('Licensed 2D Seismic Data 2024') and utilized to further investigate potential faulting in the project area. 2D lines in the Pre 2024 Licensed 2D Seismic Data set are from multiple sources of various vintages with various degrees of image quality. All lines in this data set were acquired between 1960 and 1990 and contain only original

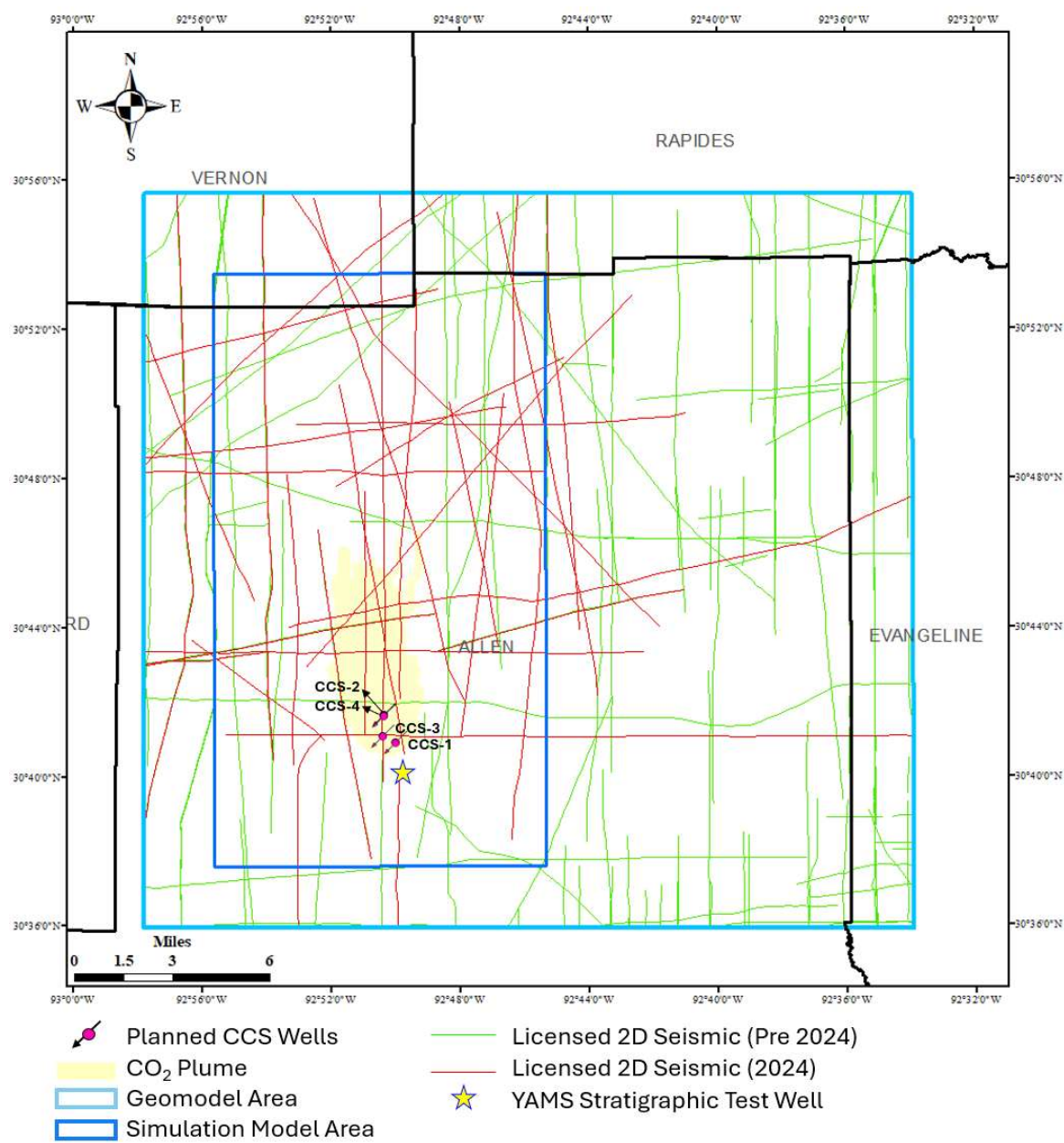
processed volumes. The 2024 Licensed 2D Seismic Data set was licensed from Seismic Exchange Inc, and contains lines from surveys acquired by multiple operators between 1969 and 1985 that were reprocessed together between 2011 and 2012. Issues such as poor sampling of the AOR area, poor navigation, 2D line ties, and amplitude balancing present in the Pre 2024 data set are significantly improved upon by the reprocessing of the 2024 data set.

An example well-seismic tie is shown in Figure NAR-27. The synthetic seismic was generated using a sonic log (SON) from the IVA R Hanchey 1 well (SN 148896) with a constant density (as no density log was available) convolved with a 20 Hz Ricker wavelet. The tie is qualitatively viable and provides a confident solution for the horizon to well top interpretation.

The Pre 2024 and 2024 data sets were examined at length to investigate potential faulting. Figure NAR-28 shows a North-South composite seismic line that bisects the AOR. The exact location of the line and specific two-way-time information may not be provided according to the license agreement with Seismic Exchange Inc. Key horizons including the Top Jackson and Top Anahuac (which define the base and near top of the Storage Complex) are interpreted from the well tie shown in Figure NAR-27. The line is vertically exaggerated in order to highlight faulting, and interpreted faults are shown as solid black lines. Faulting within the CO<sub>2</sub> plume area and across most of the AOR is almost exclusively isolated vertically to the interval below the Top Wilcox, with only one fault (starred) showing offset extending slightly above the Top Wilcox. Faulting below the Top Wilcox may be more complex than shown in this interpretation.

Two faults that extend into the injection zone are interpreted south of the CO<sub>2</sub> plume area. Figure NAR-28 shows that offset along the faults (solid black lines) are interpreted to extend into the Frio Injection Zone (between the Top Jackson and Top Anahuac). These two faults are projected vertically through the Top Anahuac (dashed black lines) to represent any potential sub-seismic vertical extension of the faulting, however minimal to no offset is attributed to layers in the geomodel above where offset is inferred from seismic. A map view of the two faults is shown in Figure NAR-29 along the CO<sub>2</sub> plume and AOR outlines. The southern most portion of the AOR as defined by the threshold pressure front appears to interact with Fault 1, however the magnitude of the pressure change predicted at the fault intersection (maximum pressure increase of 97 psi) is significantly below the calculated pressure increase required to induce shear failure along the fault (1100 psi increase) (see Figures AOR-37 and AOR-38). As such, the interaction of the distal pressure front with Fault 1 as currently mapped on 2D seismic poses no tangible risk to the project.

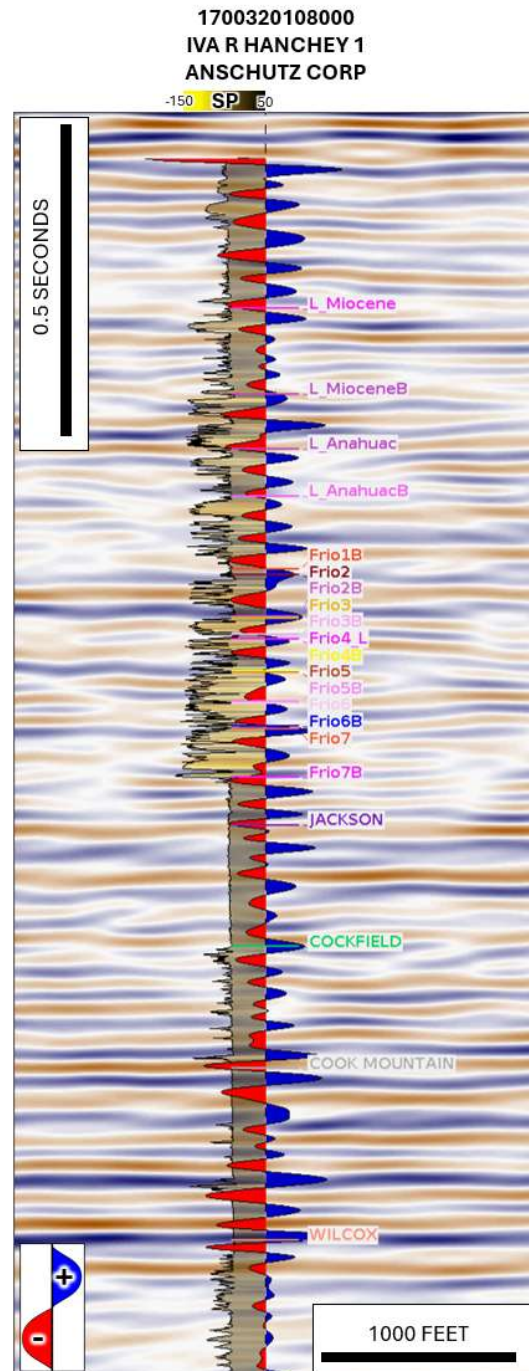




**Figure NAR-26—Map showing 2D seismic data used in Site Characterization.**

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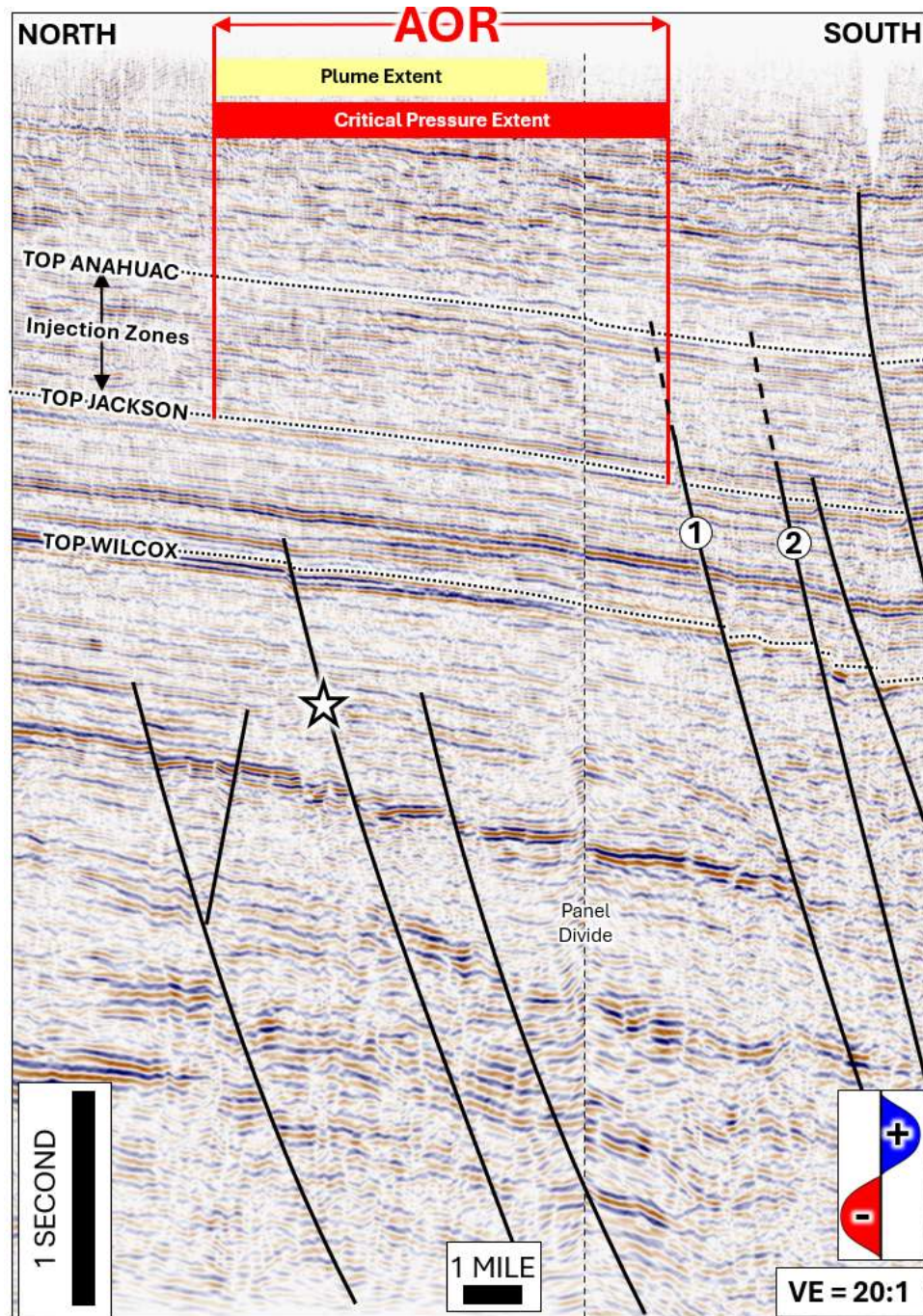
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Seismic data owned or controlled by Seismic Exchange, Inc.; Interpretation is that of Magnolia Sequestration Hub, LLC.

**Figure NAR-27—2D seismic cross section showing synthetic seismic well tie.**





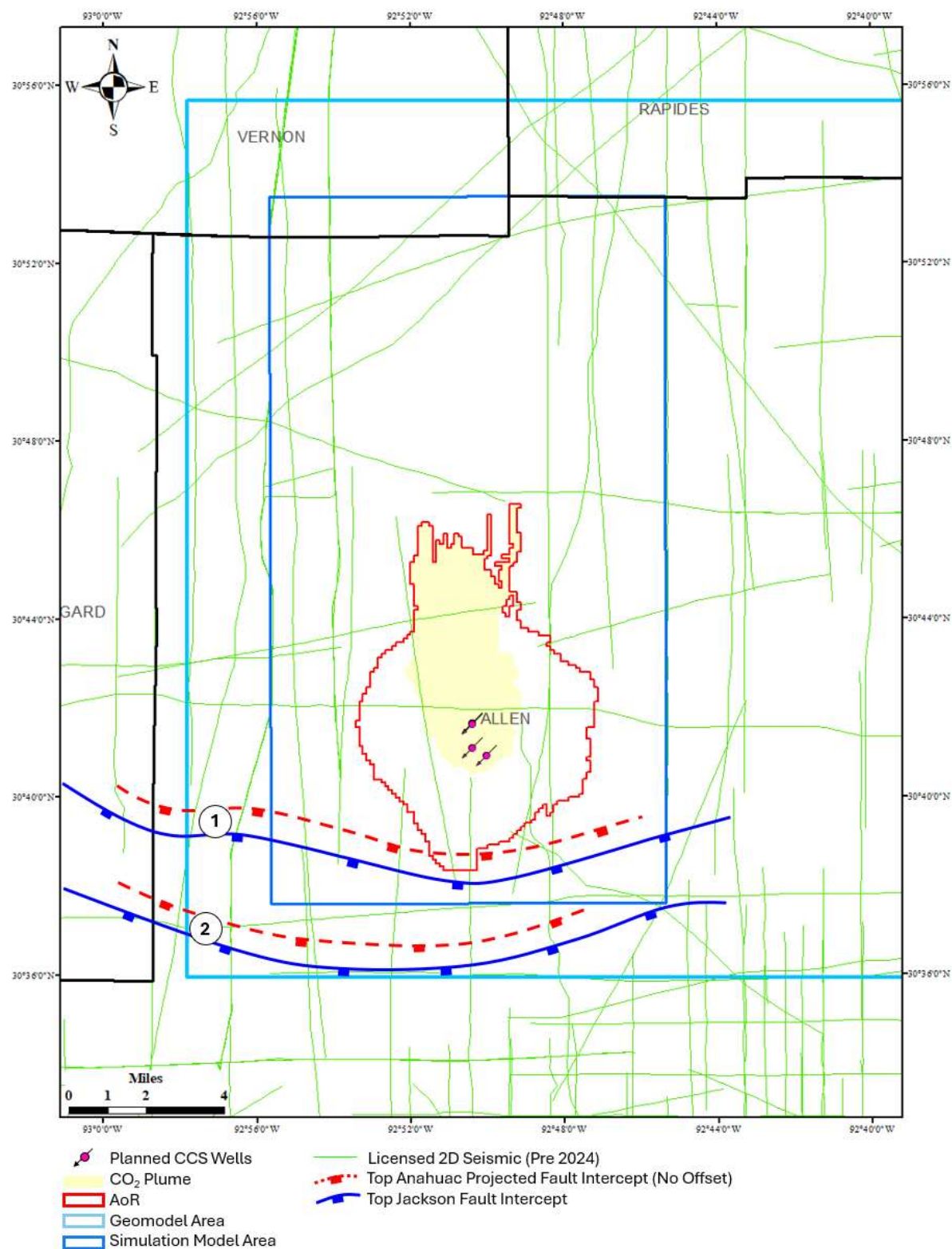
Seismic data owned or controlled by Seismic Exchange, Inc.;  
Interpretation is that of Magnolia Sequestration Hub, LLC.

**Figure NAR-28—Representative 2D seismic composite cross section composed of 2 seismic lines showing North-South transect through the AOR.**



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**Figure NAR-29—2D seismic data set used for Geomodel fault mapping with faults incorporated into Geomodel labeled.**

### 2.2.1.2 Fractures

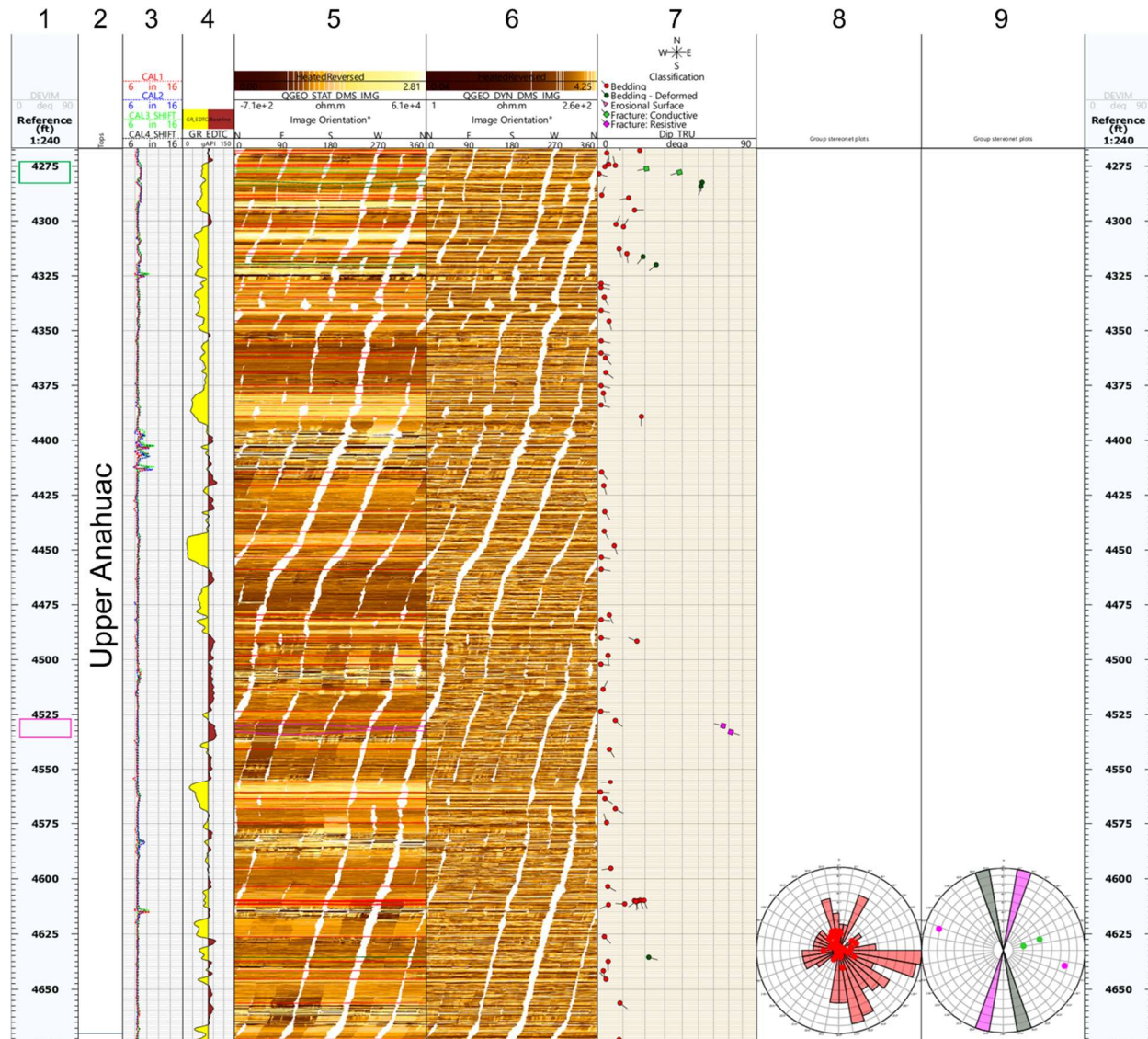
The potential for subseismic faults and fractures was assessed by interpretation of data collected with the Schlumberger Q-Geo/NGI MicroResistivity Oil-Based Borehole Image tool logged in the YAM MLR 004 (SN975950) well. The tool logged all zones in the well, with the resulting image quality ranging from good to challenged. Over the entire well, only four natural fractures were observed in NGI, all in the Upper Anahuac: two conductive, low dip fractures and two resistive, high dip fractures. Figure NAR-30 shows image log results and interpretations for the Upper Anahuac and Figure NAR-31 zooms in on the two intervals with natural fractures. While it is possible the two conductive fractures observed in the Anahuac are small micro-faults and not Mode-1 extensional fractures, no damage zone was observed around them or into the Lower Miocene Upper Confining Zone. Whole core taken in the Lower Miocene, Frio4, Frio7, and Vicksburg was also assessed for faults and fractures. A low-angle surface interpreted to be a fracture was observed in the Lower Miocene in whole core. The isolation of this feature suggests that is developed due to adjustment to stress post-deposition, but it is not part of a larger fault/fracture system.

From the NGI, no fractures or faults were observed in the Lower Miocene Confining Zone (Figure NAR-32), Lower Anahuac and Lower Anahuac\_B Intermediate/Confining Zone (Figure NAR-33), or Vicksburg Lower Confining Zone (Figure NAR-34). No faults or fractures were observed in the Frio Injection Zones. Image logs and interpretation for all zones are located in Narrative Appendix A.

All image log figures show 10 tracks: track 1 is measured depth, track 2 is the zone; track 3 displays the wellbore geometry from the 4-arm caliper of the tool and is an indicator of image log quality, as borehole rugosity (rightward deflection) prevents good pad contact with the borehole and results in a lower-quality image. Track 4 displays the Gamma Ray (GR) colored by probable lithology. Tracks 5 and 6 are the static and dynamic microresistivity image plots of the near wellbore face, respectively; track 5 is annotated with interpretation. Track 7 displays the dip tadpoles and their associated classifications; Track 8 displays the bedding dip angle and dip azimuth on a group stereonet plot; track 9 displays fracture dip angle and dip azimuth on a group stereonet plot, and track 10 is measured depth.

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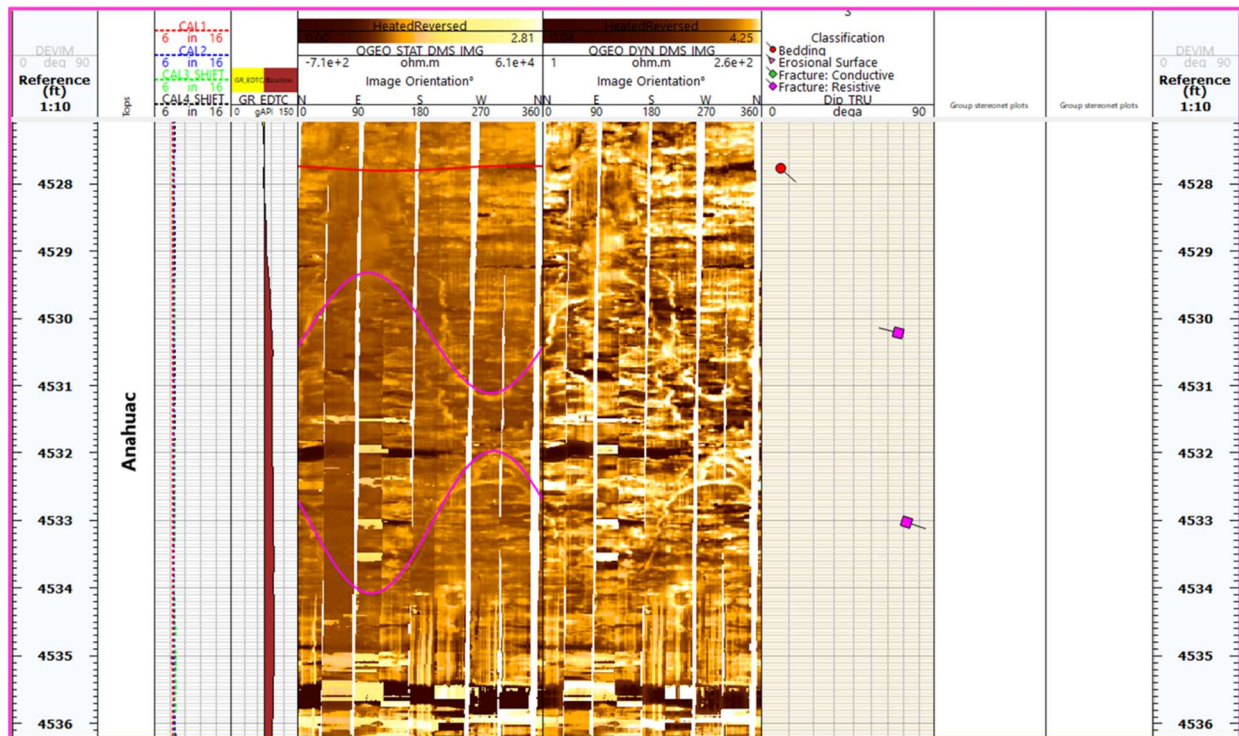
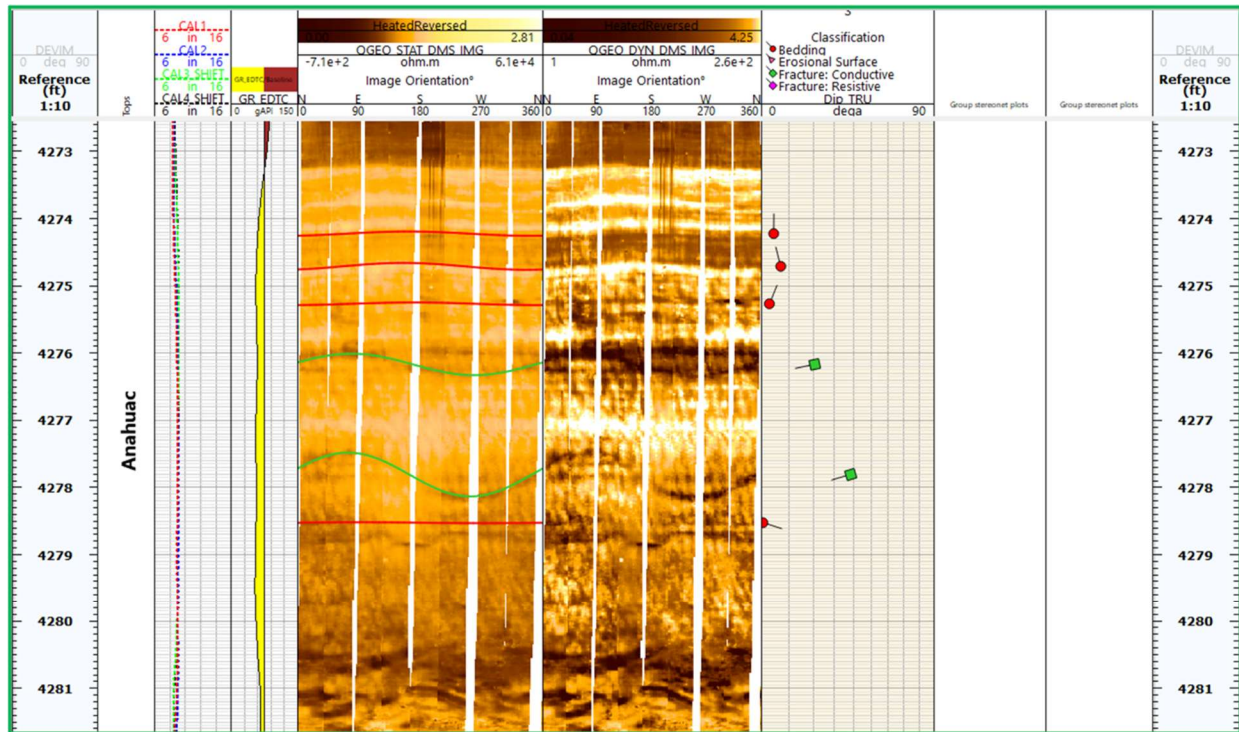


**Figure NAR-30—Image log plot of Upper Anahuac Zone from the YAMS MLR 004 (SN 975950). Most bed dips are low angle and strike to the SSE, consistent with structural mapping. Two sets of fractures, a shallow set of conductive fractures and a deeper set of resistive fractures, are shown in light green and pink box tadpoles, respectively, in track 7 and on the stereonet in track 9. Green and pink boxes in track 1 show the depths in Figure NAR-31**



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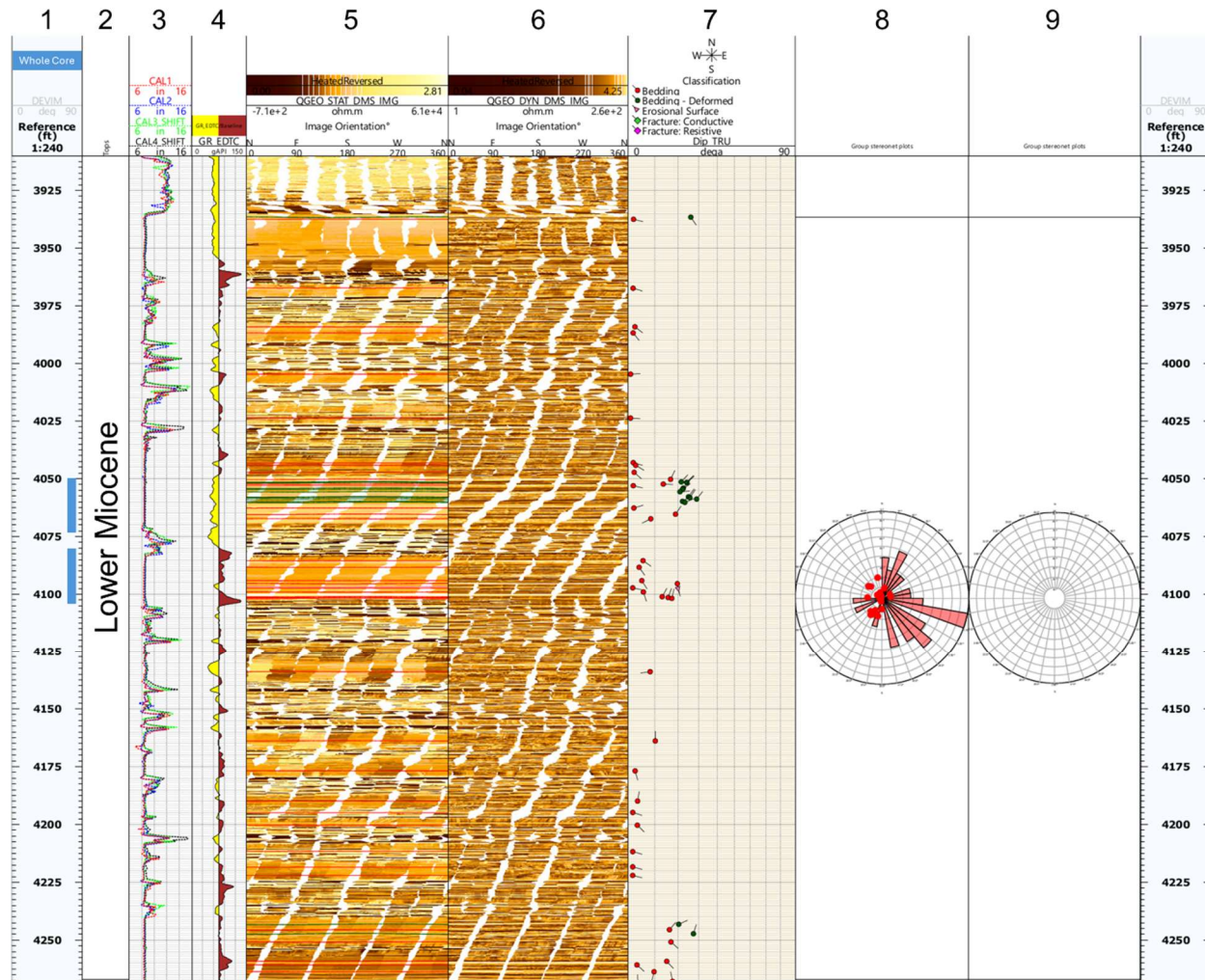
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**Figure NAR-31—Image log plot of sets of two fractures within Upper Anahuac Zone from the YAMS MLR 004 (SN 975950). Green box shows two conductive fractures and pink box shows two higher-dip resistive (cemented) fractures.**

