

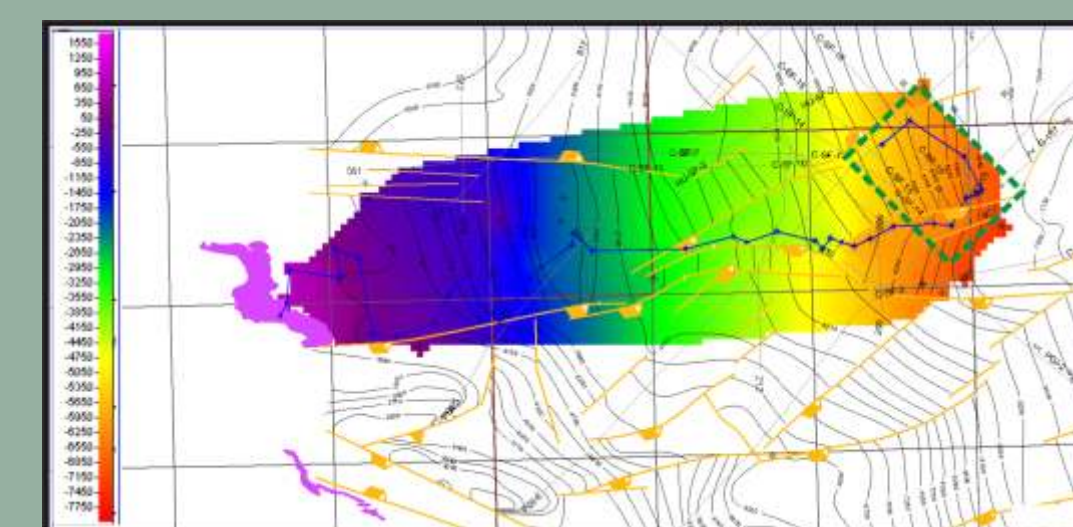
