Seismic Review of Rita SWD #1 Location
27-22S-27E

20964-Exhibit 1-038

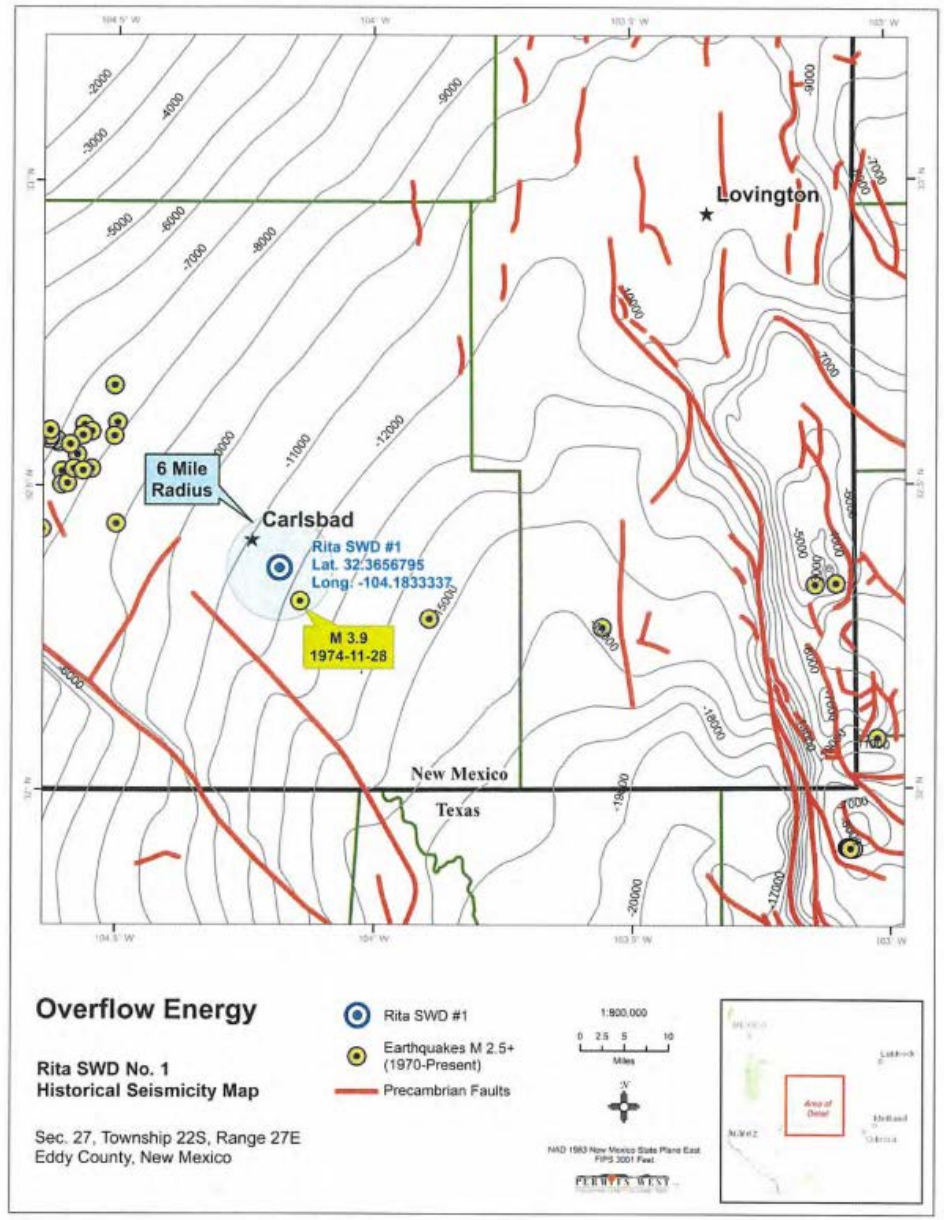


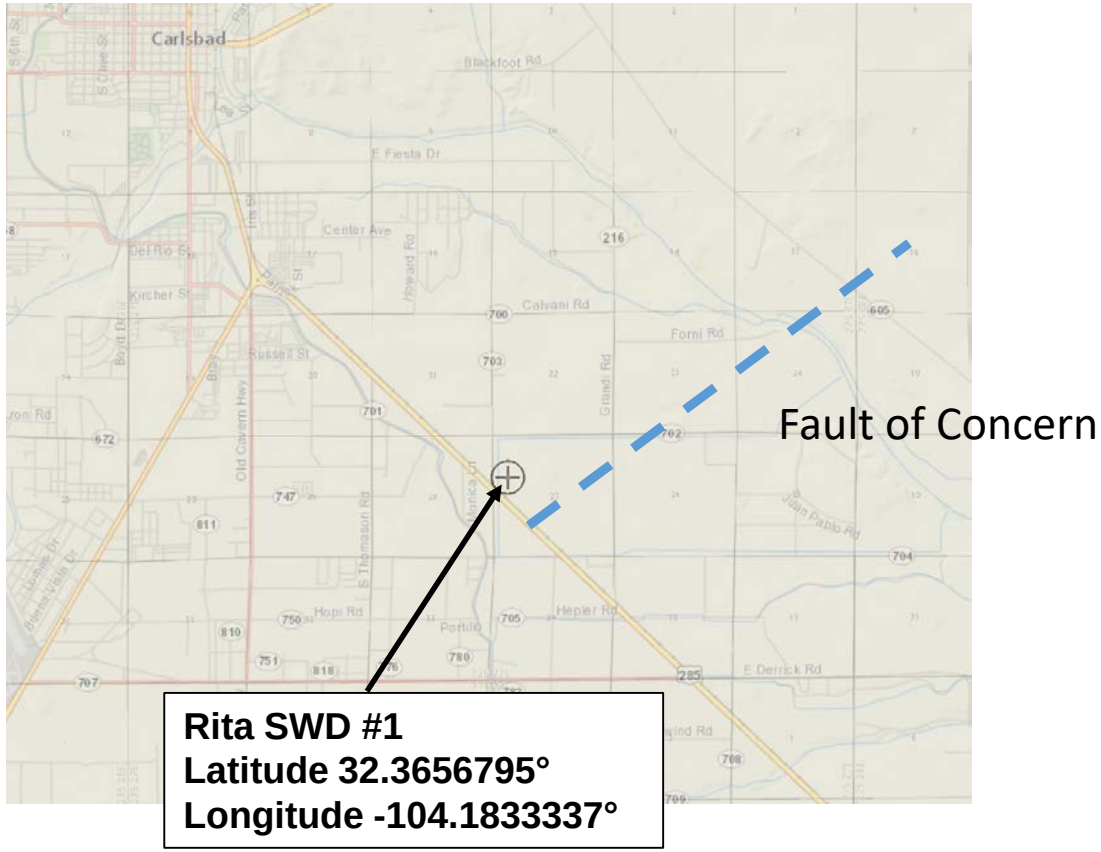
Figure 1. Structural contour map of the Precambrian basement in feet below sea level. Red lines represent the locations of Precambrian basement-penetrating faults (Ewing et al., 1990). The Rita SWD #1 well lies ~9 miles NE of the closest deeply penetrating fault and 4 miles from the closest historic earthquake.

