SURFACE GEOLOGIC MAPPING, SEISMIC, AND WELL DATA RESOLVE COMPLEX FAULTING AT TEAPOT DOME FIELD, NATRONA CO., WYOMING

Mark Milliken and Brian Black

Rocky Mountain Oilfield Testing Center

Casper, Wyoming

2006 WGA FIELD CONFERENCE

September 18, 2006

Organization

- Introduction
- Purpose and goals of study
- Past work
- Stratigraphy and seismic character
- Surface mapping
- Subsurface mapping and fault interpretation
- Production potential
- Further research opportunities

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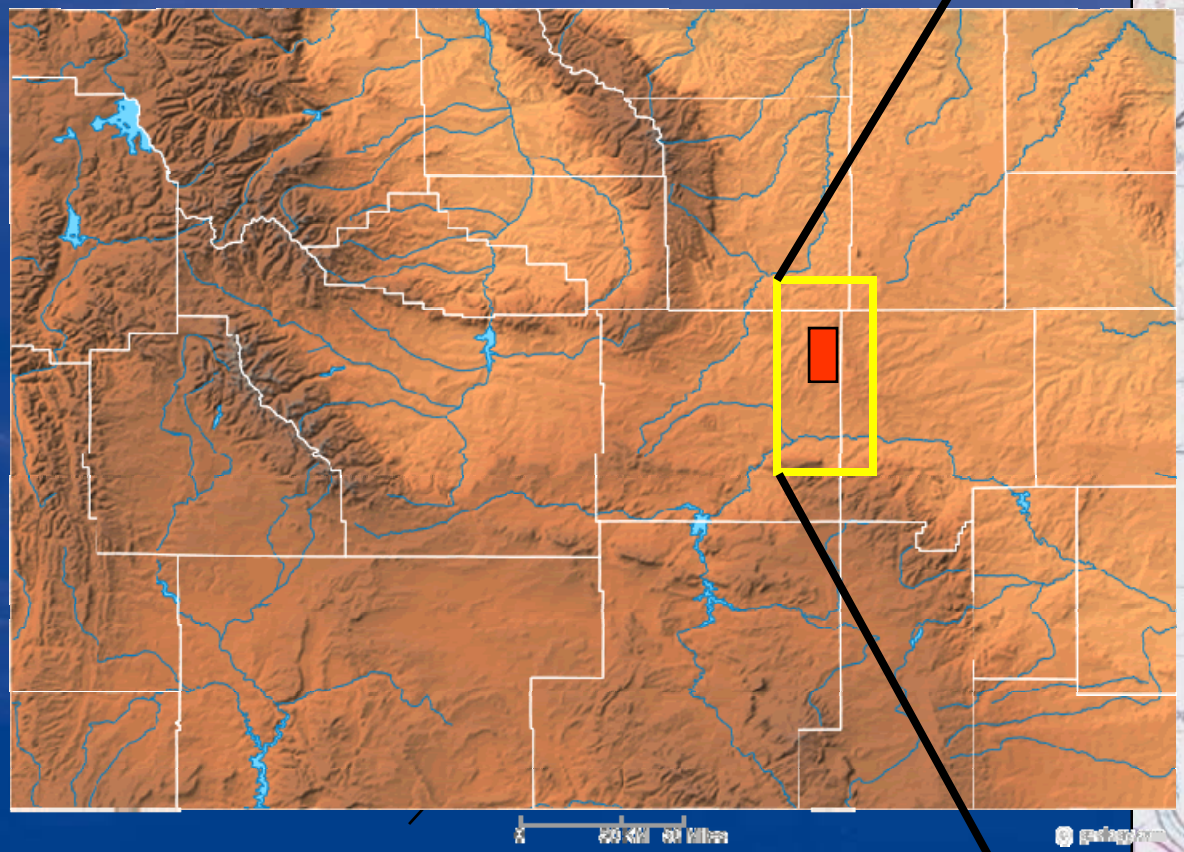
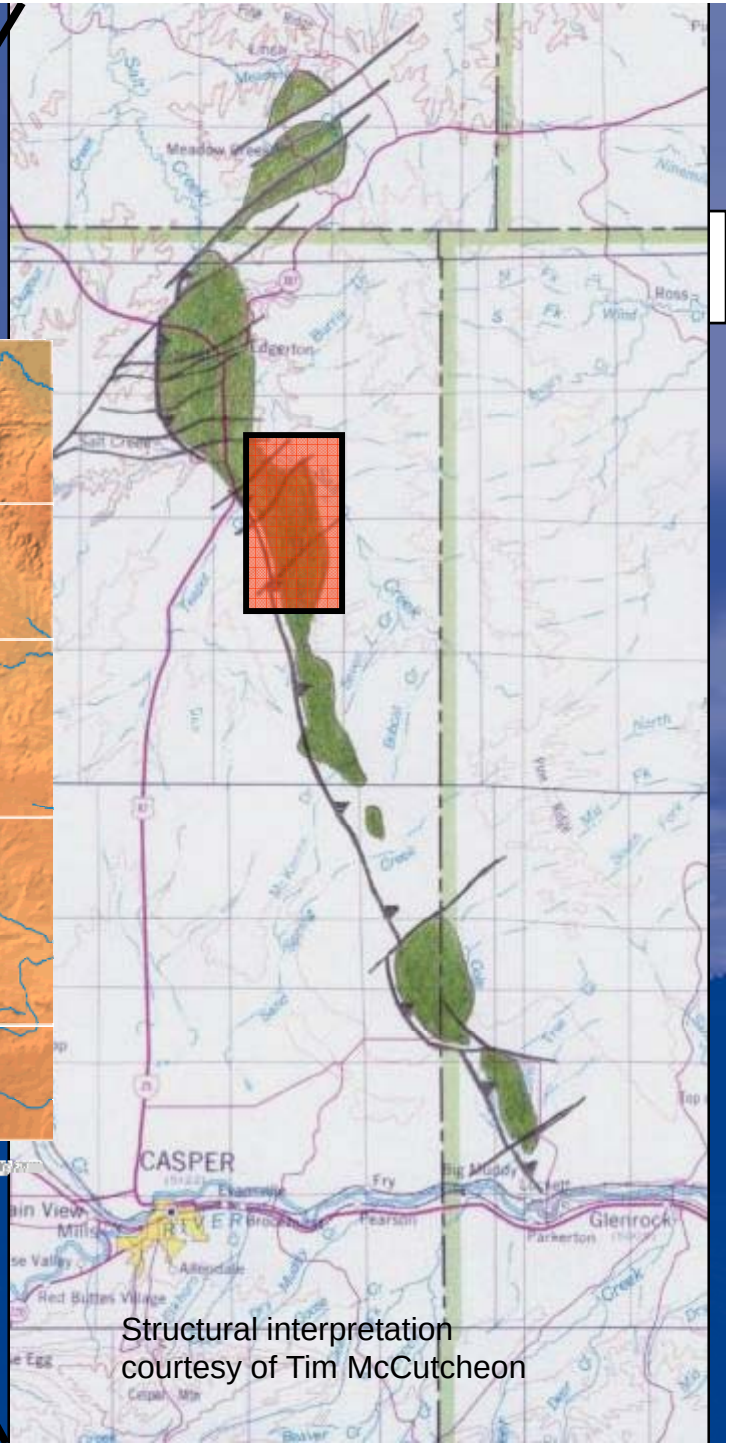
NPR-3 Location





Structural interpretation courtesy of Tim McCutcheon

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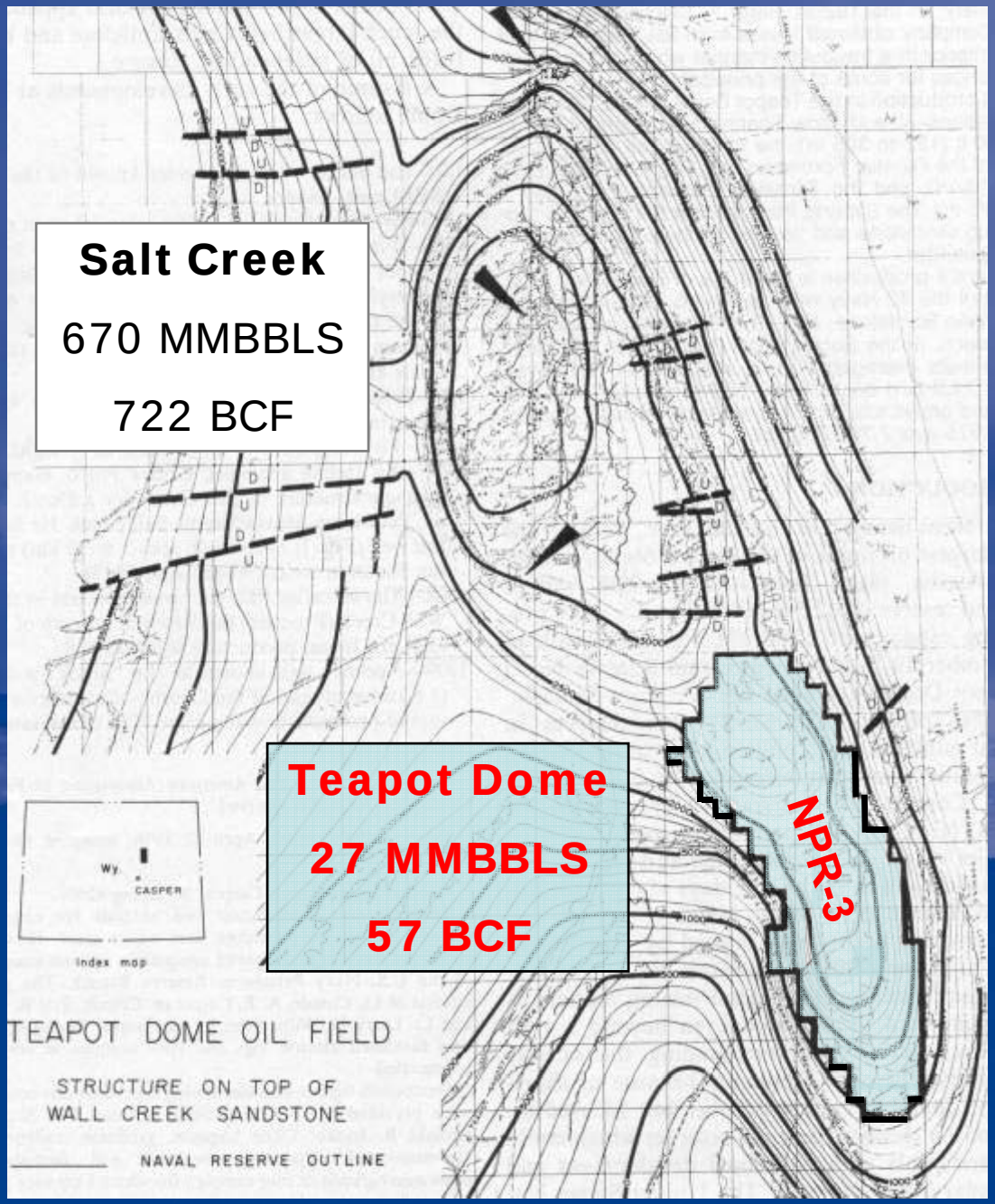
Cumulative Production



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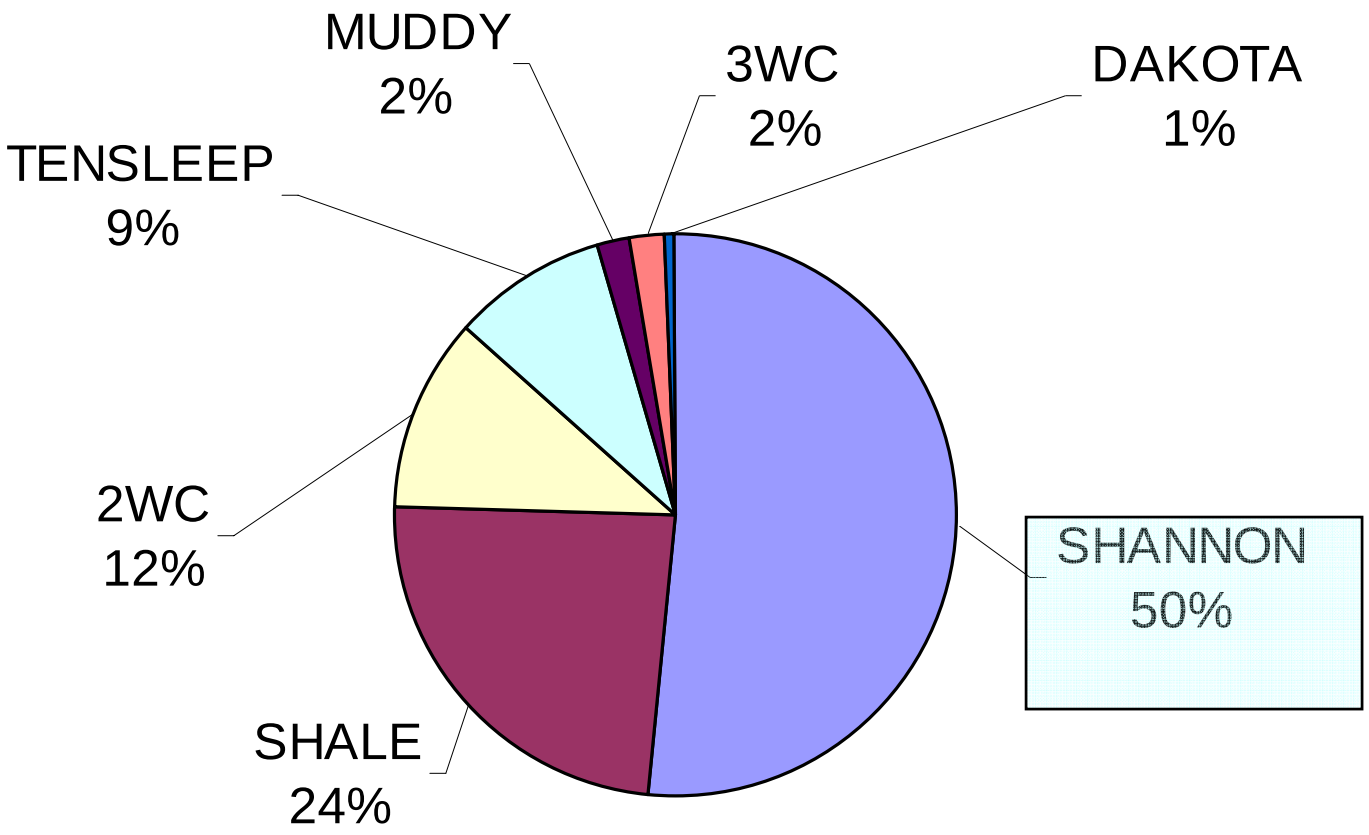
NPR3 PRODUCTION



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Purpose and Goals of Study

- Tie surface geology to subsurface using old fashioned field work and cutting edge workstation technology.
- Determine individual fault block geometries and fault sealing character.
- Identify new primary potential production from undrained fracture systems and fault blocks.

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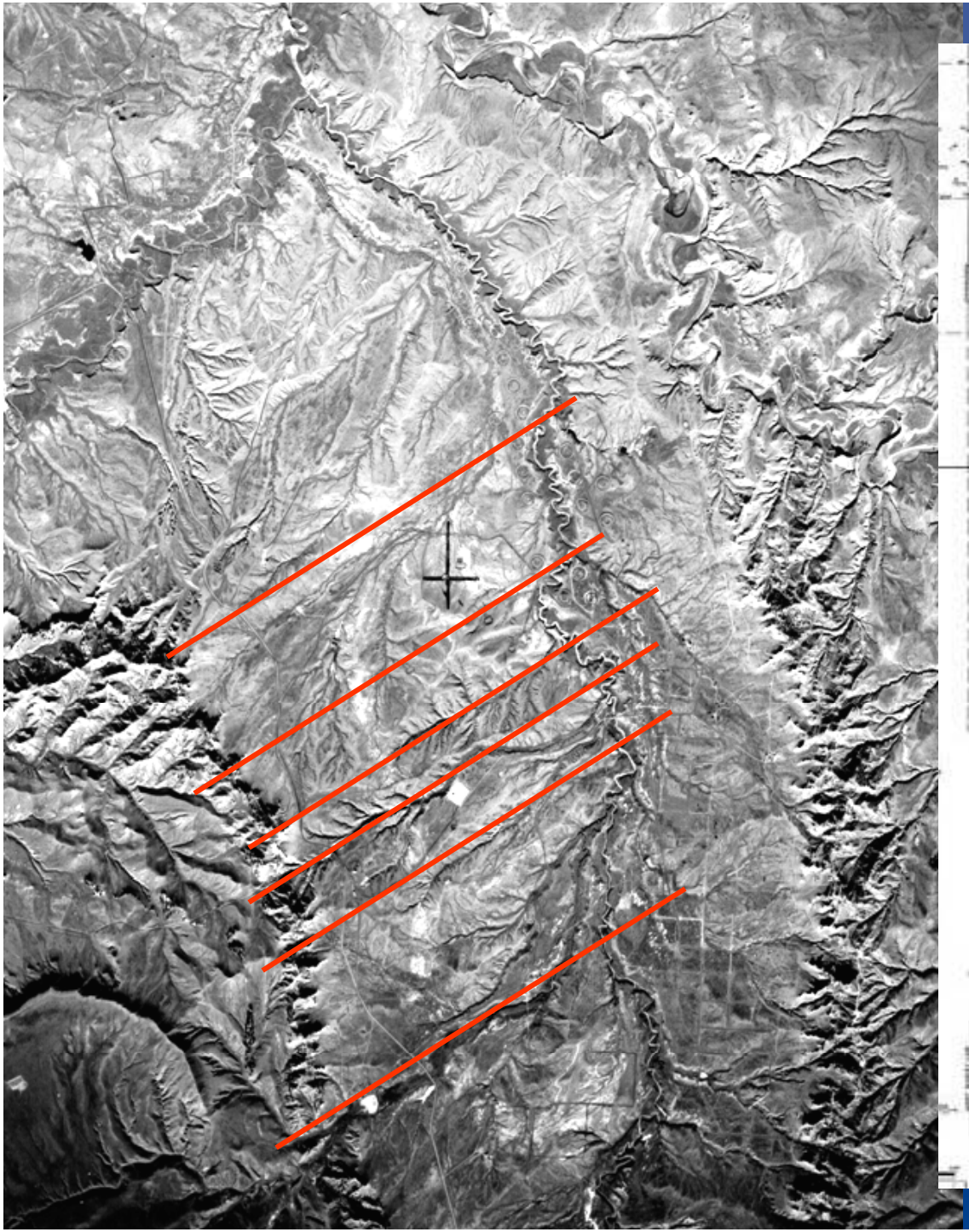

