Rock Volatiles Stratigraphy of Meramec, Upper Osage, and Lower Osage carbonates in Fairway Resource’s NW STACK wells: logging horizontal STACK wells from PDC cuttings’ volatile chemistry

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NW STACK – Cored Wells

- Woods
- Alfalfa
- Major
- Dewey
- Blaine

2 - Whole Cored Wells
2 - Side Wall Cored Wells
Type Log & Generalized Depositional Model

(modified from Vanden Berg & Grammer, 2016, AAPG Mem. 112)
I. **Mound (Bioherm) Facies (Diverse Skeletal Grainstone)**
   - Large, open pores (and some bitumen)
   - **Best** Oil Production

II. **Clean Crinoidal Grainstone Facies**
   - Dissolution & mostly microporosity
   - Background (fair to good) Oil Production

III. **Mixed Crinoid/Siliceous or Silty Facies**
   - Mostly nanoporosity (& high Gas/Oil ratios)
   - Fair to Poor Oil Production w/ high gas content
I. Mound (Bioherm) Facies (Diverse Skeletal Grainstone)

- Large, open pores (and some bitumen)
- Best Oil Production
RESERVOIR TYPE I – Mound Facies
II. **Clean Crinoidal Grainstone Facies**

- Dissolution & mostly microporosity
- Background (fair to good) Oil Production
RESERVOIR TYPE II — Clean Crinoidal Facies

Pl. Light

Pl. Light + W.C.

0.5 mm

0.5 mm

OSAGE
RESERVOIR TYPE III

III. Mixed Crinoid/Siliceous or Silty Facies

- Mostly nanoporosity (higher Gas/Oil ratios)
- Fair to poor oil production with higher gas content
RESERVOIR TYPE III — Mixed Crinoid/Siliceous Facies

Limestone

Chert

10 mm

0.2 mm

Pl. Light

Calcite

Chert

OSAGE
Starting Material: PDC Cuttings

PDC Cuttings

Sub-Millimeter in size

Gently Caught

Washed and Dried then Loaded

Or

Sealed at Well Immediately after Gently Caught, and Washed. Usually sealed less than a minute after the cuttings are caught.

WBM or OBM
New Wells and Old Wells
Rock Bit Cuttings and Core Also.
AHS’s Unique CT/MS Technology

1. Cuttings (or Mud) Samples
   Sealed or Bagged at Well Site
2. Older well cuttings washed or unwashed
3. Oil based mud and PDC bits have limited impact

Sample Volatiles Analyzed Using Mass Spectrometry

Well Cuttings

LN2 Cryo Trap Separation

MS Analysis

Quantitative Reservoir Contents

The 4th Log
AHS Products and Interpretation

<table>
<thead>
<tr>
<th>Category</th>
<th>Sample depth</th>
<th>C1-C10, Total Gas/Oil</th>
<th>Frac &amp; Perm</th>
<th>Prospect Evaluation</th>
<th>HC Analysis</th>
<th>Well Tops</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interpretation</td>
<td></td>
<td>HC Detection, ID: faults, fractures, rock types, etc.</td>
<td>AHS exclusive analysis</td>
<td>Proximity to Pay, Organic Acids, Oil Migration</td>
<td>Pay Zone Mapping, product quality</td>
<td>From Client</td>
</tr>
</tbody>
</table>
Fault May Feed Oil Into Reservoir

Tighter Rocks Maintain Oil and Gas from Cuttings through Drilling and Transport to the Surface

High Toluene/Benzene ratio at fault = Zone of Active Oil Migration

AHS Predicted Preferred Reservoir Zones

High Porosity High Permeability Rocks Can Lose Oil During Drilling, Transport, and Sample Prep
Potential Rock Type 1 CO₂ Response

Possibly Bioherms
Largest Grains
Largest Fluid Inclusions
Highest CO₂ Release
Potential Rock Type 1 CO$_2$ Response
Potential Rock Type 2 CO₂ Response

Potential ROCK Type 2 Crinoidal Grainstones Large Grains Large Fluid Inclusions 2nd Highest CO₂ Release
Potential Rock Types 1 and 2

Potential ROCK Types 1 and 2 CO₂ Responses:
Bioherms and Shelf Grainstones
Reservoirs May Show Low Cuttings Oil Response

High Performing Well

Low Cuttings Oil Responses

High Porosity High Permeability Rocks Can Lose Oil During Drilling, Transport, and Sample Prep

AHS Predicted Preferred Reservoir Zones
Reservoirs May Be Filled by Nearby Fault

High Performing Well

Lateral Drilled Along N-S Fault

AHS Predicted Preferred Reservoir Zones

Nearby Parallel Fault May be Filling Reservoirs the Entire Length of Lateral

High Porosity High Permeability Rocks Can Lose Oil During Drilling, Transport, and Sample Prep
Fault May Feed Oil Into Reservoir

Tighter Rocks Maintain Oil and Gas from Cuttings through Drilling and Transport to the Surface

High Toluene/Benzene ratio at fault = Zone of Active Oil Migration

AHS Predicted Preferred Reservoir Zones

High Porosity High Permeability Rocks Can Lose Oil During Drilling, Transport, and Sample Prep
Faults Might Feed Reservoirs and Create Porosity

Lateral Drilled through a Fault

High Toluene/Benzene = Oil Migration along Fault

AHS Predicted Preferred Reservoir Zones Surrounding Fault

High Acetic Acid Toe Side of Fault

Small Fault Feeding Small Reservoir
Faults Migrating Oil and Acetic Acid

Lateral Drilled through 2 NE-SW Faults

- Very High Acetic Acid and Toluene/Benzene
- Oil and Acid Rich Oil Field Brines Migrating on NE-SW Faults
Faults Migrating Oil and Acetic Acid

- Lateral Drilled through 2 NE-SW Faults
- Very High Acetic Acid and Toluene/Benzene
- Oil and Acid Rich Oil Field Brines Migrating on NE-SW Faults
- High Response Scaling
Conclusions

• Fairway Resources is successful in producing liquids in the NW STACK by applying a variety of innovative technologies
  • Rock typing identifies potentially producible facies

• AHS RVStrat attempts to map reservoir quality, oil and gas migration and pay zones
  • Combined with rock type facies for more predictive mapping and results

• Faults can be chemically identified
  • Porosity creation may increase rock facies reserves
  • Oil migration pathways provide clarity for well placement and potentially producible zones