Summary of Seismic Observations

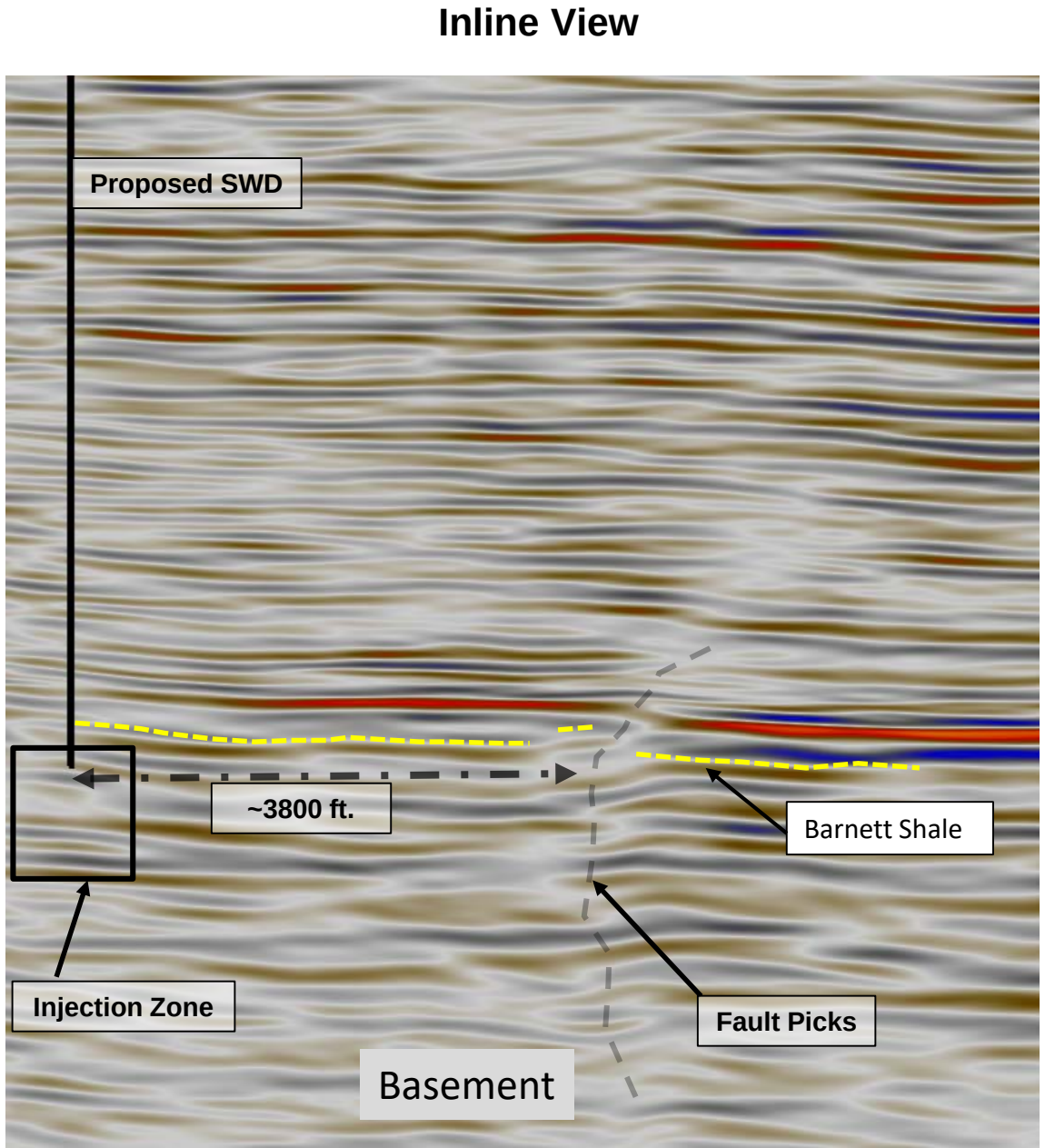
1.) Rita SWD #1:

One N-S fault pick at 3800 ft from proposed SWD well location. Seismic W-E cross section shows injecting into a faulted zone and the fault extending into basement rock.

