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

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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

From Blakey, 2012
Paradox Basin

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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
Cane Creek Structure

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

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

- Lower seal
- Thickness range = 10 to 81 feet
- Average thickness = 36 feet
- Generally thicker in south
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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Fidelity E&P Co.
Long Canyon 1
- 1st successful vertical well
- Producing since 1962
- 2013 production = 2,665 BBLS
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Cum Oil = 1.1 million BBLs
Cum Gas = 1.2 BCF
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

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- Hell Roaring Field
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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

Kane Springs Fed 10-1 = 644,309 over 21 yrs
VS
Cane Creek 12-1 = 615,683 over 1.5 yrs
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

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Threemile 12-7
• Hatch Point Field
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Thermal Maturity

Avg Tmax (# samples)  
* Denotes cuttings used

Peak/Late

Early

447 (1*)
453 (1)
436 (1*)
442 (4)
440 (9)
441 (2)

442 (4)
440 (9)
441 (2)

* 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

- 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
Remington 21-1H Geochemical Analysis

Psuedo Van Krevelen Plot

- TYPE I
- TYPE II
- TYPE III
- TYPE IV

HYDROGEN INDEX (H, mg H/Cg TOC)

OXYGEN INDEX (OI, mg CO₂/g TOC)
Remington 21-1H Geochemical Analysis

Psuedo Van Krevelen Plot

- TYPE I oil-prone, usually lacustrine
- TYPE II oil-prone, usually marine
- Mixed TYPE II-III oil-gas-prone
- TYPE III gas-prone
- TYPE IV inert
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 Paradox Upstream

Cisco State 36-13

- Total thickness = 70 ft

- **B Interval**
  - 26 feet thick
  - Silty dolomite, thin black shale, and minor mottled anhydrite

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- No open fractures
CCI Paradox Unit
Cisco State 36-13

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

Top B
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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