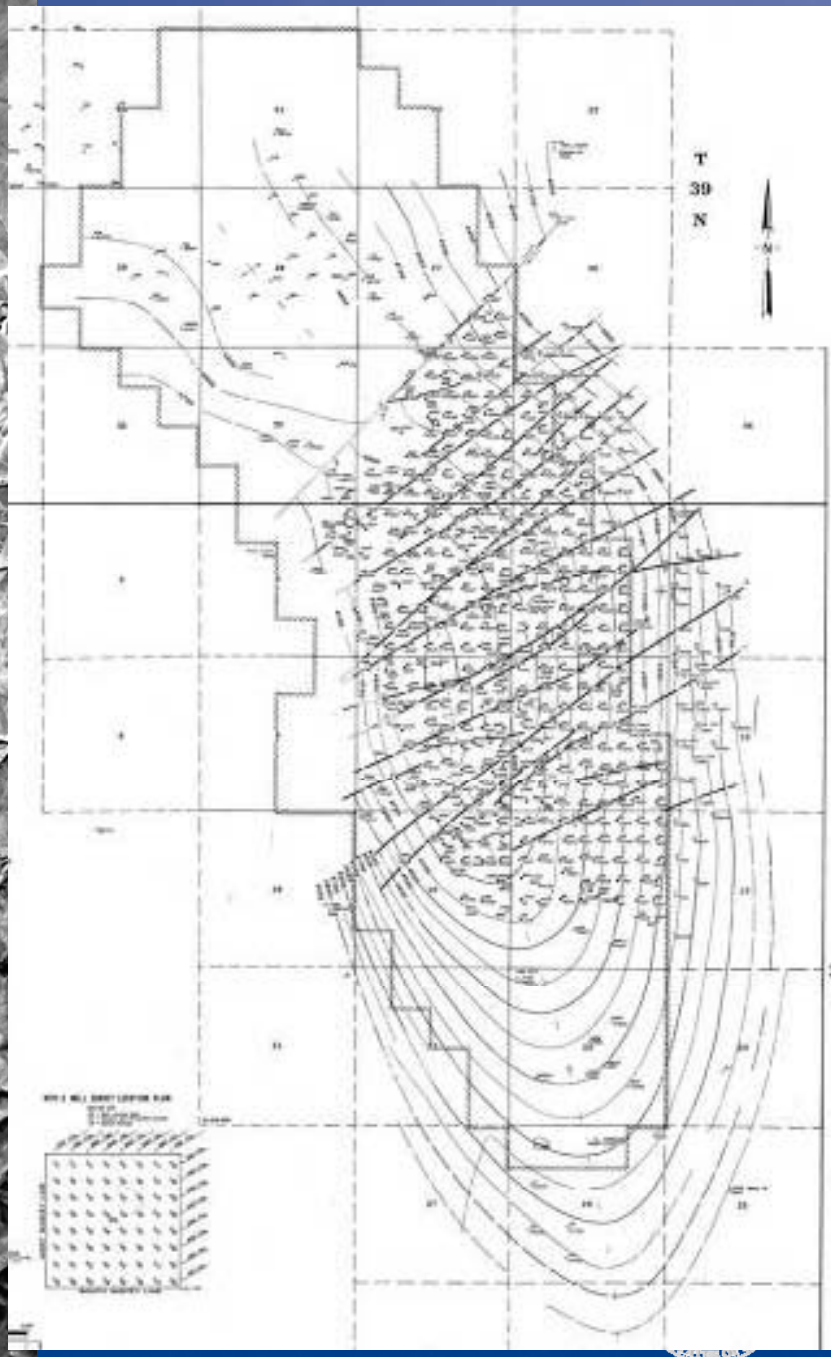
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39
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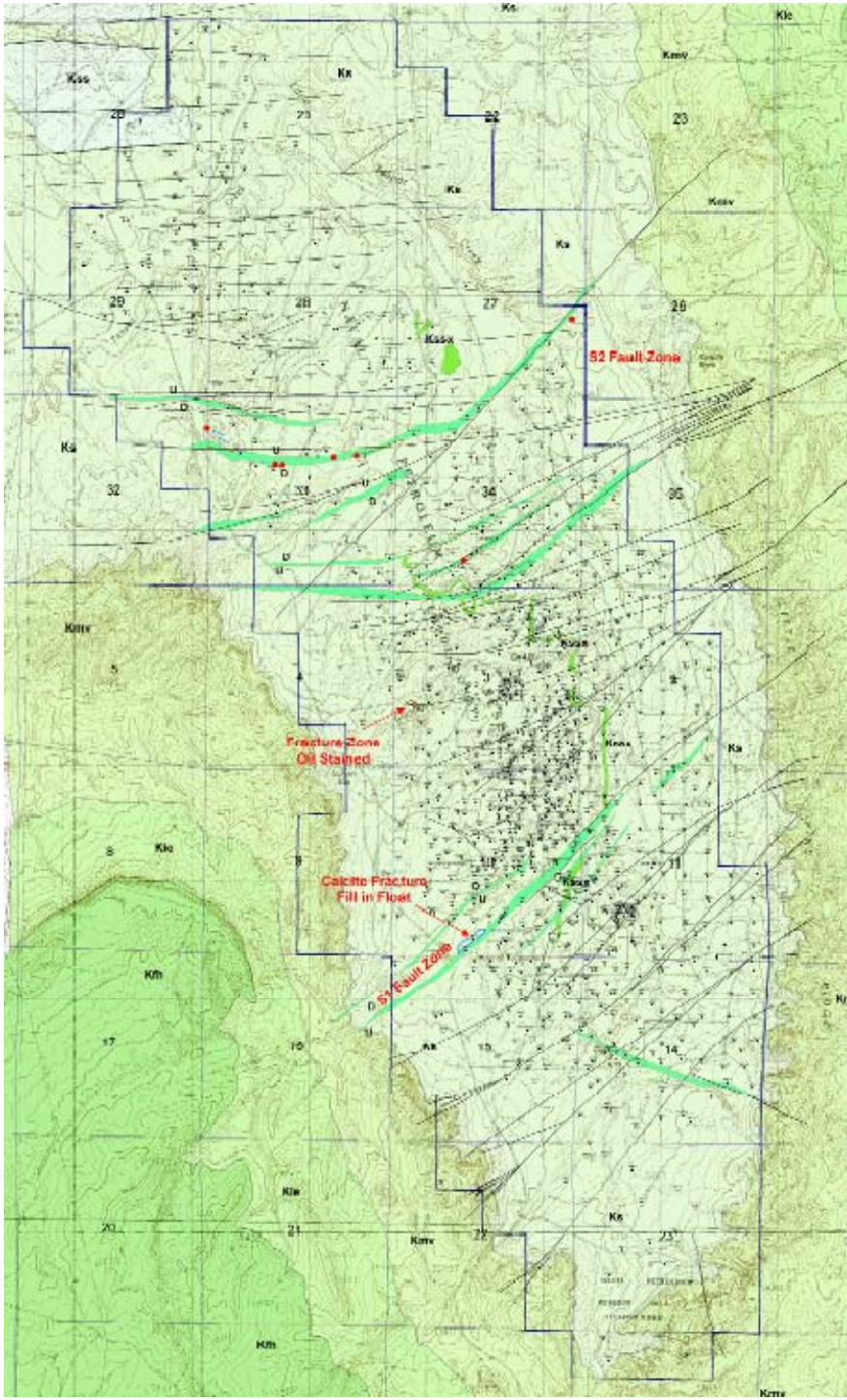

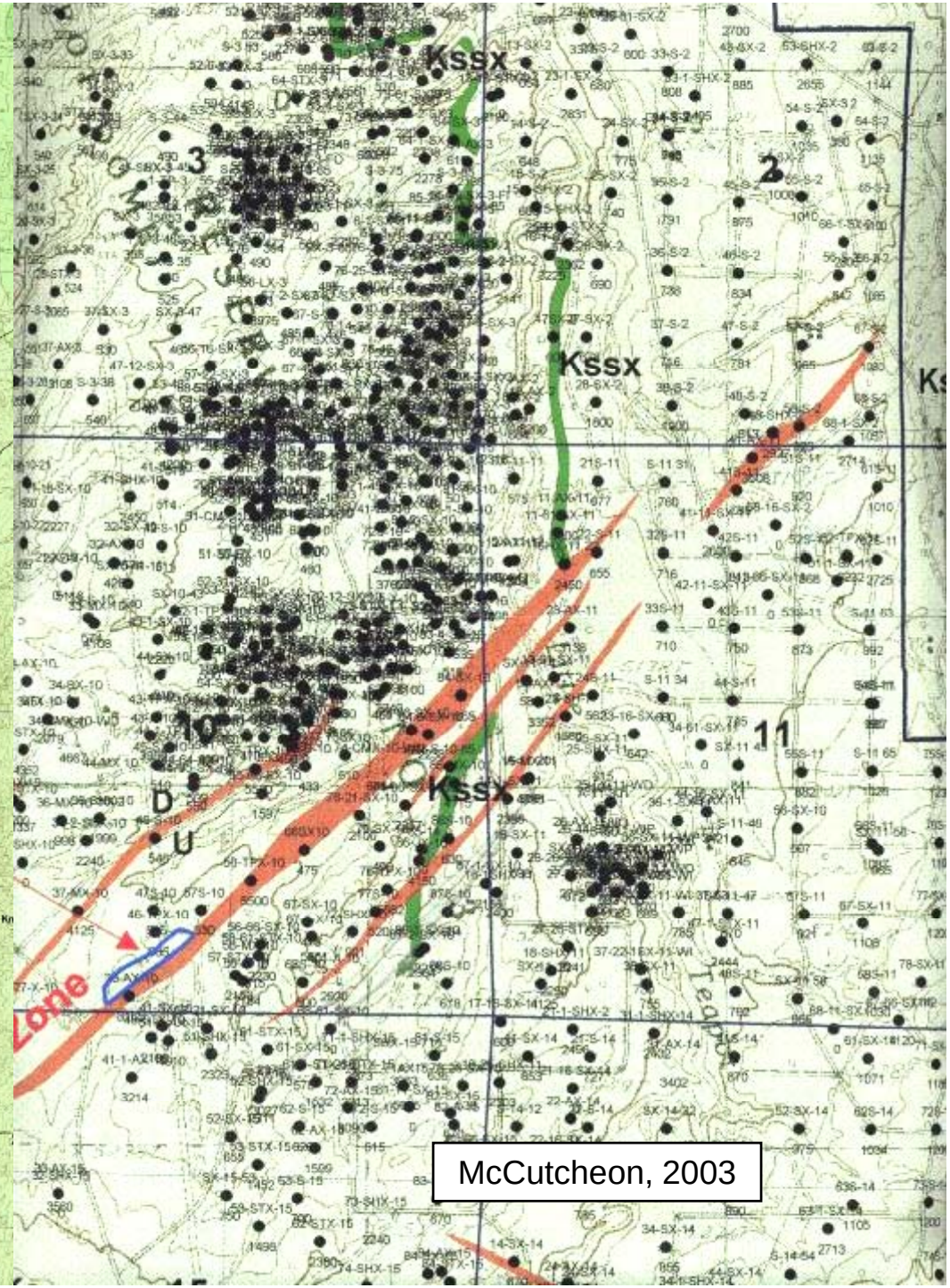

McCutcheon, 2003

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Teapot Dome Geologic Column

Natrona County, Wyoming
T 38 & 39 N R 78 W

Period	Formation		Lithology	Thickness	Depth	Productive
Upper Cretaceous	Steele			195		
		Sussex		30		□
				290	225	
		Shannon		120	515	■
				1355	635	◙
	Niobrara Shale			450	1990	◙
	Carlisle Shale			240	2440	□
	Frontier	1st Wall Creek		160	2680	□
				245	2840	
		2nd Wall Creek		65	3085	■
				175	3150	
		3rd Wall Creek		5	3325	◙
				265	3330	
Lower Cretaceous	Mowry Shale			230	3595	
	Muddy Sandstone			15	3825	◙
	Thermopolis Shale			135	3840	
	Dakota			85	3975	◙
	Lakota			10	4060	◙
Jurassic	Morrison			270	4070	□
	Sundance	Upper		95	4340	
		Lower		150	4435	□
Triassic	Chugwater Group	Crow Mtn		80	4585	
		Alcova LS		20	4665	
		Red Peak		520	4685	□
Permian	Goose Egg			320	5205	□
Pennsylvanian	Tensleep			320	5525	■
	Amsden			160	5845	
Mississippian	Madison			300	6005	
Cambrian through Devonian	Undifferentiated			780	6305	
Pre-Cambrian	Granite				7085	

Rocky Mountain Oilfield Testing Center (RMOTC), Casper Wyoming

Currently productive ■
Productive in past ◙
Potentially productive □

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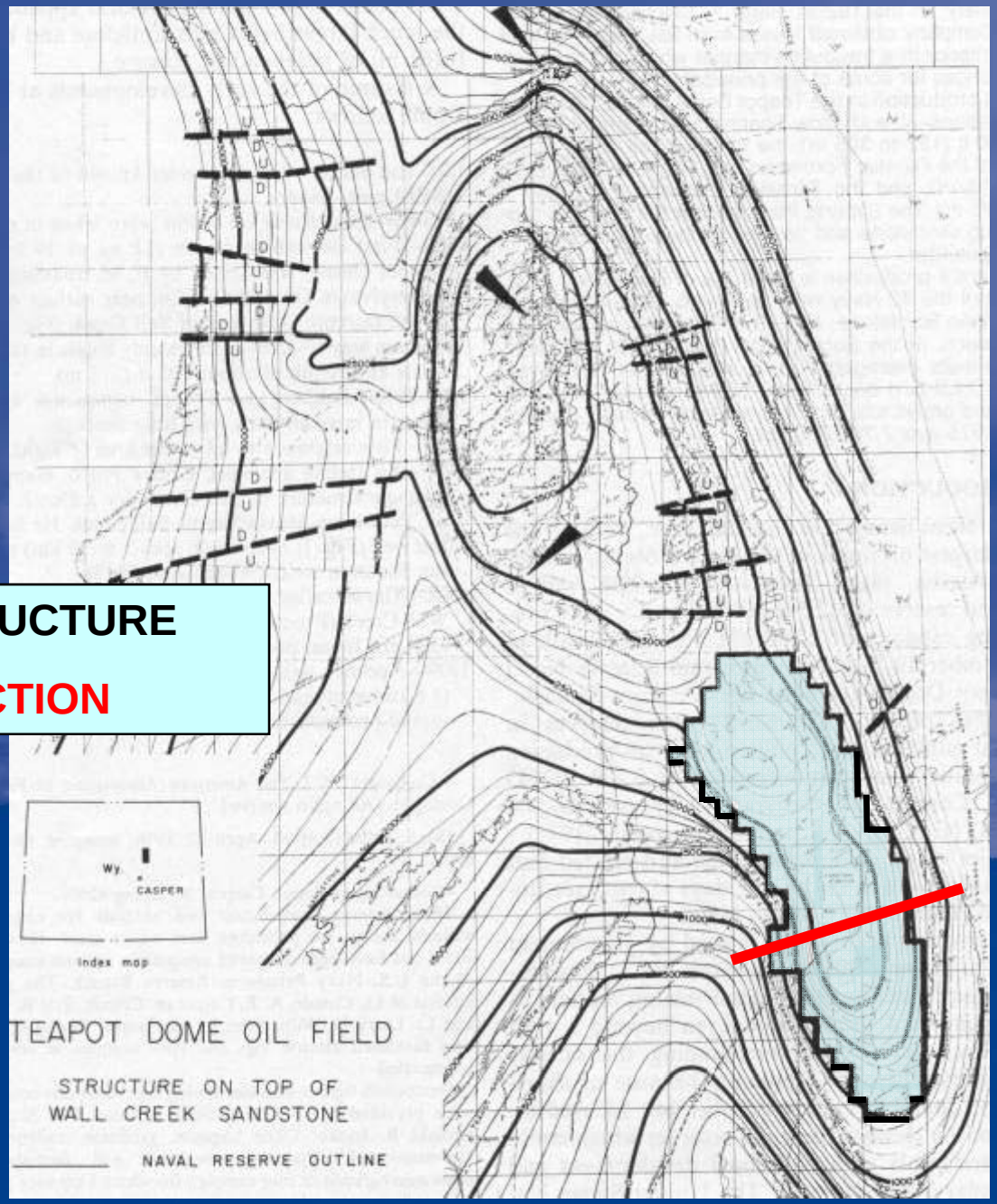
NPR-3 STRUCTURE

DIP SECTION



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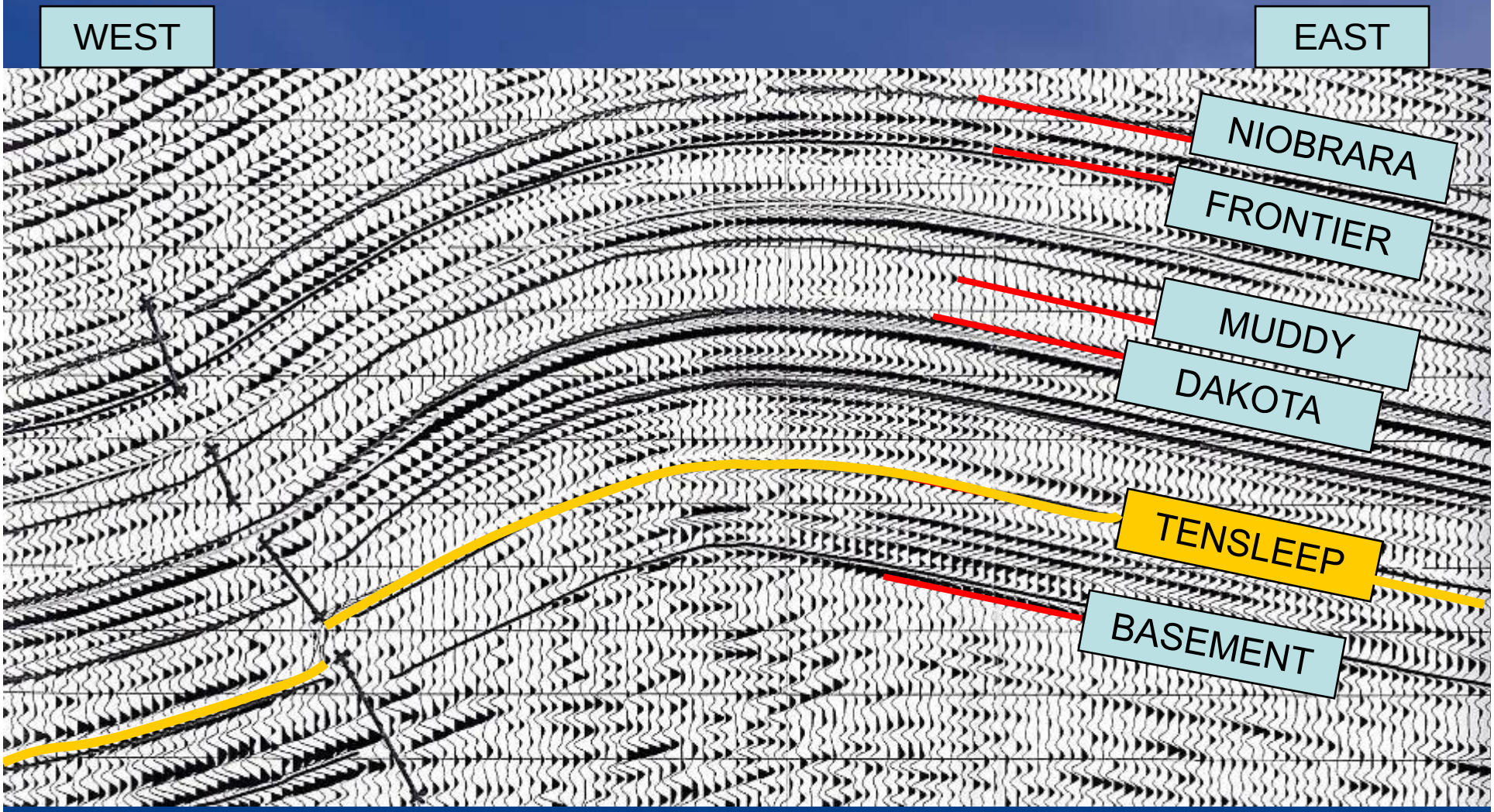
NPR-3 Dip Section



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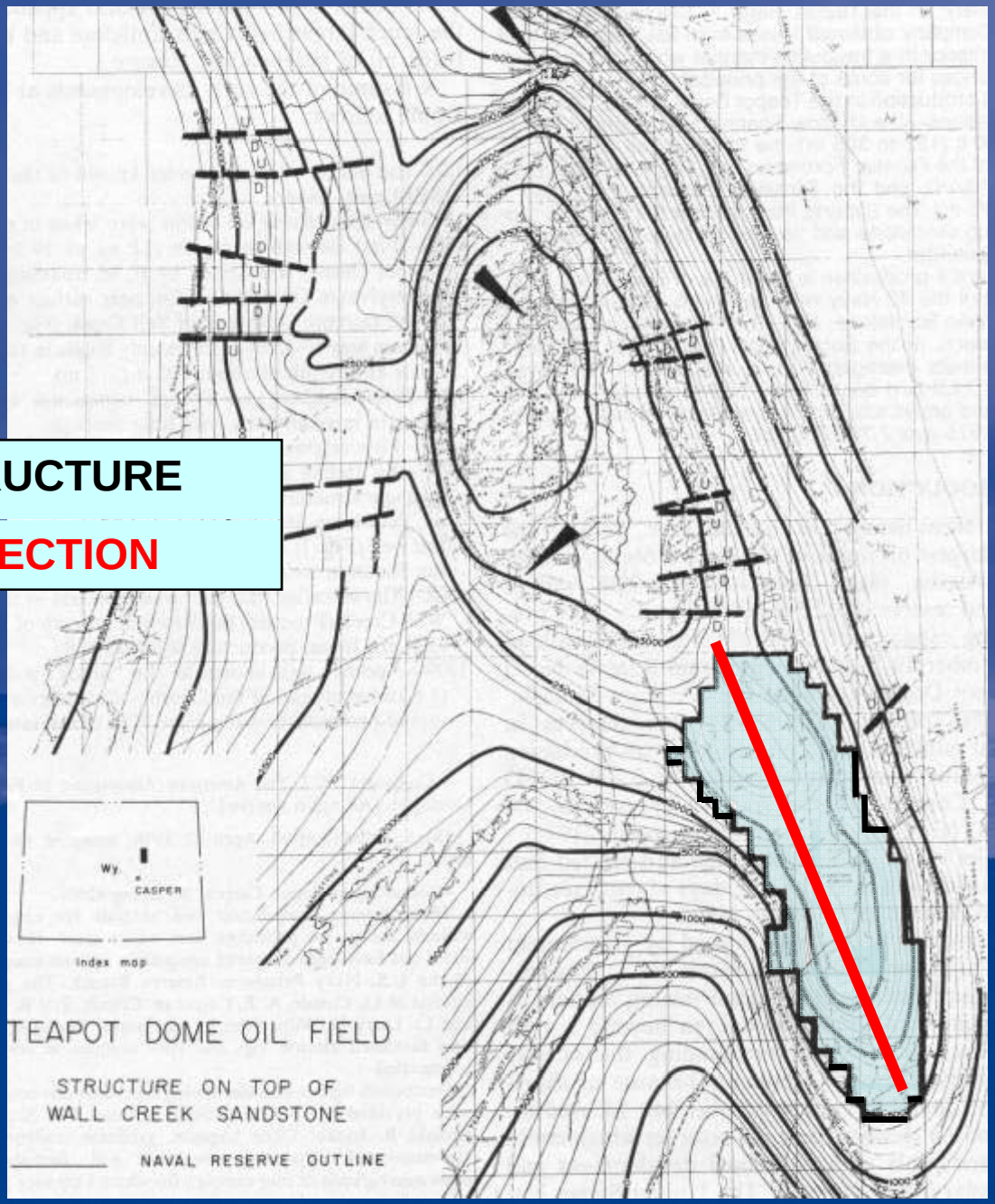
NPR-3 STRUCTURE

