Assessment of In-Place Oil Shale Resources in the Green River Formation, Greater Green River Basin, Wyoming, Colorado, and Utah

By

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Assessments of all three basins are complete and available at the USGS Oil Shale home page and on CD-ROM.
The assessment consists of 6 chapters

- **Chapter 1** (9.95 MB)
  Assessment of In-Place Oil Shale Resources of the Eocene Green River Formation, Greater Green River Basin, Wyoming, Colorado, and Utah
  By Ronald C. Johnson, Tracey J. Mercier, Robert T. Ryder, Michael E. Brownfield, and Jesse G. Self

- **Chapter 2** (18.2 MB)
  Methodology for Calculating Oil Shale Resources for the Green River and Washakie Basins, Southwestern Wyoming
  By Tracey J. Mercier, Michael E. Brownfield, and Ronald C. Johnson

- **Chapter 3** (524 kB)
  The GIS Project for the Geologic Assessment of In-Place Oil Shale Resources of the Eocene Green River Formation, Greater Green River Basin, Wyoming, Colorado, and Utah
  By Tracey J. Mercier, Gregory L. Gunther, and Christopher C. Skinner

- **Chapter 4** (5.62 MB)
  Calculation of Overburden above the LaClede Bed of the Laney Member of the Eocene Green River Formation, Green River and Washakie Basins, Southwestern Wyoming
  By Tracey J. Mercier

- **Chapter 5** (2.1 MB)
  Stratigraphic Cross Sections of the Eocene Green River Formation in the Green River Basin, Southwestern Wyoming, Northwestern Colorado, and Northeastern Utah
  By Jesse G. Self, Robert T. Ryder, Ronald C. Johnson, Michael E. Brownfield, and Tracey J. Mercier

- **Chapter 6** (1.80 MB)
  Fischer Assay Histograms of Oil-Shale Drill Cores and Rotary Cuttings from the Great Divide, Green River, and Washakie Basins, Southwestern Wyoming
Piceance Basin: 1,335 square miles (3,458 square kilometers). **In place resource: 1.52 trillion barrels**

Uinta Basin: 3,834 square miles (9,930 square kilometers). **In-place resource: 1.32 trillion barrels**

Greater Green River Basin: 5,500 square miles (14,244 square kilometers). **In-place: 1.44 trillion barrels**

The Piceance Basin has the smallest area and largest resource.
The Laramide orogeny broke up the central part of the Rocky Mountain foreland basin from Latest Cretaceous through Eocene time into a series of basins and uplifts.

Land masses and oceans in Late Cretaceous Campanian time.
During early stages of Laramied orogeny, the Cretaceous seaway retreated from the Rocky Mountain region and was replaced by a series of basins and uplifts.

Lakes that developed in Laramide basins:
1) Lake Uinta in the Piceance and Uinta Basins (Eocene)
2) Lake Gosiute in the Greater Green River (Eocene)
3) Lake Waltman in Wind River (Paleocene)
4) Lake Tatman in the Bighorn (Eocene)
The Green River Formation was deposited in two large lakes, Lake Gosiute in the Greater Green River Basin and Lake Uinta in the Uinta and Piceance Basins.

The basins were formed during the Laramide Orogeny from Late Cretaceous through Eocene time.
Lakes formed in other Laramide basins as well. This is the extent of Lake Waltman in the Wind River Basin in Late Paleocene time.
Lake Waltman produced organic-rich shale considered a source rock for oil and gas but not rich enough to be an oil shale
The Greater Green River Basin is subdivided by relatively minor structural arches into the Hoback, Green River, Great Divide, Washakie, and Sand Wash Basins.
Structure contour map on the top of the Upper Cretaceous Mesaverde Group showing surrounding uplifts. Modified from Johnson and others (2005).
Map of the Greater Green River Basin showing areas underlain by oil shale and all drill holes with oil shale information.

Note that there is little control in the Great Divide Basin and no control for the Sand Wash Basin.

We only assessed the oil shale in the Green River and Washakie Basins.
This map shows total oil in thousands of barrels per acre for all of the three units assessed.
Lake Gosiiute can be subdivided into three general phases: 1) an early fresh to near fresh water stage (Tipton Member), 2) a restricted saline phase (Wilkins Peak Member, and 3) a late near freshwater stage (Laney Member).

Generalized east-west cross section of Green River Basin. Assessed units are outlined in heavy black.
Isopach map of Lake Gosiute rocks—from base of Tipton Member to top of LaClede Bed indicates a thinning toward the Wind River Uplift.
Structure contour map on the top of the LaClede Bed of the Laney Member. This map was used to calculate overburden in the LaClede Bed.
Twenty-four detailed cross sections were constructed for this assessment.

Note the thickening of the Green River Formation toward the south in this cross section.

