

Chapter 5

Stratigraphic Cross Sections of the Eocene Green River Formation in the Piceance Basin, Northwestern Colorado

By Jesse G. Self, Ronald C. Johnson, Michael E. Brownfield, and Tracey J. Mercier



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Oil Shale and Nahcolite Resources of the Piceance Basin, Colorado

By U.S. Geological Survey Oil Shale Assessment Team

U.S. Geological Survey Digital Data Series DDS-69-Y

U.S. Department of the Interior
KEN SALAZAR, Secretary

U.S. Geological Survey
Marcia K. McNutt, Director

U.S. Geological Survey, Reston, Virginia: 2010

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Suggested citation:

Self, J.G., Johnson, R.C., Brownfield, M.E., and Mercier, T.J., 2010, Stratigraphic cross sections of the Eocene Green River Formation in the Piceance Basin, northwestern Colorado: U.S. Geological Survey Digital Data Series DDS-69-Y, chp. 5, 7 p.

ISBN: 1-4113-2668-2

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Stratigraphic Cross Sections of the Eocene Green River Formation in the Piceance Basin, Northwestern Colorado

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Introduction

For several decades, the U.S. Geological Survey (USGS) collected cores, cuttings, and other subsurface data from boreholes drilled to evaluate the oil shale deposits in the Eocene Green River Formation in the Piceance Basin of northwestern Colorado (fig. 1). In Colorado, the Green River Formation was deposited in Lake Uinta during early to middle Eocene time, with the richest oil shale deposits in the Garden Gulch and Parachute Creek Members (fig. 2). It was from this area that data were collected and preserved for use by researchers and industry in anticipation of the time when Green River oil shale deposits would become an economically viable alternate source of unconventional fossil fuel.

The types of data collected include (1) thousands of Fischer (shale oil) assays (American Society for Testing and Materials, 1980) on cores and cuttings from rotary-drilled holes; (2) geophysical and lithologic logs of drill holes; and (3) measured sections from outcrops within the Piceance Basin. As part of the in-place assessment of the oil shale resources of the Green River Formation in the Piceance Basin conducted by the USGS, subsurface stratigraphic cross sections were created using various types of data for correlation. These cross sections are presented on plates 1–13 in this report.

Stratigraphy of the Green River Formation, Colorado and Utah

The Green River Formation consists of fine-grained lacustrine and fluvial-lacustrine rocks that were deposited in the Eocene Lake Uinta. The lake expanded early in its history, during the Long Point transgression (Johnson, 1985), to cover much of the Piceance and Uinta Basins, as well as the intervening Douglas Creek arch, an area between the two basins with low rates of subsidence. Lake Uinta remained a single unbroken lake across both basins and the Douglas Creek arch throughout most of its history, and most of the Green River Formation can be recognized in both basins. In the Piceance Basin (fig. 3), the early stages of the lake are marked by clay-rich oil shale zones referred to as the Garden Gulch Member,

whereas the younger oil shale zones deposited in the lake are carbonate-rich and referred to as the Parachute Creek Member. These oil shale units grade marginward into marginal lacustrine rocks of the Douglas Creek and Anvil Points Members. The oldest member of the Green River Formation is the Cow Ridge Member, which intertongues with the variegated mudstones, sandstones, and siltstones of the underlying Wasatch Formation. The names Garden Gulch, Parachute Creek, and Douglas Creek Members of the Green River Formation were first used by Bradley (1931); the name Anvil Points Member was first used by Donnell (1953); and the name Cow Ridge Member was first used by Johnson (1984). The sandstones and siltstones containing abundant volcanic debris that intertongue with the upper part of the Green River Formation are referred to as the Uinta Formation (Cashion and Donnell, 1974; see plate 13).

Cross Sections

The 13 cross sections prepared for this assessment used the same stratigraphic contacts as were drawn in previous studies (Pitman and Johnson, 1978; Pitman, 1979; Pitman and others, 1989) in order for resource-assessment results to be comparable. In these new sections, we also: (1) separate the Green River oil shale-bearing strata into alternating layers of oil-rich zones (R-zones) and oil-lean zones (L-zones), following Cashion and Donnell (1972), because they are recognizable in much of the Piceance Basin; and (2) distinguish between the clay-rich zones (zones R-0 through L-1) within the Garden Gulch Member, and the carbonate-rich zones (zones above L-1) within the Parachute Creek Member (fig. 2).

