[AV]Structural Architecture, Petroleum Systems, and Geological Implications for the Covenant Field Discovery, Sevier County, Utah

By

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Search and Discovery Article #110014 (2005)
Posted August 30, 2005

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Abstract

Structural analysis, seismic interpretation, and organic geochemistry are all part of the petroleum systems synthesis that contribute to the Covenant Field discovery in Central Utah by Wolverine Gas and Oil Corporation. The Kings Meadow Ranch 17-1 penetrates a highly porous and permeable reservoir in the Jurassic Navajo Sandstone which contains a 450-foot oil column. The Covenant Field is located along a frontal structural uplift to the Central Utah thrust belt, where Late Cretaceous – Early Tertiary compressional deformation resulted in the development of thrust faults and associated hanging wall anticlines buttressed against the ancestral Ephraim extensional fault. The traps are charged from Mississippian foreland basin sediments to the west of the discovery, and hydrocarbon generation was driven by the initial sedimentary loading (oil generation) followed by tectonic loading (gas generation) associated with the evolving thrust belt. Evaporite deposition in the overlying Arapien Formation provides a highly effective seal for the accumulations. Jurassic extensional faults may be critical in defining the location of thrust faults and antiformal stacks, which in turn define structural traps along this newly discovered onshore hydrocarbon province.

WOLVERINE GAS and OIL COMPANY
of UTAH, LLC

Energy Exploration in Partnership with the Environment

Structural Architecture, Petroleum Systems, and Geological Implications for the Covenant Field Discovery Sevier County, Utah

Doug Strickland - Presenter

Co-Authors and special thanks to:

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Dan Schelling (Structural Geology International LLC)

David A. Wavrek (Petroleum Systems International, Inc.)

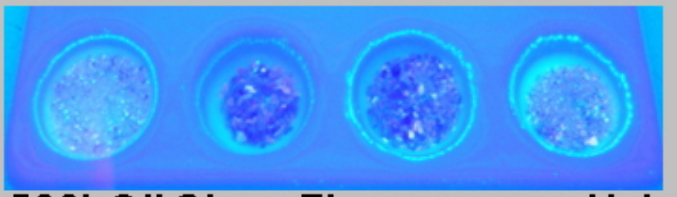
Frank Royse, Jr., Paul Lamerson, Jim Medlin, Tadd Schermer, Bill Brown (Former Chevron employees)

Drilling 2003 *Christmas comes Early!*

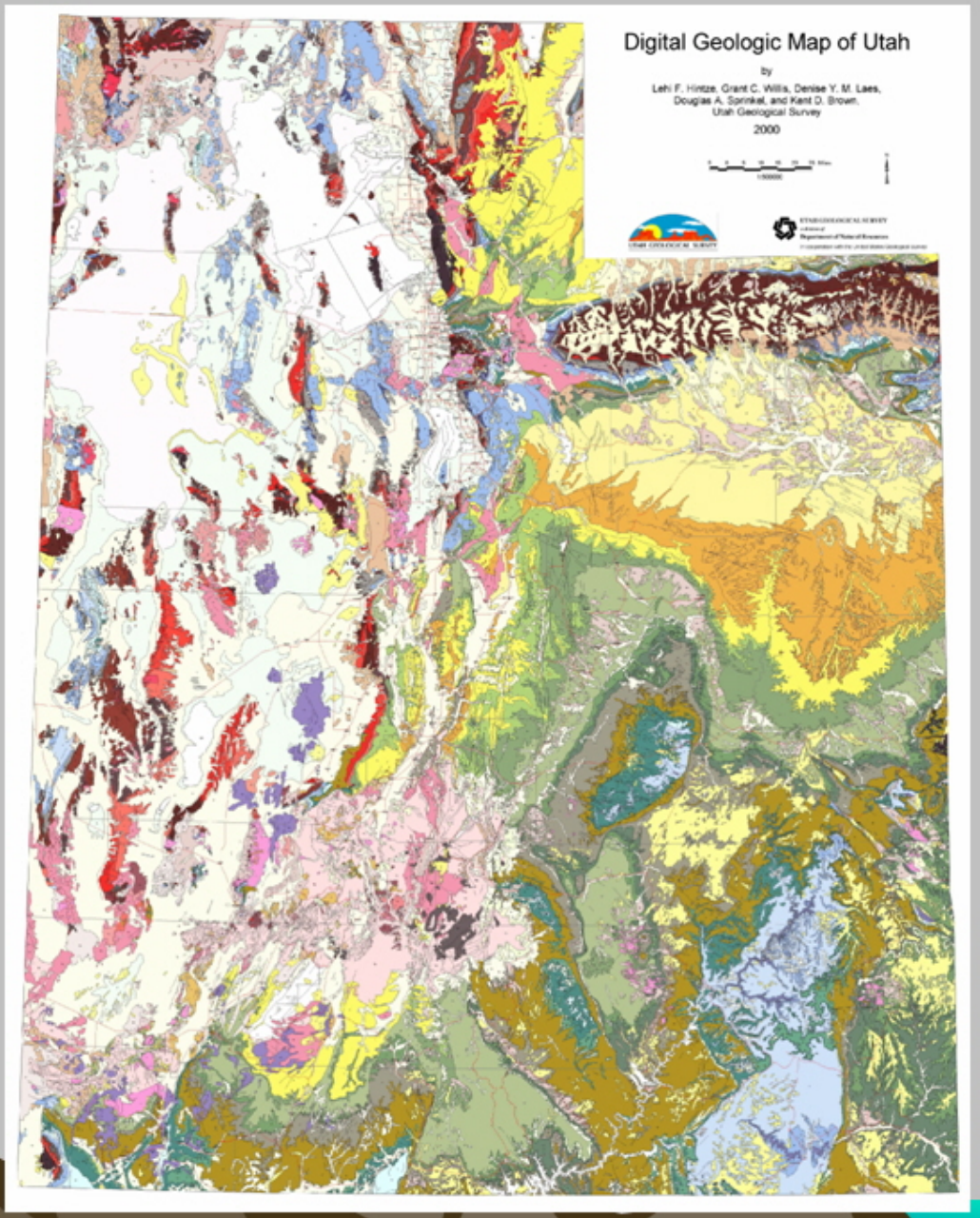
Dec 22nd Navajo at 5840 ft (instead of 7200 ft) with strong oil show

