

PS 3D Seismic Mapping of Deep Basement Features in Osage County, Oklahoma*

Kevin Liner¹ and Christopher Liner¹

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¹Department of Geosciences, University of Arkansas, Fayetteville, AR (kliner@uark.edu)

Abstract

3D seismic data in Osage County, Oklahoma is interpreted for basement features that influence overlying sedimentary layers. The 3D survey is on the Chautauqua platform about fifty miles North West of Tulsa, Oklahoma. Stratigraphy of the work area spans Pennsylvanian to Precambrian formations, with basement depth averaging around 4,000 ft. Our goal is to track probable faults and fractures through the granite basement and demonstrate association with shallow structures as an aid in understanding the structural evolution of the area. Osage county has a long history of petroleum production from Penn. and Miss. reservoirs, is near the mineralized lead-zinc mine district of NE Oklahoma, and has been the target of recent deep drilling to test helium potential. We interpret the seismic data using open source software, OpendTect. Our initial attempt to interpret fractures involved picking in time slices, but that method resulted in fault surfaces that are irregular and discontinuous. Marking events in vertical section results in a clear, continuous fault surface. This workflow will be applied in further deep event mapping. Our work may result in a better understanding of basement rocks of Osage county and aid future exploration for unconventional Mississippian petroleum targets and mineral resources.

3D Seismic Mapping of Deep Basement Features in Osage County, Oklahoma



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University of Arkansas, Department of Geosciences, University of Arkansas, 346 Arkansas Ave, Ozark Hall 114, Fayetteville, Arkansas 72701; Kliner@uark.edu

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1 - STUDY AREA

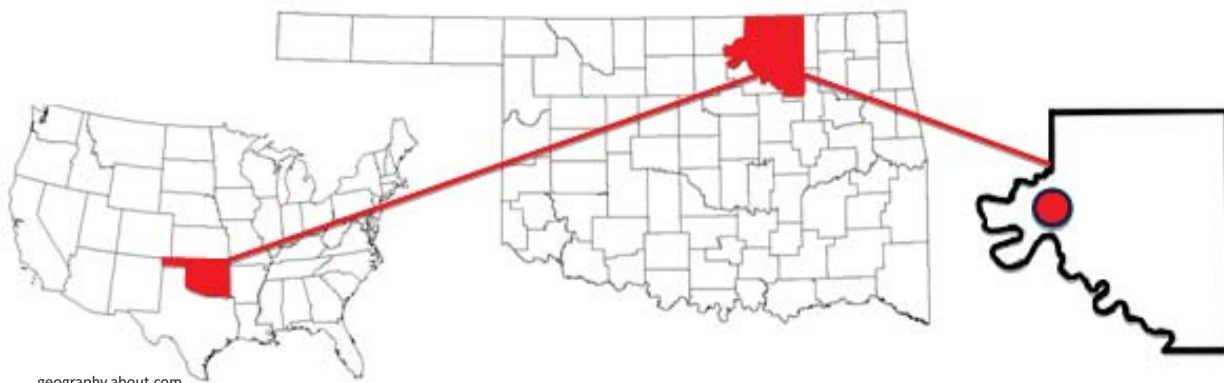


Figure 1: Map of the United State, the state of Oklahoma, and county map of Osage County with a red dot marking the location of the survey.

2 - GEOLOGIC SETTING

The Stratigraphic location of the work area is the Precambrian age granite and extends up into the Cambrian, Ordovician, and Mississippian sections. The depth of the granite in Osage County is around 4500ft deep. The top of the Mississippian begins at about 3010ft.