The cross sections (see fig. 4 for locations) were constructed using 68 of the 780 oil-yield histograms created for this assessment, geophysical logs collected from wells drilled for oil and gas exploration, and 12 surface sections measured from outcrops within the Piceance Basin; table 1 provides information for the data used. The correlation datum for cross sections 1–12 (pls. 1–12) is the top of the R-4 zone, and for cross section 13 (pl. 13) the datum is the bottom of the R-5 zone. A horizontal scale of 1 in. = 0.5 mi and a vertical scale of 1.3 in. = 100 ft were selected to best accommodate the

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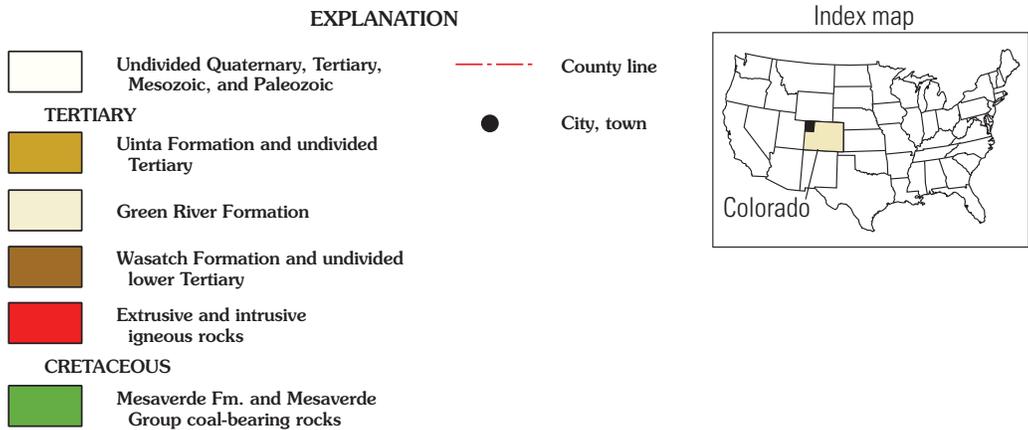
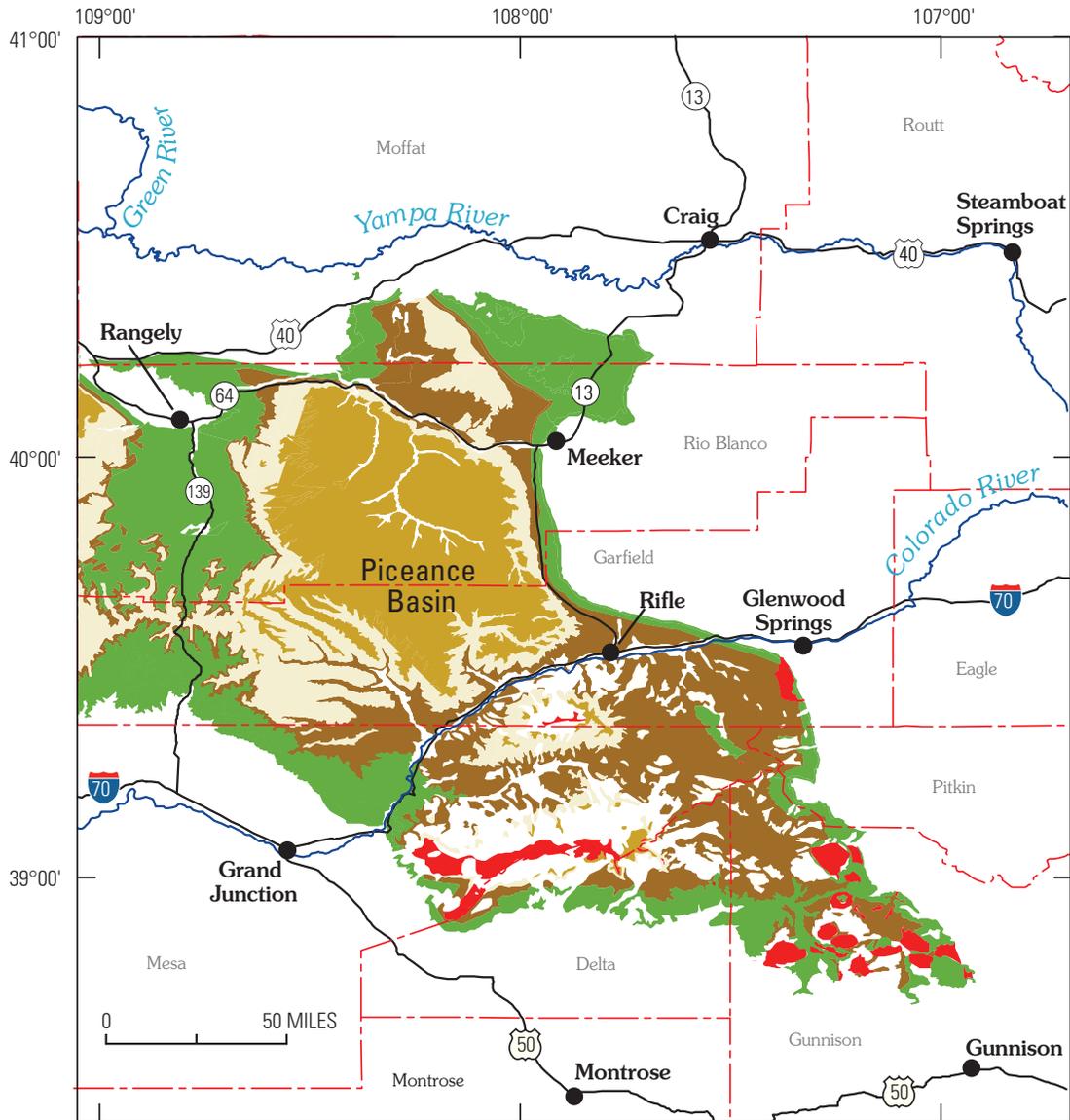