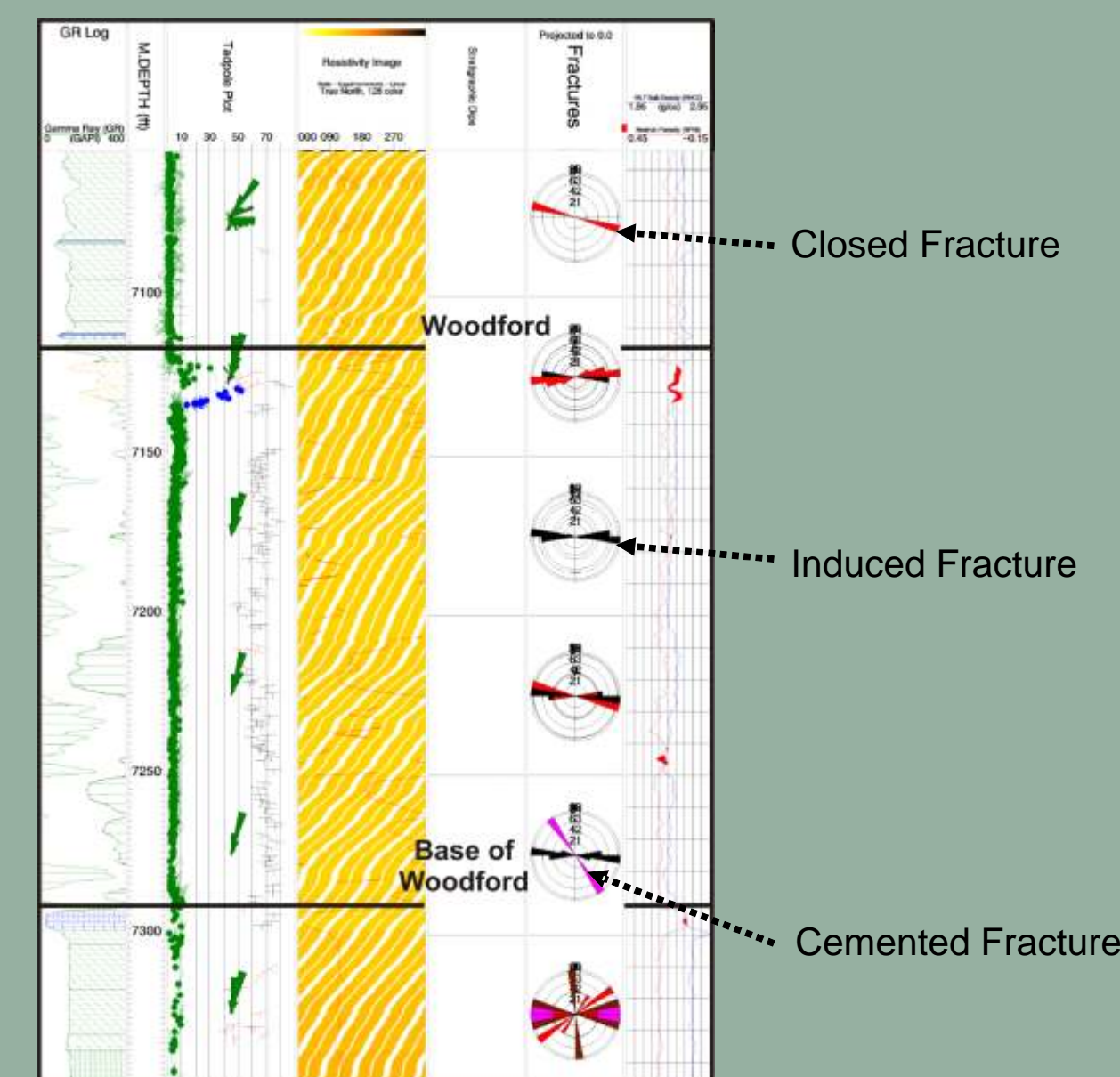