STRIKE SECTION



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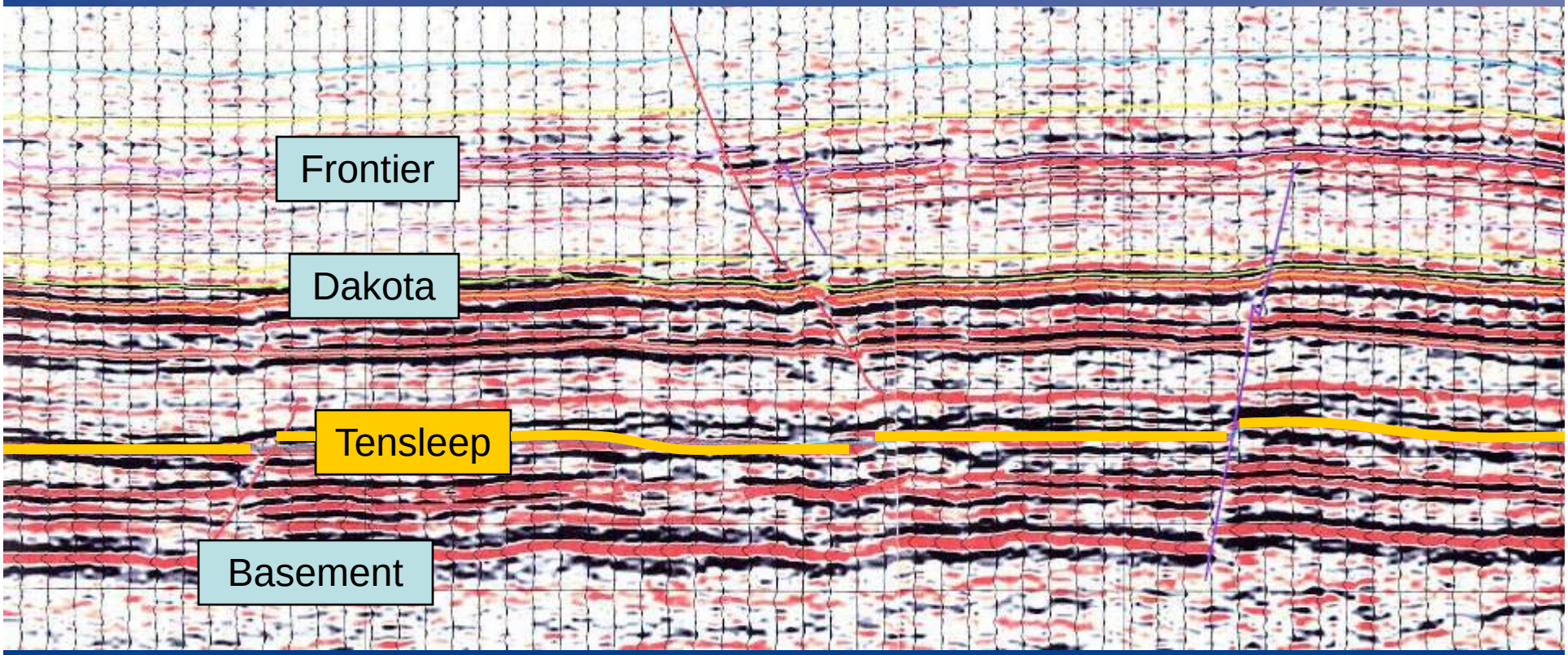
NPR-3 Strike Section



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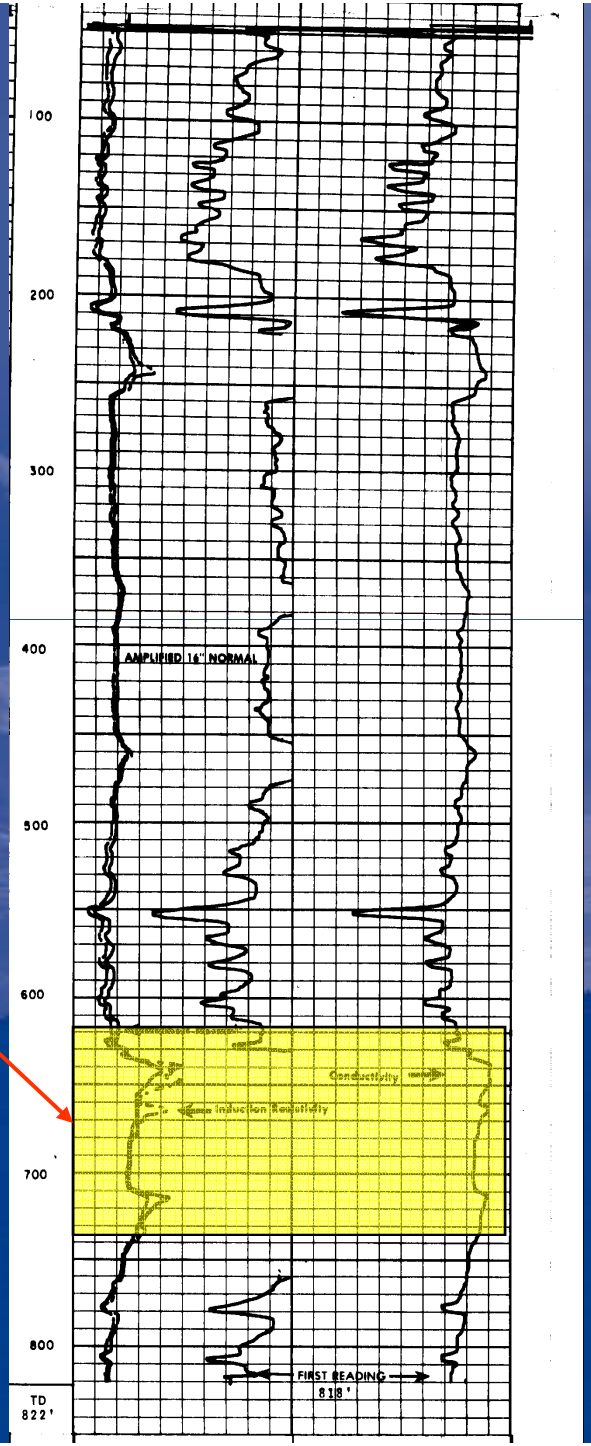
UPPER CRETACEOUS STEELE SHALE FORMATION

Shannon A and B Sandstones



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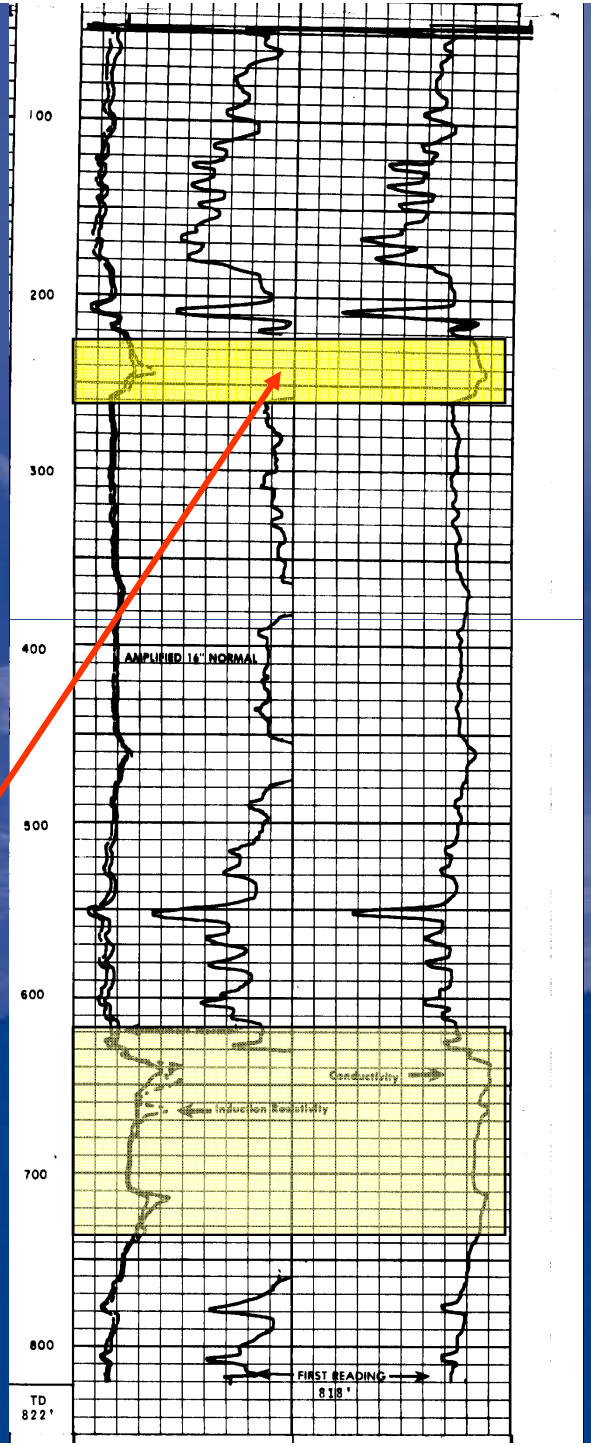
Sussex Sandstone



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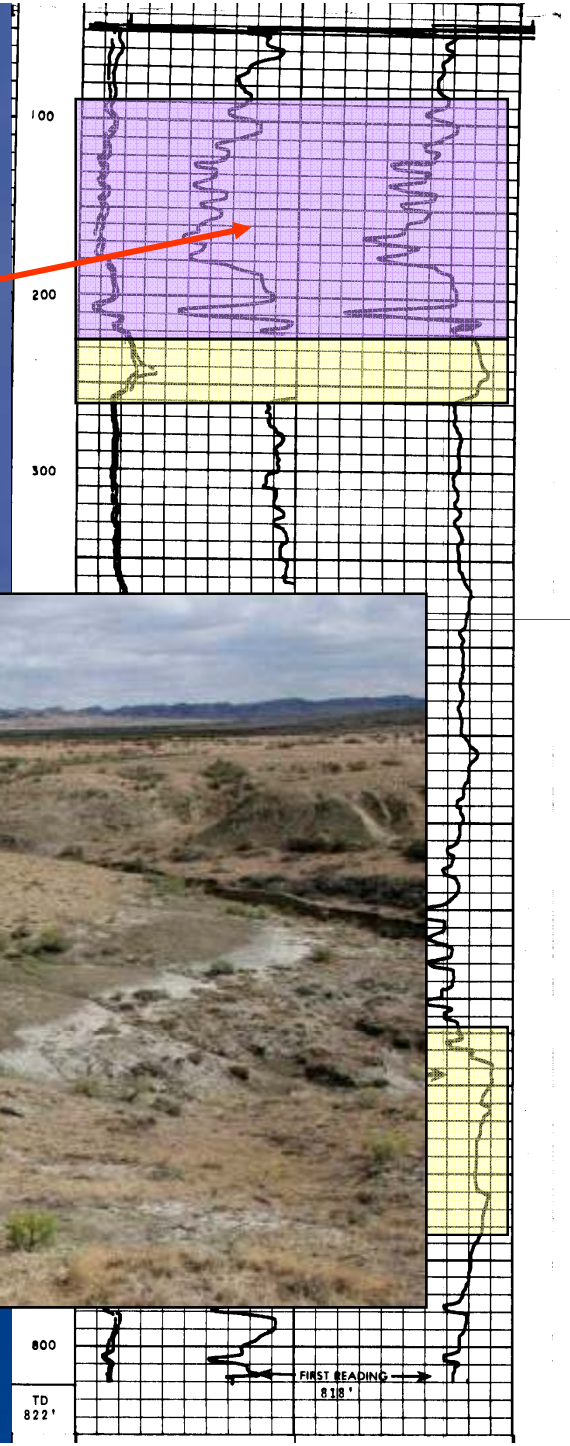
Sussex Bentonites



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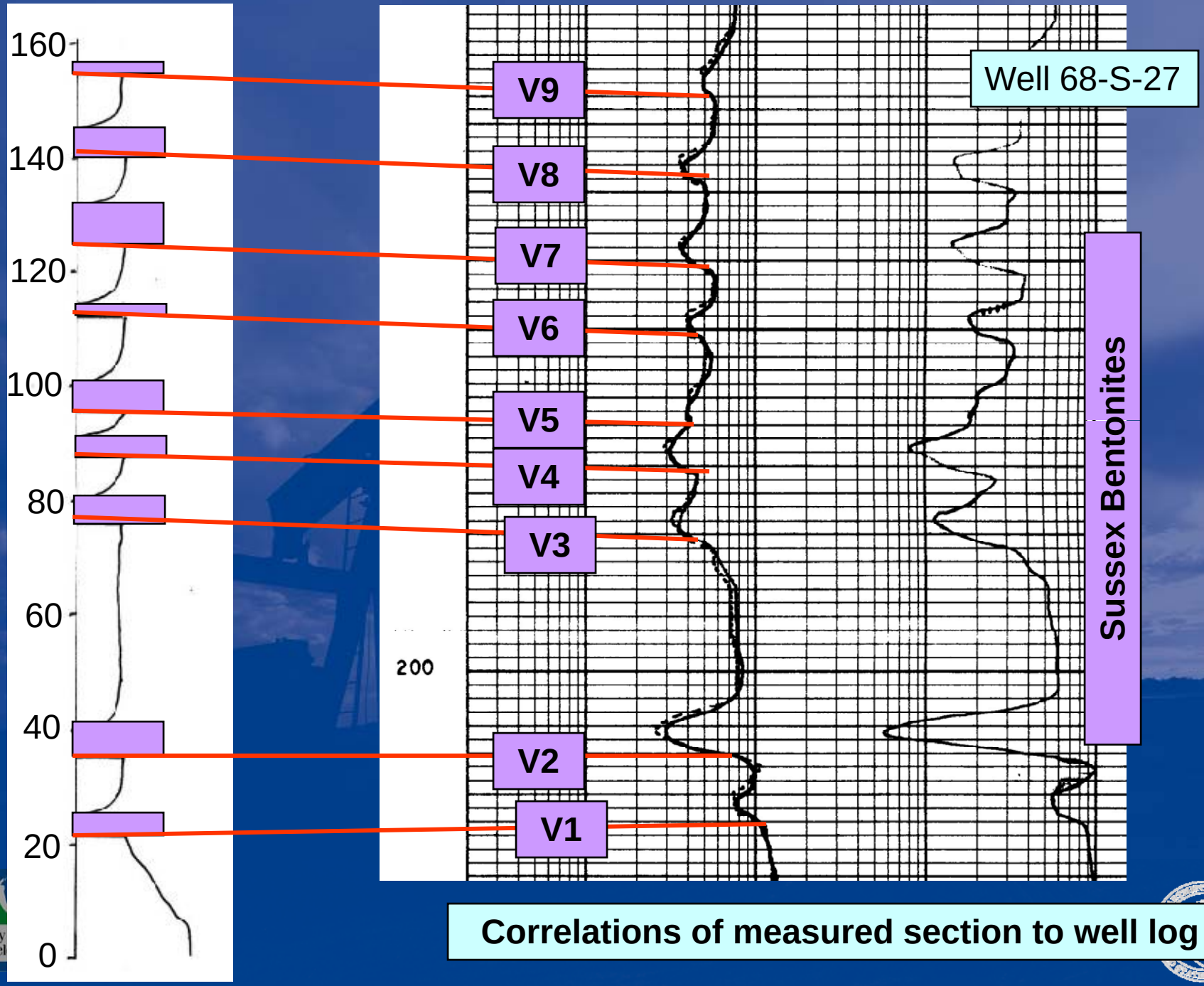
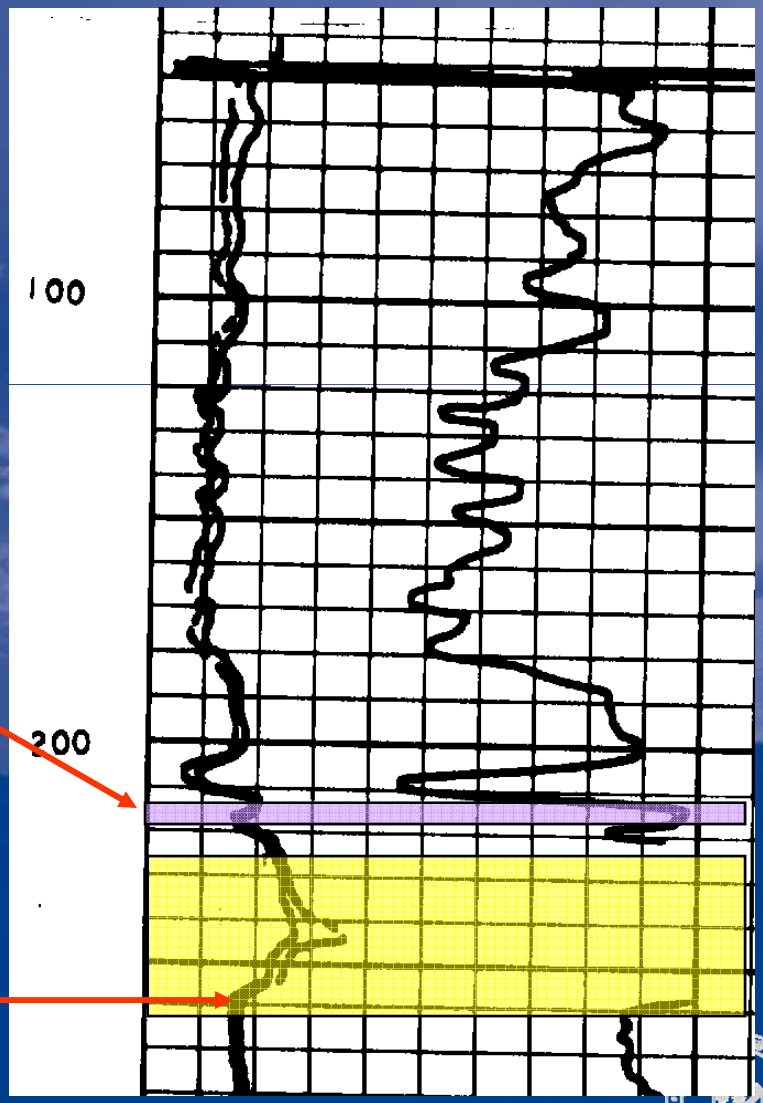


Correlations of measured section to well log

Outcrop Character



Outcrop Character Sussex Bentonites

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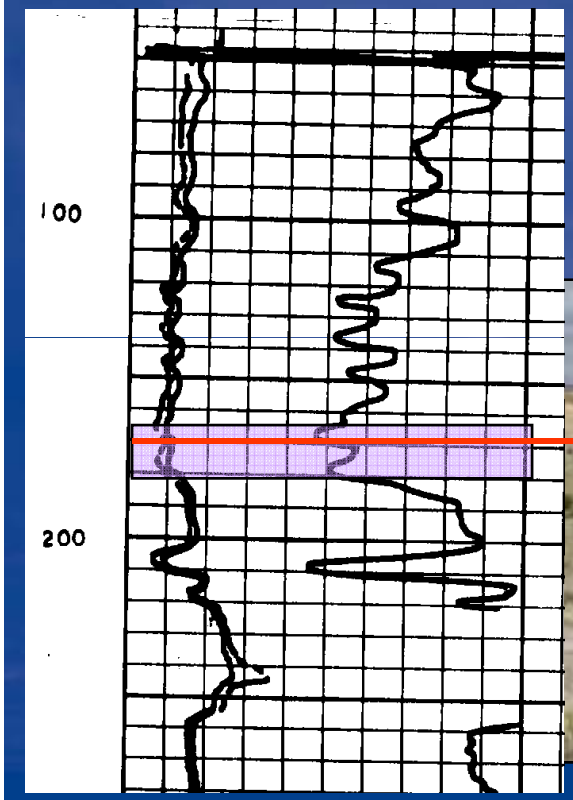
Outcrop Character Sussex Bentonites



