Re-examination of Utah’s oil shale deposits: Historical database and new resource evaluation

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Outline

1) Oil shale overview

2) Utah Oil Shale Database

3) New research – revised resource evaluation
Oil Shale vs. Tar Sands

- **“Oil shale”**
  - Silty marlstone containing relatively large amounts of organic matter called kerogen
  - Kerogen can be heated to produce shale oil and natural gas
  - Considered a source rock for conventional crude resources

- **Tar sands**
  - A type of sandstone from which the lighter fractions of crude oil have escaped, leaving a residual asphalt to fill the pore spaces
  - Considered a reservoir rock – bitumen coats the sand grains
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Oil Shale in the Western U.S.

- U.S., Israel, Estonia, China, Australia, Morocco, Jordan, and Brazil
- Largest oil shale deposits in the world are located in the Eocene Green River Formation in Utah, Colorado, and Wyoming
Oil Shale Stratigraphy

USGS - Coyote Wash 1

- Mahogany bed

- Eocene
  - Green River Formation
    - Parachute Creek Member
    - Douglas Creek Member

- Paleocene
  - Wasatch Formation

- Cretaceous
  - Mesaverde Group
Oil Shale Stratigraphy

B-groove

Mahogany bed

USGS - Coyote Wash 1

Mahogany bed

OIL YIELD (GALLONS PER TON)

Depth (ft)

0 20 40 60 80 1900

R-8

A-groove

Mahogany Zone (R-7)

B-groove

R-6

L-5

R-5

L-4

R-4

2100

2300

2500

2700

2900
Hell’s hole overlook at Evacuation Creek, Uinta Basin
In-Place Reserves

- Total within the Green River Formation – 1.5 to 1.8 trillion bbls
  - Colorado – 1.0 trillion barrels
  - Wyoming – 300 billion barrels
  - Utah – 165 billion to 321 billion barrels

World conventional crude reserves – 1.3 trillion barrels
U.S. conventional crude reserves – 22 billion barrels
Saudi Arabia conventional crude reserves – 262 billion barrels
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![Bar Chart of Billion Barrels of shale oil in various countries](chart.png)
Recoverable Reserves in Utah

- Short answer
  - ??????
  - No proven technology for commercial recovery
Recoverable Reserves in Utah

• Short answer
  – ??????
  – No proven technology for commercial recovery

• Long answer
  – Possibly 50% of in-place reserves – 80 to 160 billion bbls
  – 30 gpt with a thickness of 15 feet – 20 billion bbls ??
Recovery Methods

- Underground/surface mining and surface retorting
Recovery Methods

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**Environmental concerns:**
- Disturbance of mined land
- Disposal of spent shale
- Use of water resources
- Greenhouse gas emissions
- Impacts on water and air quality
Recovery Methods

- **In-situ retorting**
  - Heat shale slowly to 650 to 700 degrees F
  - Recover 1/3 gas and 2/3 light oil
  - In Colorado, potential for 1 acre to yield 1 million barrels of oil
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**Advantages:**
- Much less land disturbance
- No tailings
- Better recovery efficiency
- Allows access to deeper oil shale reserves
- Higher-quality product
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  – Groundwater contamination
  – Energy consumption
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**Water & Temperature Monitor Wells**

**Freeze Wells**

**Heater & Producer Wells**

**Fractured Shale**

**Water Bearing Zone**
Federal Lease Recipients

- **Colorado** — *in-situ*
  - Shell Frontier Oil & Gas Co.
  - Chevron Shale Oil Co.
  - EGL Resources Inc.

- **Utah** — surface retort
  - Oil Shale Exploration Co.
    - Plans to use 30,000 tons of shale left outside the White River mine

**State Lease - Oil Tech, Inc. (Millennium Synfuels, LLC)**

- Surface retort
- No access to rich oil shale
White River Oil Shale Mine, Uinta Basin
Mined oil shale at the White River Mine
Preservation of historical oil shale data presented in a useable electronic format:

- Digital Fischer assays for 581 wells
- Scanned geophysical logs for 173 wells
- Lithologic descriptions for 168 wells
- Formation tops information for over 1,000 wells
- Extensive Utah oil shale bibliography with nearly 1,000 references
New Research

Goals:
– New comprehensive resource evaluation for entire Uinta Basin
– Improved surface minable, underground minable, and in-situ resource maps
– Improved structure contour and isopach maps for selected oil shale zones

Methods:
– Use oil and gas logs to pick tops of several important oil shale zones
– Create pseudo-Fischer assay logs from digitized density or sonic logs of oil and gas wells
– Determine zones of richness – 15 gpt, 25 gpt, and 35 gpt
Depth to Mahogany Bed
Depth to Mahogany Bed
Depth to Mahogany Bed
Surface mining potential

0-500 ft
Depth to Mahogany Bed
Underground mining potential

Will be further constrained by resource potential
Oil yield from Fischer assay (gpt) vs. Bulk density (g/cm$^3$)

- $R^2 = 0.75$
- Standard Deviation = 5.0

USGS - Coyote Wash 1
Oil yield from Fischer assay (gpt) vs Bulk density (g/cm³)

- **Sonic**
  - $R^2 = 0.69$
  - STDEV = 5.4

- **Both density and sonic**
  - $R^2 = 0.80$
  - STDEV = 4.3

**USGS - Coyote Wash 1**
USGS - Coyote Wash 1

- Oil yield from Fischer assay
- Oil yield calculated from density log

Depth (ft)

Gallons per ton

1900 2100 2300 2500 2700 2900
- Digitized log from oil and gas well (126)
- Oil shale well with Fischer assays (70)
Average of 15 gpt
617 ft
Average of 25 gpt
124 ft
Average of 35 gpt

40 ft
“Back-of-the-envelope”

**Underground mine:**
- **Assumptions:**
  - 40 ft of 35 gpt oil shale
  - 5,000 acre lease
  - 50% material recovery
  - 90% shale oil extraction efficiency
- **Results:**
  - 200 million bbls of oil
  - 30,000 bbls per day for 20 years

**In-situ methods:**
- **Assumptions:**
  - 124 ft of 25 gpt oil shale
  - 5,000 acre lease
  - 60% shale oil extraction efficiency
- **Results:**
  - 700 million bbls of oil
  - 95,000 bbls per day for 20 years
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(2006 data)

- **Utah crude oil production**
  = 50,000 bbls per day
- **Utah petroleum consumption**
  = 145,000 bbls per day
- **U.S. crude oil production**
  = 5 million bbls per day
- **U.S. petroleum consumption**
  = 21 million bbls per day
- **U.S. crude oil imports**
  = 10 million bbls per day

- **Utah’s refinery capacity**
  = 167,000 bbls per day
- **Utah’s refinery inputs**
  = 151,000 bbls per day
- **Utah’s spare refinery capacity**
  = 16,000 bbls per day