Dec 24th established Nav-1 will flow and correlation to Rangely Weber oil

Nav-2 Duplex at 8150 ft

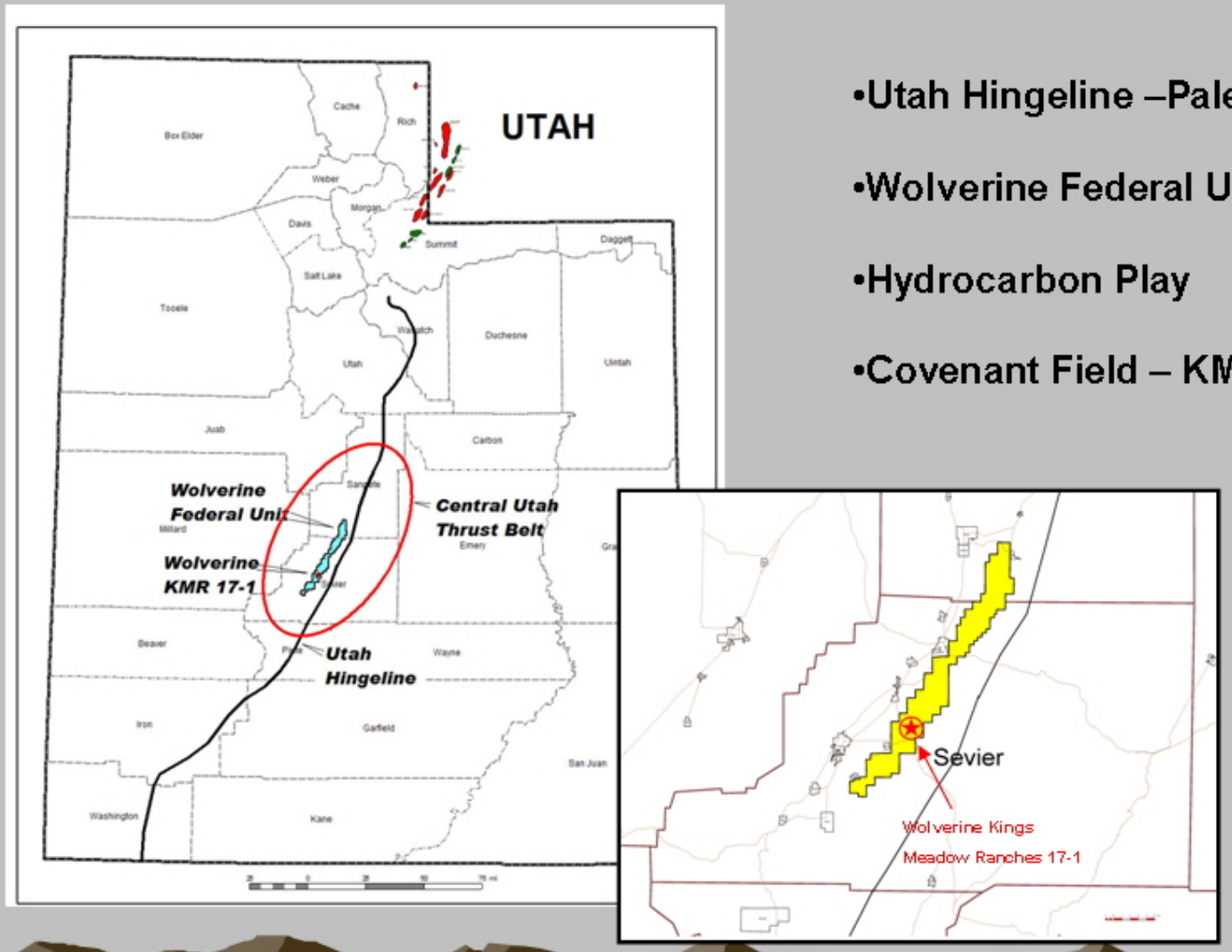


500' *Oil Show* Fluorescence Halo's

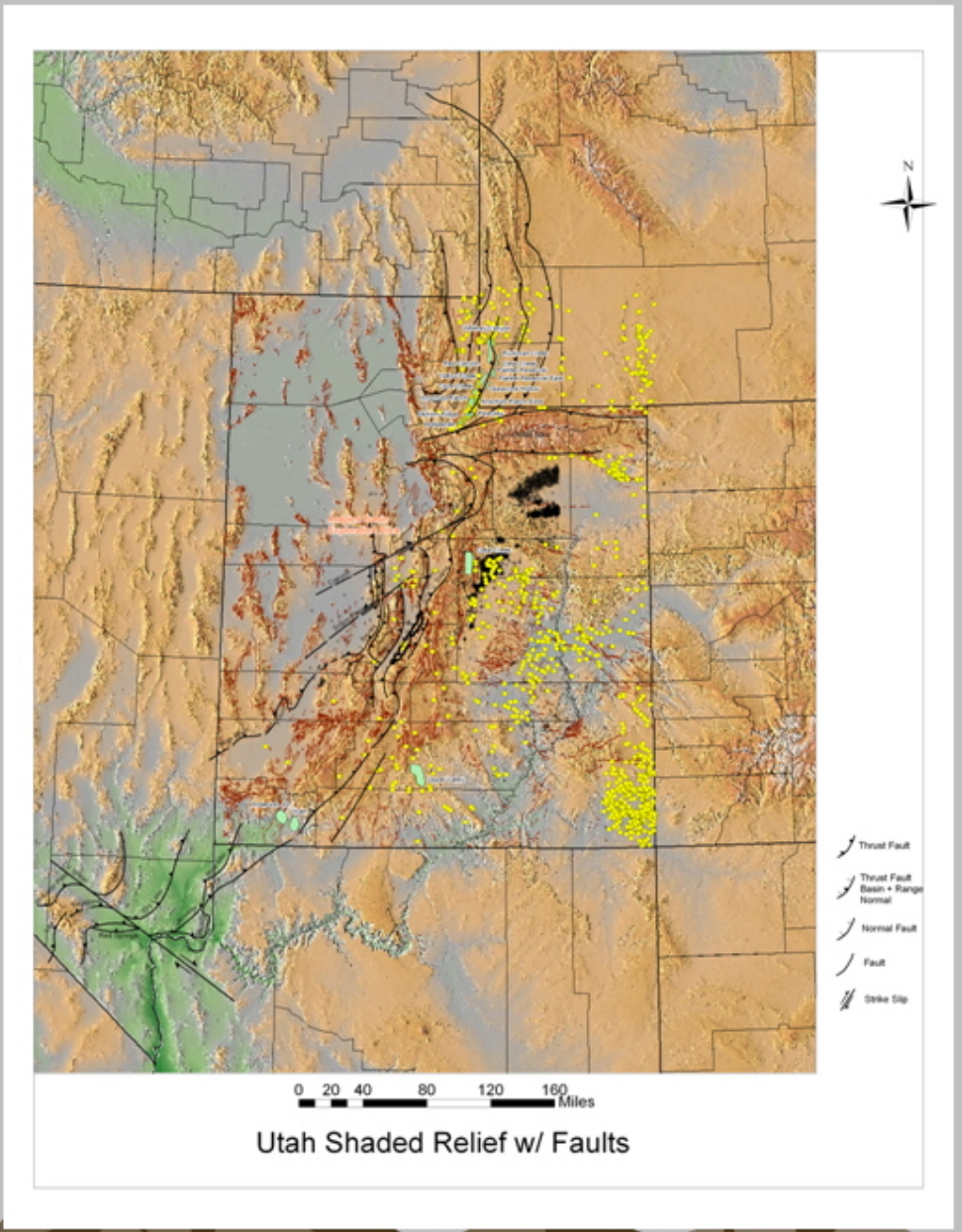

Digital Geologic Map of Utah
by
Lehi F. Hintze, Grant C. Willis, Denise Y. M. Laes,
Douglas A. Sprinkel, and Kent D. Brown,
Utah Geological Survey
2000

Utah Hingeline and Thrust Belt Province

Sevier County



- Utah Hingeline –Paleozoic Shelf Margin
- Wolverine Federal Unit – 65,980 acres
- Hydrocarbon Play
- Covenant Field – KMR 17-1



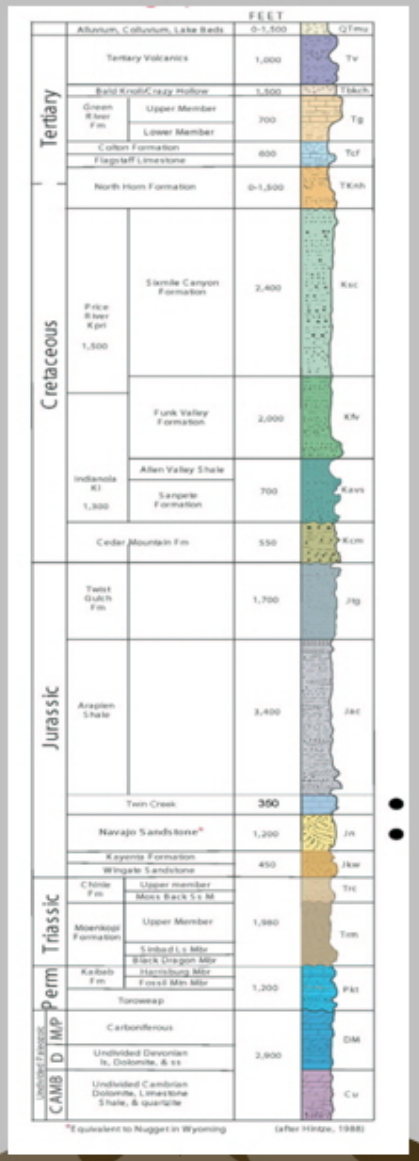
Utah Shaded Relief w/ Faults

- Wyoming/NE Utah Thrust Belt
  - Fadel Gheit (Oppenheimer):

    "It's very unlikely because U.S. onshore has been picked clean, if you will…

    That's like finding a wallet in the subway after all the cleaners went through it. It's possible, but very unlikely."

Sevier County Stratigraphic Section

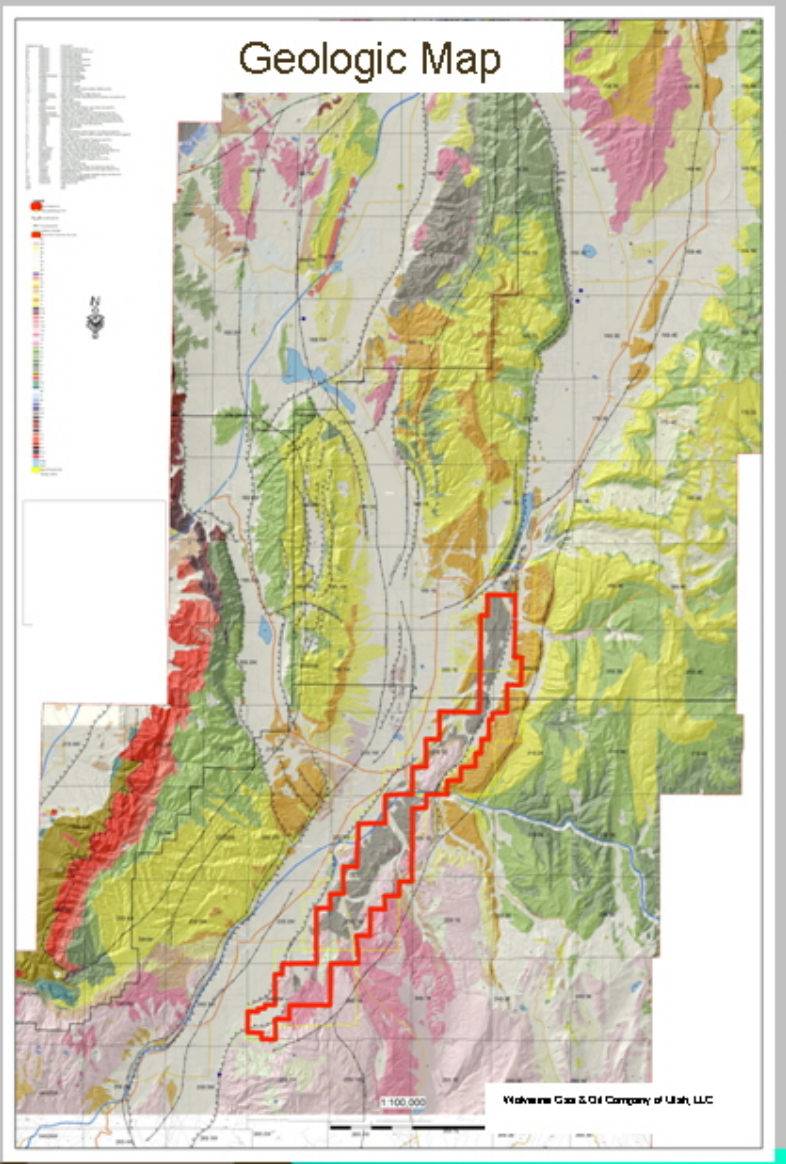


Seal: Arapien
5,550 ft

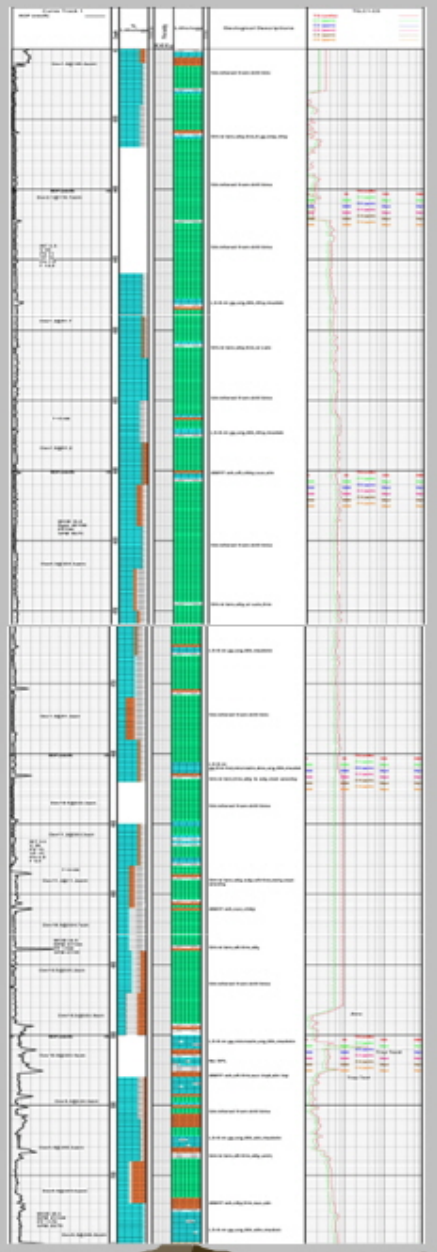
Reservoir: Navajo
1,200 ft
Twin Creek
350 ft