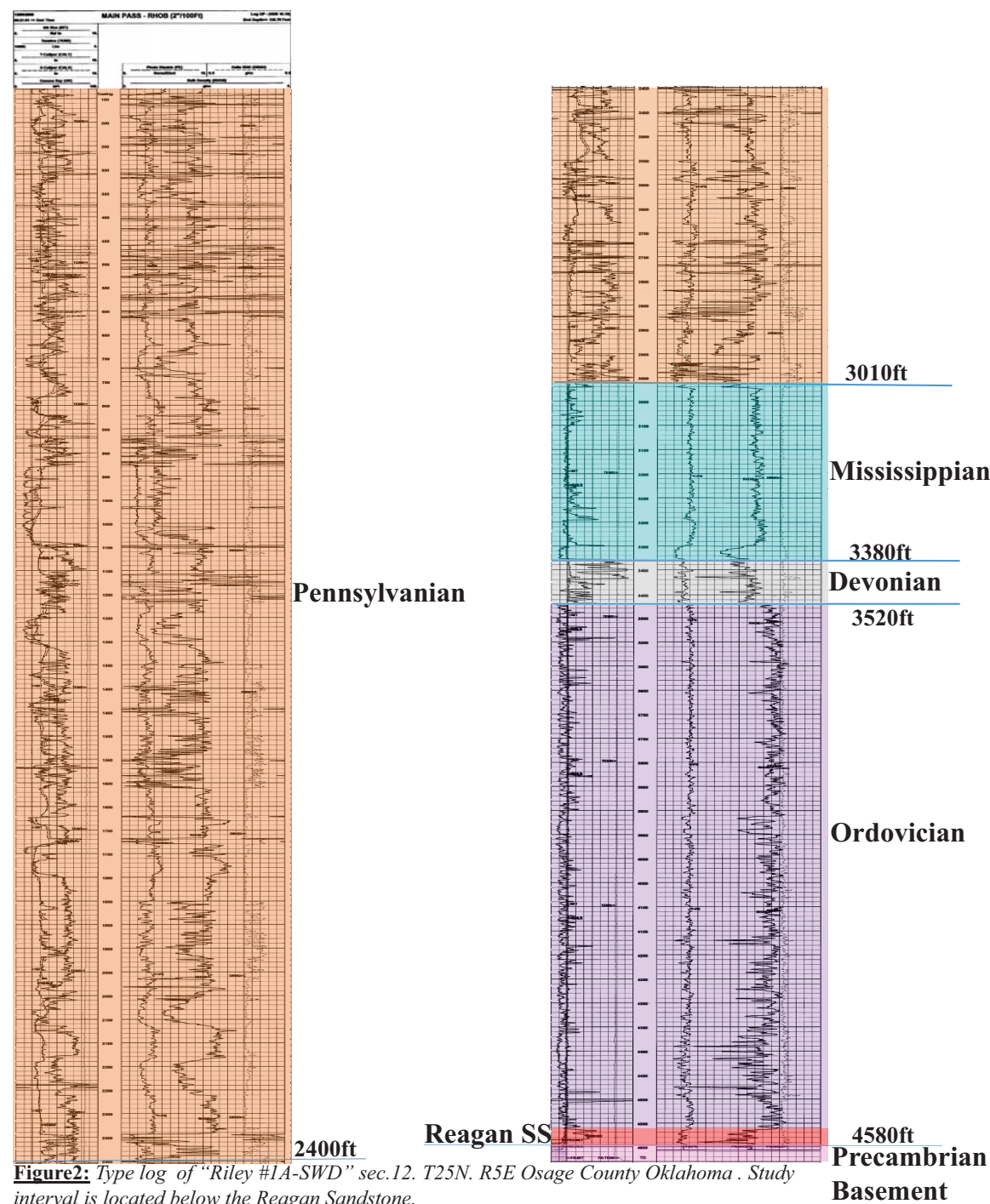


Figure2: Type log of "Riley #1A-SWD" sec.12, T25N, R5E Osage County Oklahoma. Study interval is located below the Reagan Sandstone.

3 - BASEMENT EVENTS

In figure 3 you can see a red box inside the box are three dark colored events. These events are the fractures we are tracking for the study. Currently we believe they are mineralized veins of lead or zinc. The fractures vary in size but most are very persistent of many lines of data. Usually the fractures persist around 60 lines. A few of the fractures visible on the survey continue up into overlying units. Those are the fractures of most interest.

