



# **Geological Evaluation of the Cane Creek Shale, Pennsylvanian Paradox Formation, Paradox Basin, Southeastern Utah**

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**Utah Geological Survey**

**Project Funded by:**  
**U.S. Department of Energy – National Energy Technology Laboratory**  
**and Utah Geological Survey**



# Purpose and Rational of Study

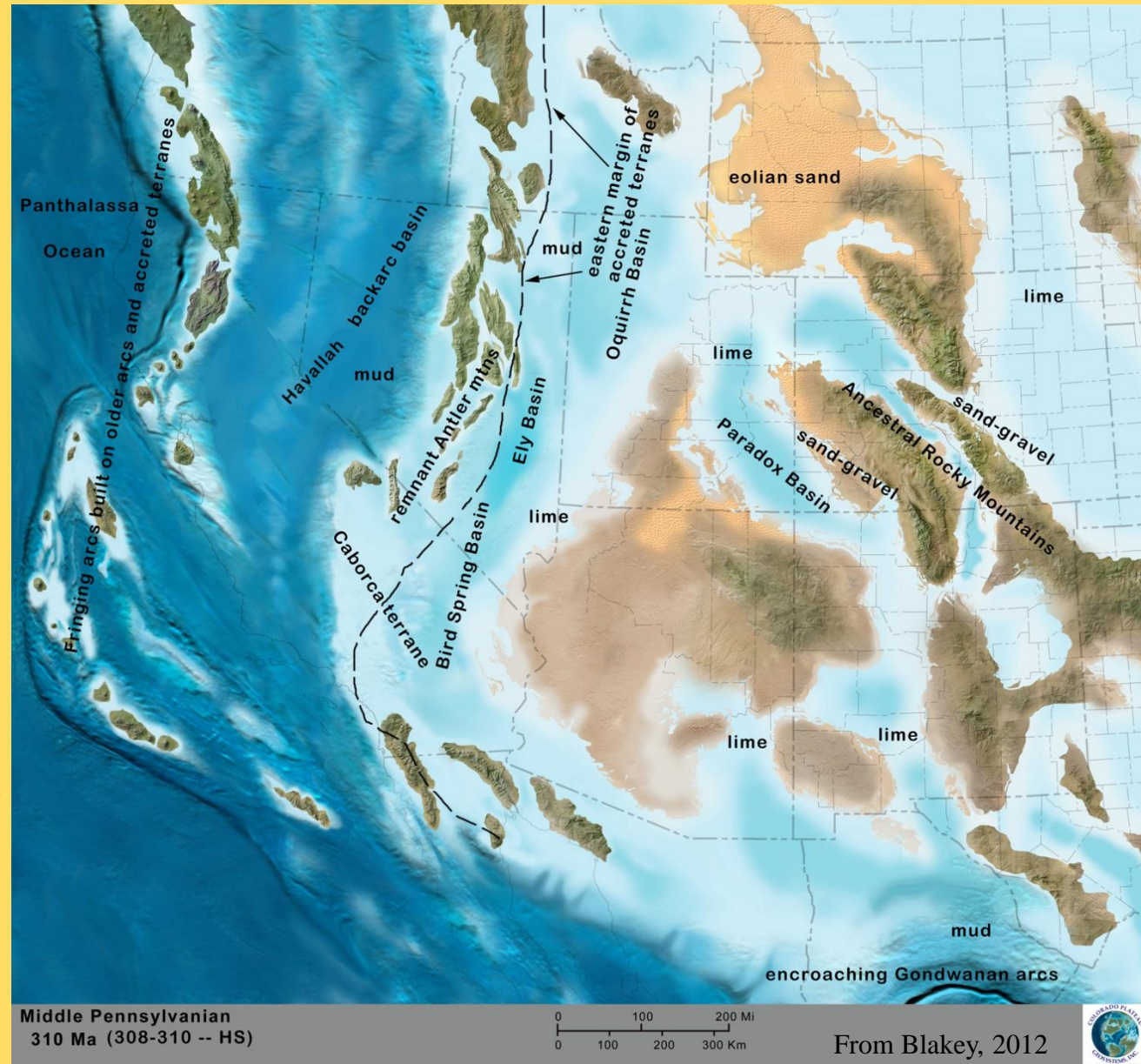
- Goals:
  - To gain insight into the geological, geochemical, and geomechanical rock properties of Cane Creek shale.
  - To further define the play and the reservoir characteristics
- Limited research has been conducted or published
- 103 million barrels oil (95% confidence) undiscovered in Cane Creek shale (USGS 2012 Assessment)

# Study Resources

- Data compiled from over 160 wells
- Access to core from seven wells and cuttings from over 30 wells
  - Detailed core descriptions
  - Geomechanics and geochemistry
    - Rock mechanics (headed by Energy and Geoscience Institute, University of Utah)
- Data from industry
  - Fidelity E&P Company
  - CCI Paradox Upstream, LLC

# Paradox Basin

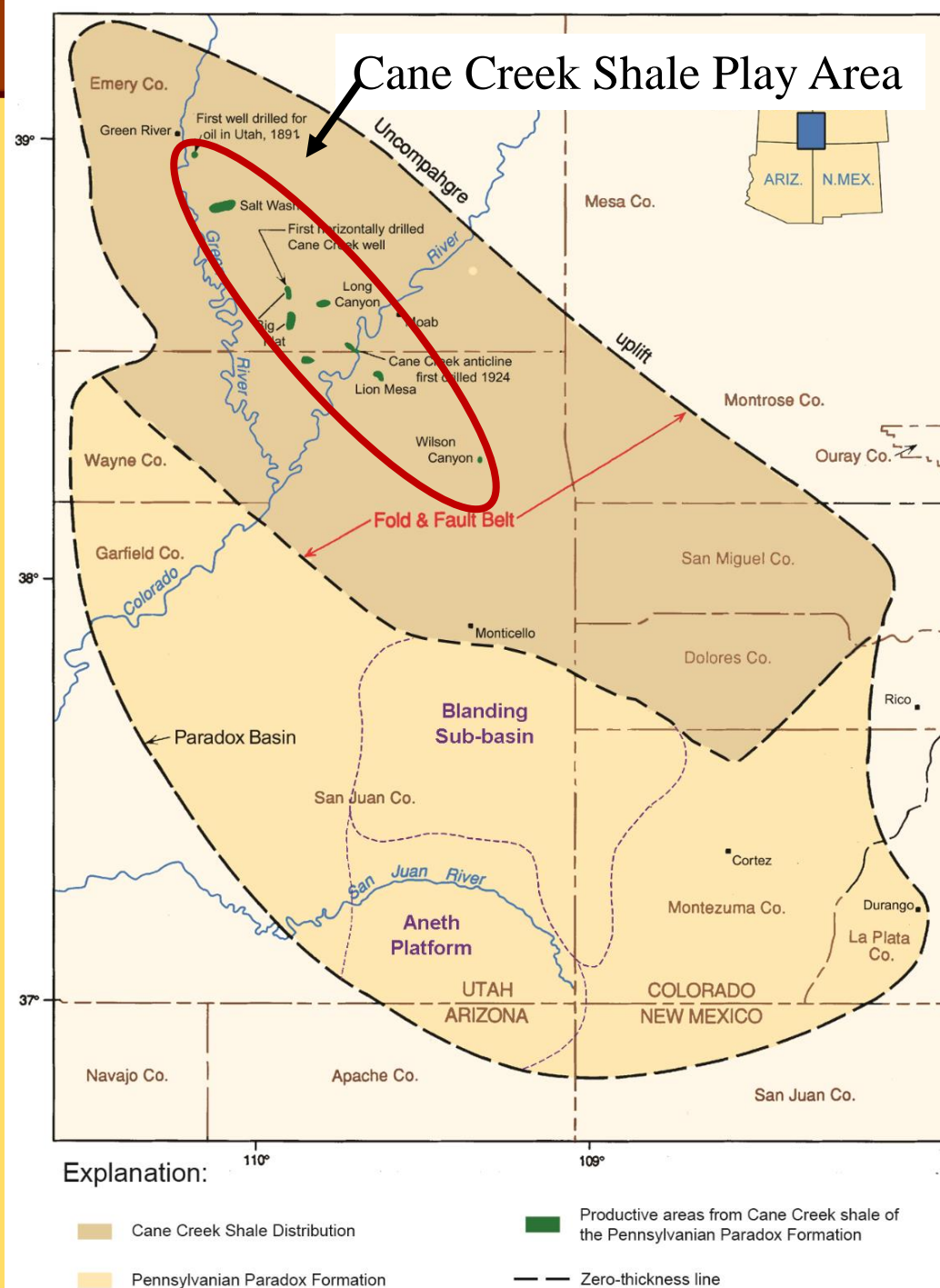
- Pennsylvanian
- Coupled to Uncompahgre uplift
- Sediments record alternating marine flooding – evaporation events





# Paradox Basin

- Pennsylvanian
- Coupled to Uncompahgre uplift
- Sediments record alternating marine flooding – evaporation events



# Stratigraphy of Paradox Fm

- 500 to 5000 ft thick
- 29 or more salt/clastic cycles
- Clastic cycles - interbedded dolomite, dolomitic siltstone, anhydrite, and black, organic-rich shale
- Cane Creek shale base of cycle 21

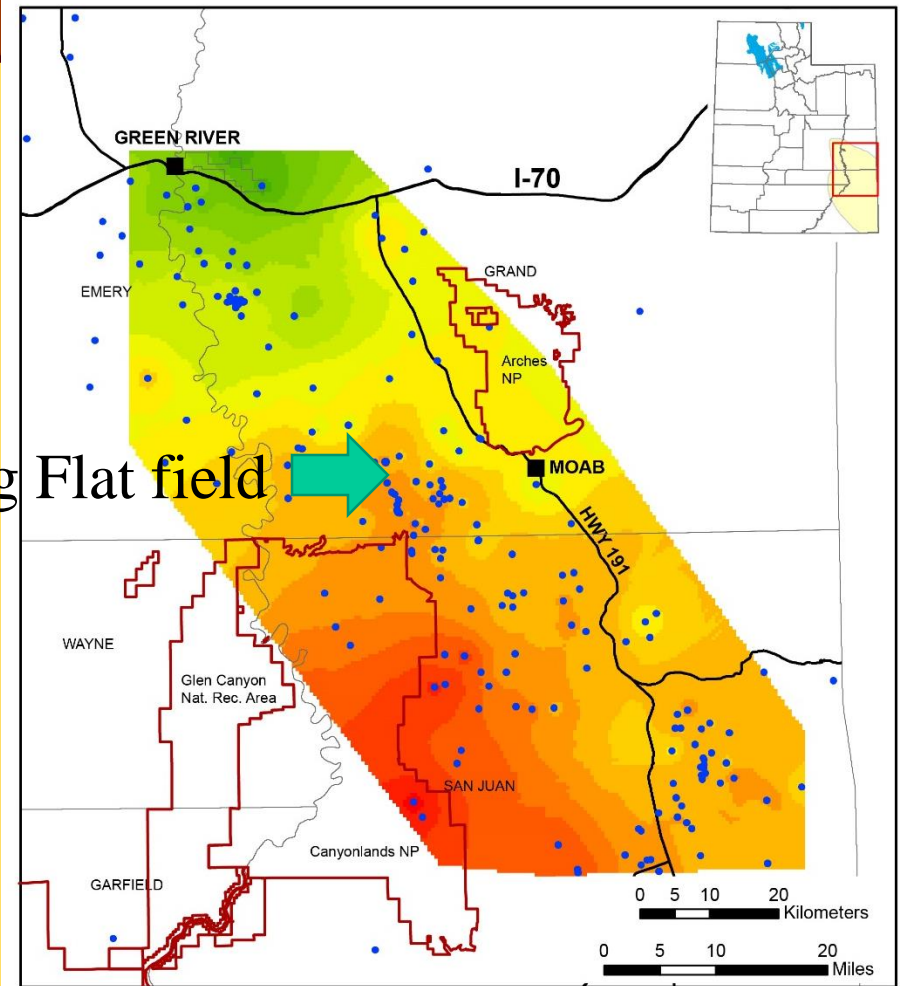
PENNSYLVANIAN			SYSTEM							
Atokan	?	Desmoinesian	Missourian	Virgilian	SERIES					
	HERMOSA									
Pinkerton Trail	Paradox	upper	Honaker Trail	FORMATION	MEMBER	ZONE	EVAPORITE CYCLE			
								lower	middle	
Ismay	2	Hovenweep								
								3	Gothic	
			Desert Creek	4				5	Chimney	
				6				7	Rock	
			Akah	8				9		
				10				11		
			Barker Creek	12-13				14		
				15				16		
				17				18		
				19				20		
				21				22-23	Cane Creek	
			Alkali Gulch	24				25		
				26				27		
				28				29		

Modified from Hite, 1960.