CHARACTERIZATION OF THE WOODFORD SHALE IN OUTCROP AND SUBSURFACE IN PONTOTOC AND COAL COUNTIES, OKLAHOMA

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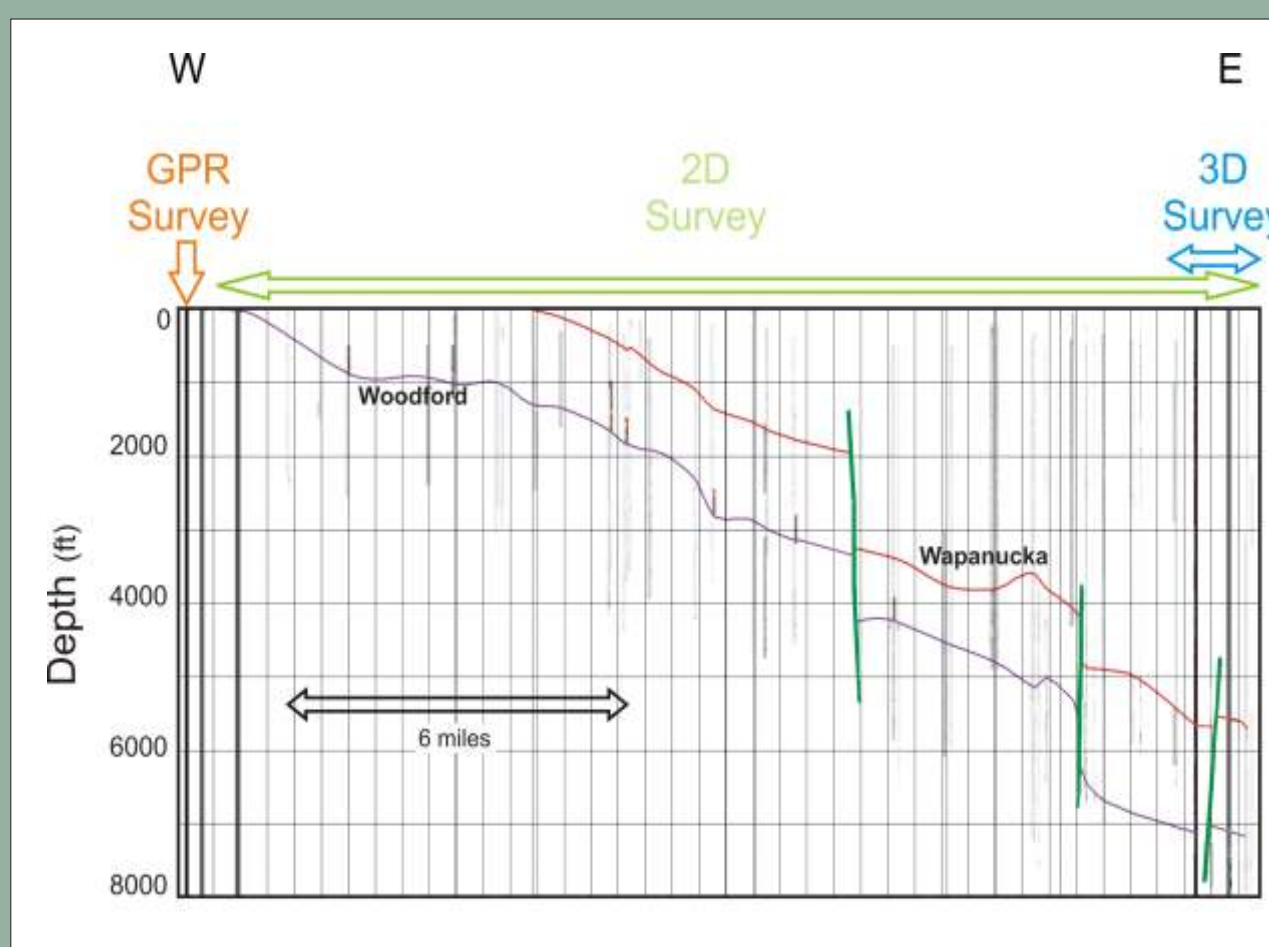