Need to analyze potential of fault slip and induced seismicity on this potential near vertical fault.



Seismic Evaluation



Near vertical faults observed on seismic on inline (E-W) view at ~3800 ft. east of proposed Rita SWD #1. The major fault line can be seen in cross line and inline and it is a high angle reverse fault and would have the lowest pore pressure for fault slip in the area. This fault was active from basement to Pennsylvanian times (Canyon-Cisco-Strawn groups).

Recommend modeling pore pressure changes to evaluate slip stability of near vertical fault. Other non-vertical faults will require higher pore pressure to slip. Local fault lines are not high angle (>80 degrees) and are not basement connected.

Fault Slip Analysis for Rita SWD #1

Stanford | News Service

FEBRUARY 27, 2017

Stanford scientists develop new tool to reduce risk of triggering manmade earthquakes

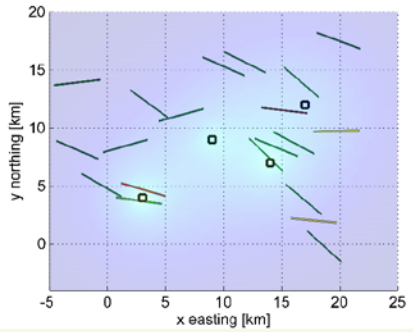
A new software tool can help reduce the risk of triggering manmade earthquakes by calculating the probability that oil and gas production activities will trigger slip in nearby faults.

BY KER THAN

A new, freely available software tool developed by Stanford scientists will enable energy companies and regulatory agencies to calculate the probability of triggering manmade earthquakes from wastewater injection and other activities associated with oil and gas production.

"Faults are everywhere in the Earth's crust, so you can't avoid them. Fortunately, the majority of them are not active and pose no hazard to the public. The trick is to identify which faults are likely to be problematic, and that's what our tool does," said Mark Zoback, professor of geophysics at Stanford's School of Earth, Energy & Environmental Sciences. Zoback developed the approach with his graduate student Rall Walsh.

Oil and gas operations can generate significant quantities of "produced water" – brackish water that needs to be disposed of through deep injection to protect drinking water. Energy companies also dispose of water that flows back after hydraulic fracturing in the same way. This process can increase pore pressure – the pressure of groundwater trapped within the tiny spaces inside rocks in the subsurface –



Rita SWD #1 Input Parameters in FSP Tool

Vertical Stress Gradient [psi/ft]	1.05
Max Horiz. Stress Gradient [psi/ft]	0.86465
Min Horiz. Stress Gradient [psi/ft]	0.62875
Max Hor Stress Direction [deg N CW]	155
Initial Res. Pressure Gradient [psi/ft]	0.43
Reference Depth for Calculations [ft]	13700
Aquifer Thickness [ft]	200
Porosity [%]	5
Permeability [mD]	35

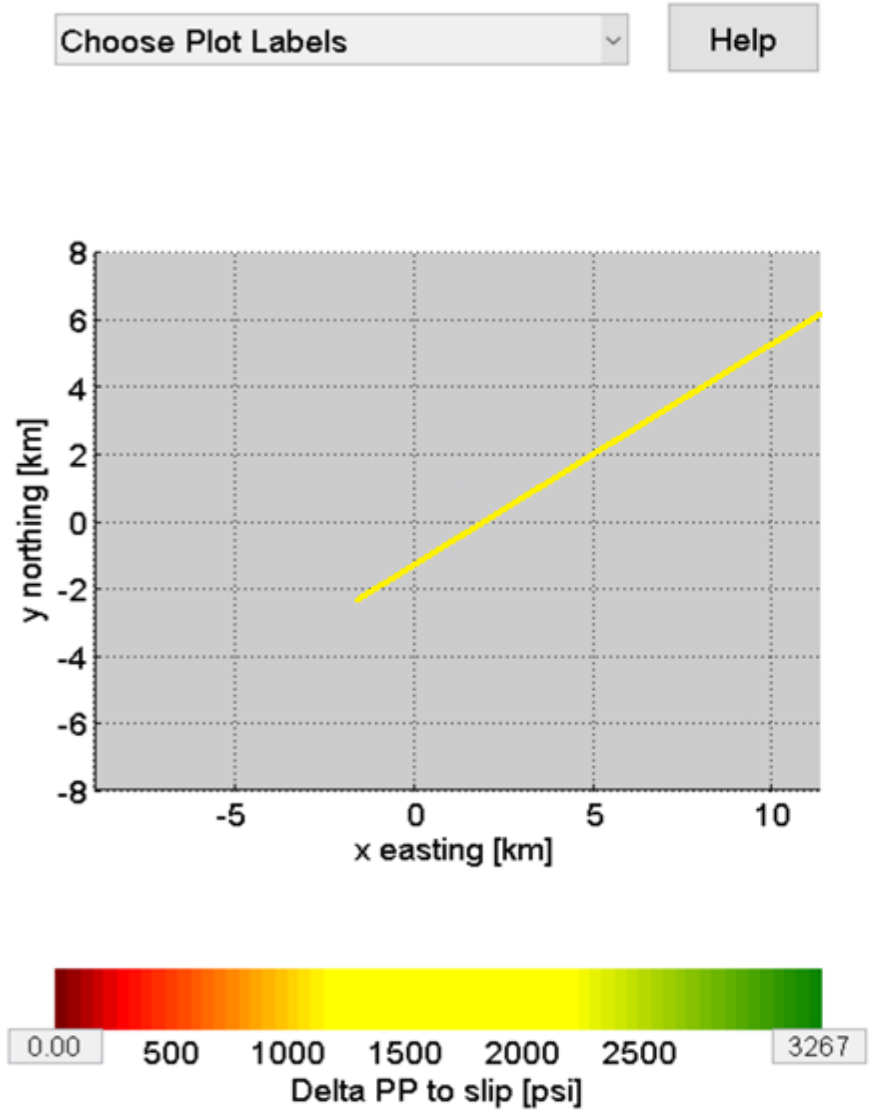
Inj. Rate [bbl/day]	Start Year [yr]	End Year [yr]
25000	2020	2045

