Seismic Reflection Data Interpretation to Support Project ECO$_2$S, Kemper County, Mississippi*

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Abstract

Interpretations of 2D seismic lines were utilized to reduce uncertainty of faulting locations and the possibility of lateral pinch out in the ECO$_2$S project area. Large offsetting faults could allow for leakage pathways of CO_2 into overlying aquifers or to the surface. However, the seismic shows only minor faults above the regional Paleozoic unconformity with no major offset. The reservoir maintains an adequate gross thickness for storage of CO_2.

Introduction

The Geological Survey of Alabama (GSA) has undertaken interpretation of 2D seismic reflection data to support the project "Establishing an Early CO_2 Storage Complex in Kemper County, Mississippi: Project ECO2S." Project ECO$_2$S was one of three Phase II (Storage Complex Feasibility) projects awarded recently under the U.S. Department of Energy's Carbon Storage Assurance Facility Enterprise (CarbonSAFE) initiative, which seeks to help mitigate carbon dioxide emissions from the burning of fossil fuels.

One of the uncertainties identified was the risk of faults that could offset reservoirs seals which could result in the loss of CO_2 captured and stored in the prospective formations. Seismic data was obtained encompassing the field area to image any large faults cutting the interval. As an added benefit of this study the lateral continuity of the overall reservoir could be determined within seismic resolution.

Interpretation Results

High quality seismic reflection surveys were collected by Western Geophysical Company and Amoco Production Company in the early to mid-1980s to facilitate deep hydrocarbon exploration in the Kemper County, Mississippi, area. Although some interpretations of these data were published (e.g. Hale-Erlich and Coleman, 1993), these were highly generalized. A more detailed analysis is required to evaluate the distribution and integrity of the potential CO_2 sinks in Kemper County, Mississippi.

Key seismic lines in the vicinity of the Kemper energy facility were identified and acquired for interpretation (Figure 1). Building upon the pre-feasibility work completed by the project team, horizons of interest were identified and mapped, including the previously identified geologically favorable intervals: two Lower Cretaceous saline formations (Paluxy Formation and the Washita-Fredericksburg interval) and one Upper Cretaceous interval (Lower Tuscaloosa Massive Sand). There are laterally extensive shales within these formations that act as seals, and the overlying thick Tuscaloosa Marine Shale acts as a major regional confining unit.

There are three easily identified and interpreted seismic reflectors (Figure 2). The shallowest reflector is the Selma Chalk which acts as a seal for the entire study area. The seismic data show a strong, laterally continuous reflector with a fairly constant strong amplitude. One of the key uncertainties identified during risk assessment was the possibility of a large offsetting fault through the chalk which could provide a migration pathway from the closed sequestration system to aquifers or the surface. No such faults are observed in the seismic lines, with only minor faults present within the Cretaceous section.

The second bounding reflector is the top of the Paleozoic section which is marked by a massive unconformity. This erosional surface dips slightly to the west and is marked by relatively flat reflectors above and erratic heterogeneity of reflectors below that demonstrate pinch outs against the surface. The Paleozoic section is not imaged very well and therefore only limited interpretation of the internal faulting and stratigraphy has been conducted. However, this interval is much more faulted as compared to the shallower study interval.

The deepest key reflector surface is the top of the basement which is imaged at the base of the seismic section as a fairly continuous strong reflector with a bumpy and irregular surface. The Paleozoic section displays pinch outs and downlapping reflectors against this surface, while below the top internal reflectors are more flat and smooth, although very low amplitude.

Conclusions

Analysis and interpretation of the seismic lines confirm that the three saline formations (the Paluxy, the Washita-Fredericksburg, and the Tuscaloosa Massive Sand) are regionally extensive but internally heterogeneous and maintain considerable thickness within the study area. Additionally, the study verifies the presence and continuity of multiple sealing layers, including the regional seals of the Tuscaloosa Marine Shale and the substantial chalk of the Selma Group. The Selma chalk shows no sign of large offsetting faults that would allow for leak pathways from the potential injection reservoirs to aquifers or the surface.