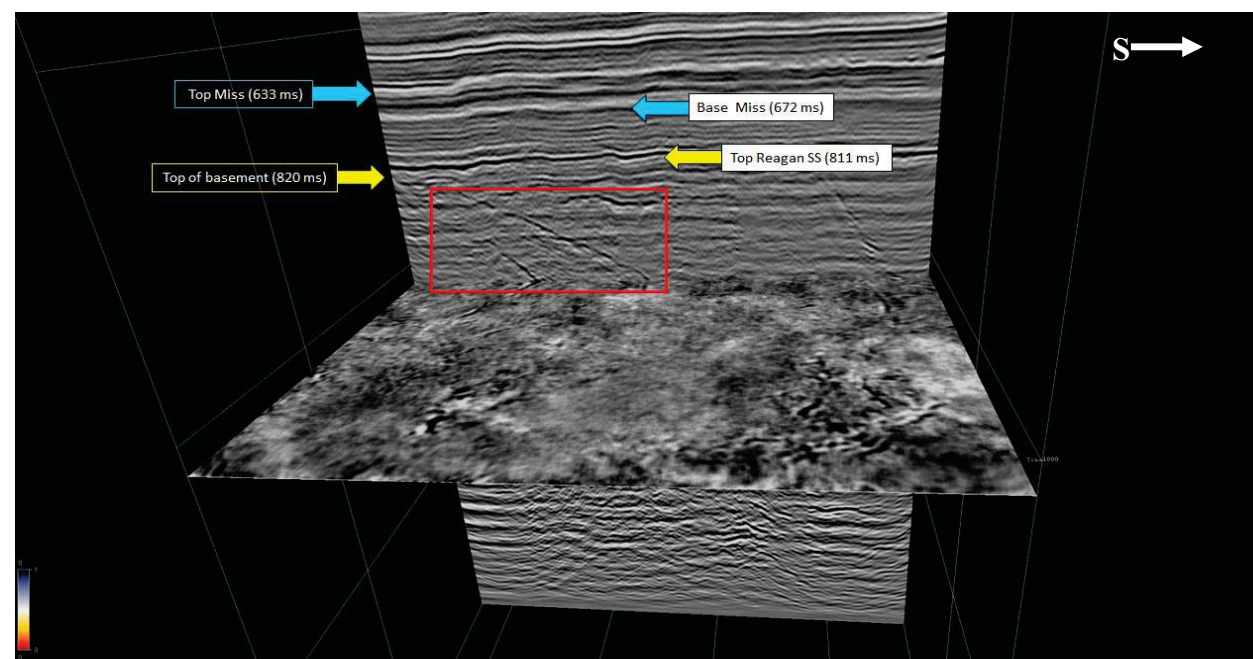


Figure 3: Image from OpendTect with formation locations marked in milliseconds. The red box points out the type of events when a conducting the study on. Crossline 11104, Z-slice 1048

