Discoveries from the Updip Expansion of the SCOOP Play*

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Abstract

Eastward expansion of the SCOOP horizontal play has begun and data is being collected to understand and quantify risk associated with development in and around the Golden Trend Field. The issues of reservoir pressure, product type, reservoir productivity, and fault hazards have been poorly understood in this part of the play. This article presents production, core, log and pressure data collected during a twelve month horizontal drilling program that was designed to test these properties in the Woodford and Springer formations.
Discoveries from the Updip Expansion of the SCOOP Play

AAPG Mid-Continent Section Meeting
Oklahoma City, OK
October 2017
Drilling Activity in SCOOP

Outline for today’s talk

- Overview of updip SCOOP structural setting
- SCOOP area type log
- Type log of current horizontal targets
- AOI cross section
- Interval isopach mapping
- Core data overview
- Production and fluid analysis overview
Structural setting for SCOOP Golden Trend

- Portion of updip SCOOP play is uplifted by ~E-W faults (overall horst block, faults generalized)
- Depths range from ~8,000’ TVD to ~13,000’ TVD on the uplifted block
- Core SCOOP play ranges from ~12,000 TVD to ~15,000 TVD to the southwest
Structural setting for SCOOP Golden Trend

Stylized Cross Section – Not to scale

Core SCOOP

Casillas AOI

Trapping Seal
Multiple zones throughout the Golden Trend are productive

- Pennsylvanian Sequences
  - Douglas/Tonkawa
  - Cherokee Group
- Mississippian Sequences
  - Goddard (Springer Shale)
  - Sycamore/Meramec
- Devonian
  - Woodford
- Silurian/Ordovician
  - Hunton
  - Viola
  - Simpson
  - Arbuckle
Current Target Type Log

- **Goddard 300** – 2 wells drilled
  - Reservoir Analysis:
    - Sidewall Cores – XRD, XRF, Thin Sections, Poro/Perm, TOC/Vro
    - Cuttings – CST/ROT stability analysis, SRA, VRe

- **Sycamore/Meramec** – 8 wells drilled, 1 drilling
  - Reservoir Analysis:
    - Whole Core – XRD, XRF, SEM/Thin Sections, Poro/Perm, TOC/Pyrolysis, Saturations, Geomechanics
    - Plugs/Sidewall Cores – XRD, XRF, Thin Sections, Poro/Perm, TOC/Vro
    - Cuttings – CST/ROT stability analysis

- **Woodford** – 11 wells drilled, 2 Drilling
  - Reservoir Analysis:
    - Whole core – XRD, XRF, SEM/Thin Sections, Poro/Perm, TOC/Pyrolysis, Saturations, Geomechanics
“Sycamore” Lateral Reservoir Changes

- The Mississippian section throughout this area shows significant lateral facies changes
- Section to south made up of shale (A), interbedded silts (B), and shale (C)
- Section to north made up mainly of shales, with very little siltstone
Sycamore Gross Isopach Map – With Core Control Map

- Gross isopach over Sycamore section shows a rapid thinning as you go from SW to NE.
- Thick NW SE trend closely correlates with section where major lateral facies change occurs (middle siltstone package present in SW vs not present to NE).

Whole Core Data
Plug Data
Sycamore “A” Interval Isopach Map

- Lower Sycamore isopach shows similar NW-SE trending thick
- Section thins to the NE and SW
- Average porosity: 8-9%
- Average k: ~95 μD (PDP)
- 49% Q, 7% Ca, 29% Cl

![Whole Core Data](image1)

- Yellow marker: Whole Core Data
- Red marker: Plug Data
Middle Sycamore isopach map shows overall thinning to the NE, as cleaner siltstones thin and disappear.