The Wilkins Peak grades marginward into the Cathedral Bluffs Tongue of the Wasatch Formation, a fluvial unit.
LaClede Bed on Lookout Mountain in the Sand Wash Basin
Four maps were generated for each assessed unit

- Isopach map
- Variations in oil yield in gallons per ton
- Variations in oil yield in barrels per acre
- Total oil in place in each 6-mile by 6-mile township
Maps showing variations in weight percent oil will be generated in the future. This is a weight percent oil map for the Mahogany zone in the Uinta and Piceance Basins.
Assessment of the Tipton Shale Member

We assessed the Scheggs and Rife beds together because they cannot be everywhere distinguished.
The Tipton phase of Lake Gosiute formed when an earlier freshwater lake expanded to cover much of the Greater Green River Basin.
The Scheggs Bed of the Tipton Member represents the maximum expansion of Lake Gosiute shortly after the lake formed. Modified from Roehler (1992; 1993).
The Rife Bed represents the upper saline phase of the Tipton shale.
Isopach map of the Tipton Shale Member
Variations in gallons per ton oil for the Tipton Shale Member
Variations in barrels of oil per acre for the Tipton Shale Member
Oil yield in barrels per 6-mile by 6-mile township for the Tipton Shale Member
Assessment of the Wilkins Peak Member.

The member grades into the Cathedral Bluffs tongue of the Wasatch Formation toward the basin margins.
The Wilkins Peak is the main saline phase of Lake Gosiute when large amounts of trona were deposited.

Roehler (1992; 1993) suggested that the contact between the Rife Bed and overlying Wilkins Peak Member was gradational. Pietras and others (2003) suggest that the contact is sharp and represents a sequence boundary.
Thickness of Wilkins Peak Member and time-equivalent Cathedral Bluffs Tongue of the Wasatch Formation. The interval thickens toward the Uinta Uplift and central part of Washakie Basin.
The Wilkins Peak grades into the fluvial Cathedral Bluffs Tongue of the Wasatch Formation towards the basin boundaries.
During deposition of the Wilkins Peak Member, Lake Gosiute was highly saline and largely confined to that part of the Greater Green River Basin west of the Rock Springs uplift. Modified from Roehler (1992; 1993).
This reconstruction assumes that the Wilkins Peak saline phase is time equivalent to the saline phase in the Parachute Creek Member in Lake Uinta.
Isopach map of just the Wilkins Peak Member
Variations in gallons per ton oil for the Wilkins Peak Member. The Member is richest in the northern part of the Green River Basin but is quite thin there.
Total oil in barrels of oil per acre is greater farther south where the Wilkins Peak Member is thickest.
Oil yield in barrels per 6-mile by 6-mile township for the Wilkins Peak Member
Assessment of the LaClede Bed of the Laney Member
Lake Gosiute expanded and became fresher during deposition of the Laney Member ultimately draining southward into Lake Uinta. The richest interval from this period is the LaClede Bed.
Lake Gosiute was gradually filled in from north to south by volcanioclastics during deposition of the Laney Member.
Volcaniclastics pushed Lake Gosiute farther and farther to the south, ultimately filling it in.
Lake Gosiute probably drained south into Lake Uinta during deposition of the LaClede Bed.

This changed Lake Gosiute from saline to fresh and caused Lake Uinta to expand.

The Mahogany zone, the richest zone in the Uinta and Piceance Basins was deposited during this period.
As tongues of the Green River Formation join the LaClede bed, they are included in the assessment of the LaClede.
The LaClede Bed is thickest in the Washakie Basin largely because Lake Gosiute persisted there the longest.
The LaClede Bed is richest in the eastern part of the Green River Basin and western part of the Washakie Basin.
Total oil in the LaClede Bed is greatest in the Washakie Basin where Lake Gosiate persisted the longest.
Oil yield in barrels per 6-mile by 6-mile township for the LaClede Bed
Total barrels of oil per acre for all three assessment units
Total oil in place in the Greater Green River Basin

- LaClede Bed: 377.2 billion barrels
- Wilkins Peak Member: 705 billion barrels
- Tipton Shale Member: 362.8 billion barrels

Total oil in place: 1.44 trillion barrels
Other oil shale papers submitted for publication

- “Spatial and Stratigraphic Distribution of Water in Oil Shale of the Green River Formation using Fischer Assay, Piceance Basin, Northwestern Colorado” by Ronald C. Johnson, Tracey J. Mercier, and Michael E. Brownfield

- “Isopach maps and Isoresource maps for the Oil Shale Deposits in the Eocene Green River Formation for the Combined Uinta and Piceance Basins, Utah and Colorado” by Tracey J. Mercier, and Ronald C. Johnson
Gallons per ton and gallons per acre of water in the R-3 oil shale zone, Piceance Basin
Weight percent oil map for the combined Uinta and Piceance Basins
We are currently developing an interactive tool—the oil shale calculator— for the oil shale web site that allows the user to calculate individualized oil shale resource numbers.
We will be adding layers such as federal and state lands, cultural features, overburden, ect to assist the user in selecting areas of interest.
It should be possible to add other functions to the calculator such as in putting a desired minimum oil yield and have the calculator display and add up all cells that equal or exceed that minimum
Thank You