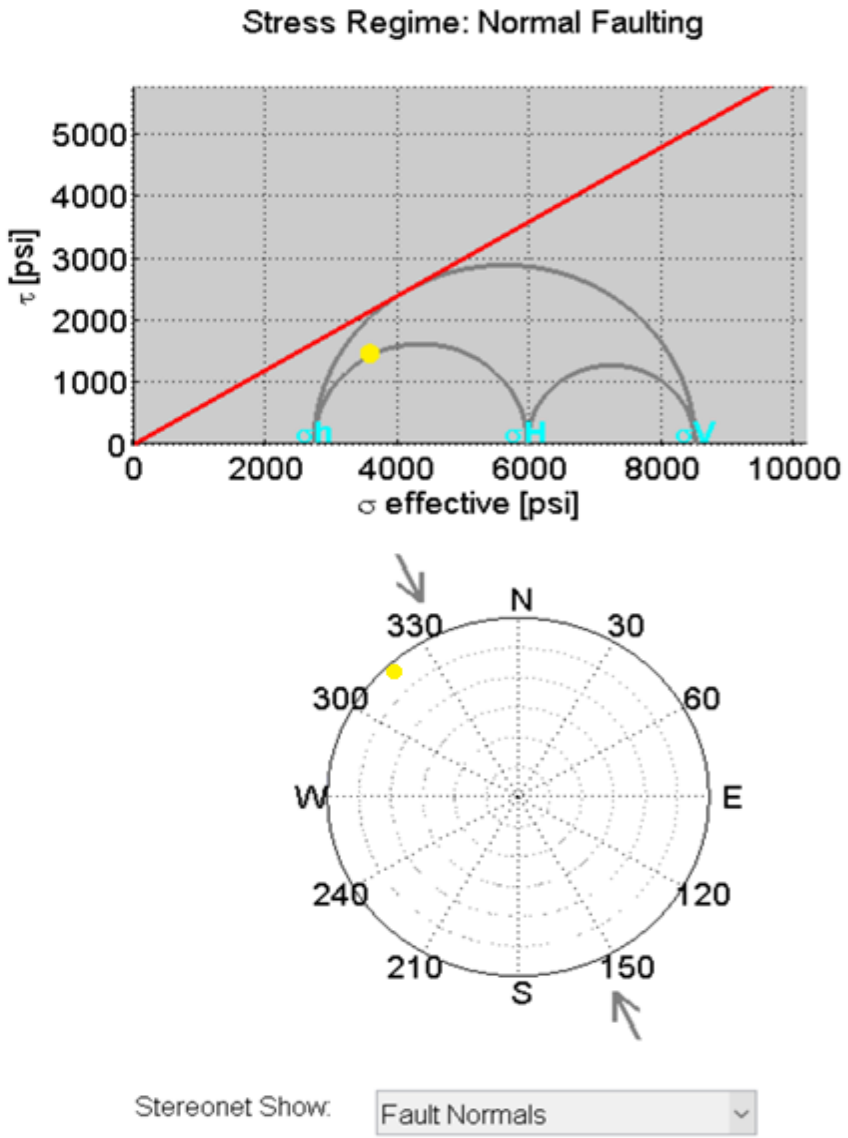
	X [East km]	Y [North km]	Strike [Deg]	Dip [Deg]	Length [km]
1	1.1600	0	5	85	2

Fault Slip Analysis for Rita SWD #1: Geomechanics

Key Points

- Stress Regime below tangent line in Mohr Circle
- Assume average injection of 25,000 bbl/d over 25 straight years