- Average porosity: 5%
- Average k: ~4 μD (PDP)
- 37% O, 24% Ca, 20% Cl
Upper Sycamore seems to be the most consistent and mappable portion of the section

- Overall thickness variations are smaller than other portions of the section
- Average porosity: 4-5%
- Average k: 100-150 nD (PDP)
- 43% Q, 8% Ca, 29% Cl
Sycamore TOC and Geomechanical data – Multiple Landing Zones

- TOC data from core plugs throughout the Sycamore show source rock potential
  - Upper Sycamore averages ~3.5% TOC
  - Middle Sycamore averages <1% TOC
  - Lower Sycamore averages ~1-2% TOC
- Maturity average - ~0.8-0.9 Vre
- Relative brittleness testing was completed using a mini-rebound hammer
  - Sycamore section has a “natural break” in trend near the middle of the section, with another break present near the top of the Woodford, and middle Woodford
  - In the Woodford, these breaks correlate to the “Upper” and “Lower” drilling targets
- If the same applies to the Sycamore, multiple landing zones may be present within the section
  - Frac barriers (or baffles) may be limiting completion efficiencies
Producing Wells in Sycamore Section

Sycamore Gross Isopach Map

- **CLR - Pudge**
  - IP30: 95 bopd, 10.3 mmcfd
  - EUR: 120 mbo, 13.7 bcf

- **NFX - Wendling**
  - IP30: 920 bopd, 1.05 mmcfd
  - EUR: 679 mbo, 1.5 bcf

- **MRO - Winter Creek (flowback)**
  - IP30: 553 bopd, 2.5 mmcfd (14 day avg)

- **CPRP - Stella - Drilling**
  - IP30: 751 bopd, 3.7 mmcfd
  - EUR: 1,070 mbo, 2.2 bcf

- **CPRP - Dogfish - WOC**
  - IP30: 240 bopd, 4.7 mmcfd
  - EUR: 85 mbo, 5.7 bcf

- **CPRP - Lulyn**
  - IP30: 240 bopd, 4.7 mmcfd
  - EUR: 85 mbo, 5.7 bcf

- **CPRP - Trapper (flowback)**
  - 370 bopd, 2.7 mmcfd

- **CPRP - Massive - WOC**
  - IP30: 1091 bopd, 2.5 mmcfd
  - EUR: 645 mbo, 5.1 bcf

- **CPRP - Whitney**
  - IP30: 735 bopd, 2.9 mmcfd
  - EUR: 420 mbo, 6.6 bcf

- **CPRP - Massive - WOC**
  - IP30: 735 bopd, 2.9 mmcfd
  - EUR: 420 mbo, 6.6 bcf

- **CPRP - Castle**
  - IP30: 536 bopd, 3.6 mmcfd
  - EUR: 225 mbo, 5 bcf

- **Citizen - Branch (flowback)**
  - IP30: 316 bopd, 2.1 mmcfd (14 day average)

- **Citizen - Branch (flowback)**
  - 316 bopd, 2.1 mmcfd (14 day average)

- **CLR - Ryan Express**
  - IP30: 145 bopd, 6 mmcfd
  - EUR: 235 mbo, 13.4 bcf

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- **Sycamore A**

- **Sycamore C**

- **Sycamore A/C (B not Present)**

- **Non Op Wells**

- **CPRP Op Wells**
Produced fluids from vertical wells show a product mix that is different than expected based on Woodford Ro mapping (public and in house data).

With an increase in horizontal drilling activity, a more detailed expected hydrocarbon map can be created for this area.

Updip area has a similar product mix to that in the Core SCOOP area.

A produced oil and gas sampling and analysis program was started to better understand where hydrocarbons originated in this area.

- Locally derived or migrated from deeper in the trend.
- Oil and gas analysis was completed on 10 samples throughout the area.
- Whole oil GC analysis shows similar organic facies, with varying degrees of maturity as one cause of higher than expected gas rates.
Gas isotope analysis completed on 8 wells

One well (Lori Ann) had a bad sample

Multiple isotopic comparisons were made which indicate maturity of the gas, and potential for higher temperature gas migration

Abrams plot shows that gases seem to be generated at relatively lower maturities

Chung plot shows a slight increase in the trend of the Carbon Isotope Value, indicating HT gas
SUMMARY/FUTURE WORK

- Updip portion of SCOOP Woodford shows product mix similar to that in the deeper SCOOP trend.

- Reservoir mapping and core analysis of the Mississippian section in updip portion of the SCOOP show variable facies (siltstones and shales) from southwest to northeast.

- Wells drilled in different facies of Mississippian section show promising production results, which when paired with geomechanical data lead to multiple potential landing/drilling targets.

- Regional production and fluid analysis testing will be continued to further study predicted vs actual product mix.

- Continued core and log analyses are planned throughout the area to further enhance our understanding of the Goddard and Mississippian reservoirs:
  - Depositional environments for each reservoir will be key to understanding facies changes throughout the area.