Well Control



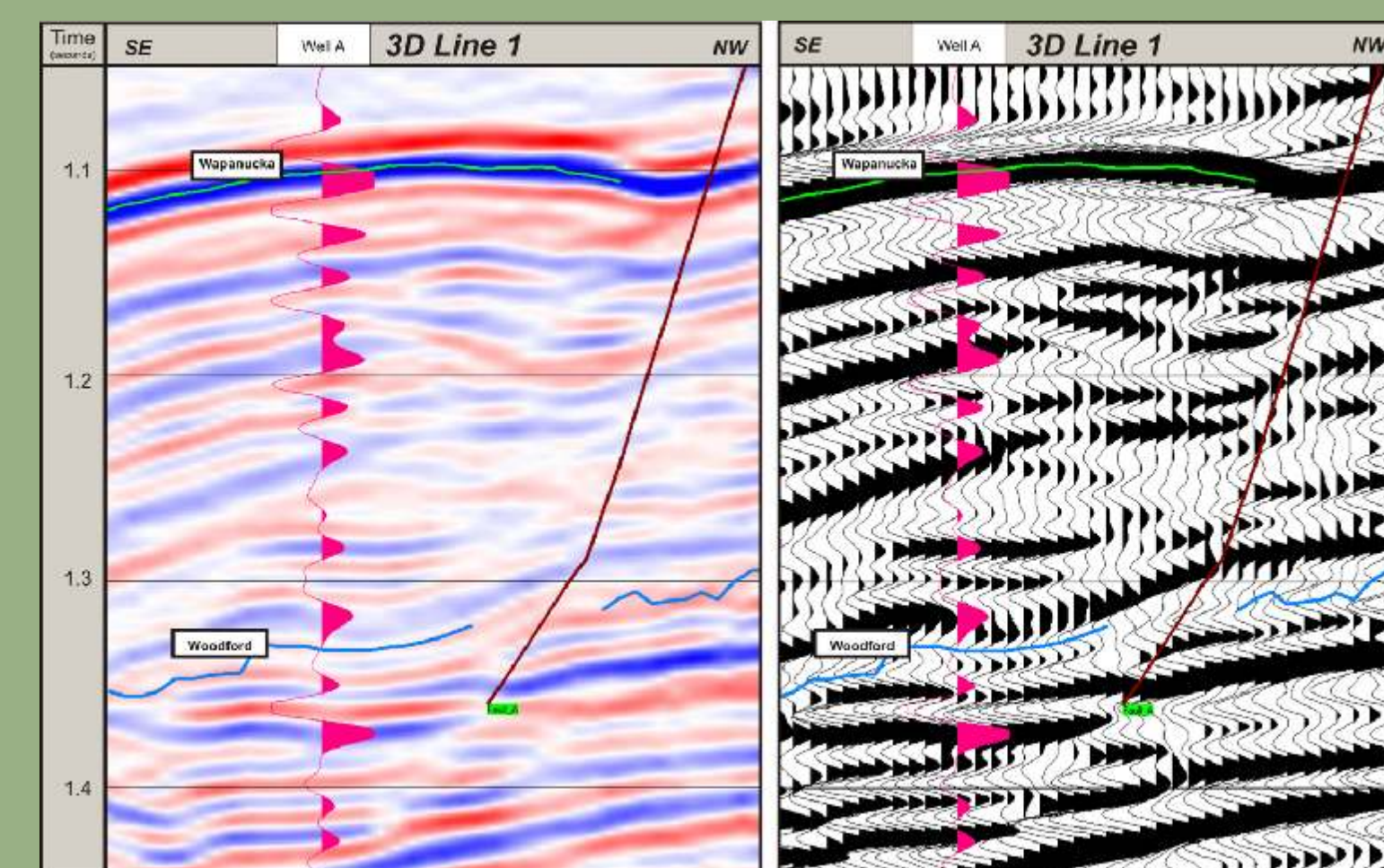
The Woodford horizon picked on a grid of 2D seismic lines. The horizon has been rudimentarily depth converted. The resulting map shows the relative basinward dip of the Woodford from approximately 900 ft at outcrop to over 7500 ft within 3D survey area.

A dip analysis log plot extracted from an FMI log ran in Well A highlights the three fracture types typically encountered in the Woodford. The closed and drilling-induced fractures have a general S90E orientation. The plot also shows the Woodford has a shallow dip.



A cross section from the study area. The extent of the three data sets is indicated relative to the cross section. The red and purple lines delineate the Wapanucka and Woodford formations respectively. The faults are indicated by dark green. The cross section exemplifies the general eastward structural dip in the study area