Arapien Valley Bedrock Geology

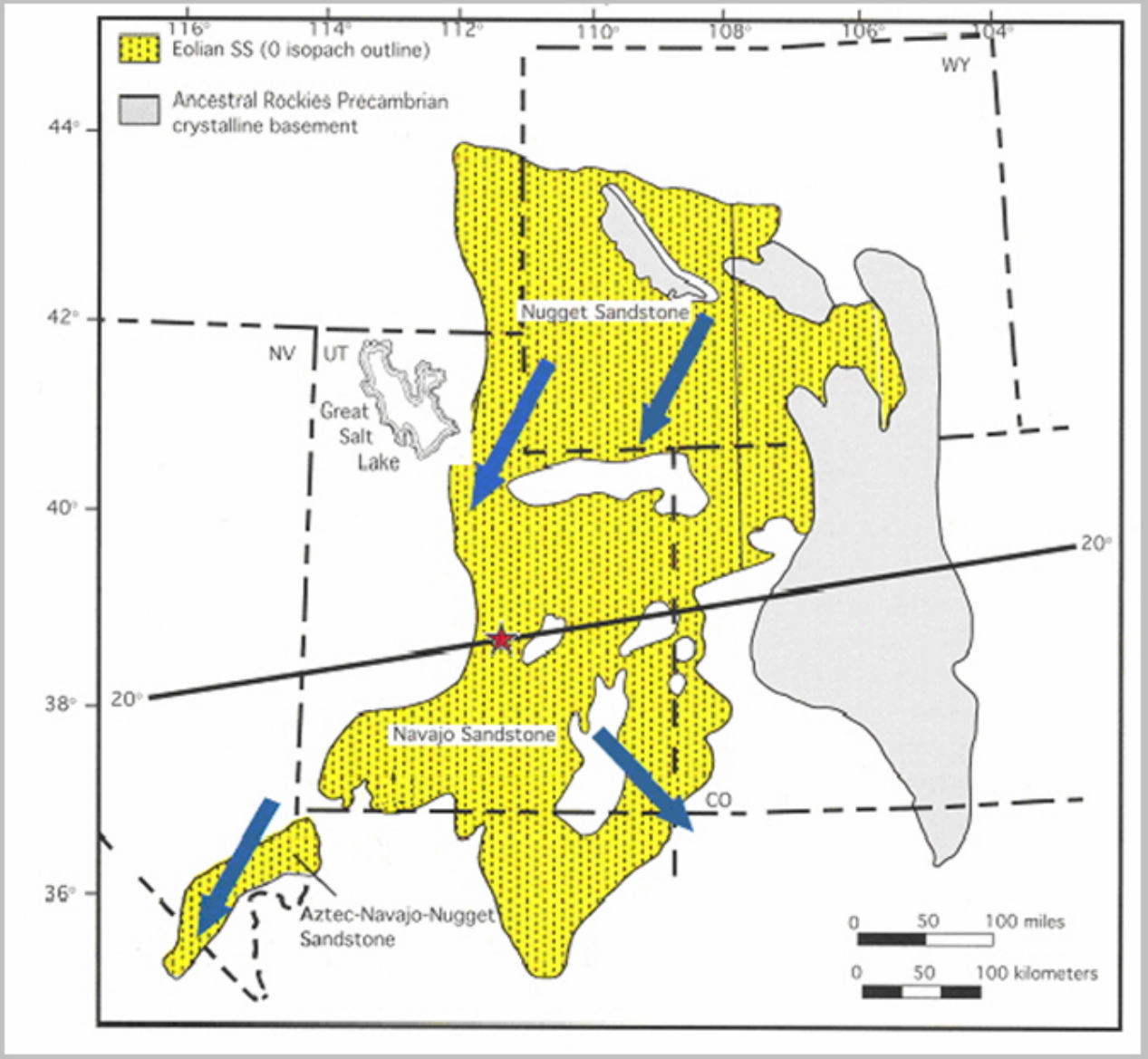
Arapien Outcrop as first mapped by Dutton, 1870



Arapien Seal



Fed. 17-2 Mudlog
4300' – 5000'

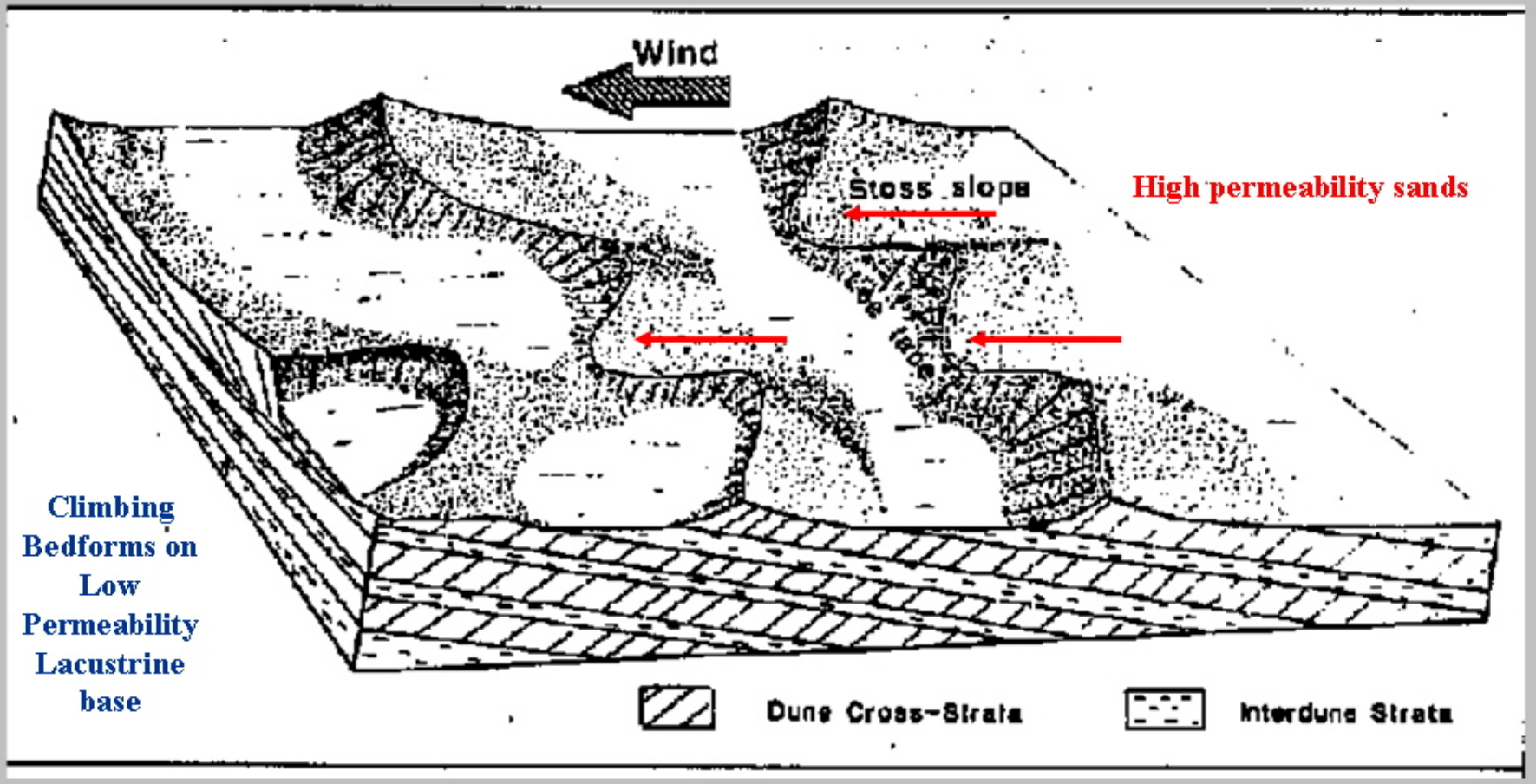


Reservoir:

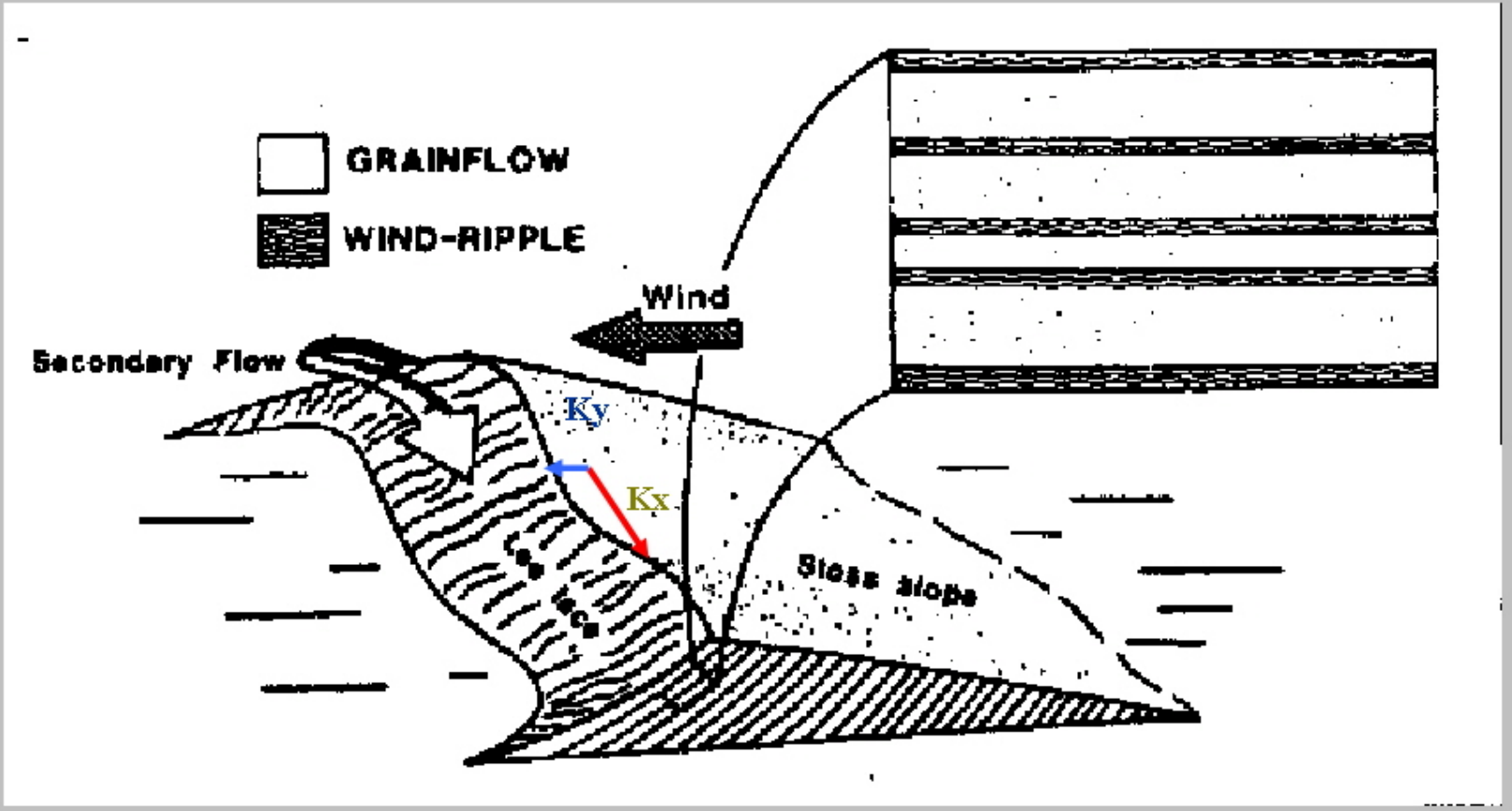
Navajo

Navajo Sandstone Outcrops

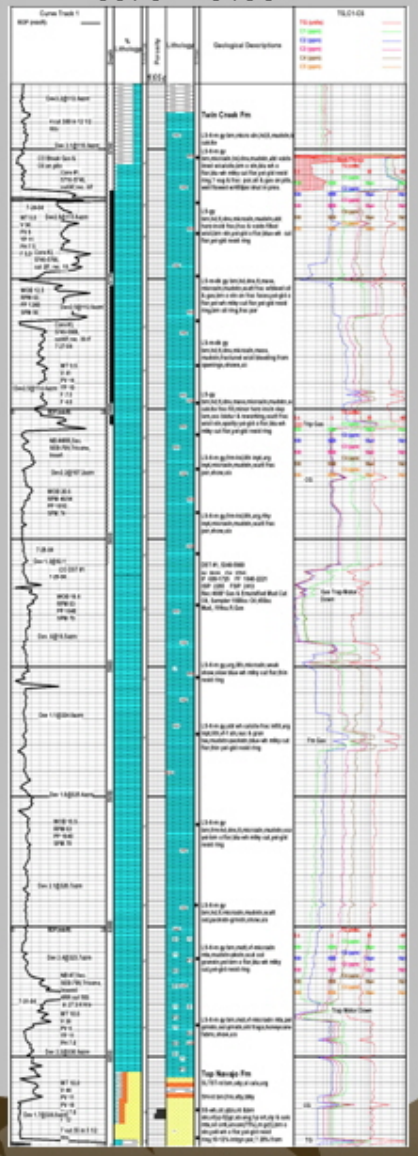
Inter-dune Coarse Deposits



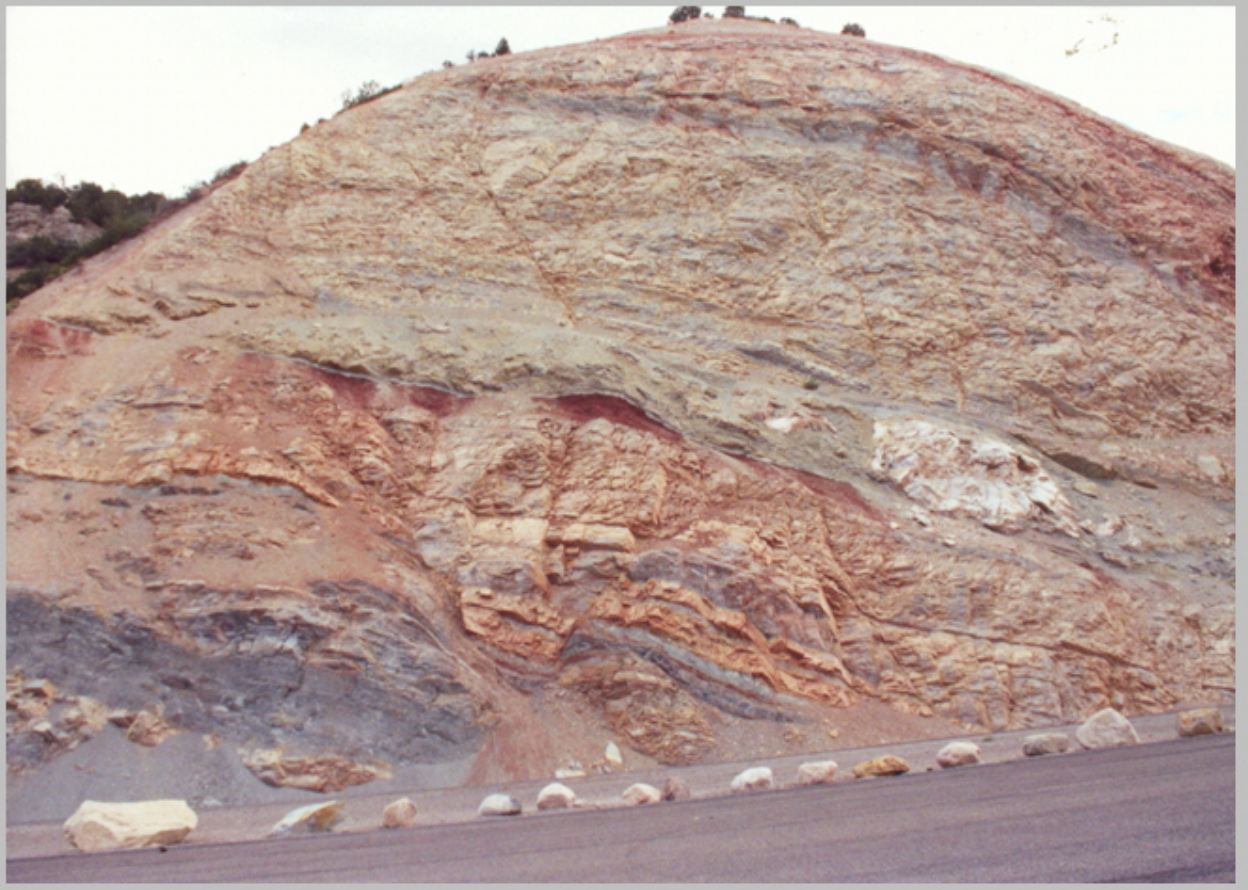
Aeolian Anisotropy



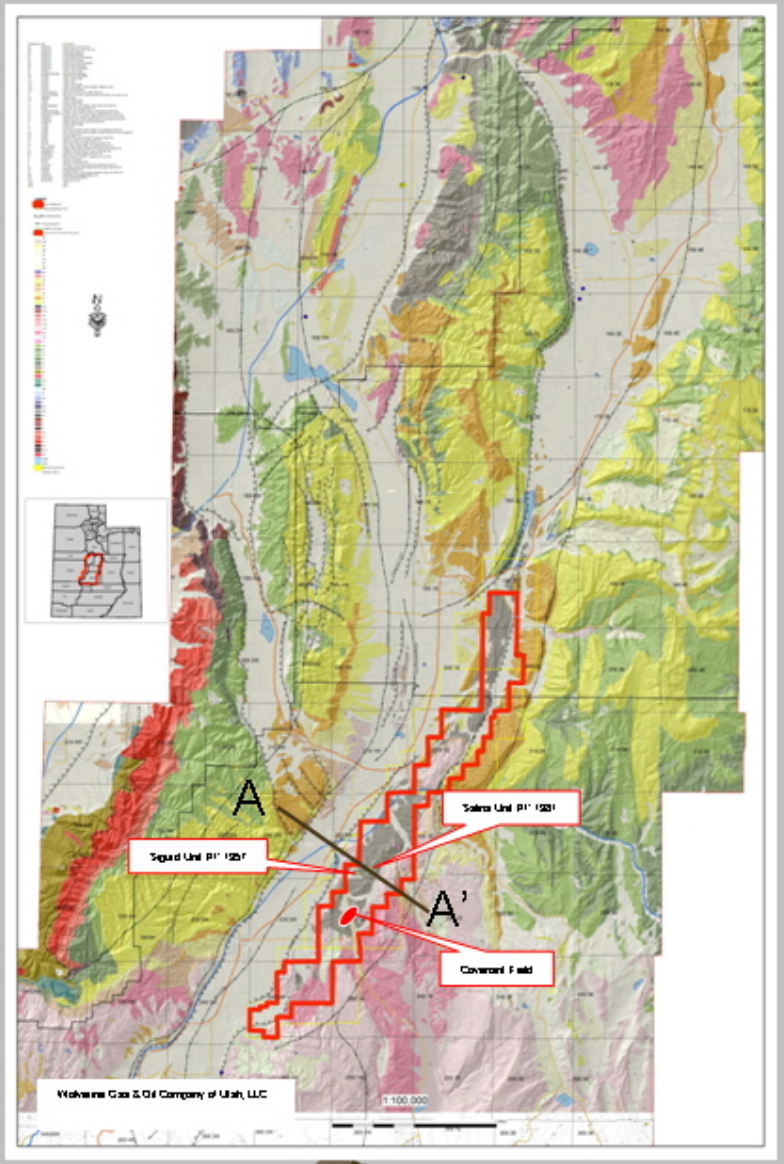
Fed. 17-2 Mudlog
5675' – 6100'