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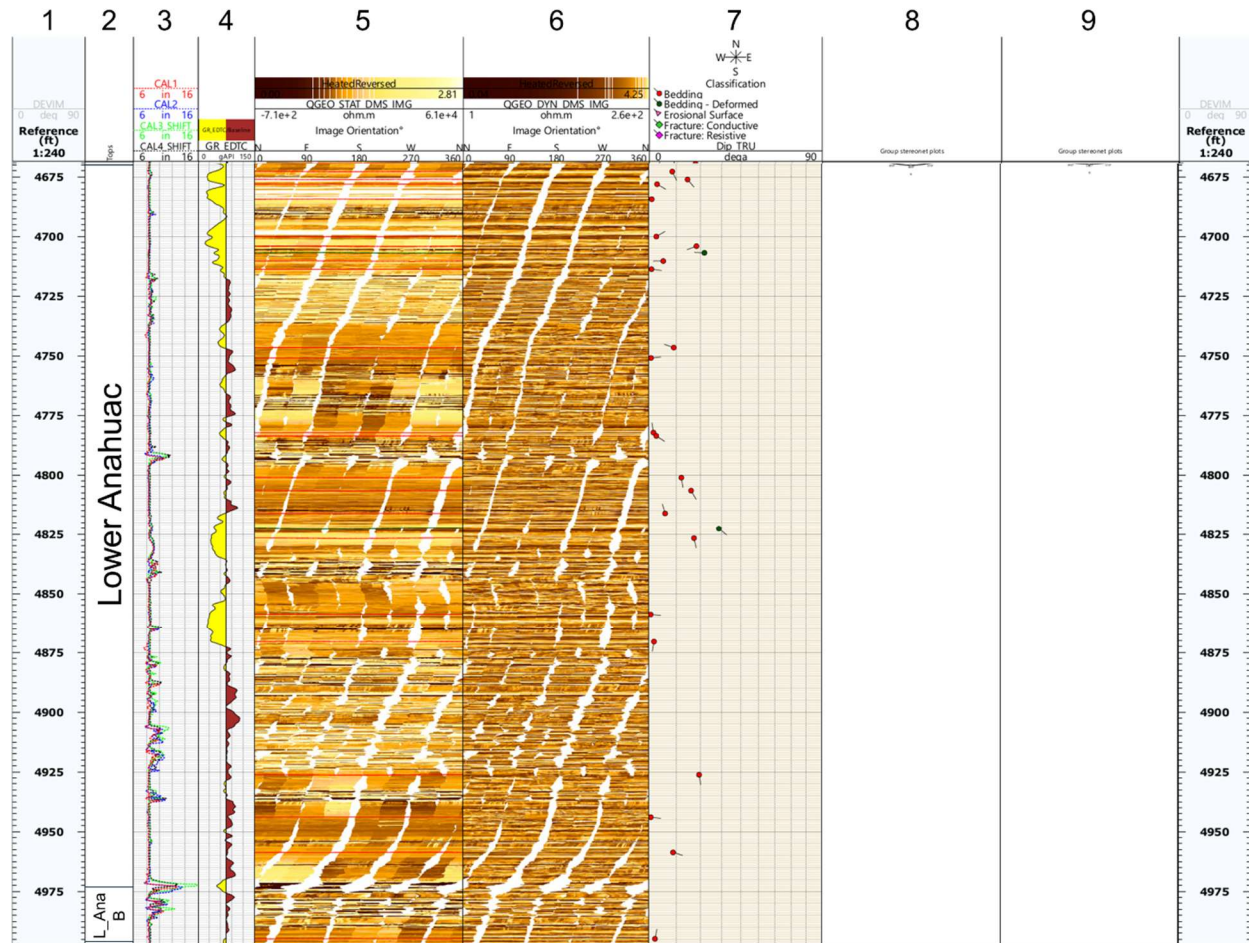


**Figure NAR-32—Well-log image plot of the Lower Miocene Upper Confining Zone from the YAMS MLR 004 (SN 975950). Most bed dips are  $<10^\circ$  (red circle tadpoles). Swarms of dips  $10\text{--}30^\circ$  from 4050 – 4100' (blue bars in track 1) coincide with high-angle cross-bedding observed in whole core. No faults or fractures are observed in this zone.**



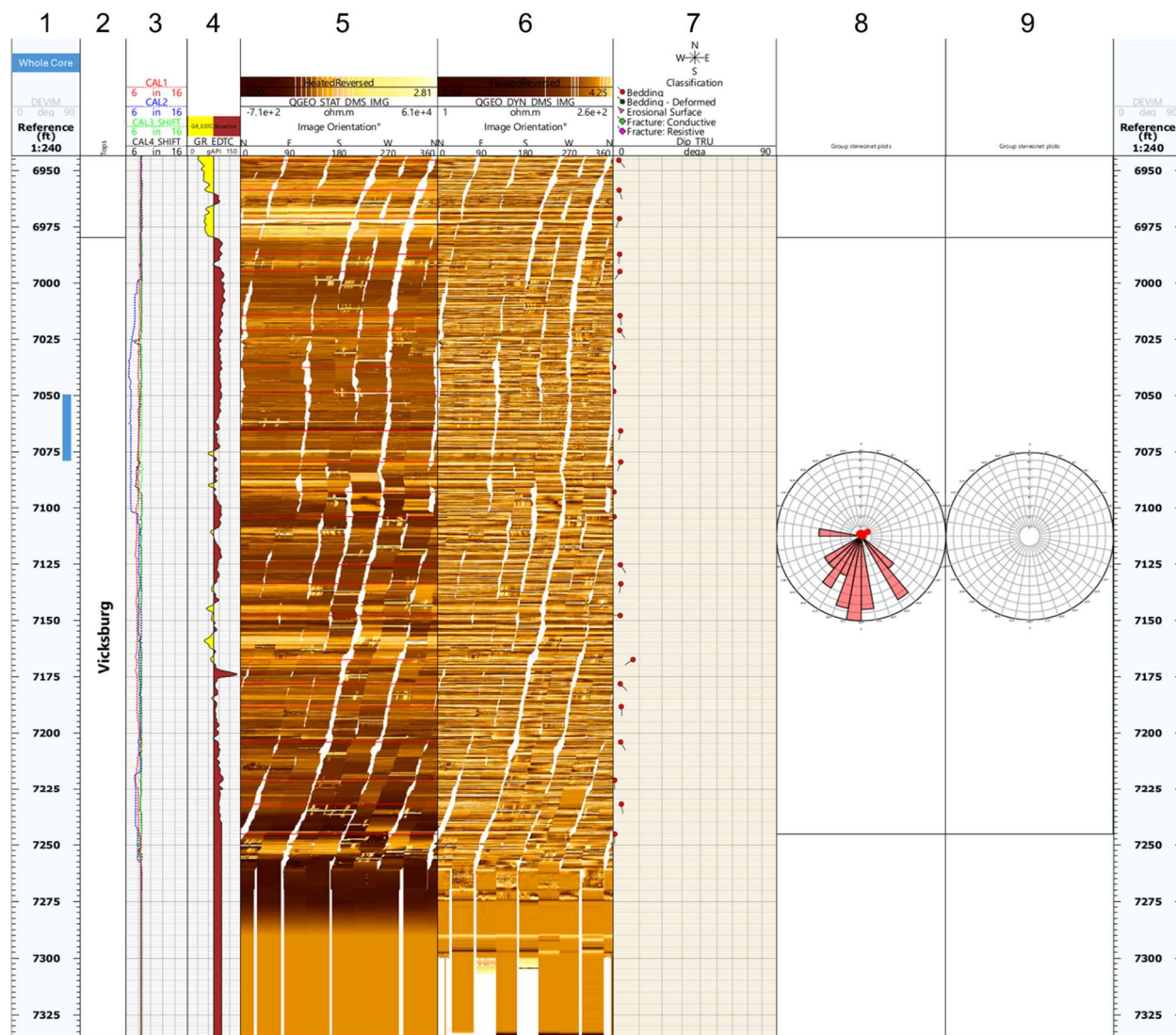
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**Figure NAR-33—Image log plot of Lower Anahuac and L\_Anahuac\_B Zones from the YAMS MLR 004 (SN 975950). Bed dips, shown with circular tadpoles, are mostly  $<10^\circ$ . Higher dips up to  $30^\circ$  mainly occur in sandy intervals and are likely associated with cross-bedding in channel features. No faults or fractures are observed in these zones.**





**Figure NAR-34—Well-log image plot of the Vicksburg Lower Confining Zone from the YAMS MLR 004 (SN 975950). Bed dips (red tadpoles) are  $<10^\circ$  to the south, consistent observations from whole core (blue box) and local structure mapping. No faults or fractures are observed in this zone.**

### 2.2.2 Injection and Confining Zone Characterization Data

Injection and confining zone characterization data consists of existing well data in conjunction with results from the YAMS MLR 004 (SN 975950) stratigraphic test well.

Potential injection and confining zone tops and bases were identified from 19 top correlations in 116 wells. Correlations were based on log data and included picks on GR, SON, spontaneous potential (SP), and resistivity (RES), where present. Of those wells, 84 were within the geomodel area. Digital log coverage and sufficient quality for petrophysical analysis of VSH/PHIE were found in 69 wells over the greater area of investigation. Correlations were refined based on petrophysically checked wells and the YAMS MLR 004 (SN 975950) stratigraphic test well.

Petrophysical curves from the 54 wells within the geomodel, 19 horizons, and 18 zones were used as inputs for the geomodel.

The YAMS MLR 004 (SN 975950) drilled to a total depth of 7,322 ft. measured depth (MD), in the Vicksburg Lower Confining Zone. Openhole logging while drilling (LWD) logs were run from 183 – 7310 ft. MD, and include GR, rate of penetration (ROP) and Mudlogs. Openhole wireline logs were run from 218 – 7,322 ft. MD and include GR, RES, neutron (NEU), density (DEN), SP, caliper, digital temperature capacitance (DTC), distributed temperature sensor (DTS), and next generation imager (NGI). Additional openhole wireline logs were added from 3,906.5 – 7,322 ft. MD, and include combinable magnetic resonance (CMR), hostile environment natural gamma ray sonde (HNGS), Litho scanner, and sonic scanner (SS).

Five intervals of whole core were collected between 4,050 – 7,078.5 ft. MD with 133 ft. recovered. Evaluations were performed on the core to calibrate well log data for model input. Evaluations included routine core analysis (RCA) results including porosity and permeability from 75 samples, x-ray diffraction (XRD) on 28 samples, high pressure mercury injection capillary pressure (MICP) on 11 samples, laser particle size distribution analysis (LPSA) on 56 samples, scanning electron microscope (SEM) on two samples, and thin sections of 12 samples. Thin sections were characterized and interpreted for composition, grain sorting, visible porosity, and diagenesis.

Rotary sidewall cores (RSWC) were taken from 4,007.5 – 7,032.99 ft. MD, with 66 samples recovered, 22 successfully analyzed for RCA (porosity, permeability), and 6 analyzed for MICP. XRD analysis was performed on 63 samples. 6 samples had thin sections made and interpreted for lithology, grain size, visible porosity, and diagenesis.

Formation pressure, fracture pressure, and injectivity data were collected with MDT (modular dynamic test) tools and well tests. 18 formation pressures were recorded with the MDT tool and 6 MDT mini-frac pressure were recorded. Two step rate tests were performed: one from 6,630 – 6,760' and one from 6,050 – 6,100. A pressure transient analysis (PTA) model was created from these tests. See AOR\_CA Section 2.9 for a pressure-depth plot of the YAMS MLR 004 (SN 975950) with MDT, minifrac, and step rate test formation pressures and interpreted fracture pressures. See AOR\_CA Appendix C for step rate test results.

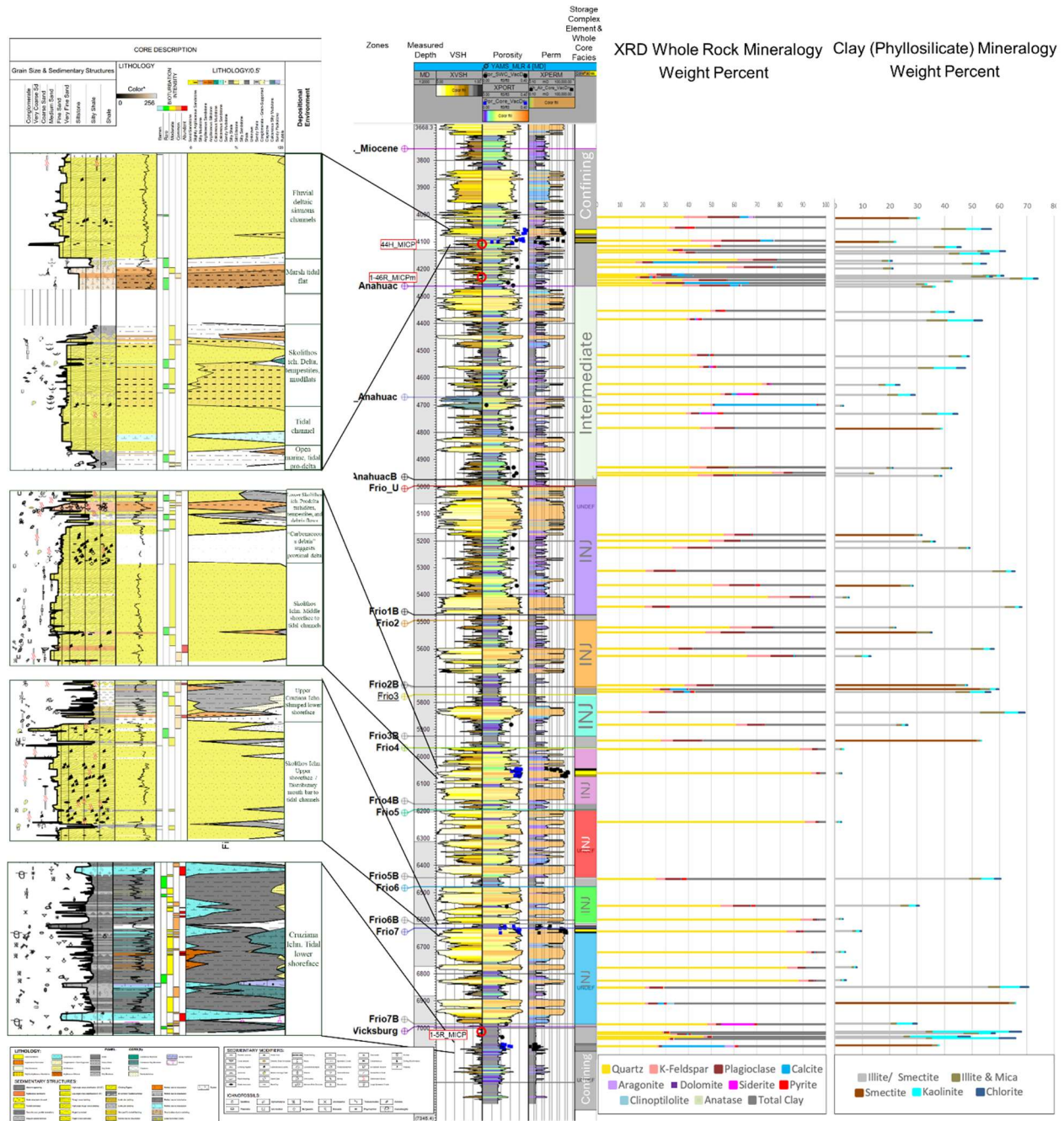
Data from the YAMS MLR 004 (SN 975950) well that were used in petrophysical analysis, geomodel building, and simulation are included in Appendix C of the AOR\_CA.

Figure NAR-35 shows an overview of the YAMS MLR 004 (SN 975950) well with locations of whole core, RSWC, XRD samples, and select MICP results. The left side of the figure shows the core description with interpretation of environment of deposition. The middle log plot shows measured depth, volume of shale, porosity, permeability and whole core facies and is annotated with zone tops and storage complex elements. The right side of the figure shows depth-registered weight percent whole rock mineralogy from XRD analysis.

Appendix C of the AOR\_CA for results from core, well test, pressures, fluid, and cuttings analyses results.

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**Figure NAR-35—Overview of YAMS MLR 004 (SN 975950) stratigraphic test well data collected to assist in confining, injection, and intermediate zone characterization. Red circles indicate where MICP data shown in Table NAR-2 are located.**

**\*\* Figure available in high resolution in supplementary documentation submittal \*\***

### 2.2.3 Confining Zones

Confining zones were first identified based on regional mapping of shales (e.g. Figures NAR-23 and NAR-24). Table NAR-1 enumerates confining zone depth ranges and maximum, mean, and minimum thickness over the site. It also includes average shale porosity and permeability values at the YAMS MLR 004 (SN 975950). Core plug routine core analysis (RCA) porosity and



permeability data from the YAMS MLR 004 (SN 975950) well were used to calibrate petrophysically-determined porosity and permeability curves, upon which average properties are based. Maps of confining zone depth structure, thickness, and modeled average porosity and permeability are located in Appendix B.

**Table NAR-1—Confining zone depths and average thickness from geomodel; average porosity and permeability for shales by zone from YAMS MLR 004 (SN 975950) well**

| Regional Zone | Storage Element | Top Name    | Horizon Depth Ranges (ft TVDSS) |         | Zone Thickness (ft) |      |     | YAMS Shale Average |        |
|---------------|-----------------|-------------|---------------------------------|---------|---------------------|------|-----|--------------------|--------|
|               |                 |             | Shallowest                      | Deepest | Min                 | Mean | Max | Φ (%)              | K (md) |
| Lower Miocene | Upper Confining | L_Miocene   | 1778                            | 4468    | 477                 | 537  | 614 | 29                 | 2.4    |
| Anahuac       | Confining       | L_Anahuac_B | 2834                            | 5888    | 18                  | 36   | 64  | 25                 | 1.7    |
| Upper Frio    | Confining       | Frio1_B     | 3239                            | 6220    | 25                  | 34   | 51  | 28                 | 2.2    |
|               | Confining       | Frio2_B     | 3426                            | 6619    | 12                  | 23   | 32  | 22                 | 1.4    |
|               | Confining       | Frio3_B     | 3578                            | 6780    | 11                  | 24   | 39  | 24                 | 1.5    |
|               | Confining       | Frio4_B     | 3802                            | 7129    | 10                  | 22   | 40  | 22                 | 1.2    |
| Lower Frio    | Confining       | Frio5_B     | 4029                            | 7398    | 10                  | 21   | 39  | 20                 | 0.9    |
|               | Confining       | Frio6_B     | 4195                            | 7530    | 4                   | 26   | 50  | 21                 | 1.1    |
|               | Confining       | Frio7_B     | 4432                            | 7723    | 0                   | 91   | 345 | 18                 | 0.8    |
| Vicksburg     | Confining       | Vicksburg   | 4439                            | 7793    |                     |      |     | 14                 | 1.0    |

Individual shale units within the Lower Miocene, Anahuac, and Frio have capillary entry pressure values that show they can resist considerable buoyancy force of a CO<sub>2</sub> column. Hydrodynamic sealing capacity was determined from 3 core high pressure MICP measurement samples converted to CO<sub>2</sub>-Water reservoir conditions. These samples were selected from shale sealing facies based on their very low permeability, very small pore throat radius and depths within the Lower Miocene Upper Confining Zone and Vicksburg Lower Confining Zone.

Capillary entry pressures tested in a mercury-air system were converted to column heights for supercritical CO<sub>2</sub>-brine system. Table NAR-2 shows results for three of the best shale seal facies sampled: two from the Lower Miocene Upper Confining Zone and one from the Vicksburg Lower Confining Zone. Additional information on these zones from XRD and whole core is found in Sections 2.2.4.1 and 2.2.4.3.

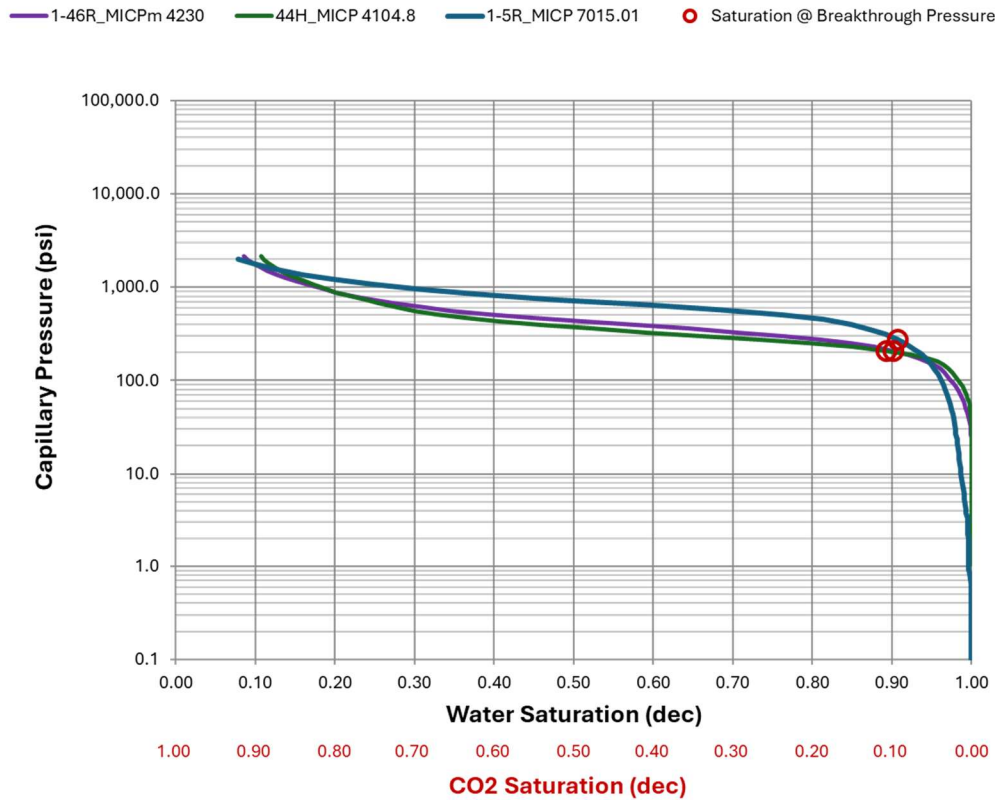
**Table NAR-2—Confining zones hydrodynamic sealing capacity from the YAMS MLR 004 (SN 975950).**

| Zone          | Sample      | Lithology | Depth (ft) | Porosity (%) | Permeability (mD) | Breakthrough Pressure (psi) | *CO <sub>2</sub> Saturation (dec) | *Water Saturation (dec) | *Pore Throat Radius (microns) | *Seal Height (ft) |
|---------------|-------------|-----------|------------|--------------|-------------------|-----------------------------|-----------------------------------|-------------------------|-------------------------------|-------------------|
| Lower Miocene | 44H_MICP    | Shale     | 4104.8     | 18.5         | 0.003             | 209.0                       | 0.11                              | 0.89                    | 0.02                          | 1472              |
| Lower Miocene | 1-46R_MICPm | Shale     | 4230       | 19.2         | 0.002             | 209.0                       | 0.10                              | 0.90                    | 0.02                          | 1472              |
| Vicksburg     | 1-5R_MICP   | Shale     | 7015.01    | 14.06        | 0.0009            | 275.7                       | 0.09                              | 0.91                    | 0.01                          | 1941              |

\*Values at breakthrough pressure in CO<sub>2</sub>-Water system

The minimum saturation and seal entry pressure by which a sealing rock reaches to form a connected filament of CO<sub>2</sub> within the interconnected pores is referred to as the critical CO<sub>2</sub> saturation and breakthrough pressure. Schowalter, 1979, experimented on sandstones, shales and chinks and concluded that an average of 10% saturation is needed to establish a connected filament. This also suggests that if CO<sub>2</sub> saturation were to continue, thus increasing buoyancy pressure, then more migration of CO<sub>2</sub> would extend through the interconnected pores. This can be seen on the capillary plateau from the range of approximately 10-50% where small pressure increases create substantial increases in CO<sub>2</sub> saturation (Figure NAR-36).

### Capillary Pressure (CO<sub>2</sub>-Water system) vs. Sw



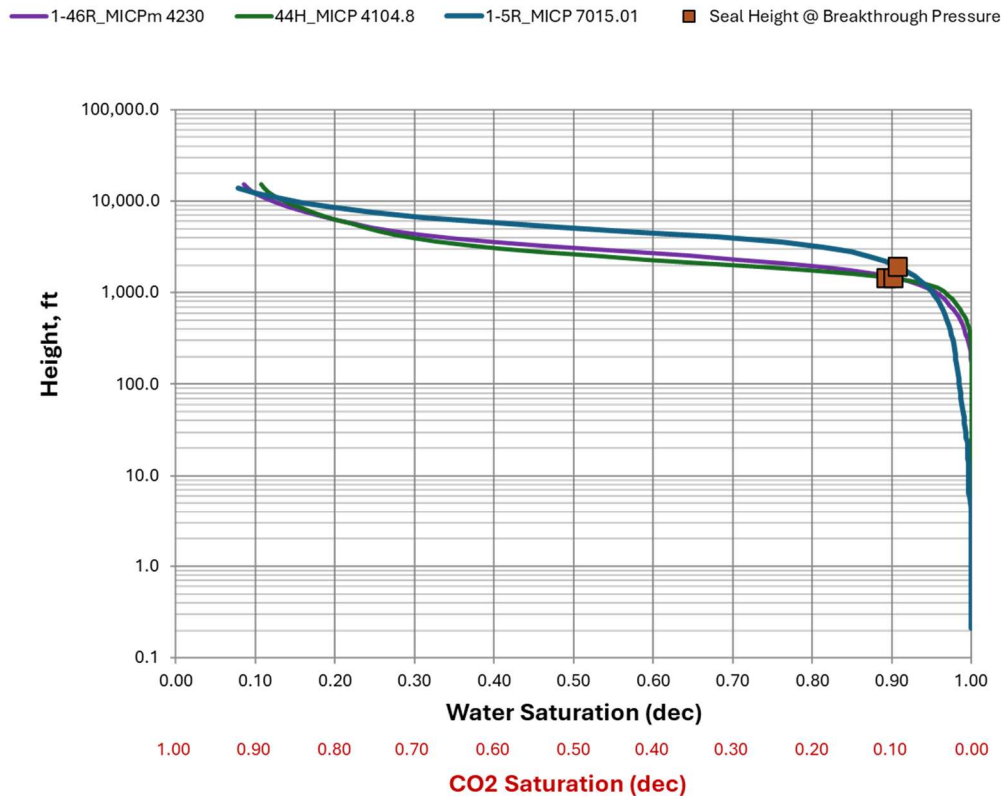
**Figure NAR-36— Cross-plot of water/CO<sub>2</sub> saturation on the x-axis and capillary pressure on the y-axis converted into a CO<sub>2</sub>-Water system from the YAMS MLR 004 (SN 975950). The red circles represent the breakthrough pressure and critical saturation needed to initiate a continuous filament of CO<sub>2</sub> in the interconnected pores.**

At the point of intersection between critical saturation (~10% CO<sub>2</sub> saturation) and breakthrough pressure a minimum sealing height capacity can be calculated representing the CO<sub>2</sub> column height that an overlying seal can retain.

In this case the estimated average critical saturation and average breakthrough pressure needed to initiate a connected filament of CO<sub>2</sub> in the overlying Lower Miocene Upper Confining Zone is 10.5% saturation and 209 psi. In the Vicksburg Lower Confining Zone, a critical saturation of 10% saturation and breakthrough pressure of 275.7 psi (Figure NAR-36).

The minimum sealing height capacity was then calculated for each confining zone using the breakthrough pressure at the critical saturation using water and CO<sub>2</sub> densities (AOR\_CA Appendix C). The minimum sealing height capacity for the Lower Miocene Upper Confining Zone is 1,472 ft. and for the Vicksburg Lower Confining Zone is 1,941 ft (Figure NAR-37).

### Seal Height @ Reservoir Conditions vs. Sw



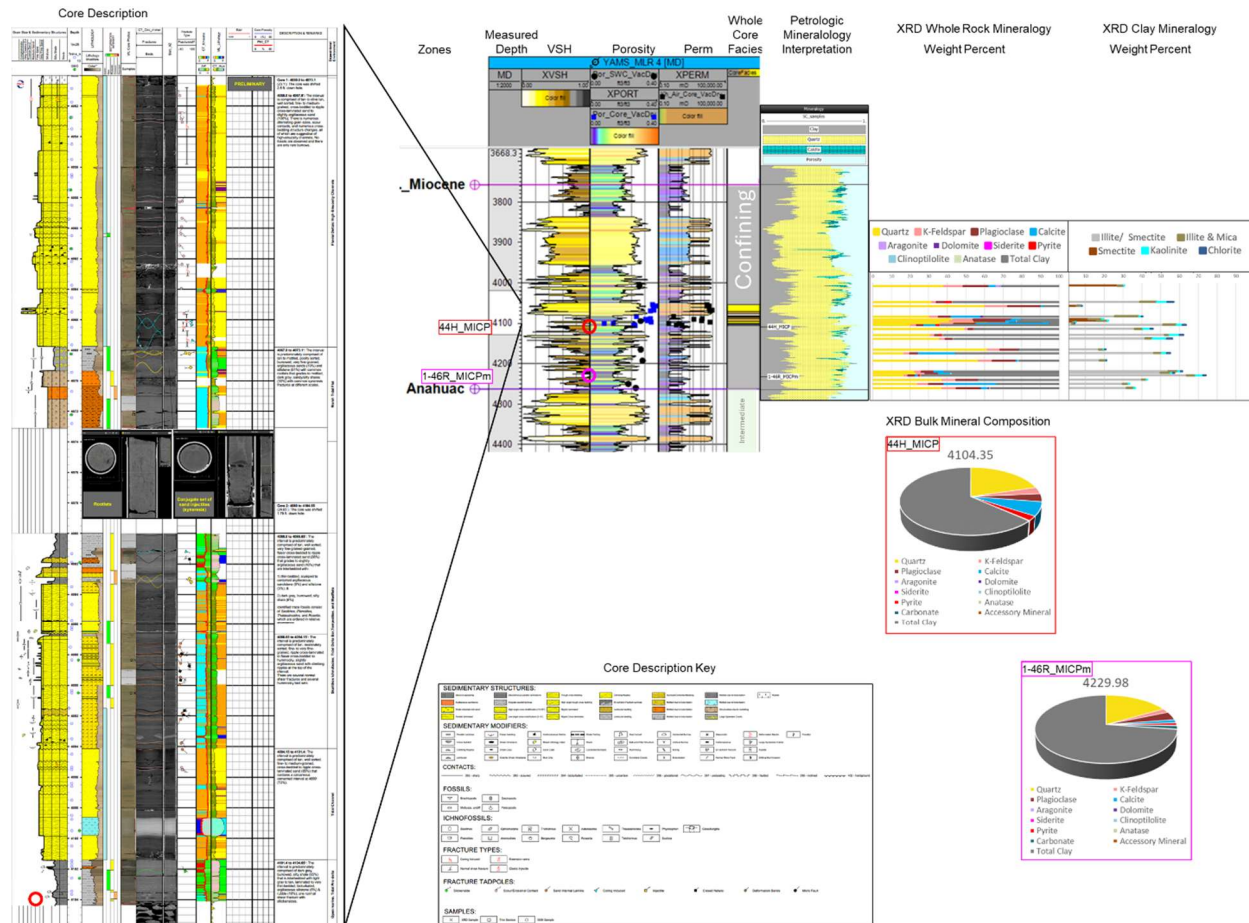
**Figure NAR-37—Cross-plot of water/CO<sub>2</sub> saturation on the x-axis and sealing height on the y-axis from the YAMS MLR 004 (SN 975950). The red squares is approximately at the 10% critical saturation of CO<sub>2</sub> represent the minimum column height of CO<sub>2</sub> that can be held by the sealing shales.**

#### 2.2.3.1 Lower Miocene Uppermost Confining Zone

The Lower Miocene Confining Zone is the uppermost confining zone for the sequestration complex. It is a shale-rich interval punctuated by sharp-base thin sand intervals that are interpreted as channels in an off-axis fluvial-deltaic setting. The whole core taken from this interval intersected one of these sandy channels: high-angle cross-bedding indicative of sinuous channels was observed. While permeability values greater than 4 darcies were measured in horizontal plugs from one of these sands, they come from a discontinuous sandy body that is isolated in space from other channels. Moreover, these channelized sands are above the shale-prone lowest Lower Miocene, which is interpreted to be the primary upper confining zone. The core also sampled red-brown clays that are interpreted as tidal flats and grey shales at the base that are interpreted to have been deposited in a shallow marine, off-axis setting (Figure NAR-38). The zone varies in thickness from 477 to 614 feet thick and is 40-90% shale across the modeled area. Net shale thickness ranges from 230 to 460 feet (see figure NAR-74). Average clay weight percent from XRD is 43% across all lithologies, with local shales up to 74% weight percent clay. The basal part of the Lower Miocene is interpreted to be part of a 4<sup>th</sup> order transgressive systems tract (TST) and is a regionally-mappable shale (Figures NAR-23 and



NAR-24). The first occurrence of nannofossil *Cyclocargolithus floridanus* (<5  $\mu$ m) confirms that the shales in this interval have marine influence, and a lower Miocene age for the section.