# Cane Creek Structure

- Deeper in north part of study area
- Shallow near western edge/shelf of basin
- Majority of production from Big Flat area

Big Flat field



- Cane Creek Penetration
- City
- Road
- National Park Boundary

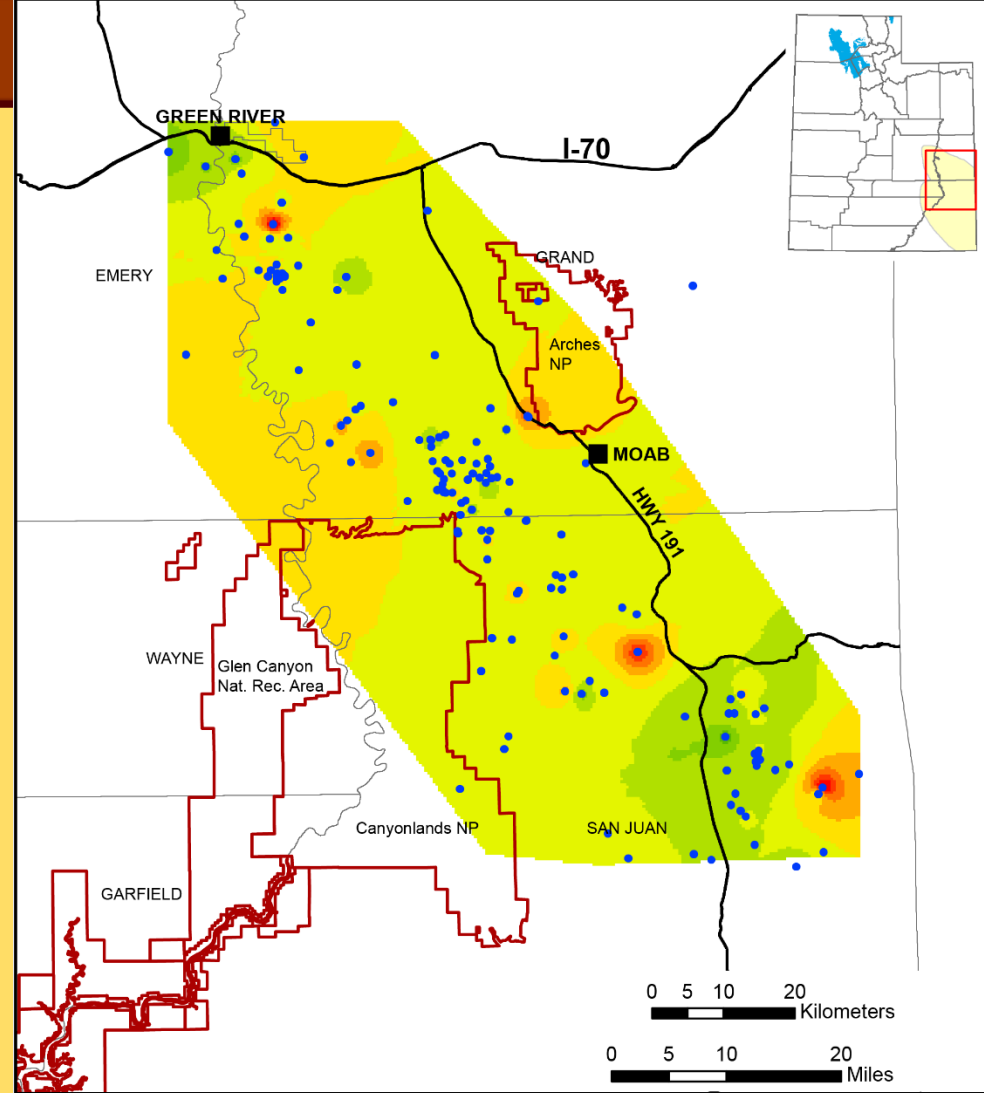


Structure Top of Cane Creek Shale (feet)



# Cane Creek Thickness

- Average = 90 feet
  - 120+ feet thick
- Thickest spots possibly due to faulting in fold/fault belt of basin
- NW-SE trending “fairway”



- Cane Creek Penetration
- City
- Road
- National Park Boundary



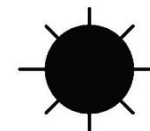
## Thickness of the Cane Creek Shale (feet)

0-20	100 - 120
20 - 40	120 - 140
40 - 60	140 - 160
60 - 80	160 - 180
80 - 100	180 - 200

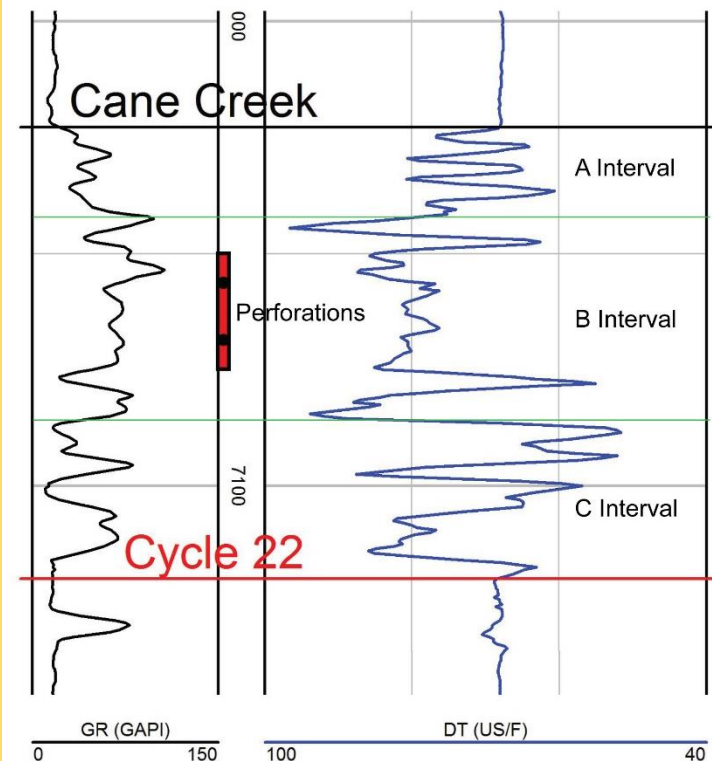
# Type Log of Cane Creek

- **A Interval (seal)** –silty dolomite with thin organic-rich shale and abundant anhydrite
- **B Interval (reservoir)**–silty dolomite with thin organic-rich shale and minor mottled anhydrite
- **C Interval (seal)**–silty dolomite with abundant anhydrite and minor shale

4301915925  
Southern Natural Gas Co  
Long Canyon, #1



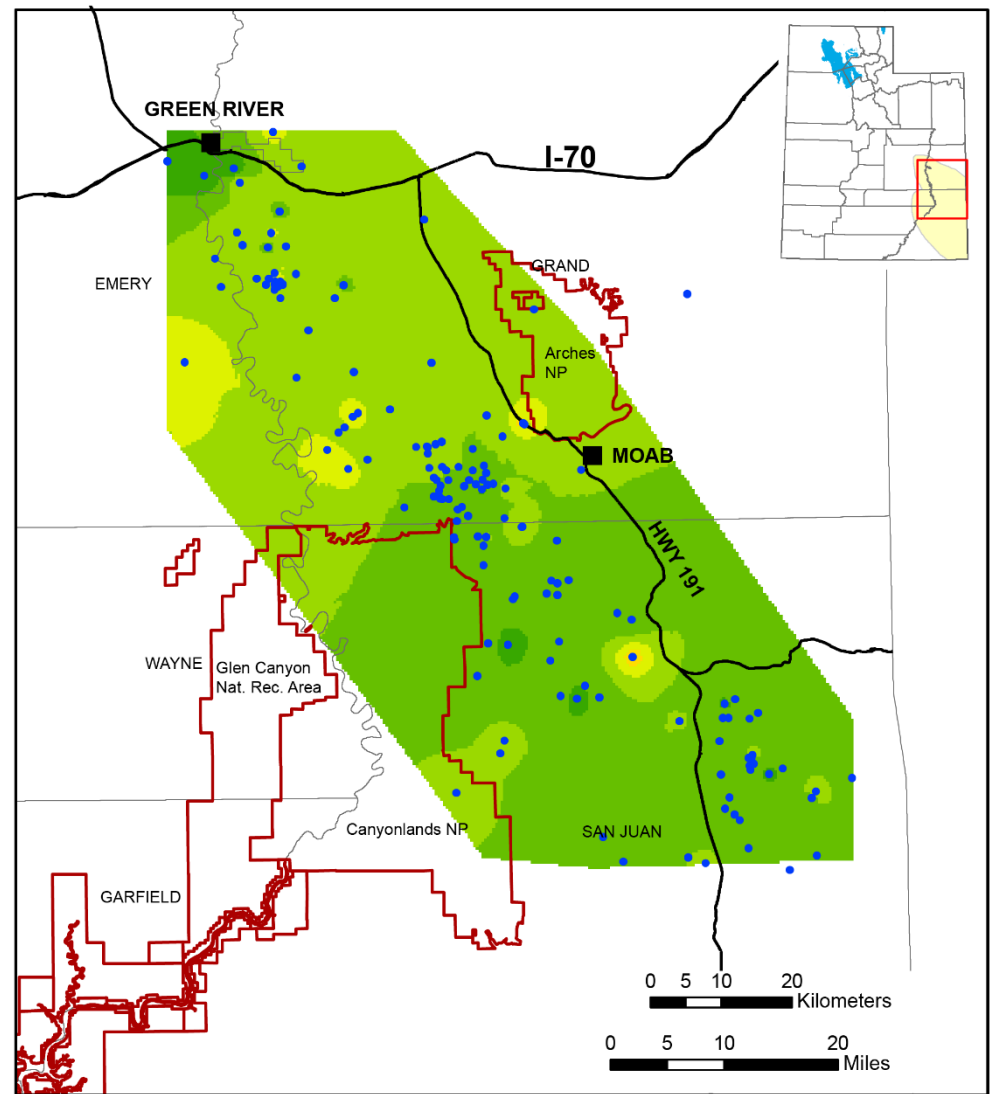
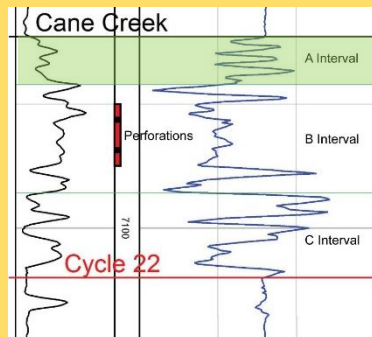
TD 8130 FT  
KB 5794.0 FT





## A Interval

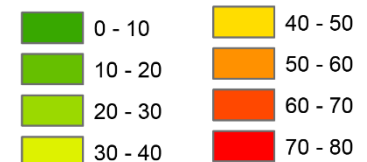
- Upper seal
- Generally thicker to north
- Thickness range = 10 to 84 feet
- Average thickness = 31 feet



- Cane Creek Penetration
- City
- Road
- National Park Boundary

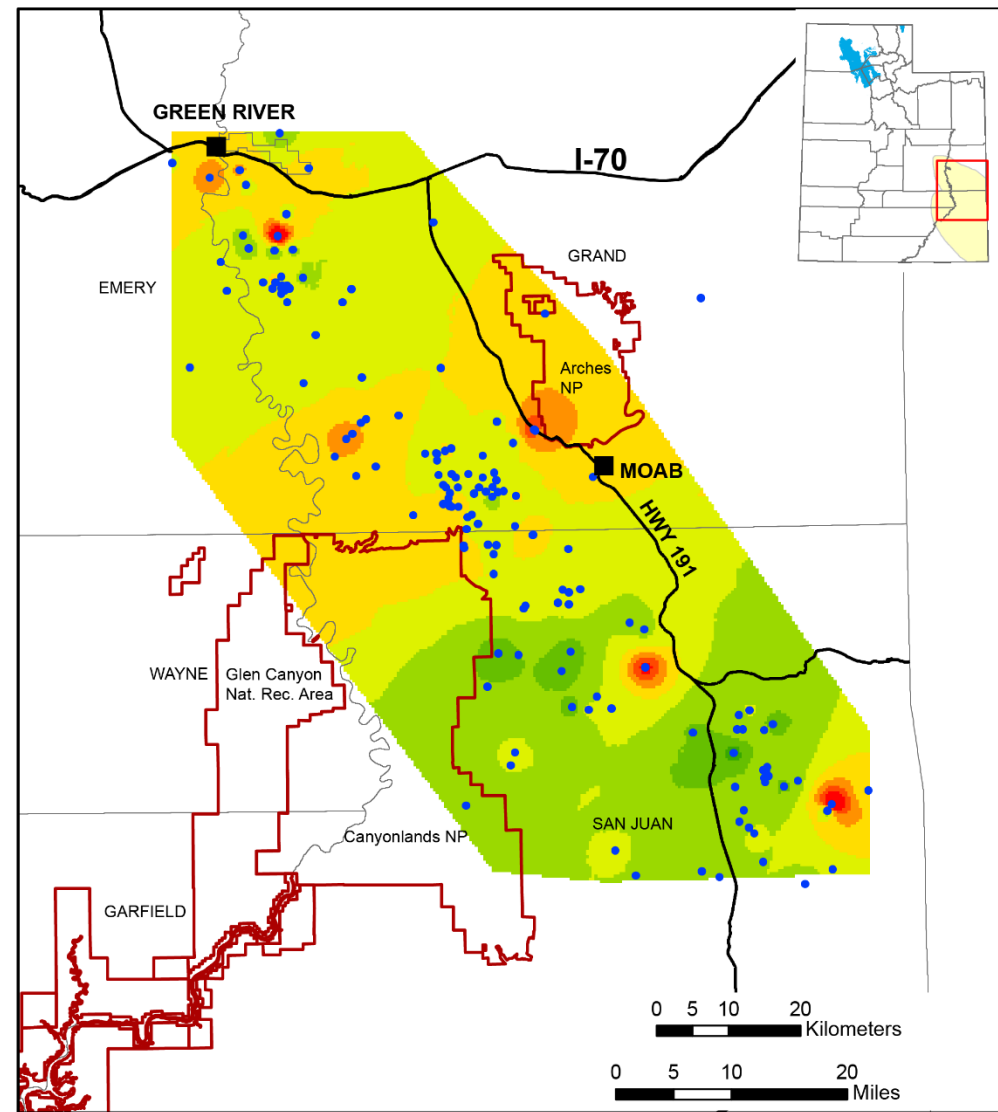
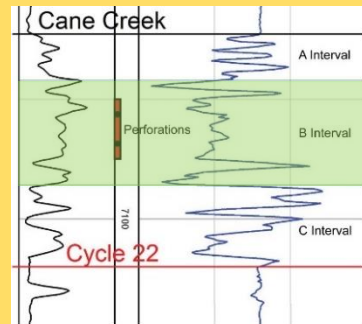


### Thickness of the Cane Creek Shale A Interval (feet)



## B Interval

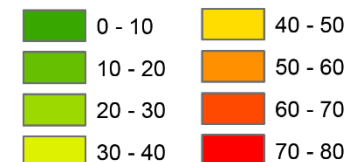
- Reservoir
- Thickness range = 4 to 72 feet
- Average thickness = 26 feet
- Thicker E-W band near middle of play area
- Low variance in thickness
- Natural fractures trend NE-SW