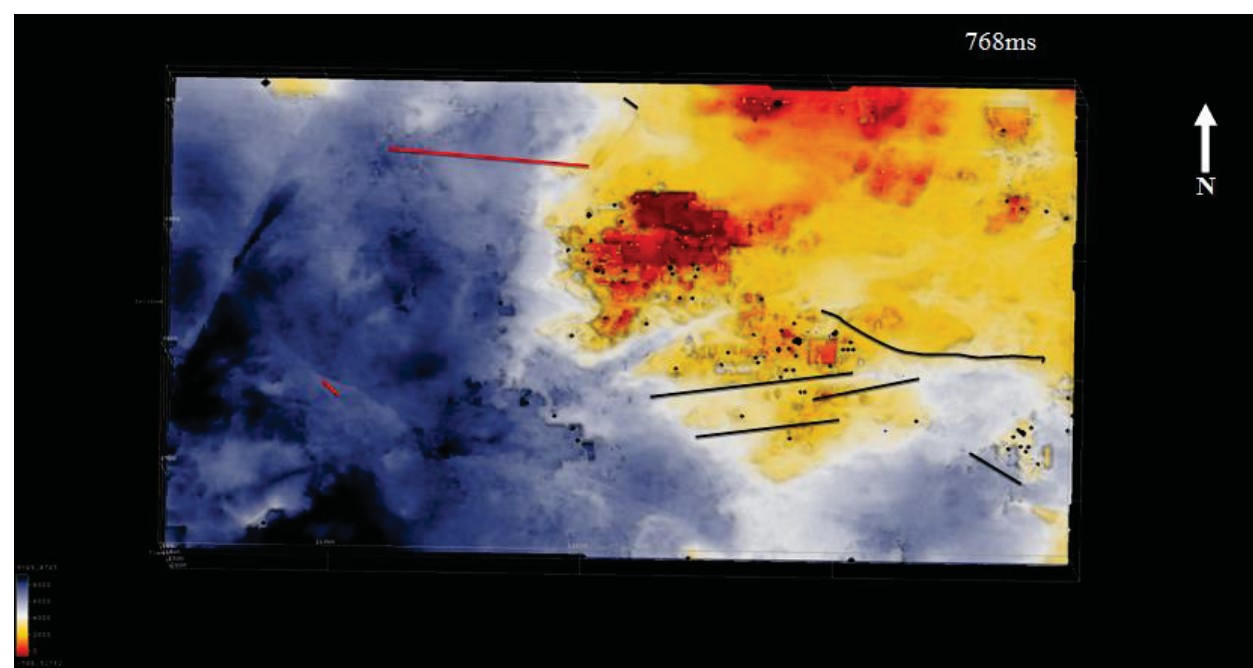


Figure 4: Image of the basement events that are located below the Reagan sandstone. You are looking straight down at the basement events.

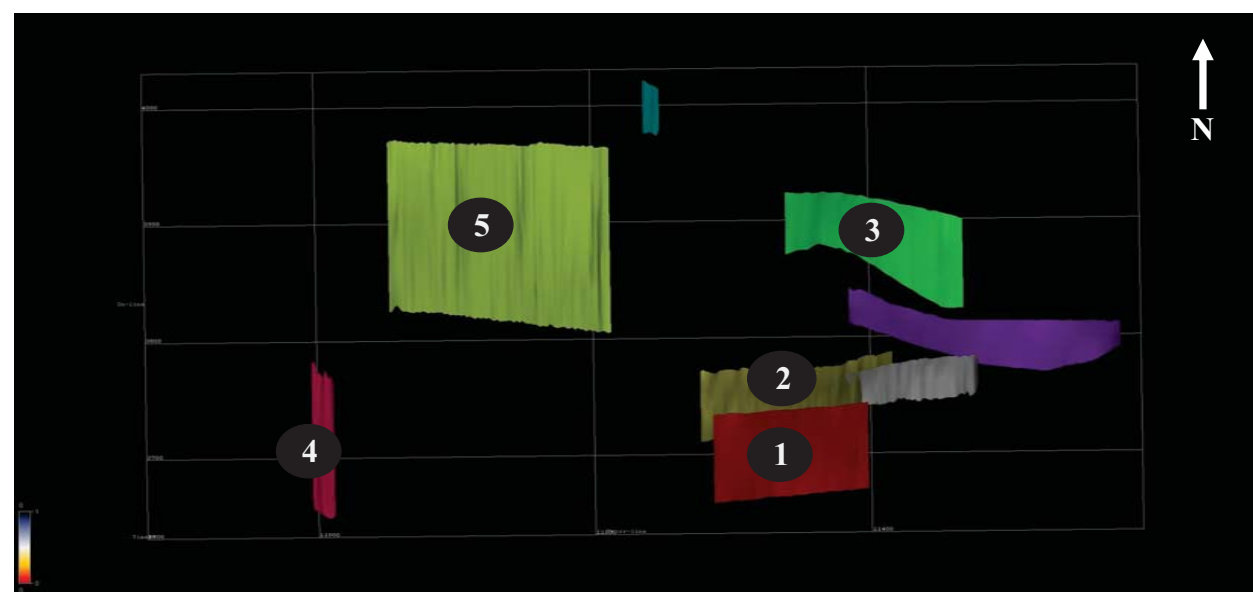


Figure 5: Is a horizon of timbered hills sandstone created in OpendTect. The lines are the basement lineaments marked to show the location below the timber hills.