Seismic

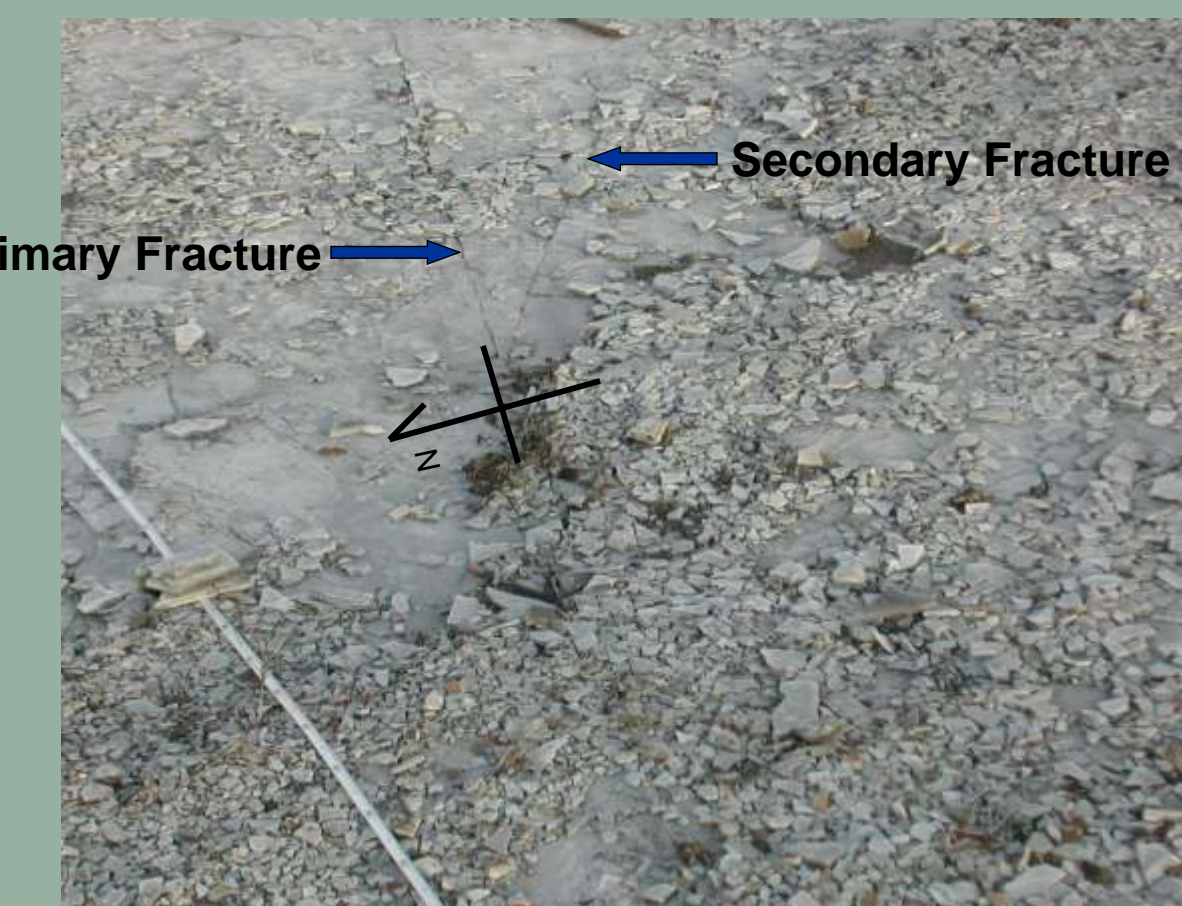


The dip of the Woodford, purple, is less homogeneous in cross section. Large offset normal faults, dark green, divide the Woodford's dip into the basin. The regional faults in this study area can have 1200 ft+ throws. The faults are regional in nature enabling a general structural view from only 2D seismic lines.