- Cane Creek Penetration
- City
- Road
- National Park Boundary

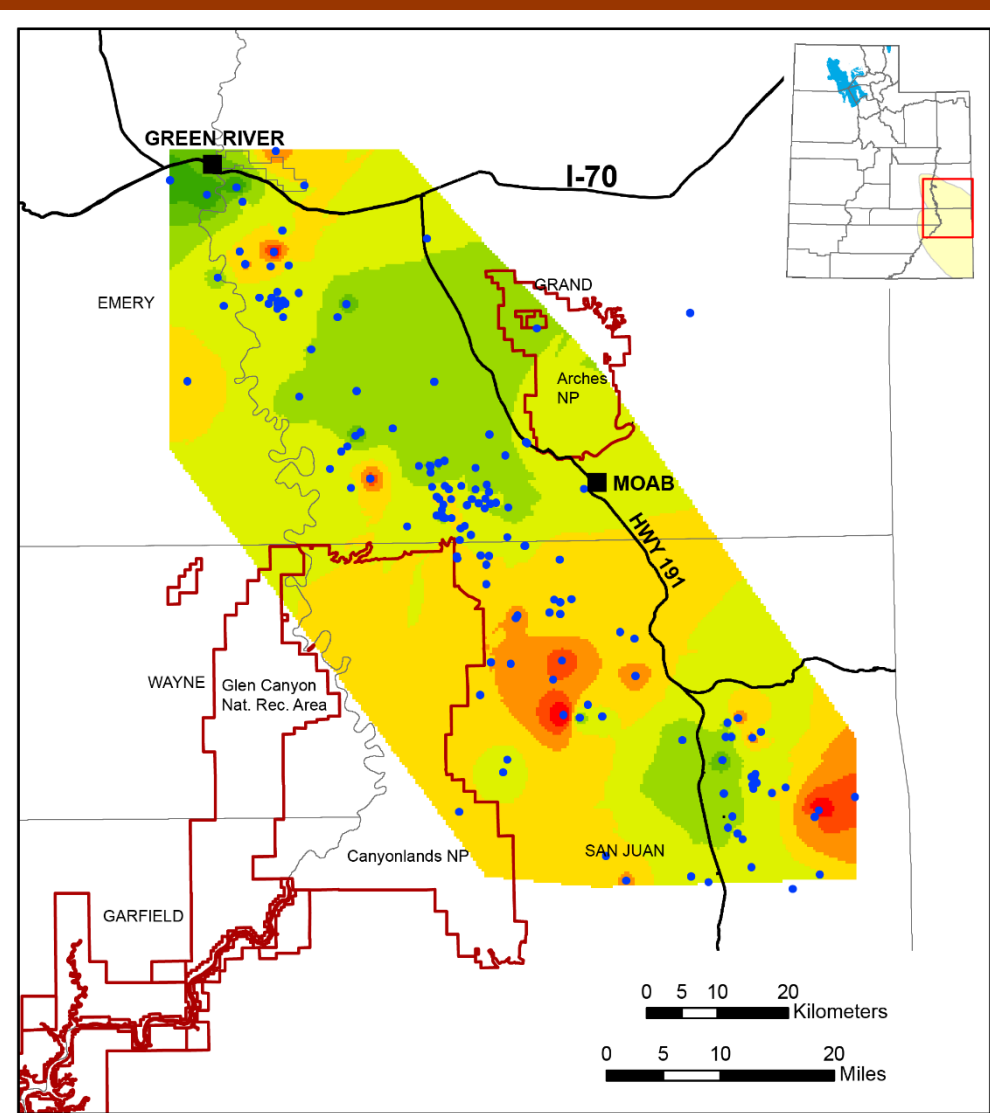
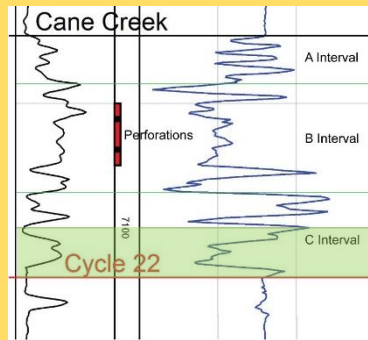


### Thickness of the Cane Creek B Interval (feet)



## C Interval

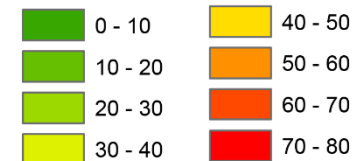
- Lower seal
- Thickness range = 10 to 81 feet
- Average thickness = 36 feet
- Generally thicker in south



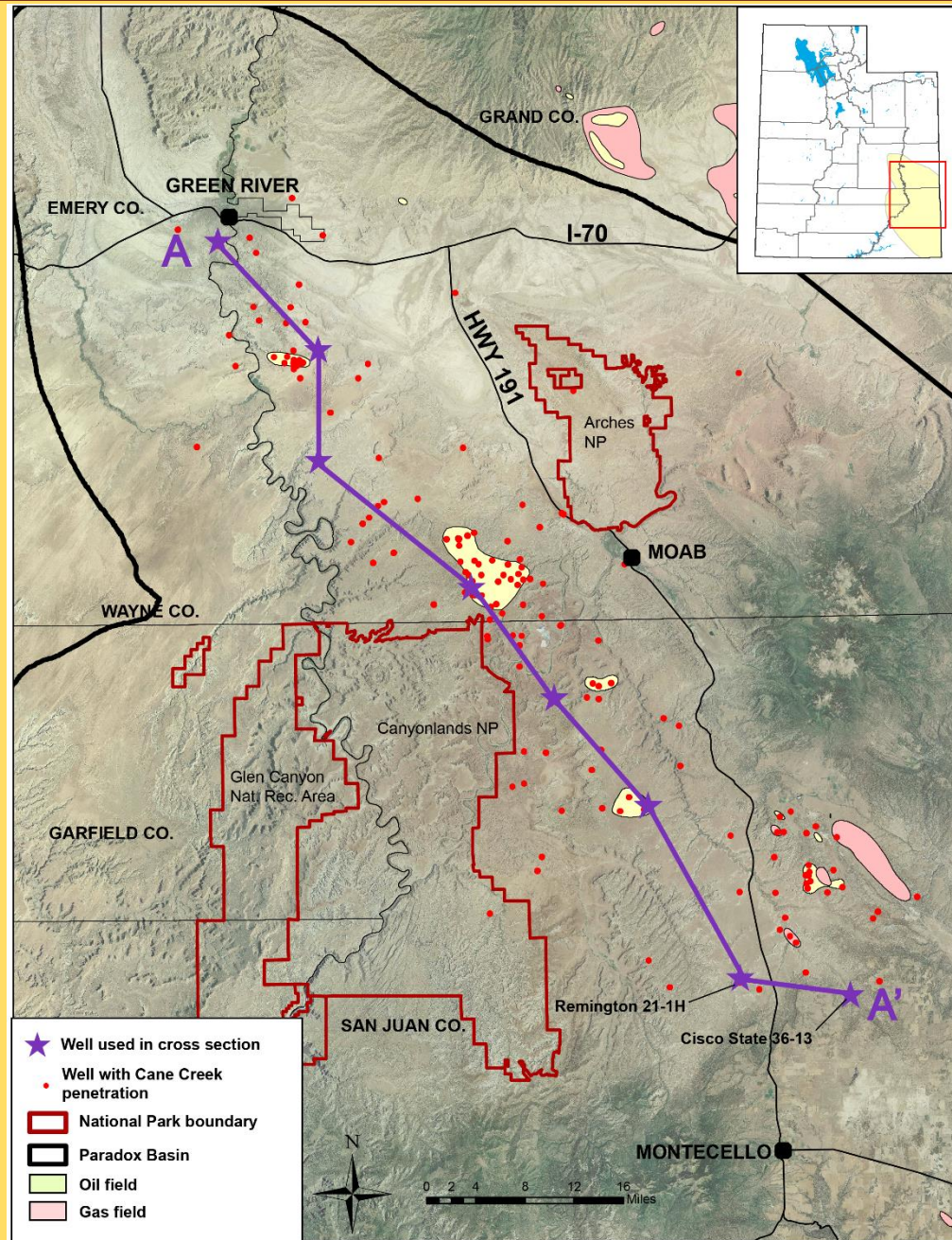
- Cane Creek Penetration
- City
- Road
- National Park Boundary