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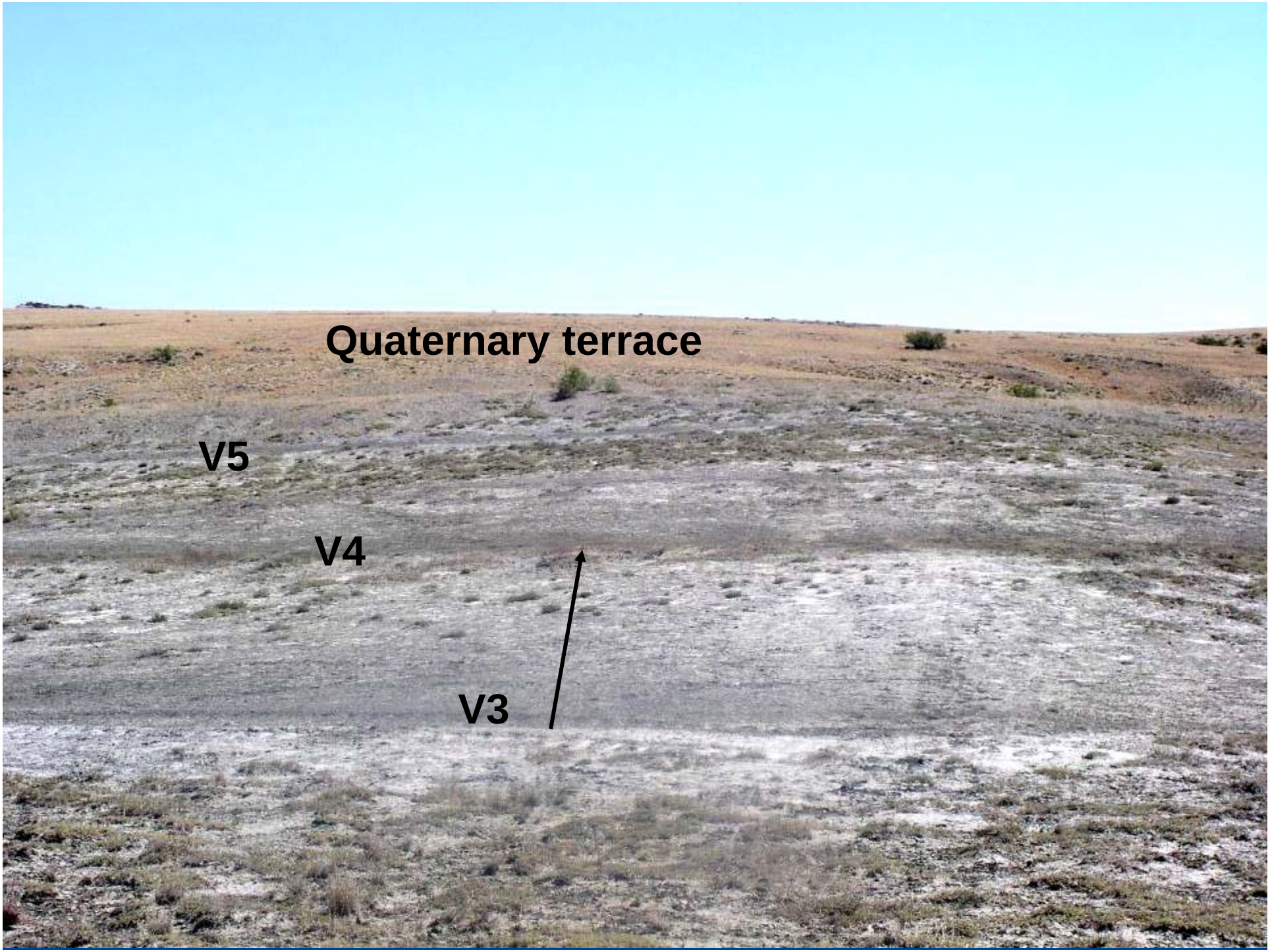
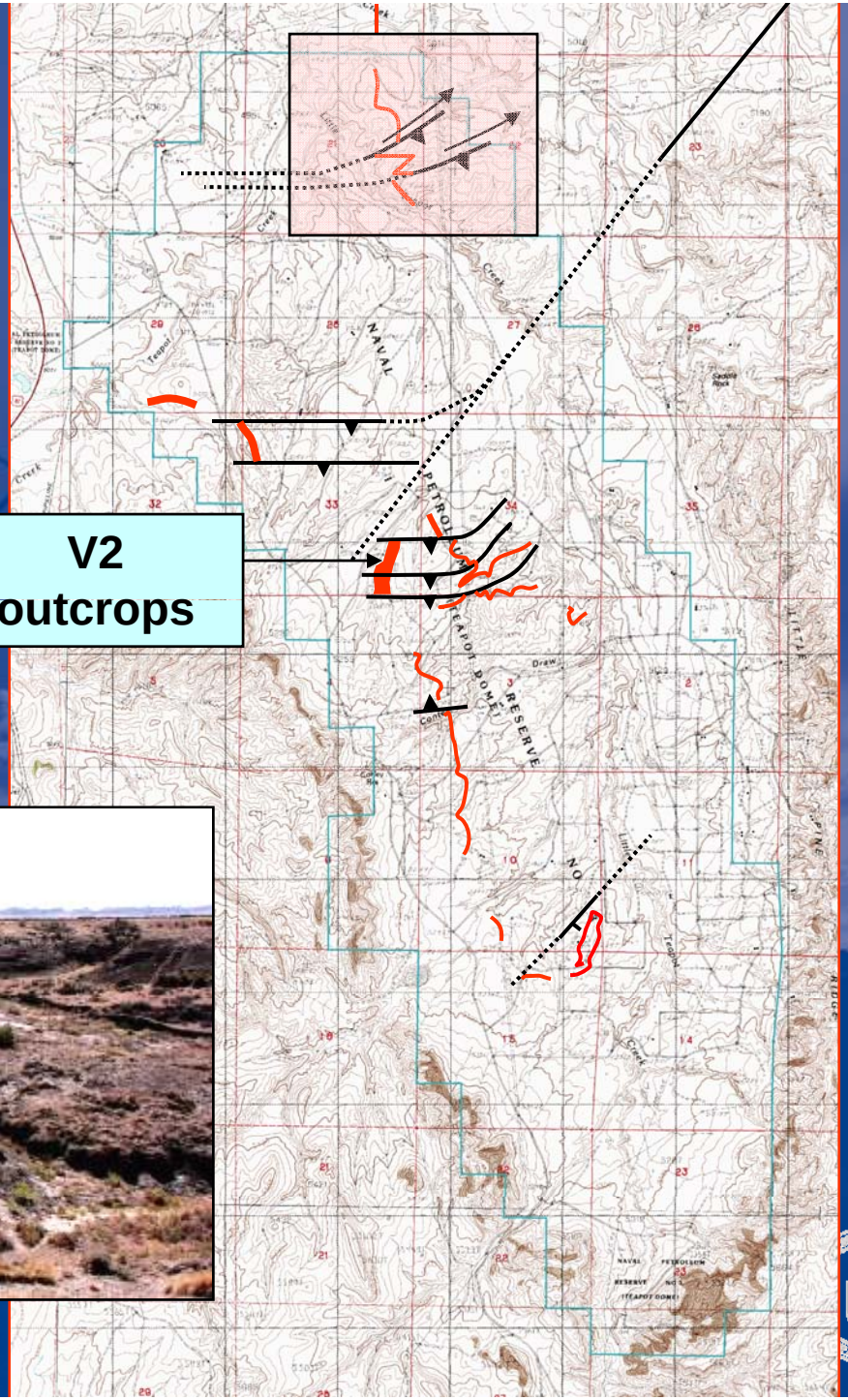

Quaternary terrace
V5
V4
V3

Surface Faulting at NPR-3



V2 outcrops

Sussex V2 Bentonite

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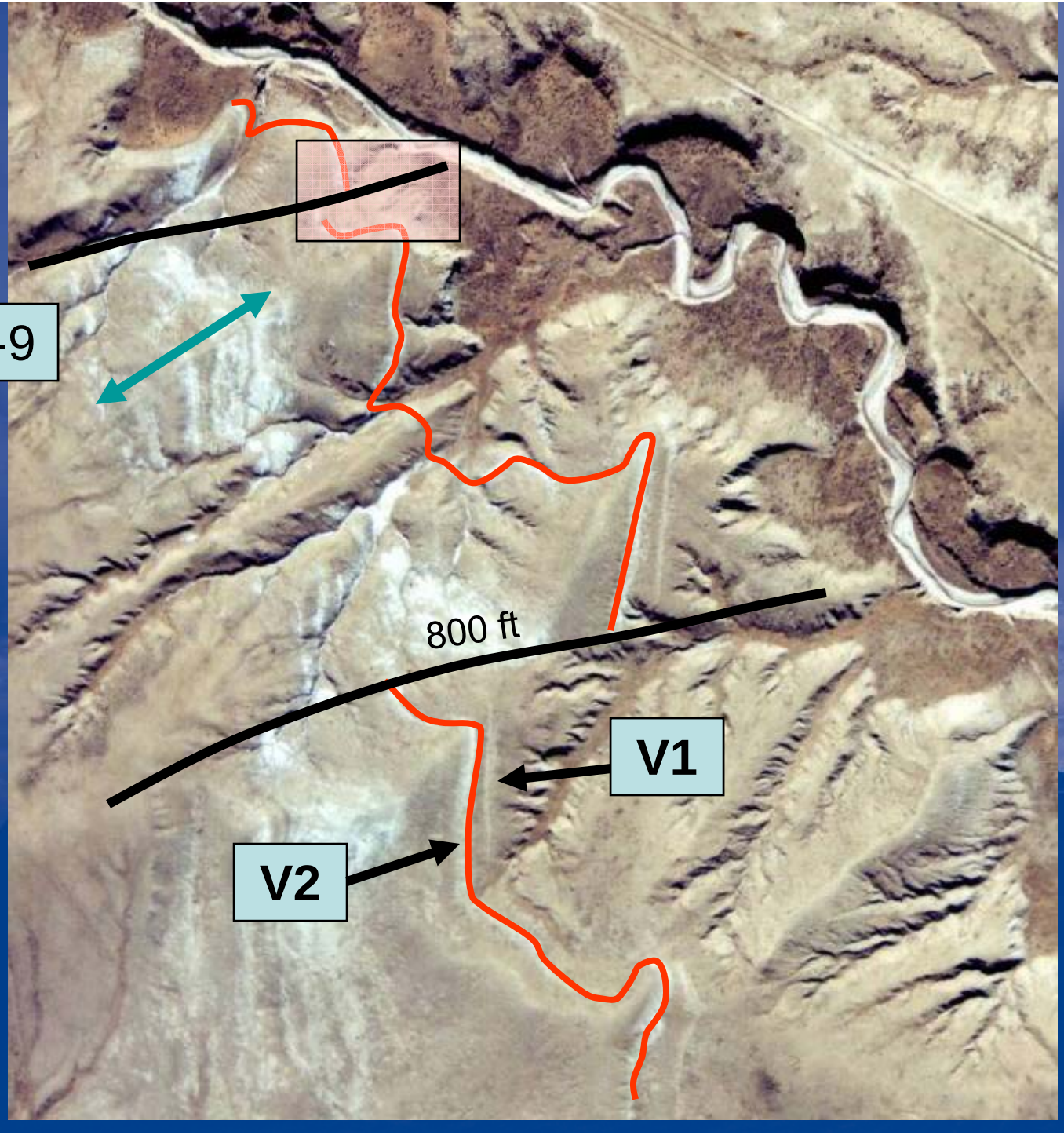

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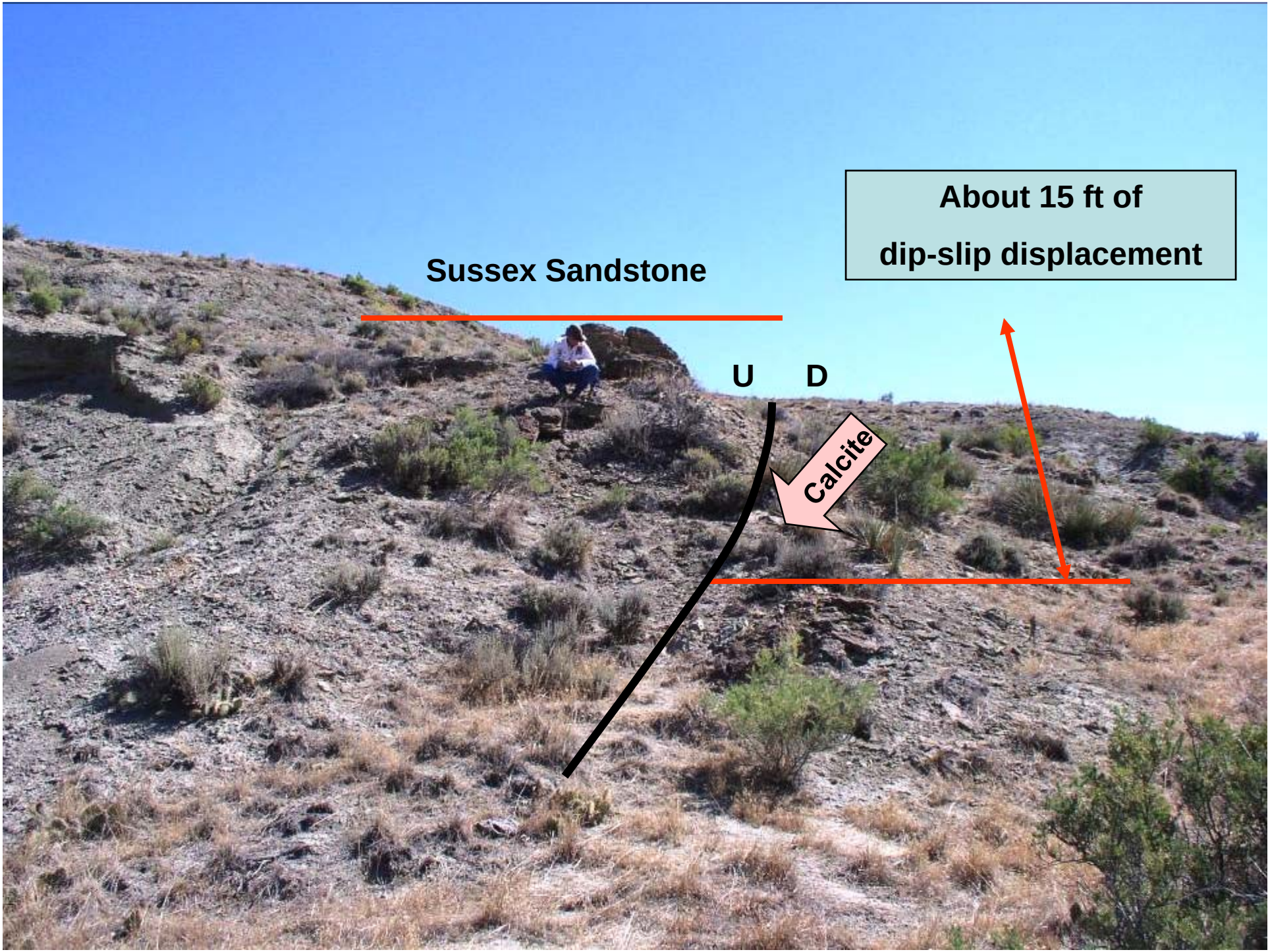
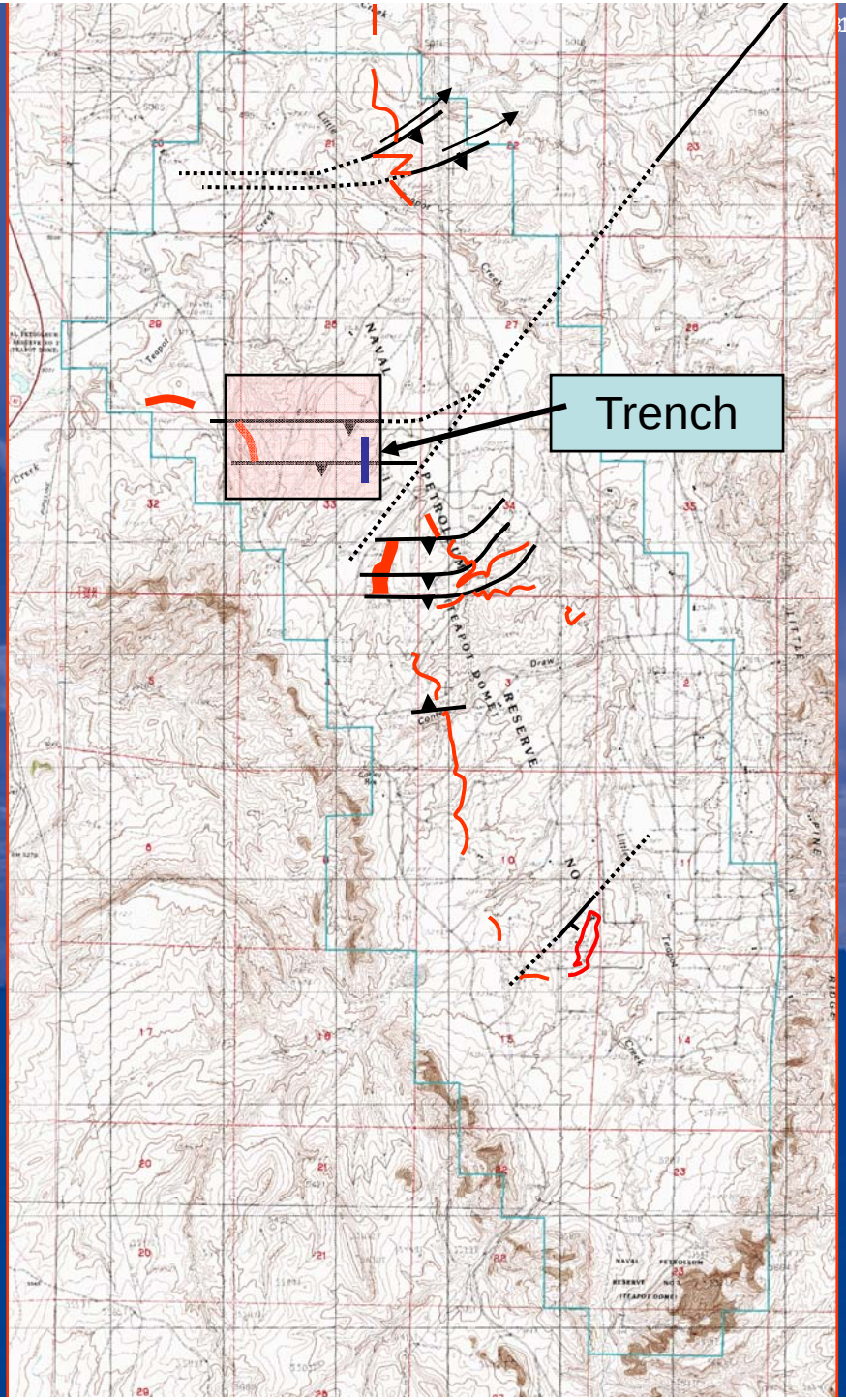
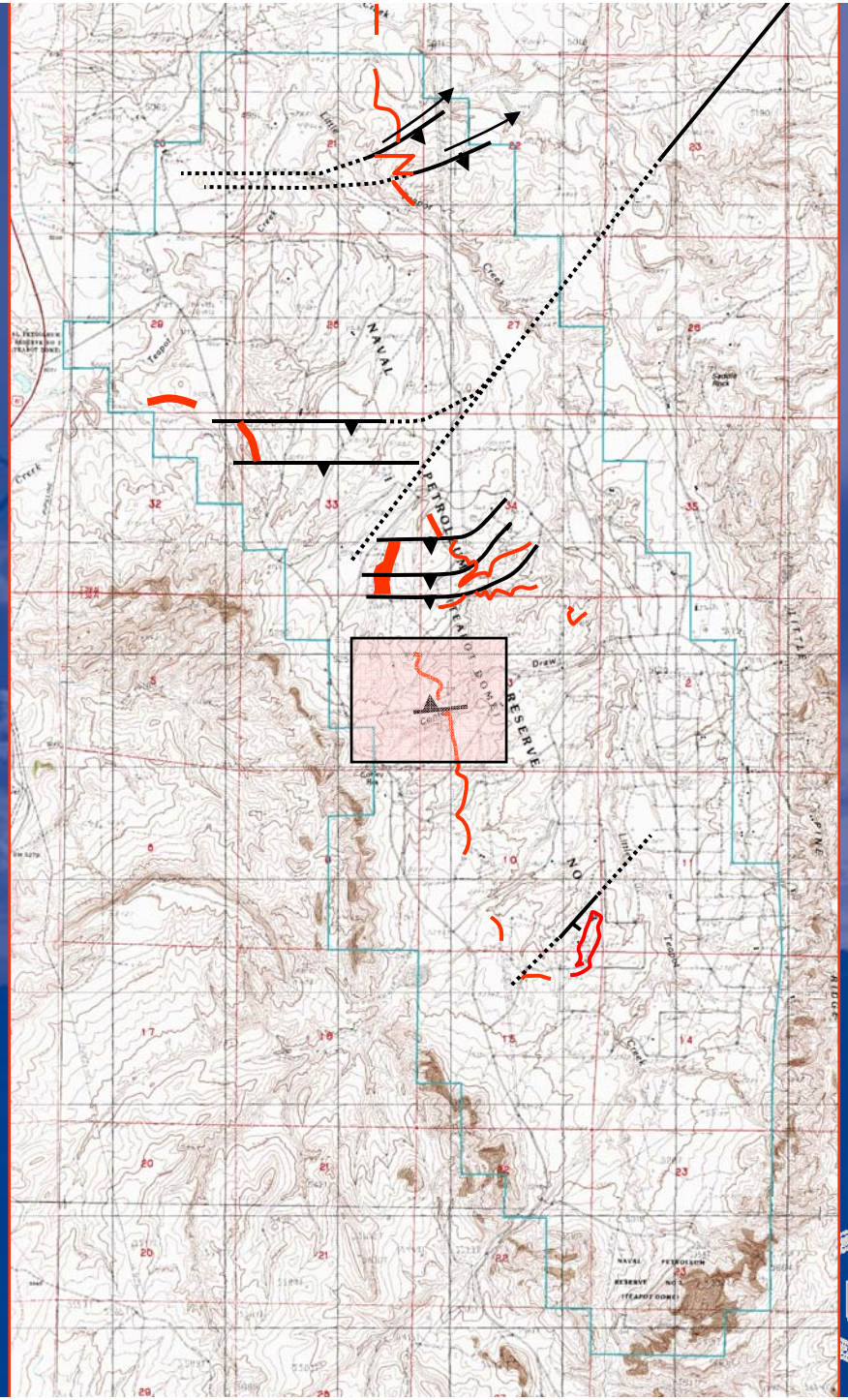

About 15 ft of
dip-slip displacement
Sussex Sandstone
U
D
Calcite


Trench
NAVAL
PETROLEUM
TEAPOT DOME
RESERVE
NO

Surface Faulting at NPR-3



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Research by Brennan and others, 2006, USGS OFR 2006-1214