Reservoir: Twin Creek

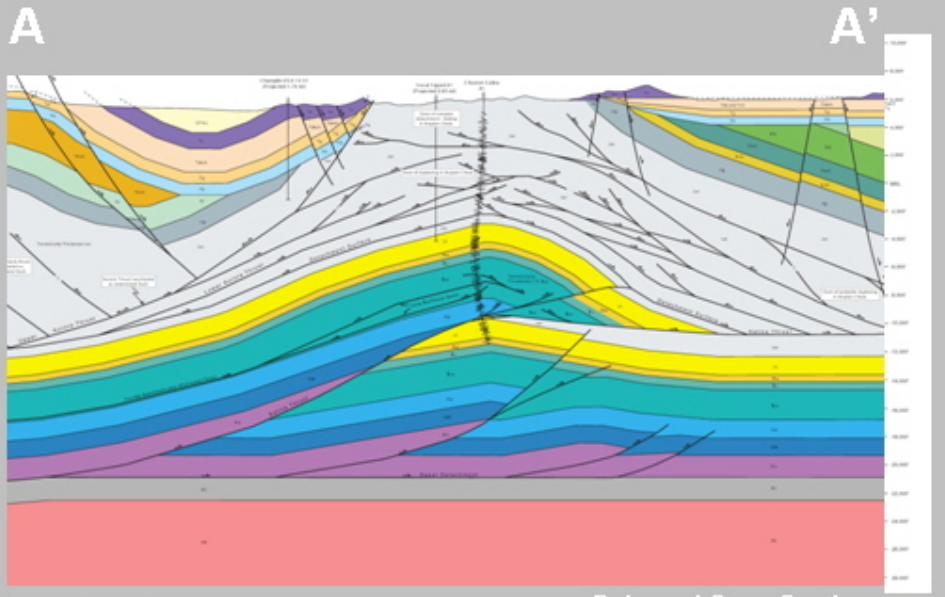


Geologic Map



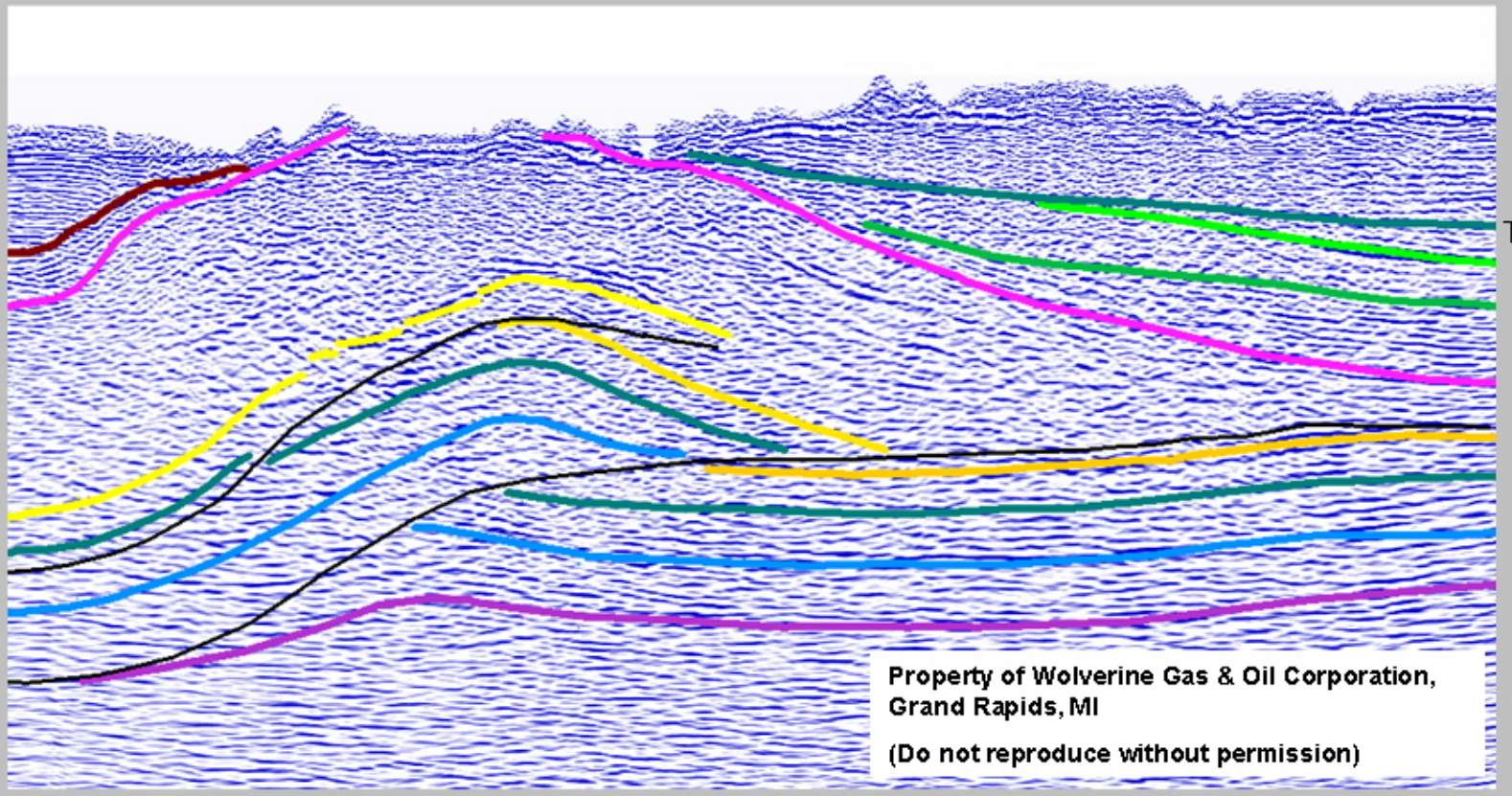
Pre-Drill Geology

- **Pre-Drill, hanging wall anticline target at 7,200 feet**
- **1981 Chevron well – 17,423' (hanging wall and footwall)**
- **Modeled as simple fault-bend fold**

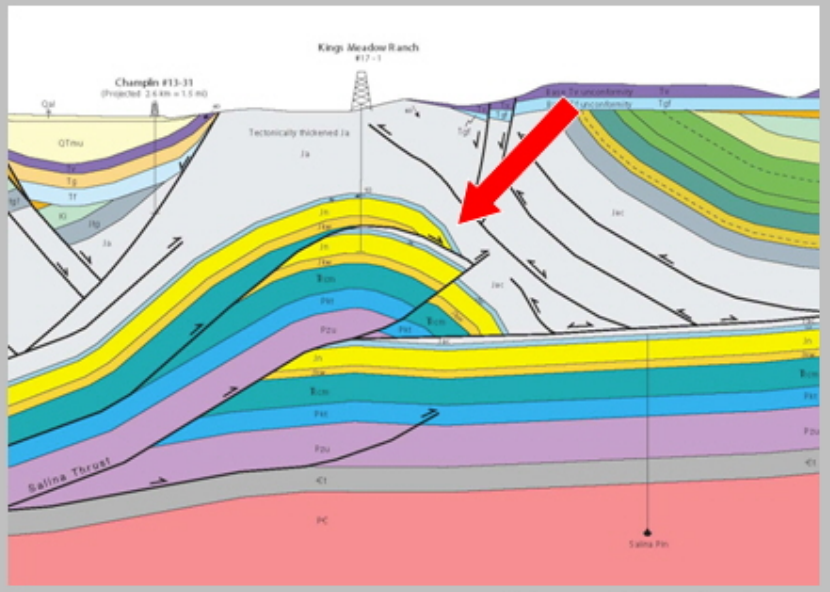


Balanced Cross Section
D. Schelling, 2001

Seismic line over anticline
Post-Drill

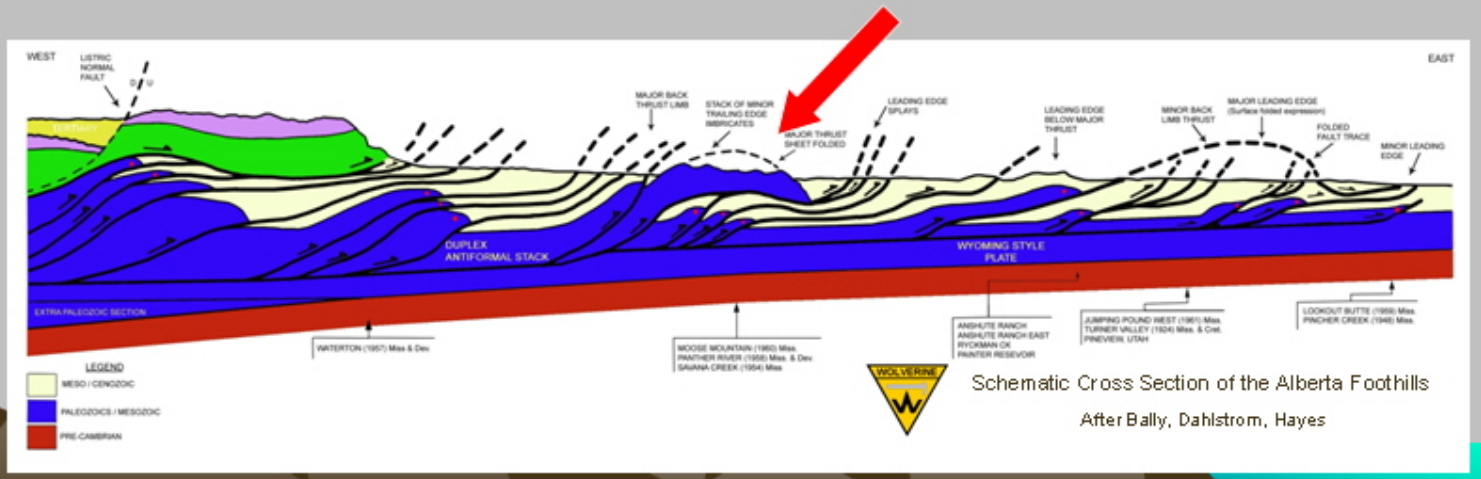


Post-Drill Geology



Balanced Cross Section
D. Schelling, 2004

- Post-Drill – duplexing of hanging wall
- Repeated Navajo
- Similar to Alberta Foothills structural style



Schematic Cross Section of the Alberta Foothills

After Bally, Dahlstrom, Hayes

“TRAP” Summary

Salina structure = large-scale fault bend fold

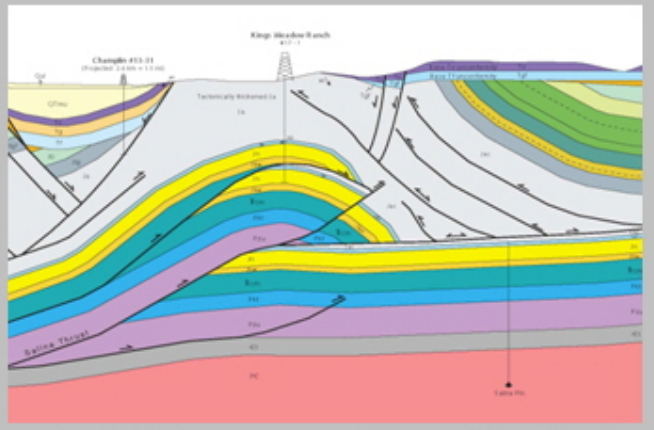
Passive-roof duplexing w/ detachment in Arapien