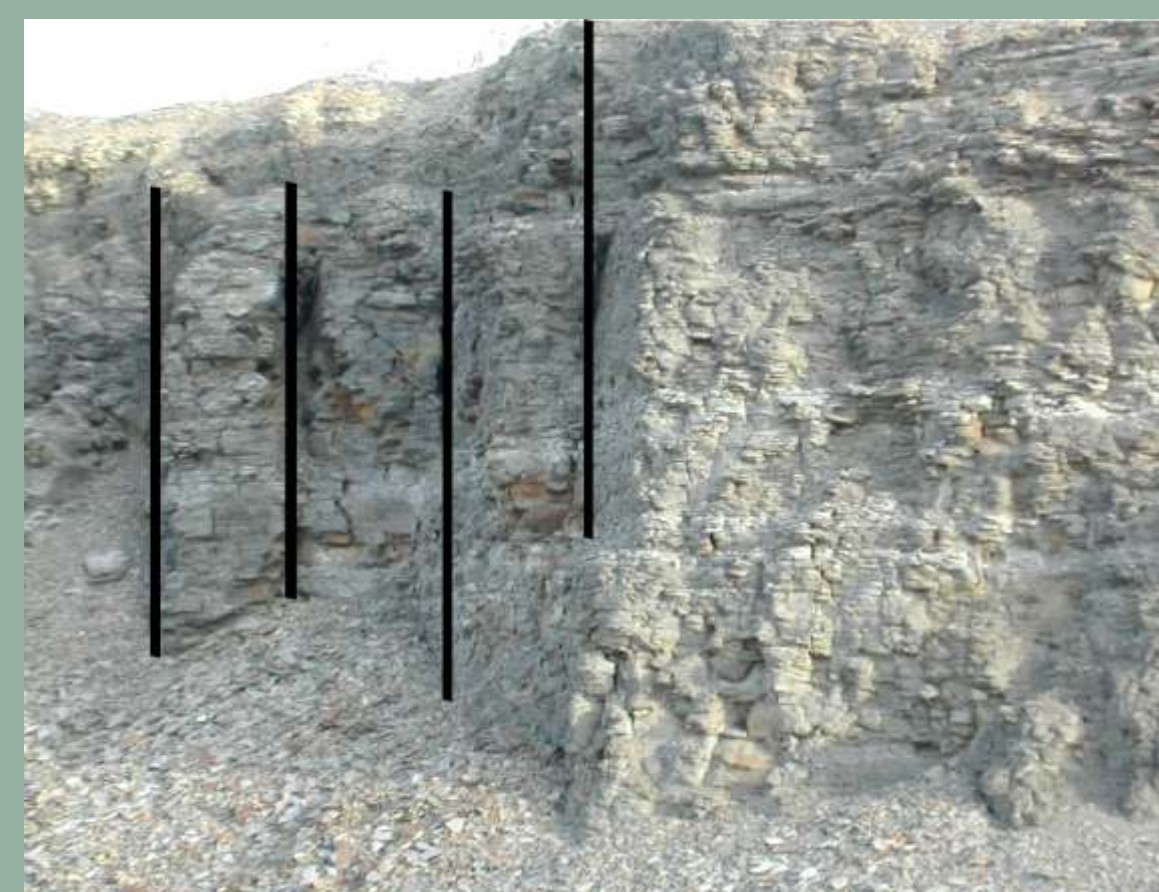
Faults and Fractures



An eastward-facing photograph from the Woodford outcrop. The green arrows point toward the primary east-west fractures. The fractures are evenly separated by approximately 7 meters and extend beyond the project area.

