Illinois Storage Corridor
CarbonSAFE Phase III

Prairie State Generating Company
2D Seismic Interpretation

Technical Report

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DISCLAIMER

EXECUTIVE SUMMARY

The objectives of the Illinois Storage Corridor (ISC) project are to accelerate commercial deployment of carbon capture utilization and storage at two individual sites and receive approvals for Underground Injection Control (UIC) Class VI permits for construction at each site (ISC Project Narrative, 2020). As part of this project, and as part of the subsurface geologic characterization, two-dimensional (2D) seismic data was acquired at both sites. This report summarizes the findings from two phases of 2D acquisition and seismic interpretation at the Prairie State Generating Company site near Marissa, Illinois.

The seismic data indicates the presence of three faults that completely transect the storage and confining units. The initial 2021 2D seismic acquisition revealed the presence of a feature two miles east of the Lively Grove #1 characterization well. The feature is a polyphase fault with a component of strike-slip motion, forming a small positive flower structure. The second phase of 2D seismic acquisition in 2022 constrained the maximum extent of the fault, indicating it has a relatively limited length. Other 2022 seismic lines revealed the presence of two other faults that transect the storage and confining units in the southwest and northeast portions of the 2D seismic acquisition area.

The 2021 and 2022 2D seismic surveys have identified three specific locations within the project area that may have an elevated risk of out of zone CO_2 migration due to faulting. Further technical work will be needed to quantify this risk and determine how and if this risk will impact the placement of CO_2 injection wells across the project area.

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INTRODUCTION

This report summarizes the stratigraphic and structural interpretation of two-dimensional (2D) seismic lines acquired in Washington County, Illinois in 2021 and 2022 as part of the Illinois Storage Corridor project. The objectives of the 2D seismic programs were to contribute to the subsurface characterization of the St. Peter-Everton and Knox storage complexes by evaluating the continuity of potential storage reservoirs and confining units across the project area, and to determine if any geologic features are present that would increase out of zone migration risk to the proposed carbon dioxide (CO_2) storage project.

2021 2D SEISMIC

In 2021, three 2D seismic lines were acquired and processed in Washington County, Illinois immediately north of the Prairie State Energy Campus (PSEC – Figure 1). Table 1 lists the acquisition parameters for this survey.

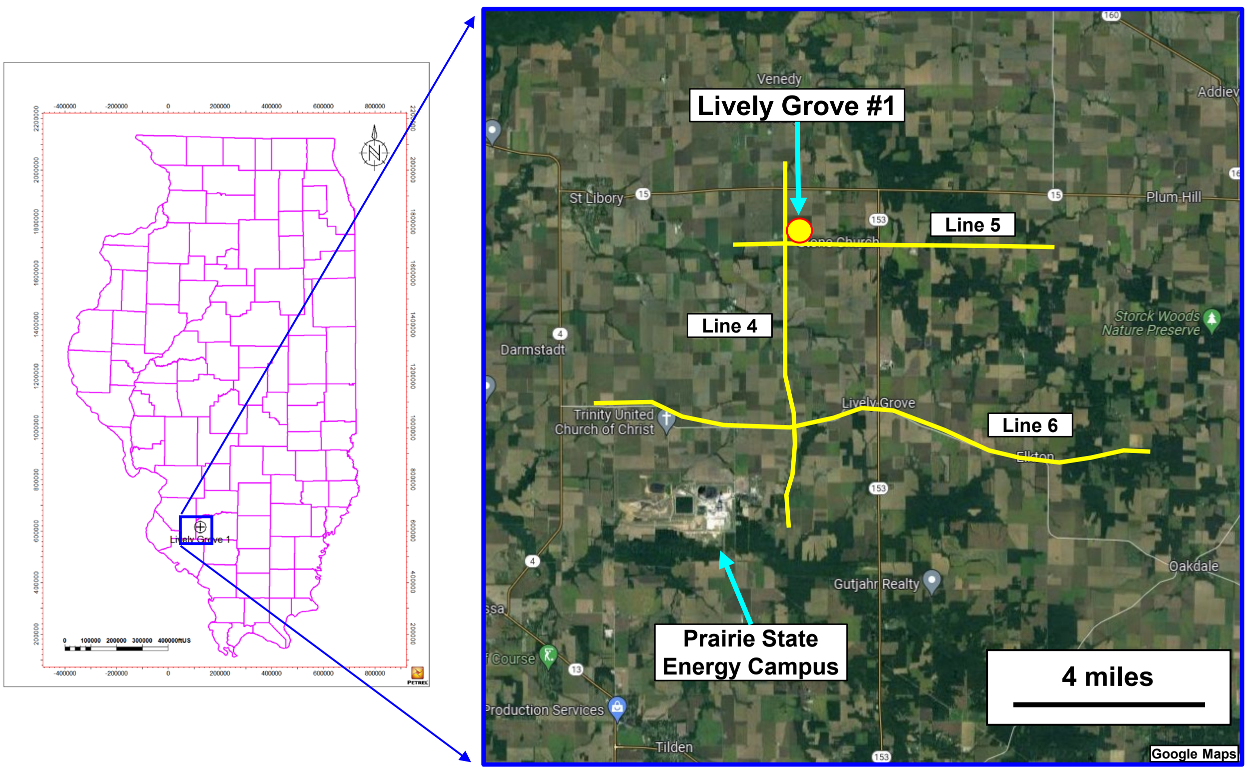

Figure 1:Seismic basemap for 2021 2D acquisition (Google maps).

Table 1. 2021 2D seismic survey acquisition parameters.

Source Type	**Vibroseis IVI ~60,000 lb peak force per vibe**
Number of Vibrators per VP	2 each
Vibe Output	70%
Source Spacing	110 feet
Sweeps	2-minimum per station
Sweep Design	2-96 Hz Linear with 0.5 s tapers
Sweep Length	16 seconds
Record Length	5 seconds
Receiver Spacing	20 feet
Receiver Sampling	2 milliseconds
Receiver Type	STYDE Nodal 150 g 1C 1-125 Hz with 28 days memory
Receiver Installation	All receivers were spiked
Minimum Offset	15,000 feet
Tail Spread	~6,000 feet where possible

Synthetic Seismogram and Well-tie

Shortly after the final seismic data was available during the fourth quarter of 2021 (Q4 2021), the Lively Grove #1 characterization well was drilled. Log and Vertical Seismic Profiling (VSP) data from this well were used to tie the well to the seismic. The density and sonic logs were reviewed for log quality. The sonic log did not need any editing. Minor issues were found in the density log, including bad data in a borehole washout, a few spikes with high non-real values, and missing values between hole sections. The density and sonic logs were used to generate an impedance log. The impedance log was then convolved with a selected wavelet to produce the initial synthetic seismogram.

The wavelet used for the final well-tie was an extracted reverse polarity wavelet using a window of 350-850 milliseconds (ms) two-way travel time (twtt). This wavelet was extracted from the seismic trace closest to the well on Line 5 (trace 641 – Figure 2). As part of an iterative process, the extracted wavelet was used to generate synthetic seismograms using both normal and reverse polarity. Based upon the character tie and shape of each resulting synthetic seismogram, it became clear that the polarity used by the processing contractor was opposite to that used in the Petrel™ interpretation package. Hence the extracted wavelet used in the final well-tie was reverse polarity.

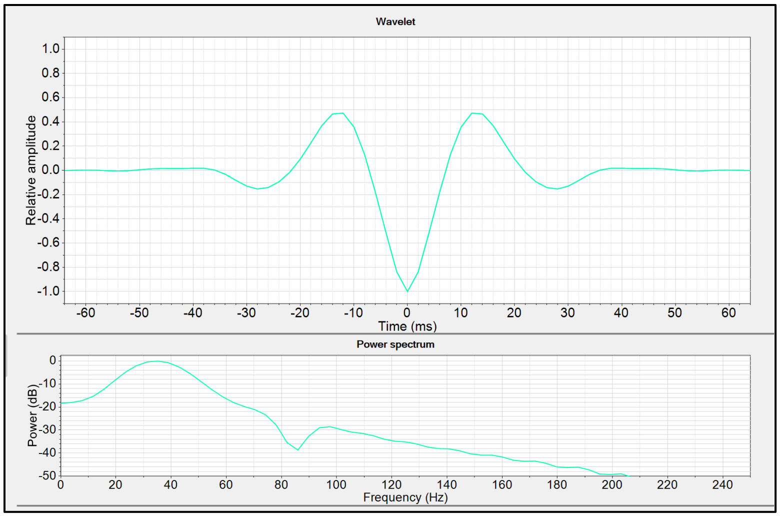

Figure 2: Extracted reverse wavelet from Line 5 at Lively Grove #1 location, trace 641.

For the initial time-depth relationship, the time-depth pairs from the final processed Vertical Seismic Profile (VSP) were applied. The final well-tie had a bulk shift of 49 ms down, which resulted in a very good character tie (Figure 3).