Acknowledgement

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Reference Cited

Hale-Erlich, W.S., and J.L. Coleman Jr., 1993, Ouachita-Appalachian Juncture: A Paleozoic transpressional zone in the Southeastern United States of America: American Association of Petroleum Geologists Bulletin, v. 77/4, p. 552-568.

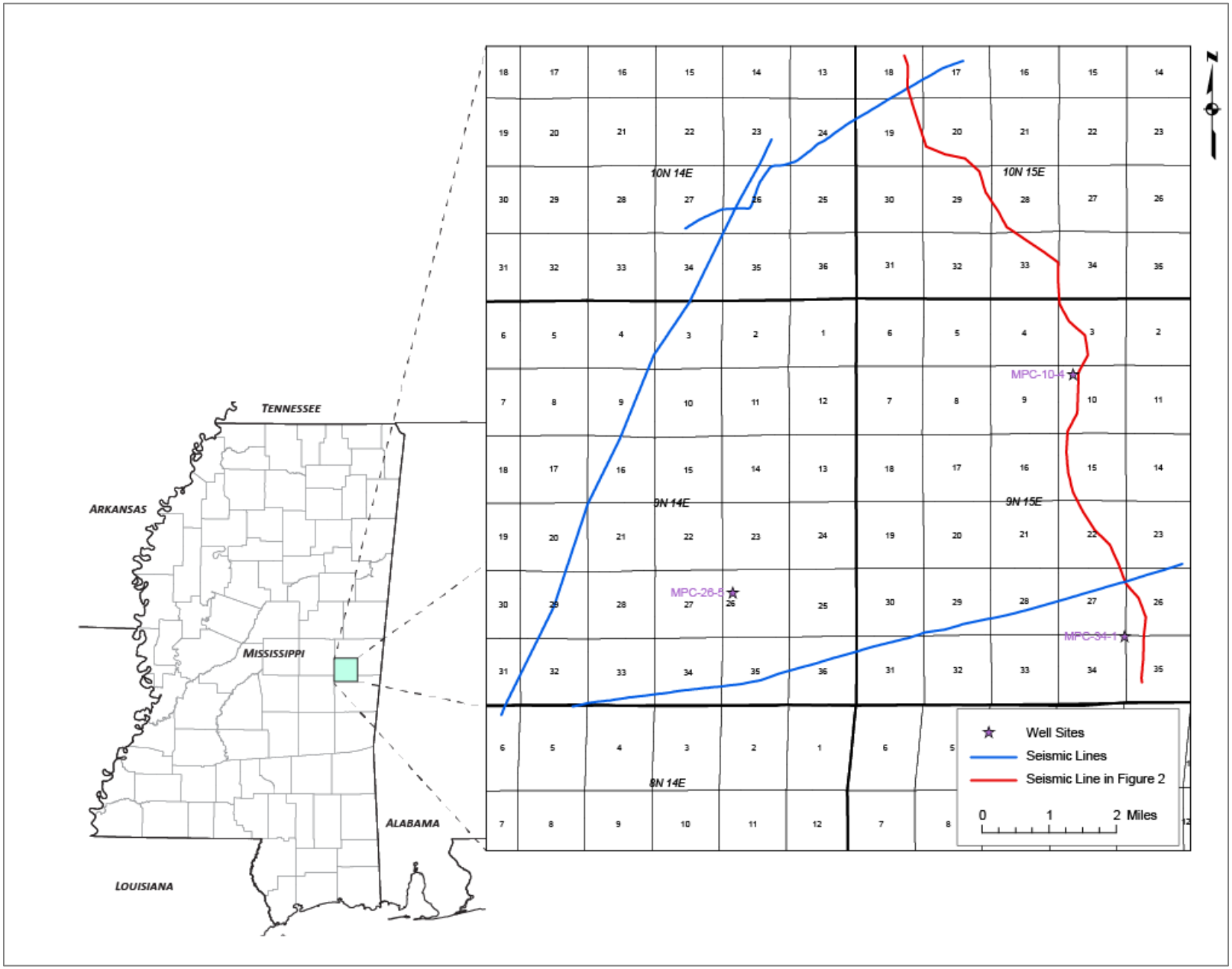

Figure 1. Field map of ECO2S Project area showing the placement four 2D seismic lines and three existing well bores. The line highlighted red is displayed with an interpretation in Figure 2.