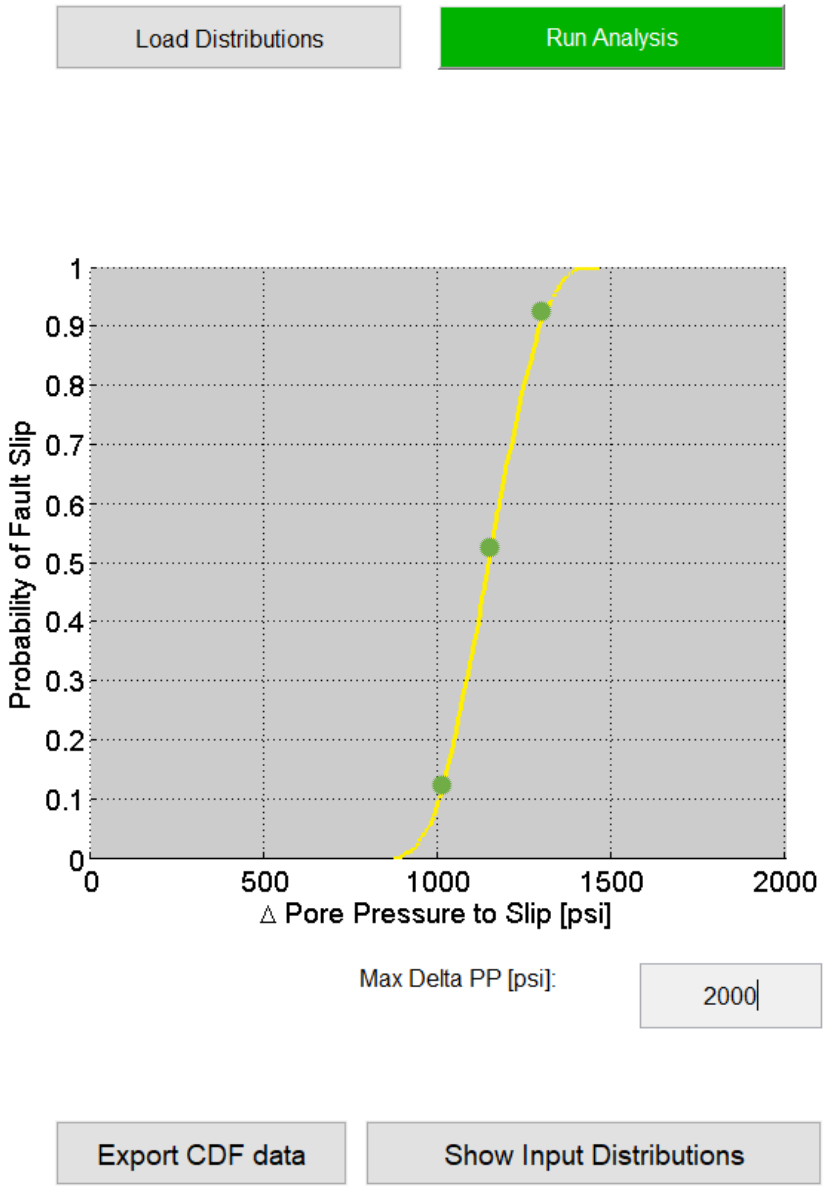


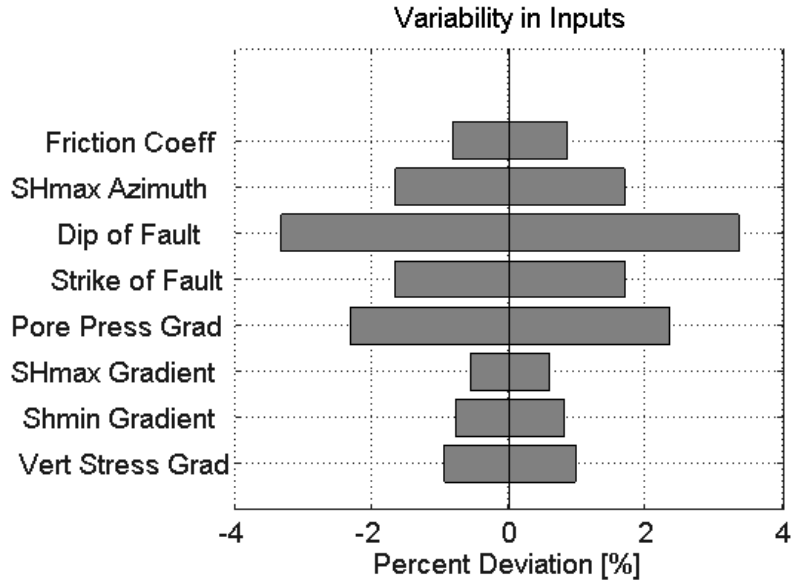
Fault Slip Analysis for Rita SWD #1: Geomechanics Probability

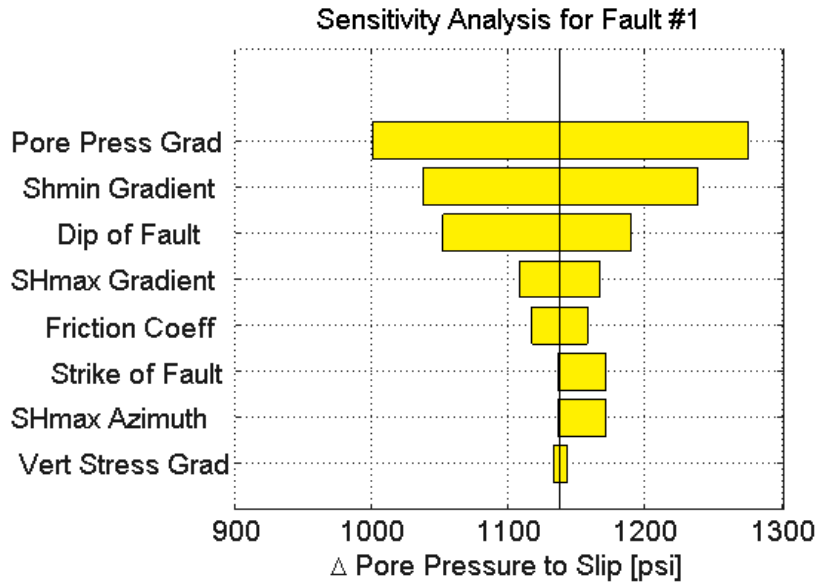
Key Points

- Monte Carlo Simulation

o P10 @ 943 psi – 0.54 psi/foot
o P50 @ 1137 psi – 0.55 psi/foot
o P90 @ 1340 psi – 0.56 psi/foot