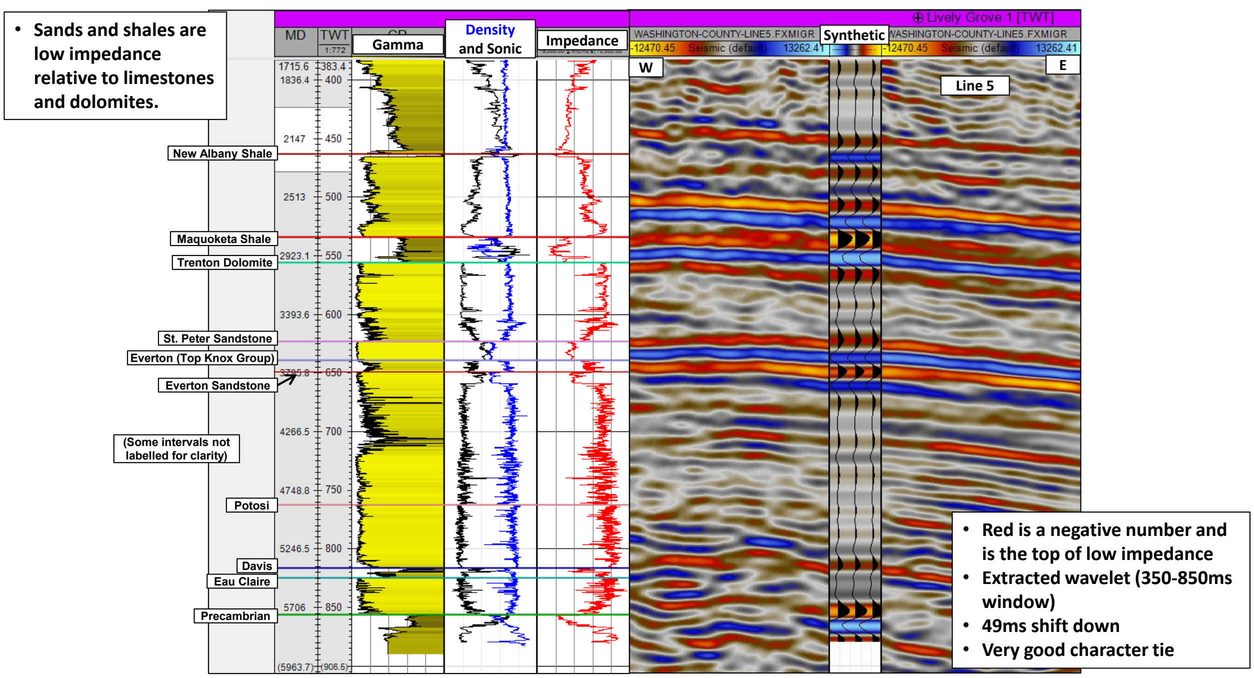

Figure 3: Lively Grove #1 well-tie to Washington County 2D seismic Line 5

The key stratigraphic units generally had strong impedance contrasts that resulted in mappable reflectors. The shales and sandstones were low impedance relative to the limestones and dolomites. The horizons interpreted include the top New Albany Shale, top Maquoketa Group, base Maquoketa Group/top Trenton, top St. Peter Sandstone, top Everton Formation (top Knox), top Everton sandstone, base Everton sandstone, top Davis Formation, top Eau Claire Formation and top Precambrian. Additionally, horizons between the base Maquoketa and top St. Peter Sandstone, and Knox Group between the base Everton and the top Davis, were not interpreted, since these intervals do not have strong impedance contrasts with mappable seismic reflectors.

The following sections will discuss each seismic line individually.

Line 5 Interpretation

Figure 4 shows Line 5, the line that is closest to the Lively Grove well, which is located about 600 feet to the north of trace 642 (Figure 1). The gamma ray log and the blue synthetic trace are shown on the well. The reflectors for each mapped horizon extend across the entire line without significant change in amplitude or thickness, indicating a lack of facies change or significant thickness change.

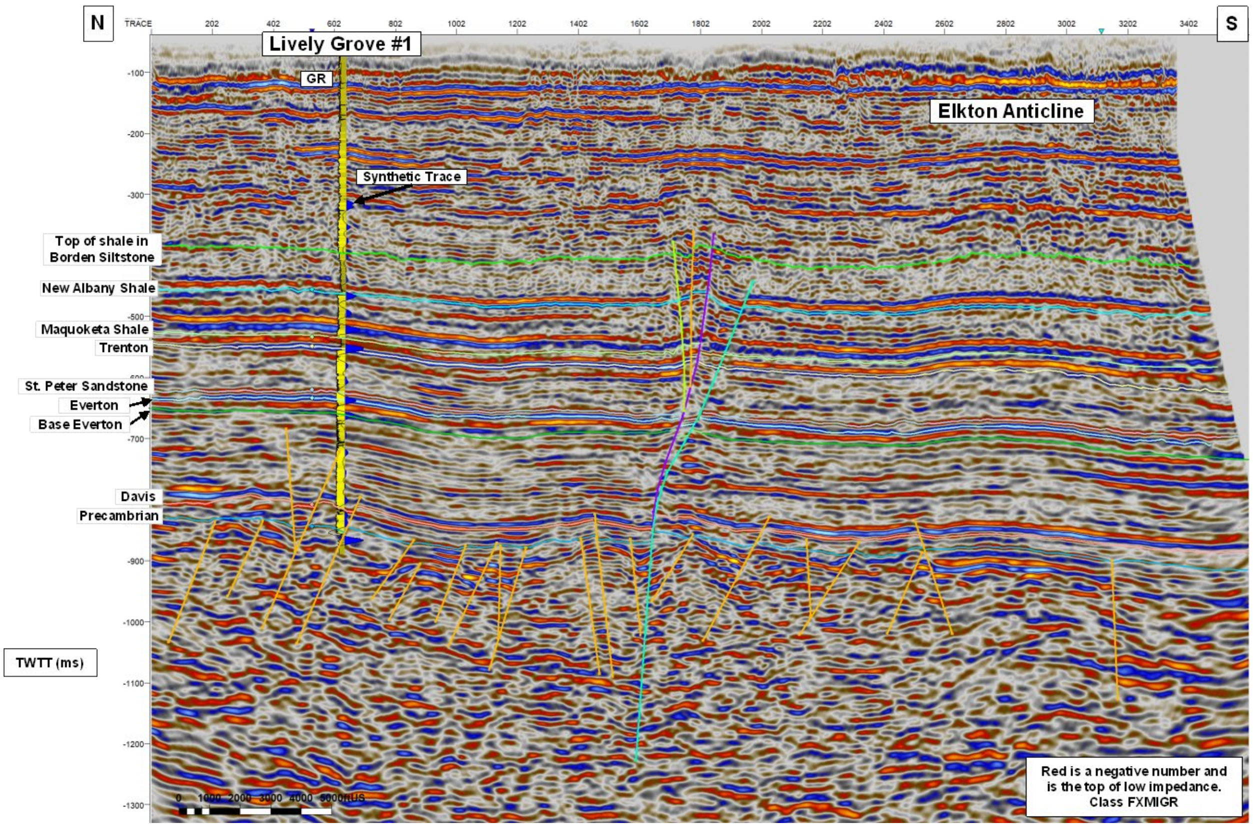

Figure 4: Line 5, showing large fault complex offsetting much of the Paleozoic stratigraphy.

A large fault system transects both the potential storage reservoirs (Potosi Group, Everton sandstone, and St. Peter Sandstone) and the potential sealing intervals (Maquoketa Group and New Albany Shale). The other two lines, Lines 4 and 6, do not have any kind of similar geologic feature (other lines discussed below). This fault system is located about 2 miles to the east of the Lively Grove #1 well. The fault system emerges from the Precambrian as a single fault, splits into multiple faults as part of a positive flower structure with an additional eastern normal fault and extends up into the Mississippian strata where the faults tip out (see Figure 5 for a zoomed in view of this fault system). In addition to this fault system, the line shows the Elkton anticline, which contains the Elkton North oil field immediately to the north. This field produces from the Hardin sandstone, which sits on top of the Devonian/Silurian carbonates. The sandstone is thin, varying in thickness across the field from 2-8 feet.

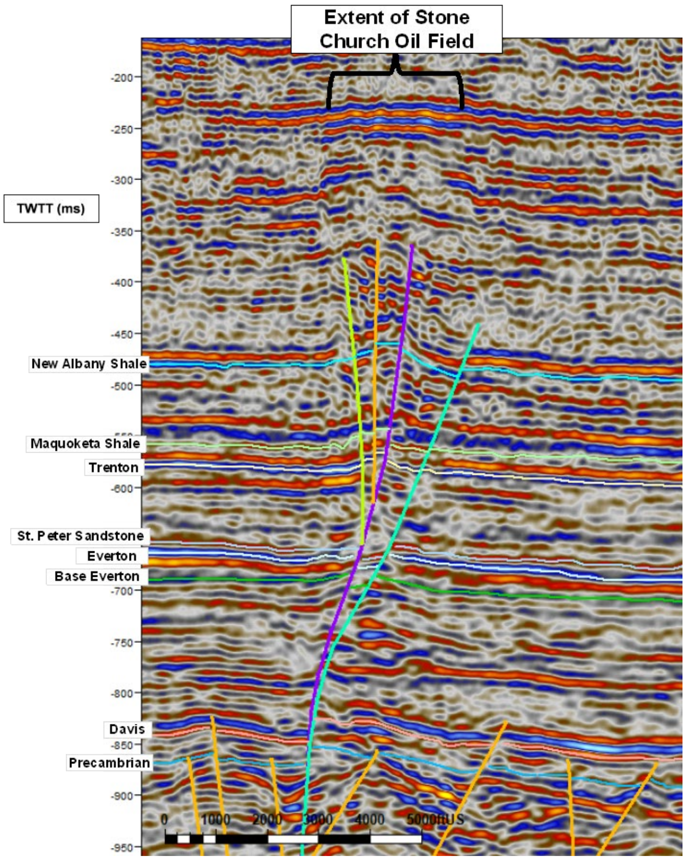

Figure 5: Zoomed in view of Line 5 fault complex.

This fault system shows at least two phases of movement. The first phase was a period of strike-slip faulting with a component of reverse motion, illustrated by the interpreted positive flower structure. The flower structure is composed of many small offset reverse faults, and there are likely additional faults below seismic resolution within the core of the flower structure. The flower structure may have formed at a restraining bend along a dominantly strike-slip fault (Huang et al, 2017). Additional 2D seismic was acquired in 2022 (to be discussed below) which may help to further understand the evolution of this fault system.

The second phase of movement of this fault system appears to be normal/extensional movement, with some or most of the extension taken up by the sage green fault on the east side of the structure. It is not known whether this fault was originally a reverse fault and part of the initial positive flower structure. The main evidence for the second phase of movement being extension with normal faulting is the fact that the current observed offset at the Precambrian unconformity is normal offset. The initial fault likely formed with initial strike slip plus reverse motion, and then at a later phase the stress regime changed to extension. Either the eastern green fault formed at this time, or the green fault was previously part of the positive flower structure with reverse offset, and then the extensional stress regime caused relaxation along this fault to form the normal fault offset that we see on the seismic line. This deformation could be related to northern directed deformation as described in McBride (1998).