Tectonic repetition of Navajo section

Tertiary extensional faulting along Arapien detachment

Sequential unconformities define structural evolution of Salina trend

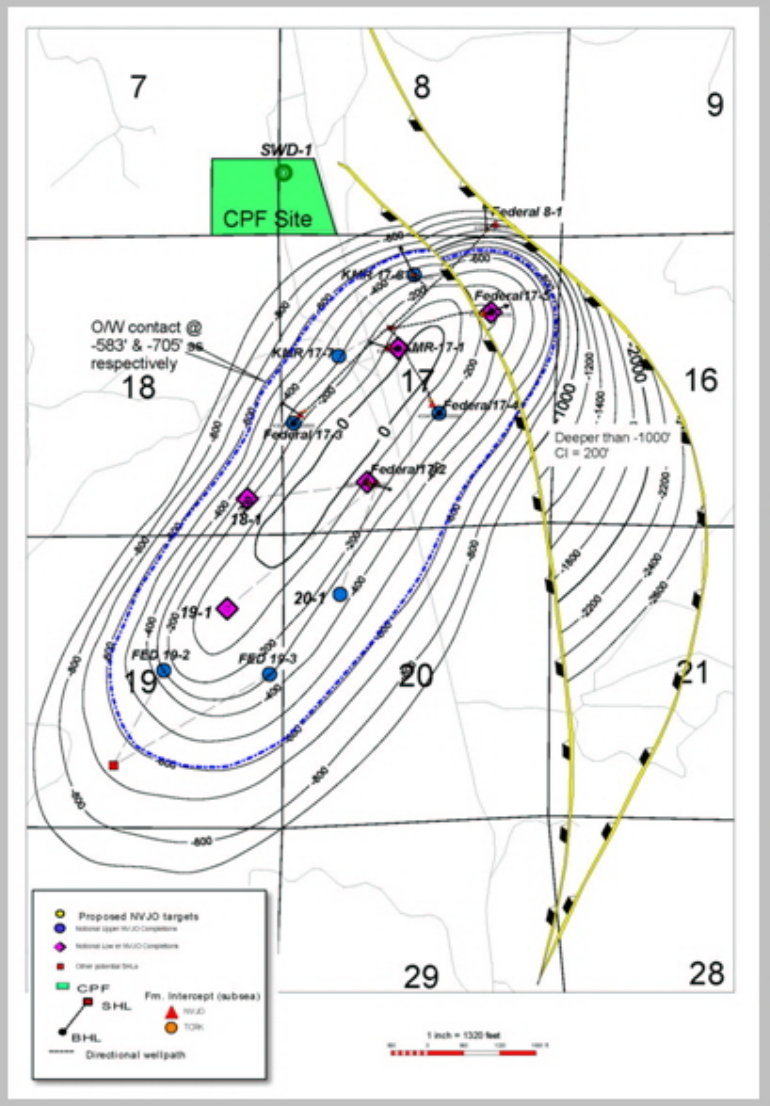
Role of thin-skinned deformation, passive-roof duplexing, and extensional faulting critical to trap-development at Covenant field



Arapien Shale
Navajo Sandstone

Balanced Cross Section
D. Schelling, 2004

Covenant Field Status (May 24th 2005)

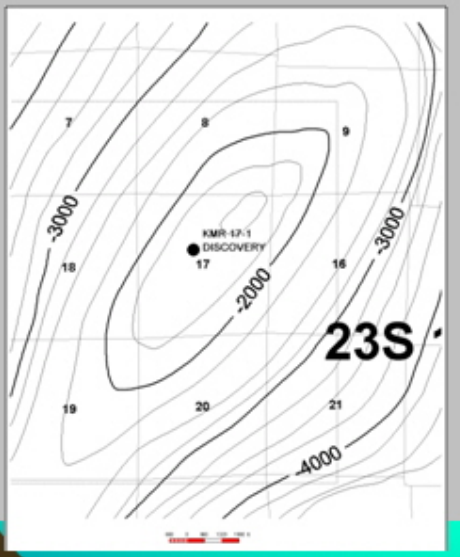


Navajo Structure (ss)
and proposed drilling

Wells drilled in oil pay (6)
Production rates (2 wells)
1600 bopd
160 bwpd
40 API oil: low GOR

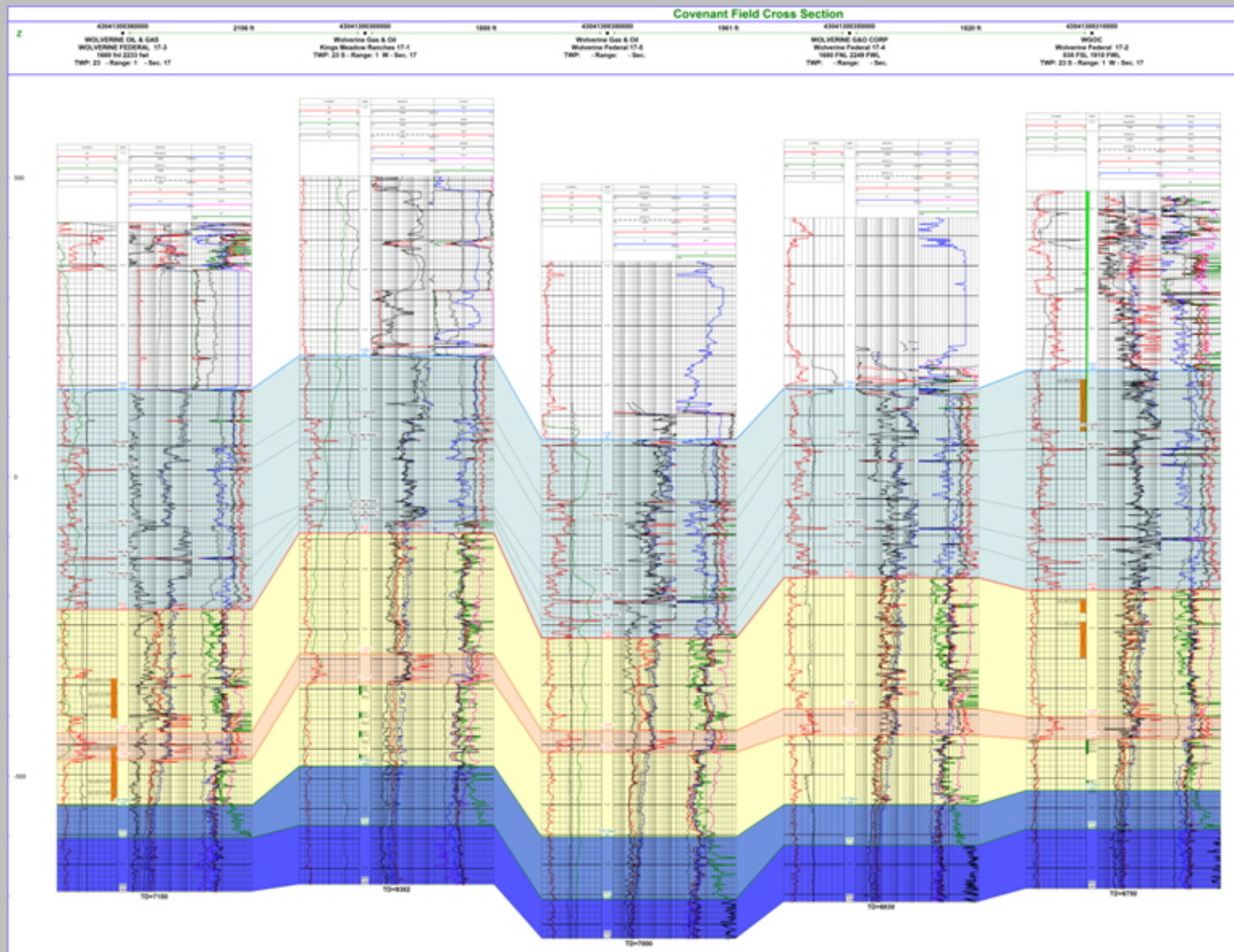
Cum Production 5-2004 to date:
286,479 BO for KMR 17-1
2,977 BW
397,698 BO for field

Offset tests to drill (6) from
2 surface pads
5,000 bopd CPF on line in Fall



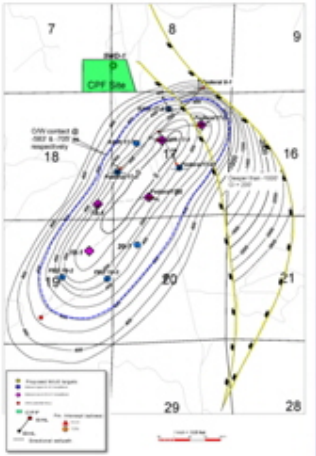
Navajo Structure
Pre-Drill (ss)

Covenant Field Cross Section

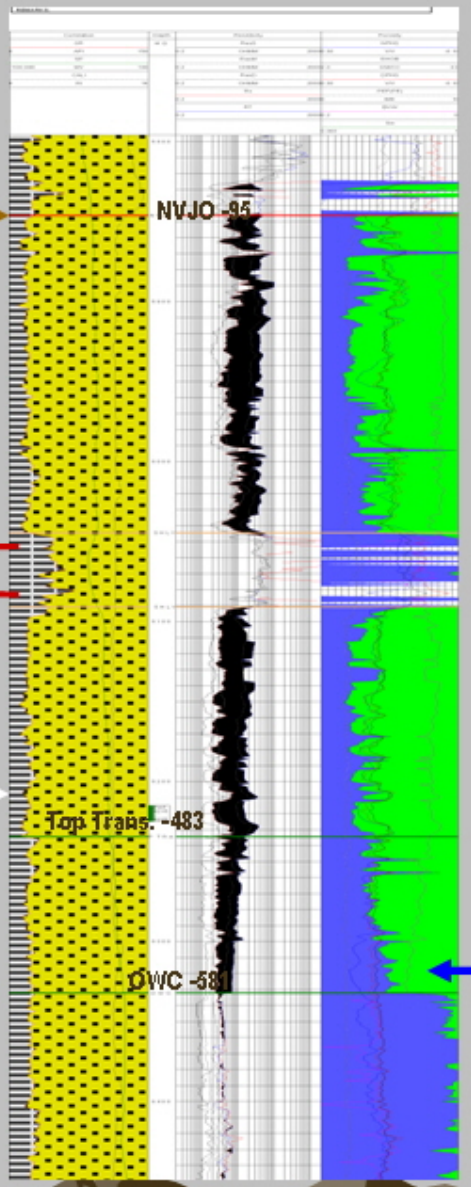


We have drilled a small fault in the field.

Notice the oil/water contact in the 17-5 is 122 feet lower than the other wells.