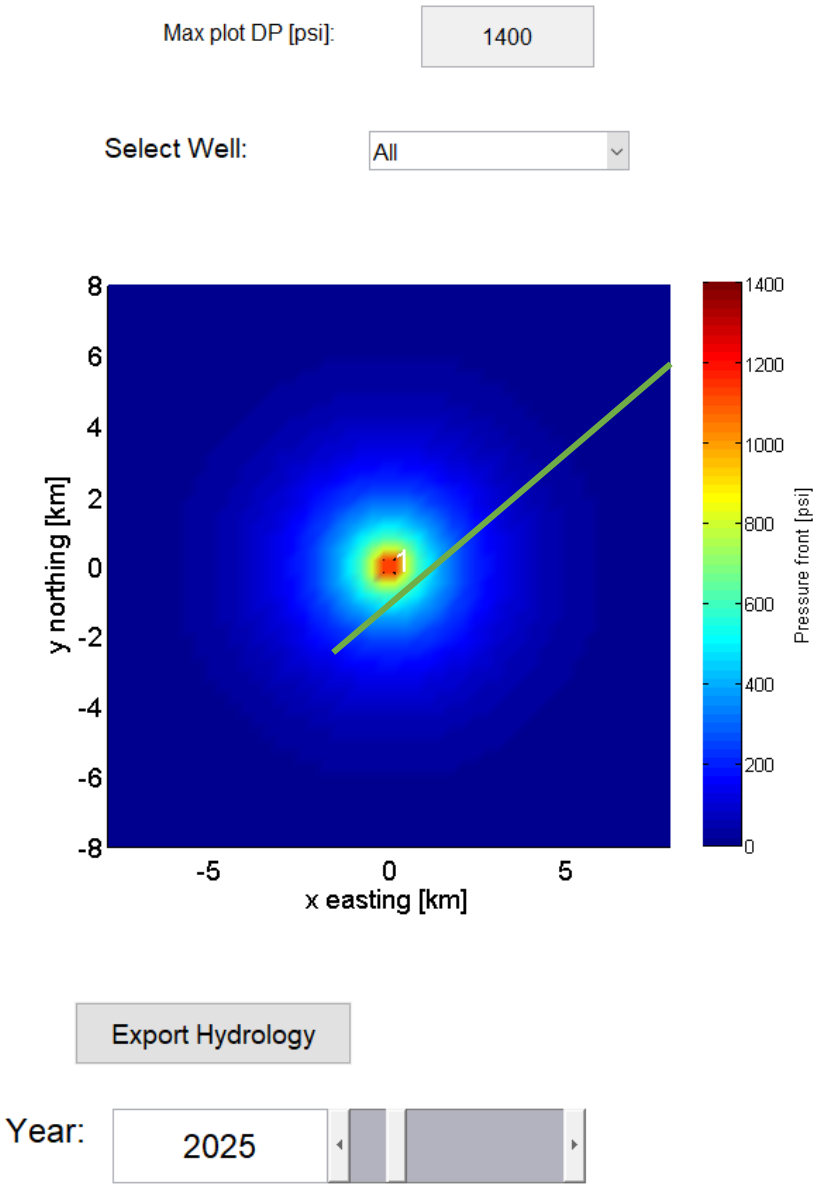


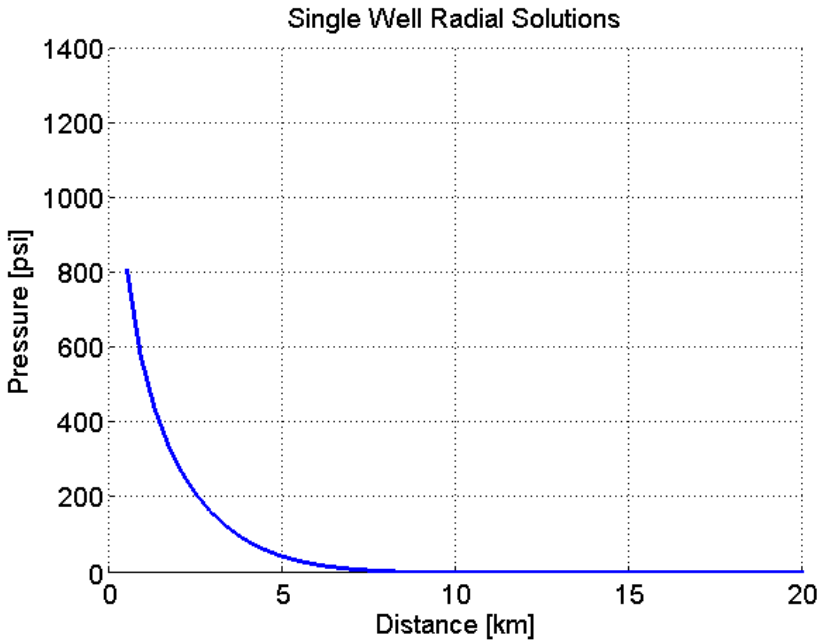


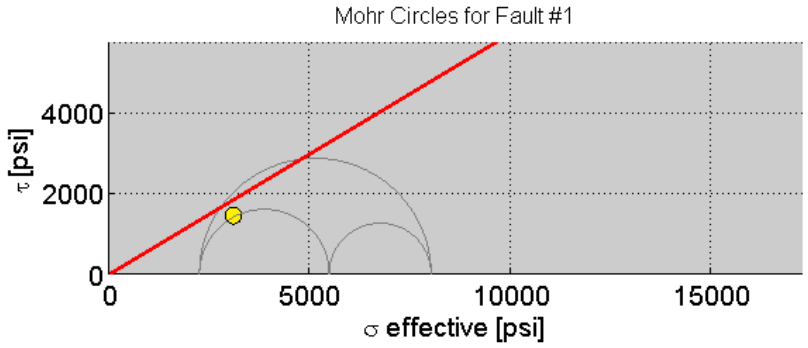
Fault Slip Analysis for Rita SWD #1: Hydrology @ 5 year