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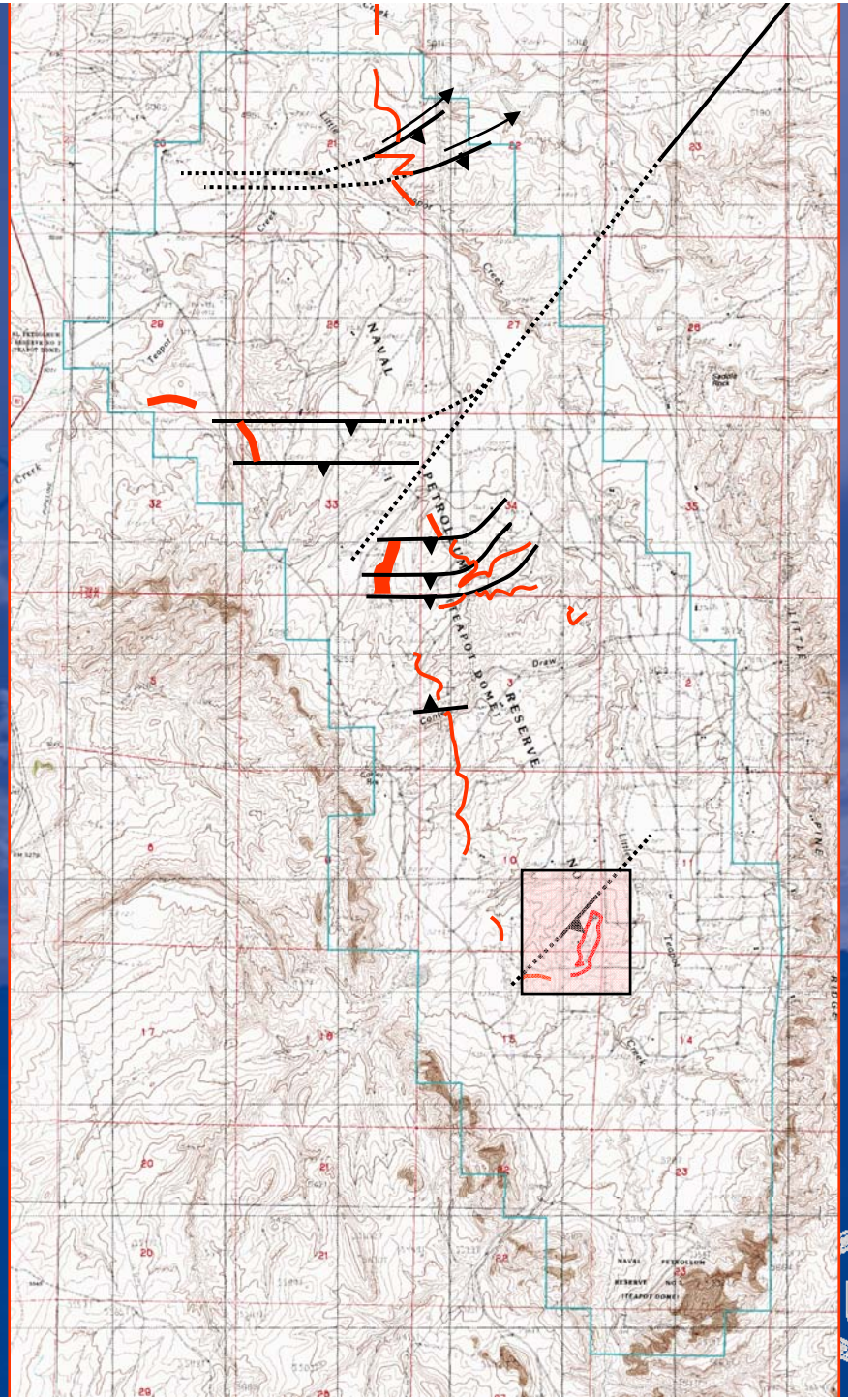
Section 10 normal faulting



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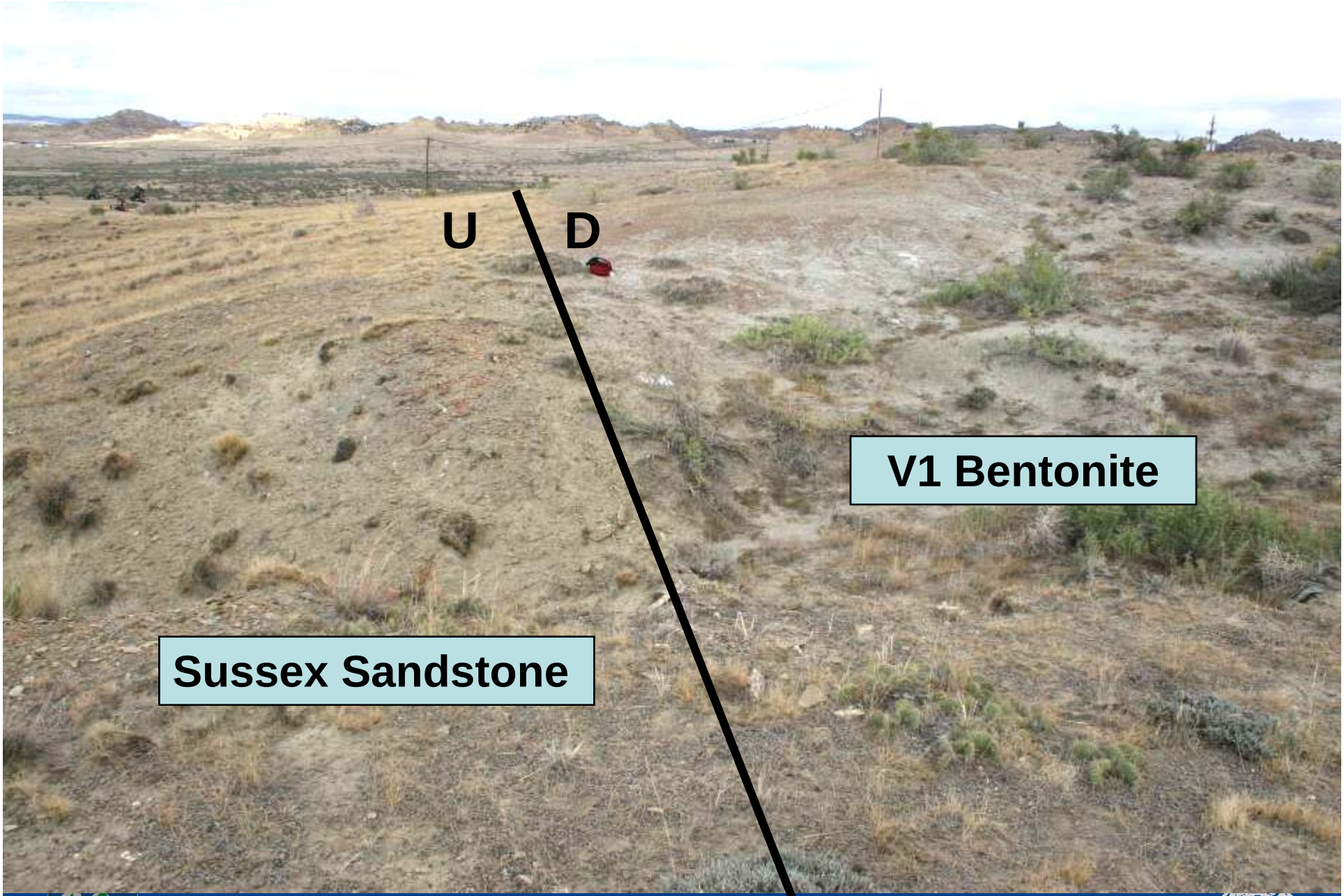

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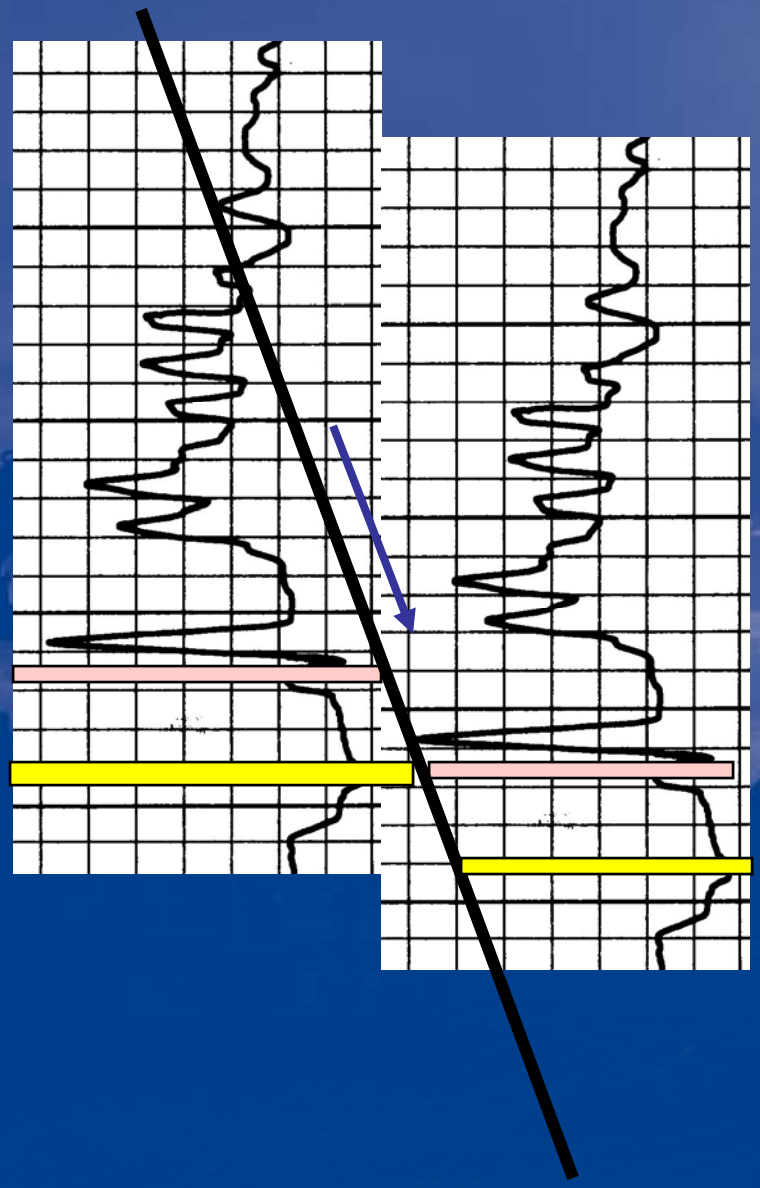
Section 10 Fault



V1 Bentonite

Sussex Sandstone

About 25 feet of dip-slip displacement

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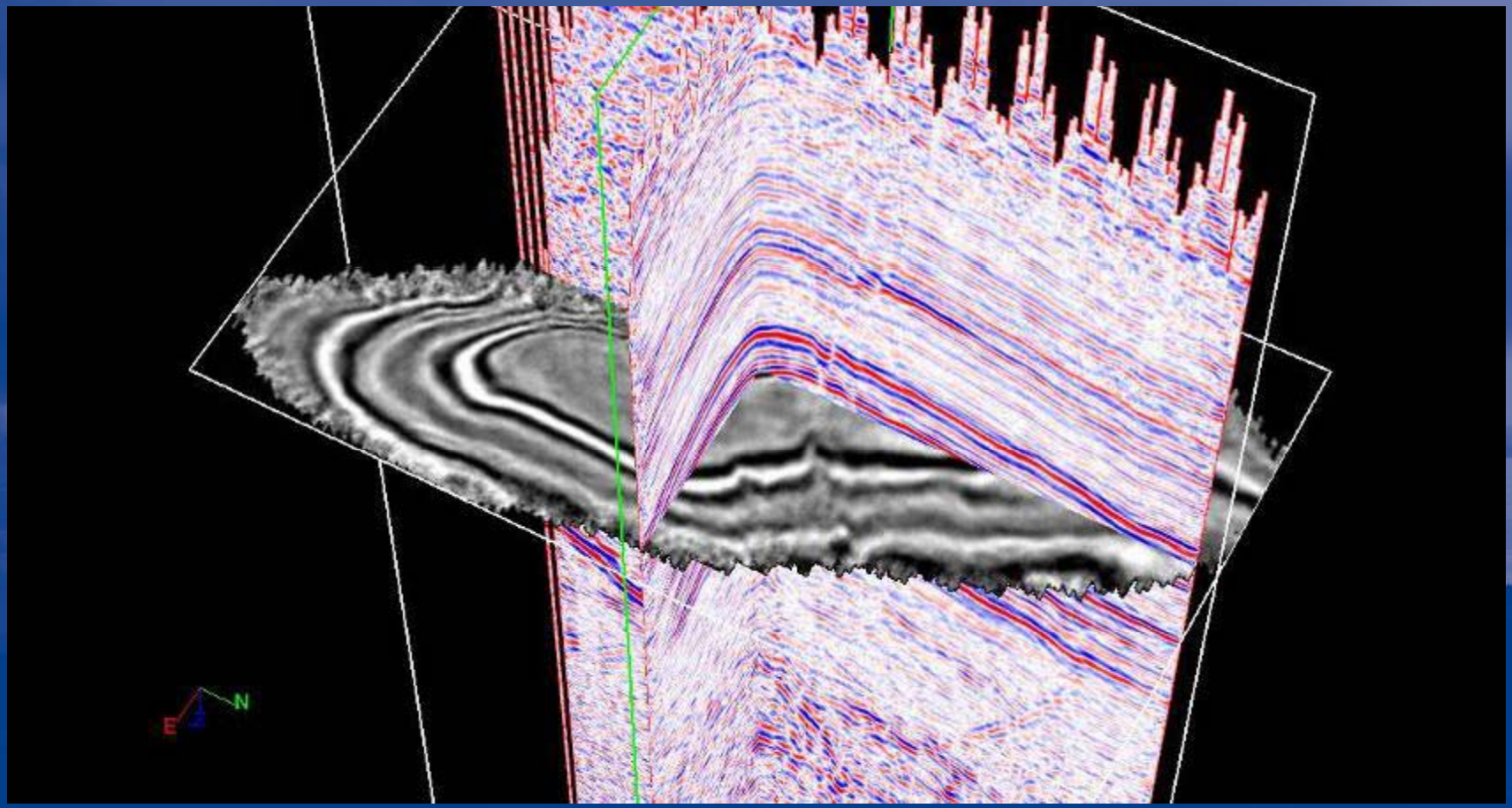
Combining Cutting Edge Technology with Old Fashioned Geological Interpretation



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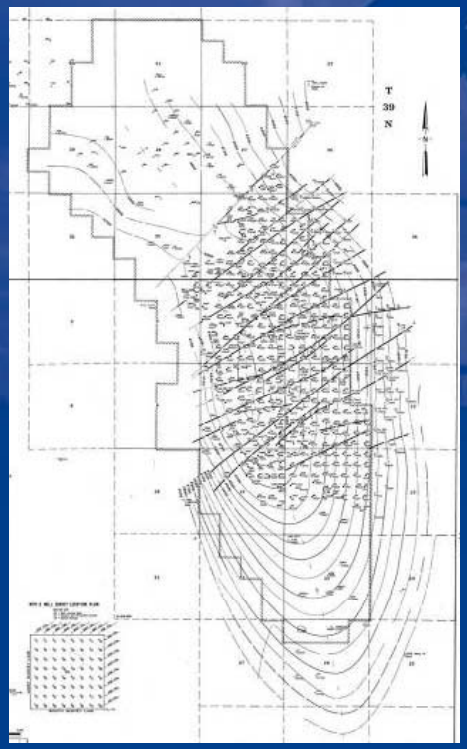
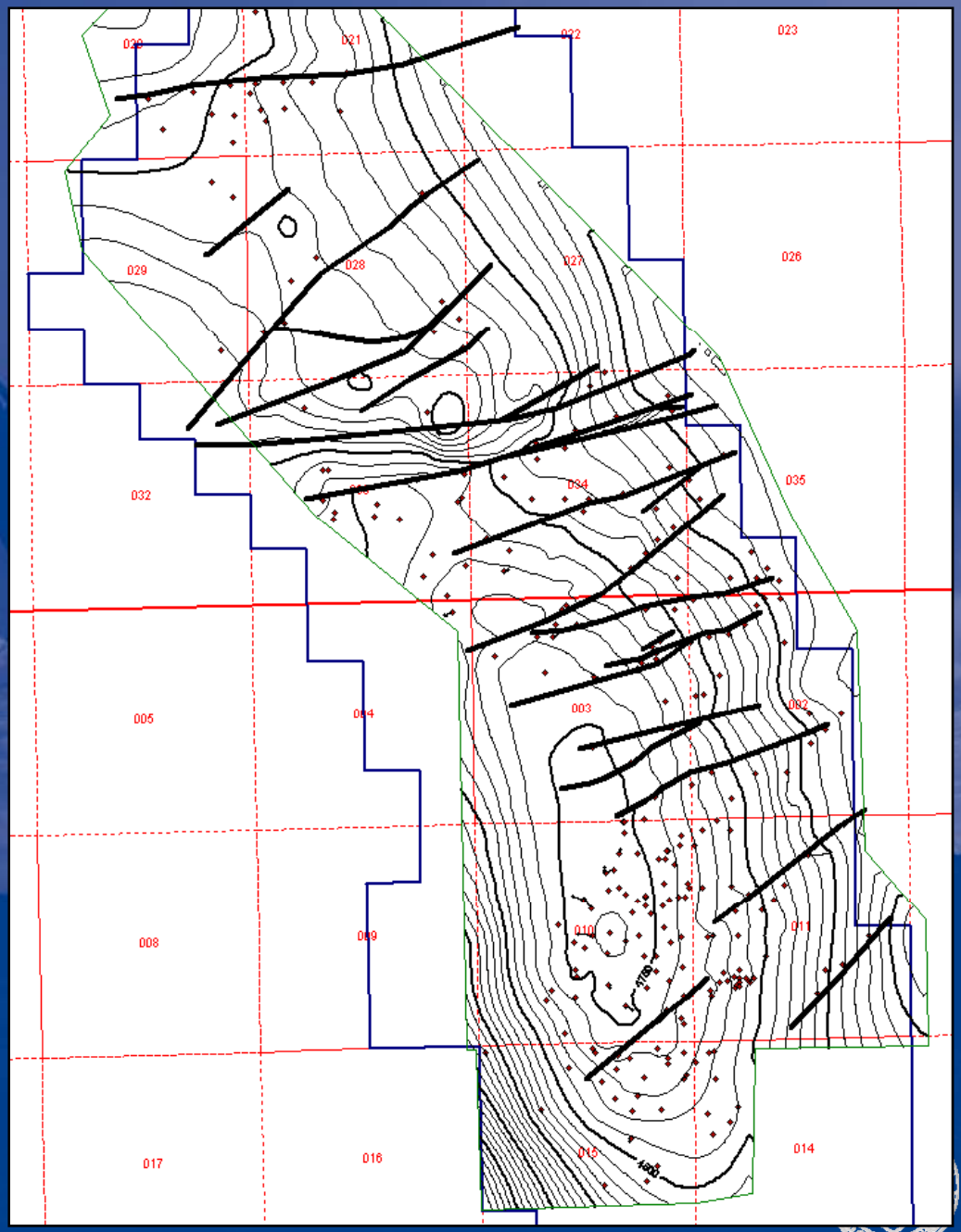
Subsurface faulting in Shannon sandstone