Directly above this fault system and the associated positive flower structure is a small four-way closure with an oil field (Stone Church) currently producing from Devonian reef dolomites immediately below the New Albany Shale (Figure 6). The Illinois State Geological Survey's (ISGS) Illinois Oil (ILOIL) database indicates there are 11 producing wells in the field with one saltwater disposal well. Figure 6 shows the Herbert and Ruth Lange well with the perforated interval notated. Initial production was 15 barrels of oil per day with 50 barrels of water per day pumping from the Devonian perforations from 2,199-2,340 feet MD (ILOIL database).

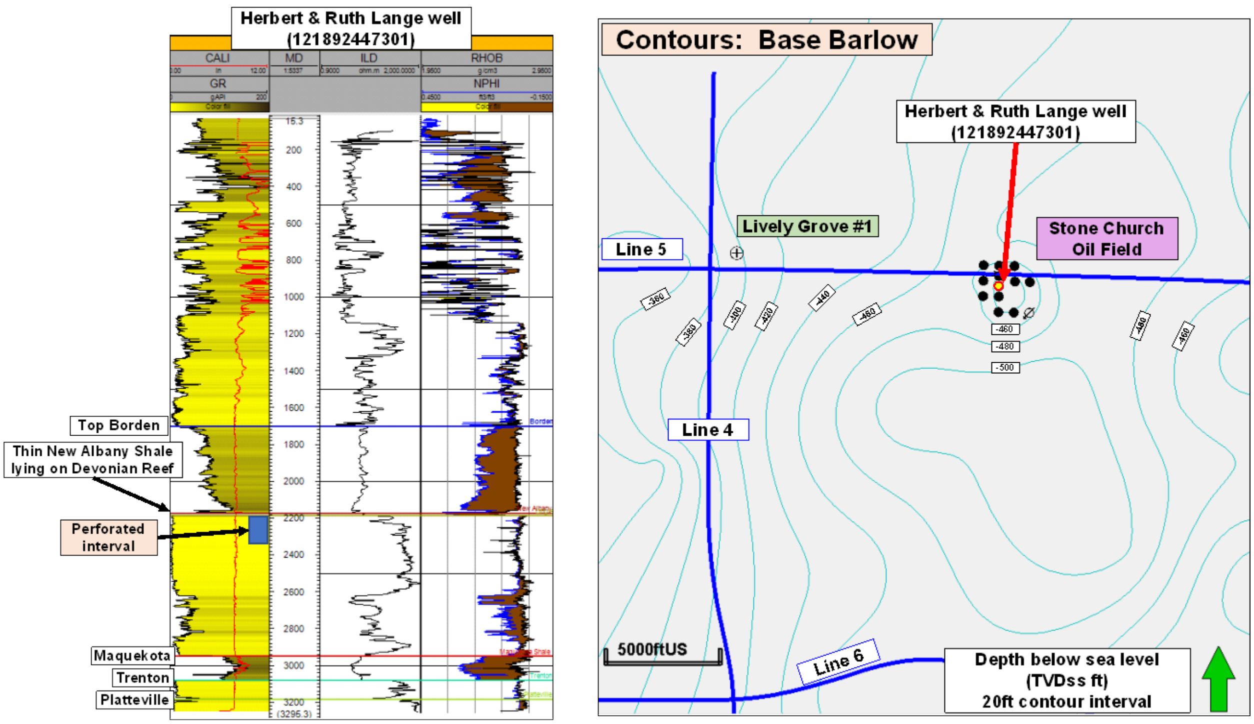

Figure 6: Herbert and Ruth Lange well produces from the field formed by the flower structure. Map on the right shows the contours of the Base Barlow with the 12 wells associated with the Stone Church oil field.

In addition to this fault system, Line 5 shows that there are numerous other faults coming out of the Precambrian basement and tipping out mostly in the Eau Claire or Davis Formations, with a few tipping out in the Knox Group formations. Most offsets appear to be normal, and there are likely more faults than mapped due to the lack of continuous impedance contrasts within the Precambrian. It is possible that the Lively Grove #1 well penetrated one of these faults while drilling the Precambrian, although no definitive evidence was observed on well log data. While all three seismic lines at Prairie State show basement faults, Line 5 seems to show a much higher density of these faults than the other two lines, as well as when compared to other modern seismic lines in the Illinois Basin associated with other CarbonSAFE projects. The reasons for this are not known. There may have been zones of weakness that accommodated a higher degree of extension within the Illinois Basin during periods of extensional stress, and Line 5 may be imaging one of these zones.

Line 4 Interpretation

Line 4 (Figure 7) is oriented north-south. The Lively Grove #1 well is located about 1,100 feet east of Line 4 at trace 3155 (Figure 1). The peak frequency content of Line 4 appears to be lower than Lines 5 and 6. There is also more amplitude variation in the mapped horizons. At the intersection of Line 4 and 5, the St. Peter red trough on Line 4 is lower amplitude than on Line 5. Overall, the top St. Peter Sandstone red trough is lower amplitude on Line 4 than on Line 5 and shows more variation in amplitude. This is interpreted to be an artifact of either acquisition or processing, and not a facies or thickness change. It is believed that Line 4 does not show significant facies or thickness changes of the stratigraphy, but it is recognized that there is higher uncertainty in this interpretation due to the subtle frequency and amplitude differences from the other two lines.

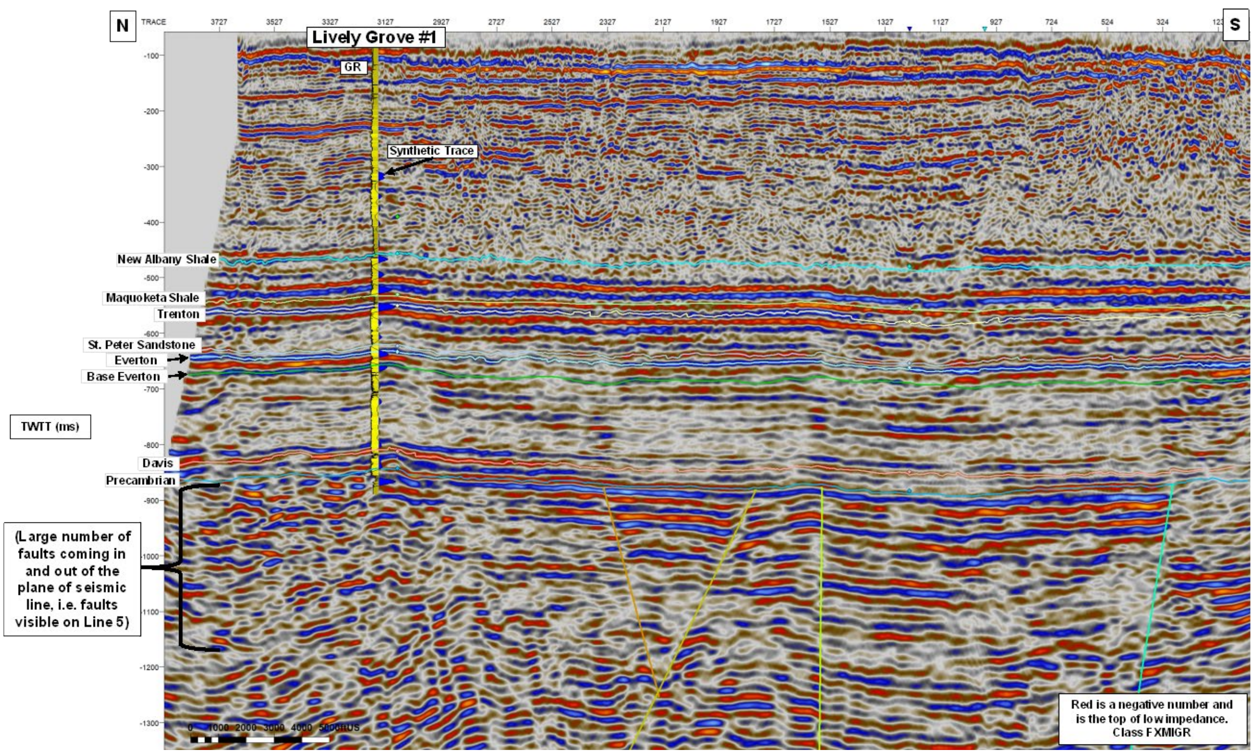

Figure 7: Line 4 seismic line, showing relatively unstructured gently dipping stratigraphy.

Some of the basement faults interpreted on Line 5 are coming out of the plane of Line 4 on its northern end. This is consistent with the appearance of the basement reflectors; in the heavily faulted northern end, the basement reflectors are discontinuous and have variable dips and amplitude. However, the central and south portions of Line 4 show more continuous basement reflectors. In this region there are four mapped faults in the basement, and all appear to be truncated at the Precambrian unconformity. The Paleozoic stratigraphy is unfaulted on this line and is gently folded near the Lively Grove well as well as above the sage-green basement fault.

Line 6 Interpretation

Line 6 (Figure 8) is oriented east-west. It is located about 3.6 miles south of the Lively Grove #1 well (Figure 1). The reflectors for the top of the St. Peter and Everton Sandstone’s show more amplitude variation than the other two lines, but there is nearby well control that shows the St. Peter Sandstone has similar thickness and reservoir quality as the Lively Grove #1 well. It is possible that the dolomites that overlie both sandstones are changing rock properties such that the top sandstone reflectors show more variability. The other reflectors for the other horizons are more consistent in amplitude across the line.

