Effects of geologic structures on organic carbon concentrations and thermal maturities in organic-rich Upper Devonian shales

Katherine Schmid and Antonette Markowski
Pennsylvania Geological Survey
Introduction

- Predicting the effects of geologic structures on the distribution of organic carbon and development of thermal maturity in shales is important for oil and gas companies who want to develop drilling programs in organic-rich shales
  - Shales need to contain at least 1% TOC to produce hydrocarbons
  - Shales need to reach a thermal maturity of about 0.6 to produce any oil or natural gas
Outline

- Shales
- Structures
- TOC results
- Thermal maturity results
- Conclusions
Upper Devonian Shales

- West Falls Formation
  - Rhinestreet Member
- Genesee Formation
  - Geneseo Member
- Harrell Formation
  - Burket Member
Major Geologic Structures

- Allegheny Front
- Rome Trough
- Lineaments
<table>
<thead>
<tr>
<th>Range</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;5.0</td>
<td>Red</td>
</tr>
<tr>
<td>4.5 – 5.0</td>
<td>Orange</td>
</tr>
<tr>
<td>4.0 – 4.5</td>
<td>Yellow</td>
</tr>
<tr>
<td>3.5 – 4.0</td>
<td>Green</td>
</tr>
<tr>
<td>3.0 – 3.5</td>
<td>Blue</td>
</tr>
<tr>
<td>2.5 – 3.0</td>
<td>Gray</td>
</tr>
<tr>
<td>2.0 – 2.5</td>
<td>Light Gray</td>
</tr>
<tr>
<td>1.5 – 2.0</td>
<td>Dark Gray</td>
</tr>
<tr>
<td>&lt;1.5</td>
<td>Black</td>
</tr>
</tbody>
</table>
West Falls TOC Results

A map showing the distribution of TOC results across a region. The map uses color gradients to indicate different concentration levels, with key concentrations labeled as:

- >3.5
- 3.0 – 3.5
- 2.5 – 3.0
- 2.0 – 2.5
- 1.5 – 2.0
- 1.0 – 1.5
- 0.5 – 1.0
- <0.5

The map highlights areas with higher concentrations in the northeastern part of the region.
Paleogeography

Genesee/Harrell time

West Falls time
### Thermal Maturity Table

<table>
<thead>
<tr>
<th>Maturity Stage</th>
<th>% $R_0$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immature</td>
<td>0.20 – 0.60</td>
</tr>
<tr>
<td>Early Oil</td>
<td>0.60 – 0.65</td>
</tr>
<tr>
<td>Peak Oil</td>
<td>0.65 – 0.90</td>
</tr>
<tr>
<td>Wet Gas</td>
<td>0.90 – 1.50</td>
</tr>
<tr>
<td>Dry Gas</td>
<td>1.50 – 2.50</td>
</tr>
<tr>
<td>Overmature</td>
<td>&gt;2.50</td>
</tr>
</tbody>
</table>
Genesee/Harrell Thermal Maturity Results

- >2.5
- 2.0 – 2.5
- 1.5 – 2.0
- 1.0 – 1.5
- <1.0
Genesee/Harrell Thermal Maturity Results

- >2.5
- 2.0 – 2.5
- 1.5 – 2.0
- 1.0 – 1.5
- <1.0
West Falls Thermal Maturity Results

- >2.5
- 2.25-2.5
- 2.0 – 2.25
- 1.75 – 2.0
- 1.5 – 1.75
- 1.25 – 1.5
- 1.0 – 1.25
- 0.75 – 1.0
- <0.75
Conclusions

Genesee/Harrell
• The Allegheny Front displays strong influence on thermal maturity
• The Rome Trough shows some control on TOC and thermal maturity
• Lineaments show little effect on TOC and thermal maturity

West Falls
• The Allegheny Front displays strong influence on thermal maturity
• The Rome Trough shows little influence on TOC and thermal maturity
• Lineaments show strong effects on TOC and thermal maturity
Thank you!

Questions?