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

Oil Shale Assessment Project Fact Sheet

Using a geology-based assessment methodology, the U.S. Geological Survey estimated a total of 1.32 trillion barrels of oil in place in eighteen oil shale zones in the Eocene Green River Formation in the Uinta Basin, Utah and Colorado.

Introduction

The U.S. Geological Survey (USGS) recently completed a reassessment of in-place oil shale resources, regardless of richness, in the Eocene Green River Formation in the Uinta Basin, Utah and Colorado (fig. 1). The oil shale interval in the Uinta Basin is subdivided into eighteen "rich" and "lean" zones (fig. 2) that were assessed separately. These zones, originally defined by Cashion and Donnell (1972), are roughly time-stratigraphic units consisting of distinctive, laterally continuous intervals of rich and lean oil shale beds that can be traced throughout much of the Uinta Basin. This assessment uses oil-yield values in gallons per ton (GPT) from four sources: (1) Fischer-assayed samples from core holes specifically cored to assess oil shale, (2) Fischer-assayed cuttings from oil and gas tests, (3) Fischer-assayed surface samples, and (4) estimated oil yields from surface samples. Core data are confined largely to the eastern and southeastern parts of the basin (fig. 1) where rich oil shale intervals occur at shallow depth favorable for development. Results from cuttings are less precise than those from core, and there is the ever-present possibility of contamination from uphole caving. To minimize these effects, this study used only cuttings data in which the sample collection interval is no greater than 10 ft, missing intervals are minimal, and the characteristic pattern of rich and lean zones, established from core results (fig. 2), are clearly delineated on oil-yield histograms. Comparisons of results from cuttings data and nearby core holes indicate that cuttings data are 10–20 percent too low for rich oil shale zones and as much as 10 percent too high for most lean oil shale zones. We did not apply any correction factors to the cuttings data for this assessment. Surface samples were used only in areas where no core or cuttings data were available.

The Fischer assay method is a standardized laboratory test for determining the oil yield from oil shale that has been almost universally used to determine oil yields for Green River Formation oil shales (Stanfield and Frost, 1949; American Society for Testing and Materials, 1980). Fischer assay does not necessarily measure the maximum amount of oil that an oil shale can produce, and there are retorting methods that yield

Photo: Evacuation Creek, Uinta Basin, northeastern Utah.