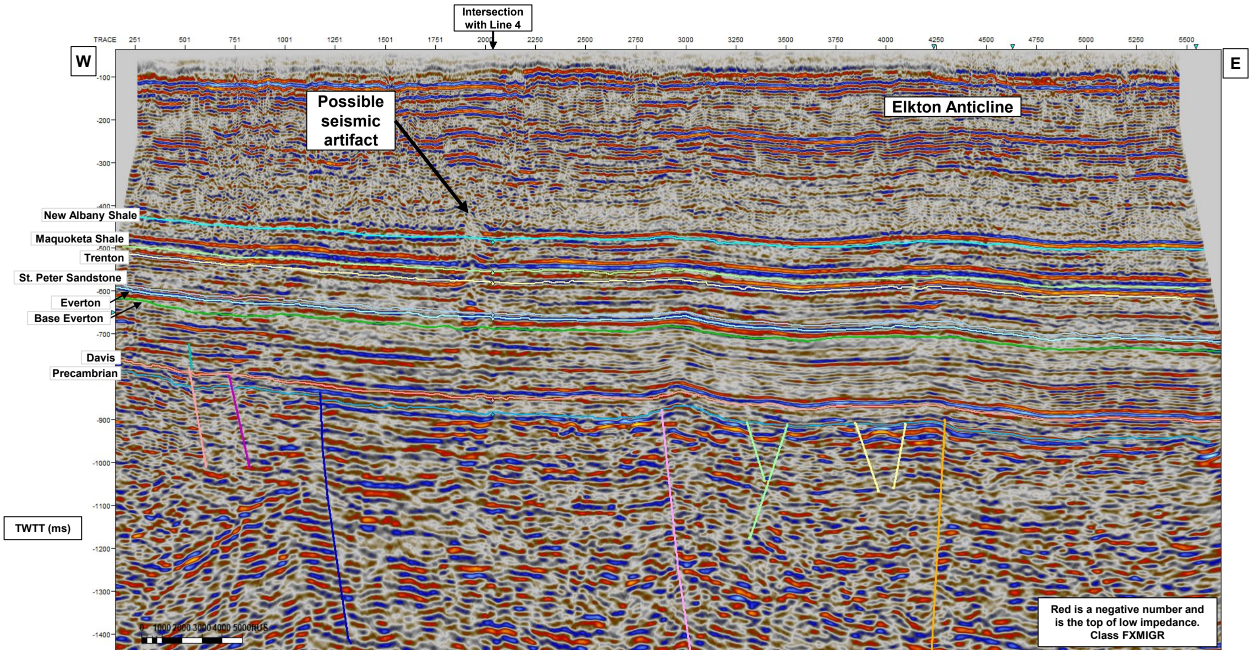

Figure 8: Line 6 seismic line, showing slightly folded Paleozoic stratigraphy that is unfaulted.

Like Line 4, the Paleozoic has some gentle folding. The Elkton Anticline is seen on this line. Just west of the intersection of Line 6 with Line 4 is an area of disrupted reflectors from the New Albany down to just below the Everton. Reflectors from about 2-3 reflectors below the Everton down to below the Precambrian are only slightly disrupted to not disrupted. Initially this feature was assumed to be some kind of seismic processing artifact that may have been a result of some strong lateral velocity or density contrasts in the shallow stratigraphy. However, it is possible that this is another strike-slip fault similar to the one seen on Line 5, and the offset in the strata above the Precambrian and below the Everton is purely strike-slip with no vertical displacement. This is less likely but is geologically plausible.

The basement faults are mostly normal faults except for the pink fault, which forms the overlying small anticline, and which may tip out in the Eau Claire. The three northernmost faults (pink, magenta, blue) also appear to tip out in the Eau Claire, Davis, and Knox Formations. The other faults are truncated at the Precambrian unconformity.

Implications of Line 5 Fault

The key finding from the stratigraphic and structural interpretation of the three 2D seismic lines at Prairie State was the large fault with associated positive flower structure seen two miles east of the Lively Grove #1 well on Line 5. Given that this fault completely transects both the potential storage reservoirs and potential seals, the fault may have an elevated risk of out of zone CO_2 migration. Further data was needed to characterize this fault.

2022 2D SEISMIC

Since the Line 5 fault is only visible on one seismic line, there is significant uncertainty in its orientation and length. The Illinois Storage Corridor project team made the decision to acquire additional 2D seismic (Figure 9) in order to:

- Fully characterize the fault on Line 5, including its orientation, length, and throw
- Expand the area where the subsurface is characterized by 2D seismic to allow for greater flexibility in placing the first CO_2 injection well(s).

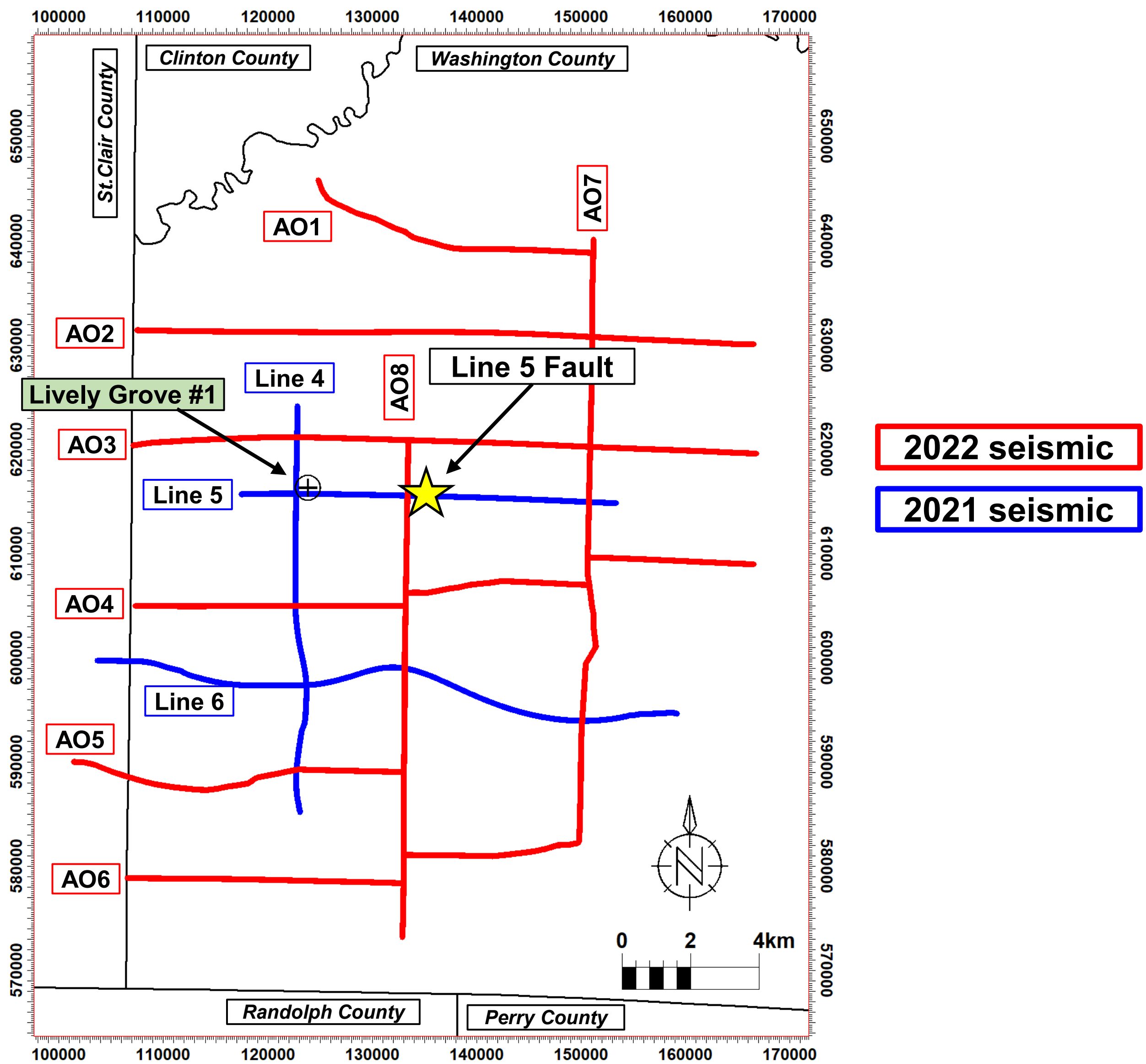

Figure 9: Map showing the 2021 and 2022 vintages of 2D seismic in the Prairie State/Washington County area. The blue lines are the existing 2021 lines, and the lines in red are the newly acquired 2022 lines.

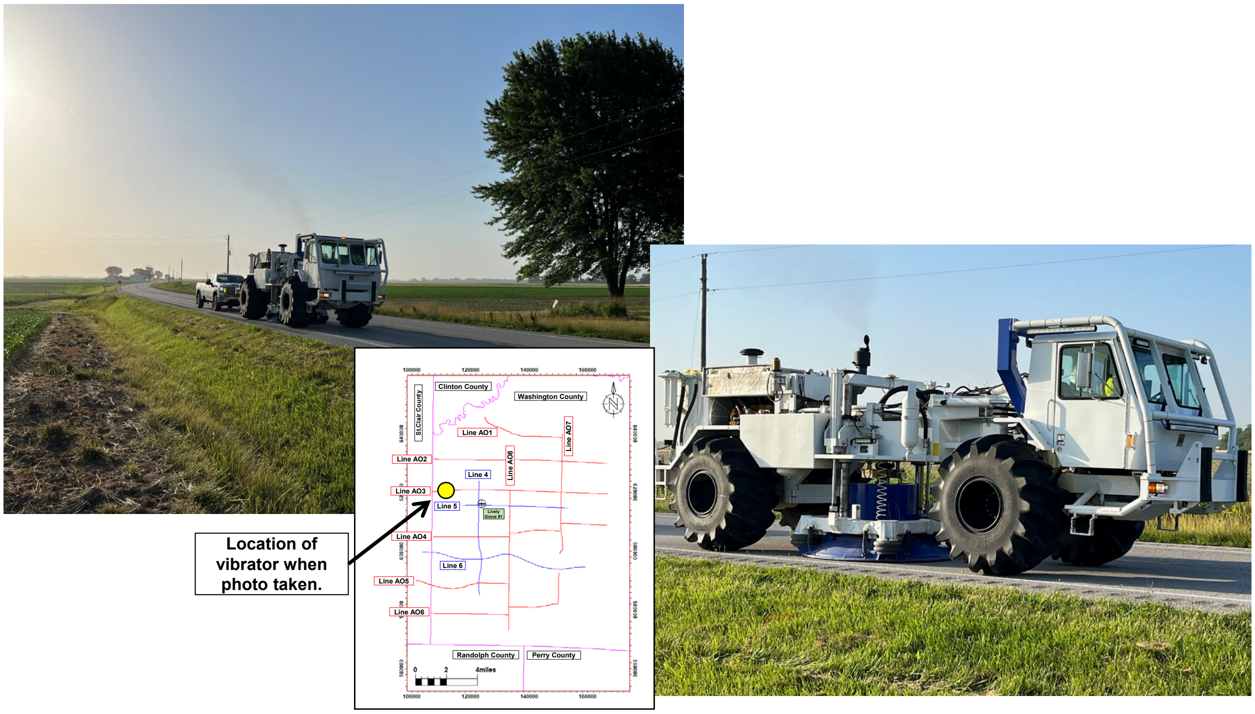

Figure 10: Vibrator truck contracted by Explor acquiring new 2D seismic data in Washington County. Pictures taken by the author on June 14, 2022.