### Thickness of the Cane Creek Shale C Interval (feet)

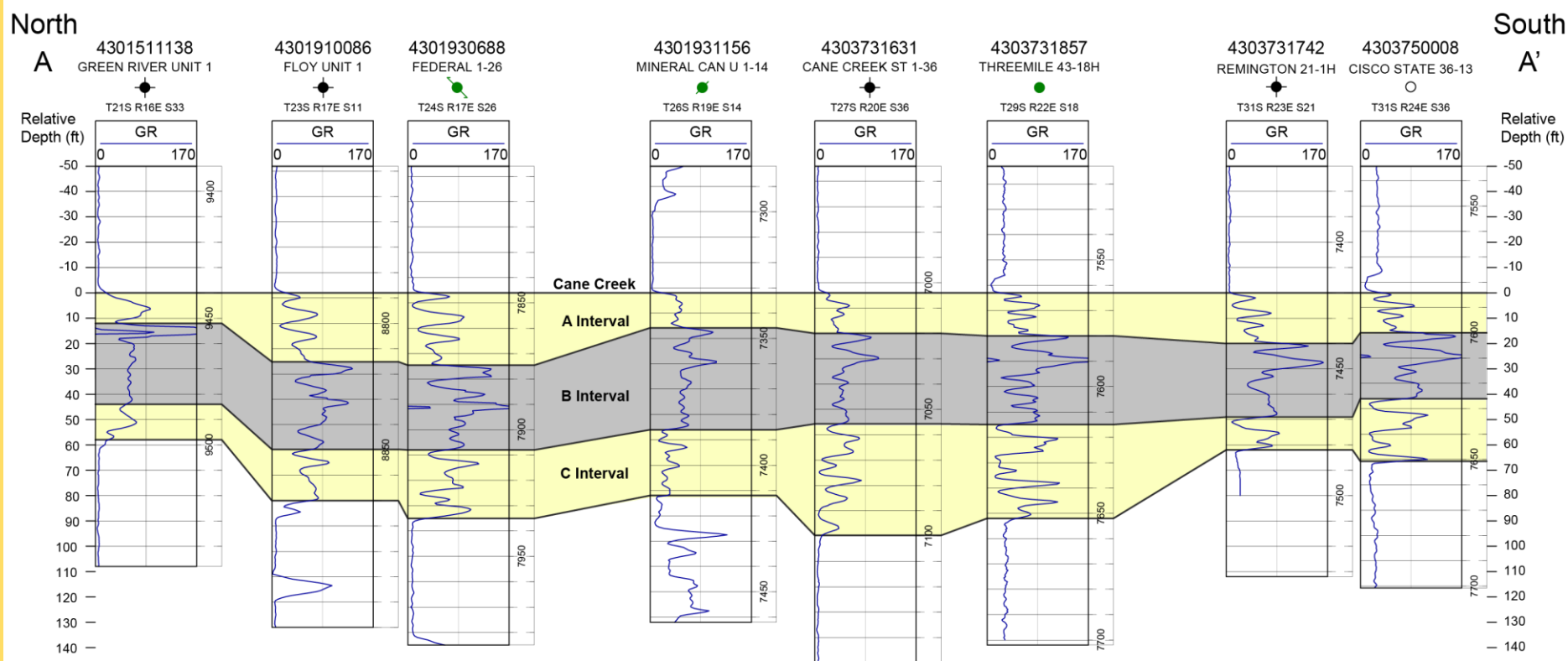


# Cross Section





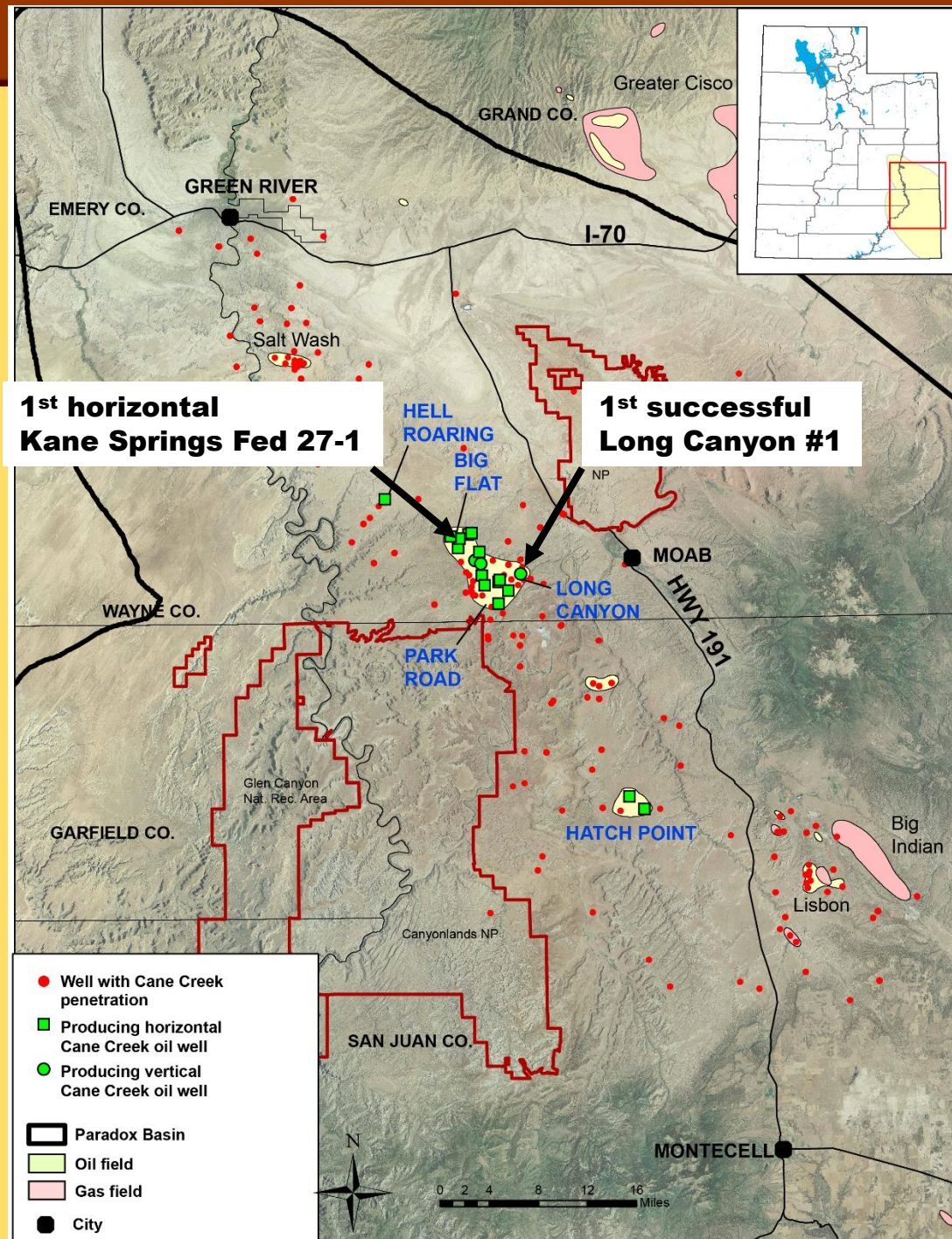
# Cross Section





# Cane Creek Production

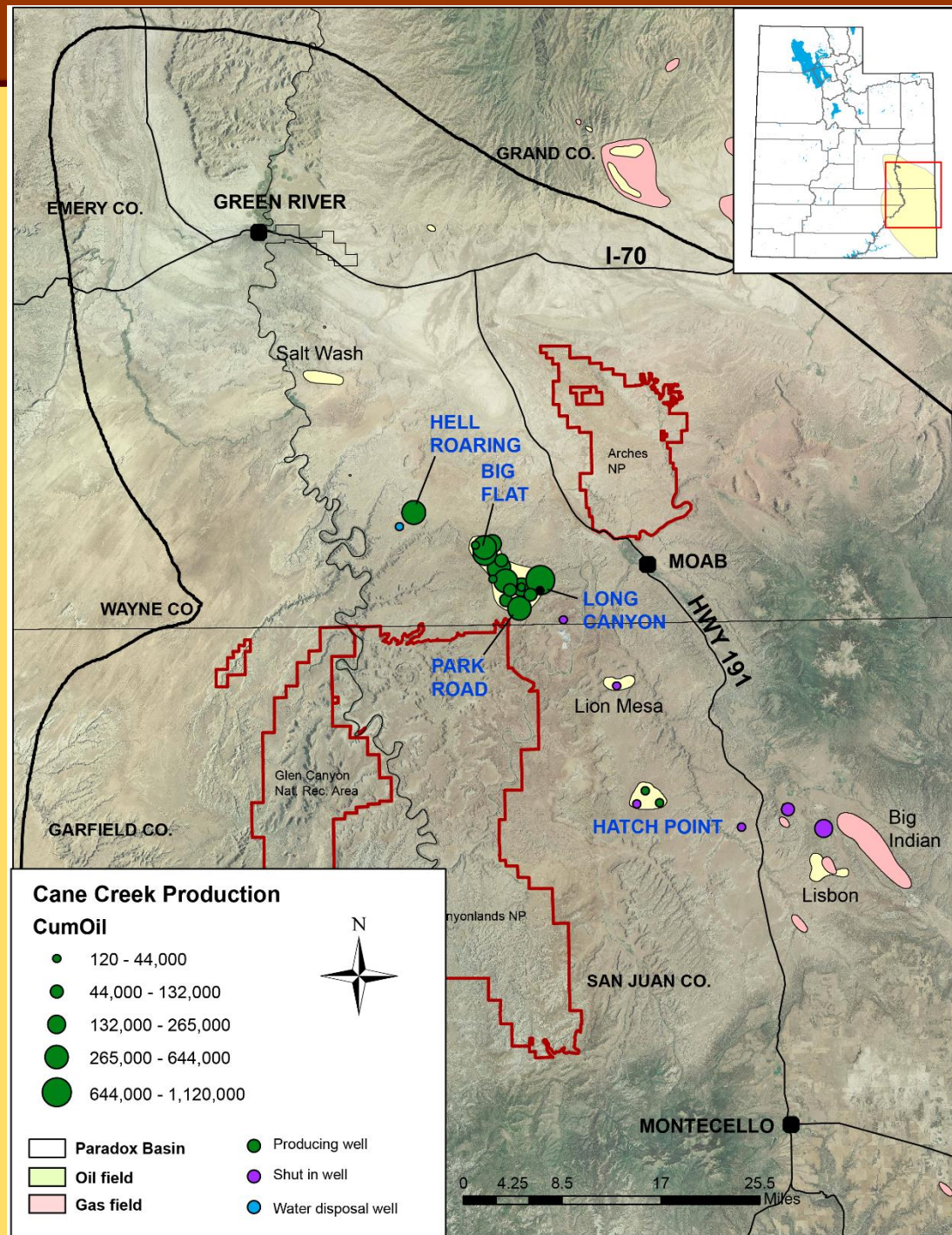
- Currently 5 producing fields
- Producing since 1960s
- 1st horizontal in 1991
- Cane Creek shale cumulative oil production >5.4 million barrels





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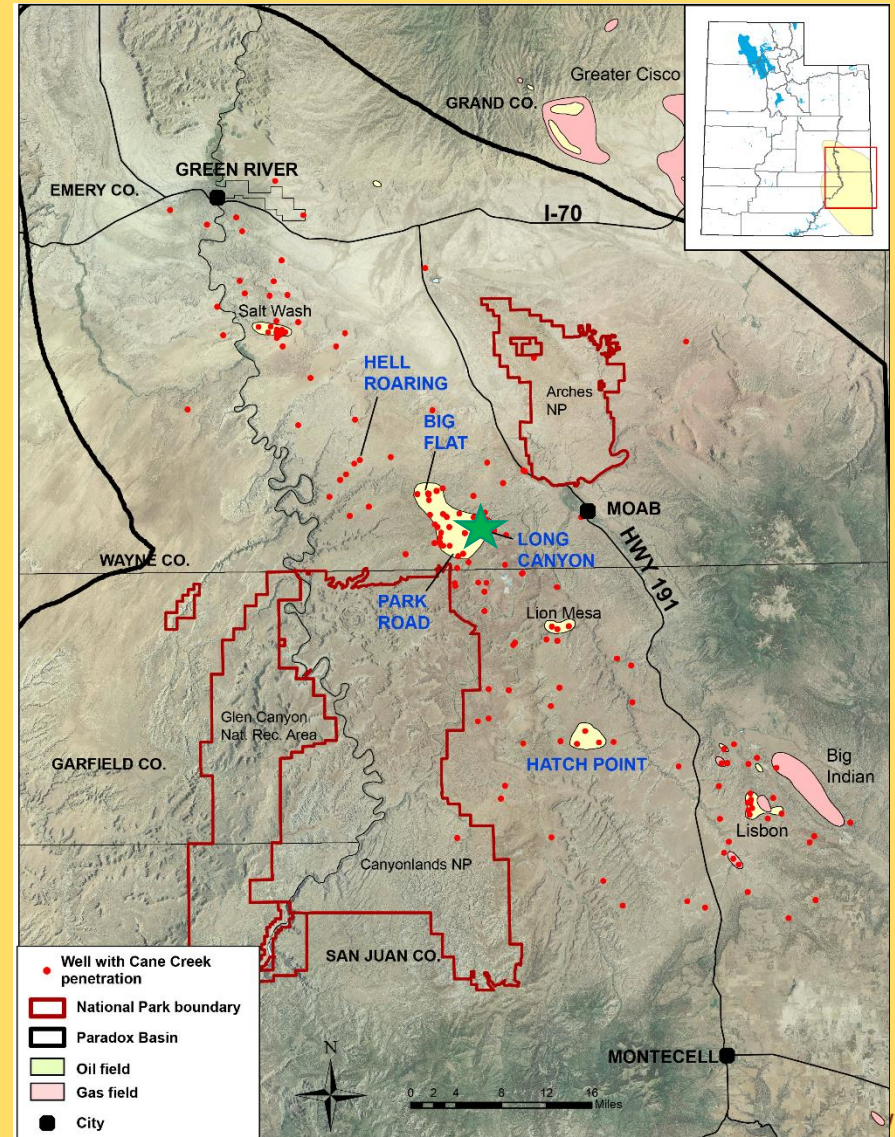


# Cane Creek Production

Fidelity E&P Co.

Long Canyon 1

- 1<sup>st</sup> successful vertical well
- Producing since 1962
- 2013 production = 2,665 BBLS

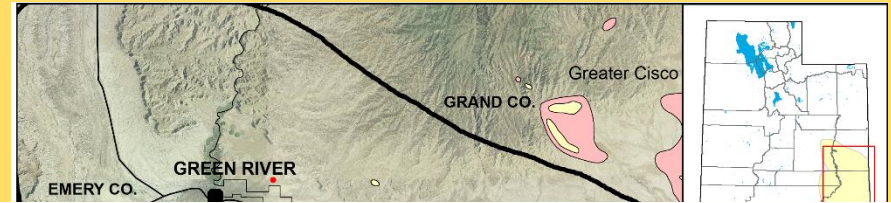


# Cane Creek Production

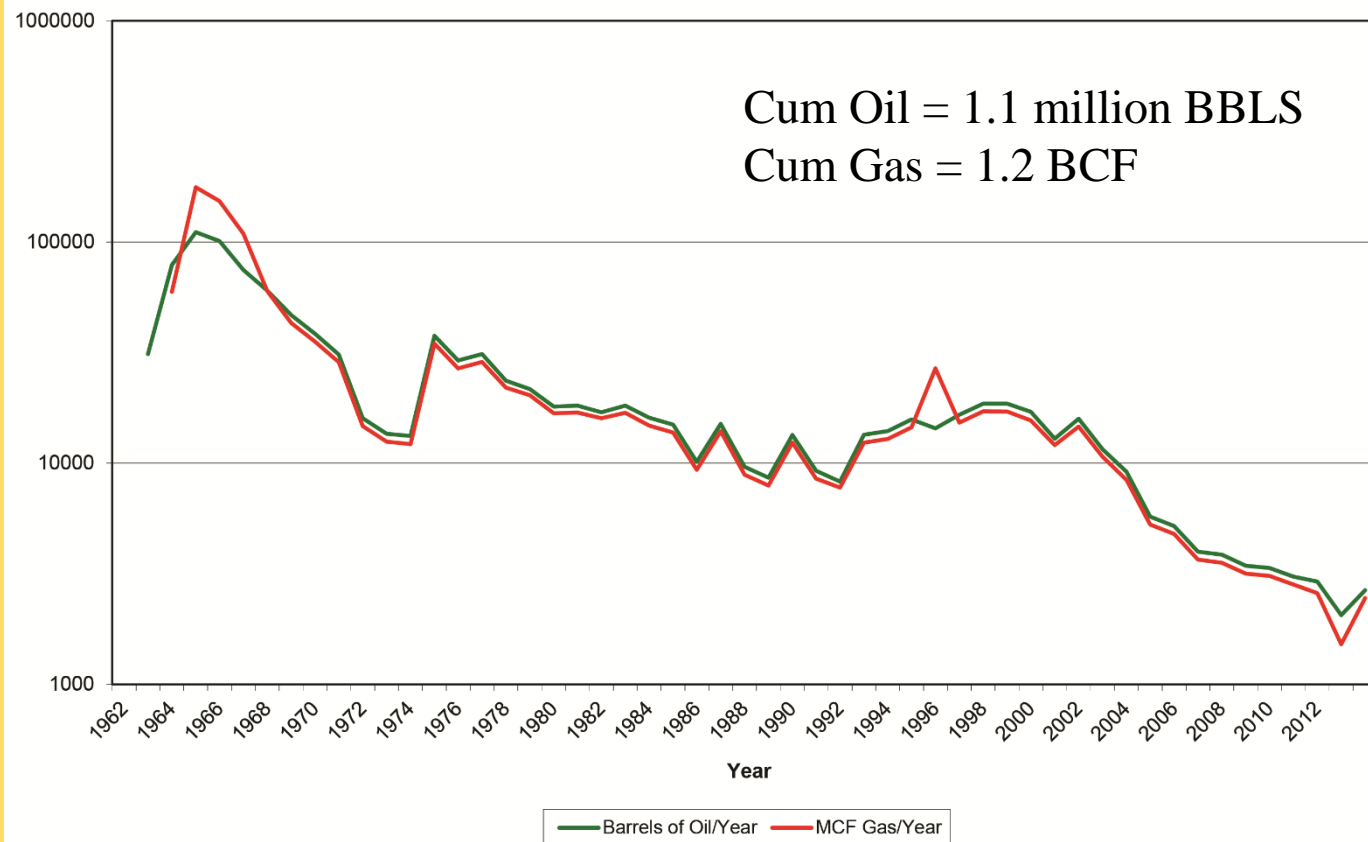
Fidelity E&P Co.