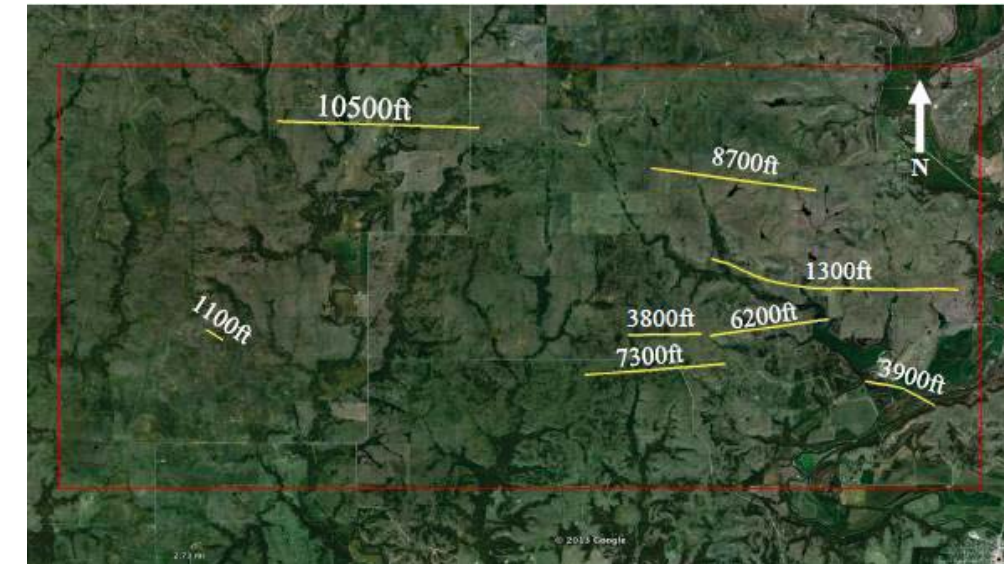


Figure 6: Shows basement features at the top of Washington County Rhyolite group that go up into overlying Cambrian group. The features have been measured in Google earth to show the size of the features.

4 - DATA AND SOFTWARE

Data Description

Survey size :50 sq mi

Dominant wavelength:40Hz

Vertical resolution:119ft

Granite Velocity:1900fps

Lateral Resolution:237ft

The seismic program being used is OpendTect 4.4 (dGB Earth Sciences). OpendTect is a open source seismic interpretation software. This program gives us the ability to track the fractures and make a seismic surface of each fracture. Also with this program multiple horizons can be tracked to study the effect of fractures on shallower structures.

5 - TECHNIQUE

A few problems were encountered when first tracking the fractures in OpendTect. It was discovered that the program could not make a surface for the fractures when tracked in z-slices so the decision was made to track the fractures in crossline. The next problem encountered was when tracking the fractures the edges were very jagged and sometimes the fracture would become very faint and hard to track. The current method for tracking the fractures is to find the fractures in z-slice and make a guide line with OpendTect on the top and bottom of the fracture. The technique gives me the ability to continue to track the fractures through the faint sections and gives me the best surface to take dips from.

6 - OUTCROP ANALYSIS

The same Precambrian age granite that is over 4000ft below the surface in Osage County outcrops in Mayes county, Oklahoma 100 miles south east of the survey area. This outcrop of the Spavinaw granite offers a unique opportunity to see the same granite being studied with seismic in Osage county. The granite is located below the spillway at Spavinaw lake.