Key Points

- 25,000 bbl/d rate
- Pressure at 1.16 km at major fault lines
- Assumes radial flow regime and pressure above pore pressure at ~400 psi
- **ΔP at 5 year is ~400 psi vs:**
  - P10 @ 943 psi – 0.54 psi/foot
  - P50 @ 1137 psi – 0.55 psi/foot
  - P90 @ 1340 psi – 0.56 psi/foot



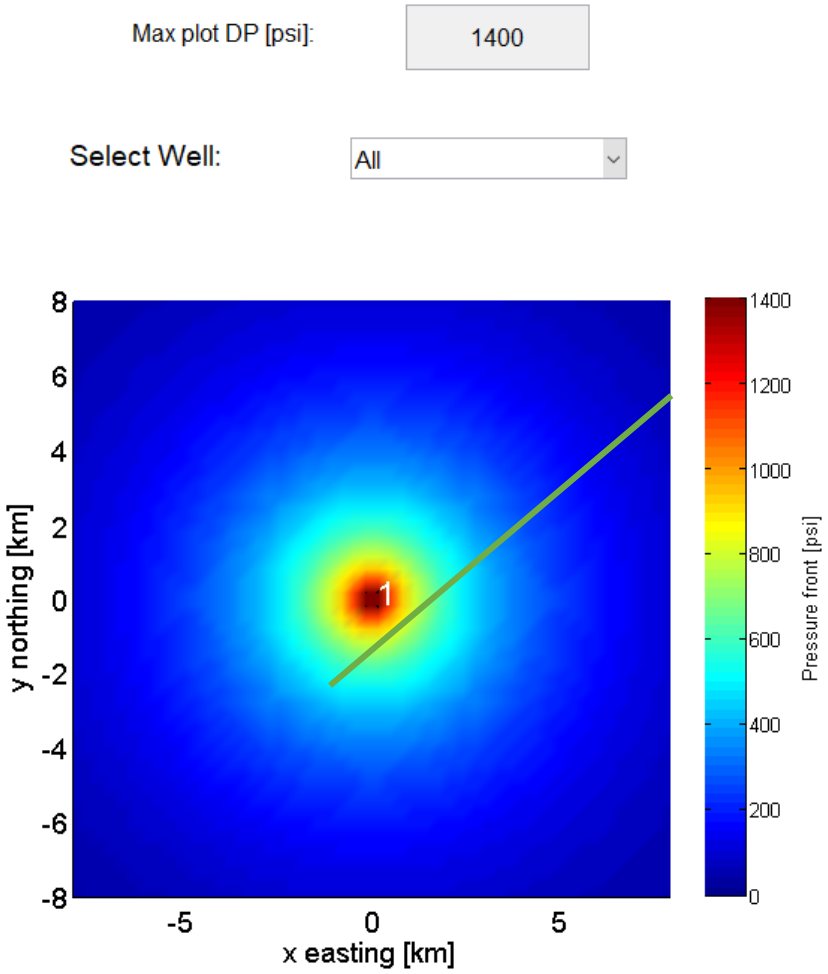


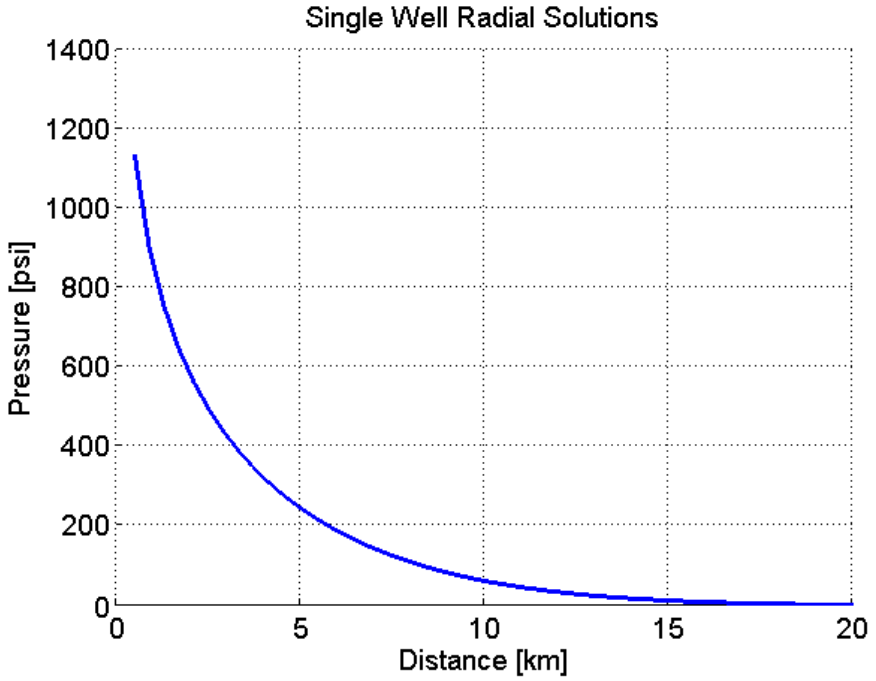


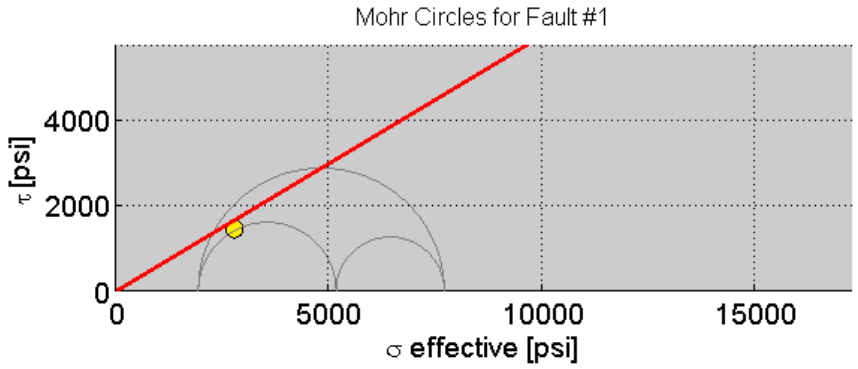
Fault Slip Analysis for Rita SWD #1: Hydrology @ 25 year