Table 2: 2022 2D seismic survey acquisition parameters.

Source Type	**Vibroseis**
Number of Vibrators per VP	One
Vibe Output	65%
Source Spacing	40 feet
Sweeps	1 per station
Sweep Design	2-96 Hz Linear with 0.5 s tapers
Sweep Length	16 seconds
Record Length	5 seconds
Receiver Spacing	20 feet
Receiver Sampling	2 milliseconds
Receiver Type	STYDE Nodal
Receiver Installation	Buried to the top

Characterization of the Line 5 Fault on 2022 lines AO3, AO4, and AO8

This first section discussing the 2022 2D seismic will be about the characterization of the large fault seen on the 2021 Line 5 (Figures 4 and 5). Three of the 2022 lines directly contributed to the characterization of the Line 5 fault to determine the fault's extent and orientation: Lines AO3, AO4, and AO8 (See Figure 11). Line AO3 is parallel to Line 5 and is one mile north. Line AO4 lies between 1.6-2.0 miles south of Line 5. Due to the nature of the roads that were utilized to acquire the seismic, the line has a couple of offset "jogs". Line AO8 runs north-south and crosses Line 5 about 200-500 feet west of where the fault is imaged on Line 5.

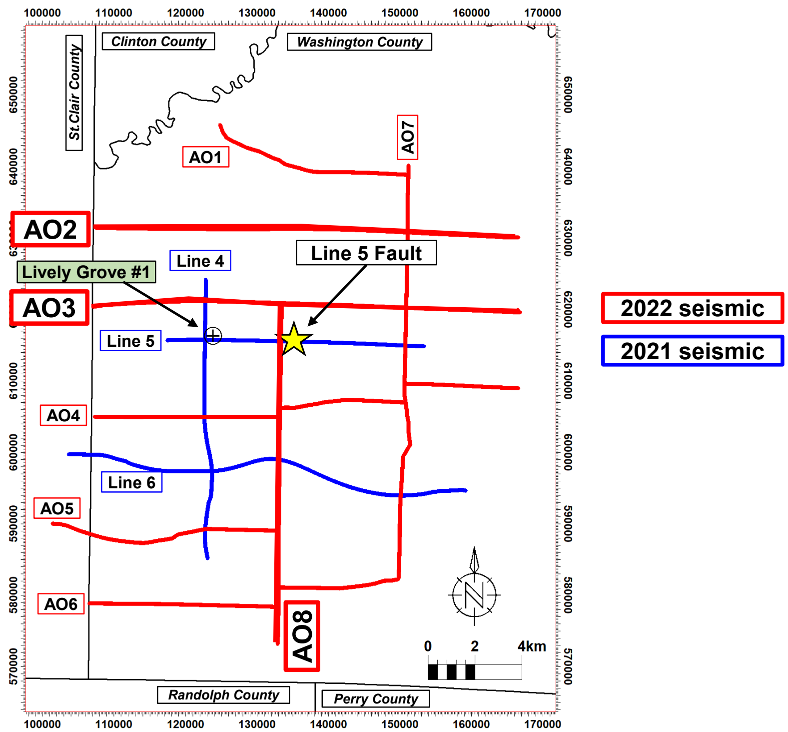

Figure 11: Map highlighting lines contributing to the characterization of the fault initially observed on the 2021 Line 5 line: Lines AO3, AO4, and AO8.

Line AO3 Interpretation

No fault that might correlate to the fault observed on Line 5 is seen on line AO3 (Figure 12). There are two faults towards the eastern downdip portion of the line, but these faults are too far to the east to tie to the Line 5 fault. The blue fault originating in the Precambrian is a small offset normal fault, with a small splay normal fault that appears to slightly offset the proposed storage reservoirs (St. Peter and Everton Sandstones) but tips out in the Trenton before reaching the confining unit Maquoketa Group. The small green normal fault partially covered by the inset basemap tips out in the Davis Shale above the Precambrian and is of no concern to the storage or confining units.

Like most of the seismic lines, the Precambrian section likely contains many more faults that are either completely contained within the Precambrian or are eroded at the Precambrian unconformity.

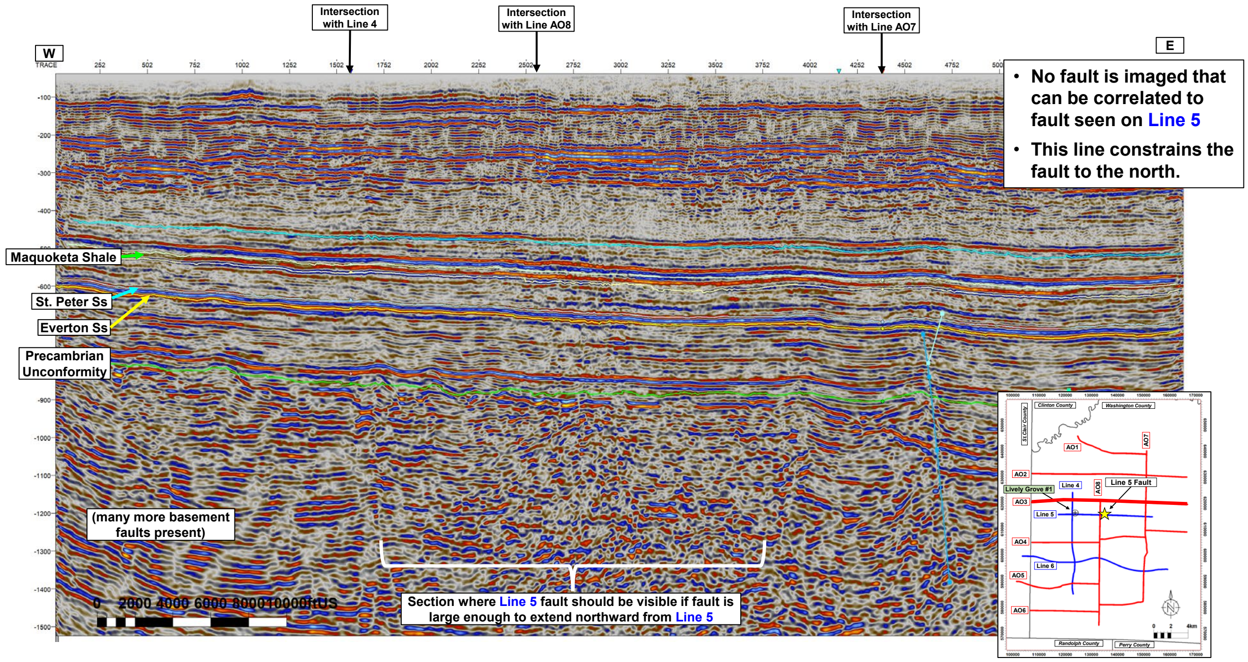

Figure 12: East-west Line AO3, one mile north of 2021 Line 5. Inset map shows where the major fault is located on Line 5. No corresponding fault is observed on AO3, suggesting the fault throw decreases to zero before reaching AO3 to the north.

Line AO4 Interpretation

Line AO4, shown in Figure 13, has very little structure in the Paleozoic except for one small anticlinal feature just east of the intersection with Line 4. This feature may be formed by basement-involved structuring from faults that are either completely within the Precambrian or are eroded at the Precambrian unconformity. Line AO4 does not show any faults that offset the Paleozoic section. The fault seen on Line 5 apparently dies out to the south before reaching Line AO4.

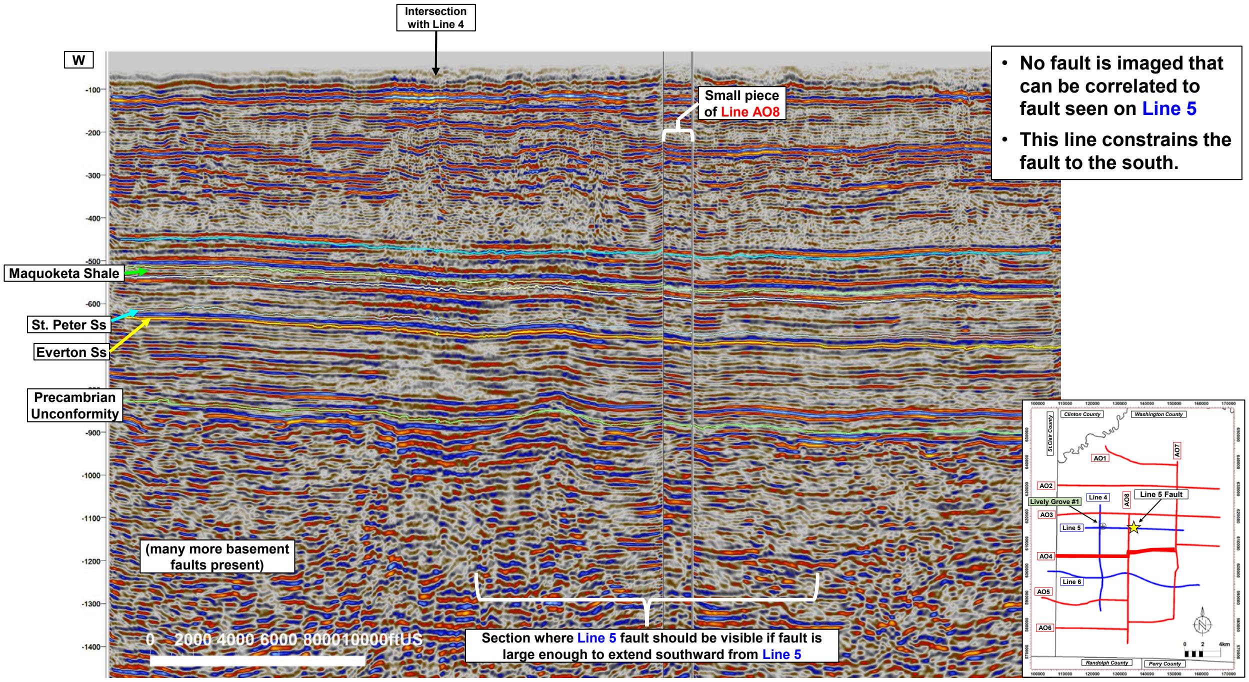

Figure 13: East-west Line AO4, between 1.6-2.0 miles south of 2021 Line 5. Inset map shows where the major fault is located on Line 5. No corresponding fault is observed on AO4, suggesting the fault throw decreases to zero before reaching AO4 to the north.