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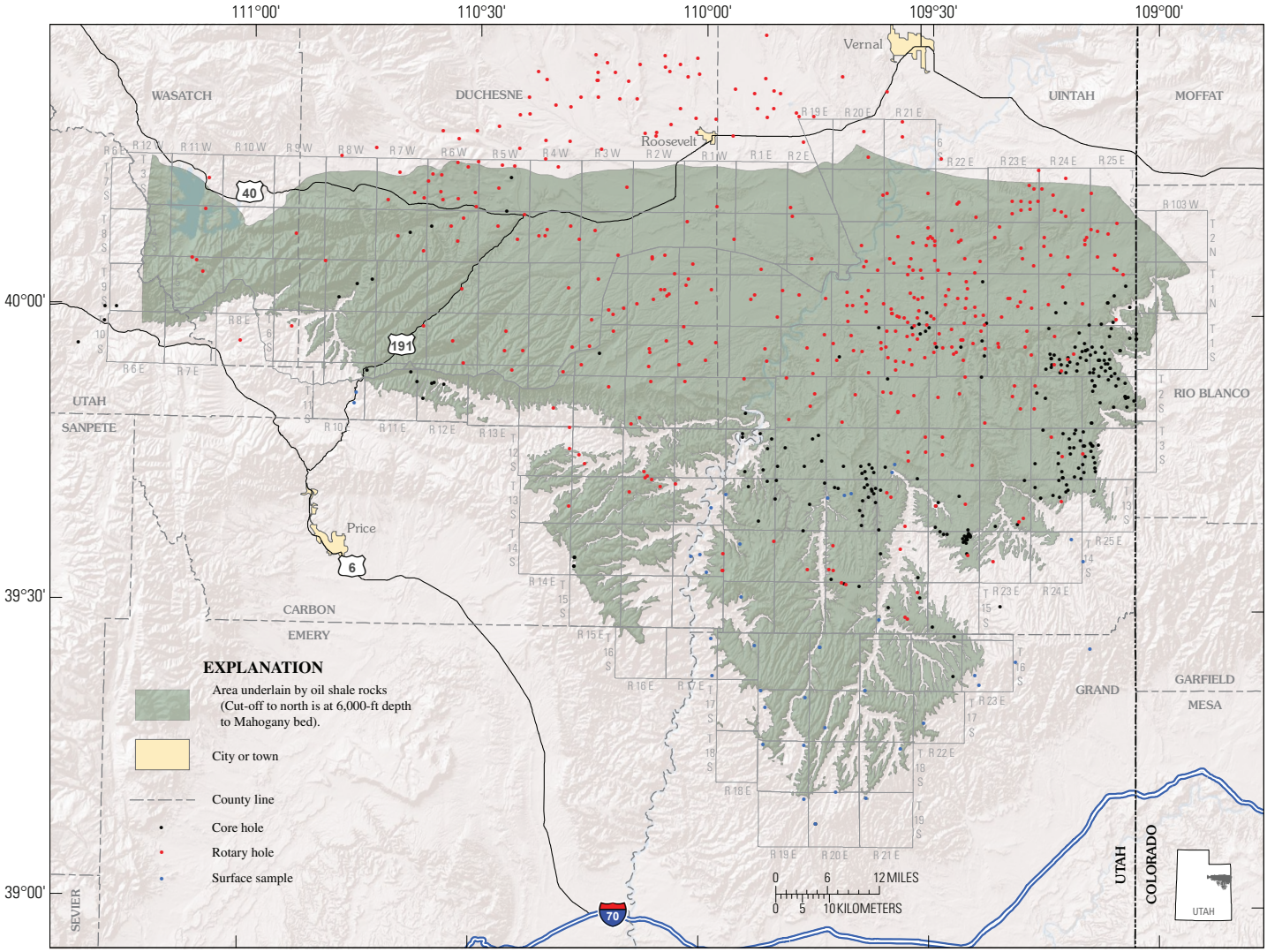

Figure 1. Distribution of oil shale deposits in the Eocene Green River Formation, Uinta Basin, Utah and Colorado. Control points used in resource assessment are shown.

more oil volume than the Fischer assay method. Oil yields achieved by other technologies, however, are typically reported as a percentage of the Fischer assay oil yield, and thus Fischer assay is still considered the standard to which other methods are compared.

Methodology

In this assessment, a spatial interpolation and extrapolation method for generating resource maps and computing resource volumes was used—the Radial Basis Function (RBF) in ArcGIS GeoStatistical Analyst (Environmental Systems Research Institute, Inc.[1] (ESRI), Redlands, Calif., 2006, version 9.2).

The RBF method in GeoStatistical Analyst is an exact interpolator; it will honor all data points without introducing errors at those locations. Where it is important for the modeling method to honor the measured values, RBF can also extrapolate values above or below the actual values away from the data-point locations. The final resource models for each oil shale zone were created using a sampling method containing eight moving window sectors with eight neighbors in each sector.

Although the RBF method does not generate as complete an error estimate as kriging, it does give the difference between the predicted and measured value for each control point, and it does give an overall difference value for an entire oil shale zone model. To obtain the difference between the predicted value and the measured value, the RBF method predicts a value at a given control point from the nearest control points (in this assessment, eight neighbors are used) without knowing the actual value measured at that control point. That predicted value is then compared with the measured value, and the difference between the two is calculated.