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Annual Production

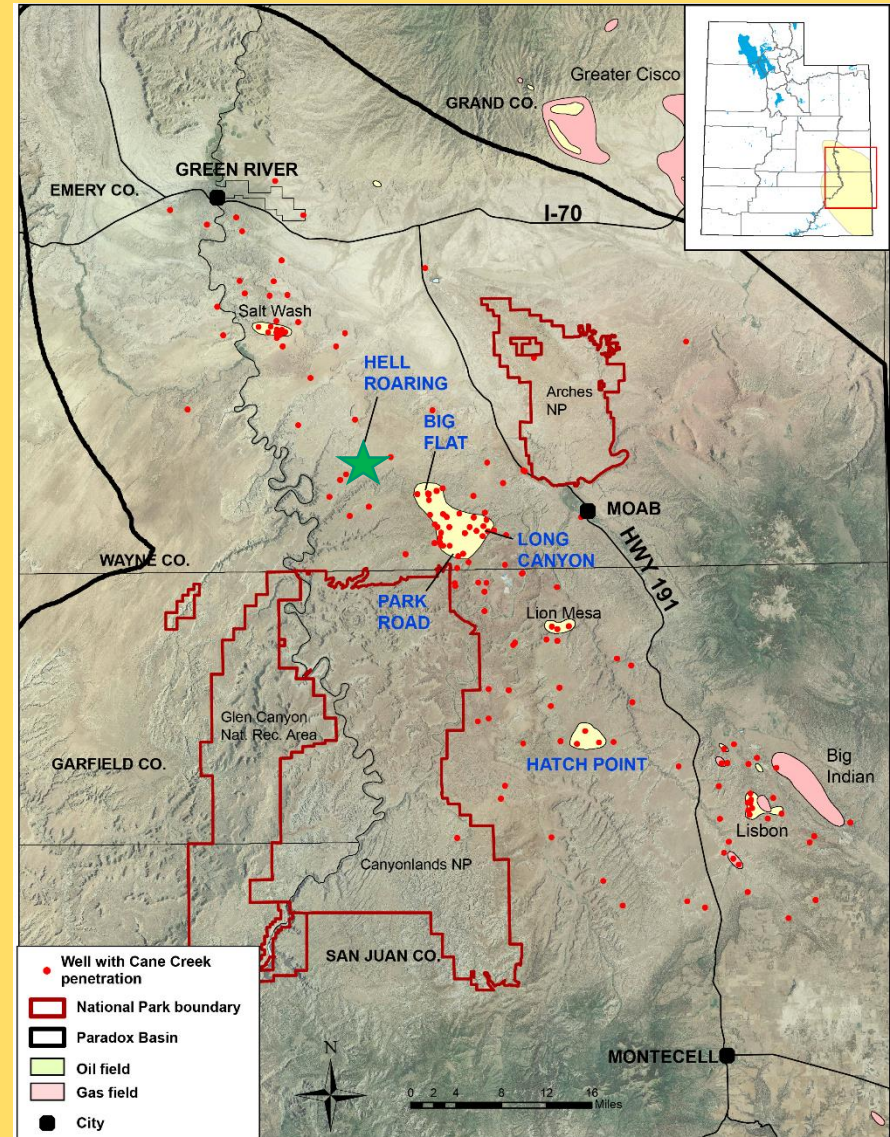




# Cane Creek Production

Fidelity E&P Co.  
Kane Springs Fed  
10-1

- Hell Roaring Field
- Horizontal, ~700 ft
- Producing since Nov. 1992
- 2013 production = 6,319 BBLS

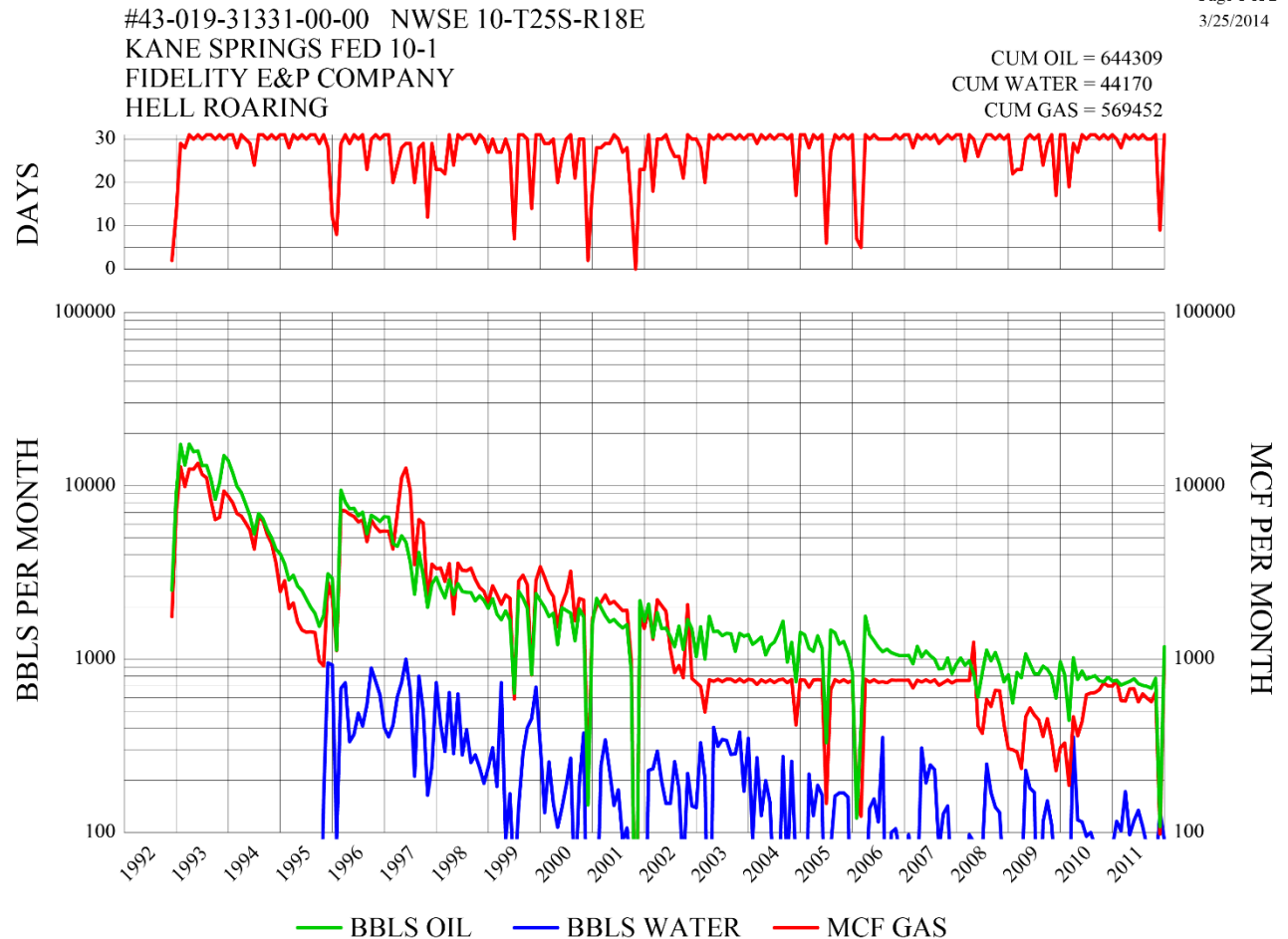




# Cane Creek Production

## Fidelity E&P Co. Kane Springs Fed 10-1

- Hell Roaring Field
- Horizontal, ~700 ft
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- 2013 production = 6,319 BBLS

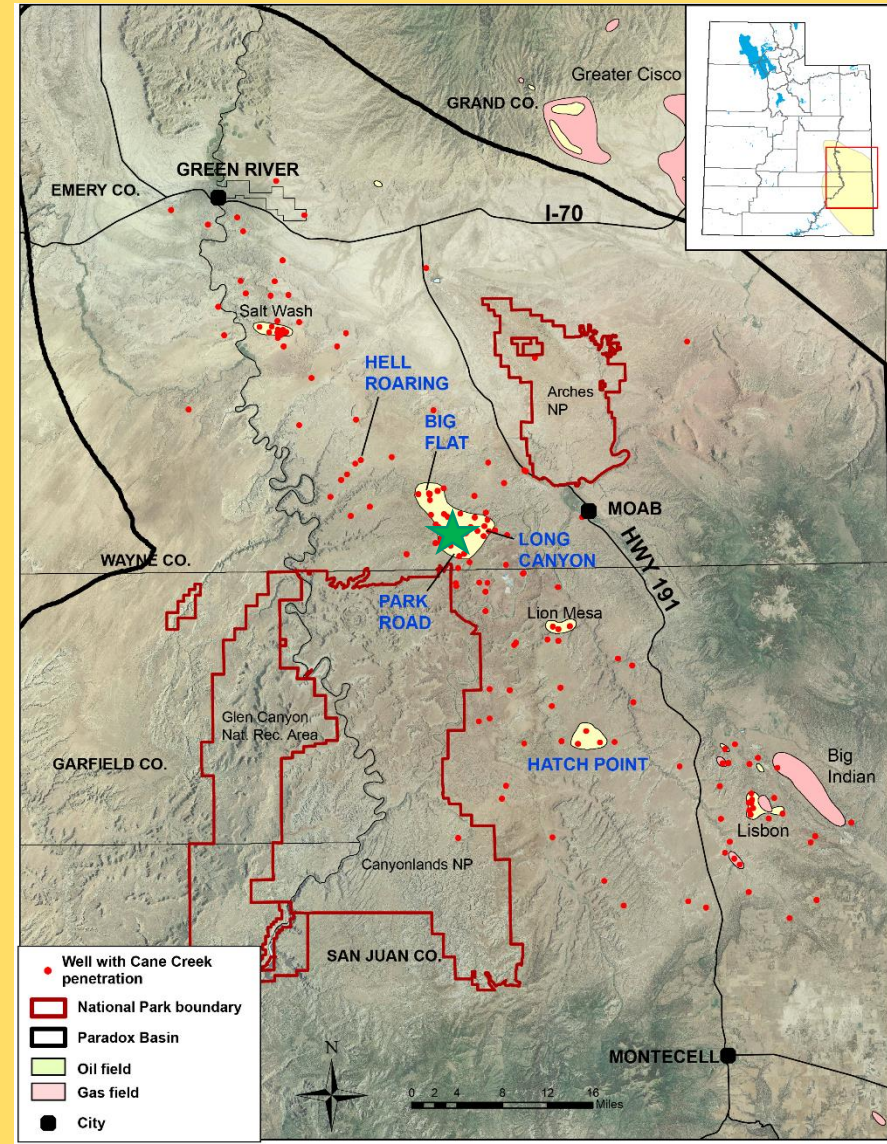


# Cane Creek Production

Fidelity E&P Co.

Cane Creek 12-1

- Big Flat Field
- Horizontal, ~2400 ft
- Completed Nov. 2012
- 2013 production = 437,488 BBLS

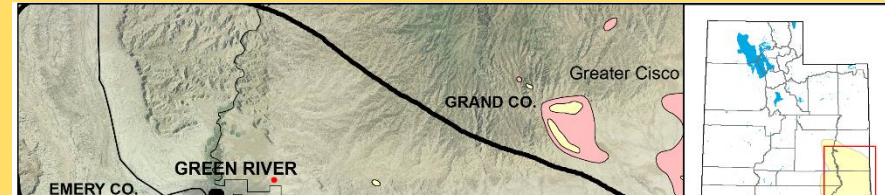


# Cane Creek Production

Fidelity E&P Co.

Cane Creek 12-1

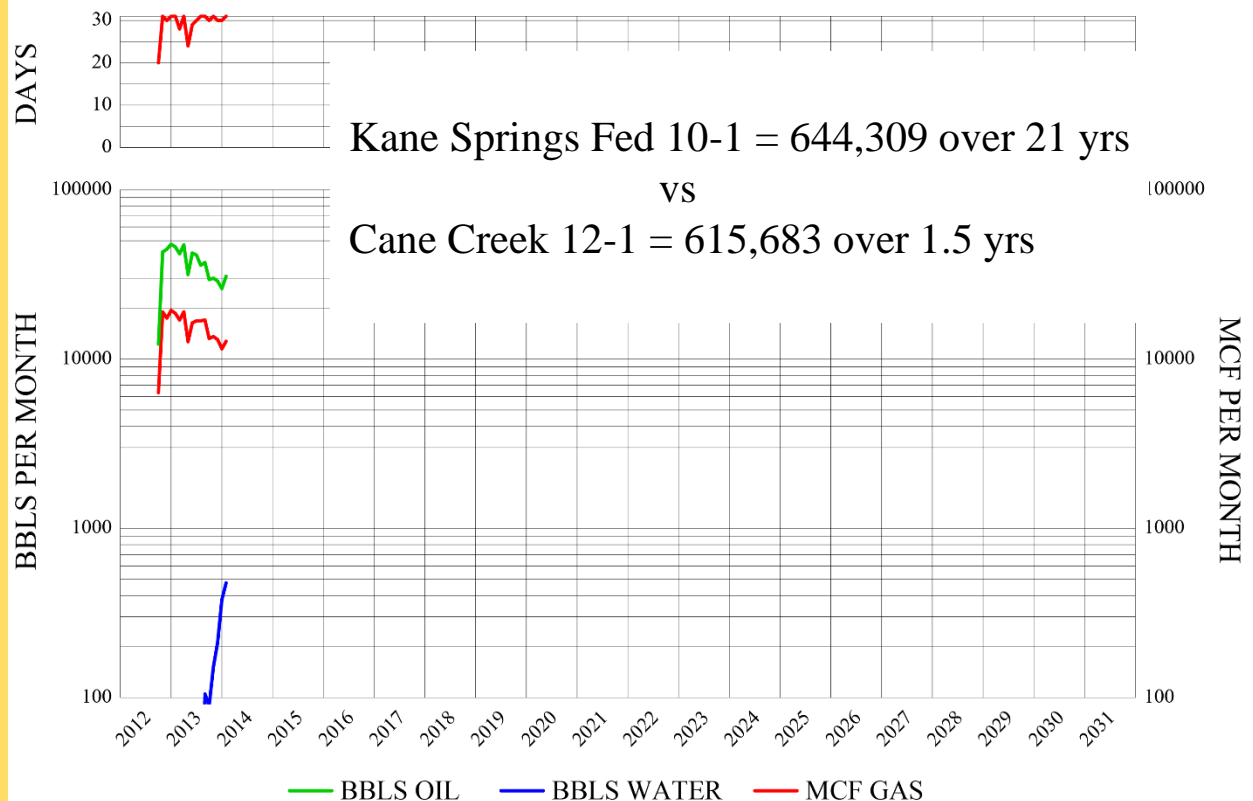
- Big Flat Field
- Horizontal, ~2400 ft
- Completed Nov. 2012
- 2013 production = 437,488 BBLS



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3/27/2014

#43-019-50009-00-00 NESW 12-T26S-R19E  
CANE CREEK UNIT 12-1  
FIDELITY E&P COMPANY  
BIG FLAT

CUM OIL = 615683  
CUM WATER = 1680  
CUM GAS = 260486



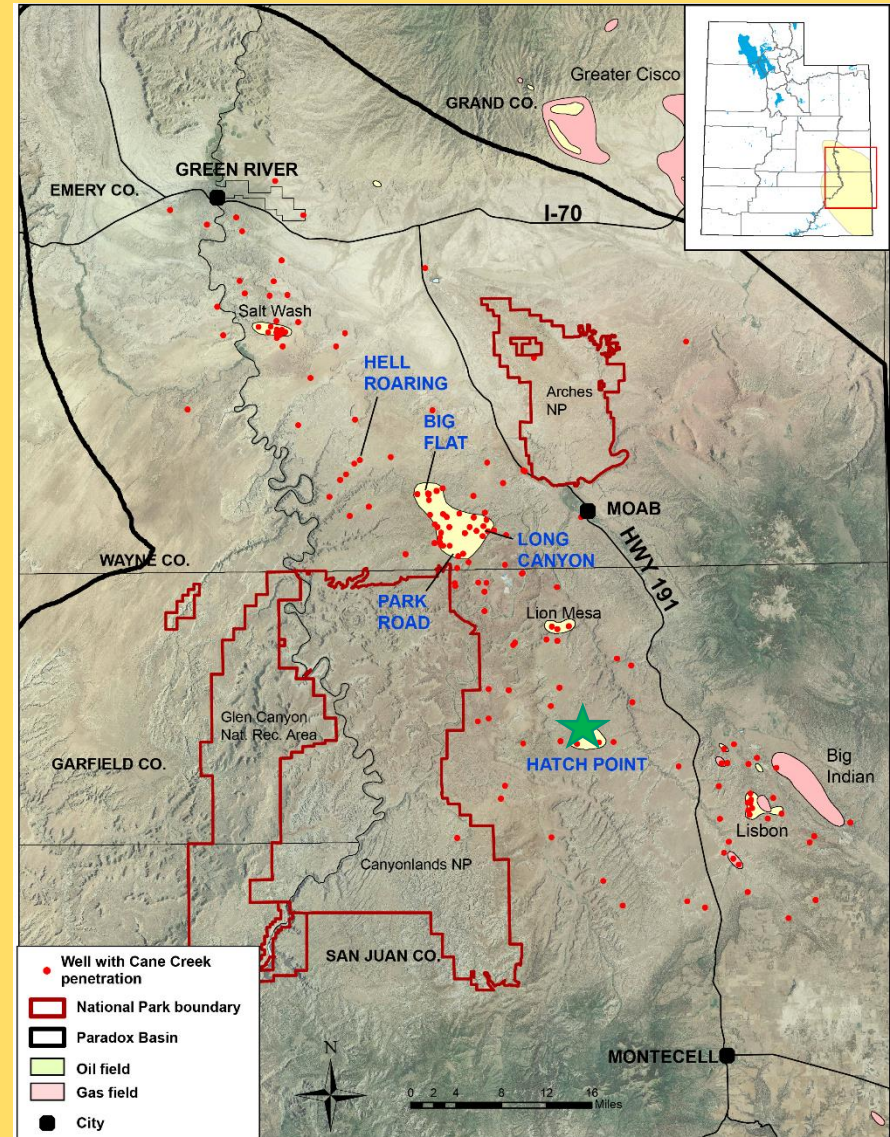


# Cane Creek Production

Fidelity E&P Co.