Line AO8 Interpretation

Line AO8, shown in Figure 14, also has very little structure in the Paleozoic except for a broad, shallow anticlinal structure near the midpoint of the line. This is very likely underlaid by a deep Precambrian structure. Several clear dip panels of Precambrian reflectors are visible, suggesting the presence of several large Precambrian faults. However, none of these faults are observed offsetting the Precambrian unconformity. In addition, no fault is visible in the Paleozoic that could be correlated to the Line 5 fault.

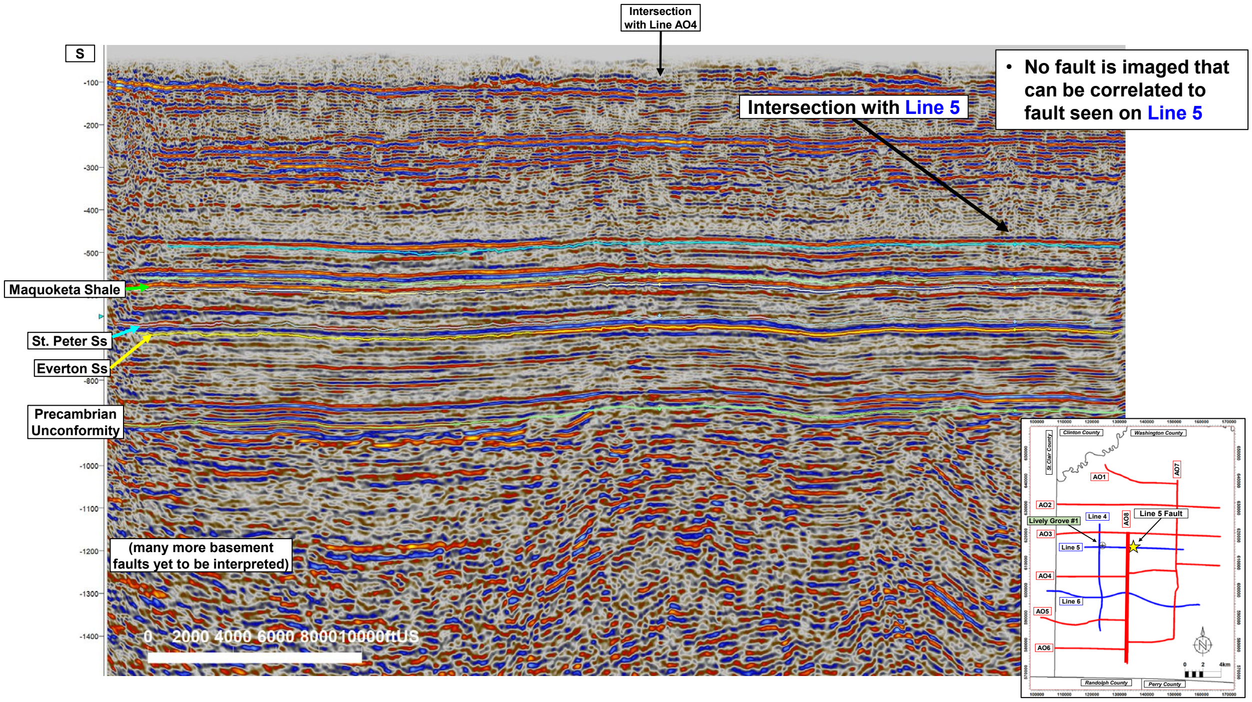

Figure 14: Line AO8, which runs north-south and is located about 400 feet west of the location of the Line 5 Fault. No fault is visible in the Paleozoic section, indicating the Line 5 fault is oriented very close to north-south.

Summary of the characterization of the fault observed on Line 5

The additional 2D seismic data acquired in 2022 has characterized the fault observed on the 2021 Line 5 2D seismic line (Figure 15). The fault has been shown to have a limited extent to the north and south, as it is not visible on either Line AO3 or Line AO4 to the north and south respectively. The fault dies out in both directions before reaching those two seismic lines. Additionally, the orientation of the fault has been partly characterized, as the fault is not visible on north-south line AO8, and therefore the fault strike can be assumed to be largely north-south. The area around the Line 5 fault may have an elevated risk of out of zone CO_2 migration. Further technical work will be needed to quantify this risk and determine how and if this risk will impact the placement of CO_2 injection wells in the vicinity of the fault.

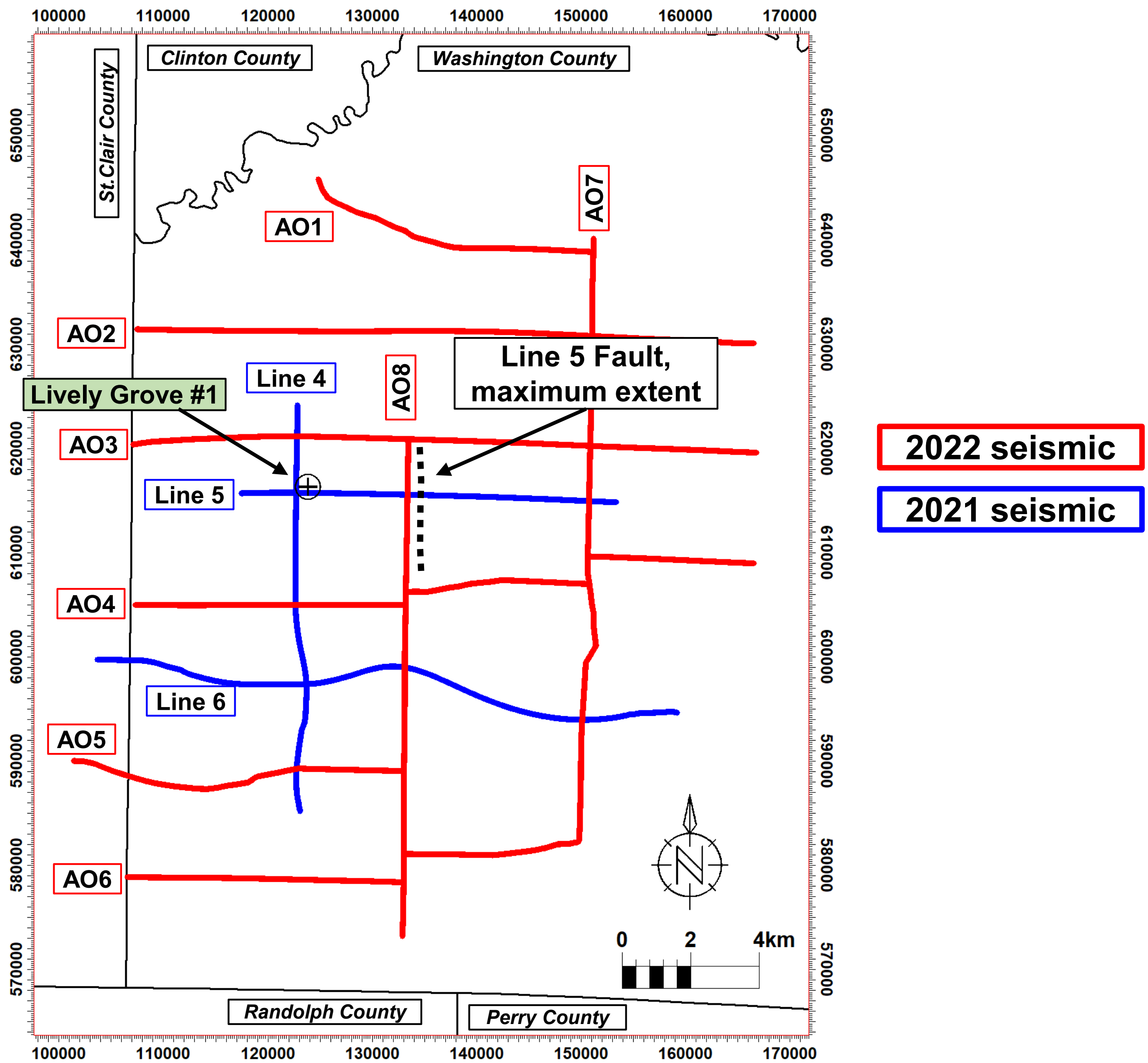

Figure 15: Seismic basemap with Line 5 fault shown with maximum possible extent based upon interpretation of Lines AO3, AO4, and AO8.

The remainder of this section of the report will summarize the findings of the remaining 2022 seismic lines, beginning with line AO1 in the north.