**Figure NAR-38—YAMS MLR 004 (SN 975950) core description well logs, zones, petrophysically interpreted mineralogy, and XRD bulk and clay mineralogy with a focus on the Lower Miocene. The two samples collected for confining zone sealing integrity and sealing height capacity, discussed in section 2.2.4, are highlighted in red and pink circles and boxes.**

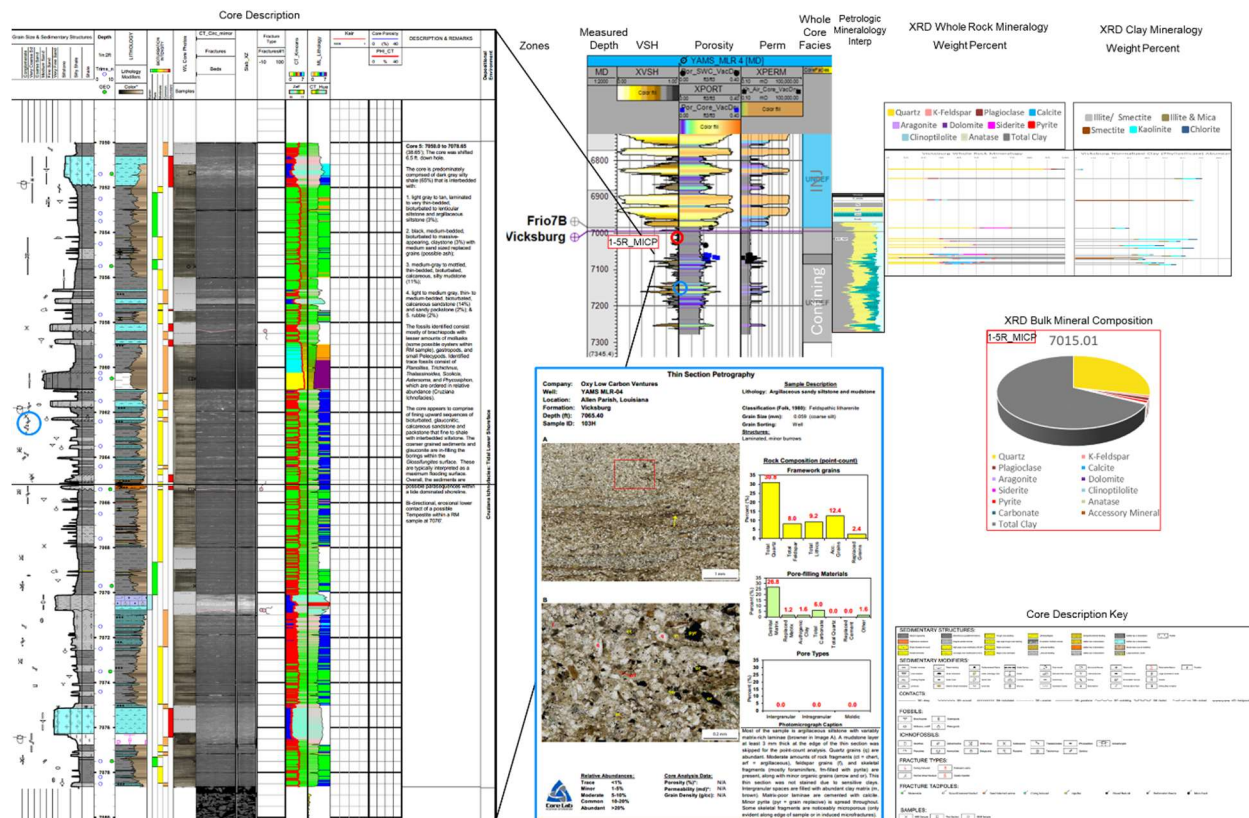
**\*\* Figure available in high resolution in supplementary documentation submittal \*\***

### 2.2.3.2 Lower Anahuac and Intra-Frio Confining Zones

Within the Frio Injection Zone and at the base of the Anahuac Intermediate Zone are recognized parasequence sets, the bases of which are shale-prone and part of regionally mappable Transgressive Systems Tracts shown in the stratigraphic cross sections in Figures NAR-23 and NAR-24. The units are labeled with “\_B” suffix (e.g. Table NAR-1) and range in thickness from 4 – 64 feet and average horizontal permeability of <3 md. Average total clay weight percent from XRD is 53% in these zones. Whole core taken from the Frio6\_B is interpreted as slumped lower shoreface, and nannofossil returns from this same interval support a strong marine influence and upper Oligocene age. The core exhibits horizontally-laminated shales, a fabric favorable for very low vertical permeability. See Section 2.2.4.2 for the core description from the Frio6\_B interval.

### 2.2.3.3 Vicksburg Lower Confining Zone

The Vicksburg shale is the underlying lower confining unit of the Magnolia project and is a regionally correlatable shaley unit, the base of which is defined by the top Yegua/Cockfield sand (e.g. Figures NAR-4 and NAR-7). To the south of Magnolia Hub, the Vicksburg is a topseal for oil and gas fields; its high SP log character is consistent through the Magnolia hub and to the north, evincing its regional deposition. Its sealing qualities are supported by data collected in the YAMS MLR 004 stratigraphic test well, particularly by MICP data that show a capillary entry pressure  $\text{CO}_2$  column height equivalent of 1,941 feet. A lower shoreface environment of deposition from whole core and the highest nannofossil counts in the entire well occur in the Vicksburg and confirm its marine setting and Early Oligocene age. Figure NAR-39 shows an overview of the Vicksburg interval at YAMS and includes the whole core description, well logs, petrophysically-interpreted mineralogy, and callouts of samples selected for confining zone sealing integrity and sealing height capacity.



**Figure NAR-39—YAMS MLR 004 (SN 975950) core description, well logs, thin section example, zones, petrophysically interpreted mineralogy, and XRD bulk and clay mineralogy with a focus on the Vicksburg.**

The sample collected for confining zone sealing integrity and sealing height capacity, discussed in section 2.2.4, is highlighted in red. Thin section from whole core shows laminated nature of these fine-grained rocks.

*\*\* Figure available in high resolution in supplementary documentation submittal \*\**

### 2.2.4 Injection Zones

The seven injection zone targets within the Frio are composed of sands deposited in third-order highstand systems tracts shown in Figures NAR-23 and NAR-24. These units range in thickness

from 51 to 481 feet thick with individual sand bodies on the order of tens of feet thick. Porosity values in the sands and silts range from 29 to 33%, decreasing with depth. Permeabilities typically average greater than 2 Darcies. Table NAR-3 summarizes the depth ranges of these zones within the modeled area and zone thickness variability. Average porosities and permeabilities of the sands and silts values at the YAMS MLR 004 (SN 975950) well, as well as net sand+silt thickness for each zone, are also summarized. Core plug routine core analysis (RCA) porosity and permeability data from the YAMS MLR 004 (SN 975950) well were used to calibrate petrophysically-determined porosity and permeability curves, upon which average properties are based. Maps of injection zone depth structure, thickness, and modeled average porosity and permeability are located in Appendix B.

**Table NAR-3—Injection zone depths and average thickness from geomodel; average porosity and permeability and total net sand+silt thickness by zone from YAMS MLR 004 (SN 975950) well**

| Regional Zone | Storage Element | Top Name | Horizon Depth Ranges (ft TVDSS) |         | Zone Thickness (ft) |      |     | YAMS Sand + Silt Average |        |                    |
|---------------|-----------------|----------|---------------------------------|---------|---------------------|------|-----|--------------------------|--------|--------------------|
|               |                 |          | Shallowest                      | Deepest | Min                 | Mean | Max | Φ (%)                    | K (md) | Net thickness (ft) |
| Upper Frio    | Injection       | Frio1    | 2889                            | 5934    | 277                 | 384  | 487 | 33                       | 2569.0 | 400                |
|               | Injection       | Frio2    | 3267                            | 6248    | 141                 | 250  | 364 | 33                       | 2831.0 | 118                |
|               | Injection       | Frio3    | 3450                            | 6642    | 86                  | 122  | 157 | 29                       | 1920.0 | 62                 |
|               | Injection       | Frio4    | 3604                            | 6804    | 153                 | 220  | 319 | 30                       | 2217.0 | 190                |
| Lower Frio    | Injection       | Frio5    | 3821                            | 7163    | 148                 | 209  | 252 | 30                       | 2396.0 | 206                |
|               | Injection       | Frio6    | 4063                            | 7425    | 74                  | 132  | 199 | 30                       | 2852.0 | 114                |
|               | Injection       | Frio7    | 4235                            | 7565    | 51                  | 269  | 389 | 29                       | 2327.0 | 264                |

#### 2.2.4.1 Upper Frio Injection Zones

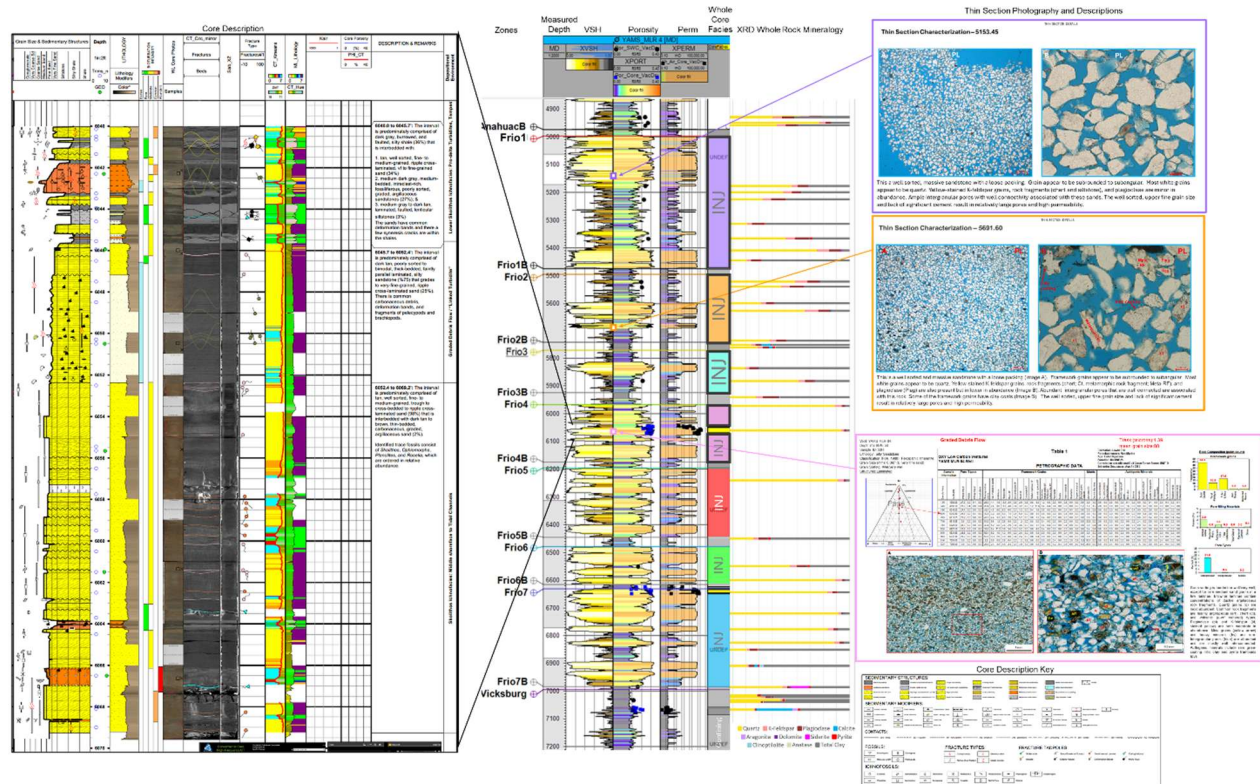
The Frio1, Frio2, Frio3, and Frio4 are targeted by CO<sub>2</sub> injection wells CCS-3 and CCS-4 for injection of 60 MTPA over the life of the project. Average porosities range from 29-33% and average permeabilities range from 1,920 – 2,569 mD. Bulk mineralogy from XRD analysis shows 53% quartz, 14% feldspar, and 33% clay. Figure NAR-40 shows an overview of the YAMS MLR 004 (SN 975950) well data used to characterize these zones. A detailed core description is in the left side of the figure; zones, petrophysical logs, and XRD data are in center, and thin section photos and description are at right. Core plug routine core analysis (RCA) porosity and permeability data from the YAMS MLR 004 (SN 975950) well were used to calibrate petrophysically-determined porosity and permeability curves, upon which average properties are based. Maps of injection zone depth structure, thickness, and modeled average porosity and permeability are located in Appendix B.

The Frio1 and Frio2 are lower net-to-gross intervals interpreted to have been deposited in an off-axis part of the fluvially-influenced portion of the delta. While these zones contain relatively more shale than the zones below, they are still excellent injection targets with net sand proportion within the AOR from 15-55% and average permeabilities between 2-3 Darcies. Thin sections show well-sorted massive sandstones with loose packing. Framework grains are subrounded to subangular and dominated by quartz with minor secondary K-feldspar, rock fragments, and plagioclase.

Frio3 and Frio4 Zones also show strong fluvial influence in a more axial position and are thus higher net-to-gross. Clean sand percent in the AOR ranges from 25-55%. Whole core taken from the middle of the Frio4 contains a shaley top in the lower Skolithos ichnological zone, then planar-laminated sands filled with organic debris typical of proximal delta setting. The bottom half of the core contains trough cross bedded and ripple laminated sands in the Skolithos



Ichnofacies. Thin sections show bimodal and well to very-well sorted quartz-dominated sands with secondary grains consisting argillaceous, chert, and volcanic rock fragments, some feldspars, and rare micas and heavy minerals. Rare authigenic grain coating clay and pyrite framboids are also observed.



**Figure NAR-40—YAMS MLR 004 (SN 975950) core description, zones, well logs, XRD weight percent, and thin section descriptions with focus on the Upper Frio Injection Zone intervals Frio1, Frio2, Frio3, and Frio4.**

**\*\* Figure available in high resolution in supplementary documentation submittal \*\***

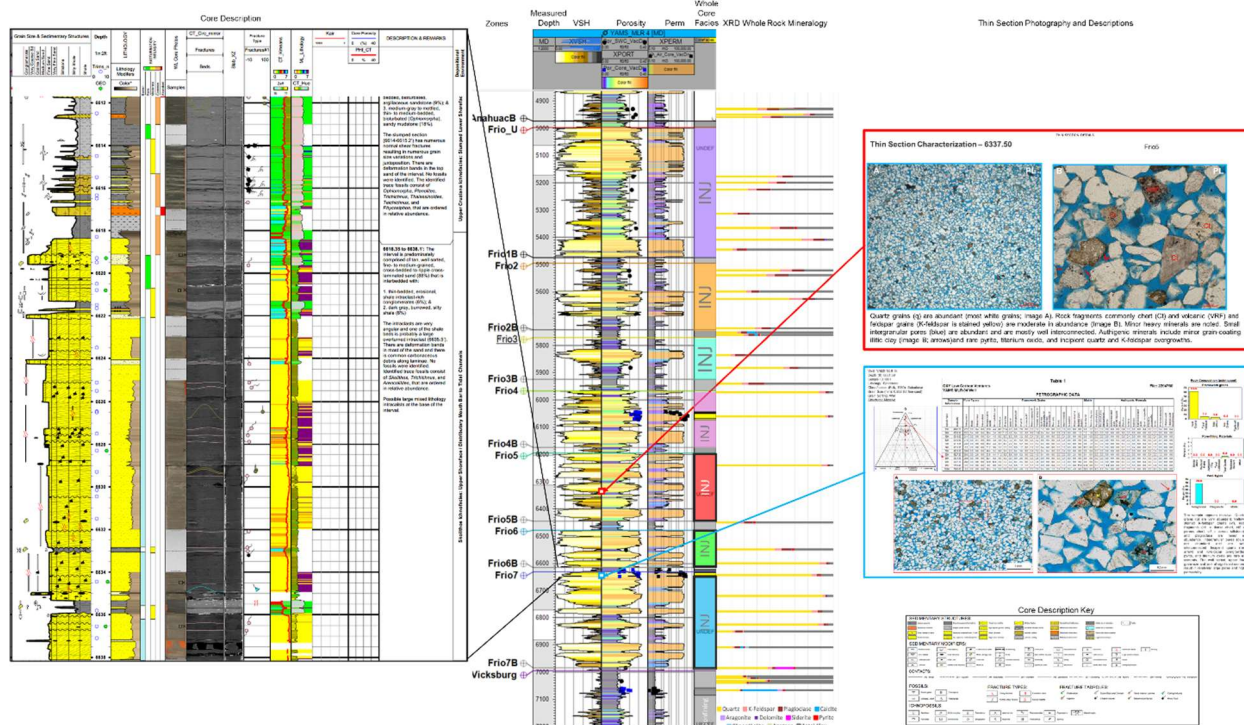
#### 2.2.4.2 Lower Frio Injection Zones

The Frio5, Frio6, and Frio7 are targeted by CO<sub>2</sub> injection wells CCS-1 and CCS-2 for injection of 60 MTPA over the life of the project. These intervals are high net-to-gross sand proportion with blocky log character and are interpreted to be influenced by shore zone processes with less fluvial influence than the Upper Frio Injection Zone. Average porosities range from 29-30% and average permeabilities range from 2,300 – 2,850 mD. Bulk mineralogy from XRD analysis shows 83% quartz, 7% feldspar, 9% clay, and 1% pyrite. Figure NAR-41 shows an overview of the YAMS MLR 004 (SN 975950) well data used to characterize these zones. A detailed core description is in the left side of the figure; zones, petrophysical logs, and XRD data are in center, and thin section photos and description are at right. Core plug RCA porosity and permeability data from the YAMS MLR 004 (SN 975950) well were used to calibrate petrophysically-determined porosity and permeability curves, upon which average properties are based. Maps of injection zone depth structure, thickness, and modeled average porosity and permeability are located in Appendix B.

The Frio5 shows a west-east sand trend with 50-70% clean sand within the AOR and blocky log character through the modeled area suggestive of shore zone depositional environment. Thin sections show well-sorted massive sandstones of predominantly quartz framework grains. Secondary components include chert, volcanic rock fragments, and feldspar grains, and minor heavy minerals. Authigenic minerals include minor grain-coating illitic clay and rare pyrite, titanium dioxide, and incipient quartz and K-feldspar overgrowths.

The Frio6 shows more fluvial influence in the northern end of the geomodel area, evidenced by thin, sharp-based sands. In the AOR, this interval is up to 90% net sand, with a rapid reduction in net-to-gross to the south as the system transitions from proximal delta front to prodelta.

The Frio7 interval thickness, high net-to-gross, excellent porosity and permeability, and extensive sandbodies make it an excellent injection target. Clean sand averages 35-85% across the geomodel and 50-85% within the Area of Review. Whole core taken from this interval contains predominantly well sorted fine- to medium-grained cross-bedded to ripple cross laminated sand interbedded with minor thin beds of shale. Thin sections show well sorted grains of primarily quartz with minor secondary feldspar, rock fragments, and plagioclase. Incipient quartz and K-feldspar overgrowths, pyrite, and titanium oxide are rare as cements. Minimal diagenesis is observed in thin section, which is aligned with expectations based on low lithic fragment, clay, and feldspar proportion and low geothermal gradient in the area. As a result, changes to injectivity with time due to geochemistry reactions are expected to be minor (see AOR\_CA Section 4.4 for geochemical modeling results).



**Figure NAR-41—YAMS MLR 004 (SN 975950) core description, zones, well logs, XRD weight percent, and thin section descriptions with focus on the Lower Frio Injection Zone intervals Frio5, Frio6, and Frio7.**

**\*\* Figure available in high resolution in supplementary documentation submittal \*\***

### 2.2.5 Anahuac Intermediate Zone

Between the Frio Injection Zone and the Lower Miocene Upper Confining Zone is the Anahuac Intermediate Zone. The basal shale of this interval, the L\_Anahuac\_B, has characteristics of a confining unit and is discussed in Section 2.2.4. The Upper Anahuac and Lower Anahuac Zones together comprise the Anahuac Intermediate storage complex element. The sands within this zone are not targeted for injection. Some of the shales have regional extent and are expected to function as secondary confining units between the top of the injection zone and the ultimate Upper Confining Zone in the Lower Miocene. Average net shale thickness for the Upper and Lower Anahuac zones across the modeled area is 307 feet (See AOR Appendix B Figure AOR-75).

Mineralogically, the Anahuac is more mixed than other zones: XRD data average 51% quartz weight percent, 35% clay, 5% calcite/carbonate, 8% feldspar, and 1% siderite and pyrite. Sands and silts in this zone from the YAMS MLR 004 (SN 975950) have average porosity of 30-34% and average permeability of 1400 – 2200 md. Zone thickness ranges from 183 to 478 feet thick, with total sand thicknesses ranging from 157 – 209 feet. Zone summary depths, thicknesses, and average porosity and permeability from the YAMS MLR 004 (SN 975950) well are summarized in NAR Table-4.

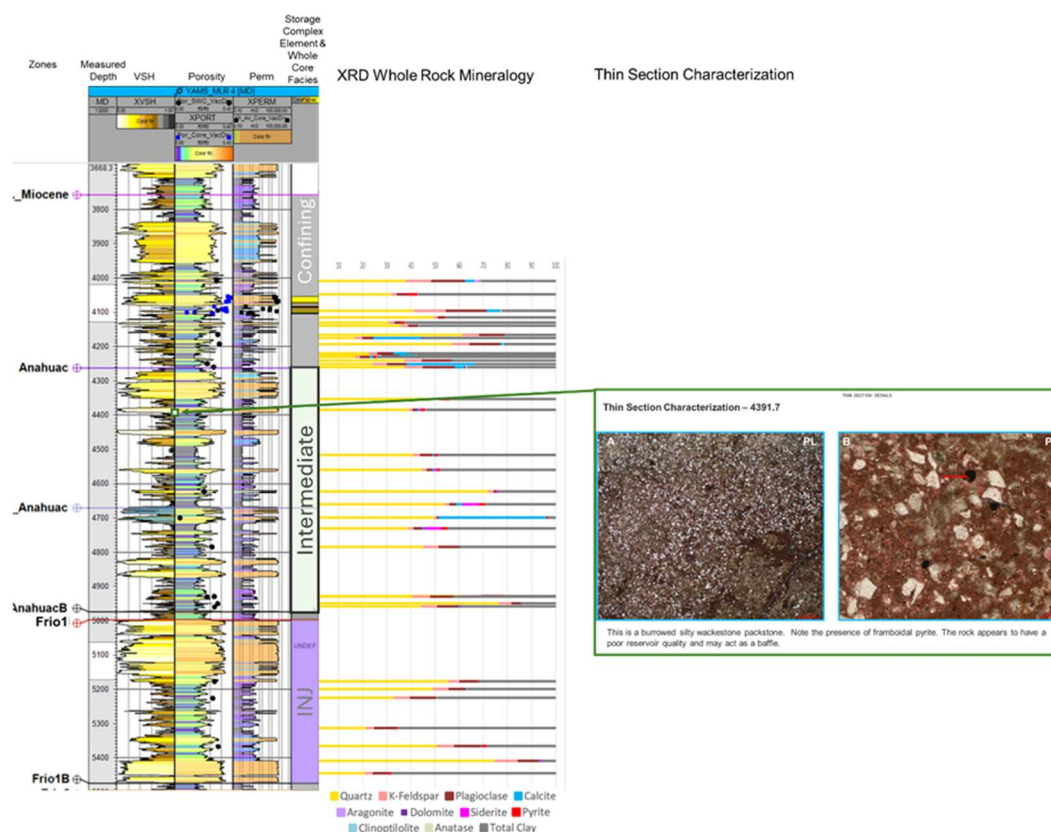


**Table NAR-4—Anahuac Intermediate zone depths and average thickness from geomodel; average porosity and permeability for sands and total net sand+silt thickness by zone from YAMS MLR 004 (SN 975950) well**

| Regional Zone | Storage Element | Top Name  | Horizon Depth Ranges (ft TVDSS) |         | Zone Thickness (ft) |      |     | YAMS Sand + Silt Average |        |                    |
|---------------|-----------------|-----------|---------------------------------|---------|---------------------|------|-----|--------------------------|--------|--------------------|
|               |                 |           | Shallowest                      | Deepest | Min                 | Mean | Max | Φ (%)                    | K (md) | Net thickness (ft) |
| Anahuac       | Intermediate    | U_Anahuac | 2327                            | 4998    | 295                 | 356  | 478 | 34                       | 2192.0 | 209                |
|               |                 | L_Anahuac | 2640                            | 5422    | 183                 | 286  | 441 | 30                       | 1424.0 | 157                |

Lithology mapping across the modeled area shows west-east trending sandy zone to the north of the AOR in the Upper Anahuac such that the Area of Review would be in a lower shoreface environment. The Lower Anahuac sand trends suggest more fluvial influence and within the AOR interval it is dominated by shale with net proportion ranging from 55-85%. Maps of injection zone depth structure, thickness, and modeled average porosity and permeability are located in Appendix B.

Figure NAR-42 provides an overview of the Anahuac Intermediate Zone data collected in the YAMS MLR 004 (SN 975950) well including petrophysical logs, storage element designation, XRD data, and an example thin section from 4,391.7 ft, which provides an example of the carbonates within this interval. The Lower Anahuac also contains a carbonate-rich interval from 4,670 – 4,710' MD, which is corroborated with XRD data. Core plug routine core analysis (RCA) porosity and permeability data from the YAMS MLR 004 (SN 975950) well were used to calibrate petrophysically-determined porosity and permeability curves, upon which average properties are based. Maps of injection zone depth structure, thickness, and modeled average porosity and permeability are located in Appendix B.

**Figure NAR-42—YAMS MLR 004 (SN 975950) zones, well logs, XRD weight percent, and thin section descriptions with focus on the Anahuac Intermediate Zone.**

**\*\* Figure available in high resolution in supplementary documentation submittal \*\***

### 2.2.6 Petrophysical and Geomechanical Information

Refer to Area of Review and Corrective Action Plan (AOR\_CA) Section 2.4 for description of petrophysical workflow, and AOR\_CA Appendix B for a list of wells used in petrophysical analyses.

In the YAMS MLR 004 (SN 975950) well, 133 ft of whole core was collected; 5 ft were selected for geomechanical testing. Results from two samples have been received for shales from the Frio6B and Vicksburg. Poisson's ratio and Young's Modulus measurements were plotted on the 1D stress model (AOR Section 2.9) and it was found to be well-calibrated.

**Table NAR-5—Whole core samples selected for geomechanical testing.**

| Sample ID | Core Number | Requested Depth | Formation Top | Lithology | Poisson's Ratio | Young's Modulus (Mpsi) | Biot's coefficient |
|-----------|-------------|-----------------|---------------|-----------|-----------------|------------------------|--------------------|
| RM-10     | 4           | 6613            | Frio6B        | shale     | 0.31            | 9.51                   | no results         |
| RM-17     | 5           | 7058            | Vicksburg     | shale     | 0.25            | 5.53                   | no results         |

The oil-based images acquired in YAMS MLR 004 (SN 975950) show no fractures or faults in any of the confining zones (see Section 2.2.1). Four fractures were observed in the Upper Anahuac Intermediate one (see Section 2.2.2.2).

To understand average ductility, rock strength, and consistency of these, core testing was conducted at New England Research laboratories. Testing made estimates of dynamic and static elastic and poroelastic properties (Young's modulus, Poisson's ratio, and Biot's coefficient) from velocities and strain measurements. Testing provided qualitative characterization of plastic deformation and is incorporated into stress characterization analytically. These measurements were used to calibrate rock property models that are inputs to the linear poroelastic stress model and understand the implication of elastic and plastic deformation on stress.

The stress model is provided as input to injection pressure models and is used explicitly in critical stress analysis (fault stability analysis). A detailed review is provided in AOR\_CA Section 2.9. Mohr-Coulomb stress analysis for the Frio shows that a pressure increase of 1,100 psi is required for fault slip, and 1,500 psi is required for matrix failure (Figure AOR-30). Modeled injection results in a maximum pressure increase of 267 psi within the AOR; the threshold pressure front is defined by a pressure increase of 96 psi (e.g. Figure AOR-31). These values are far below the differential pressure increase required for fault or matrix failure.

Anomalies and uncertainties always exist in data and, once received, will be addressed in preoperational testing via uncertainty analysis; additional analysis will be conducted if necessary.

Pore pressure measurements from modular dynamic test tool (MDT) were taken above and below the Anahuac Confining Zone in the YAMS MLR 004 (NS 975950) (see AOR\_CA Sections 2.2.4 and 2.9). A pore pressure curve interpreted between these points gives values ranging from 2,540 – 2,560 psi from the top to the base of the Anahuac Lower.

### 2.2.7 Seismicity

As shown in Figure NAR-43 and Table NAR-6, the proposed CCS site is situated in an area of central Louisiana with low historic seismic activity. Figure NAR-44 indicates that the area is also predicted to have low future seismic potential.