Threemile 12-7

- Hatch Point Field
- Horizontal, ~3,000 ft
- Producing since Jan 2011
- Produced 4,824 BBLS in 2013



# Cane Creek Production

## Fidelity E&P Co. Threemile 12-7

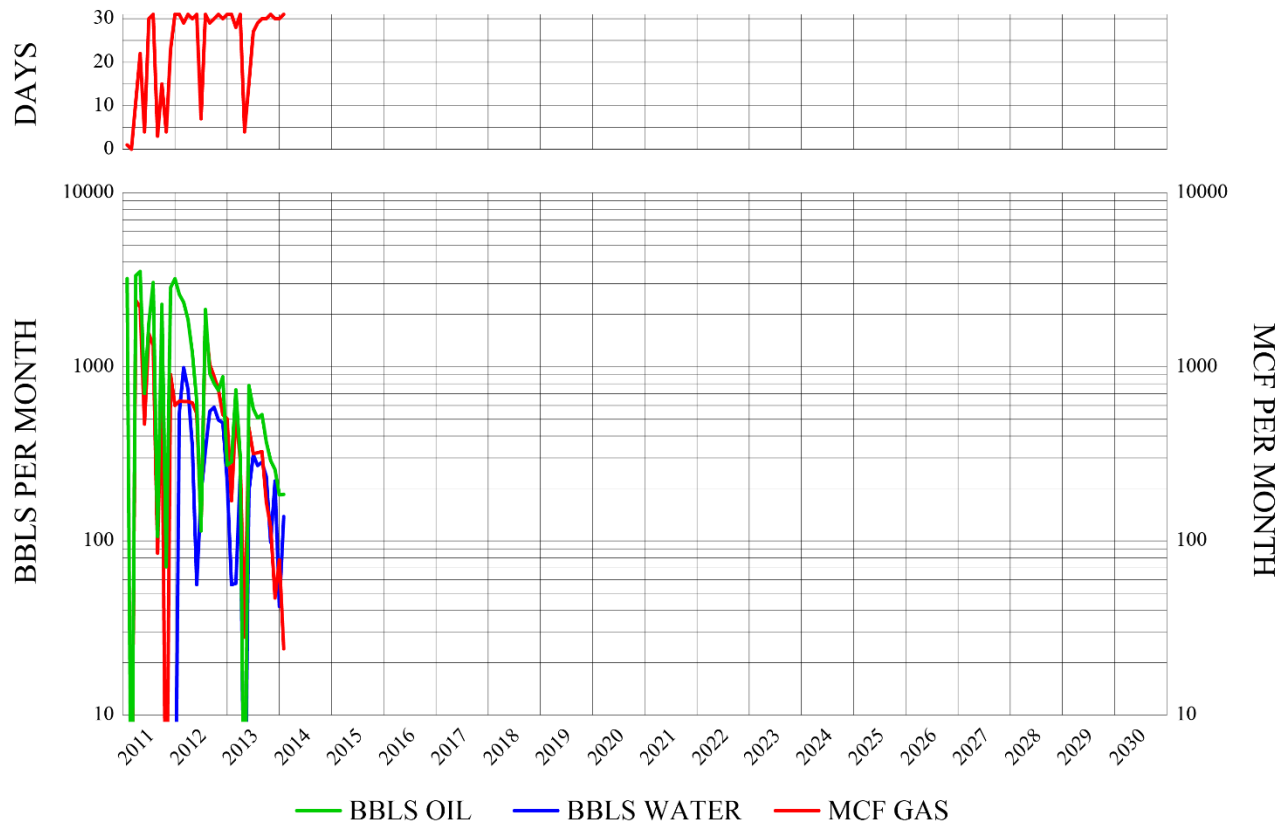
- Hatch Point Field
- Horizontal, ~3,000 ft
- Producing since Jan 2011
- Produced 4,824 BBLs in 2013