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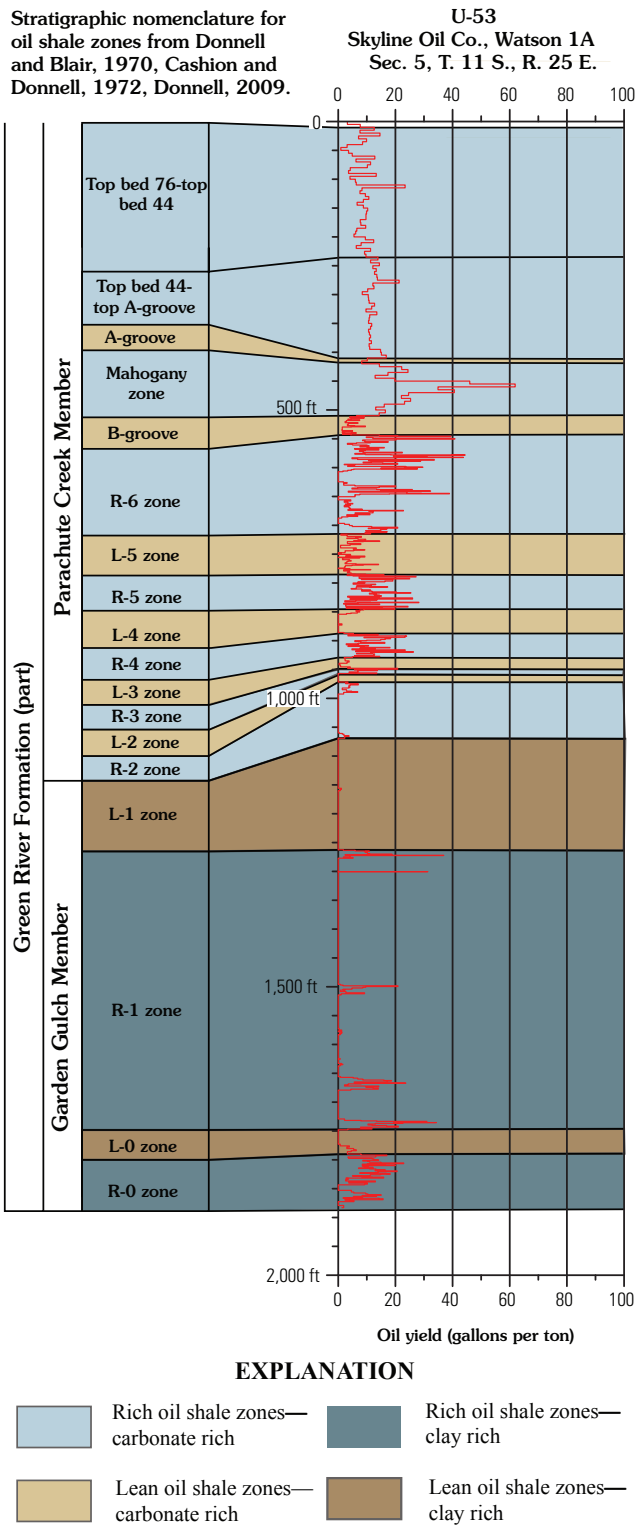

Figure 2. Oil-yield histogram in gallons per ton (shown in red) and the rich and lean oil shale zones in the Green River Formation assessed in this study.

Table 1. Oil shale resources by rich (R) and lean (L) zones in barrels for the Uinta Basin, Utah. [1 barrel of oil = 42 gallons]

Uinta Basin Oil Shale Resource Assessment	
Bed 76 to Bed 44	168,960,275,000
Bed 44 to A-groove	244,681,783,000
A-Groove	15,254,421,000
Mahogany Zone	214,578,720,000
B-Groove	37,204,118,000
R6	176,618,343,000
L5	43,951,157,000
R5	83,410,082,000
L4	24,437,647,000
R4	70,540,940,000
L3	1,375,801,000
R3	3,763,406,000
L2	1,738,790,000
R2	10,878,365,000
L1	4,985,817,000
R1	95,374,910,000
L0	5,824,455,000
R0	115,384,563,000
Total	1,318,963,593,000

Resource Summary

Table 1 lists the estimated total in-place oil for each oil shale zone in the Uinta Basin in barrels. Richest oil shale zones in the basin are, in ascending stratigraphic order, (1) R-0 zone, 115.4 billion barrels; (2) R-6 zone, 176.6 billion barrels; (3) Mahogany zone, 214.6 billion barrels, (4) Bed 44 to A-groove, 244.7 billion barrels, and (5) Bed 76 to Bed 44 with 169.0 billion barrels. Total in-place oil in the eighteen oil shale zones assessed is 1.32 trillion barrels (table 1). Figure 3 shows total in-place oil in each township for all 18 oil shale zones combined. The richest resources are in a northwest-trending area of the northeastern part of the basin (fig. 3). Maximum in-place oil in a township is over 30 billion barrels in T. 9 S., R. 23 E.