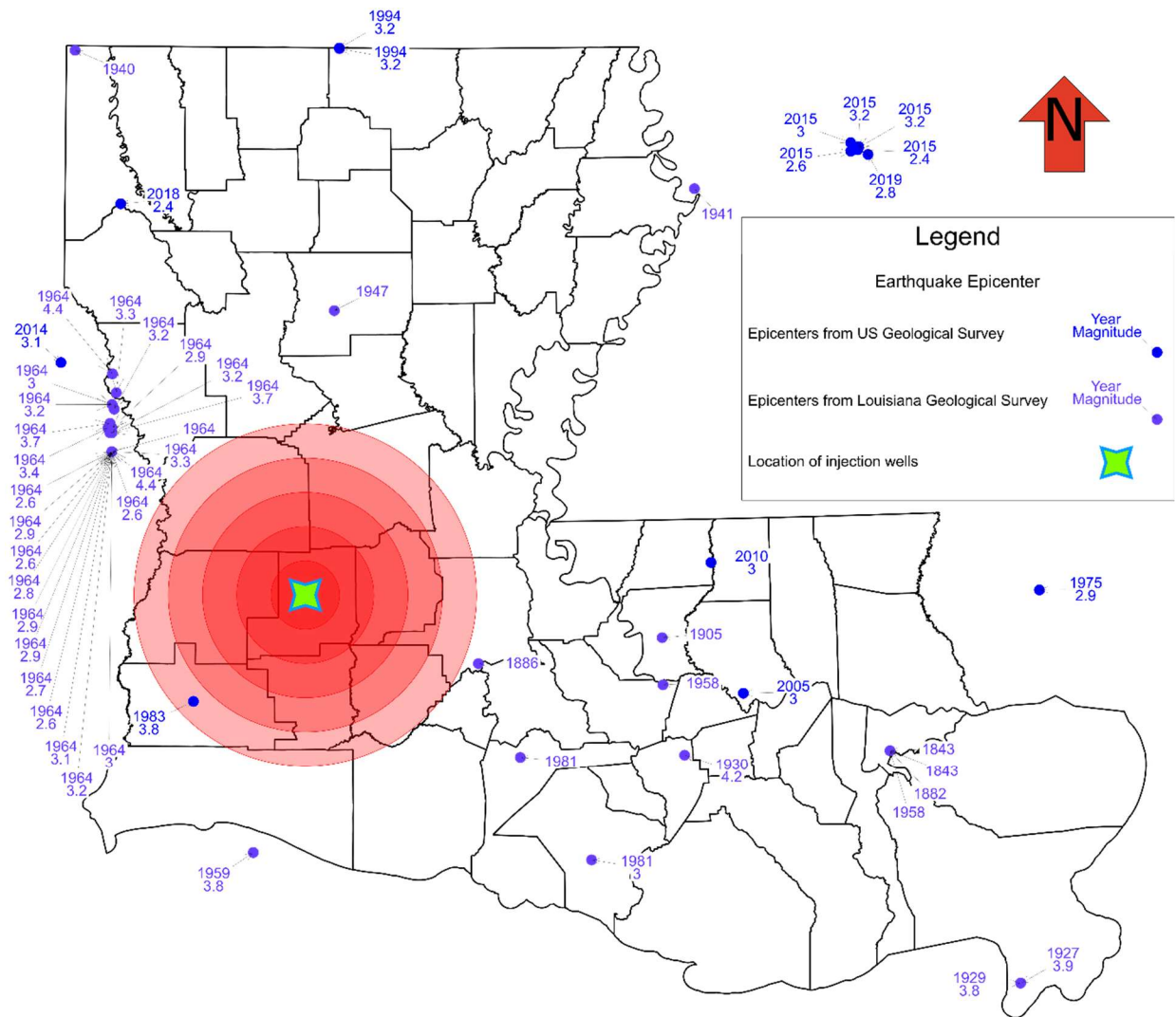
Figure NAR-45 shows the results of the assessed probability, consequence, risk matrix for induced seismicity at the project area.

Details for the basis of the probability assessment shown in Figure NAR-45 are as follows: 1) There is currently very little seismometer coverage over the assessed area to record past events, 2) There is currently no 3D seismic coverage over the assessed area, 3) Faulting within the assessed area is observed to detach in units above the basement, 4) The injection zone is greater than 10,000 ft above the estimated basement depth, and 5) The maximum increase in pressure calculated along the fault within the AOR is approximately 97 psi, or more than an order of magnitude lower than the calculated pressure increase required to induce shear failure (see AOR\_CA Section 2.9). For these reasons, the probability of inducing a seismic event within a 50-mile radius of the project area is currently low.

Details for the basis of the consequence assessment shown in Figure NAR-45 are as follows: 1) Public tolerance for induced seismicity is fragile in Louisiana, and media exposure of induced seismic events related to CCS activity is predicted to be high, 2) The project site is not proximal to critical infrastructure, 3) Local seismicity monitoring is required for CCS operations, and 4) Significant seismic events have the potential to stop project advancement. For these reasons, the consequence of inducing a significant seismic event within 50-miles of the project area is currently medium.

The risk matrix shown in Figure NAR-45 indicates a current combined risk of medium-low for the project. Significant reduction of the consequence of a seismic event is not likely reducible by a significant amount. However, the assessed probability of a seismic event is currently burdened by uncertainty due to a lack of 3D seismic and seismometer data. As such, activity planned for monitoring and verification of the project (acquisition of a baseline 3D seismic survey and deployment of a permanent seismometer array) should measurably reduce the assessed probability of a seismic event.





**Figure NAR-43—Seismic activity recorded by the USGS (2021) with additional data from the Louisiana Geological Survey (Stevenson, 2001). The red shaded circles have a radii of 10, 20, 30, 40, and 50 miles around the injection location, indicating that only one seismic event has been recorded within 50 miles of the injection site. The USGS data base was again checked in October 2024: no additional recorded seismic events were found.**

Narrative for Magnolia Sequestration Project

LA C&amp;E Permit No. 45027, 45028, 45756, and 45757

**Table NAR-6—Table of Earthquake Activity**

| <b>Year</b> | <b>Month</b> | <b>Day</b> | <b>Time (UTC)</b> | <b>Lat</b> | <b>Long</b> | <b>Depth (km)</b> | <b>Magnitude</b> | <b>Source</b> |
|-------------|--------------|------------|-------------------|------------|-------------|-------------------|------------------|---------------|
| 1843        | 02           | 14         |                   | 30.0000    | -90.0000    |                   |                  | LGS           |
| 1843        | 02           | 15         |                   | 30.0000    | -90.0000    |                   |                  | LGS           |
| 1882        | 04           | 12         | 05:00:00.00       | 30.0000    | -90.0000    |                   |                  | LGS           |
| 1886        | 01           | 22         | 16:38:00.00       | 30.4000    | -92.0000    |                   |                  | LGS           |
| 1905        | 02           | 03         |                   | 30.5000    | -91.1000    |                   |                  | LGS           |
| 1927        | 12           | 15         | 04:30:00.00       | 29.0000    | -89.4000    |                   | 3.9              | LGS           |
| 1929        | 07           | 28         | 17:00:00.00       | 29.0000    | -89.4000    |                   | 3.8              | LGS           |
| 1930        | 10           | 19         | 12:17:00.00       | 30.0000    | -91.0000    |                   | 4.2              | USGS, LGS     |
| 1940        | 12           | 02         | 16:16:00.00       | 33.0000    | -94.0000    |                   |                  | LGS           |
| 1941        | 06           | 28         | 18:30:00.00       | 32.4000    | -90.9000    |                   |                  | LGS           |
| 1947        | 09           | 20         | 21:30:00.00       | 31.9000    | -92.7000    |                   |                  | LGS           |
| 1958        | 11           | 06         | 23:08:00.00       | 30.0000    | -90.0000    |                   |                  | LGS           |
| 1958        | 11           | 19         | 18:15:00.00       | 30.3000    | -91.1000    |                   |                  | LGS           |
| 1959        | 10           | 15         | 15:45:00.00       | 29.6000    | -93.1000    |                   | 3.8              | LGS           |
| 1964        | 04           | 24         | 01:20:54.20       | 31.3800    | -93.8100    | 1.0               | 3.7              | LGS           |
| 1964        | 04           | 24         | 03:36:18.00       | 31.3000    | -93.8000    |                   | 2.6              | LGS           |
| 1964        | 04           | 24         | 07:33:51.90       | 31.4200    | -93.8100    | 5.0               | 3.7              | LGS           |
| 1964        | 04           | 24         | 07:47:17.10       | 31.3800    | -93.8000    | 5.0               | 3.2              | LGS           |
| 1964        | 04           | 24         | 07:50:56.00       | 31.3000    | -93.8000    |                   | 2.6              | LGS           |
| 1964        | 04           | 24         | 12:07:08.20       | 31.4800    | -93.7900    | 9.0               | 3.2              | LGS           |
| 1964        | 04           | 24         | 12:54:17.00       | 31.3000    | -93.8000    |                   | 2.9              | LGS           |
| 1964        | 04           | 24         | 17:22:13.00       | 31.3000    | -93.8000    |                   | 2.8              | LGS           |

Narrative for Magnolia Sequestration Project

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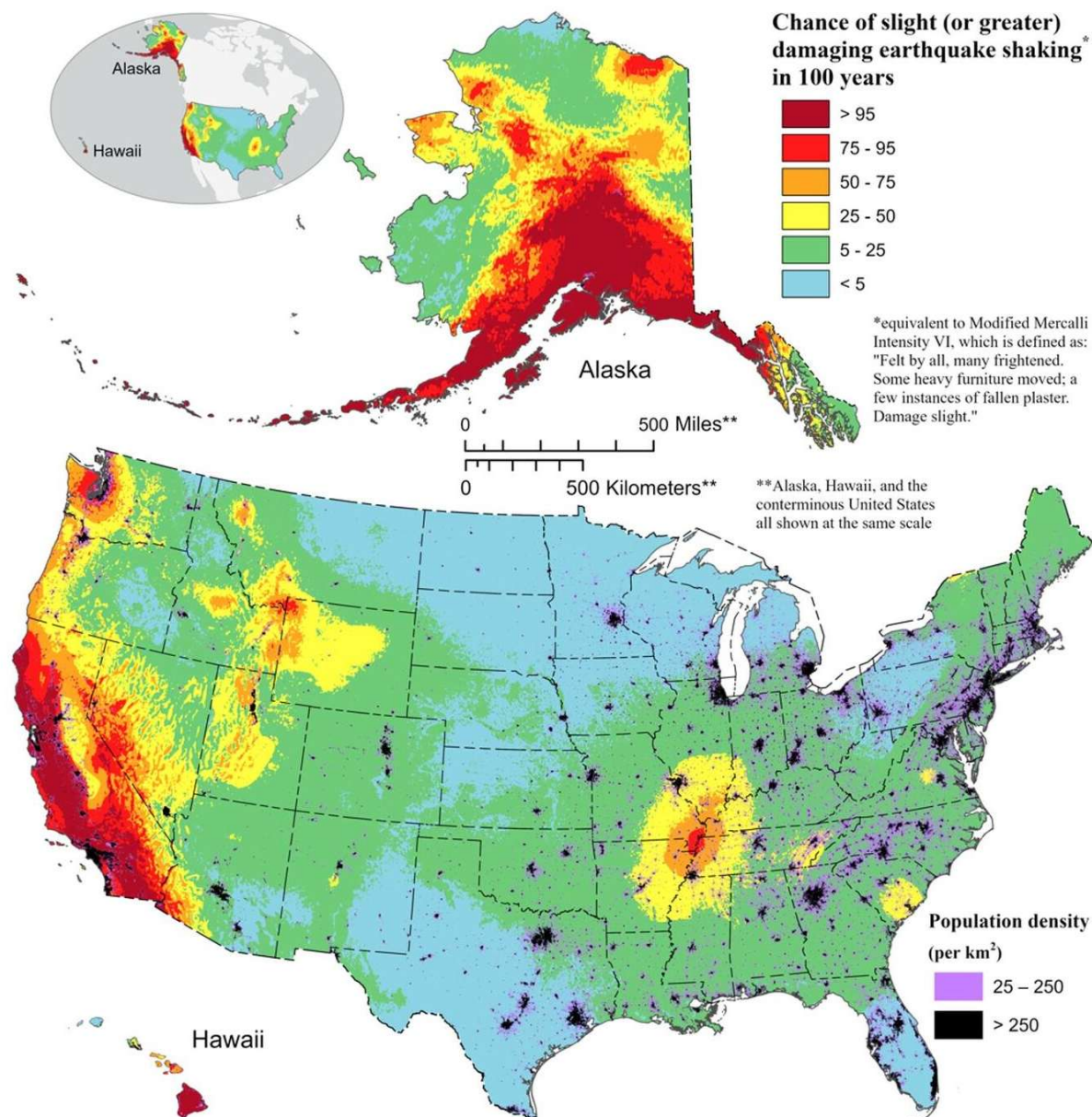
| Year | Month | Day | Time (UTC)  | Lat     | Long     | Depth (km) | Magnitude | Source    |
|------|-------|-----|-------------|---------|----------|------------|-----------|-----------|
| 1964 | 04    | 24  | 23:03:50.00 | 31.3000 | -93.8000 |            | 2.6       | LGS       |
| 1964 | 04    | 25  | 03:23:08.00 | 31.3000 | -93.8000 |            | 2.6       | LGS       |
| 1964 | 04    | 25  | 04:05:33.00 | 31.3000 | -93.8000 |            | 2.9       | LGS       |
| 1964 | 04    | 25  | 06:02:33.00 | 31.3000 | -93.8000 |            | 2.9       | LGS       |
| 1964 | 04    | 26  | 02:35:24.00 | 31.3000 | -93.8000 |            | 2.7       | LGS       |
| 1964 | 04    | 26  | 03:24:50.20 | 31.5500 | -93.7800 | 5.0        | 3.3       | LGS       |
| 1964 | 04    | 27  | 21:50:27.00 | 31.3000 | -93.8000 |            | 3.2       | LGS       |
| 1964 | 04    | 28  | 00:24:07.00 | 31.3000 | -93.8000 |            | 3.1       | LGS       |
| 1964 | 04    | 28  | 00:30:45.70 | 31.4000 | -93.8200 | 6.0        | 3.4       | LGS       |
| 1964 | 04    | 28  | 21:18:35.00 | 31.3000 | -93.8000 |            | 4.4       | LGS       |
| 1964 | 04    | 28  | 21:18:41.00 | 31.6300 | -93.8000 | 14.0       | 4.4       | LGS       |
| 1964 | 04    | 30  | 20:30:00.00 | 31.5000 | -93.8000 |            | 3.0       | LGS       |
| 1964 | 05    | 02  | 06:34:54.00 | 31.3000 | -93.8000 |            | 3.3       | LGS       |
| 1964 | 05    | 03  | 03:24:12.00 | 31.3000 | -93.8000 |            | 3.0       | LGS       |
| 1964 | 05    | 07  | 20:10:00.00 | 31.5000 | -93.8000 |            | 3.2       | LGS       |
| 1964 | 08    | 16  | 11:35:31.00 | 31.4000 | -93.8000 |            | 2.9       | LGS       |
| 1964 | 08    | 19  | 23:58:55.00 | 31.3000 | -93.8000 | 2.7        |           | LGS       |
| 1975 | 09    | 09  | 11:52:44.10 | 30.6620 | -89.2480 | 5.0        | 2.9       | USGS      |
| 1981 | 02    | 13  | 02:15:00.00 | 30.0000 | -91.8000 |            |           | LGS       |
| 1981 | 02    | 18  | 06:33:48.20 | 29.5600 | -91.4600 | 5.0        | 3.0       | LGS       |
| 1983 | 10    | 16  | 19:40:50.83 | 30.2430 | -93.3930 | 5.0        | 3.8       | USGS, LGS |
| 1994 | 06    | 10  | 23:34:02.92 | 33.0130 | -92.6710 | 5.0        | 3.2       | USGS, LGS |
| 2005 | 12    | 20  | 00:52:20.51 | 30.2580 | -90.7080 | 5.0        | 3.0       | USGS      |



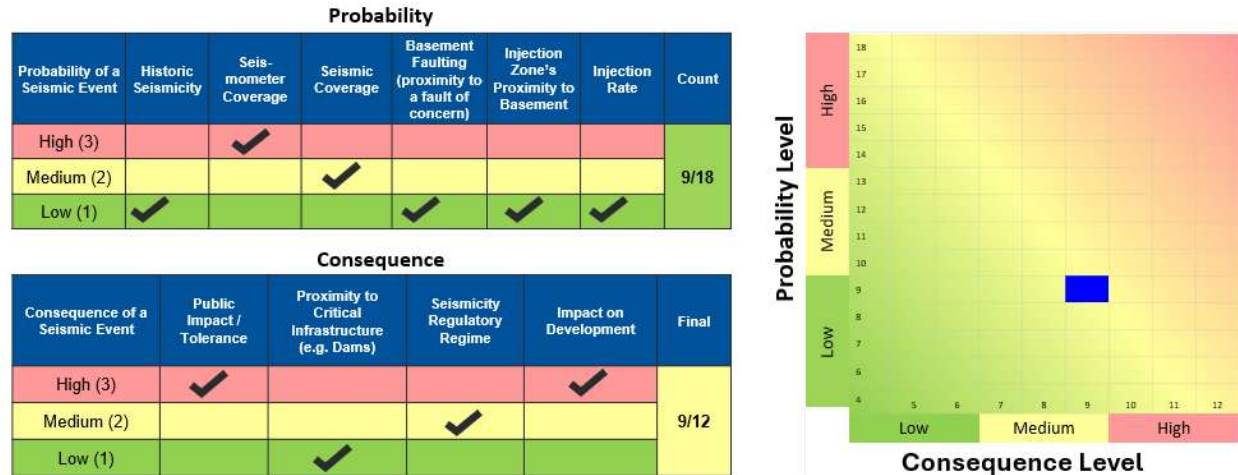
Narrative for Magnolia Sequestration Project

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| Year | Month | Day | Time (UTC)  | Lat     | Long     | Depth (km) | Magnitude | Source |
|------|-------|-----|-------------|---------|----------|------------|-----------|--------|
| 2010 | 08    | 02  | 04:34:29.35 | 30.8150 | -90.8540 | 0.4        | 3.0       | USGS   |
| 2014 | 10    | 03  | 04:52:32.65 | 31.6761 | -94.0554 | 5.0        | 3.1       | USGS   |
| 2015 | 05    | 03  | 01:08:34.86 | 32.5794 | -90.1139 | 5.0        | 3.0       | USGS   |
| 2015 | 05    | 03  | 00:39:23.59 | 32.5571 | -90.0759 | 5.0        | 3.2       | USGS   |
| 2015 | 05    | 03  | 00:33:40.70 | 32.5485 | -90.0792 | 0.0        | 2.4       | USGS   |
| 2015 | 06    | 29  | 13:23:01.49 | 32.5614 | -90.0744 | 5.0        | 3.2       | USGS   |
| 2015 | 08    | 17  | 18:00:21.99 | 32.5431 | -90.1146 | 5.0        | 2.6       | USGS   |
| 2018 | 12    | 04  | 07:14:13.78 | 32.3510 | -93.7648 | 5.0        | 2.4       | USGS   |
| 2019 | 08    | 09  | 07:33:05.67 | 32.5273 | -90.0289 | 5.0        | 2.8       | USGS   |



**Figure NAR-44—Seismic hazard map showing that peak ground accelerations have a 2% probability of being exceeded in 50 years from USGS 2023 Long-Term National Seismic Hazard Map (USGS, 2023). Seismic hazard potential in the study area is one of the lowest in the U.S.**



**Figure NAR-45—Assessed probability, consequence, risk matrix for induced seismicity within a 50-mile radius of the project area.**

### 2.2.8 Hydrologic and Hydrogeologic Information

Publicly available literature for southwestern Louisiana commonly describe base to fresh water (TDS <1,000 mg/L), but do not typically report depth of base USDW as defined by USEPA (depth at which formation water contains less than 10,000 mg/L TDS). The formal definition of a USDW, as found in the Louisiana UIC Regulations, Statewide Order No. 29-N-1 (LAC 43:XVII.101(A)) matches that of the EPA Class VI regulation and reads as follows:

*Underground source of drinking water (USDW) means an “aquifer” or its portion;*

- a) *1) Which supplies any public water system; or*
- 2) Which contains a sufficient quantity of ground water to supply a public water system;*
- and*
- i) currently supplies drinking water for human consumption; or*
- ii) contains fewer than 10,000 mg/l total dissolved solids and*
- b) *Which is not “exempted aquifer.”*

Here, site-specific interpretation for base USDW was completed using deep resistivity readings from open hole logs. Deep resistivity methodology followed Louisiana Department of Energy and Natural Resources (DENR) Office of Conservation, Injection and Mining Division (IMD) (now the Louisiana Department of Conservation and Energy, or “C&E”) guidelines. DENR-IMD methodology was applied to wells within and outside of the AOR. Results from DENR-IMD method were compared to publicly available groundwater quality and water supply well information to confirm base USDW. The DENR-IMD methodology was conducted under the following guidance:

“The IMD typically uses the deep induction curve on an e-log to define the base of the USDW. The following guidelines are used: (1) ground surface to 1,000 feet: 3 ohms or greater is considered USDW; 2) from 1,000 feet to 2,000 feet: 2 ½ ohms or greater is considered USDW; and 3) 2,000 feet and deeper: 2 ohms or greater is considered USDW.



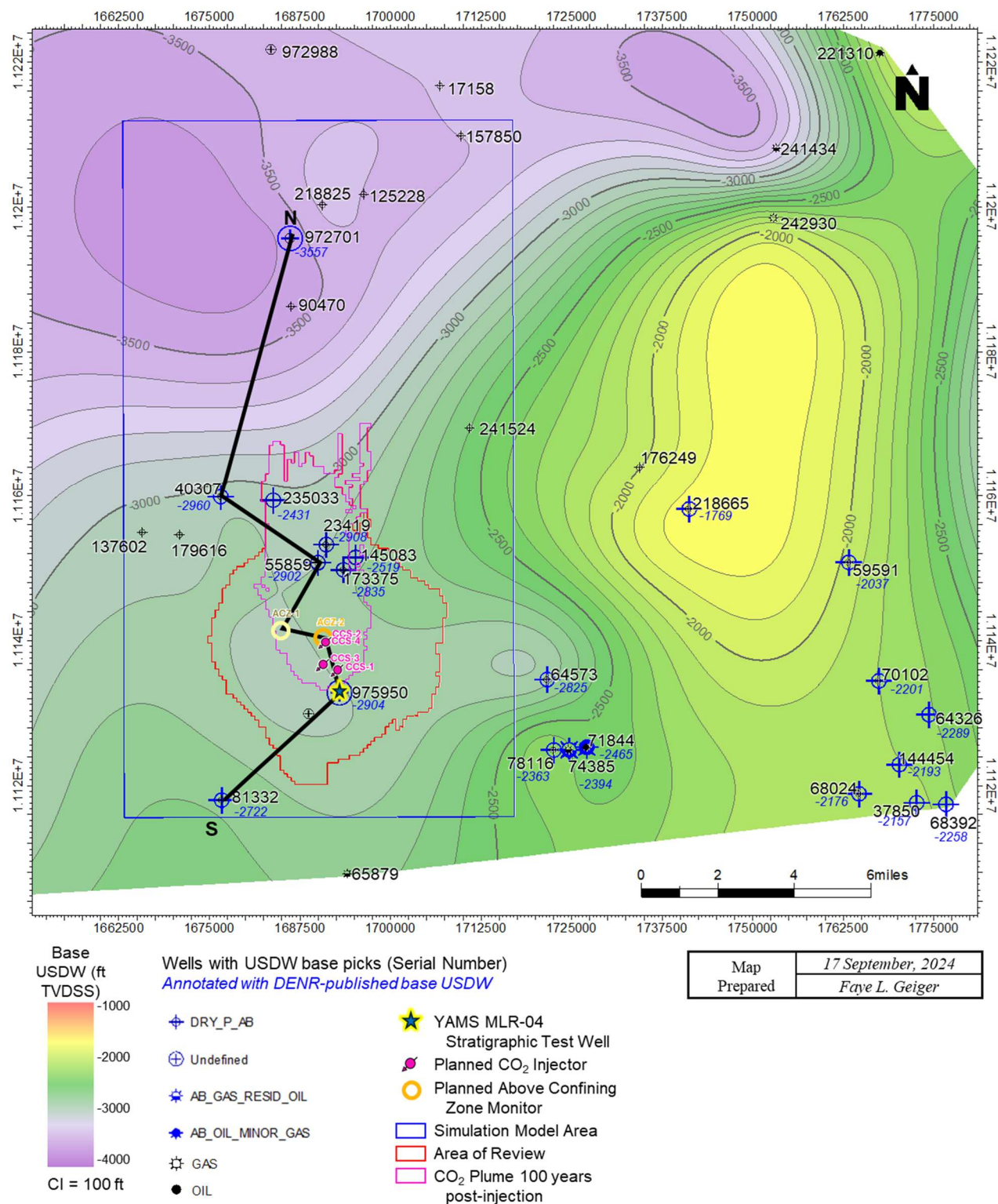
The base of the USDW is established at the base of the sand unit that contains the lowermost USDW with an isolating shale beneath it (DENR-IMD, 2022).”

One concern with deep resistivity readings is that, in addition to resistivity responses from formation fluid salinity, resistivity responds to pore fluids such as hydrocarbons, gases, and drilling fluids, as well as cementation effects in tight sandstones. Here, care was taken by technical staff to consistently select clean basal sandstones with high water saturations for formation water salinity estimation. In addition, the SONRIS database was compared to site-specific logs (Louisiana UIC, 2020). Figure NAR-46 depicts TVDSS depth to USDW using USDW picks from the SONRIS database as a correlation marker; these tops are annotated on the figure. The sand base below 2-ohm methodology was used to extend interpretation and the resulting tops were gridded. The interpreted base USDW at the Magnolia Sequestration site ranges from approximately 2,500 to 3,500 ft below ground surface and is approximately 2,700 to 3,050 ft below ground surface within the AOR.

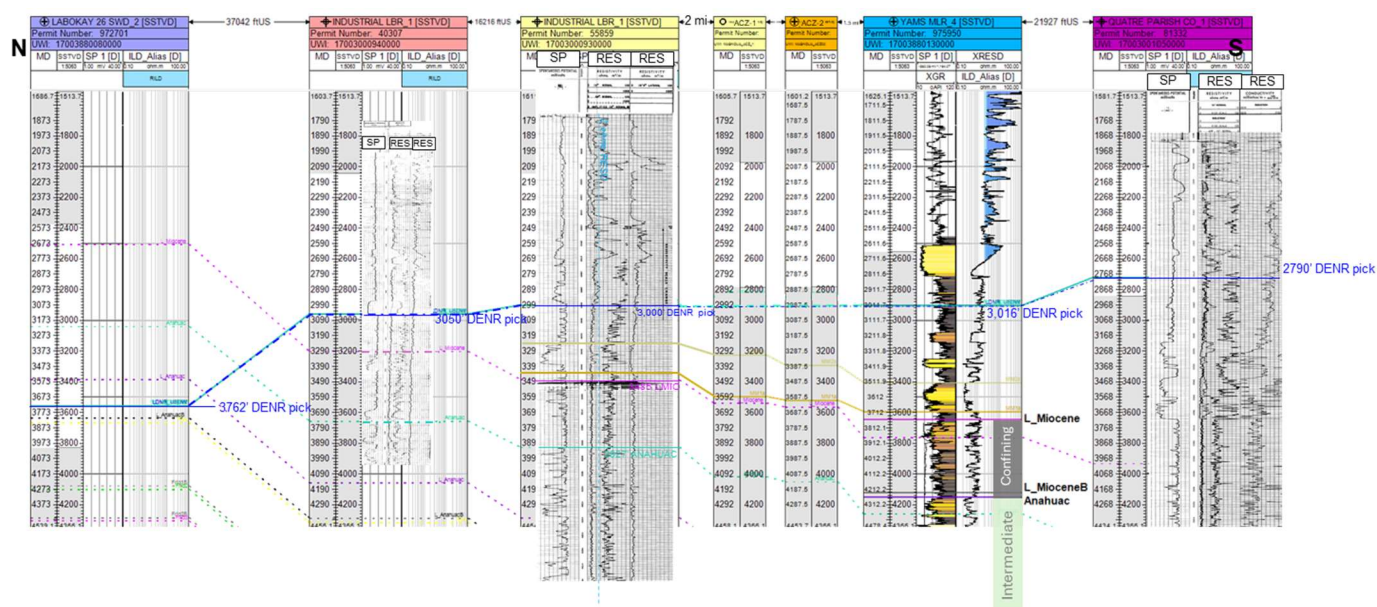
Interpreted base depth USDW in the Jasper Aquifer in planned and future potential Above Confining Zone (ACZ) wells is shown in Figure NAR-47, a cross section through the planned and future potential monitor wells and the nearest offset existing wells with C&E-published base USDW picks. Raster logs are shown where electronic logs were unavailable; depths are shown in TVDSS and MD, and base USDW from C&E is annotated in MD. The Labokay 26 SWD 2 (SN 972701) doesn't have a log, but the UIC-14 form available for this well reports a depth to base of USDW of 3,672'. The base USDW in the planned and future potential ACZ wells falls within the Williamson Creek member of the Jasper Aquifer at approximately 2,990 ft MD ft based on USDW base depths published by C&E and depth reported in an offset wells Industrial Lumber 1 (3,000 ft MD; SN 55895) and YAMS MLR 004 (3,016 ft MD; SN 975950). The vertical distance between base USDW and the top confining zone and top injection zone in this area is approximately 735 ft and 1,249 ft, respectively. State records for water supply wells in Allen Parish show relatively few existing water supply wells in the Evangeline Aquifer compared to the Chicot Aquifer, and no water supply wells in the deeper Jasper Aquifer (Prakken et. al., 2012).

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**Figure NAR-46—Depth to base USDW in TVDSS. Blue tops are picks by LDNR published in SONRIS database; aqua picks are supplemental by Oxy staff based on LDNR IMD guidelines. Depth to USDW base in AOR (red outline) range from 2900 – 3100 ft TVDSS. Note position of cross section shown in next figure.**



**Figure NAR-47—Cross section through ACZ wells and closest offset wells with base USDW picks in area. Blue picks are from Louisiana Department of Energy and Natural Resources.**

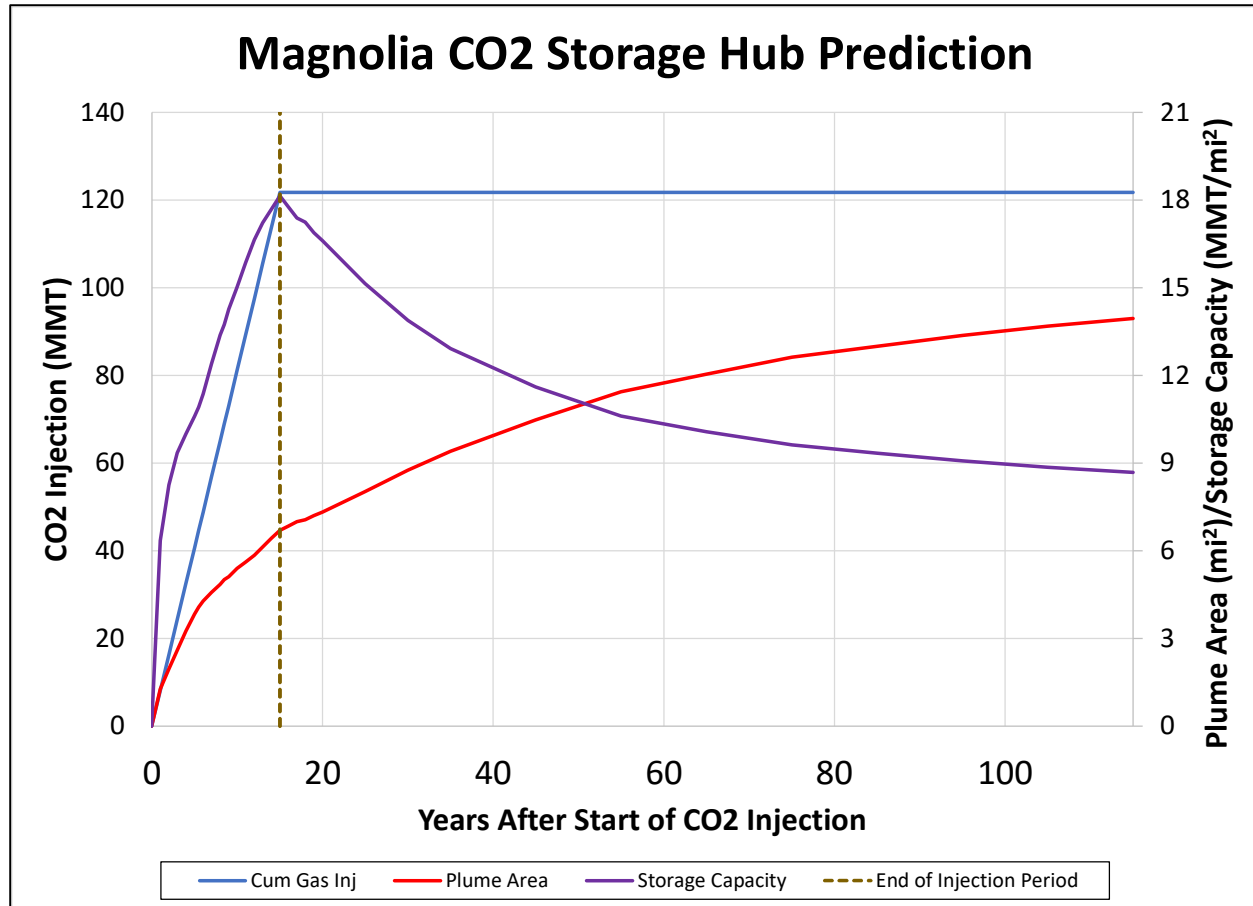
### 2.2.9 Geochemistry

A detailed description of geochemical modeling, including background and literature review, equilibrium simulation inputs and results, and Reactive-transport simulations, can be found in the AOR\_CA document Section 4.4.