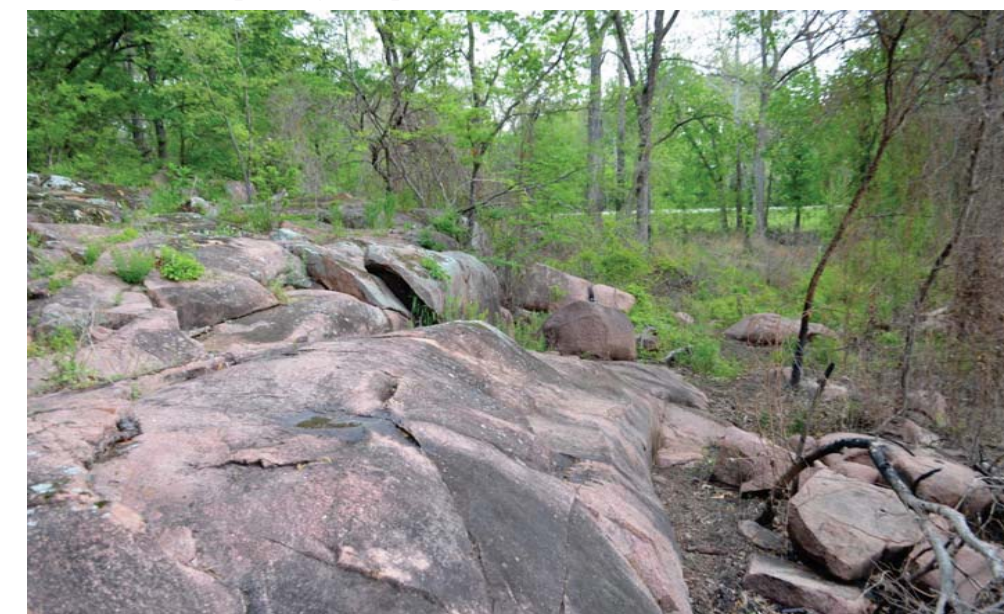


Figure 8: picture of the Spavinaw granite in Mayes county.

8 - ACKNOWLEDGEMENTS

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9 - PERSONNEL

1. Christopher Liner, Project management, regional integration, 3D seismology; 2. Doy Zachry, Stratigraphy, structure, petroleum geology; 3. Walter Manger, Paleontology, regional stratigraphy, sedimentology; 4. Greg Dumond, Structural geology, fracture mechanics, tectonic stress fields; 5. Cheyenne Xie, Stratigraphy, geochemistry, petroleum systems; 6. Ralph Davis, Fluid flow and permeability, water chemistry; 7. Jack Cothren, Digital outcrop technology, geospatial imaging, remote sensing

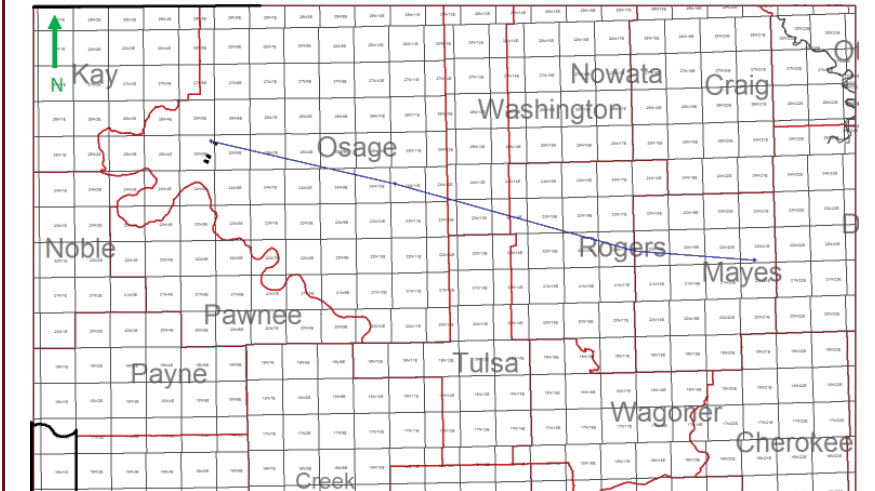


Figure 9: Shows the length of the cross section from the seismic survey to the Spavinaw granite in Mayes county.