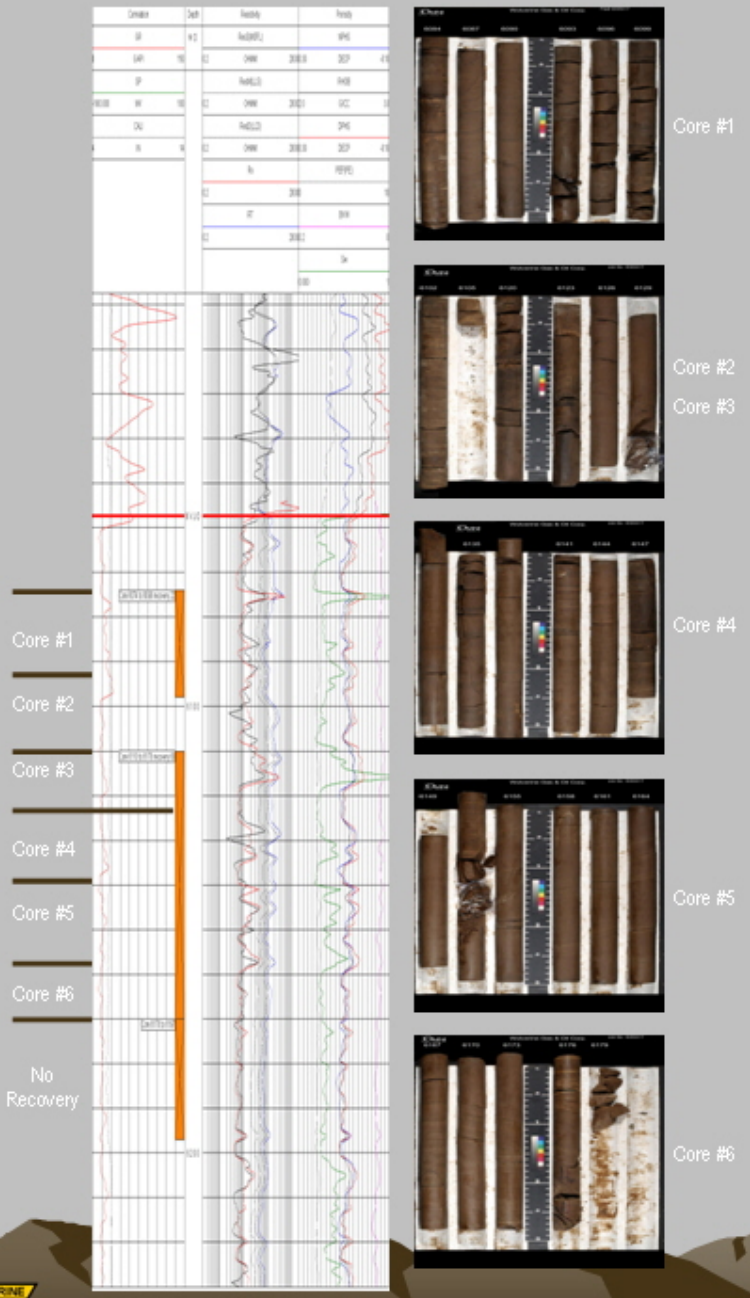


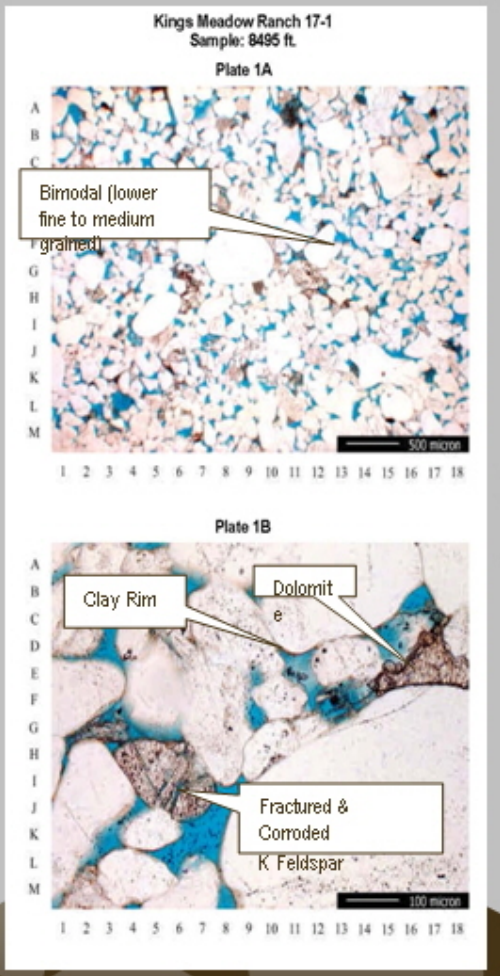
KMR 17-1 Petrophysics

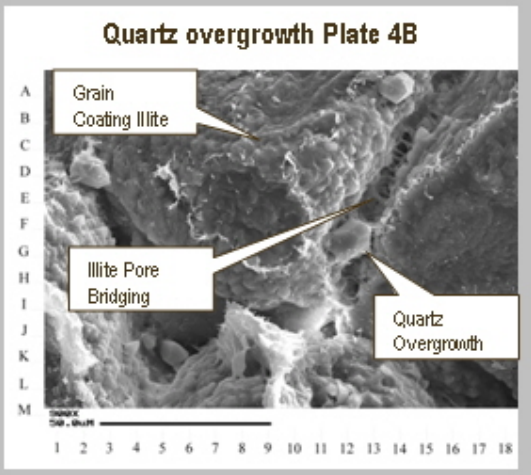


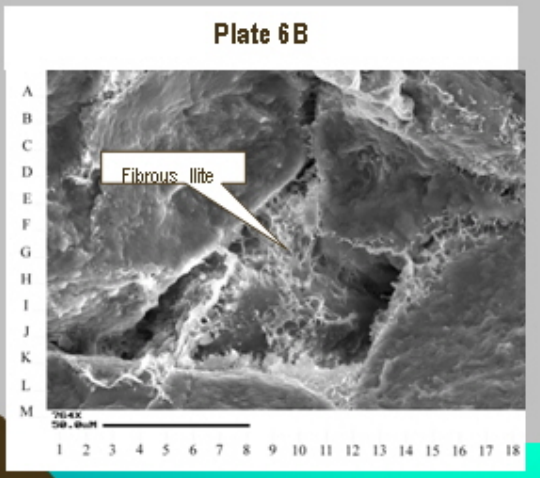
- Gross pay: 487’
- Net pay: 424’
- Average porosity: 12%
- Average Sw: 38%
- Net to Gross: 0.87
- Perm – up to 100mD
- Water Drive