### 2.3 Site Suitability

The dynamic simulation model provides an advanced method for determining the storage capacity. The GEM (v2024.10) reservoir simulator with the Greenhouse Gas (GHG) module, from Computer Modeling Group Ltd., was used in this study. The construction and physics of the base case dynamic model are described in detail in the AOR\_CA. The base case model includes CO<sub>2</sub> dissolved in the aqueous phase or as free or trapped supercritical CO<sub>2</sub> but does not model trapping due to mineralization. The Figure NAR-48 shows the change in storage capacity and CO<sub>2</sub> plume area with time from the dynamic simulation, forecasted for 100 years after end of injection. The storage capacity will reach a peak at the end of the injection period at about 18.1 million MT/mi<sup>2</sup>, then decline to a value of 8.7 million MT/mi<sup>2</sup> at 100 years after end of injection. The plume is based on the area in which 99% of the injected CO<sub>2</sub> resides, determined by vertical integration of the mass per unit area (VIMPA). The storage capacity on a per-area basis from dynamic modeling is ultimately higher near the injector than at the outer edges of the plume due to the heterogeneity of the storage formation and the CO<sub>2</sub> migration updip but is averaged over the entire area.





**Figure NAR-48—CO<sub>2</sub> plume area and storage capacity from dynamic simulation, from start of injection to 100 years post injection. Plume area is based on 99% of the vertically integrated mass per unit area (VIMPA) of CO<sub>2</sub> in the reservoir**

### **3.0 AOR and Corrective Action**

The AOR\_CA document meets the requirements of Louisiana Department of Conservation & Energy (C&E) Criteria and Standards Applicable to Class VI Wells. The key challenges are detailed characterization of the injection and confining zones, delineating all underground sources of drinking water, and implementing corrective action on existing wells within the AOR. The AOR\_CA describes the subsurface characterization, computational modeling, current AOR delineation, corrective action plan and schedule, wells requiring corrective action, and future AOR re-evaluation plan and schedule.

The plan delineates the AOR and provides any corrective action that is needed in the wells that penetrate the upper confining zone within the AOR. Delineation of the AOR is one of the key elements of the Class VI Rule to ensure USDWs in the region surrounding the geologic sequestration project may not be endangered by the injection activity.

At a fixed frequency specified in the AOR\_CA, or more frequently when monitoring and operational conditions warrant, Magnolia Sequestration Hub, LLC, must reevaluate the AOR and perform any required corrective action in the manner specified in LAC 43:XVII.3615(B) and

(C). Magnolia Sequestration Hub, LLC, must also update the AOR\_CA or demonstrate to the Commissioner that no update is needed.

Following each AOR\_CA reevaluation or demonstration showing that no new evaluation is needed, Magnolia Sequestration Hub, LLC, shall submit the resultant information in an electronic format to the Commissioner for review and approval of the results. Once approved by the Commissioner, the revised AOR\_CA will become an enforceable condition of this permit.

#### **AoR and Corrective Action GSDT Submissions**

**GSDT Module:** AoR and Corrective Action

**Tab(s):** All applicable tabs

Please use the checkbox(es) to verify the following information was submitted to the GSDT:

- ☐ Tabulation of all wells within AoR that penetrate confining zone *[LAC 43:XVII.3607(C)(2)(d)]*
- ☐ AoR and Corrective Action Plan *[LAC 43:XVII.3607(C)(2)(l) and LAC 43:XVII.3615(B)(2)]*
- ☐ Computational modeling details *[LAC 43:XVII.3615(B)(3)]*

#### **4.0 Financial Responsibility**

Magnolia Sequestration Hub, LLC, shall maintain financial responsibility and resources to meet the requirements of LAC 43:XVII.3609(C). and conditions of this permit. Financial responsibility shall be maintained through all phases of the project. The approved financial assurance mechanisms are found in the Financial Assurance Plan document of this permit. The financial instrument(s) must be sufficient to cover the cost of:

- Corrective action [meeting the requirements of LAC 43:XVII.3615(B) and (C)];
- Injection well plugging [meeting the requirements of LAC 43:XVII.3631(A)];
- Post-injection site care and site closure [meeting the requirements of LAC 43:XVII.3633(A)];
- Emergency and remedial response [meeting the requirements of LAC 43:XVII.3623(A)].

During the active life of the geologic sequestration project, Magnolia Sequestration Hub, LLC, must adjust the cost estimate for inflation within 60 days prior to the anniversary date of the establishment of the financial instrument(s) and provide this adjustment to the Commissioner in an electronic format. Magnolia Sequestration Hub, LLC, must also provide to the Commissioner written updates of adjustments to the cost estimate in an electronic format within 60 days of any amendments to the Project Plans that address the cost items covered in the financial assurance plan.

Magnolia Sequestration Hub, LLC, shall provide notification to meet the requirements of LAC 43:XVII.3609(C) and conditions of this permit.

- Whenever the current cost estimate increases to an amount greater than the face amount of a financial instrument currently in use, Magnolia Sequestration Hub, LLC, within 60 days after the increase, must either cause the face amount to be increased to an amount at

least equal to the current cost estimate and submit evidence of such an increase to the Director, or obtain other financial responsibility instruments to cover the increase. Whenever the current cost estimate decreases, the face amount of the financial assurance instrument may be reduced to the amount of the current cost estimate only after Magnolia Sequestration Hub, LLC, has received written approval from the Commissioner.

- Magnolia Sequestration Hub, LLC, must notify the Commissioner by certified mail and in an electronic format of adverse financial conditions, such as bankruptcy, that may affect the ability to carry out injection well plugging, post-injection site care and site closure, and any applicable ongoing actions under the Corrective Action and/or Emergency and Remedial Response.
  - If Magnolia Sequestration Hub LLC, or third-party provider of a financial responsibility instrument is going through a bankruptcy, Magnolia Sequestration Hub, LLC, must notify the Commissioner by certified mail and in an electronic format of the commencement of voluntary or involuntary proceedings under Title 11 (Bankruptcy), U.S. Code, which names Magnolia Sequestration Hub, LLC, as the debtor, within 10 days after commencement of the proceeding.
  - A guarantor of a corporate guarantee must make such a notification, if he or she is named as debtor, as required under the terms of the guarantee.
  - A permittee who fulfills the requirements of financial assurance by obtaining a trust fund, surety bond, letter of credit, escrow account, or insurance policy, will be deemed to be without the required financial assurance in the event of bankruptcy of the trustee (or issuing institution) or suspension/revocation of the authority of the trustee institution to act as trustee of the institution issuing the trust fund, surety bond, letter of credit, escrow account, or insurance policy.

Magnolia Sequestration Hub, LLC, must establish other financial assurance or liability coverage, acceptable to the Commissioner, within 60 days of a change to the AOR\_CA.

#### **Financial Responsibility GSDT Submissions**

**GSDT Module:** Financial Responsibility Demonstration

**Tab(s):** Cost Estimate tab and all applicable financial instrument tabs

Please use the checkbox(es) to verify the following information was submitted to the GSDT:

☐ Demonstration of financial responsibility **[LAC 43:XVII.3609(C)]**

### **5.0 Injection Well Construction**

The Magnolia CCS 1, CCS 2, CCS 3, and CCS 4 injection wells are designed with the highest standards and best practices for drilling and well construction. The operational parameters and material selection are aimed to ensure mechanical integrity in the system and to optimize the operation during the life of the project.

The well design includes three main sections: 1) conductor casing, 2) surface casing, and 3) long string section to cover the USDW, provide integrity while drilling the injection zone, acquire formation data, and isolate the target formation while running the upper completion.



### ***5.1 Proposed Stimulation Program [LAC 43:XVII.3607(C)(2)(h)]***

Stimulations to enhance the injectivity potential of the Frio Sandstone in the wells may include but are not limited to: coil tubing cleanouts, stick pipe cleanouts, acid stimulation, and freshwater flushes. Magnolia Sequestration Hub, LLC will notify and submit proposed stimulation procedures in writing to the Commissioner at least 30 days in advance of performing the stimulation in accordance with LAC 43:XVII.3629(A)(5). Within the 30-day notice period C&E may deny the stimulation, approve the stimulation as written, or approve a modified version of the stimulation. Magnolia Sequestration Hub, LLC, must carry out the stimulation according to the C&E approved procedures. The procedures will describe all fluids being pumped and prove that there will be no loss of containment due to the stimulation.

### ***5.2 Construction Procedures [LAC 43:XVII.3607(C)(2)(k)]***

The 17 ½ in. vertical wellbore will be drilled to 3,200 ft to cover base of the USDW and to provide mechanical integrity on the surface shoe to continue drilling to the next section. A deviation survey will be taken minimum every 100 ft while drilling and this section will be drilled with freshwater mud. Once the final depth is reached, the well will be circulated and conditioned to run open-hole electric logs according to the Pre-Operation Formation Testing (POT) Plan. Then, 13 3/8 in. casing will be run and cemented to surface via circulation with conventional Portland cement plus additives slurry. If there are no cement returns to the surface, the project will inform the C&E, determine the top of cement with a temperature log or equivalent, and complete the annular cement program with a top job procedure after approval by the Commissioner. After the tail cement reaches at least 500 psi compressive strength, the rig will install Section A of the wellhead and blowout preventor (BOP) equipment. The rig will then test BOP and casing according to LAC 43:XVII.3617(A)(3) requirements and pick up the drilling assembly. After drilling out the shoe track, an additional 10 to 15 ft of new formation will be drilled to execute a Formation Integrity Test (FIT).

A 12 ¼ in. vertical wellbore will be drilled from 3,200 ft to total depth (TD) while taking deviation surveys every 100 ft and collecting cutting samples to describe the formation characteristics. The well will be drilled with synthetic based mud. Once TD is reached, the well will be circulated and conditioned to run open-hole electric logs and acquire side wall cores (SWC) and water samples according to the Pre-Operational Formation Testing Plan. Then, the long string of 9 5/8-in. casing will be deployed with the DTS/DAS fiber optic cable attached to the exterior of the casing. The casing will be cemented to the surface via circulation with a combination of CO<sub>2</sub>-resistant and conventional cement slurries. Based on simulations, a stage tool will be used to perform a two-stage cementing job to establish good cement from the bottom to the surface. The depth of the stage tool or cementing stage tool will be adjusted based on actual conditions of the well after drilled.

After the cementing is complete, Section B of the wellhead will be installed, and the DTS/DAS cable will be threaded through the slips and packoff. The team will install the rest of the wellhead to prepare for completions operations. Test casing per Louisiana Statutes and Regulations LAC 43:XVII.3617(A)(3) requirements

During the completion operations, the rig will test the casing to 500 psi, condition the long string with a bit and scraper, run a CBL-VDL-USIT-CCL log to evaluate cement bonding and casing conditions, perforate the injection zone, and run the upper completion. The 5 ½" tubing and packer completion will be run to approximately 6,250 ft, in conjunction with the electric cable and pressure and temperature gauges. The fluid in the well will be displaced with packer fluid, and the packer will be set. Once the packer is set, an annular pressure test will be performed to 500 psi to validate the mechanical seal. The well will then be swabbed to obtain formation fluid samples, and a leak-off test followed by a pressure fall-off test will be performed before starting injection.

During completion operations, the rig crew will test the casing to 1,000 psi, condition the long string with a bit and scraper, and run cement bond and casing inspection logs to evaluate cement bonding and casing conditions. The 5 ½" tubing and packer completion will be run to approximately 6,010 ft, in conjunction with the electric cable and pressure and temperature gauges. The fluid in the well will be displaced with packer fluid and the packer will be set. Once the packer is set, an annular pressure test will be performed to 1,000 psi on the surface to validate the mechanical seal and integrity in the annular space between the tubing and casing. The pulse neutron log will be run through tubing to set a baseline for future surveys.

The crew will proceed to perforate the injection zone through tubing and initiate the well testing. The well will be tested for injectivity with step rate test, injectivity test, and falloff test procedures before starting CO<sub>2</sub> injection.

#### *5.2.1 Casing and Cementing*

Specific details on the proposed casing properties and cementing program are found in the Injection Well Construction Plan (CON).

### **6.0 Pre-Operational Logging and Testing**

The Magnolia CCS 1, CCS 2, CCS 3, and CCS 4 well testing program aims to obtain the chemical and physical characteristics of the injection and confining zone(s). This program includes a combination of logging, sidewall coring, formation hydrogeologic testing, and other activities performed during the drilling and construction of the CO<sub>2</sub> injection well, monitoring well(s), and any stratigraphic characterization well(s).

The pre-operational testing program will determine or verify the depth, thickness, mineralogy, lithology, porosity, permeability, and geomechanical information of the injection zone, overlying confining zone, and other relevant geologic formations. In addition, formation fluid characteristics are to be obtained from the injection zone to establish baseline data against which future measurements may be compared after the start of injection operations.

Specific details on the proposed pre-operational logging and testing program are found in Pre-Operation Testing Plan (POT).

**Pre-Operational Logging and Testing GSDT Submissions****GSDT Module:** Pre-Operational Testing**Tab(s):** Welcome tab

Please use the checkbox(es) to verify the following information was submitted to the GSDT:

☐ Proposed pre-operational testing program *[LAC 43:XVII.3607(C)(2)(g) and 3617(B)]***7.0 Well Operation**

The well was designed to maximize the rate of injection as well as reduce the surface pressure and friction alongside the tubing, while maintaining the bottomhole pressure below 90% of the frac gradient. The selected design provides enough clearance to deploy the pressure and temperature gauges on tubing and to ensure continuous surveillance of external integrity and conformance through the external fiber optic cable.

***7.1 Operational Procedures [LAC 43:XVII.3607(C)(2)(i)]***

The operational procedures detailed below describe how Magnolia Sequestration Hub, LLC, will initiate injection and conduct startup-specific monitoring of the Magnolia CCS 1, CCS 2, CCS 3, and CCS 4 wells.

The multi-stage (step-rate) startup procedure and period only apply to the initial start of injection operations until the well reaches the full injection rate. Monitoring frequencies and methodologies after the initial startup will follow the Testing and Monitoring Plan (TM).

During the startup period, the permittee will submit a daily report summarizing and interpreting the operational data. At the request of the Commissioner, the permittee may be required to schedule a daily conference call to discuss this information. A series of successfully higher injection rates, controlled with variable frequency drive pumps, will be performed. The elapsed time and pressure values will be read and recorded for each rate and time step. At no point during the procedure will the injection pressure be allowed to exceed the maximum injection pressure of 2,300 psig, which is measured at the wellhead. The injection rate will be measured and recorded using a Coriolis meter.

A spinner log will be conducted during each change (step) in rate, and the project team will look for any evidence of anomalous pressure behavior. If during the startup period any anomalous pressure behavior is observed, the project team may conduct additional logging and modify the injection rate program to characterize the anomaly better.

Additional operational parameters are detailed in the Summary of Operating Conditions (OP) documents for Magnolia CCS 1, CCS 2, CCS 3, and CCS4.

Automatic alarms and automatic shut-off systems will be installed and maintained. Successful function of the alarm system and shut-off system will be demonstrated prior to injection and once every sixth month after last approved demonstration.

At all times, pressure will be maintained on the well that will prevent the return of the injection fluid to the surface. The wellbore must be filled with a high specific gravity fluid during workovers to maintain a positive (downward) gradient and/or a plug shall be installed, which can resist the pressure differential. A blowout preventer must be installed and kept in proper operational condition whenever the wellhead is removed to work on the well.

Injection shall cease when any of the following circumstances arises:

- Failure of the well to pass a mechanical integrity test;
- A loss of mechanical integrity during operation;
- The automatic shut-off system is triggered;
- A significant unexpected change in the annulus or injection pressure;
- The Commissioner determines that the well lacks mechanical integrity; or

Permittee will cease injection according to the guidelines provided below:

- The permittee must shut-in the well by gradual reduction of the injection pressure as outlined in the OP documents; or
- The permittee must immediately cease injection and shut-in the well as outlined in the Emergency and Remedial Response Plan (ERRP).

### ***7.2 Proposed Carbon Dioxide Stream [LAC 43:XVII.3607(C)(2)(f)(iii) and (iv)]***

The proposed carbon dioxide stream composition is given in the Testing and Monitoring Plan (TM). No injectant other than that identified in this permit shall be injected into the well except fluids used for stimulation, rework, and well tests as approved by the Commissioner.

### ***7.3 Reporting and Record Keeping***

Electronic reports, submittals, notifications, and records made and maintained by Magnolia Sequestration Hub, LLC, under this permit must be in an electronic format approved by C&E. The permittee shall electronically submit all required reports to the Commissioner.

Magnolia Sequestration Hub, LLC, shall submit quarterly reports containing:

- Any changes to the physical, chemical, and other relevant characteristics of the CO<sub>2</sub> stream from the proposed operating data;
- Monthly average, maximum, and minimum values for injection pressure; flow rate and volume; and annular pressure;
- A description of any event that triggers a shut-off device required by LAC 43:XVII.621 and the response taken;



- The monthly volume and/or mass of the CO<sub>2</sub> stream injected over the reporting period and volume injected cumulatively over the life of the project;
- Monthly annulus fluid volumes gained or lost; and
- Results of the monitoring prescribed under LAC 43:XVII.3625

Any permit noncompliance shall be reported to the Commissioner within 24 hours as described below:

- any evidence that the injected carbon dioxide stream or associated pressure front may cause an endangerment to a USDW;
- any noncompliance with a permit condition, or malfunction of the injection system, which may cause fluid migration into or between USDWs;
- any triggering of a shut-off system (i.e., down-hole or at the surface);
- any failure to maintain mechanical integrity; or
- any release of carbon dioxide to the atmosphere or biosphere pursuant to compliance with the requirement at LAC 43:XVII.625(A)(8) for surface air/soil gas monitoring or other monitoring technologies, if required by the commissioner;

Within 30 days, the permittee will report to the Commissioner the results of periodic tests of mechanical integrity; any well workover, including stimulation; any other test of the injection well conducted by the permittee, if required by the Commissioner; and any test of any monitoring well required by this permit.

Magnolia Sequestration Hub, LLC, will notify the commissioner in writing in advance of doing any well work or formation testing as required in LAC 43:XVII.621(A)(9).

Magnolia Sequestration Hub, LLC, will submit all required submittals, reports, and notifications under LAC 43:XVII.3605, 3607, 3615, 3617, 3619, 3621, 3623, 3625, 3627, 3629, 3631, and 3633 to the USEPA in an electronic format approved by the USEPA.

Records shall be retained by Magnolia Sequestration Hub, LLC, as follows:

- all data collected for Class VI permit applications in LAC 43:XVII.607 shall be retained throughout the life of the geologic sequestration project and at least 10 years following site closure.
- data on the nature and composition of all injected fluids collected under LAC 43:XVII.625(A)(1)(a) shall be retained at least 10 years after site closure. The commissioner may require the owner or operator to deliver the records to the commissioner at the conclusion of the retention period.
- raw operating data from the continuous recording devices prescribed by LAC 43:XVII.3621(A)(6) shall be retained in digital format at least 10 years after collection.
- monitoring data collected under LAC 43:XVII.3625(A)(2) through 3625(A)(9) shall be retained at least 10 years after site closure.

- well plugging reports, post-injection site care data, including, if appropriate, data and information used to develop the demonstration of the alternative post-injection site care timeframe, and the site closure report collected pursuant to requirements at LAC 43:XVII.3633(A)(6) and 3633(A)(8) shall be retained at least 10 years following site closure.
- The commissioner may require the owner or operator to retain any records required under these regulations for longer than 10 years after site closure. The commissioner may require the owner or operator to deliver the records to the commissioner at any time prior to or at the conclusion of the retention period.

Magnolia Sequestration Hub, LLC, wells shall retain records as specified in LAC 43:XVII.3615(C)(4), 3629(A)(4), 3631(A)(5), 3633(A)(6), and 3633(A)(8).

## **8.0 Testing and Monitoring**

This Testing and Monitoring Plan document of this permit describes how Magnolia Sequestration Hub, LLC, will monitor the Magnolia Sequestration Project site pursuant to LAC 43:XVII.3625(A). In addition to demonstrating that the well is operating as planned, the carbon dioxide plume and pressure front are moving as predicted, and that there is no endangerment to USDWs, the monitoring data will be used to validate and adjust the geological models used to predict the distribution of the CO<sub>2</sub> within the storage zone to support AOR reevaluations and a non-endangerment demonstration.

Results of the testing and monitoring activities described below may trigger action according to the Emergency and Remedial Response Plan (ERRP).

### ***8.1 Mechanical Integrity***

Other than during periods of well workover or maintenance approved by the Commissioner, in which the sealed tubing-casing annulus is disassembled for maintenance or corrective procedures, the injection well must have and maintain mechanical integrity consistent with LAC 43:XVII.3627(A). To meet these requirements, mechanical integrity tests/demonstrations must be witnessed by the Commissioner, or an authorized representative of the Commissioner, unless prior approval has been granted by the Commissioner to run an un-witnessed test.

Magnolia Sequestration Hub, LLC, shall conduct a casing inspection log and mechanical integrity testing as follows:

- Prior to receiving authorization to inject, the permittee shall perform the testing to demonstrate internal and external mechanical integrity pursuant to LAC 43:XVII.3617(B)(1)(d) or an alternative method approved by the C&E to the requirements at LAC 43:XVII.3627(A)(5).
- Other than during periods of a well workover approved by the Commissioner, in which the sealed tubing-casing annulus is disassembled for maintenance or corrective procedures, the permittee must continuously monitor injection pressure, rate, and volumes; pressure on the annulus between tubing and long string casing; and annulus

fluid volume as specified in LAC 43:XVII.3621(A)(6)(a) and LAC 43:XVII.3627(A)(2).

- At least once per year, the permittee must perform testing to demonstrate external mechanical integrity pursuant to LAC 43:XVII.3627(A)(3) or an alternative approved by the C&E pursuant to requirements at LAC 43:XVII.3627(A)(5).
- After any workover that may compromise the internal mechanical integrity of the well, the wellbore shall be tested by means of a pressure test approved by the Commissioner and must pass this test to demonstrate mechanical integrity.
- Prior to plugging the well, the permittee shall demonstrate external mechanical integrity of the well as described in the Injection Well Plugging Plan that meets the requirements of LAC 43:XVII.3631(A)(2).

Magnolia Sequestration Hub, LLC, shall notify the Commissioner in an electronic format of his or her intent to demonstrate mechanical integrity at least 30 days prior to such demonstration. However, at the discretion of the Commissioner, a shorter time may be allowed.

Reports of mechanical integrity demonstrations that contain logs must include an interpretation of the results by a knowledgeable log analyst. The permittee shall report in an electronic format the results of a mechanical integrity demonstration.

Magnolia Sequestration Hub, LLC, shall calibrate all gauges used in mechanical integrity demonstrations and other required monitoring to an accuracy of not less than 0.5 percent of full scale, within one year prior to each required test. A copy of the calibration certificate shall be submitted to the Commissioner in an electronic format with the report of the test. Pressure gauge resolution shall be no greater than five (5) psi. Certain mechanical integrity and other testing may require greater accuracy and shall be identified in the procedure submitted to the Commissioner prior to the test.

Magnolia Sequestration Hub, LLC, must adhere to the following guidelines regarding failure to maintain mechanical integrity:

- If the permittee or Commissioner finds that the well fails to demonstrate mechanical integrity during a test; is unable to maintain mechanical integrity during operation; or that a loss of mechanical integrity as defined by LAC 43:XVII.3627(A)(1)(a) or (b) is suspected during operation (such as a significant unexpected change in the annulus or injection pressure), the permittee must:
  - Cease injection;
  - Take all steps reasonably necessary to determine whether there may have been a release of the injected CO<sub>2</sub> stream or formation fluids into any unauthorized zone. If there is evidence of USDW endangerment, the Permittee shall implement the Emergency and Remedial Response Plan document of this permit;
  - Follow the reporting requirements as directed in the Emergency and Remedial Response Plan;
  - Restore and demonstrate mechanical integrity to the satisfaction of the Commissioner and receive written approval from the Commissioner prior to resuming injection; and

- Notify the Commissioner in an electronic format when injection is expected to resume.
- If a shut-down (i.e., downhole or at the surface) is triggered, Magnolia Sequestration Hub, LLC, must investigate and identify as expeditiously as possible the cause of the shut-down. If upon such investigation, the well appears to be lacking mechanical integrity or if monitoring required indicates that the well may be lacking mechanical integrity, the permittee must take the actions as described in the Emergency and Remedial Response Plan.
- If the well loses mechanical integrity prior to the next scheduled test date, then the well must either be plugged or repaired and retested within 30 days of losing mechanical integrity. Magnolia Sequestration Hub, LLC, shall not resume injection until the mechanical integrity is demonstrated and the Commissioner gives written approval to re-commence injection in cases where the well has lost mechanical integrity.

Magnolia Sequestration Hub, LLC, shall demonstrate mechanical integrity at any time upon written notice from the Commissioner.

#### **Testing and Monitoring GSDT Submissions**

**GSDT Module:** Project Plan Submissions

**Tab(s):** Testing and Monitoring tab

Please use the checkbox(es) to verify the following information was submitted to the GSDT:

☐ Testing and Monitoring Plan [*LAC 43:XVII.3607(C)(2)(n) and LAC 43:XVII.3625(A)*]

### **9.0 Injection Well Plugging**

Upon the end of life for the Magnolia CCS injection wells, the injection wells will be plugged and abandoned relevant to the requirements of C&E Criteria and Standards Applicable to Class VI Wells. The plugging procedure and materials will be designed to prevent any unwanted fluid movement, resist the corrosive aspects of CO<sub>2</sub> with water mixtures, and protect any underground sources of drinking water (USDWs).

#### **Injection Well Plugging GSDT Submissions**

**GSDT Module:** Project Plan Submissions

**Tab(s):** Injection Well Plugging tab

Please use the checkbox(es) to verify the following information was submitted to the GSDT:

☐ Injection Well Plugging Plan [*LAC 43:XVII.3607(C)(2)(o) and LAC 43:XVII.3631(A)(3)*]

### **10.0 Post-Injection Site Care (PISC) and Site Closure**

The Post-Injection Site Care and Site Closure (PISC) plan describes the activities that Magnolia Sequestration Hub, LLC, will perform to meet the requirements of LAC 43:XVII.3633(A). Magnolia Sequestration Hub, LLC, will monitor ground water quality and track the position of



the carbon dioxide plume and pressure front for 50 years. Magnolia Sequestration Hub, LLC, may not cease post-injection monitoring until a demonstration of non-endangerment of USDWs has been approved by the C&E pursuant to LAC 43:XVII.3633(A)(2)(c). Following approval for site closure, Magnolia Sequestration Hub, LLC, will plug all monitoring wells, restore the site to its original condition, and submit a site closure report and associated documentation.

#### **PISC and Site Closure GSDT Submissions**

**GSDT Module:** Project Plan Submissions

**Tab(s):** PISC and Site Closure tab

Please use the checkbox(es) to verify the following information was submitted to the GSDT:

☐ PISC and Site Closure Plan *[LAC 43:XVII.3607(C)(2)(p) and LAC 43:XVII.3633(A)(1)]*

**GSDT Module:** Alternative PISC Timeframe Demonstration

**Tab(s):** All tabs (only if an alternative PISC timeframe is requested)

Please use the checkbox(es) to verify the following information was submitted to the GSDT:

☐ Alternative PISC timeframe demonstration *[LAC 43:XVII.3607(C)(2)(q) and LAC 43:XVII.3633(A)(3)]*

### **11.0 Emergency and Remedial Response**

The Emergency and Remedial Response Plan (ERRP) document of this permit describes actions Magnolia Sequestration Hub, LLC, shall take to address movement of the injection fluid or formation fluid in a manner that may endanger an underground source of drinking water (USDW) during the construction, operation, or post-injection site care periods.

If Magnolia Sequestration Hub, LLC, obtains evidence that the injected CO<sub>2</sub> stream and/or associated pressure front may cause an endangerment to a USDW, Magnolia Sequestration Hub, LLC, will initiate shutdown plan for the injection well, take all steps reasonably necessary to identify and characterize any release, notify the permitting agency (C&E) of the emergency event, and implement applicable portions of the approved ERRP.

#### **Emergency and Remedial Response GSDT Submissions**

**GSDT Module:** Project Plan Submissions

**Tab(s):** Emergency and Remedial Response tab

Please use the checkbox(es) to verify the following information was submitted to the GSDT:

☐ Emergency and Remedial Response Plan *[LAC 43:XVII.3607(C)(2)(r) and LAC 43:XVII.3623(A)(1)]*

**12.0 Injection Depth Waiver and Aquifer Exemption Expansion**

Injection depth waivers are not requested in this permit application.

**Injection Depth Waiver and Aquifer Exemption Expansion GSDT Submissions**

***GSDT Module:*** Injection Depth Waivers and Aquifer Exemption Expansions

***Tab(s):*** All applicable tabs

Please use the checkbox(es) to verify the following information was submitted to the GSDT:

- ☐ Injection Depth Waiver supplemental report *[Not Applicable in Louisiana]*
- ☐ Aquifer exemption expansion request and data *[LAC 43:XVII.3603(F)(2)(d) and LAC 43:XVII.3603(F)(4)]*

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**Figure NAR-49—Image Log of Lower Miocene.** Intervals with whole core noted with blue bars.