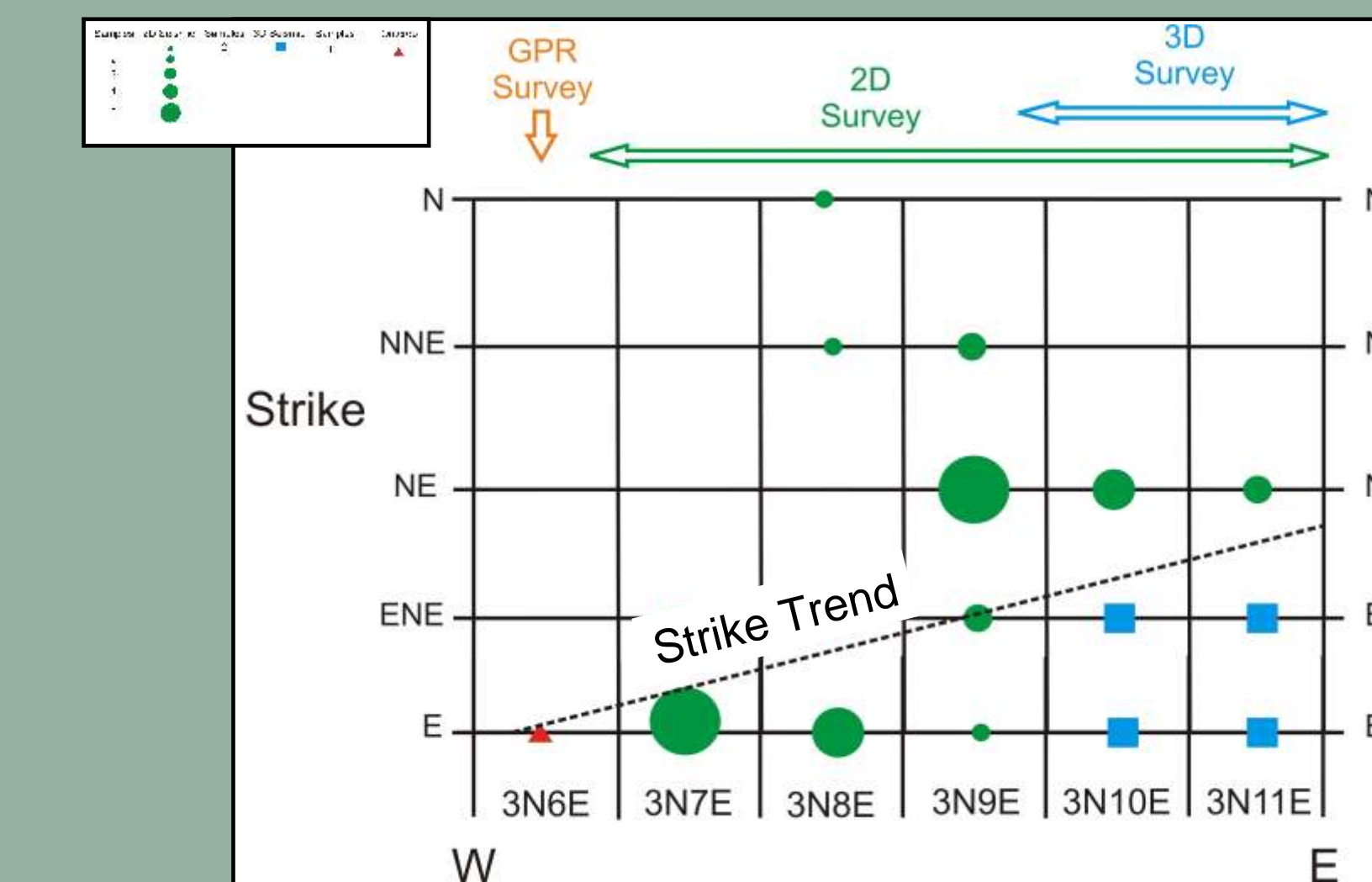


Map view photograph of a section of the quarry floor. The black arrow is pointing to a fracture from the primary set. The white arrow is pointing to a fracture from the secondary set which terminates in the vicinity of the primary fracture.



A close-up of the box from the above figure. The primary east-west striking fracture set can be seen in the vertical face of the weathered Woodford Shale. The vertical faces correspond to the fractures seen on the quarry floor.

Strike Orientation



The strike of all joints and faults in a section was plotted to determine a strike trend in the study area. The number of samples, joints and faults, are represented by symbol size. The strike trend of both was found to rotate to the North from S90E in the west to approximately N45E in the east.

- Fractures typically appear as complementary sets consisting of multiple types and orientations. While the absolute age of the fracture sets is difficult to determine one may estimate age of the sets relative to one another (Kulander et al., 1979; Pollard and Aydin, 1988; Twiss and Moores, 1992).
- At the Woodford outcrop there is one fracture set striking N90E, termed the primary set, and one striking approximately S60E, termed the secondary set.
- The primary fracture set is considered the older set because it consists of parallel, systematic fractures (Pollard and Aydin, 1988).
- The majority of the nonsystematic fractures terminate at the intersection of the primary set at the outcrop. The pre-existing primary fracture appears to be a mechanical boundary to the later sets (Gross, 1993).

- In well A drilling-induced fractures were found to strike approximately S80E.
- The borehole breakouts are approximately oriented N05E indicating the minimum horizontal stress component.
- Faults were found to strike N12E-N24E with a dip of approximately 56°.
- Natural fractures, assumed to parallel in situ stresses, were found to strike S85E.
- Mineral-filled fractures are limited to the lower Woodford with a S36E orientation.
- The majority of the induced and natural fractures strike S86E.
- Approximately 10 cemented fault planes between the Wapanucka limestone and Caney Shale indicate a general S89E strike.