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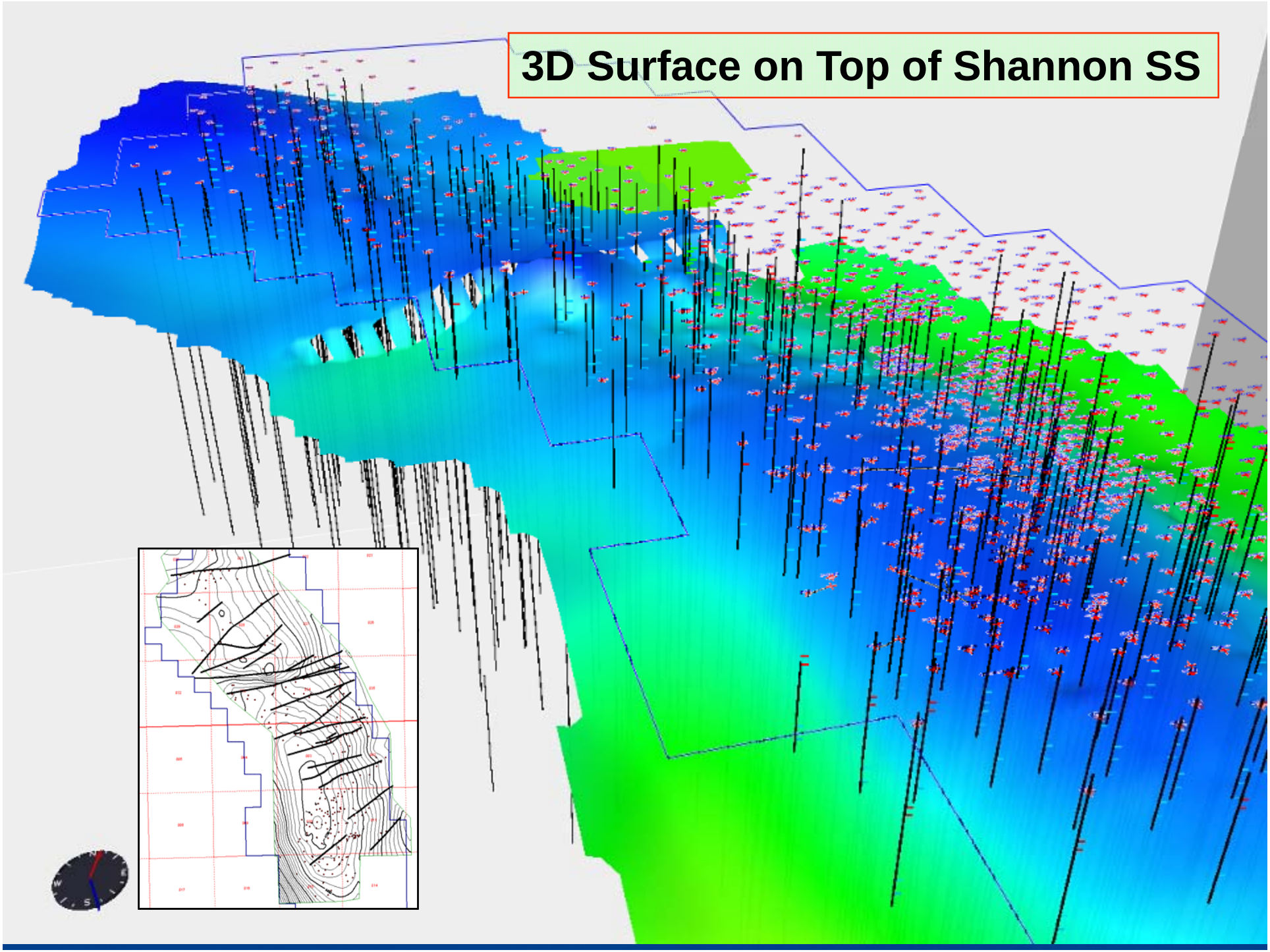
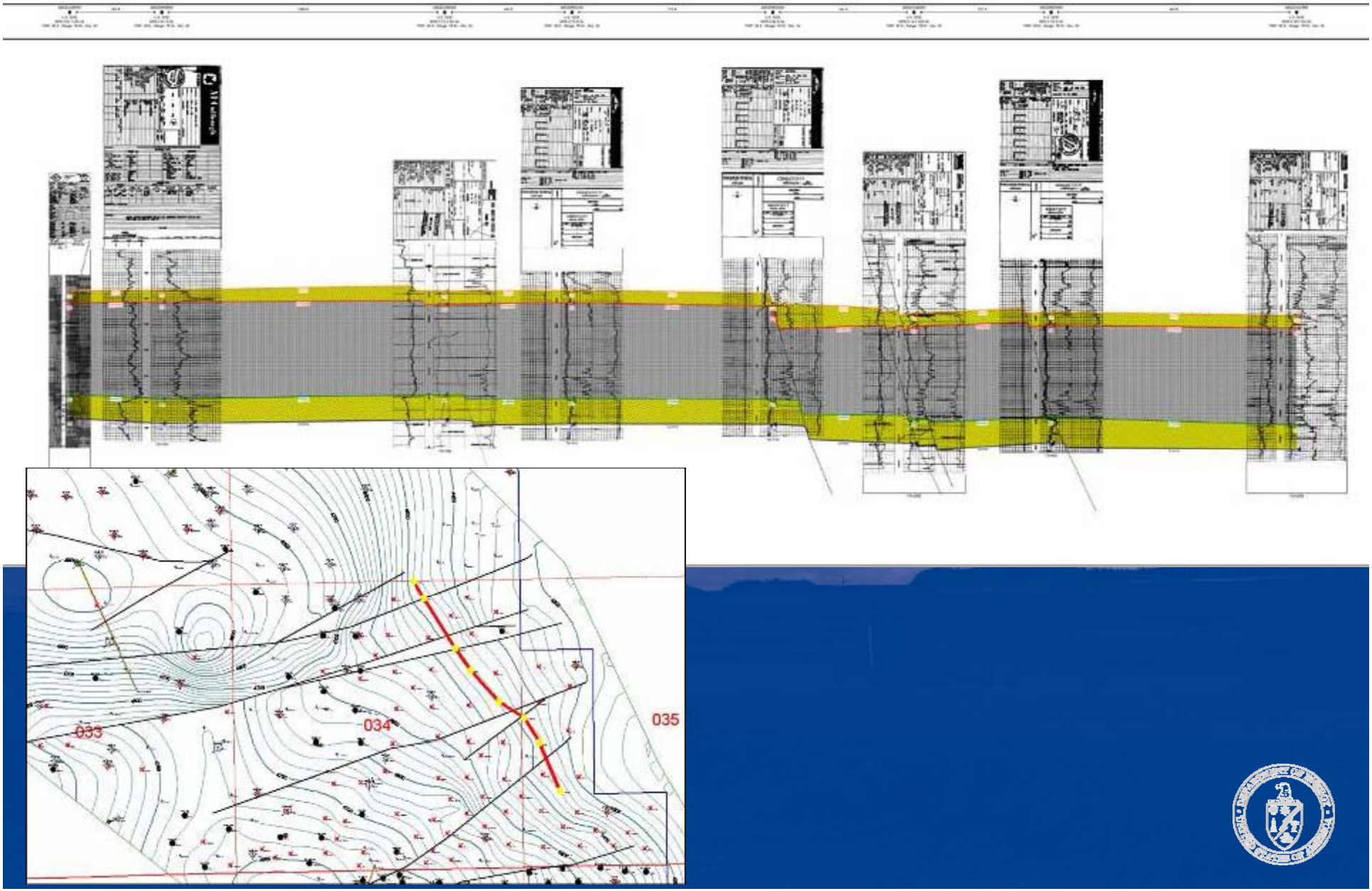
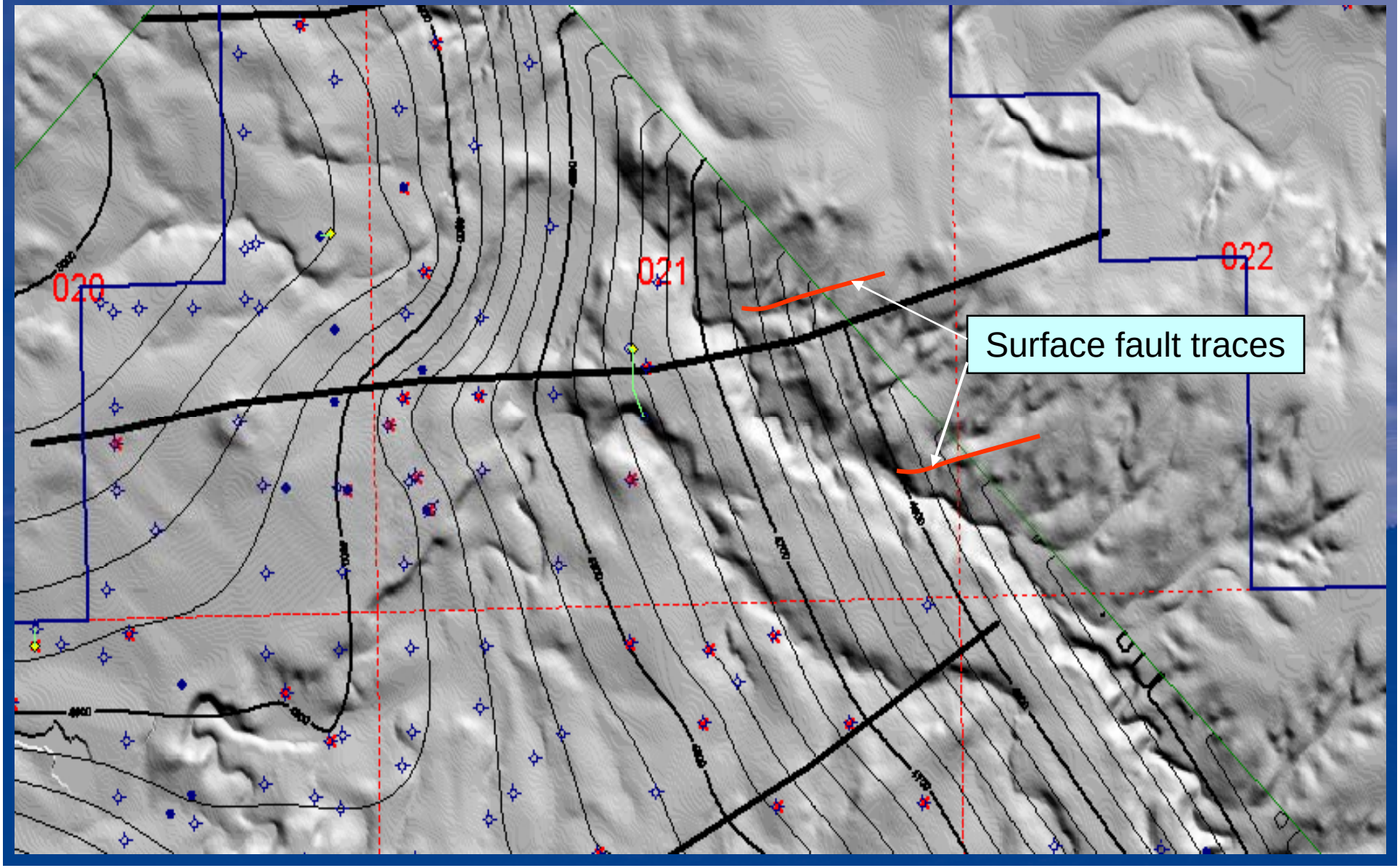
3D Surface on Top of Shannon SS

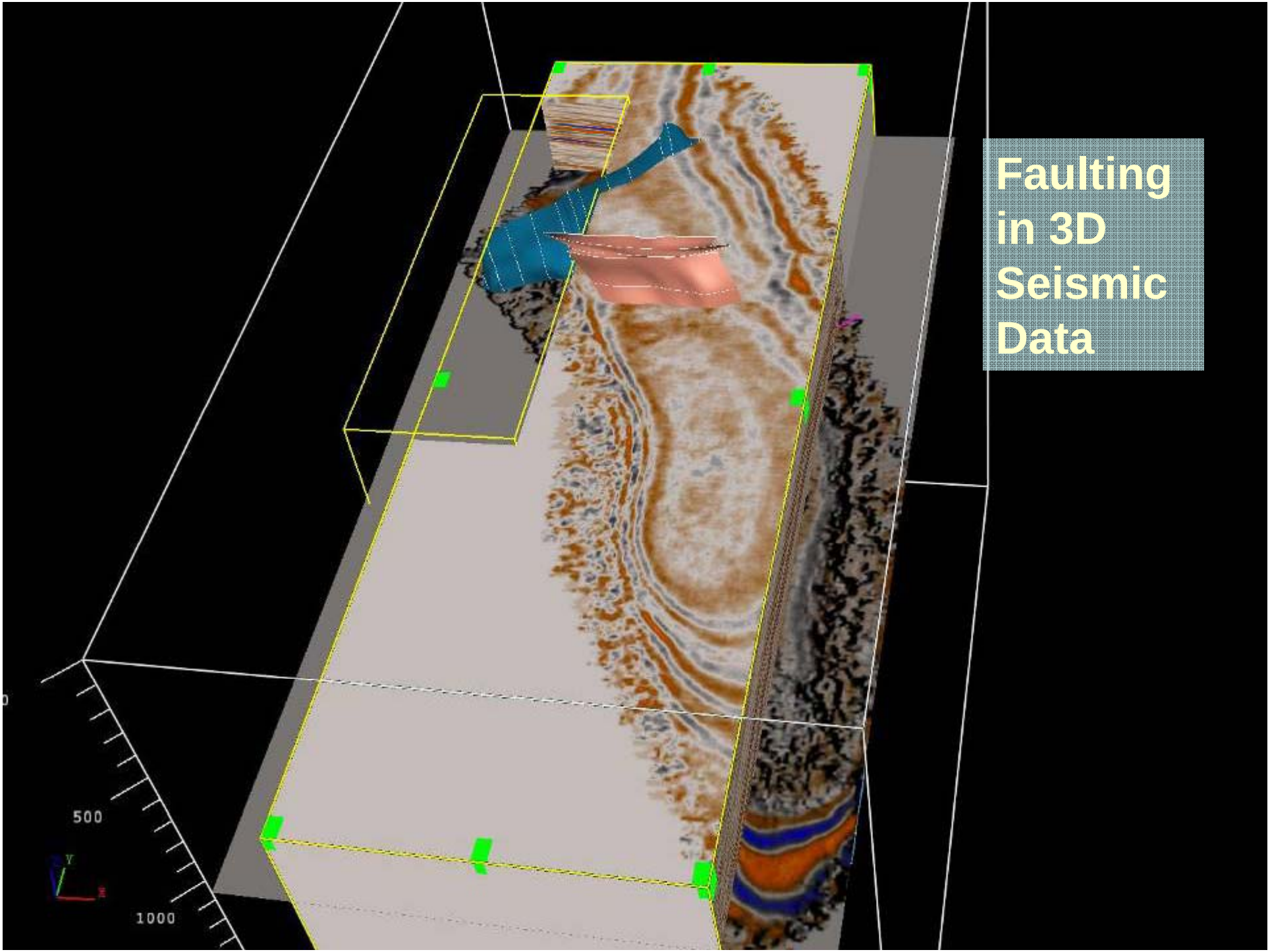


Subsurface faulting in Shannon sandstone



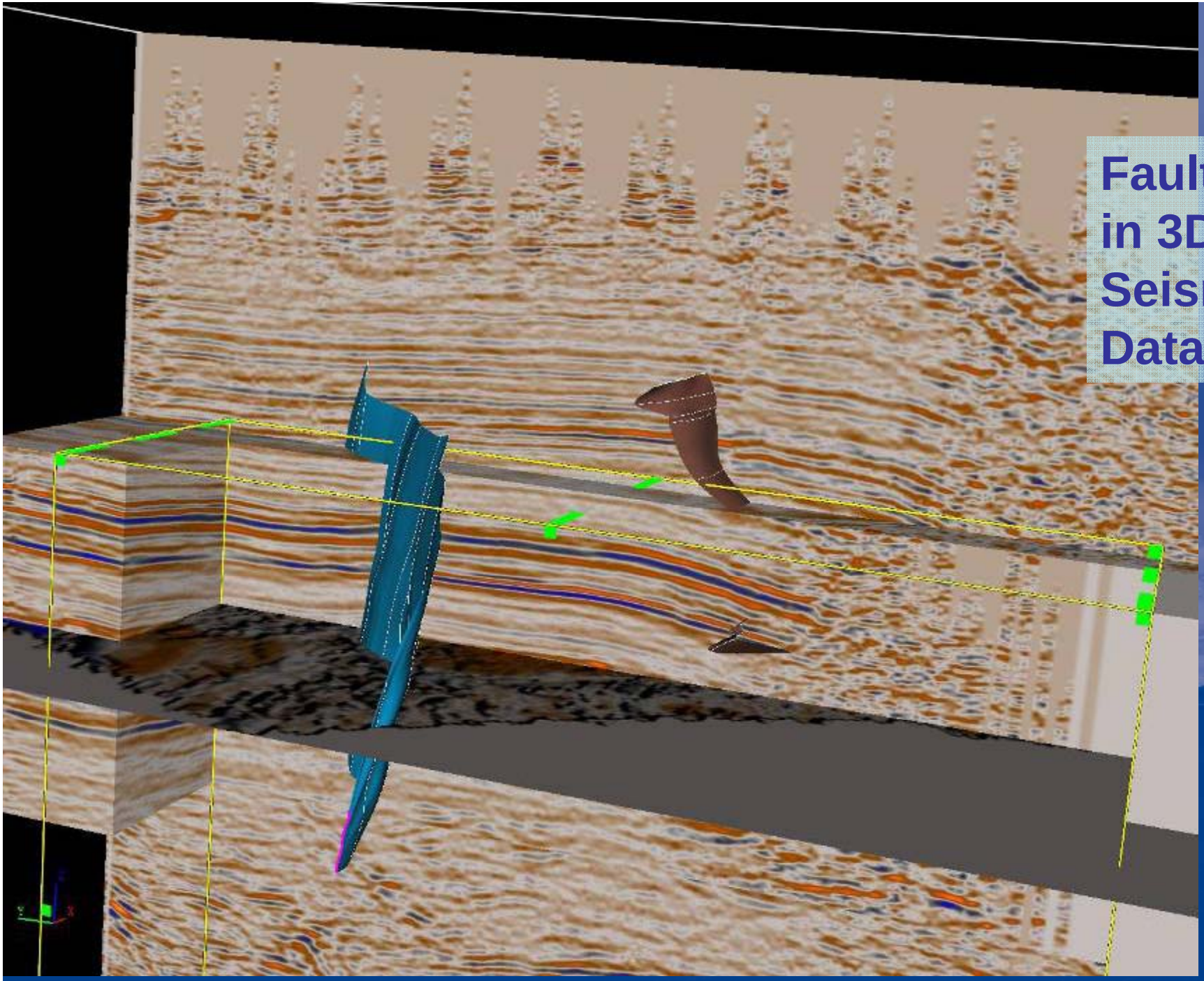
Surface and Subsurface Fault Traces

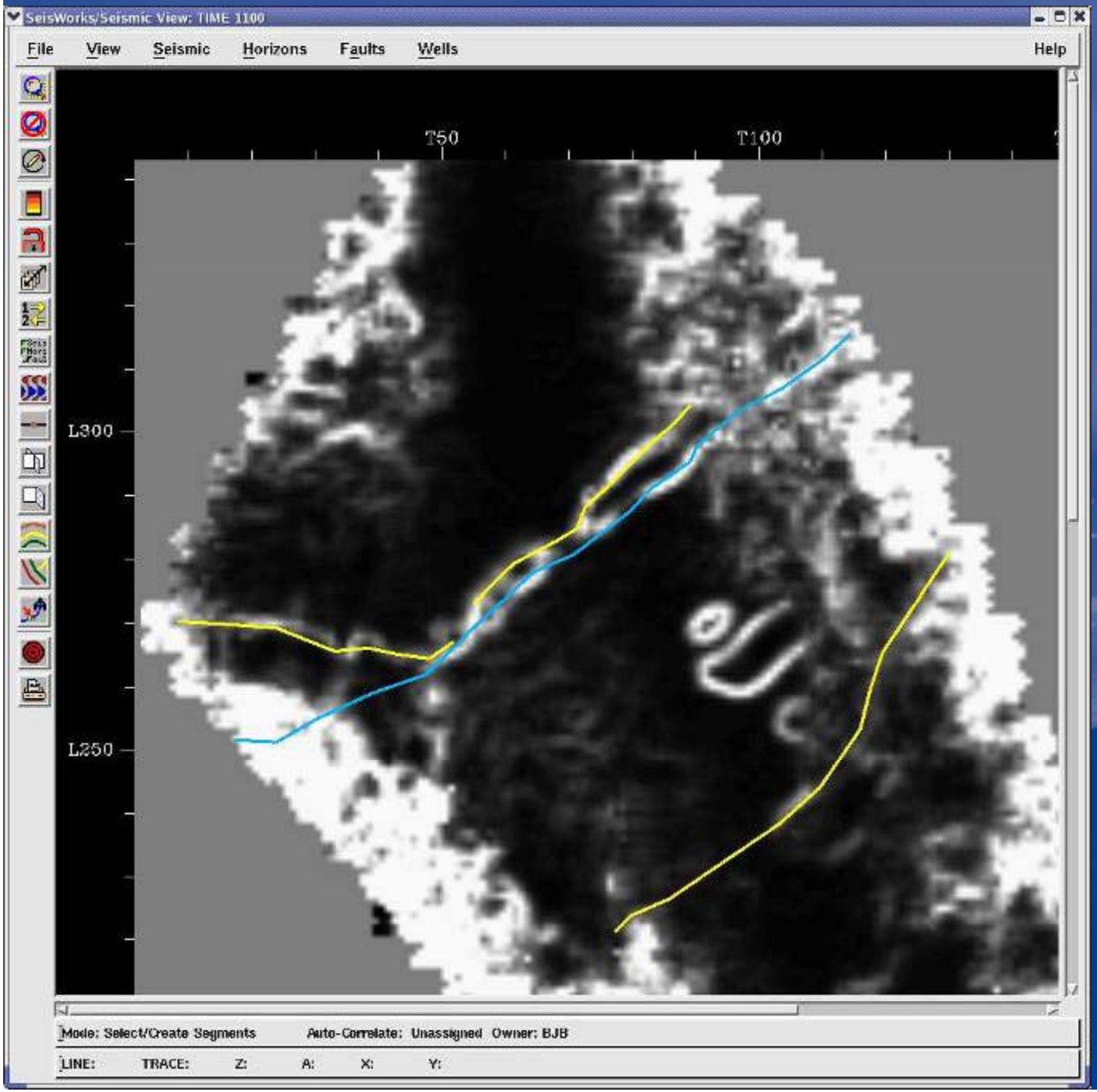




Faulting in 3D Seismic Data

Faulting in 3D Seismic Data

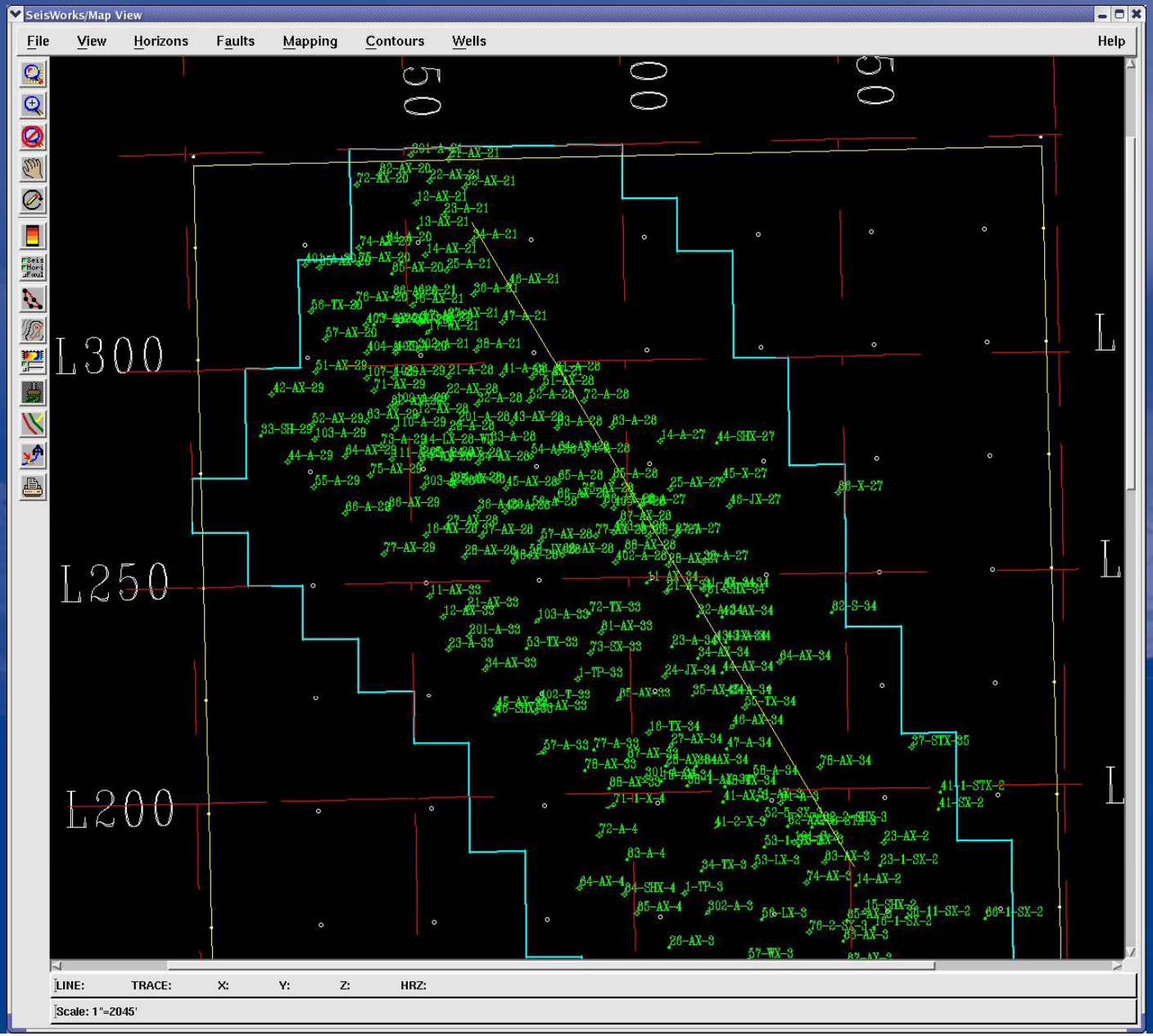




Time slice at 1100 ms showing deep faults

(approx 5000 feet below surface)