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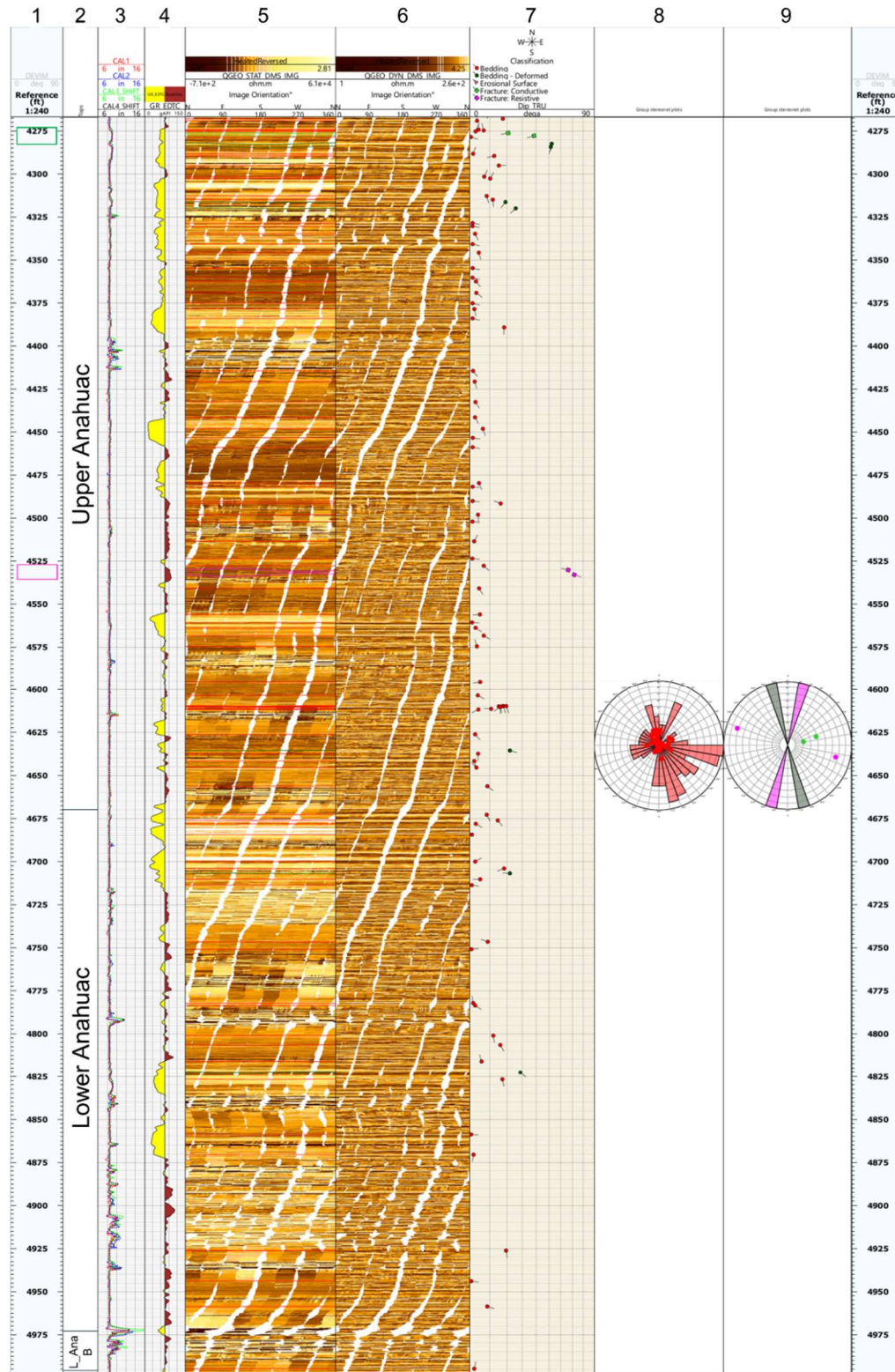
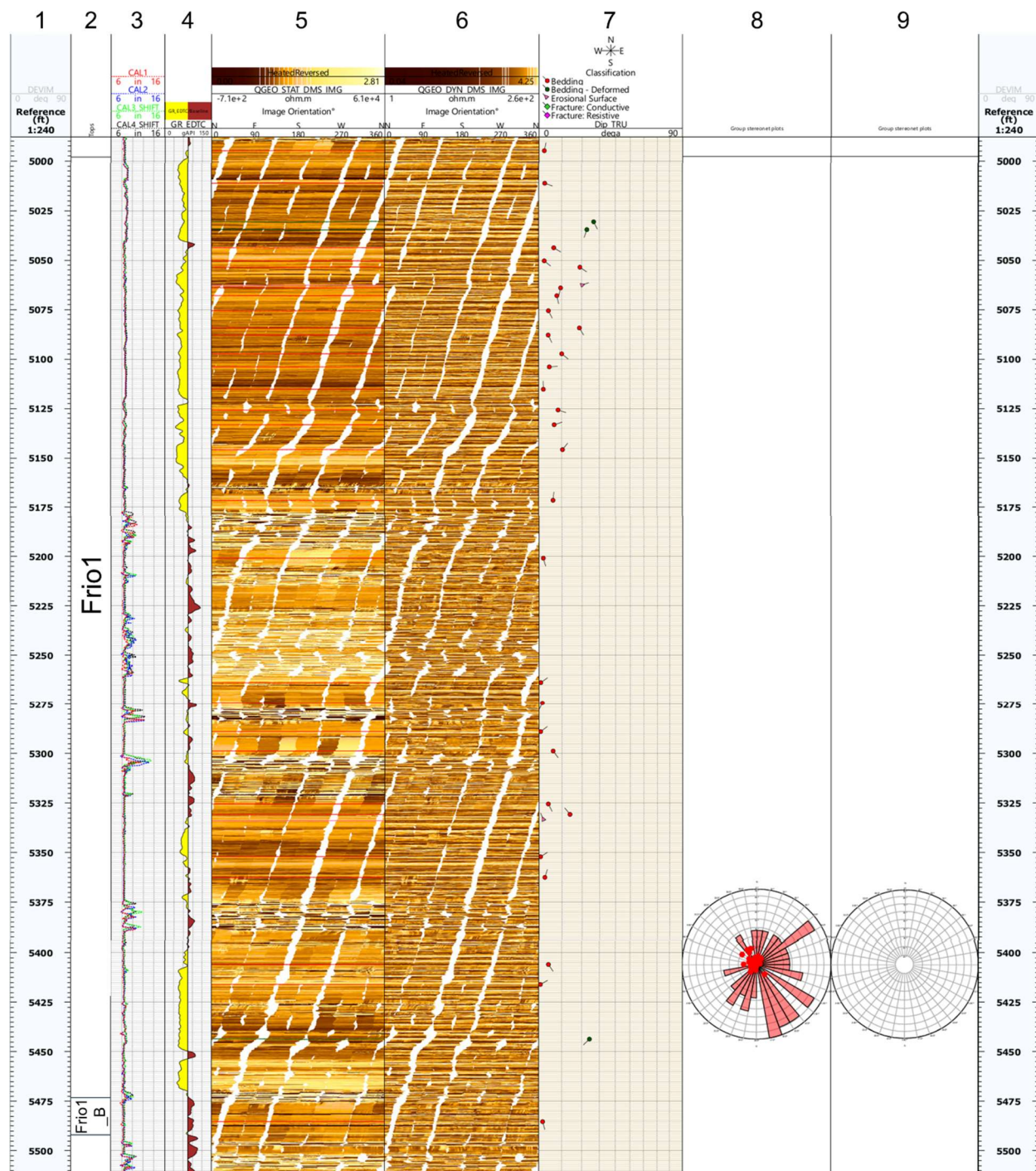


Figure NAR-50—Image Log of Anahuac. Green and Pink boxes in Track 1 are areas highlighted in figure NAR-26.



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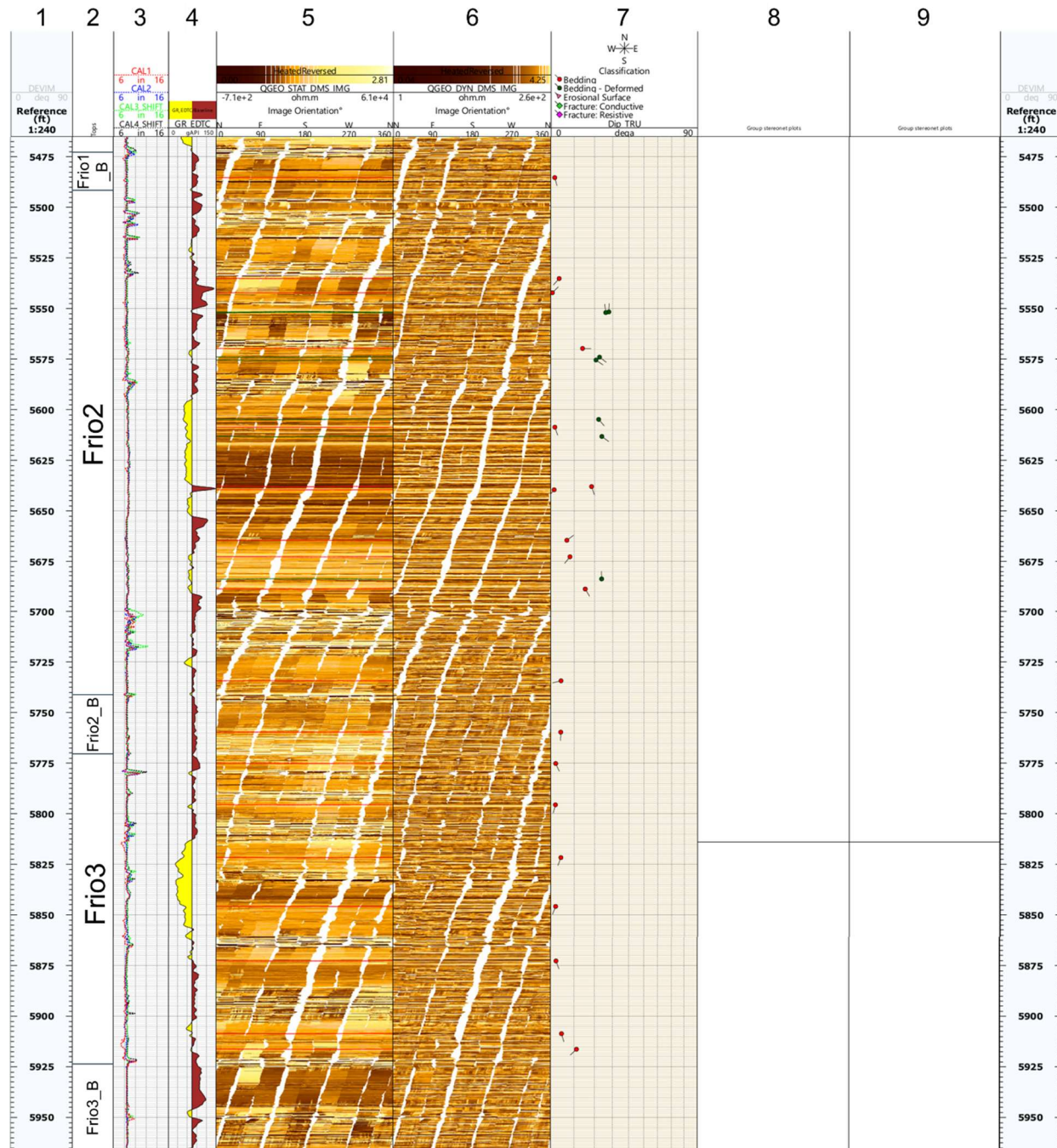


Figure NAR-52—Image Log of Frio2, Frio2\_B, Frio3, and Frio3\_B.



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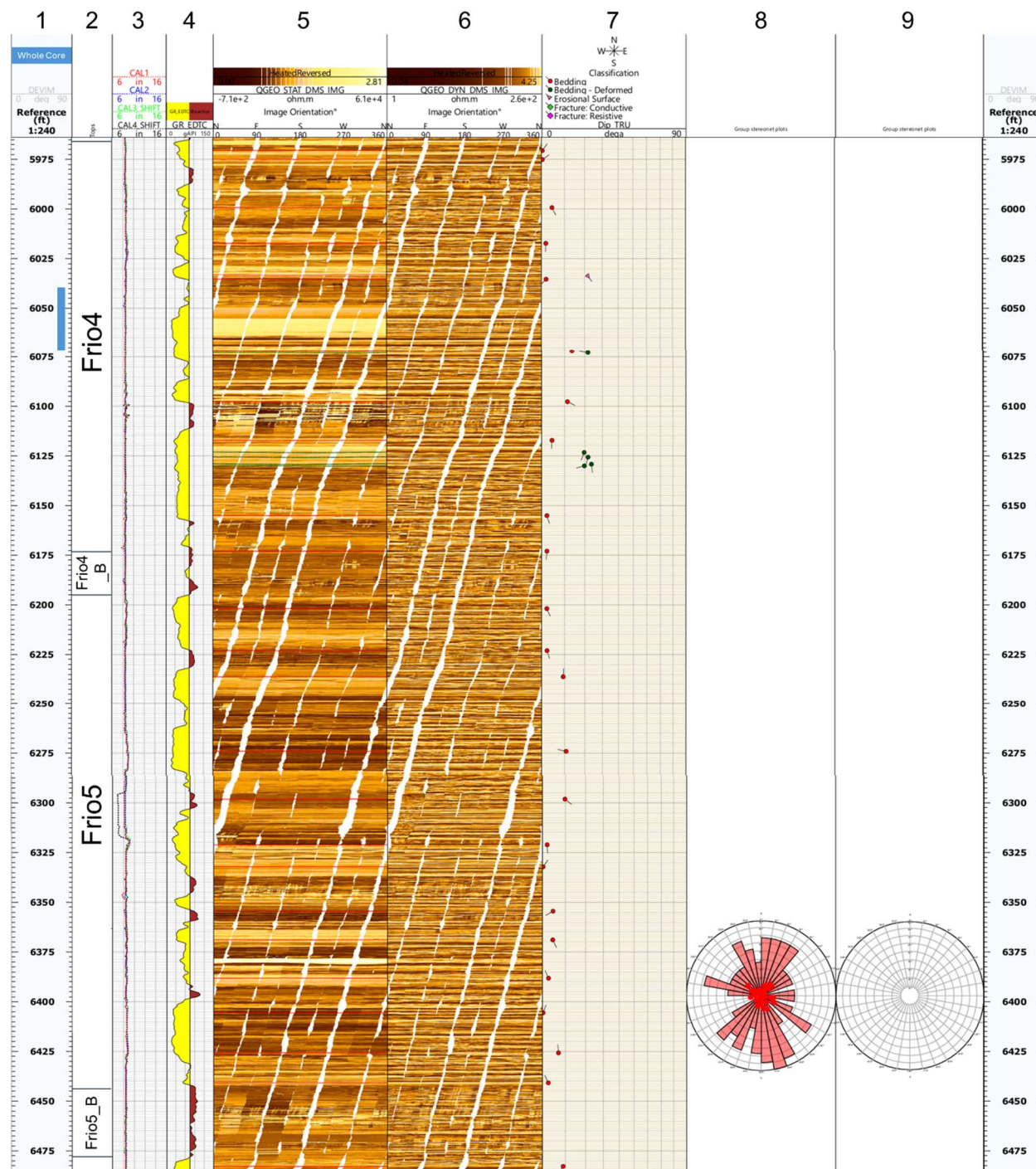


Figure NAR-53—Image Log of Frio4, Frio4\_B, Frio5, and Frio5\_B. Whole core interval in Frio4 note with blue bar.

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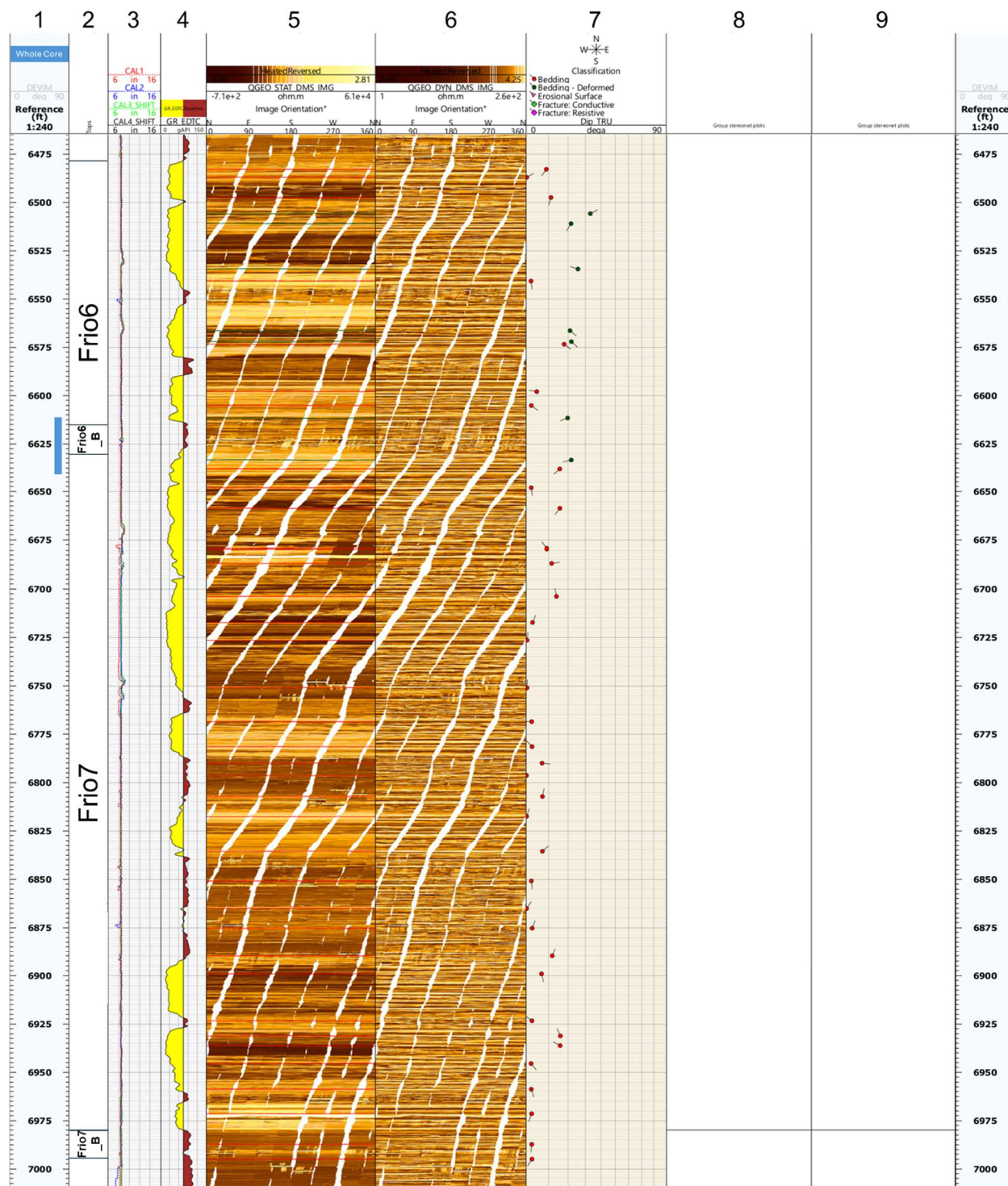


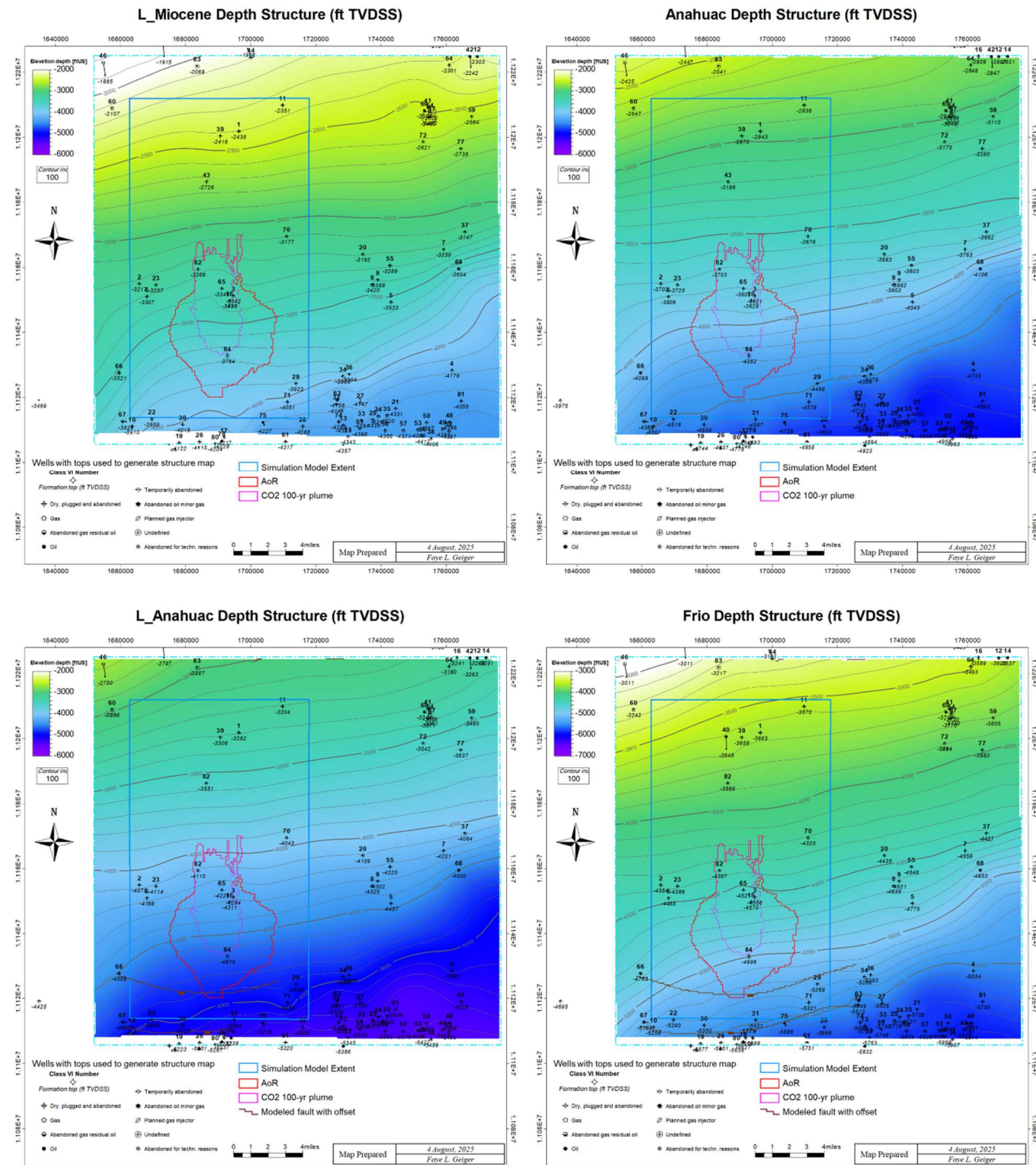
Figure NAR-54—Image Log of Frio6, Frio6\_B, Frio7, and Frio7\_B. Whole core interval in Frio6\_B and Frio7 note with blue bar.





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**Appendix B: Maps of Injection, Confining, and Intermediate Zones****Structure Maps****Figure NAR-56—Structure maps from geomodel for the L\_Miocene, Anahuac, L\_Anahuac, and Frio1.**



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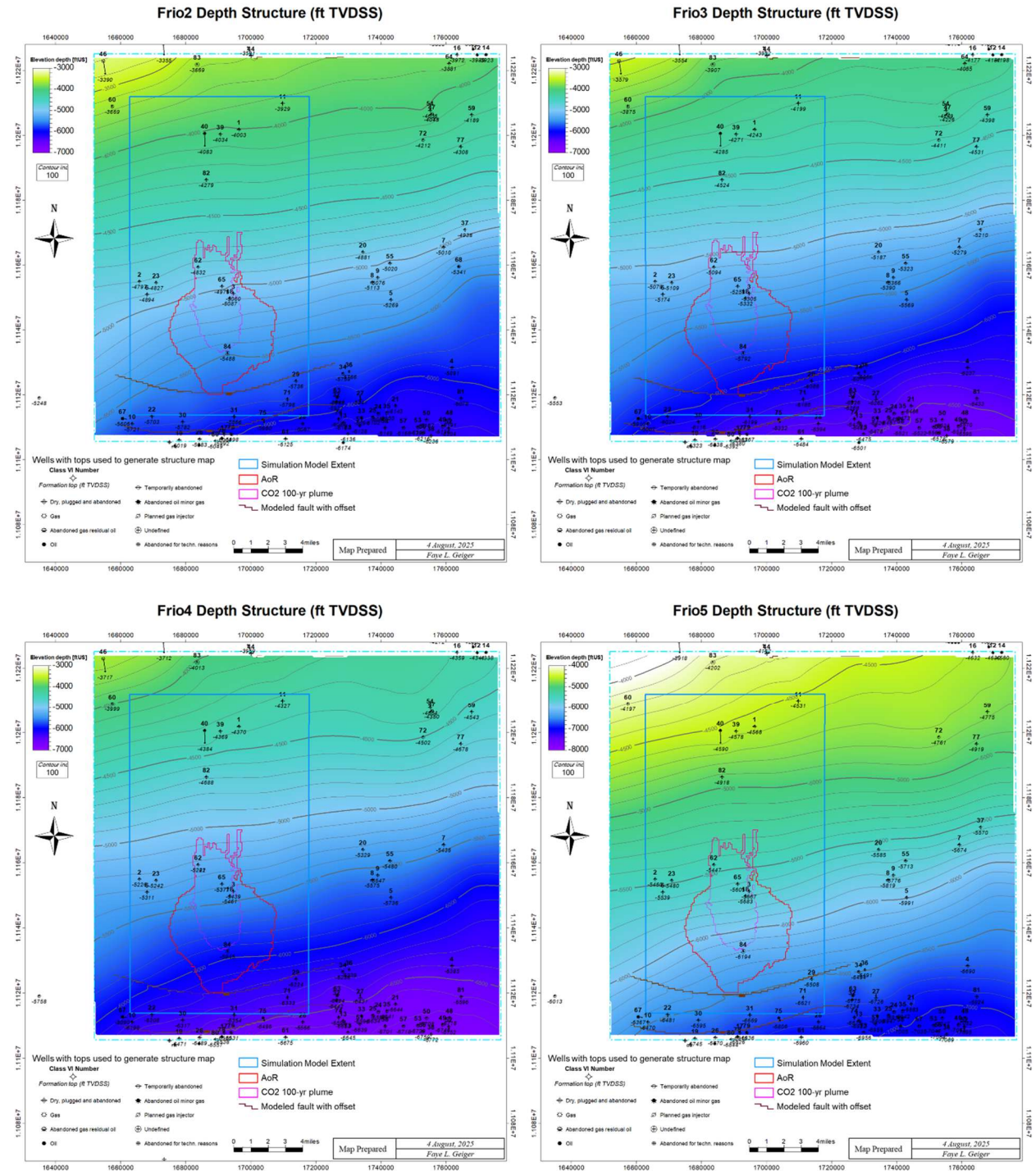


Figure NAR-57—Structure maps from geomodel for the Frio2, Frio3, Frio4, and Frio5.

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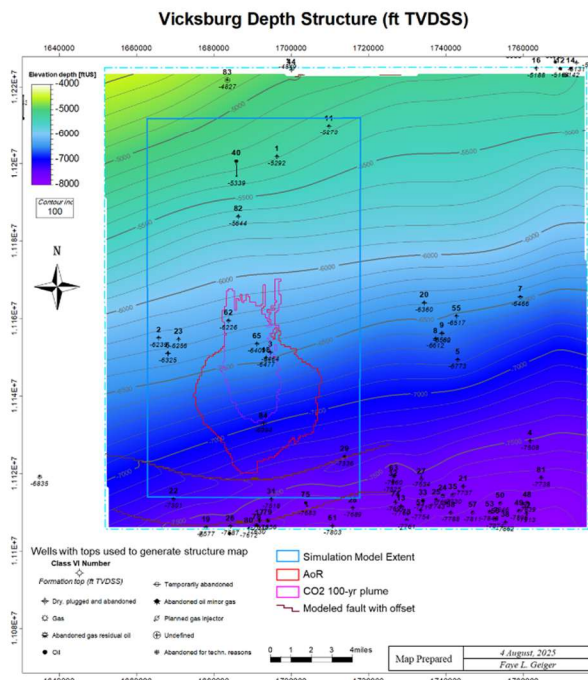
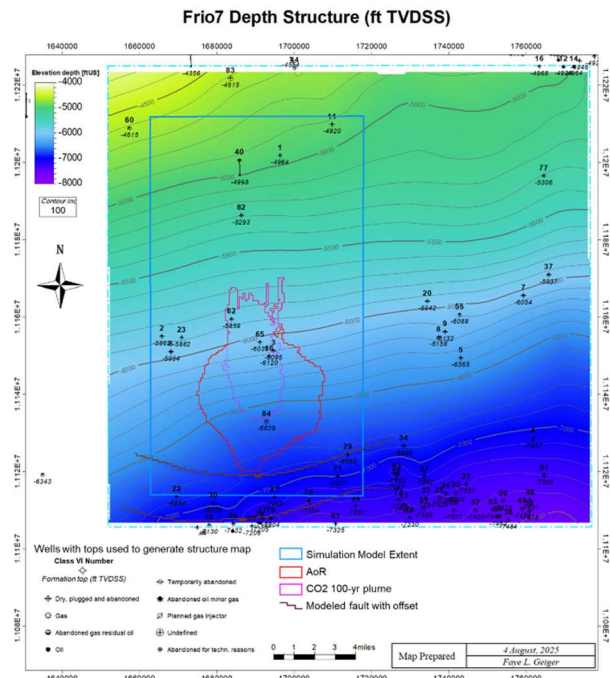
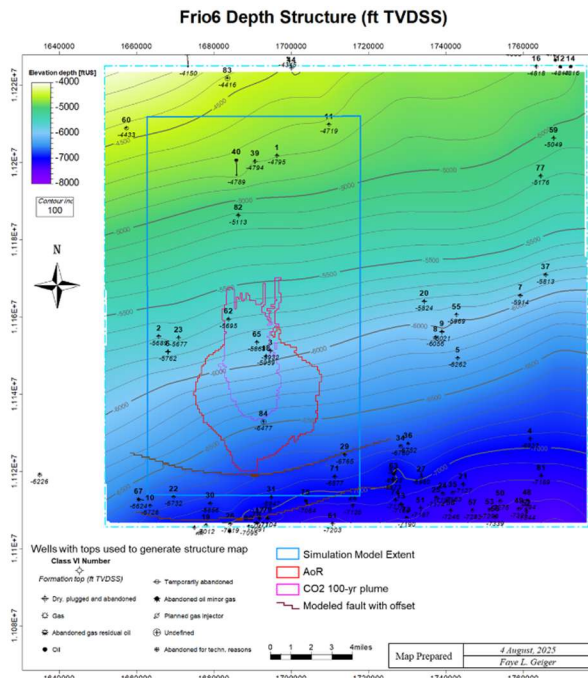
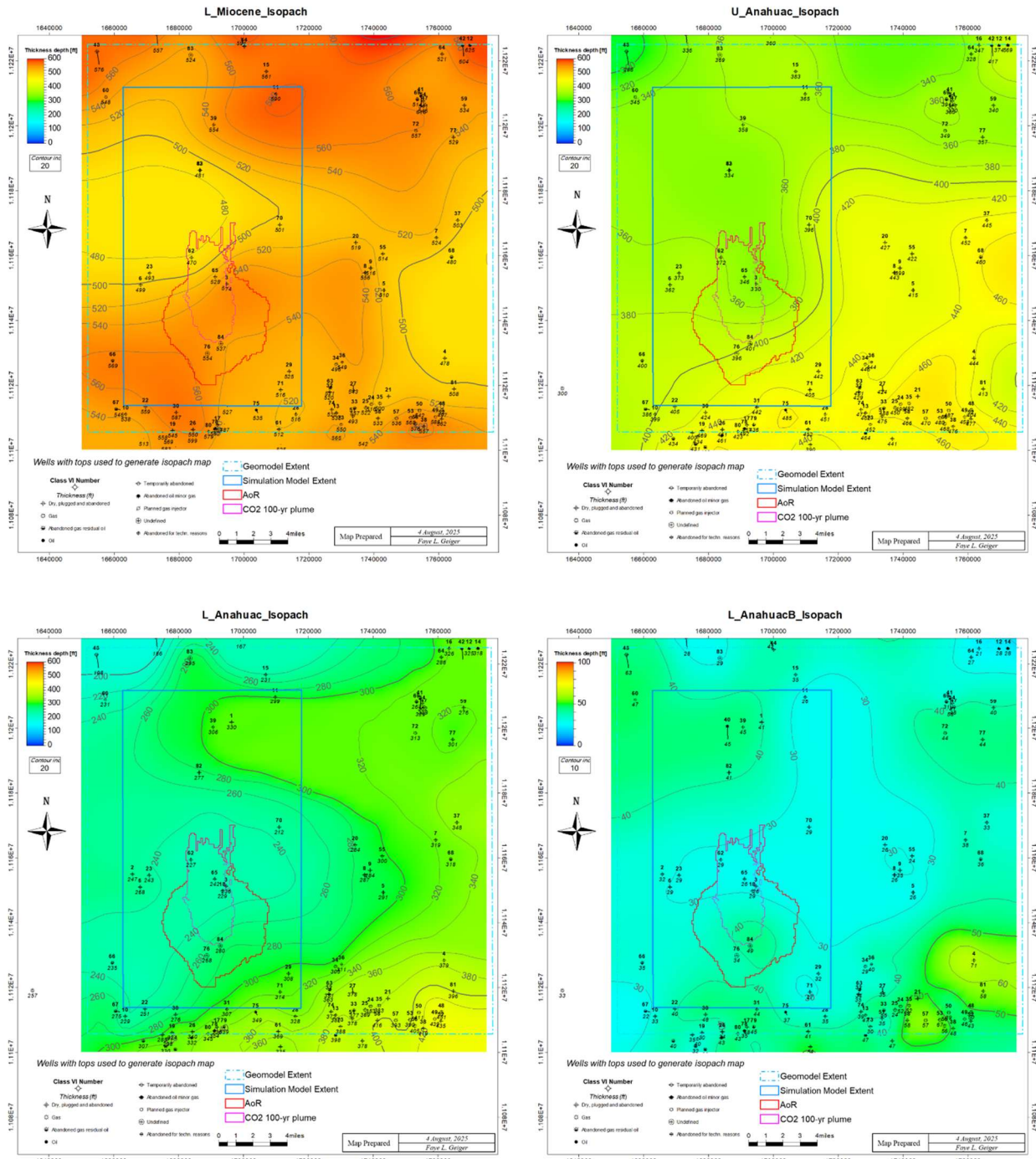


Figure NAR-58—Structure maps from geomodel for the Frio6, Frio7, and Vicksburg.