Page 1 of 1  
3/25/2014

#43-037-50001-00-00 NWSE 12-T29S-R21E  
Threemile 12-7  
FIDELITY E&P COMPANY  
HATCH POINT

CUM OIL = 43679  
CUM WATER = 7672  
CUM GAS = 21956

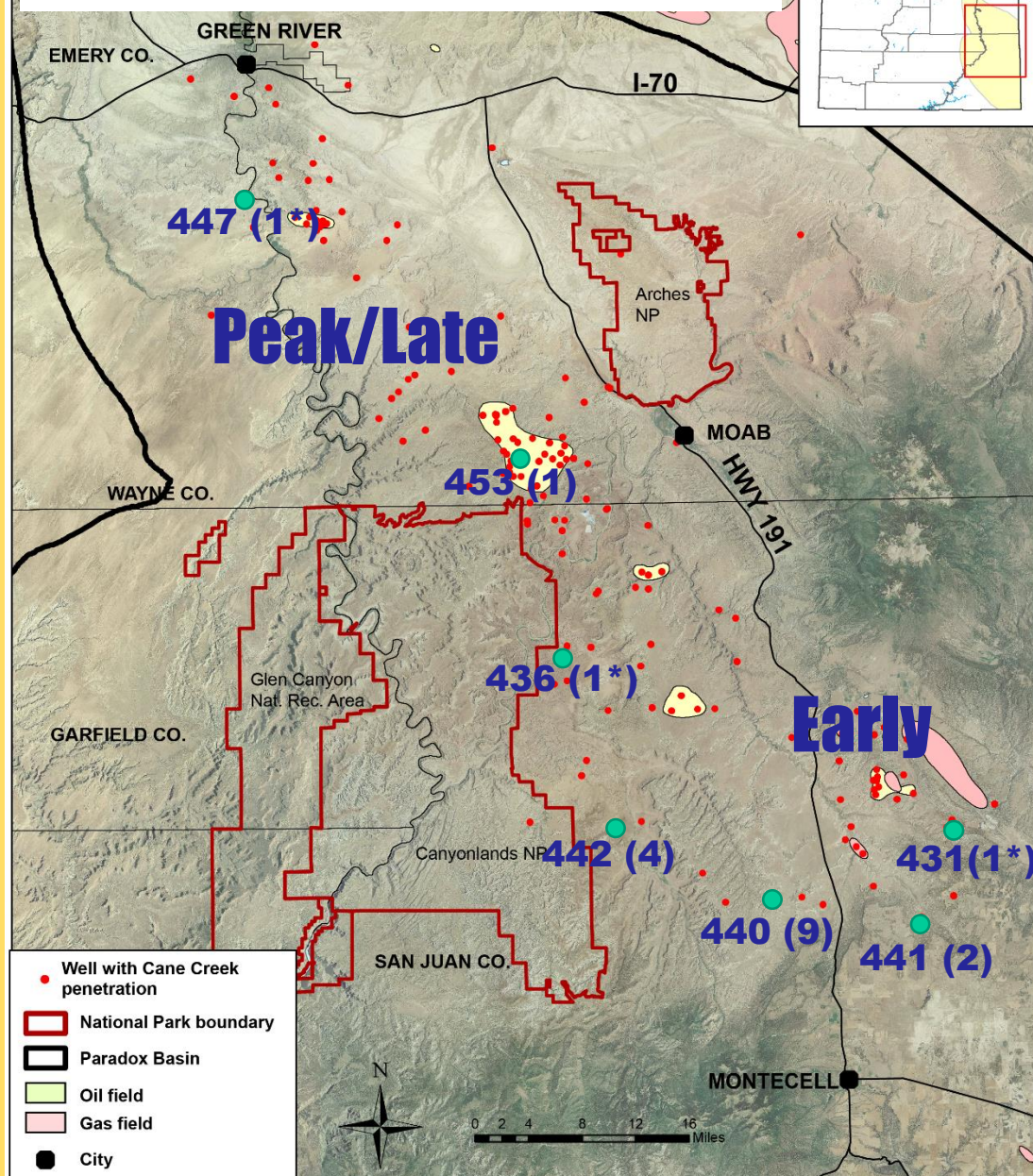




# Thermal Maturity

**Avg Tmax (# samples)**

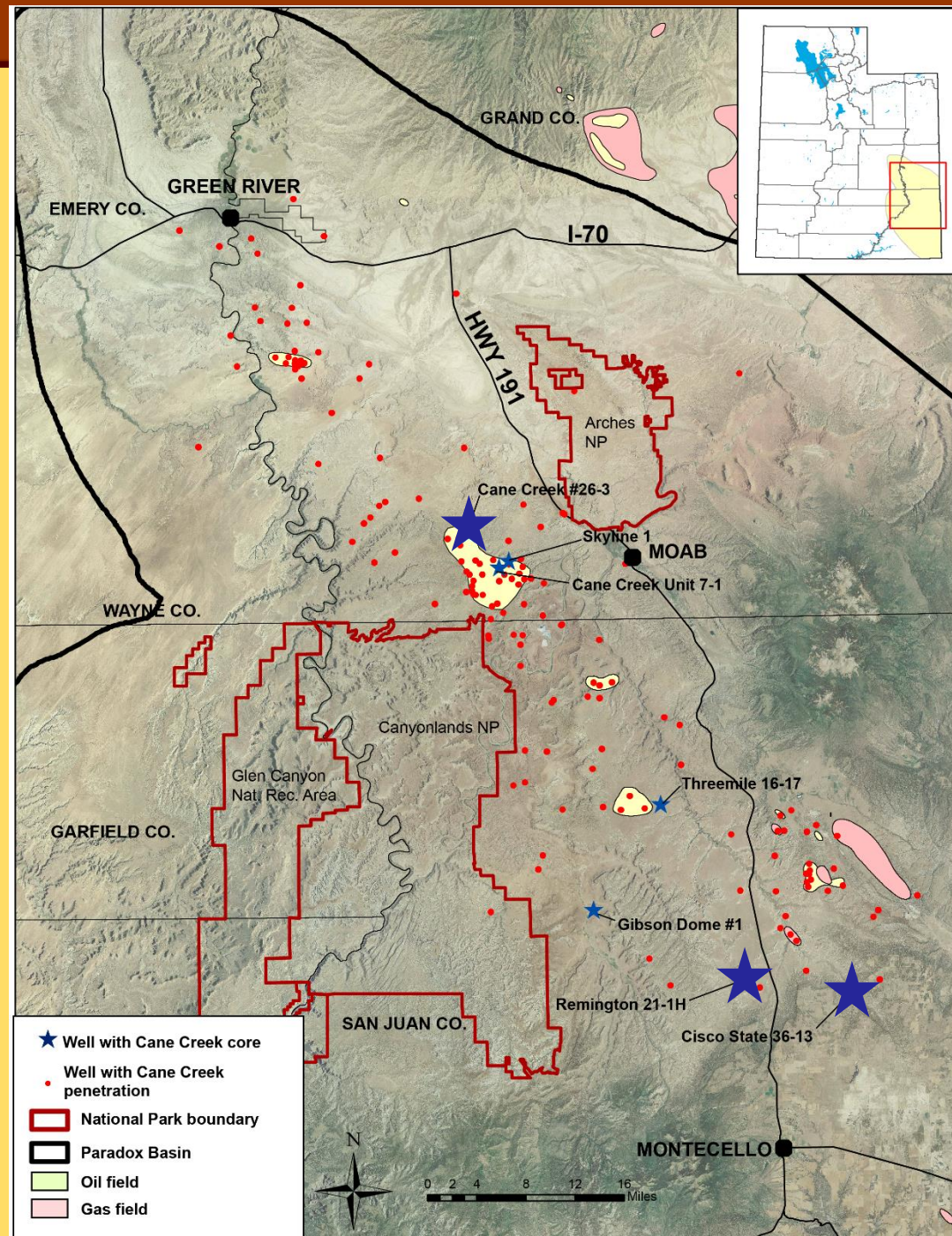
**\* Denotes cuttings used**





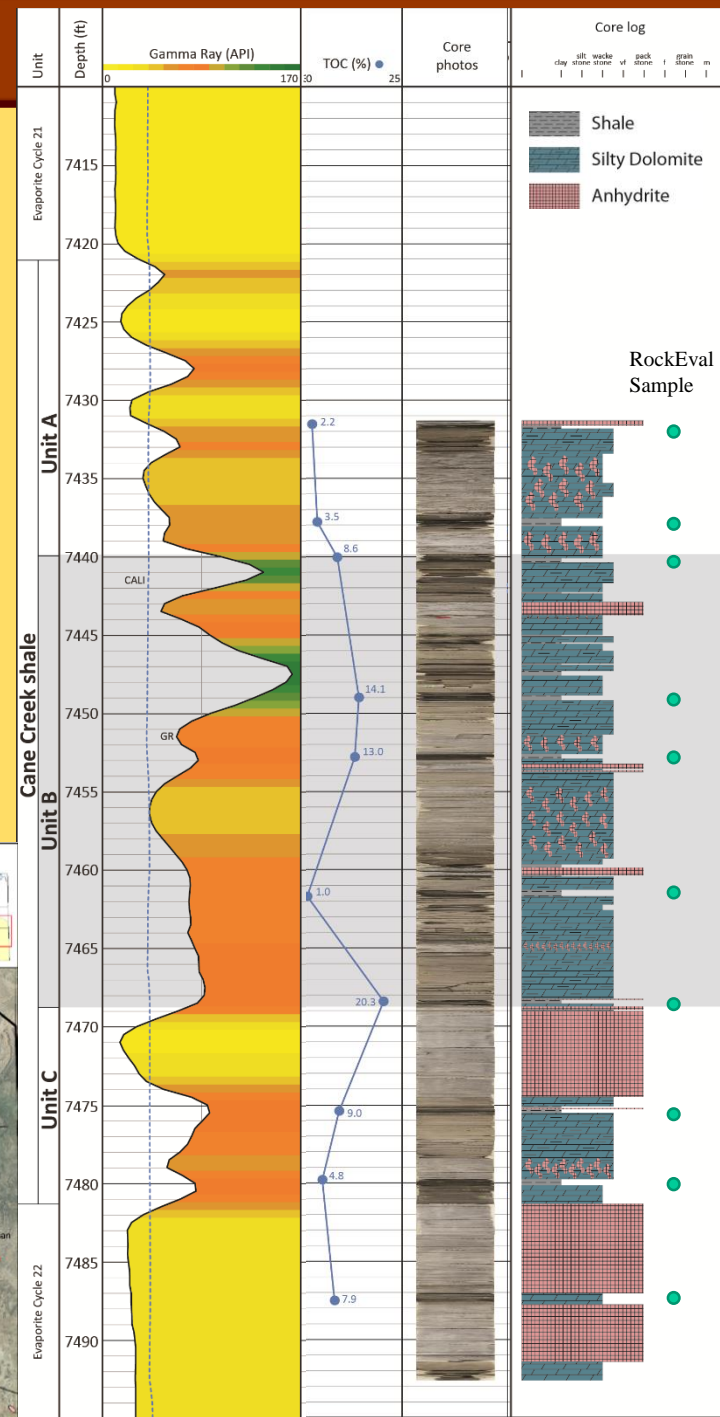
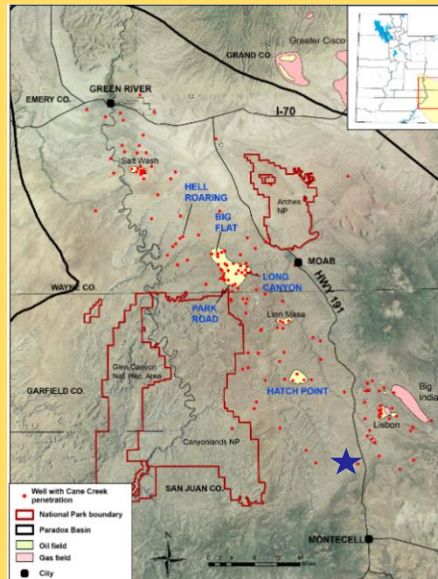
## Cane Creek Core

- Seven cores
- Currently studying
  - Cisco State 36-13
    - Vertical
    - Temp. Abandoned 2013
    - Overall thickness = 70 ft
    - B thickness = 26 ft
  - Remington 21-1H
    - Vertical with horizontal leg
    - Dry hole, P&A 2011
    - Overall thickness = 60 ft
    - B thickness = 29 ft
  - Cane Creek #26-3
    - Horizontal
    - Producing since 2012
    - Overall thickness = 90 ft
    - B thickness = ~30 ft
    - Confidential



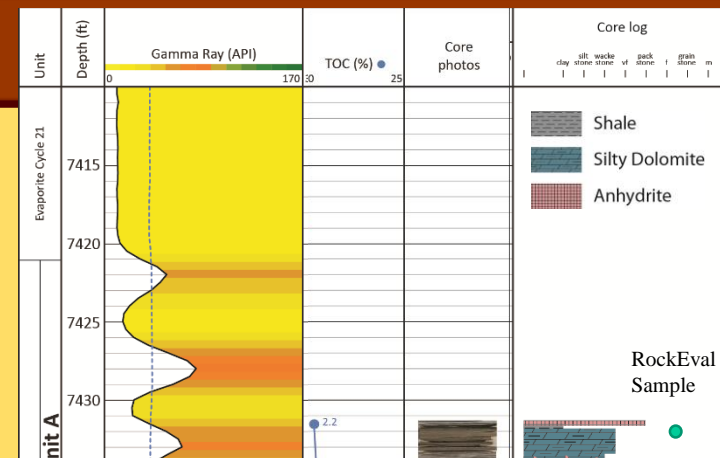
## Union Pacific Resources Remington 21-1H

- Total thickness = 60 ft
- B Interval
  - 29 feet thick
  - Silty dolomite, thin black shale, and minor mottled anhydrite
- Average TOC of shale in B interval 12%
- No open fractures

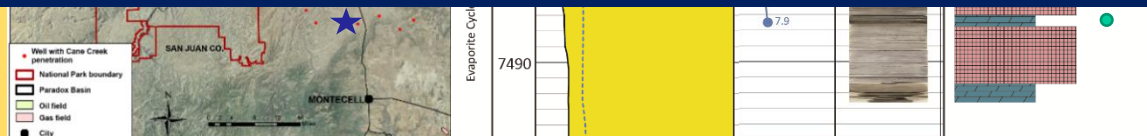




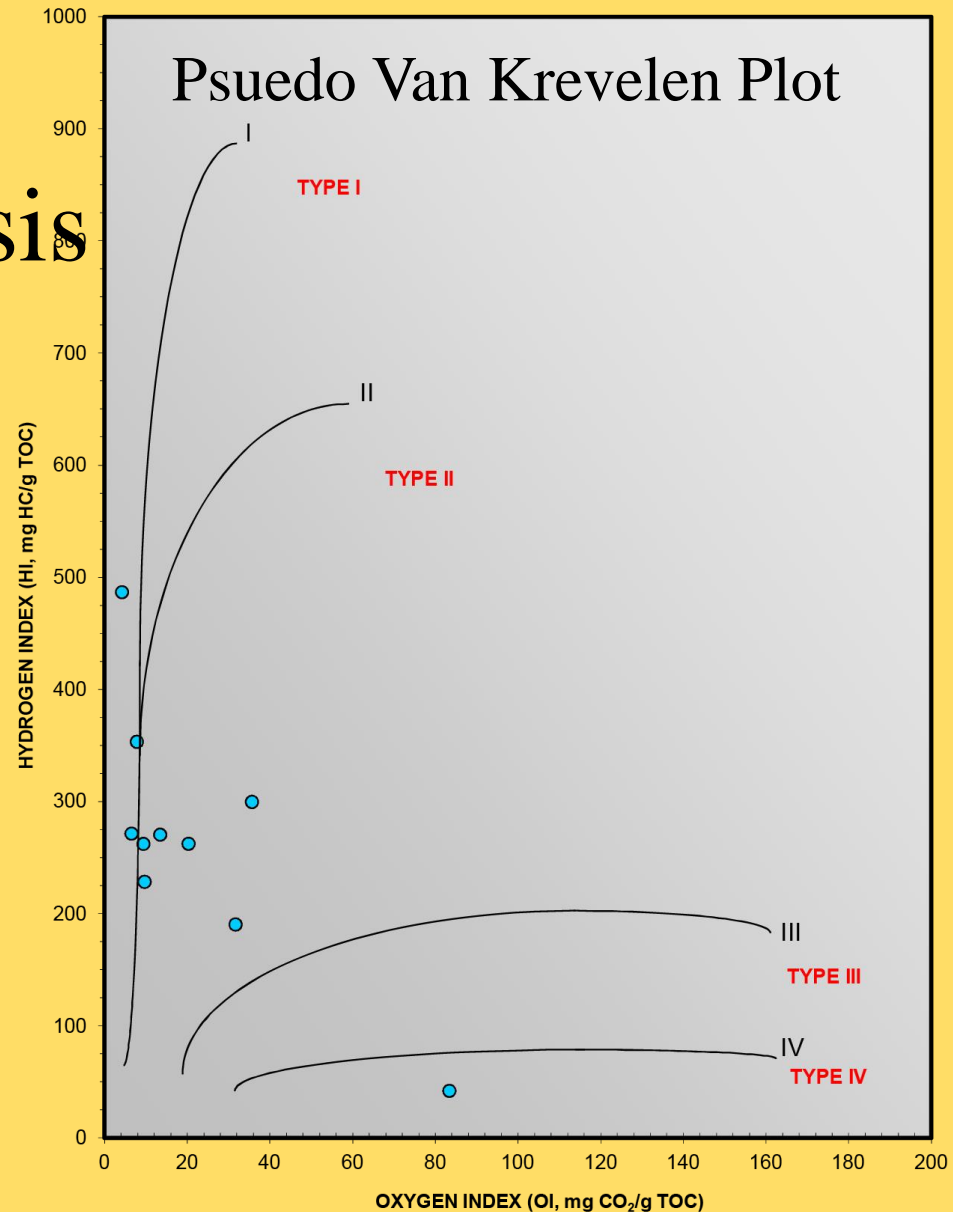
## Union Pacific Resources Remington 21-1H