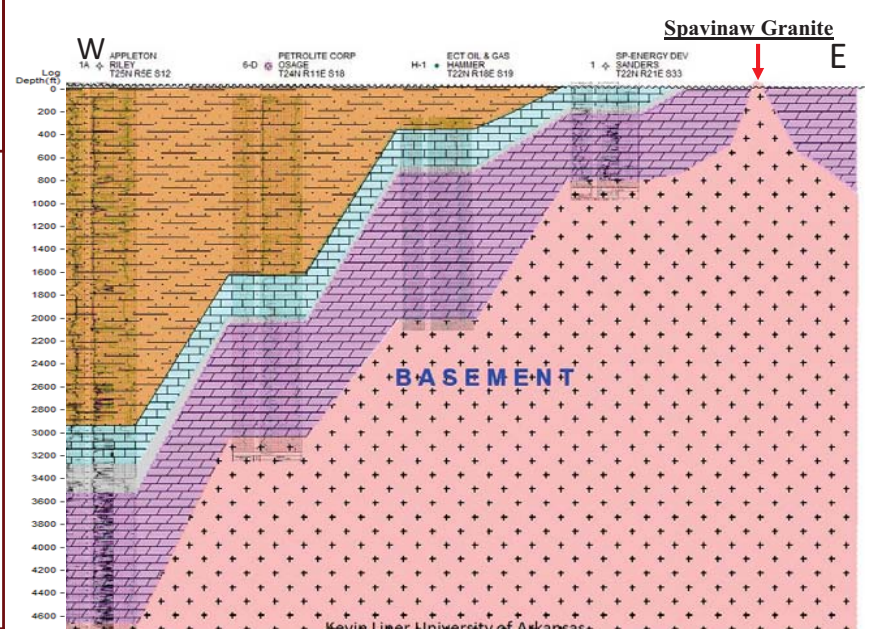


Figure 10: cross section created in Petra from correlating well logs with granite tops picked.

The Spavinaw Granite outcrop in Mayes county is thought to be the top of a granite hill that is present on the Precambrian basement surface. The shallowing of the basement can be seen on the cross section over the 100 mile distance.

7 - RESULTS

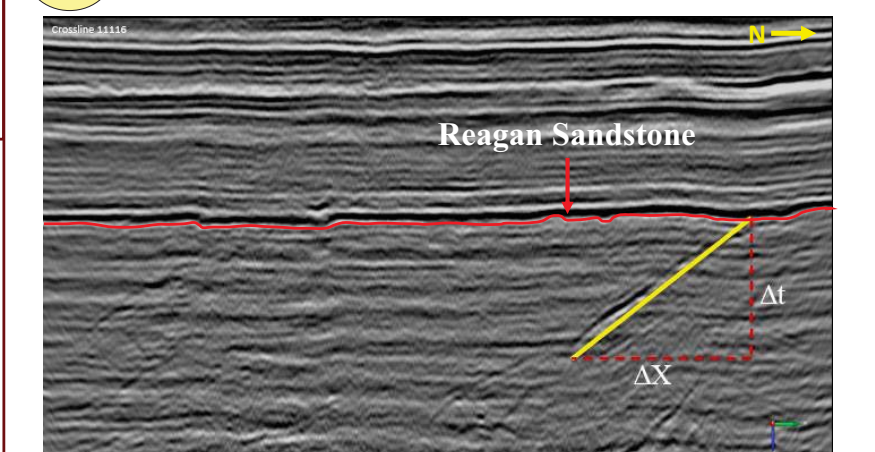


Figure 11: crossline from OpendTect with a fracture marked in yellow that shows how the dip is measured using equation (1).

If local velocity (v) is know from sonic logs, then geologic dip(θ) can be estimated from seismic slope(Δt/Δx) using equation (1).

$$\theta = \arctan\left(\frac{v \Delta t}{2 \Delta x}\right) \quad (1)$$

FRACTURES	STRIKE	DIP
1	084°	71°
2	089°	77°
3	100°	47°
4	127°	46°
5	092°	41°