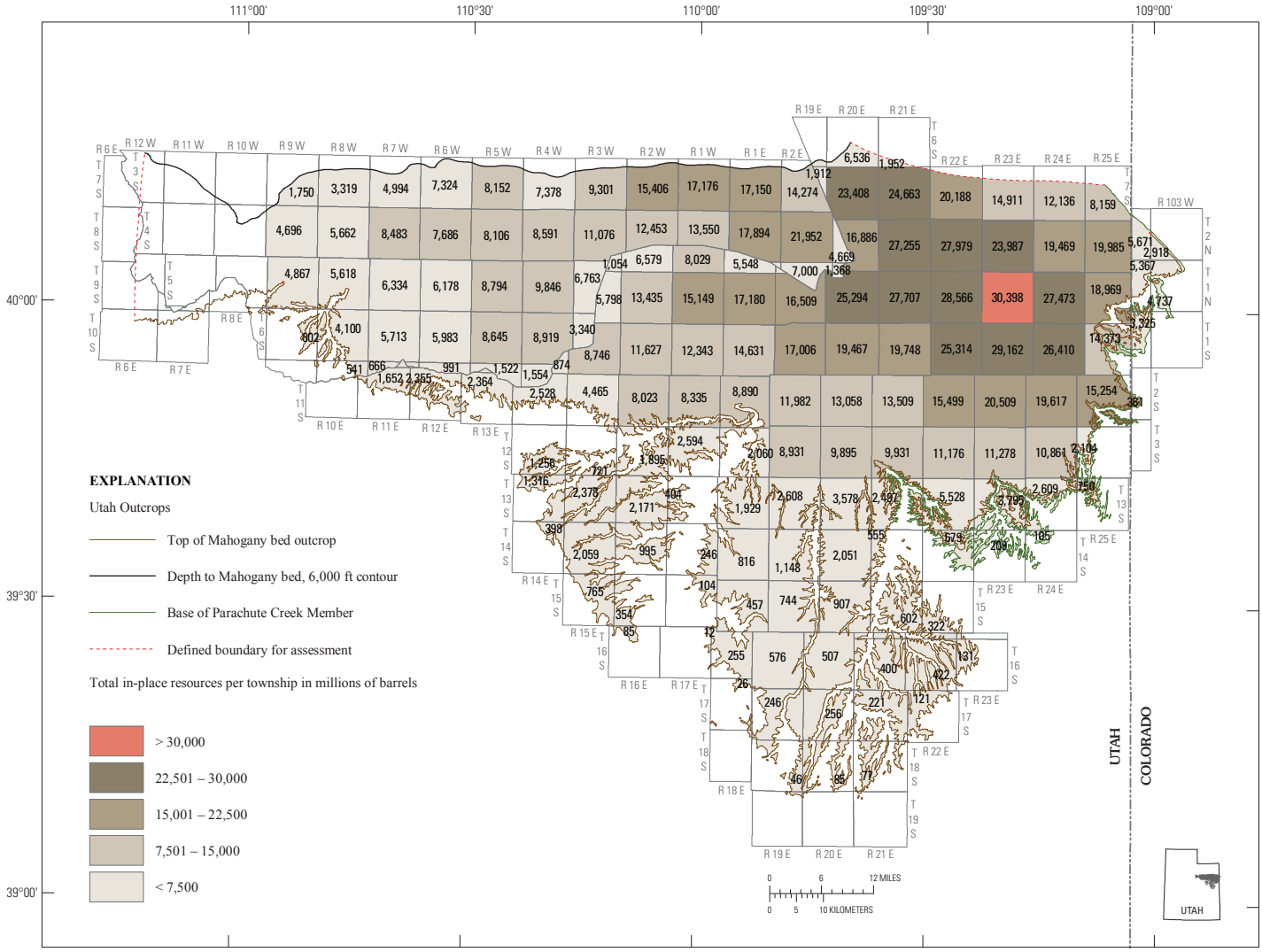

Figure 3. Total in-place oil in millions of barrels as assessed for each township in the Uinta Basin, Utah and Colorado.

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For Additional Information

Supporting geologic studies of the oil shale-bearing units, assessment units, oil shale analysis, and the methodology used in assessing the oil shale resources in the Uinta Basin are in progress. Assessment results are posted as they become available at the USGS Central Energy Team Web site: *http:/energy.cr.usgs.gov/oilshale.*

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