Faulting Interpretation in Seismic Data



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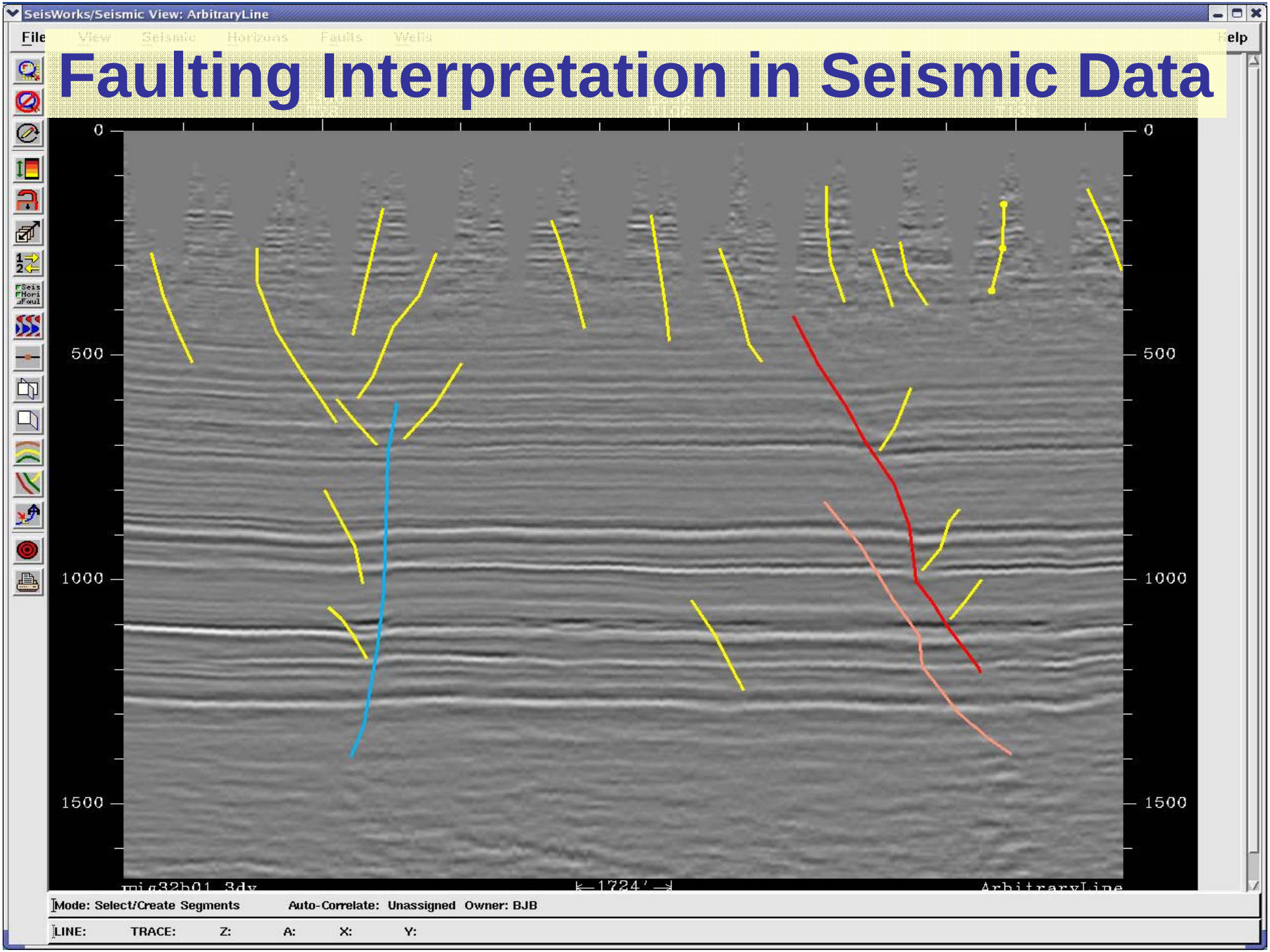
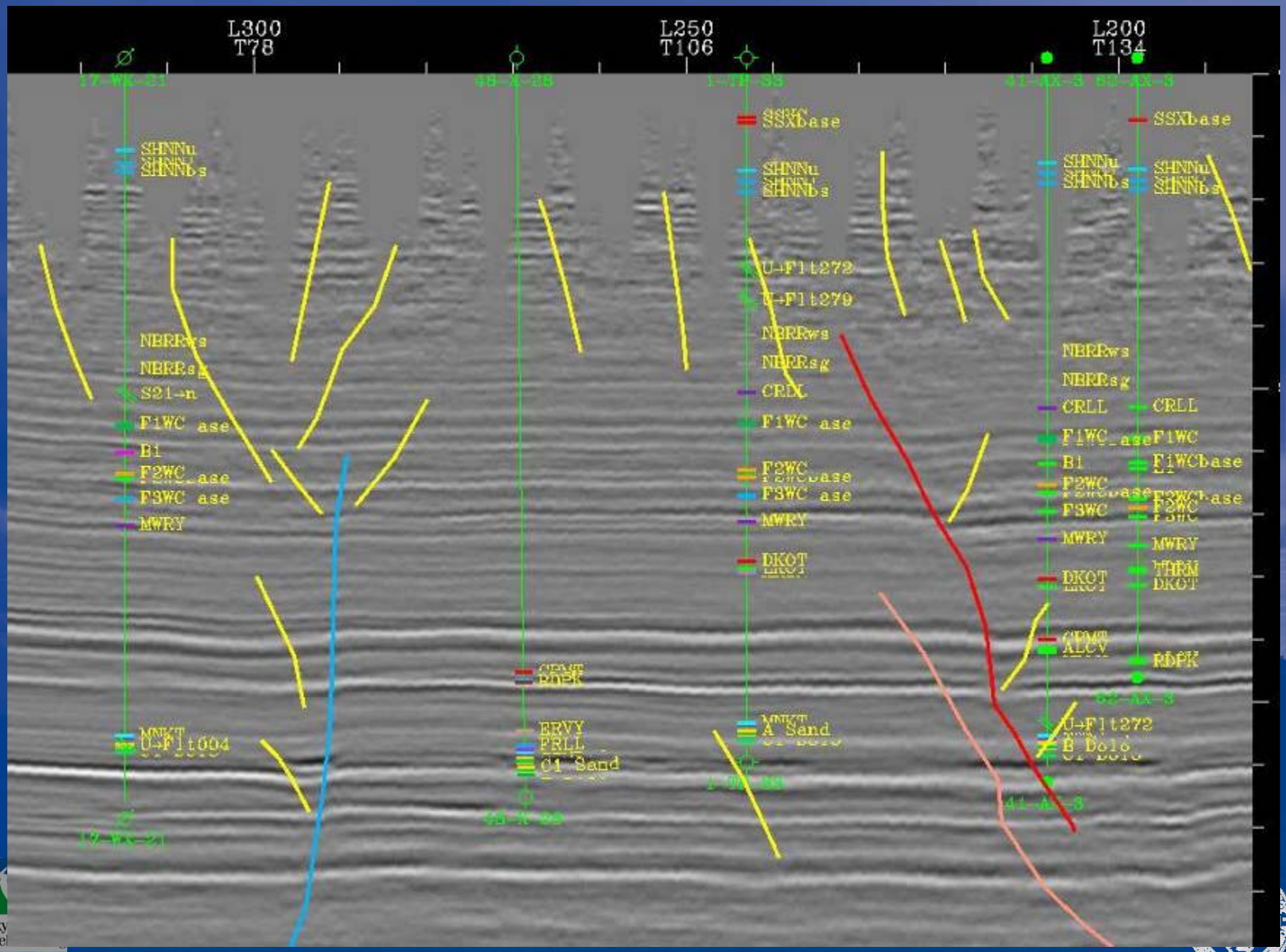
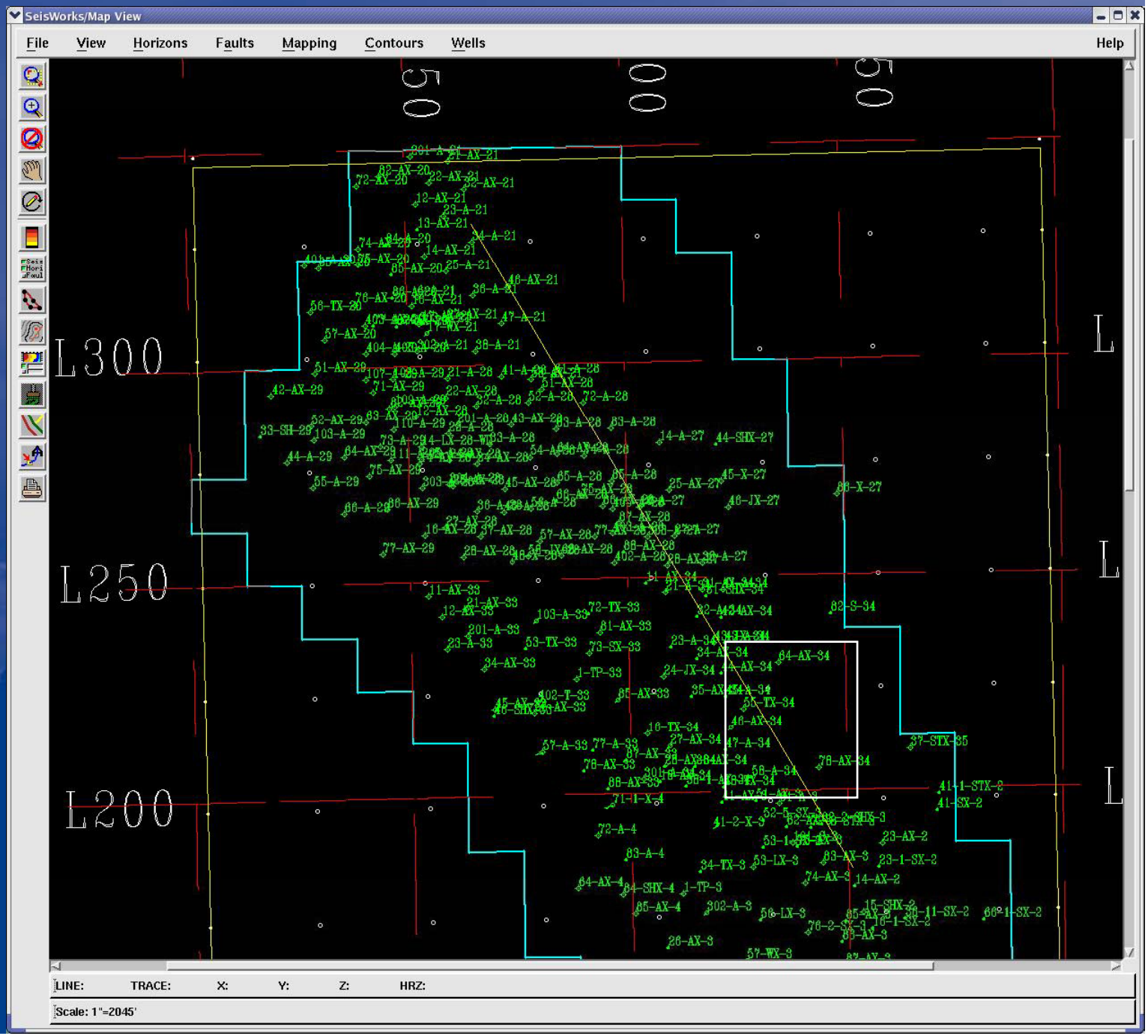
Faulting Interpretation in Seismic Data




L300
T78
L250
T106
L200
T134
SHNNu
SHNNbs
NBRRws
NBRRsg
S21→n
F1WC ase
B1
F2WC ase
F3WC ase
MWRY
MNKT
U→Flt604
SSXbase
U→Flt272
U→Flt279
CRLL
F1WC ase
F2WC
F3WC ase
DKOT
A Sand
ERVY
FRLL
C1 Sand
CRLL
F1WC
F1WCbase
F2WC
F3WC
MWRY
THRM
DKOT
ALCV
RDPK
U→Flt272
B Dolo

High Resolution Shallow 2D Seismic Acquisition



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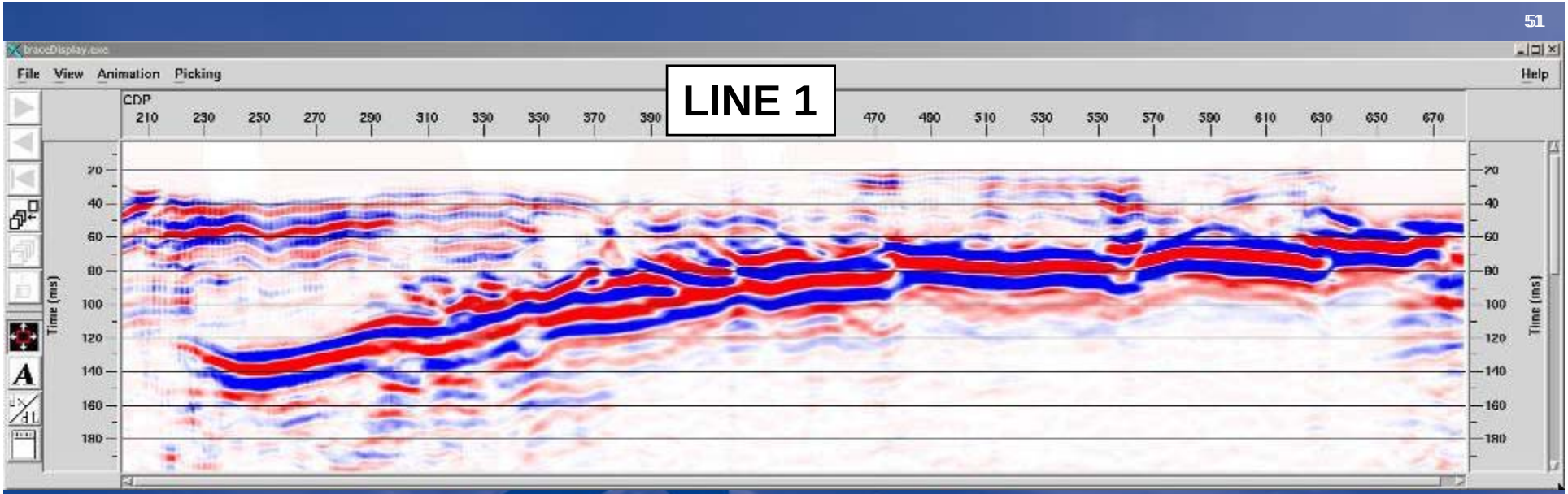
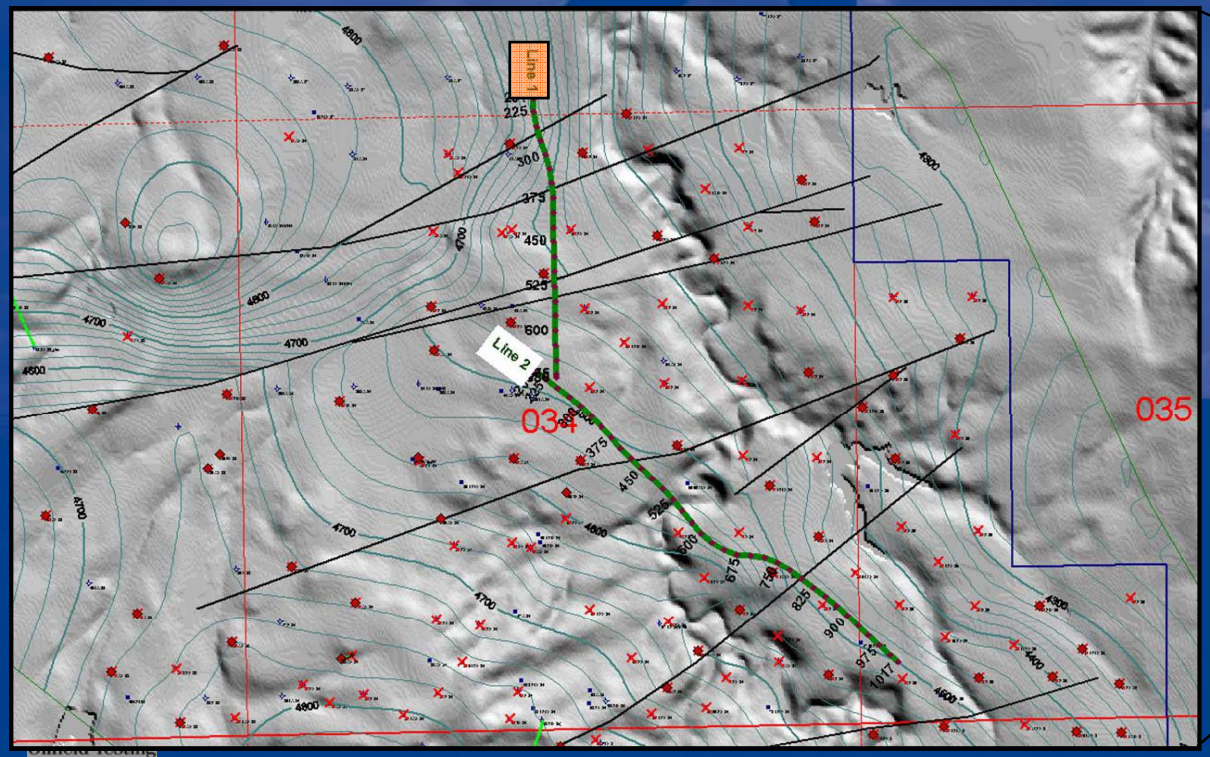
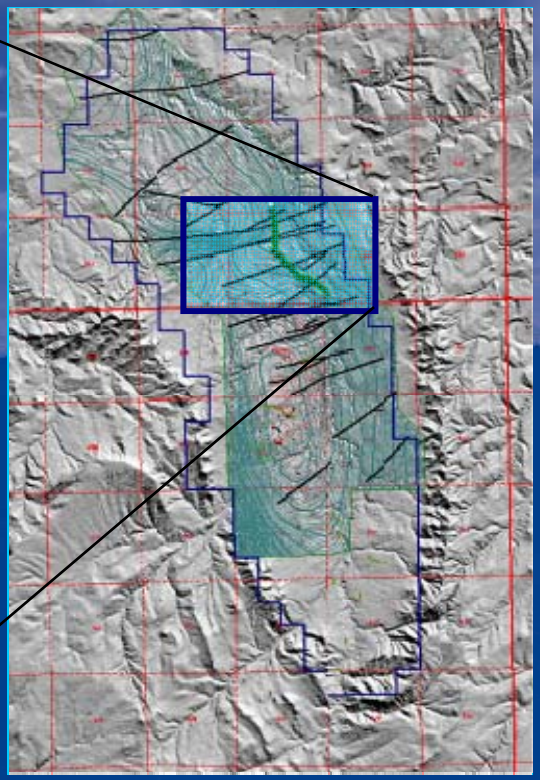
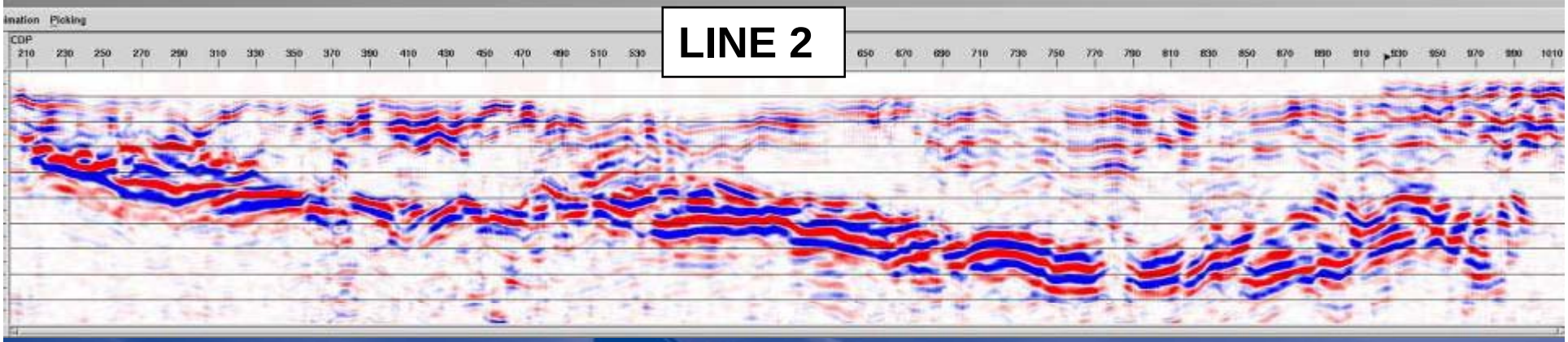
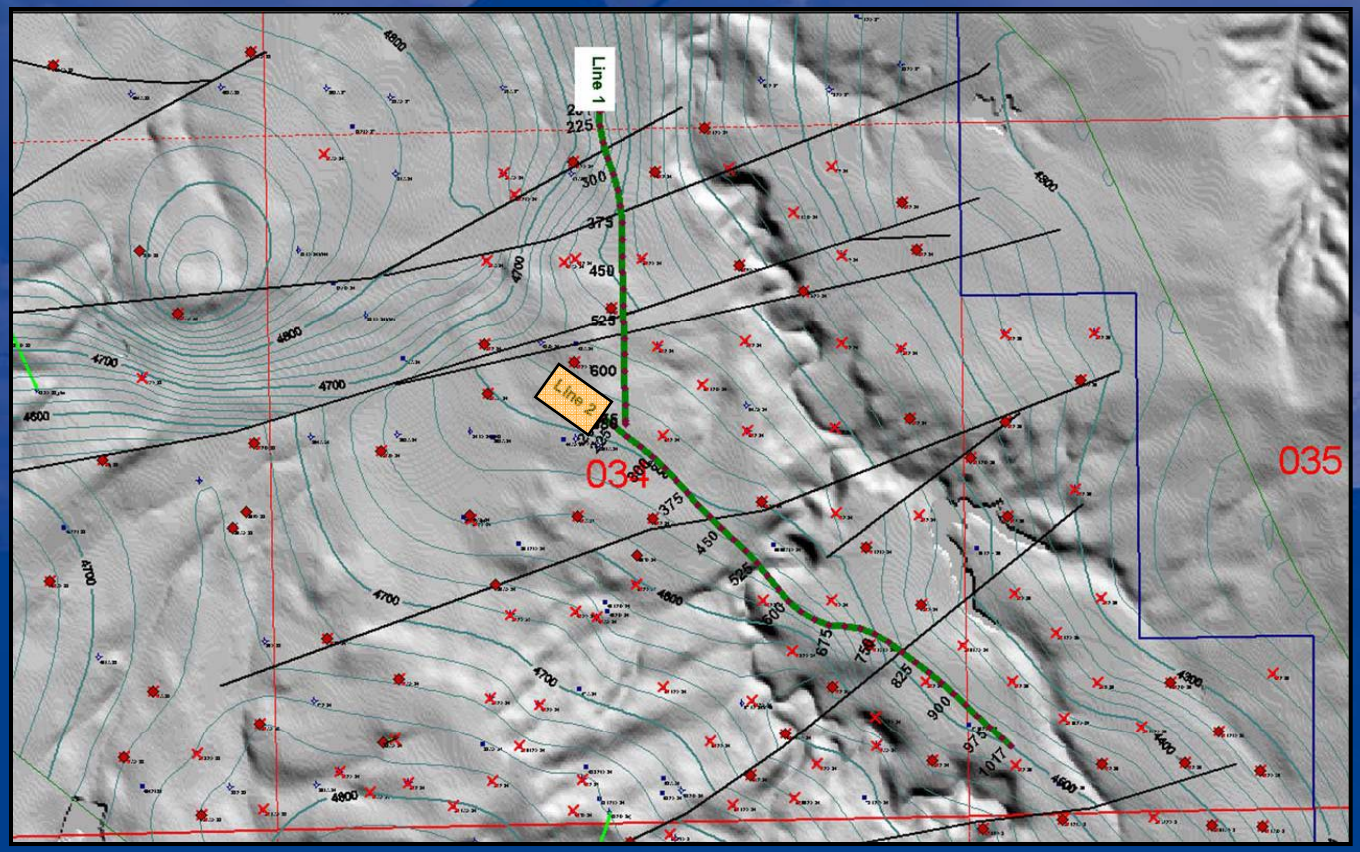