Line AO1 Interpretation

Line AO1 (Figure 16) shows no faults that transect the storage or confining units. Like most of the 2D seismic lines, faults are likely present in the Precambrian, but none penetrate the Precambrian unconformity. There is a small anticlinal structure on the west side of the line, and a smaller and subtle anticlinal structure on the east side of the line also. The stratigraphy is continuous, but the lowermost Paleozoic shows some possible thinning onto the western anticlinal structure (the first 2-3 reflectors above the Precambrian unconformity). This possible thinning is not present in the storage and confining units.

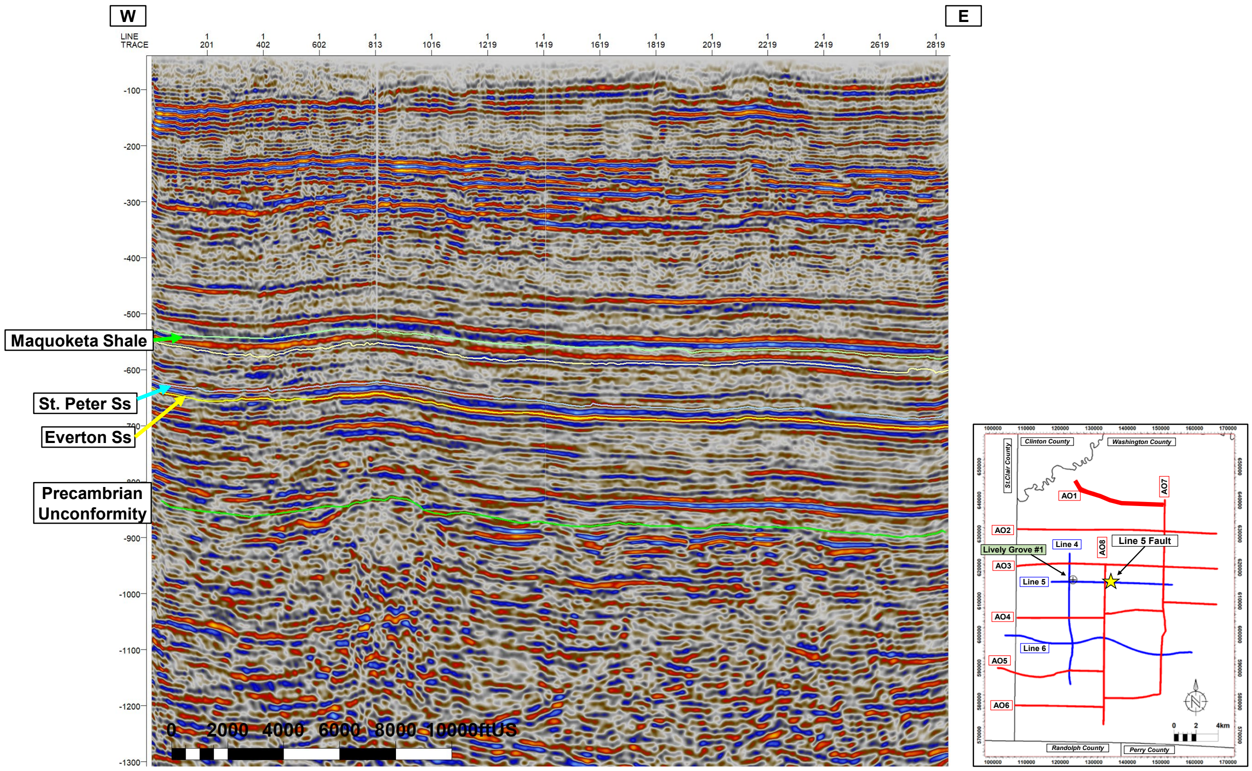

Figure 16: 2022 line AO1.

Line AO2 Interpretation

Line AO2 (Figure 17) shows two major structural features. The first is the fault on the eastern side of the line. This fault comes up from the Precambrian, transects the two storage reservoir sandstones (St. Peter and Everton), and tips out just below the Maquoketa Group confining unit. The fault has a small splay on its western side that also tips out just below the Maquoketa Group.

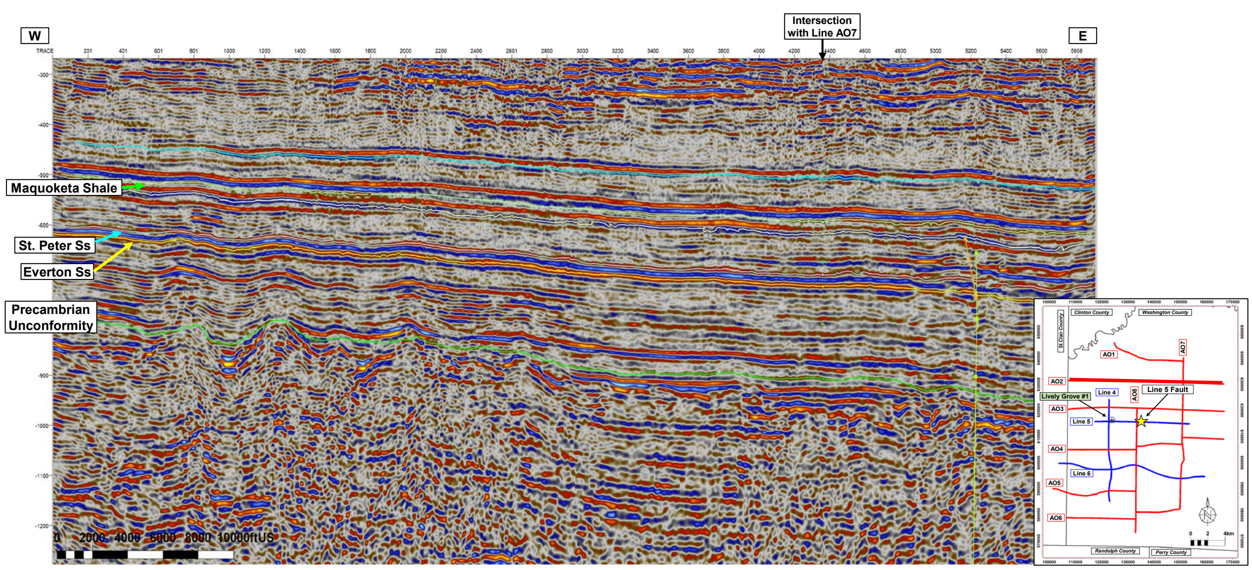

Figure 17: 2022 Line AO2.

The second structural feature is the series of basement "bumps" that appear to be part of a larger basement high. The history of these features is complex. The lowermost 2-3 reflectors of Paleozoic sediments lying on the Precambrian unconformity appear to onlap the eastern flank of the larger overall basement high. On top of the basement high on the western half of the line are a series of tight anticlinal features that emanate from the Precambrian basement. The entire visible stratigraphy on the seismic line is gently folded to some degree over the tops of these tight basement features. These features may be fault controlled, but this is difficult to say with certainty since there are no faults that cut through the Precambrian unconformity, and detailed Precambrian faults are frequently difficult to image.

Another feature to note in the Precambrian is the series of flat reflectors below the Precambrian unconformity between the mapped fault and the basement high. These reflectors could be formed by several features, such as layered igneous rocks, basaltic sills, or even Precambrian metasediments.

Line AO5 Interpretation

Line AO5 (Figure 18) does not show any faults above the Precambrian section. The line shows the stratigraphy gently dipping to the east, with a broad anticlinal feature that overlies some possible structuring in the Precambrian. On the east and west ends of the line, the Precambrian reflectors are flat lying. However, in the central part of the line, the reflectors are steeply dipping to the west, with a few cross-cutting horizontal reflectors. While this could be energy coming from out of the plane of the line, it could also be horizontal igneous (basalt) sills cutting across steeply dipping igneous or metasedimentary rocks. The very high amplitude reflector just below the Precambrian unconformity is likely a igneous/basalt sill that is denser with faster seismic velocities than the surrounding Precambrian rock, resulting in a high amplitude, high impedance reflection.

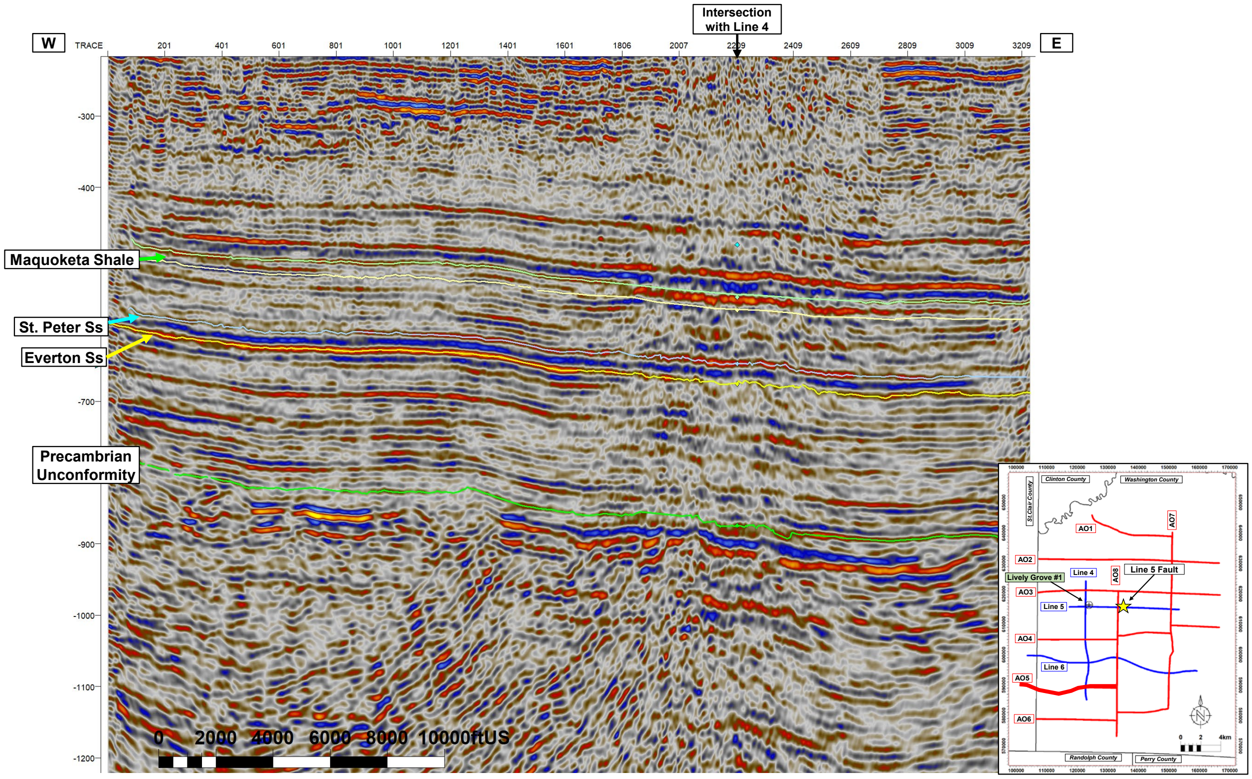

Figure 18: 2022 Line AO5.