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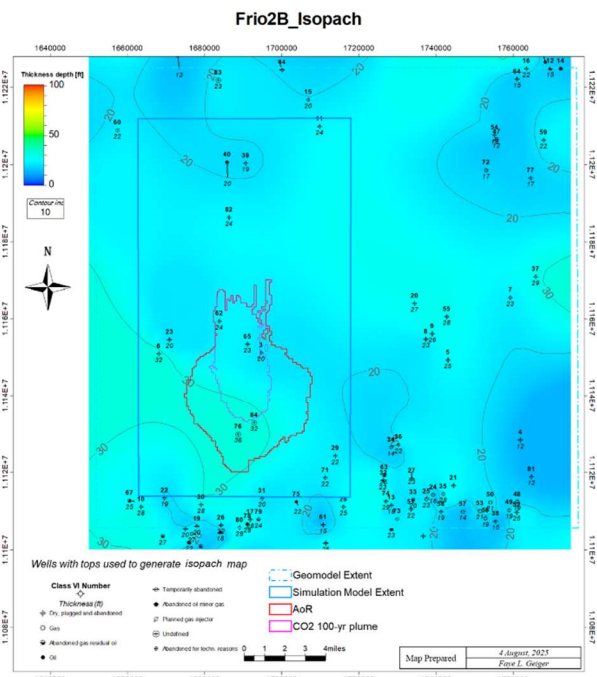
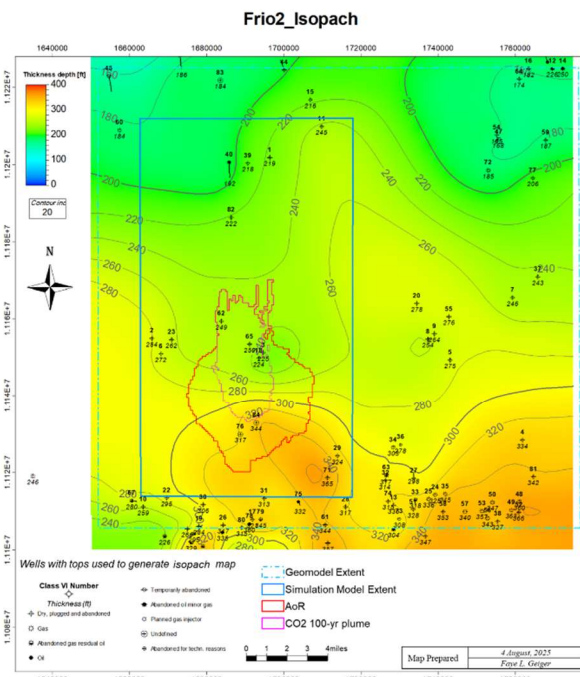
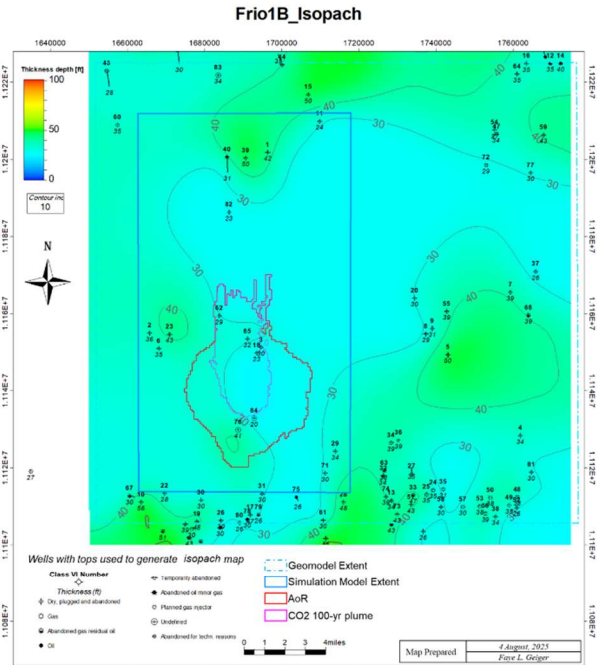
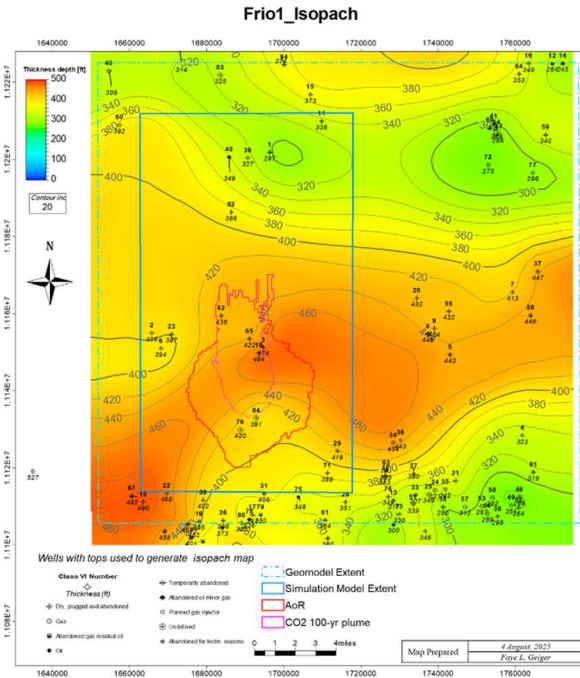
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*Isopach Maps*

**Figure NAR-59—Isopach maps from geomodel for the upper confining and intermediate zones (L\_Miocene, U\_Anahuac, L\_Anahuac, and L\_Anahuac\_B).**

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**Figure NAR-60—Isopach maps from geomodel for the upper Frio and confining zones (Frio1, Frio1\_B, Frio2, and Frio2\_B).**



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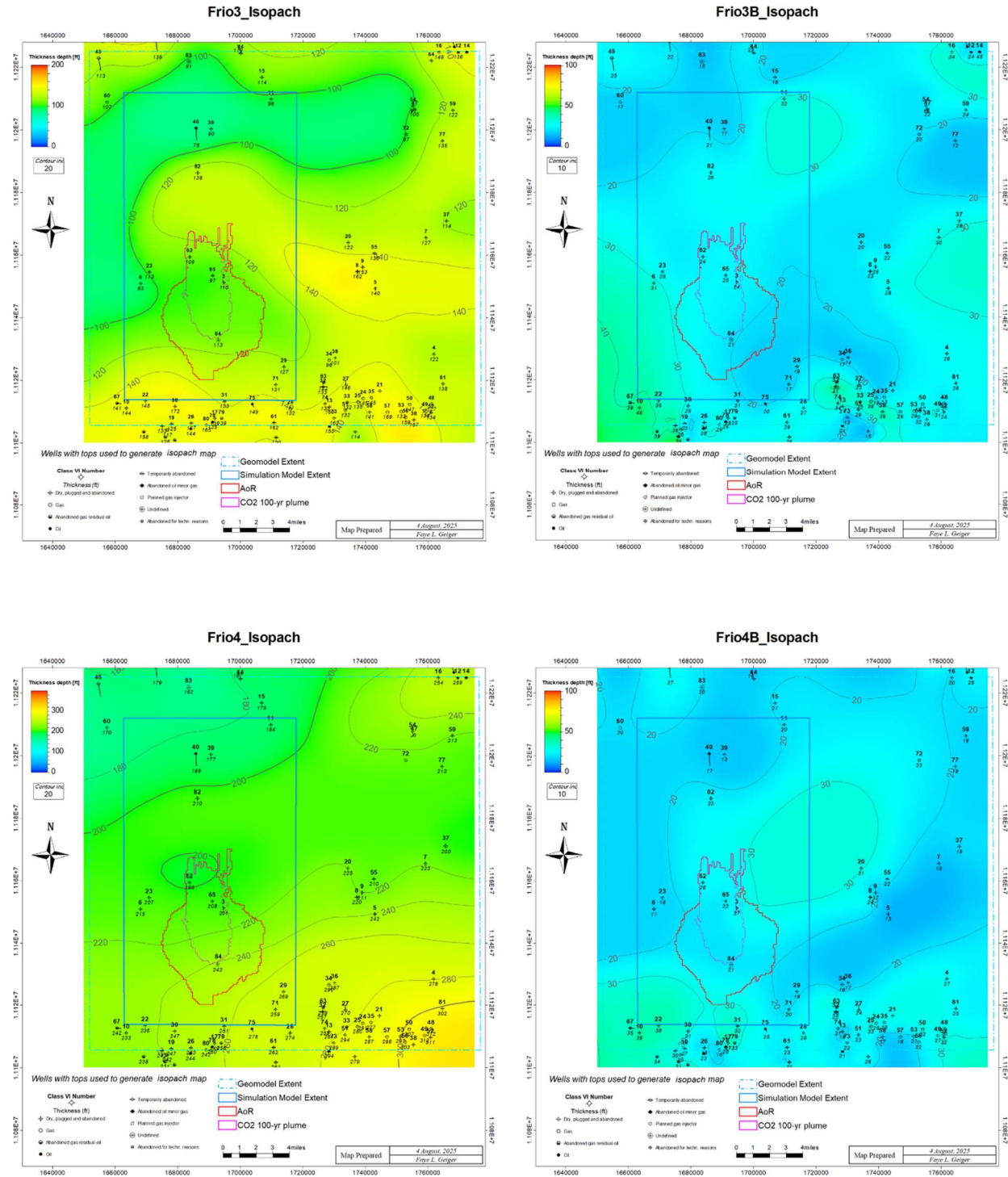


Figure NAR-61—Isopach maps from geomodel for the upper Frio and confining zones (Frio3, Frio3\_B, Frio4, and Frio4\_B).

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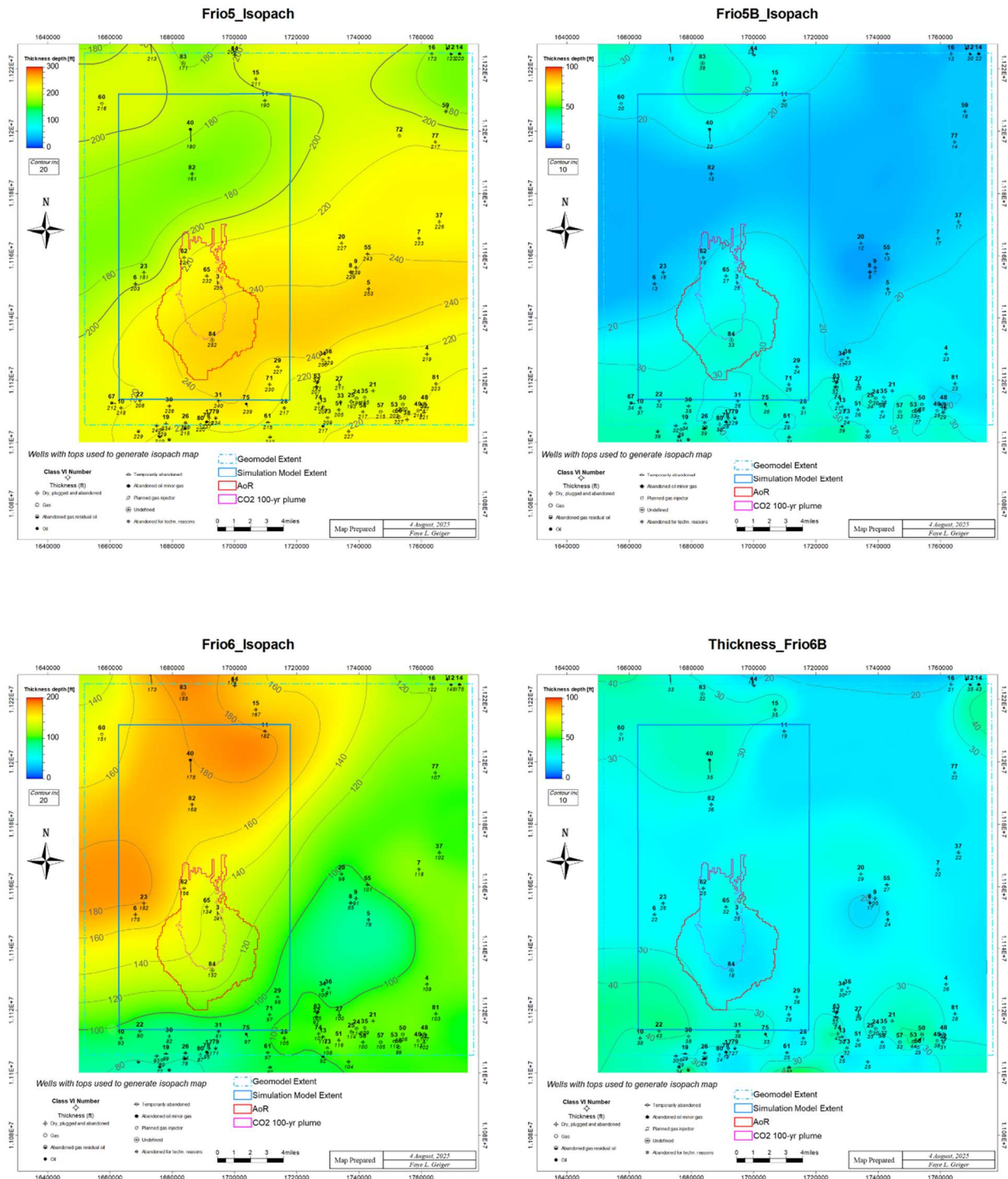
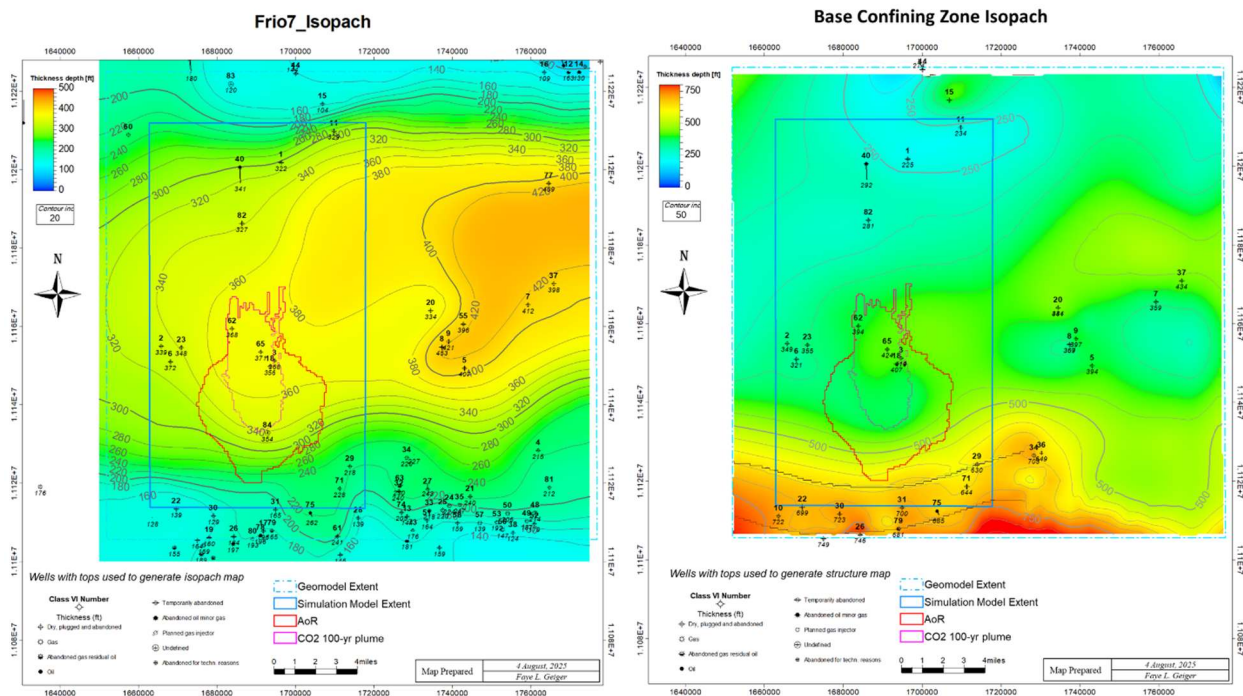


Figure NAR-62—Isopach maps from geomodel for the lower Frio and confining zones (Frio5, Frio5B, Frio6, and Frio6B).

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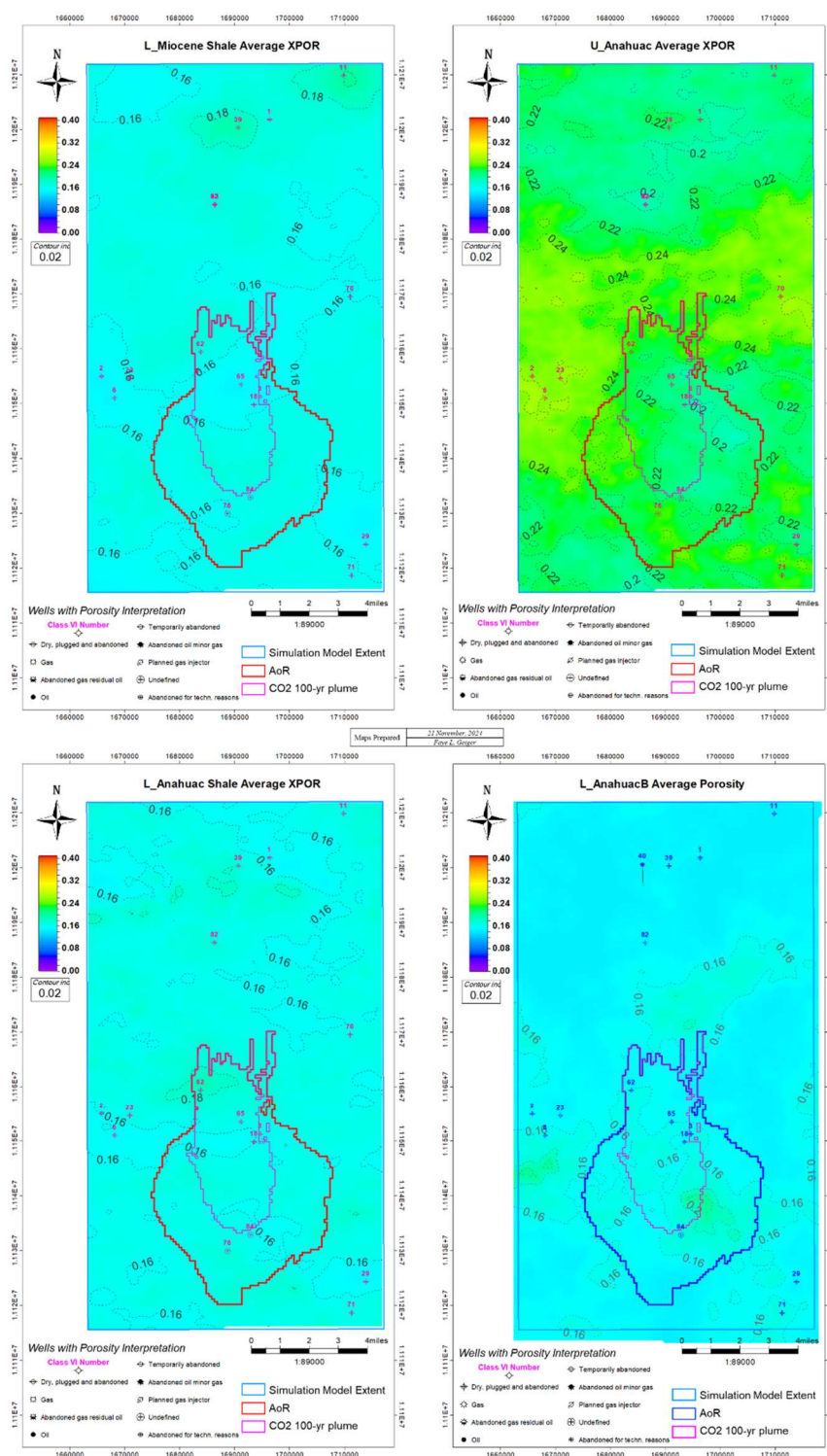


**Figure NAR-63—Isopach maps from geomodel for the Frio7 and Lower Confining Zone (Frio7\_B and Vicksburg)**



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***Properties: Porosity***

**Figure NAR-64—Porosity maps from geomodel for the upper confining and intermediate zones (L\_Miocene, U\_Anahuac, L\_Anahuac, and L\_Anahuac\_B).**

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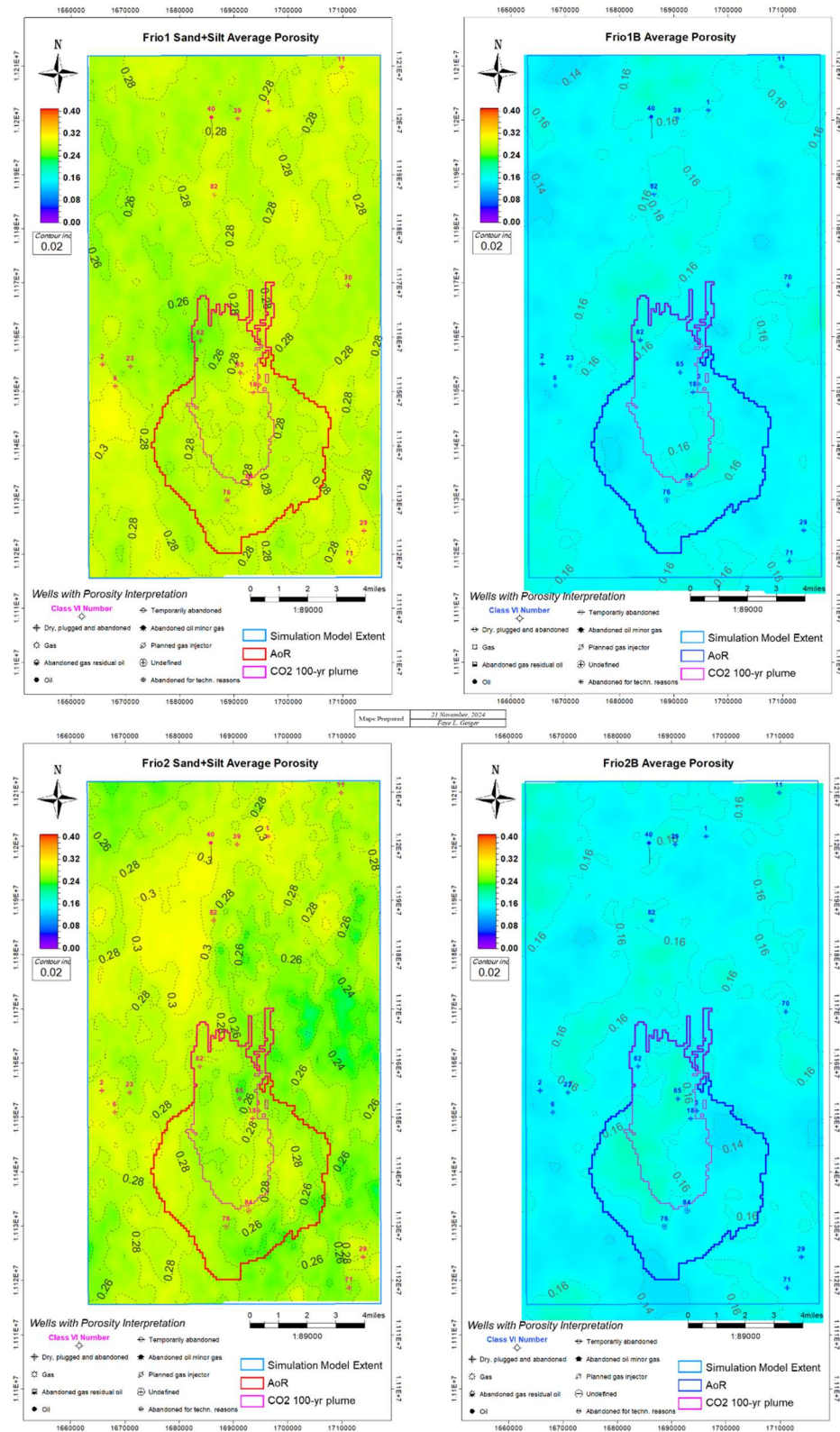


Figure NAR-65—Porosity maps from geomodel for the Frio injection and confining zones (Frio1, Frio1\_B, Frio2, and Frio2\_B).

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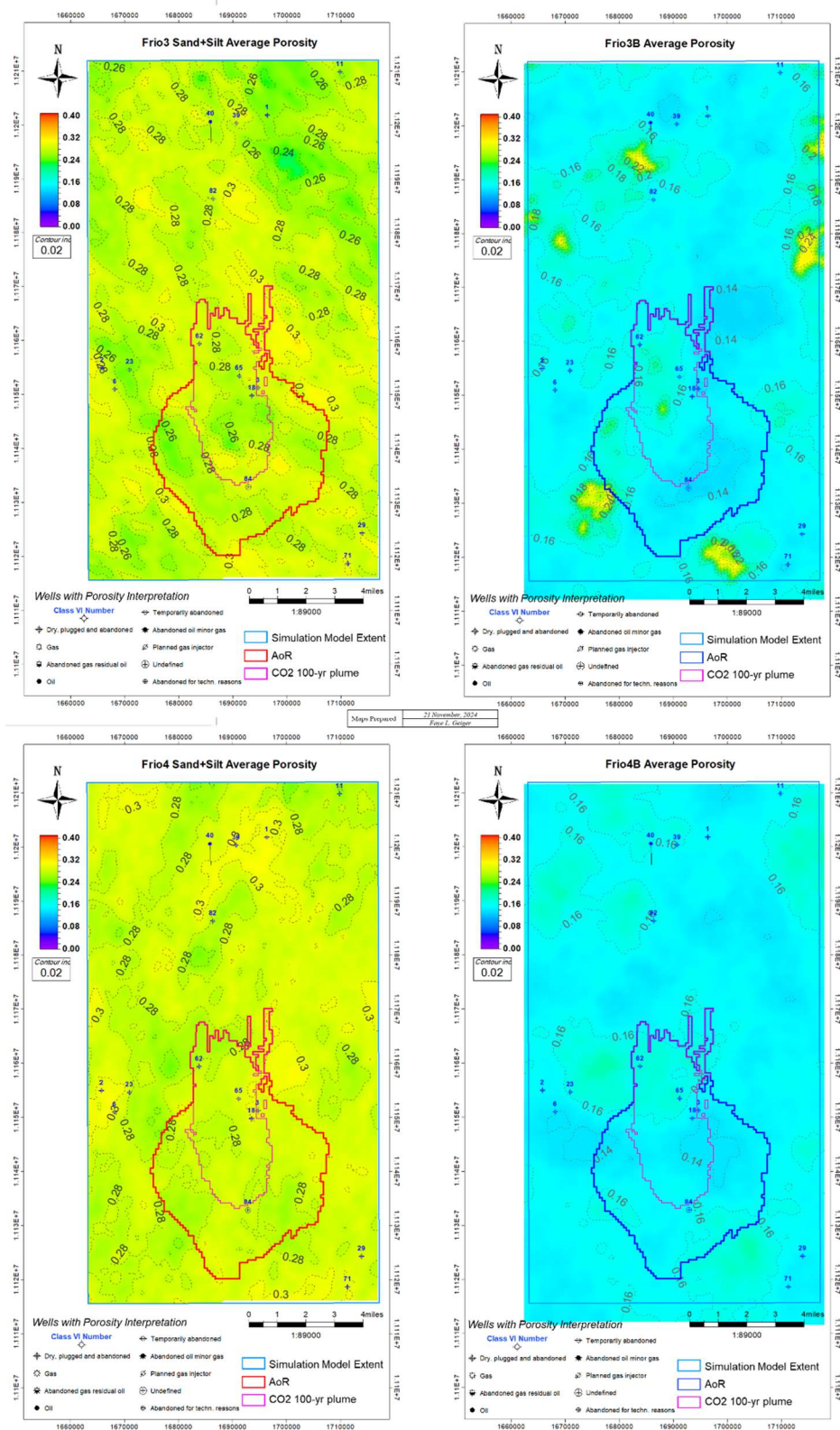


Figure NAR-66—Porosity maps from geomodel for the Frio injection and confining zones (Frio3, Frio3\_B, Frio4, and Frio4\_B).



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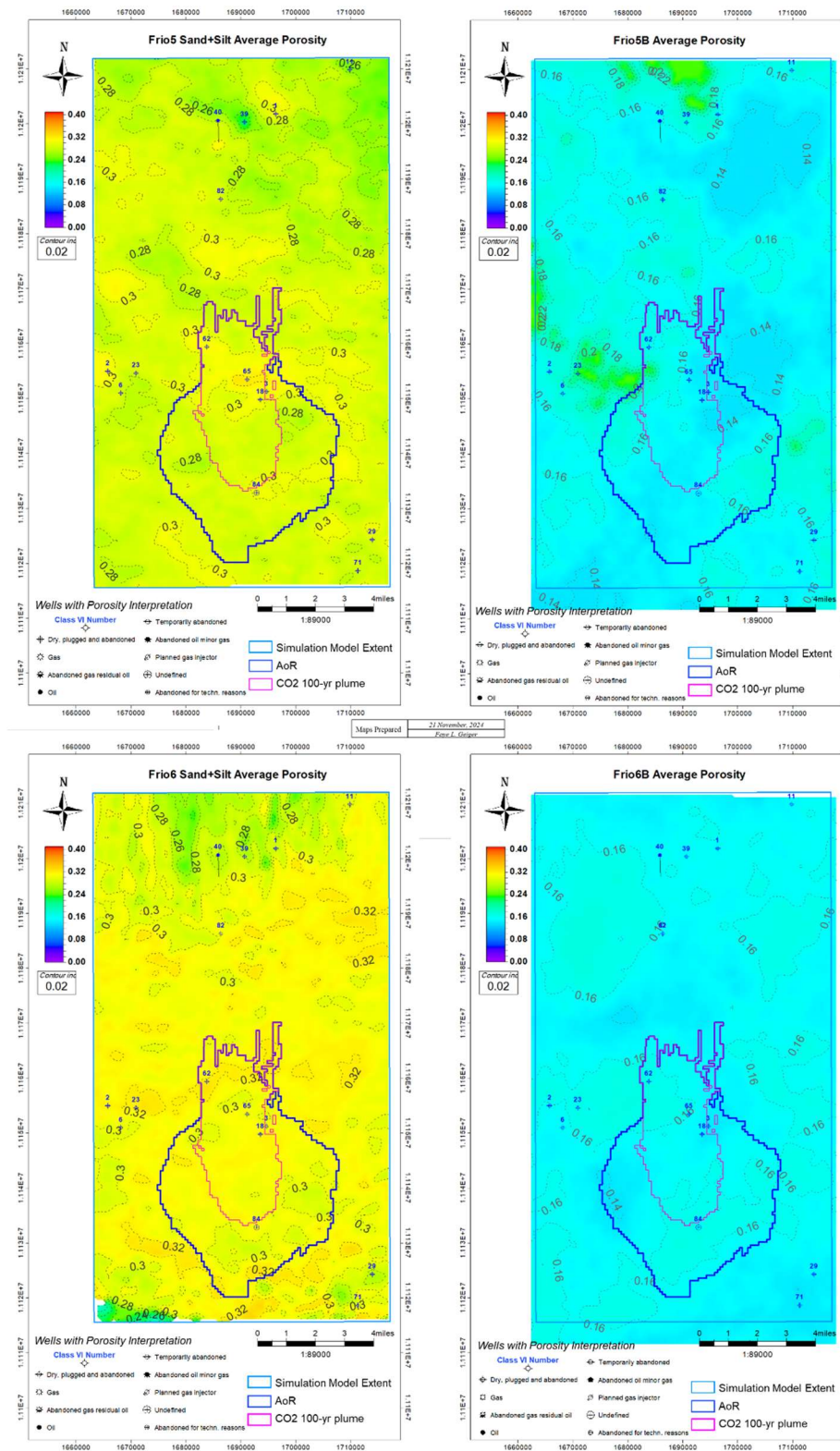
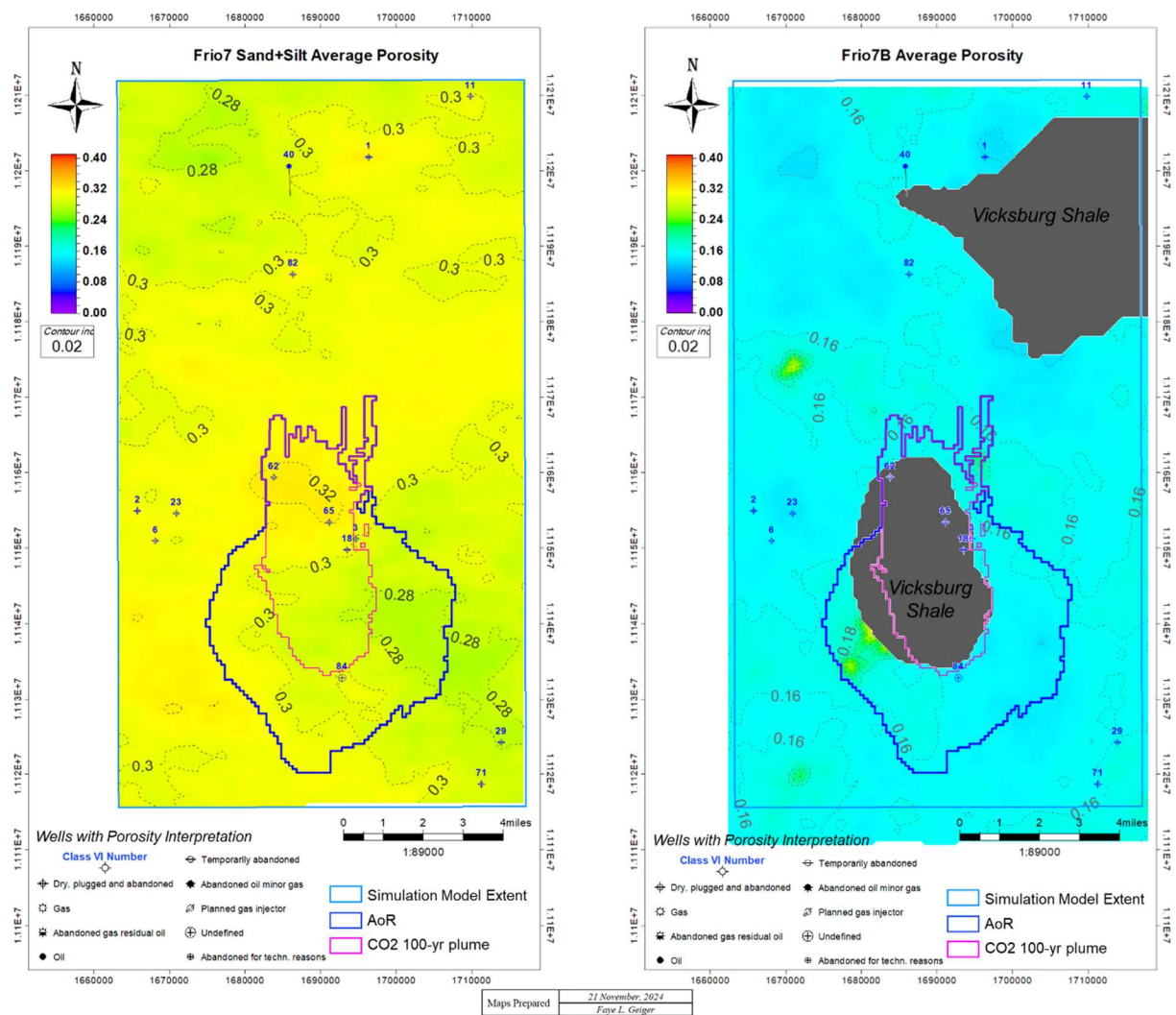


Figure NAR-67—Porosity maps from geomodel for the Frio injection and confining Zones (Frio5, Frio5\_B, Frio6, and Frio6\_B).