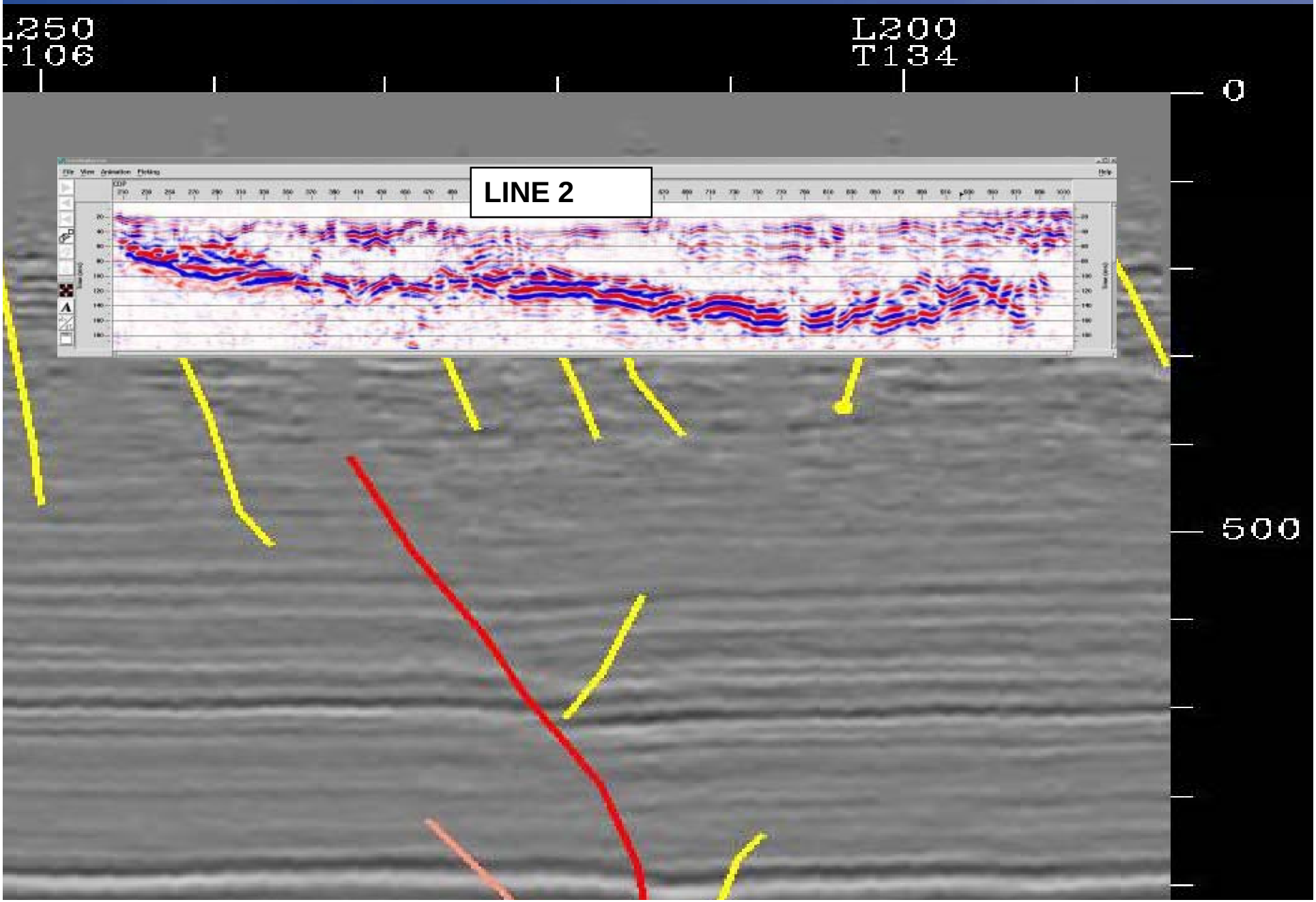
Seismic images provided by John McBride- Brigham Young University





Seismic images provided by John McBride- Brigham Young University

Comparison of 3D vs High-Res Shallow 2D Seismic



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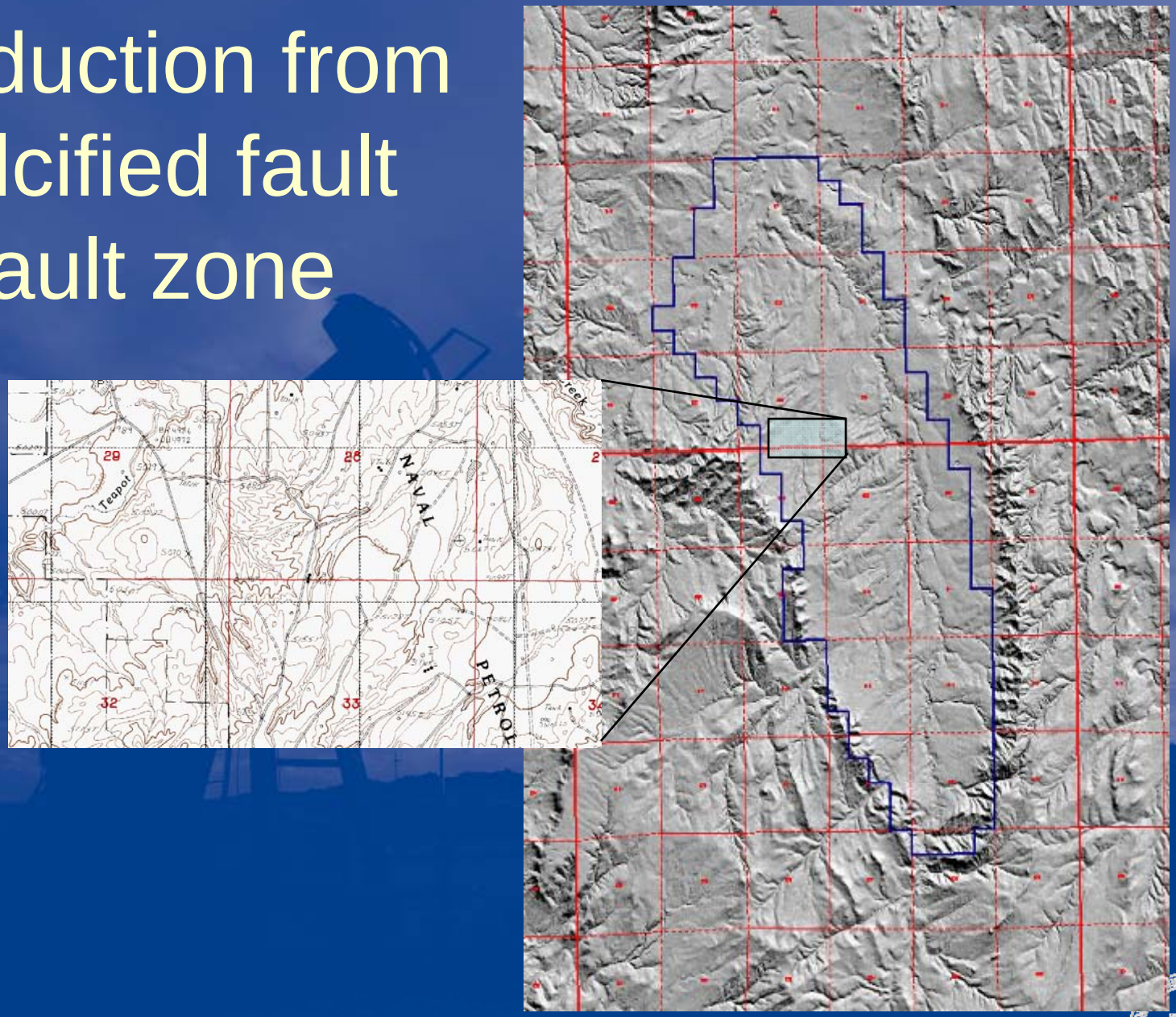
Production from calcified fault fault zone



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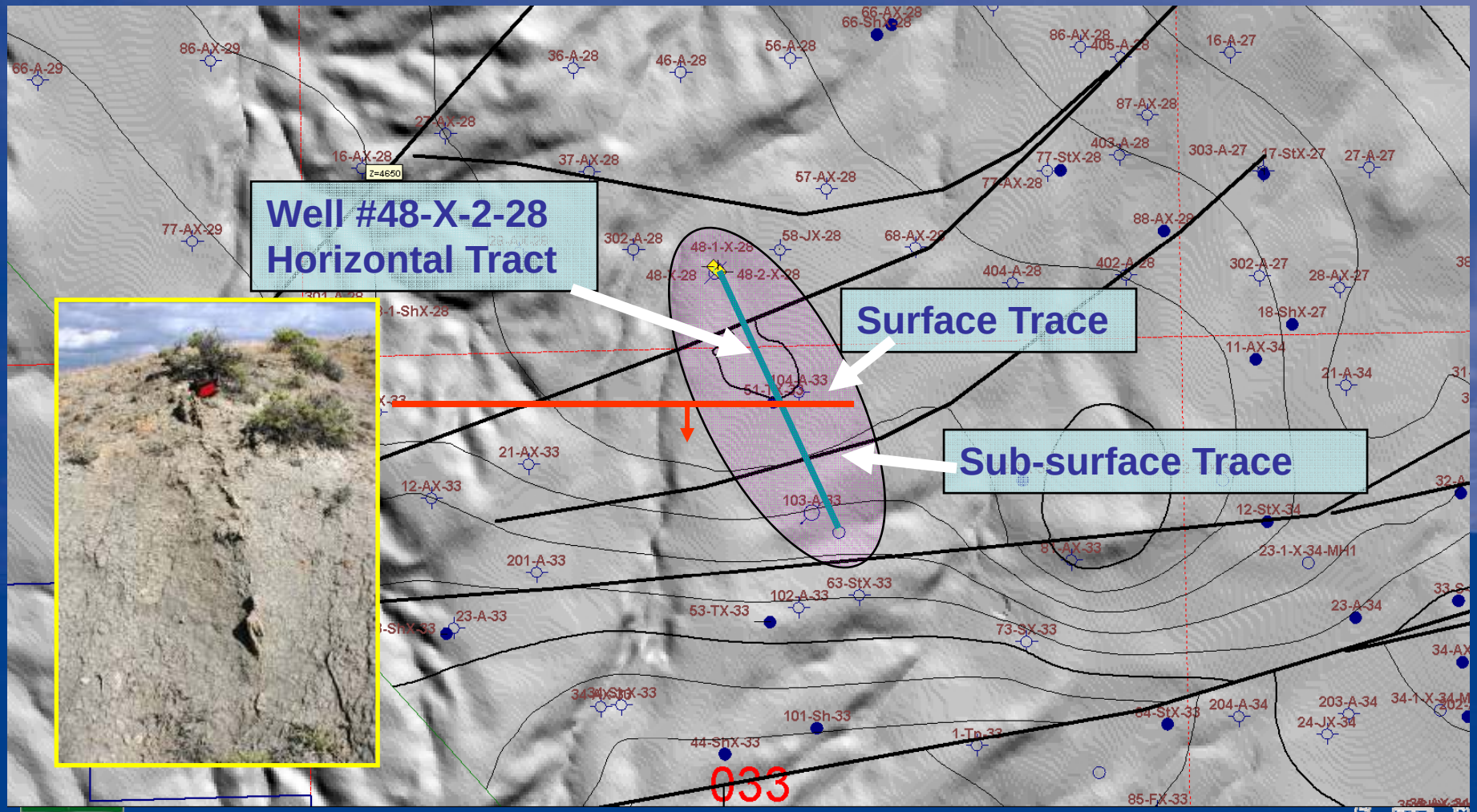
48-2-X-28 Blow-out

High pressure in fault/fracture zone within Niobrara Shale



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- Introduction
- Purpose and goals of study
- Past work
- Stratigraphy and seismic character
- Surface mapping
- Subsurface mapping and fault interpretation
- Production potential
- Further research opportunities

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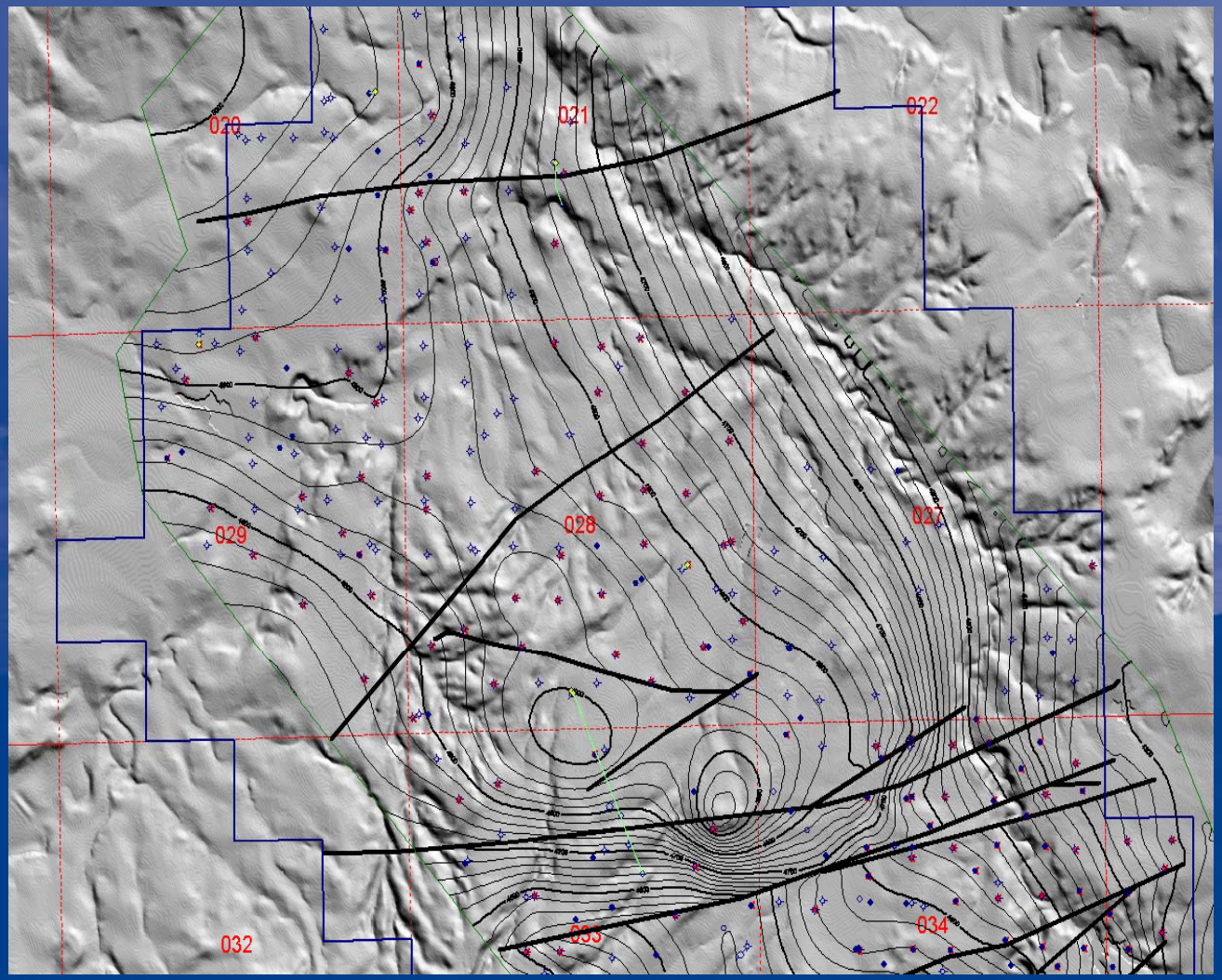
Ground-truthing of subsurface faults, tying surface faults to well data



Mapping of faults projected along trend into the Parkman Sandstone, Mesa Verde Formation

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3D Seismic Interpretation

- Structure Mapping in deeper horizons
  - Integration of well control
  - Time to Depth Conversion
- Fault Characterization and Mapping
  - Detailed mapping at reservoir scale
  - Determine vertical separation
  - Seals vs leaks
- Reservoir Characterization
  - Seismic modeling and reservoir mapping

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Questions?

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