Line AO6 Interpretation

Line AO6 (Figure 19) is the southernmost west-east line acquired for the project. A key structural feature on the western side of this line is the high angle pink fault which emanates from the Precambrian and tips out in the lower Mississippian section. This fault therefore transects both the storage reservoirs as well as the Maquoketa confining unit. The fault is visible as a high-angle (not vertical) zone of disrupted reflectors, with the top and base Maquoketa reflectors turned up adjacent to the fault plane. Given this geometry, the fault likely is dominated by strike-slip motion, particularly since there is no obvious reverse or normal motion. The fault most likely started out as an older Precambrian high angle normal fault that was reactivated at a later time in the Paleozoic as a strike-slip fault. The identification of this fault will affect the placement of CO_2 injection wells such that no CO_2 plume will intersect this fault.

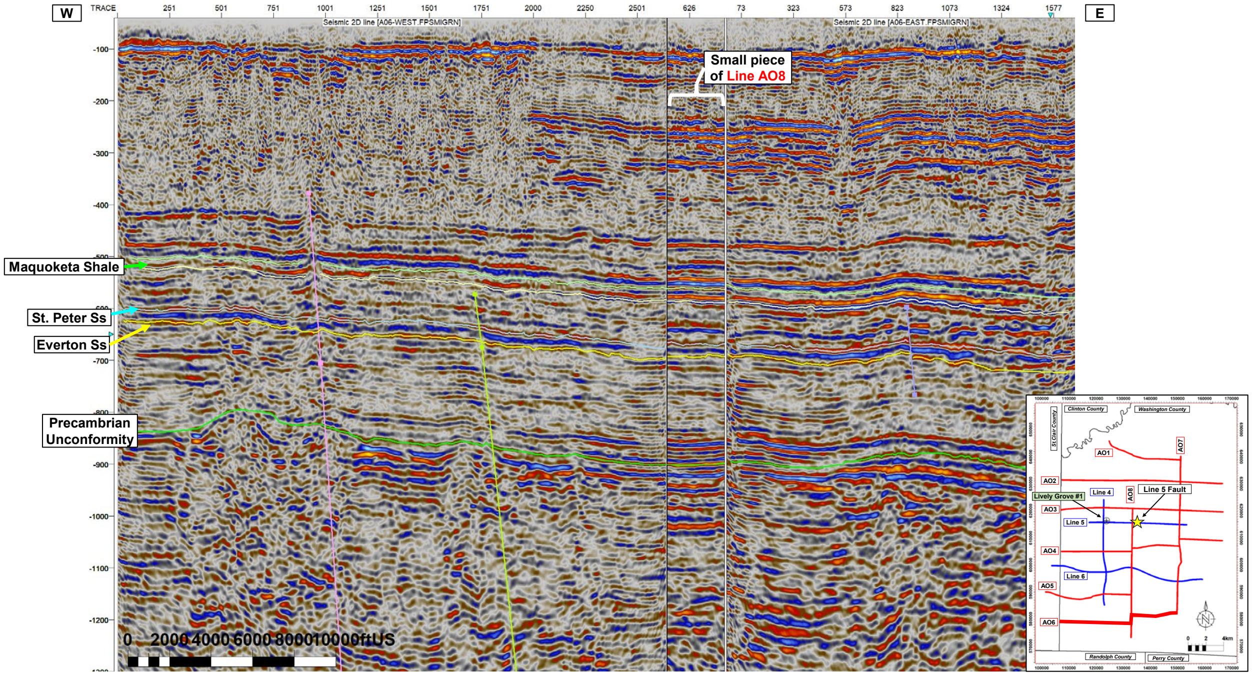

Figure 19: 2022 Line AO6.

A second fault near the central part of the line is the green fault, which is a low-throw high angle normal fault that tips out just below the Maquoketa confining unit. Throw on this fault is likely 20-40 feet, which is visible as a slight inflection of the seismic reflectors that together define the fault plane cutting through the seismic line.

A third fault is visible on the eastern side of the line. This fault is unlike the other faults identified on the 2D at Washington State. The fault looks to have a limited extent within the Trenton and Knox intervals, and appears to tip out beneath the Maquoketa. The fault is fully contained within the Trenton and Knox; unlike all other faults identified on the 2D at Washington County, this fault does not emanate from the Precambrian, but instead may be related to localized deformation of the Trenton/Knox interval. While karsting is not observed in these intervals in this part of Illinois, it is possible that this fault developed as a result of some localized karsting and/or dissolution of the dolomites and carbonates in a limited area. An alternative hypothesis is that this fault is reflecting a small zone of strike-slip motion.

Line AO7 Interpretation

Line AO7 (Figure 20) is the easternmost north-south line acquired for the project. The gap in the data is due to the inability for the acquisition teams to obtain a permit for a section of a township road, so there is a gap in the source and receiver locations of approximately 6000 feet. The processing contractor proceeded to process the line with the gap, instead of splitting the southern part of the line into a separate line.

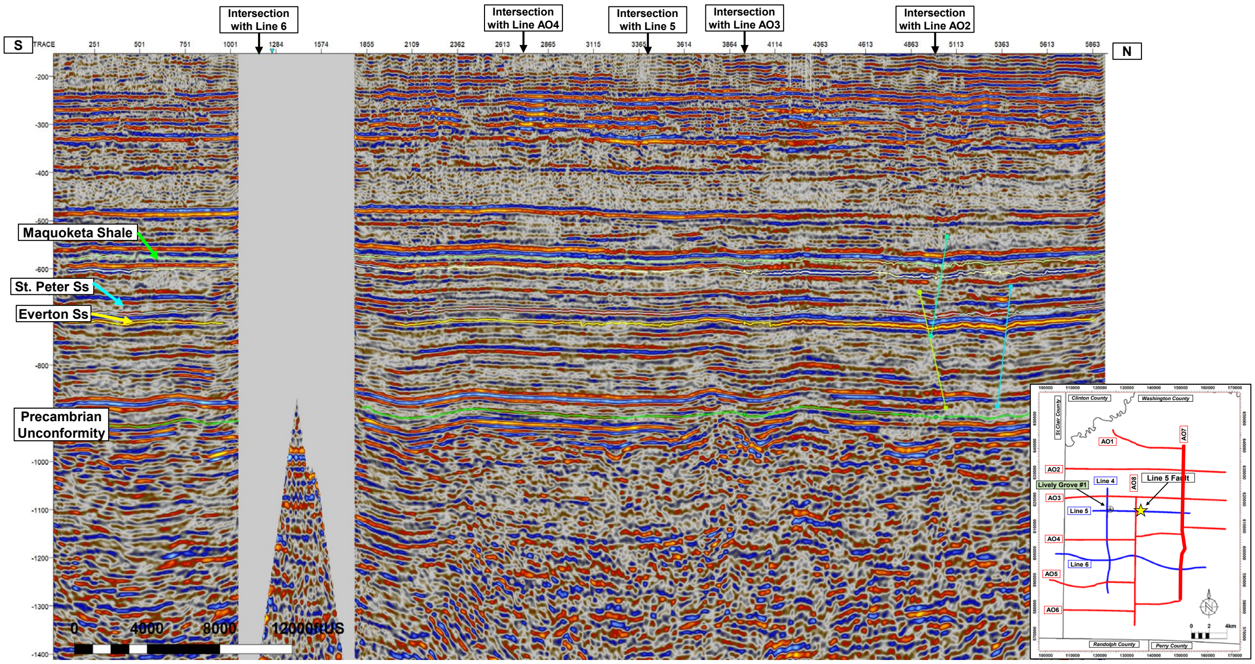

Figure 20: 2022 Line AO7. The gray area without seismic data is due to the inability to acquire seismic along a township road due to permitting issues.

Like several of the other lines, this line has some Precambrian basement features that result in small anticlinal features in the overlying Paleozoic stratigraphy. No faults are visible that emanate from the Precambrian; however, three small faults are present on the north end of the line that are contained in the Paleozoic section. The main faults are two normal faults dipping towards each other that form a small graben about 4600 feet wide at the St. Peter Sandstone level. One additional fault is a splay off of the light green fault, which transects the confining unit and both storage reservoirs. This area near these small faults will need to be avoided by CO_2 injection and resulting CO_2 plume.

SUMMARY

The purpose of the 2021 and 2022 2D seismic surveys near the Prairie State Generating Company site in Washington County, Illinois was to characterize the subsurface geology of the site for carbon storage. The seismic surveys have successfully delineated the presence of and degree of continuity of potential storage reservoirs and confining units from the interpretation of the mapped horizons and structural features. The two seismic surveys have successfully characterized the fault seen on the 2021 Line 5. The seismic has also successfully imaged faults on Lines AO6 and AO7 that transect the storage and confining units. In total, the two seismic surveys have indicated areas which may need additional study to better understand CO_2 out of zone migration risk in the vicinity of these faults.

REFERENCES

Huang, L., & Liu, C.-y. (2017). Three types of flower structures in a divergent-wrench fault zone. Journal of Geophysical Research: Solid Earth, 122, 10,478–10,497

McBride, J. H., 1998, Understanding basement tectonics of an interior cratonic basin: southern Illinois Basin, USA, Tectonophysics, Volume 293, Issues 1–2, p. 1-20.