• NVJO KMR 17-1 & Federal 17-2 Core Data

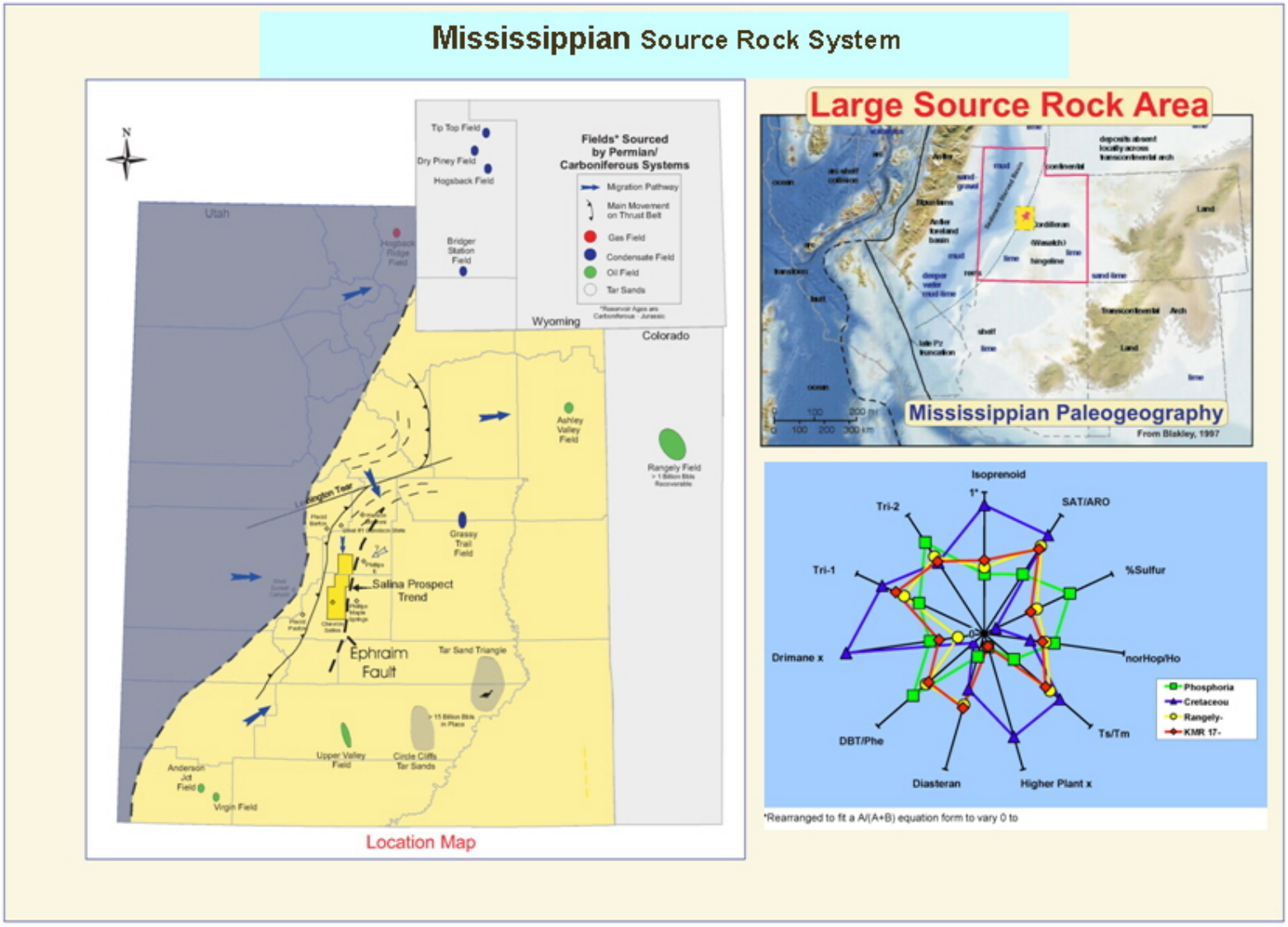




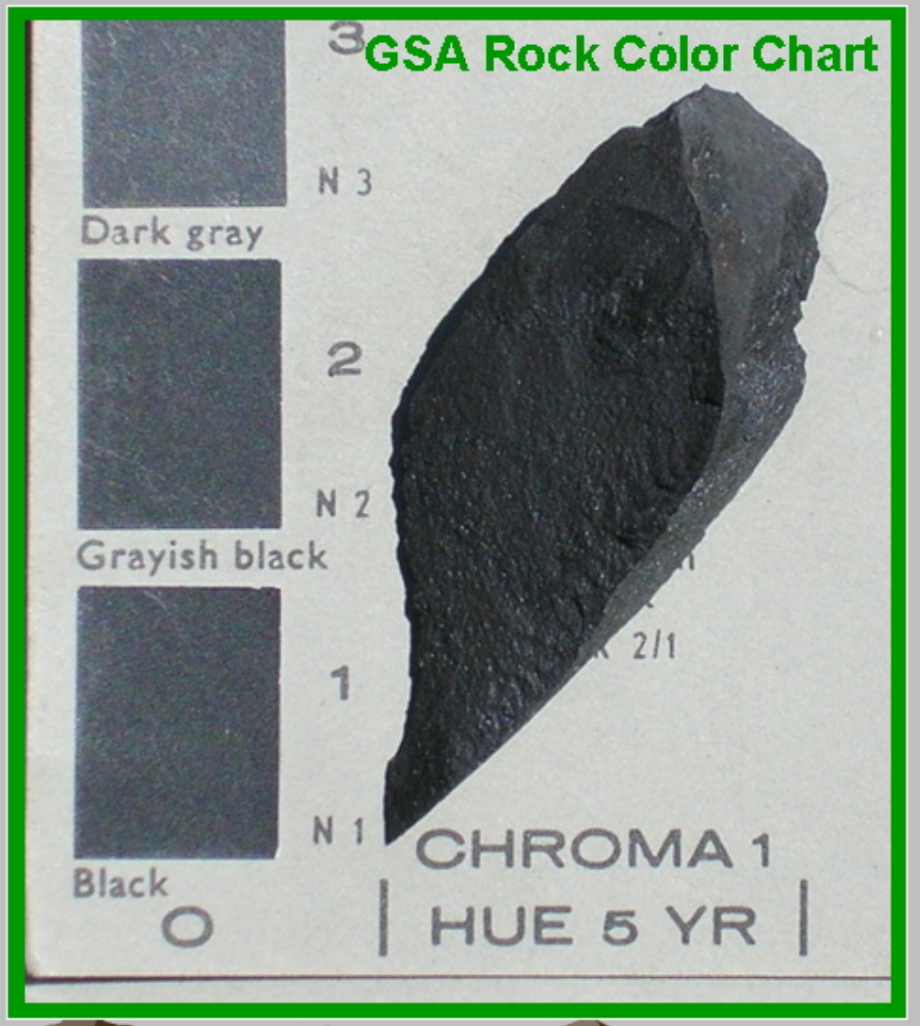




• Mississippian Paleogeography



New Paradigm SOURCE ROCK
Mississippian Formations

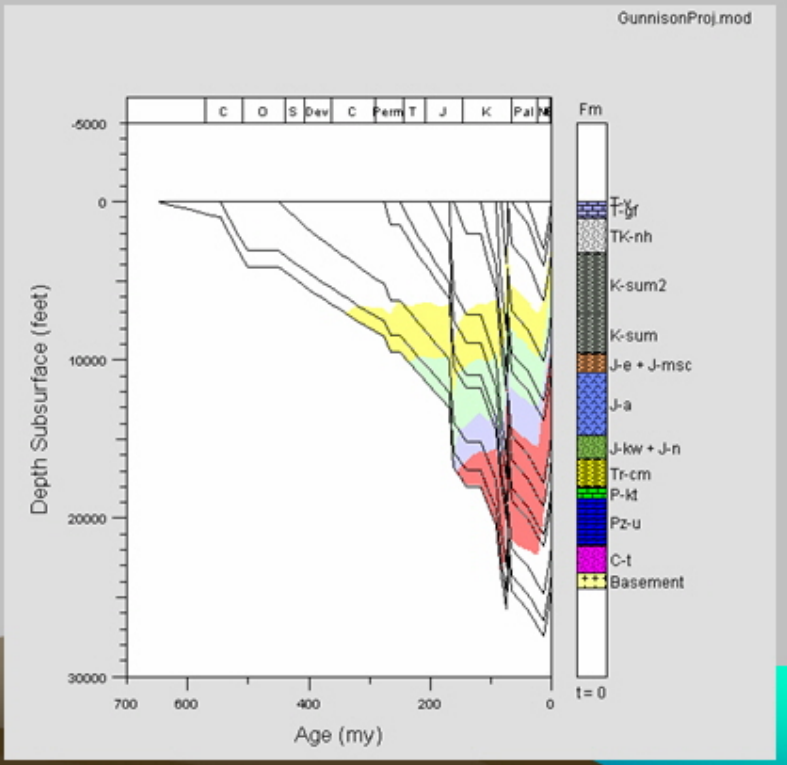


Summary:

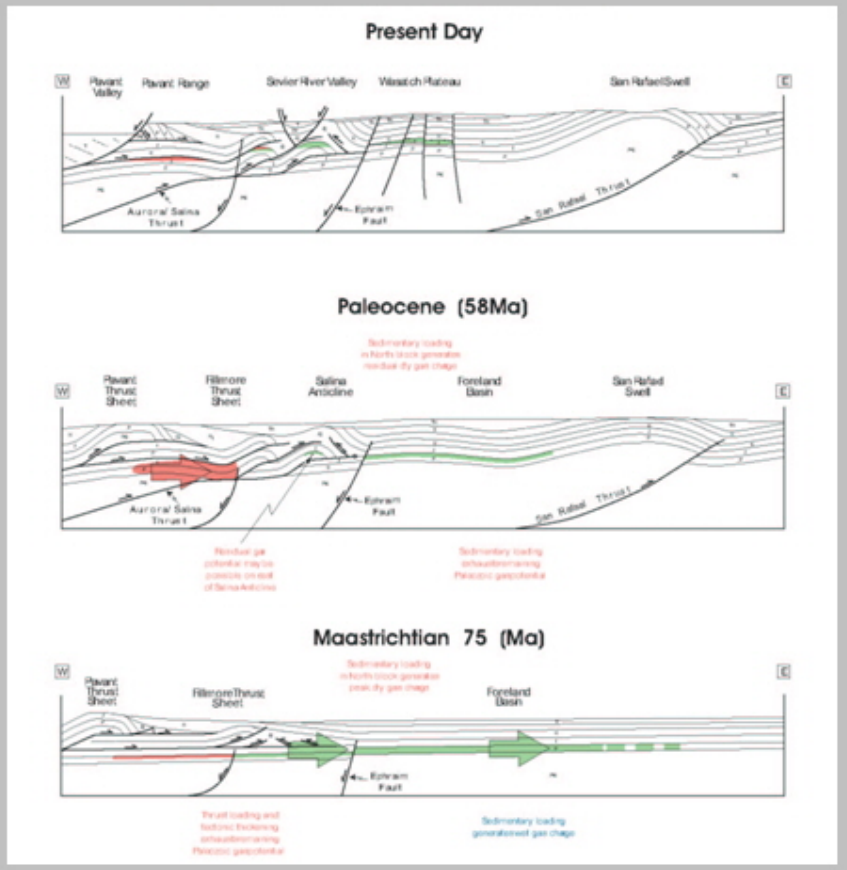
- measured over 15%TOC
- corrected (PG) 25% TOC
- 1000+ ft over 2% TOC
- highly oil-prone OM

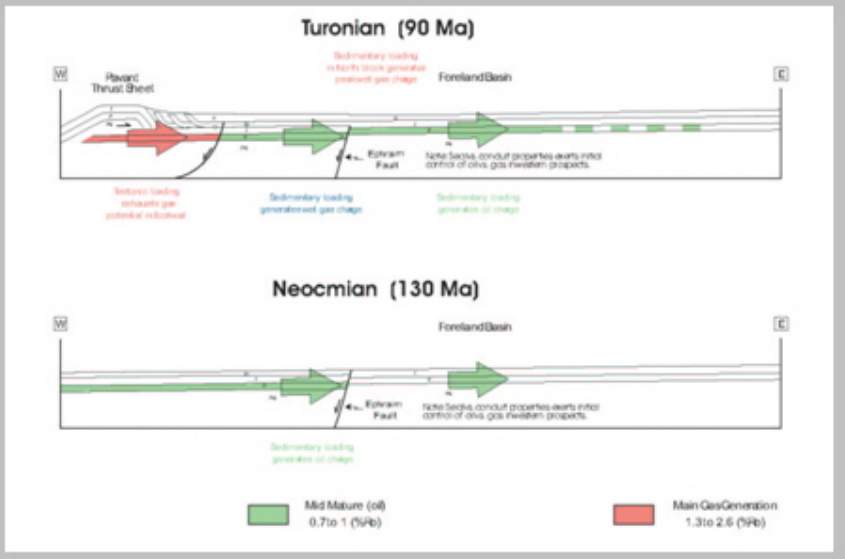
Hydrocarbon Generation – How it got started!

Neocomian (130 Ma) initial oil generation by sedimentary loading
Turonian (90Ma) initial "tectonic" loading drives gas generation
Foreland areas with rapid sediment loading provide wet gas charge
In short, the key to commercial charge is determining the formation of the trap in context of the evolving kitchen areas (vs. burned out kitchens and fault cutoff migration pathways)



Schematic Deformed and Restored Tectonic Cross Sections





revised from Wavrek (2001)

Federal Unit Prospect Generation Timeline

1957	Chevron drills Sigurd Unit #1	
1981	Chevron drills Salina Unit #1 – great dipmeter and good analog for lithology	
1995 & 1997	Chevron acquires seismic data	
2000	Wolverine buys acreage from Chevron	
(April)	SEISMIC	License 120 miles Chevron (reprocess – map)
	GEOLOGY	Regional/Prospect
2001	GEOCHEM Source study	
	STRUCTURE	Timing of hydrocarbon migration
2002	FIND DRILLING PARTNERS	
		N.A.P.E. (Houston)
		Prospect Exchange (Calgary)
2003		N.A.P.E. (Houston)
		Prospect shown to 65 Companies
(July)	FORM FEDERAL UNIT	
(Nov)	SPUD	Wolverine Gas and Oil - Kings Meadow Ranches 17-1
2004	Complete discovery	
2005	Develop Covenant Field	

Finding costs (leasehold, G&G, drilling and completion):

$5.5 million

Fully developed costs (Covenant Field):

$56.3 million