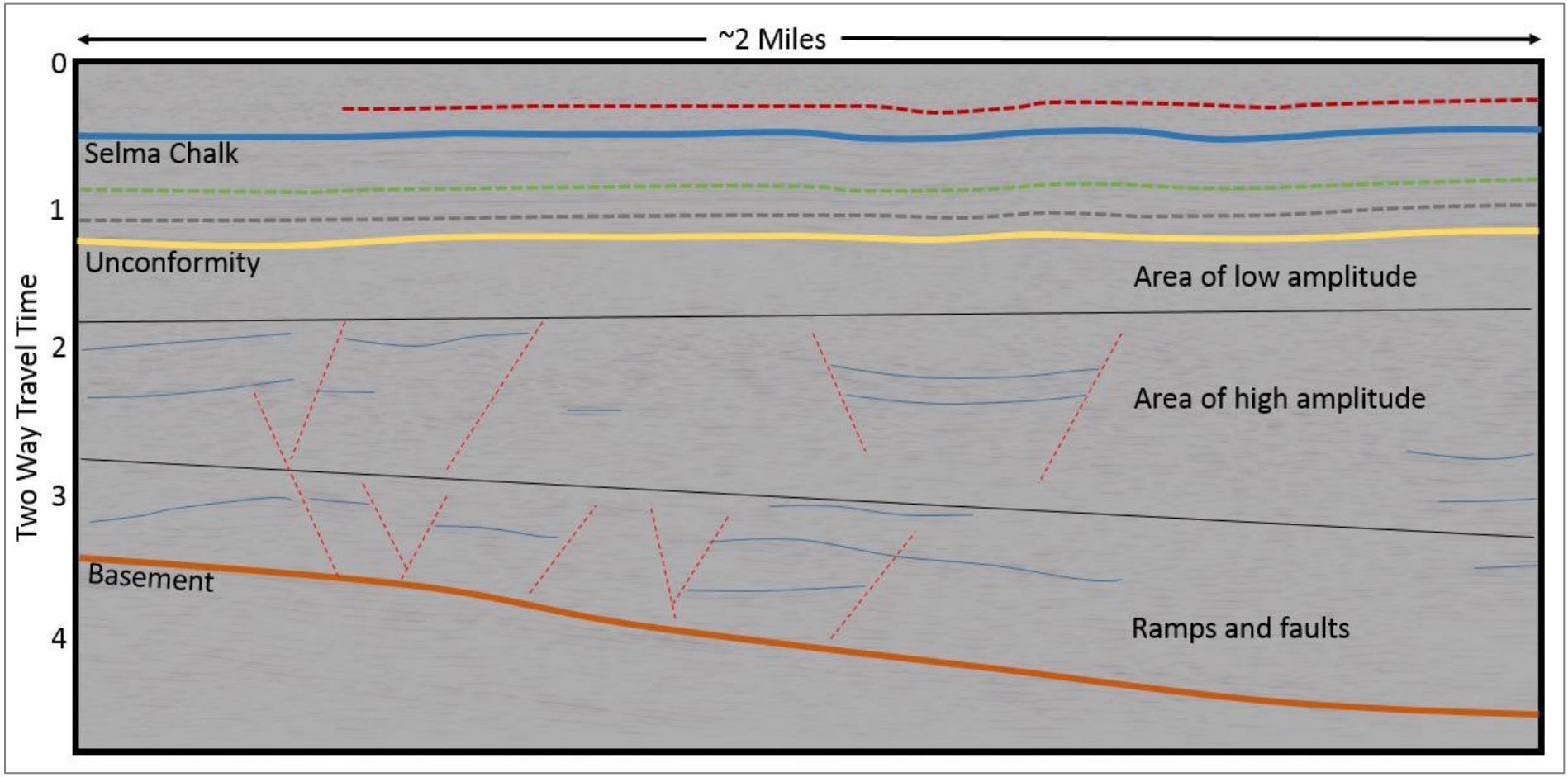

Figure 2. Seismic interpretation of line W-BWB-34 which bounds the ECO_2S Project area to the east and images the subsurface to the regional basement. The area of interest for this project is above the top of Paleozoic unconformity (yellow).