- No open fractures

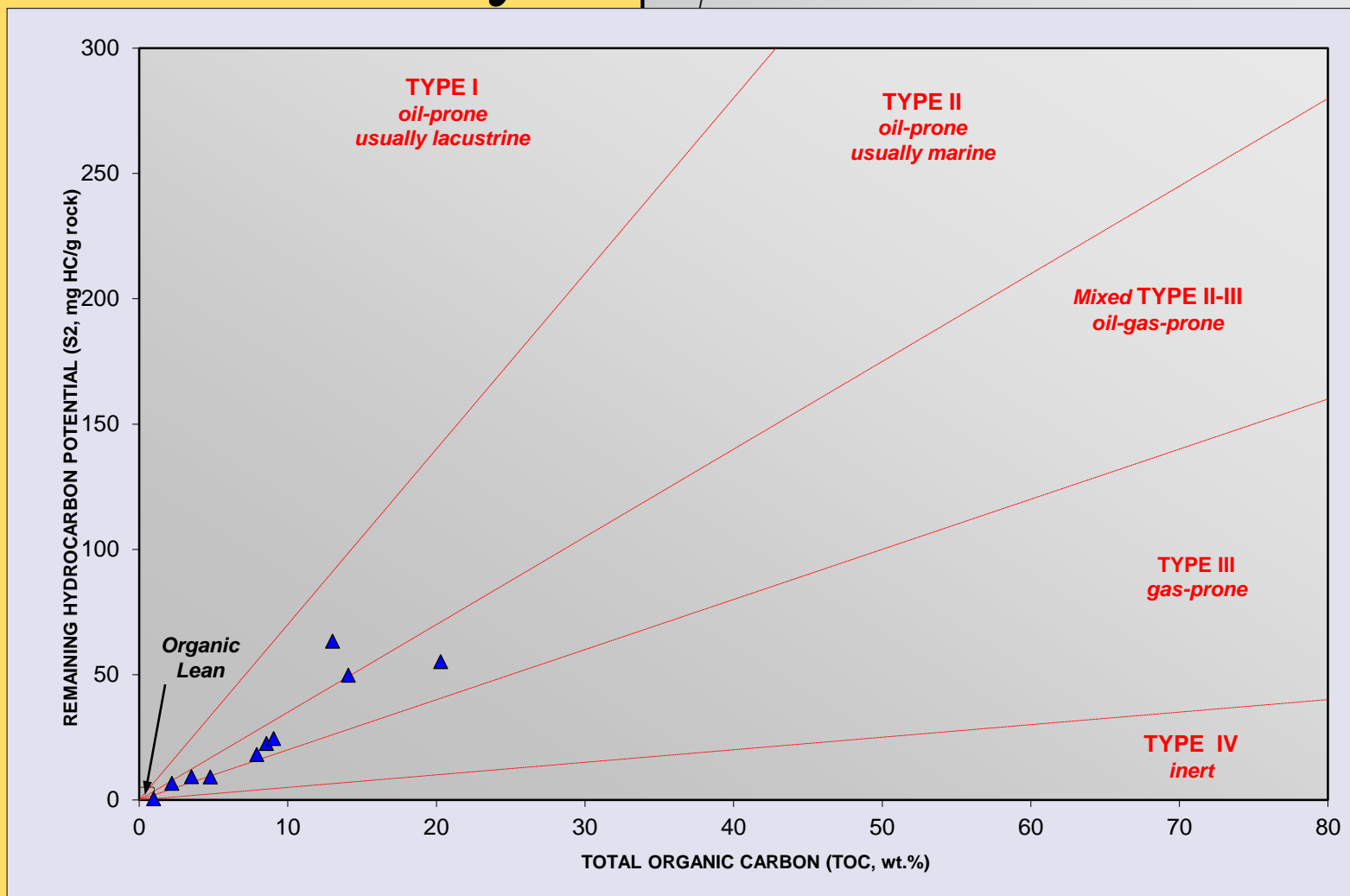


# Remington 21-1H Geochemical Analysis



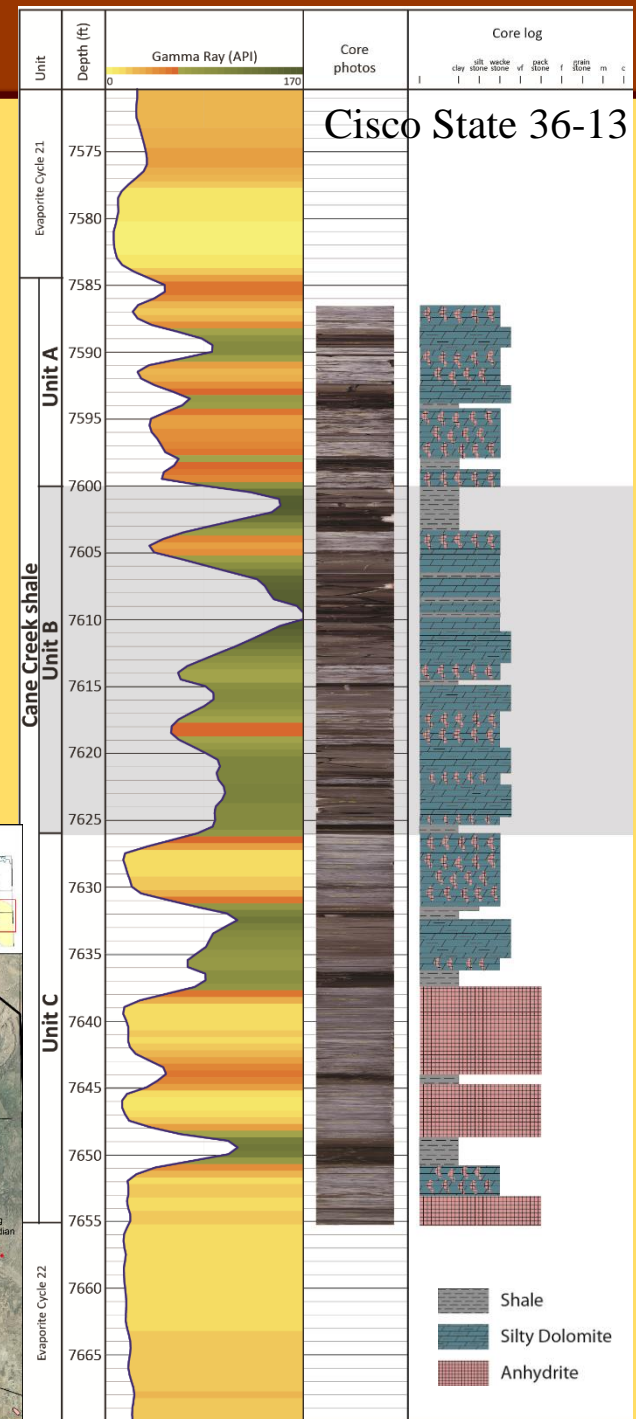
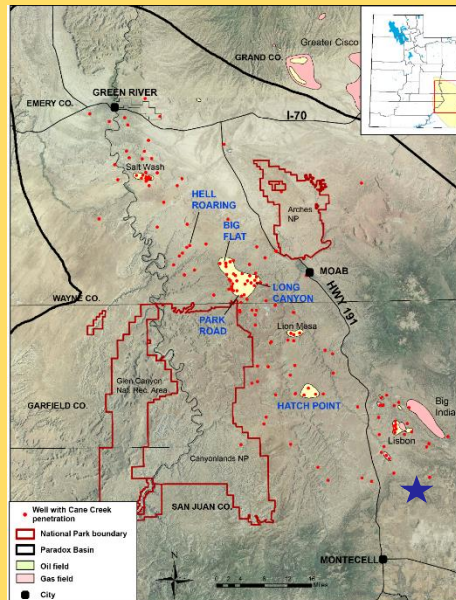


# Remington 21-1H Geochemical Analysis



## CCI Paradox Upstream Cisco State 36-13

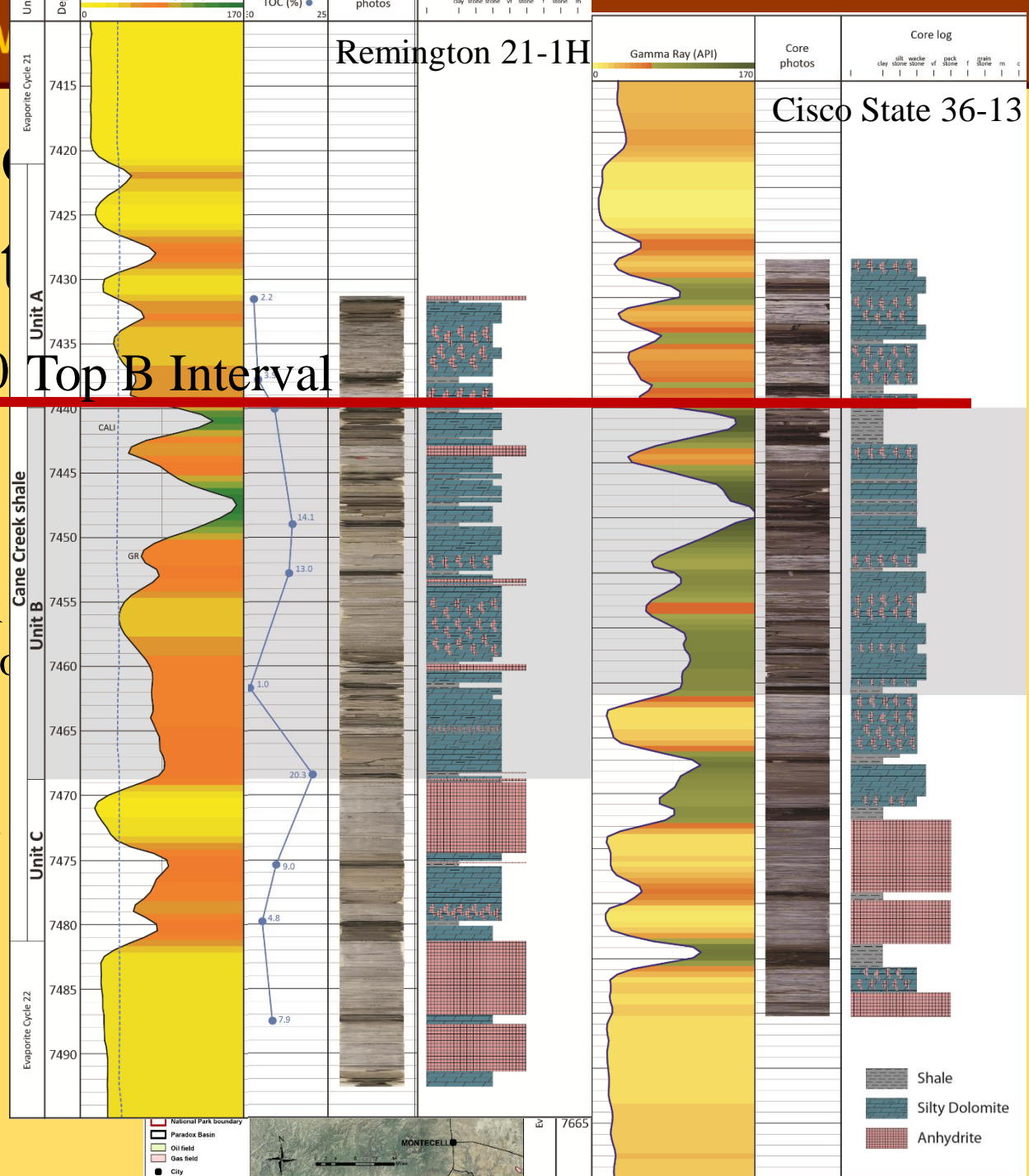
- Total thickness = 70 ft
- B Interval
  - 26 feet thick
  - Silty dolomite, thin black shale, and minor mottled anhydrite
- More shale than the Remington core
- No open fractures



# CCI Parade

## Cisco St

- Total thickness = 70
- B Interval
  - 26 feet thick
  - Silty dolomite, thin shale, and minor mudstone
- More shale than the Remington core
- No open fractures







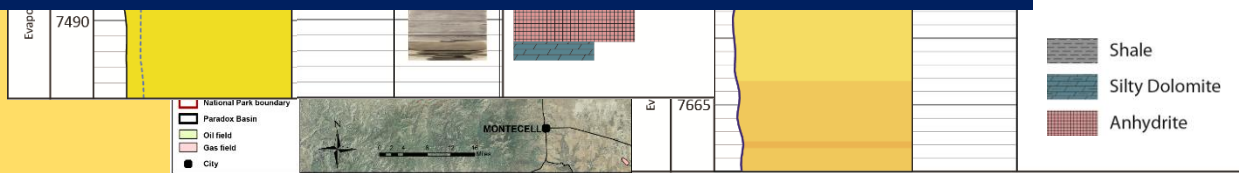
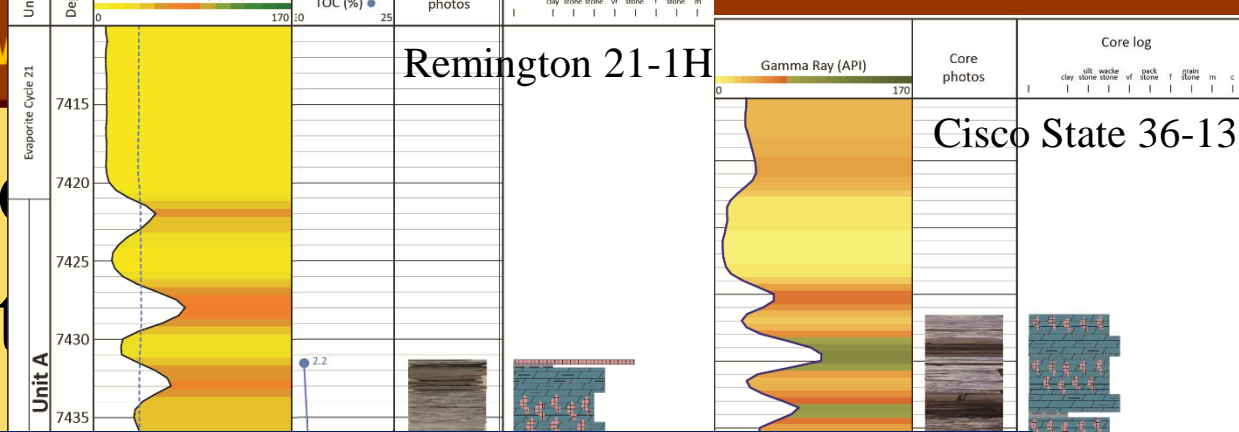
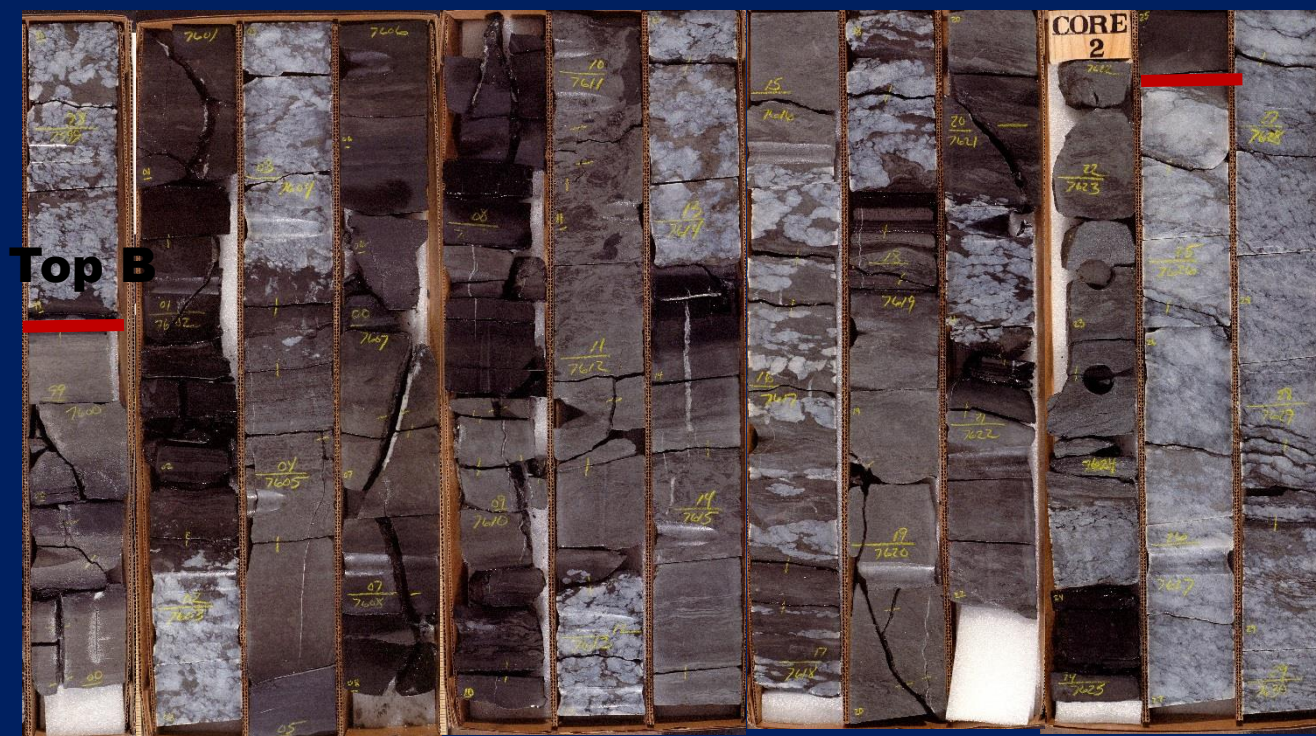
UTAH GEOLOGICAL SURVEY

# CCI Parade Cisco State

- To
- B
- M
- R
- N

Remington 21-1H

Cisco State 36-13



# Summary

## Cane Creek Shale

- Bounded by salt
- Deeper in north
- 120+ feet thick

## B Interval

- Reservoir bounded by anhydrite seals
- Dominantly silty dolomite, with some organic rich black shale and minor mottled anhydrite
- Natural open fractures not seen in core



# Summary

## Production

- Currently focused in central play area
- Production potential in north and south largely unknown
- B interval
  - Similar rock types but different lithologic percentages
  - Thickness doesn't appear to affect production
- Preliminary thermal maturity analyses indicate peak/late maturity in north and central areas, and early maturity in south

# Further work

## Detailed fracture study

- How fractures influence production

## Fluid inclusion analysis

- Understand timing of fractures

## Epifluorescence of cuttings and core

- Sweet spot identification

## Geochemistry

- Maturity analysis

## Detailed geomechanical characterization and well completion analysis (Energy and Geoscience Institute, University of Utah)

- Cisco State 36-13
- Cane Creek 26-3
- Cane Creek 7-1



# Thank you

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[stephaniecarney@utah.gov](mailto:stephaniecarney@utah.gov)