Basin-wide Evaluation of the Uppermost Green River Formation’s Oil-Shale Resource, Uinta Basin, Utah and Colorado

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November 13, 2008
Acknowledgements

• U.S. Bureau of Land Management – funding and data
• Utah School and Trust Land Administration - funding
• U.S. Geological Survey - data
1) **Scope**
   - Development of a new basin-wide oil shale assessment

2) **Methods**
   - Creation of isopach maps
   - Calculating resource numbers

3) **Results**
   - Total in-place resource
   - Potential economic resource
**Scope - Oil Shale Resource Evaluation**

1) **Focus - Entire Uinta Basin**
   - Data from 293 wells spread throughout the Uinta Basin

2) **Determined thickness of continuous intervals averaging 50, 35, 25, and 15 gallons per ton (GPT)**

3) **Created GIS-based maps**
   - Isopachs for each richness zone
   - Overburden thickness – Depth to the top of each richness zone

4) **Calculated resource numbers**
   - Total in-place resource with certain constraints

**UGS Special Study 128: due out this fall**
Methods

**Step 1:** Oil yield vs. log

**Step 2:** Create conversion equations

**Step 3:** Locate and digitize logs

**Step 4:** Calculate thickness

**Step 5:** Create isopach maps

**Step 6:** Calculate resource numbers
Step 1: Oil yield vs. geophysical log

USGS - Coyote Wash 1
Step 1: Oil yield vs. geophysical log

\[ y = -85.5x + 213.5 \]

\[ R^2 = 0.84 \]
Methods

Step 1: Oil yield vs. log

Step 2: Create conversion equations

Step 3: Locate and digitize logs

Step 4: Calculate thickness

Step 5: Create isopach maps

Step 6: Calculate resource numbers
Step 2: Created equation comparing bulk density to oil yield

- Used 8 wells with $R^2$ ranging from 0.71 to 0.87
- Used a reduced major axes regression fit

\[ y = -66.467x + 203.996 \]
Step 2: Created equation comparing sonic to oil yield

- Used 4 wells with $R^2$ ranging from 0.64 to 0.77
- Used a reduced major axes regression fit

$$ y = 0.766x - 49.237 $$
**Step 2:**
- Ground truth verses calculated yield

1.5 miles apart

Average gpt of datasets:
- Gas well = 21.4 gpt
- U045 = 21.7 gpt
**Methods**

**Step 1:** Oil yield vs. log

**Step 2:** Create conversion equations

**Step 3:** Locate and digitize logs

**Step 4:** Calculate thickness

**Step 5:** Create isopach maps

**Step 6:** Calculate resource numbers
Step 3: Data distribution
Methods

Step 1:
Oil yield vs. log

Step 2:
Create conversion equations

Step 3:
Locate and digitize logs

Step 4:
Calculate thickness

Step 5:
Create isopach maps

Step 6:
Calculate resource numbers
Step 4: Calculated thickness of certain richness zones

- Zones averaging 15, 25, 35, and 50 gpt

Average of 15 gpt

426 ft
Step 4: Calculated thickness of certain richness zones

- Zones averaging 15, 25, 35, and 50 gpt
Step 4: Calculated thickness of certain richness zones

- Zones averaging 15, 25, 35, and 50 gpt
Step 4: Calculated thickness of certain richness zones

- Zones averaging 15, 25, 35, and 50 gpt
Methods

Step 1: Oil yield vs. log

Step 2: Create conversion equations

Step 3: Locate and digitize logs

Step 4: Calculate thickness

Step 5: Create isopach maps

Step 6: Calculate resource numbers
Step 5: Created isopach maps in ArcGIS

Step 6: Calculated resource numbers

- Calculated resource for each richness zone (15, 25, 35, and 50 gpt)
- Calculated volumes in ArcGIS for each richness zone at several thickness intervals
- Used the density of each richness to convert volume to mass
  - 50 GPT = 1.90 g/cm³
  - 35 GPT = 2.09 g/cm³
  - 25 GPT = 2.21 g/cm³
  - 15 GPT = 2.34 g/cm³
- Used the richness (i.e., 50 gal per ton) to convert mass to barrels
Results

New Oil Shale Resource Estimates for Utah
Total In-Place Resource at

50 GPT
31 billion bbls

Overburden Contours

Mahogany Zone Outcrop

Continuous interval averaging 50 GPT:

- >0-5 ft
- 5-10 ft
- 10-15 ft
- 15-20 ft
Total In-Place Resource at 35 GPT 76 billion bbls
Total In-Place Resource at 25 GPT
147 billion bbls
Total In-Place Resource at 15 GPT
292 billion bbls
Total In-Place Resource by landownership

Continuous interval averaging 25 GPT:

- BLM - 72 billion bbls - 49%
- Tribal - 28 billion bbls - 19%
- Private - 25 billion bbls - 17%
- State - 13 billion bbls - 9%
- USFS - 5 billion bbls - 3%
- Other - 5 billion bbls - 3%

25 GPT isopach contours
100-130 ft
Total In-Place Resource at 25 GPT

Within oil and gas field = 40 billion bbls (27%)

Outside oil and gas field = 107 billion bbls (73%)
Total In-Place Resource on BLM Lands Potentially Open for Leasing

25 GPT
69 billion bbls
Potential Economic Resource:
Constraints:
1) 25 GPT – 147 billion bbls
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2) Less than 3000 ft of cover – 113 billion bbls
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Constraints:
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3) More than 5 ft thick – 111 billion bbls
4) Not in conflict with oil and gas – 83 billion bbls
Potential Economic Resource:

Constraints:

1) 25 GPT – 147 billion bbls
2) Less than 3000 ft of cover – 113 billion bbls
3) More than 5 ft thick – 111 billion bbls
4) Not in conflict with oil and gas – 83 billion bbls
5) Not on restricted lands – 77 billion bbls
**Take Home Message**

- Utah’s Potential Economic Oil Shale Resource = 77 billion barrels

- Roughly 75% less than numbers frequently quoted, but still very large and very significant

- The UGS supports the advancement of pilot projects to firm up technology and answer pressing questions
Additional UGS Projects - Upper Green River Formation

1) University of Utah - Energy and Geoscience Institute and Department of Chemical Engineering
   - Depositional heterogeneity and fluid flow modeling of the oil shale interval of the Green River Formation, eastern Uinta Basin, Utah

2) Dr. Jessica Whiteside - Brown University
   - Multiproxy paleoclimate reconstruction of Earth’s most recent extreme hothouse - Milankovitch cyclicity in the upper Green River Formation

3) TerraTek, a Schlumberger Company, Salt Lake City, UT
   - Continuous unconfined compressive strength profiling (TSI™ scratch testing) and other physical property analyses of upper Green River oil shales

4) UGS - NETL/DOE funded project
   - Water-related issues affecting conventional oil and gas recovery and potential oil shale development in the Uinta Basin, Utah