Key Points

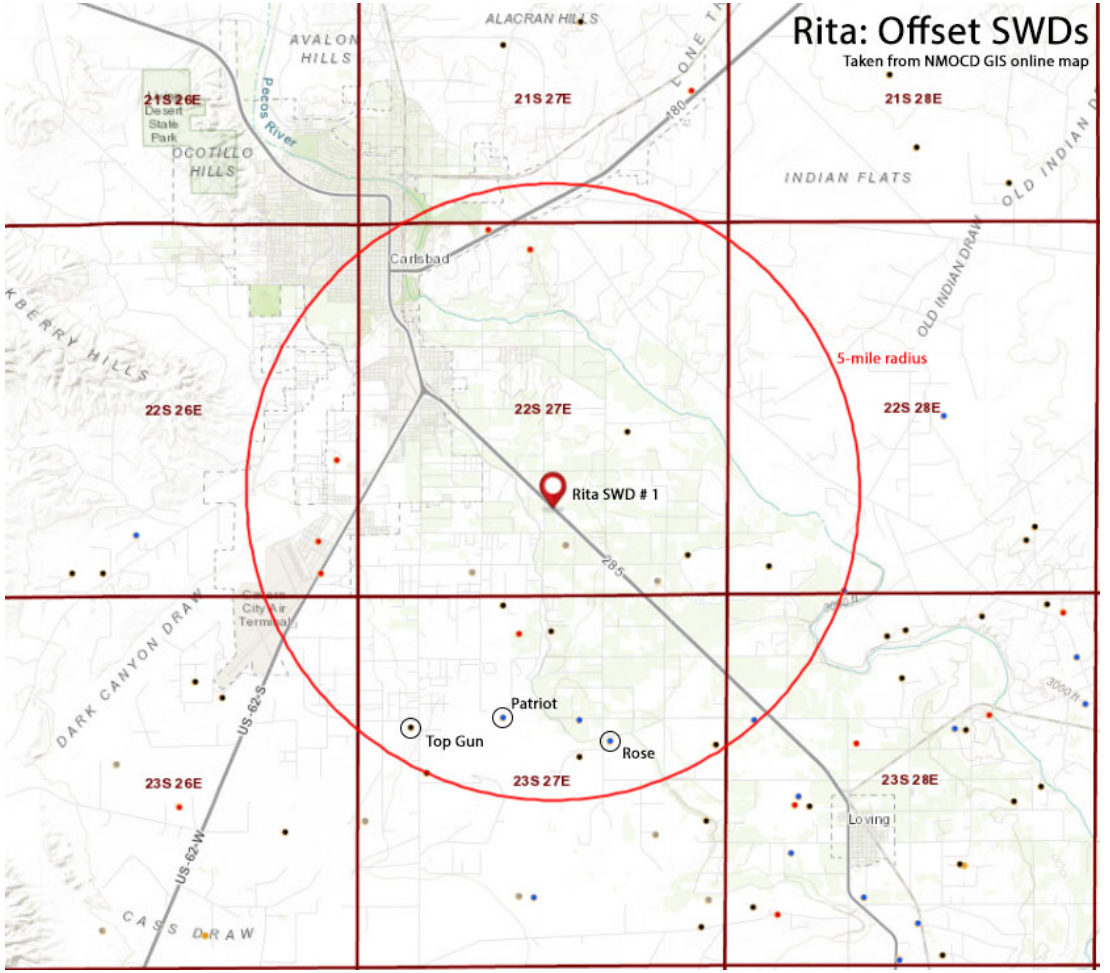
- 25,000 bbl/d rate
- Pressure at 1.16 km at major fault lines
- Assumes radial flow regime and pressure above pore pressure at ~800 psi
- **ΔP at 25 year is ~800 psi vs:**
  - P10 @ 943 psi – 0.54 psi/foot
  - P50 @ 1137 psi – 0.55 psi/foot
  - P90 @ 1340 psi – 0.56 psi/foot







Fault Slip Analysis for Rita SWD #1: Offset well Hydrology @ 25 year



- Offset wells:
  - Patriot SWD #8, 3.8 miles, 25,000 bpd
  - Rose SWD #1, 4.2 miles, 30,000 bpd
  - Top Gun Federal SWD #1, 4.5 miles, 20,000 bpd
- Cumulative effect at 25 years, is approximate 158 psi additional pore pressure rise assuming average porosity and permeability between wells, within safety margin of 179 psi for P50 case

Fault Slip Analysis for Rita SWD #1: Simulation

Key Points

- 25,000 bbl/d rate for 25 years
- Pressure at 1.16 km (3800 ft) at major fault line
- Assumes radial flow regime
- Close to zero chance of fault slip event in first 20 years
- Very low probability of fault slip during years 20 to 25 which ranges 2 – 3 %

o P10 @ 943 psi – 0.54 psi/foot
o P50 @ 1137 psi – 0.55 psi/foot
o P90 @ 1340 psi – 0.56 psi/foot