## Narrative for Magnolia Sequestration Project

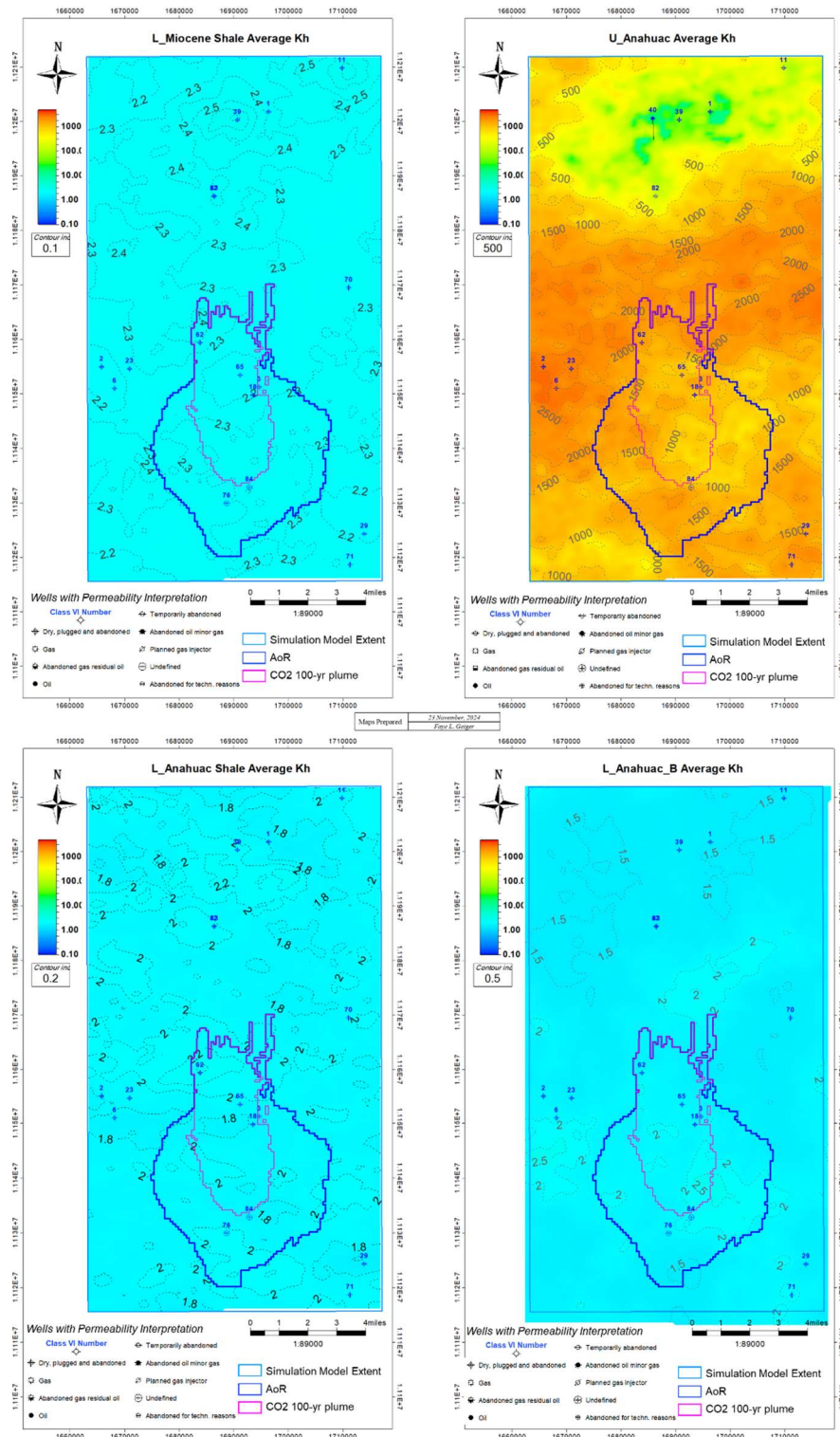
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**Figure NAR-68—Porosity maps from geomodel for the Frio injection and confining zones (Frio7 and Frio7\_B).**

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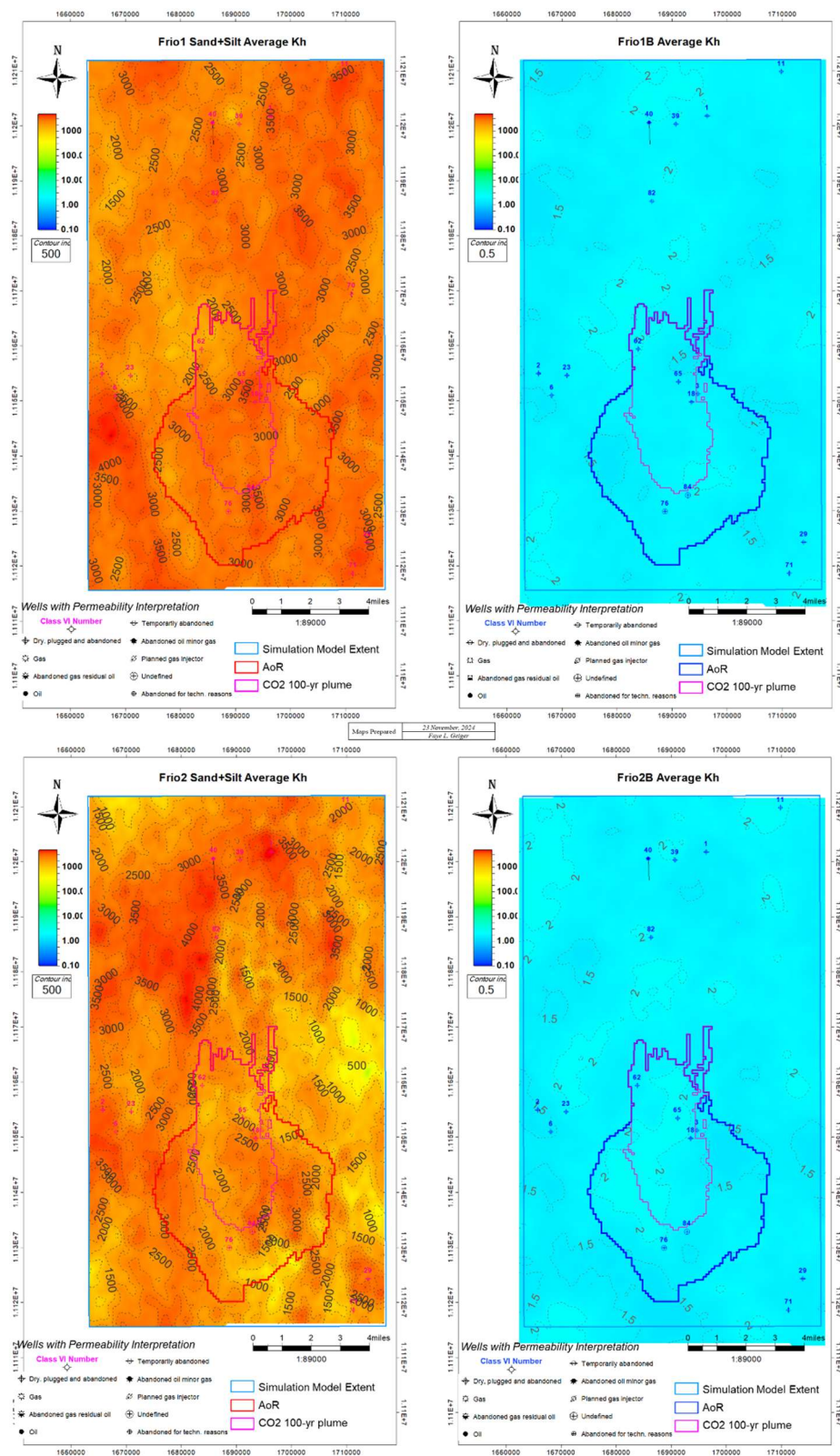
**Properties: Permeability**

**Figure NAR-69—Average horizontal permeability maps from geomodel for the upper confining and intermediate zones (L\_Miocene, U\_Anahuac, L\_Anahuac, and L\_Anahuac\_B).**



## Narrative for Magnolia Sequestration Project

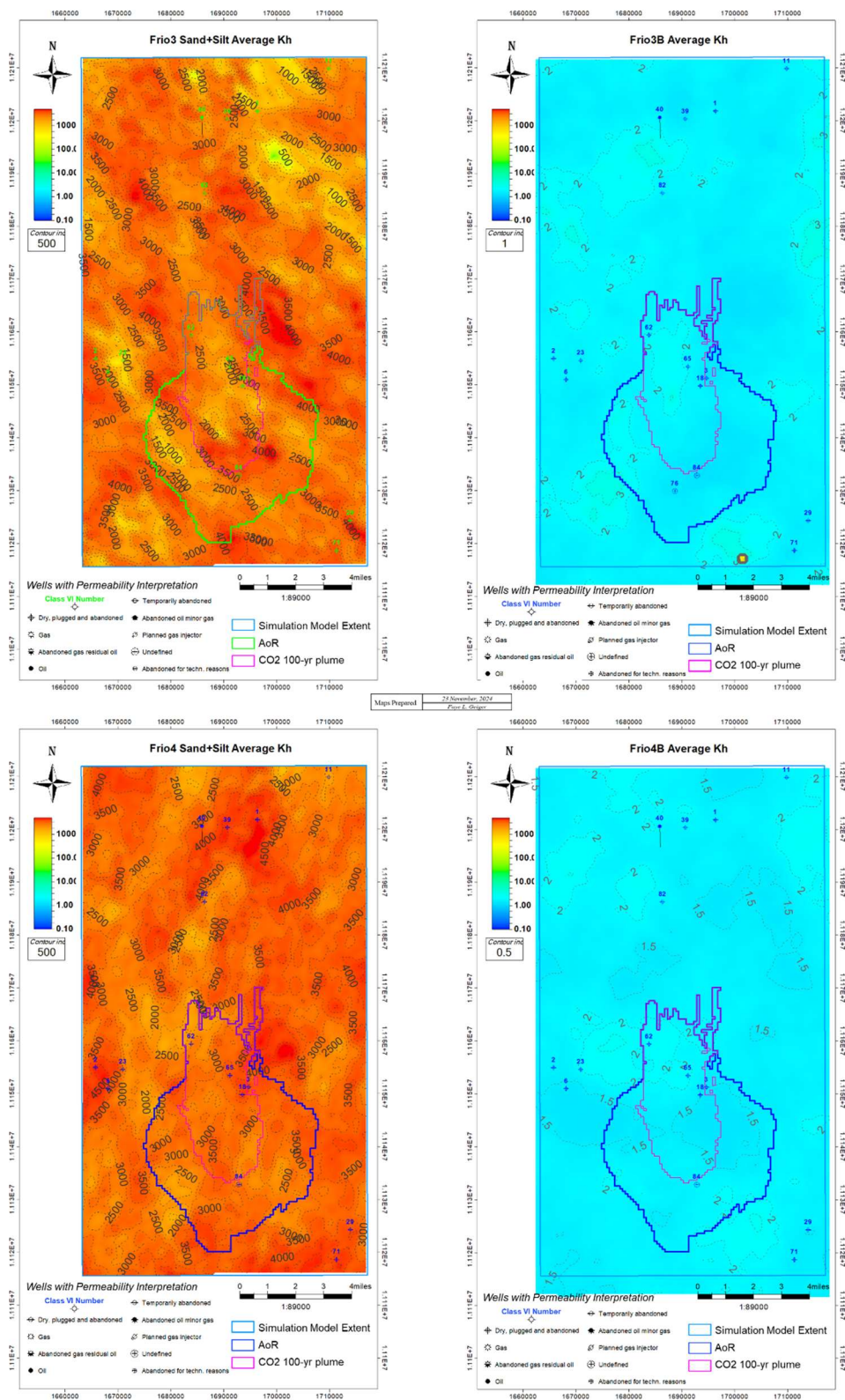
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**Figure NAR-70—Average horizontal permeability maps from geomodel for the upper Frio injection and confining zones (Frio1, Frio1\_B, Frio2, and Frio2\_B).**

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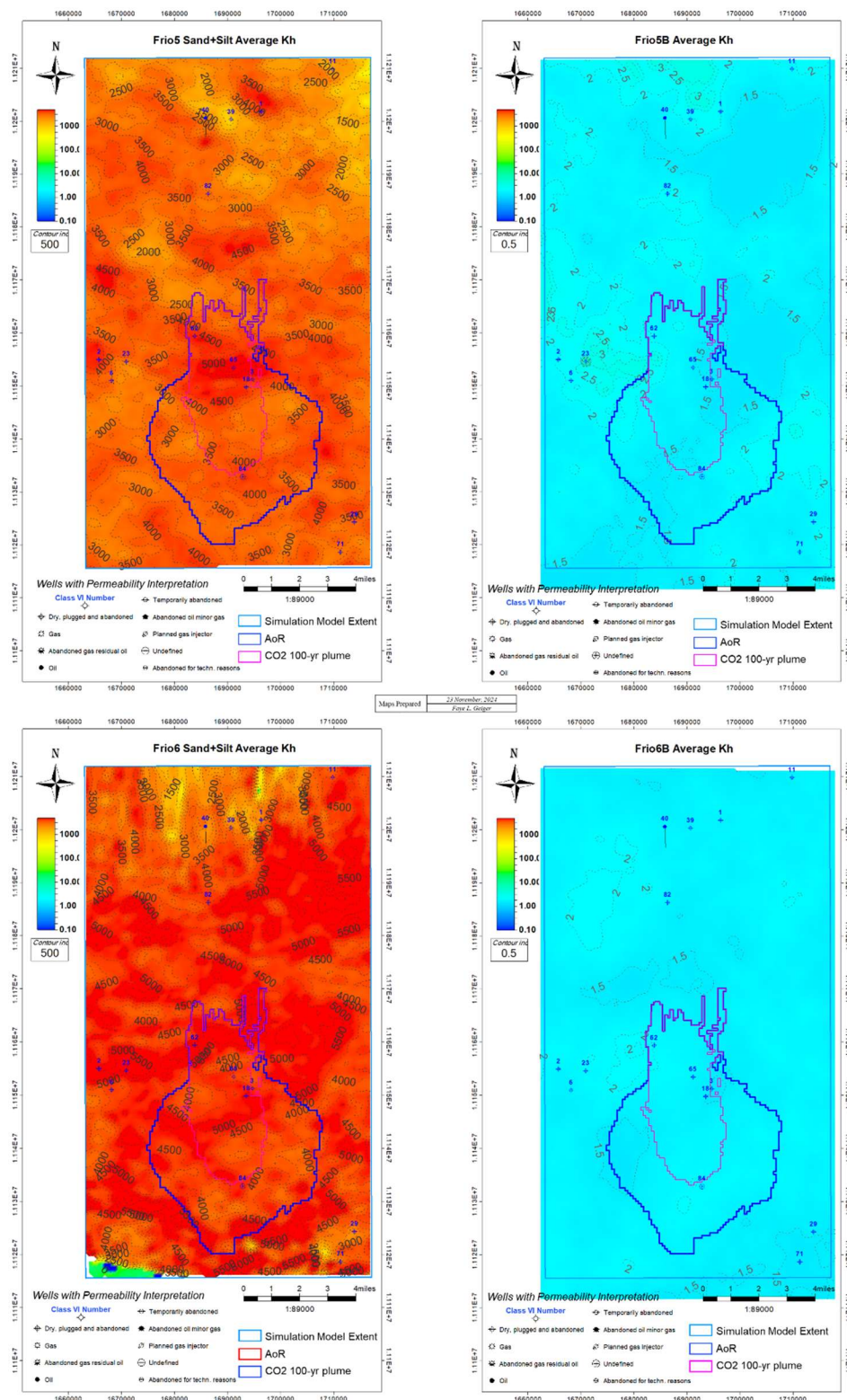


**Figure NAR-71—Average horizontal permeability maps from geomodel for the upper Frio injection and confining zones (Frio3, Frio3\_B, Frio4, and Frio4\_B).**



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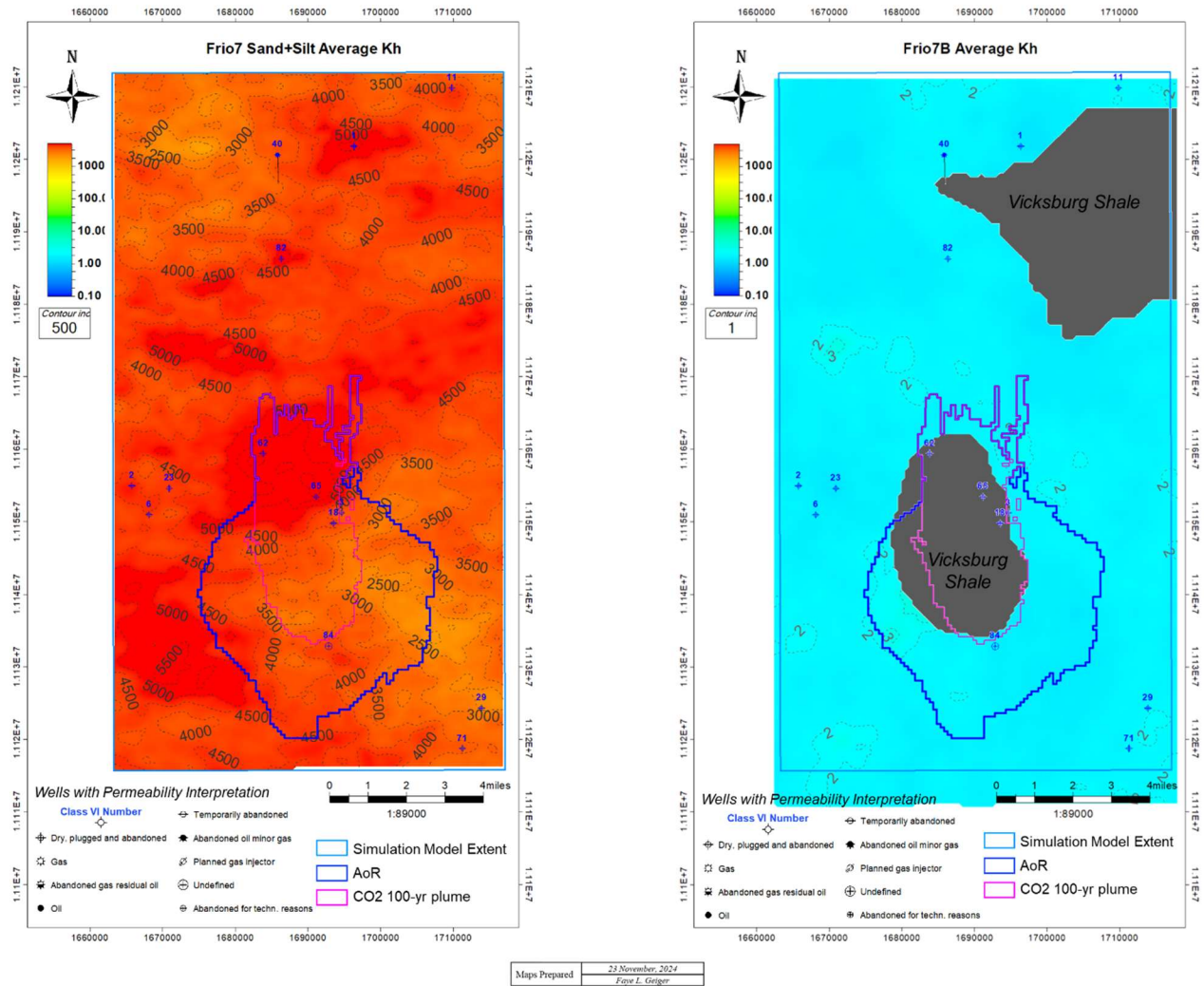


**Figure NAR-72—Average horizontal permeability maps from geomodel for the lower Frio injection and confining zones (Frio5, Frio5\_B, Frio6, and Frio6\_B).**



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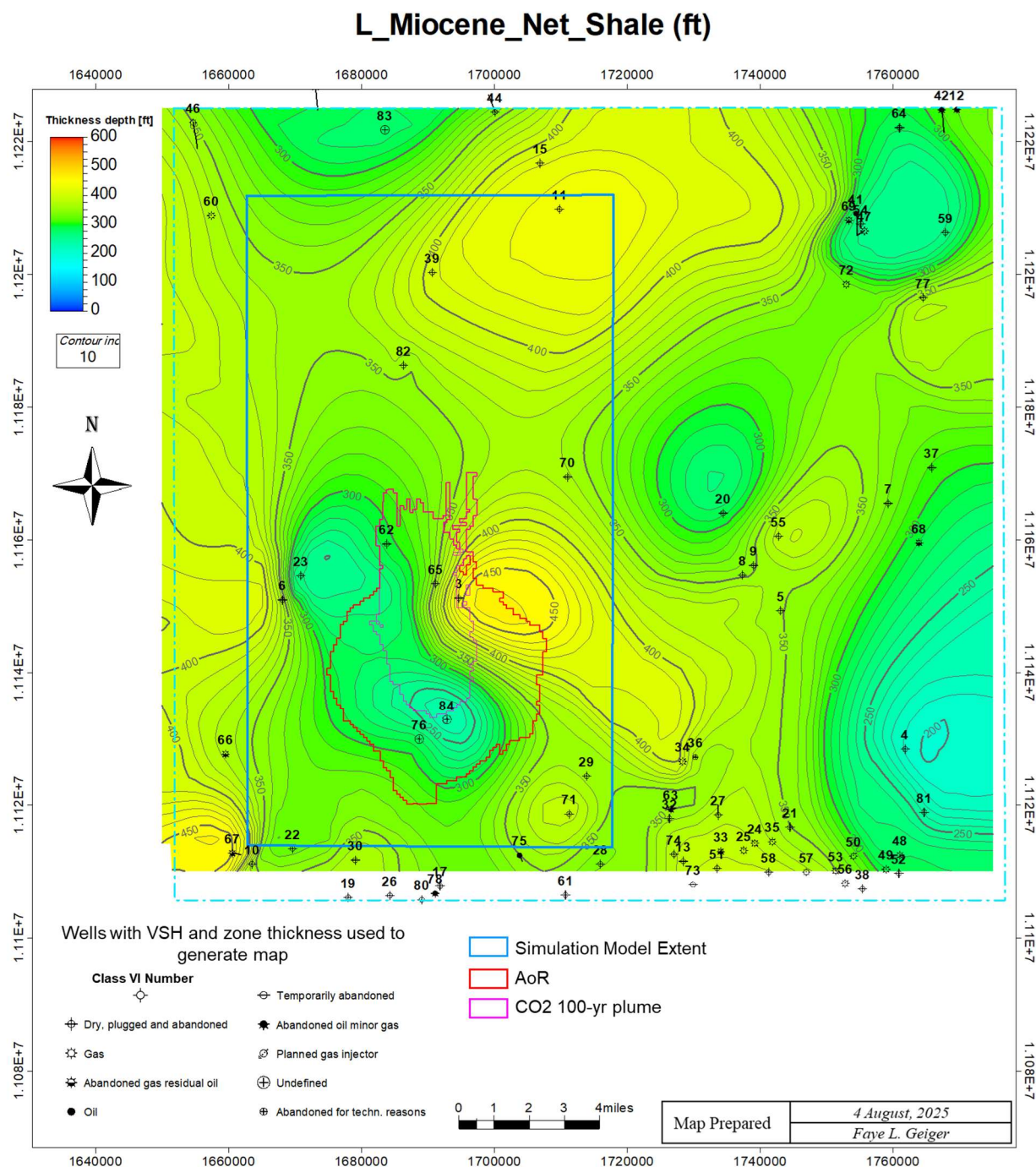
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**Figure NAR-73—Average horizontal permeability maps from geomodel for the lower Frio injection and confining zones (Frio7 and Frio7\_B).**

### Net Shale

Net shale thickness for each zone was determined by multiplying the mudstone facies (where  $XVSH \geq 0.70$  or  $XPORE \leq 0.2$ ) proportion maps with zone isopachs. Both the proportion maps and zone isopachs were gridded based on well data.



**Figure NAR-74—Net Shale Thickness in feet, Lower Miocene. Net shale thickness across the AOR ranges from 240 – 460 feet. Average net shale thickness across the modeled area is 346 ft. The YAMS-MLR-4 well (Class VI Number 84) sampled less shale over the Lower Miocene than regional trends.**



Narrative for Magnolia Sequestration Project

LA C&E Permit No. 45027, 45028, 45756, and 45757

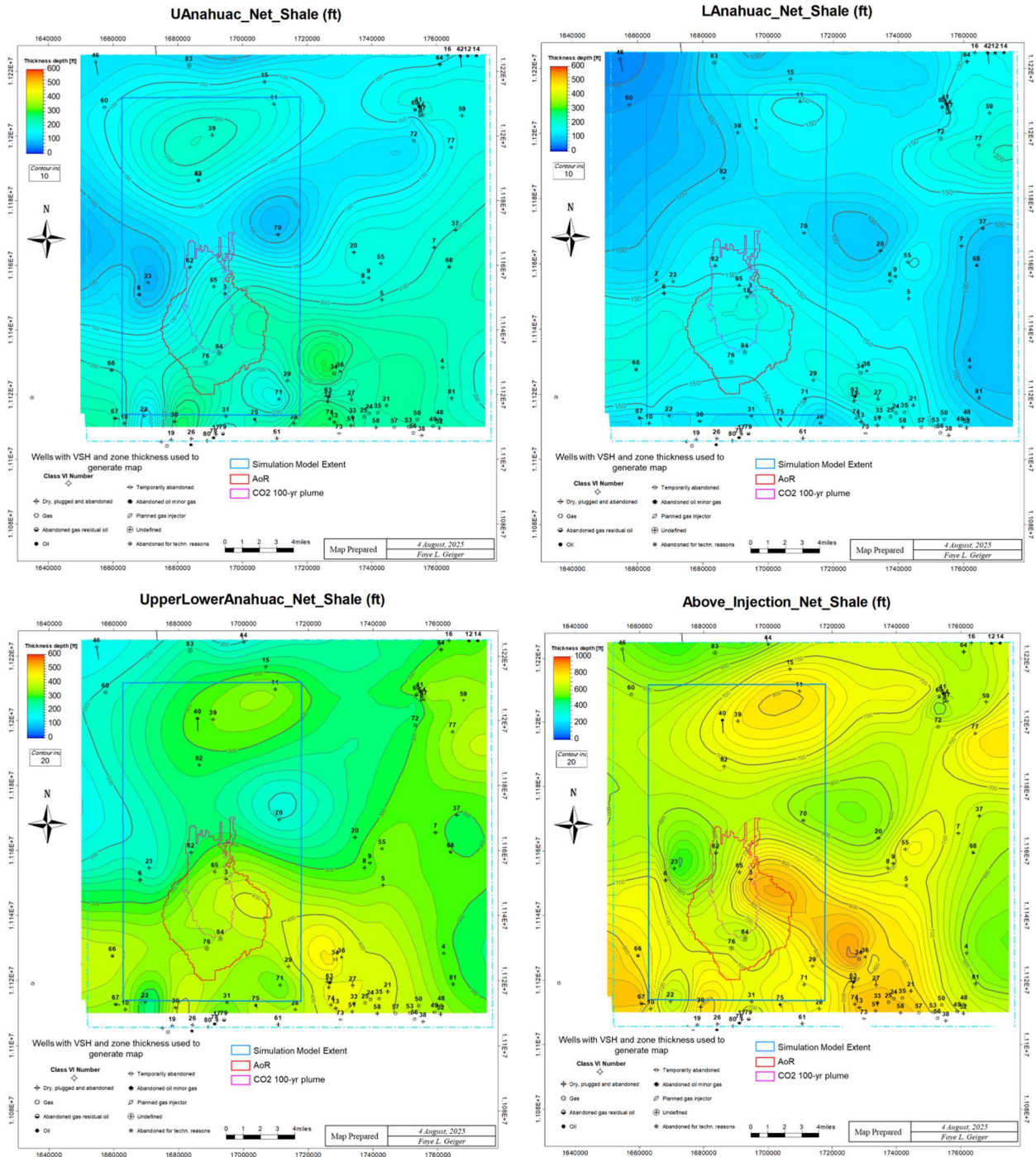


Figure NAR-75 – Top: Net Shale thickness in feet for Upper Anahuac (left) and Lower Anahuac (right). Bottom: Sum of Upper and Lower Anahuac net shale thickness (left); sum net shale thickness for all zones (Lower Miocene, Anahuac Upper, Anahuac Lower, and Lower Anahuac\_B) above top of injection (right).