Figure 1. Geologic map of northwestern Colorado showing generalized outcrops of the Cretaceous Mesaverde Formation (Group) and the Eocene Wasatch, Green River, and Uinta Formations in the Piceance Basin. Modified after Brownfield and others (2000).

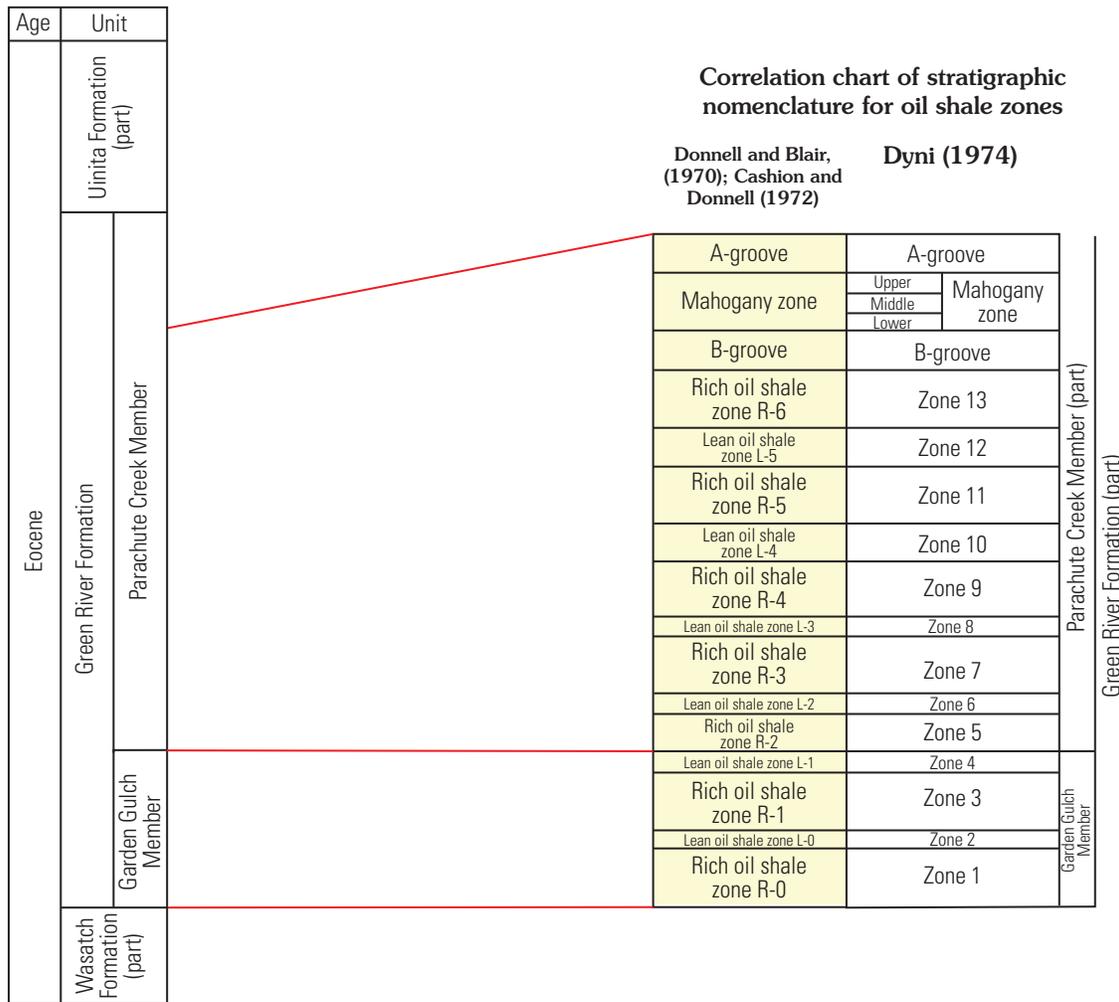


Figure 2. Stratigraphic nomenclature and correlation chart for oil-shale zones for the north-central part of the Piceance Basin, Colorado. This assessment uses the nomenclature of Donnell and Blair (1970) and Cashion and Donnell (1972) shown in yellow.

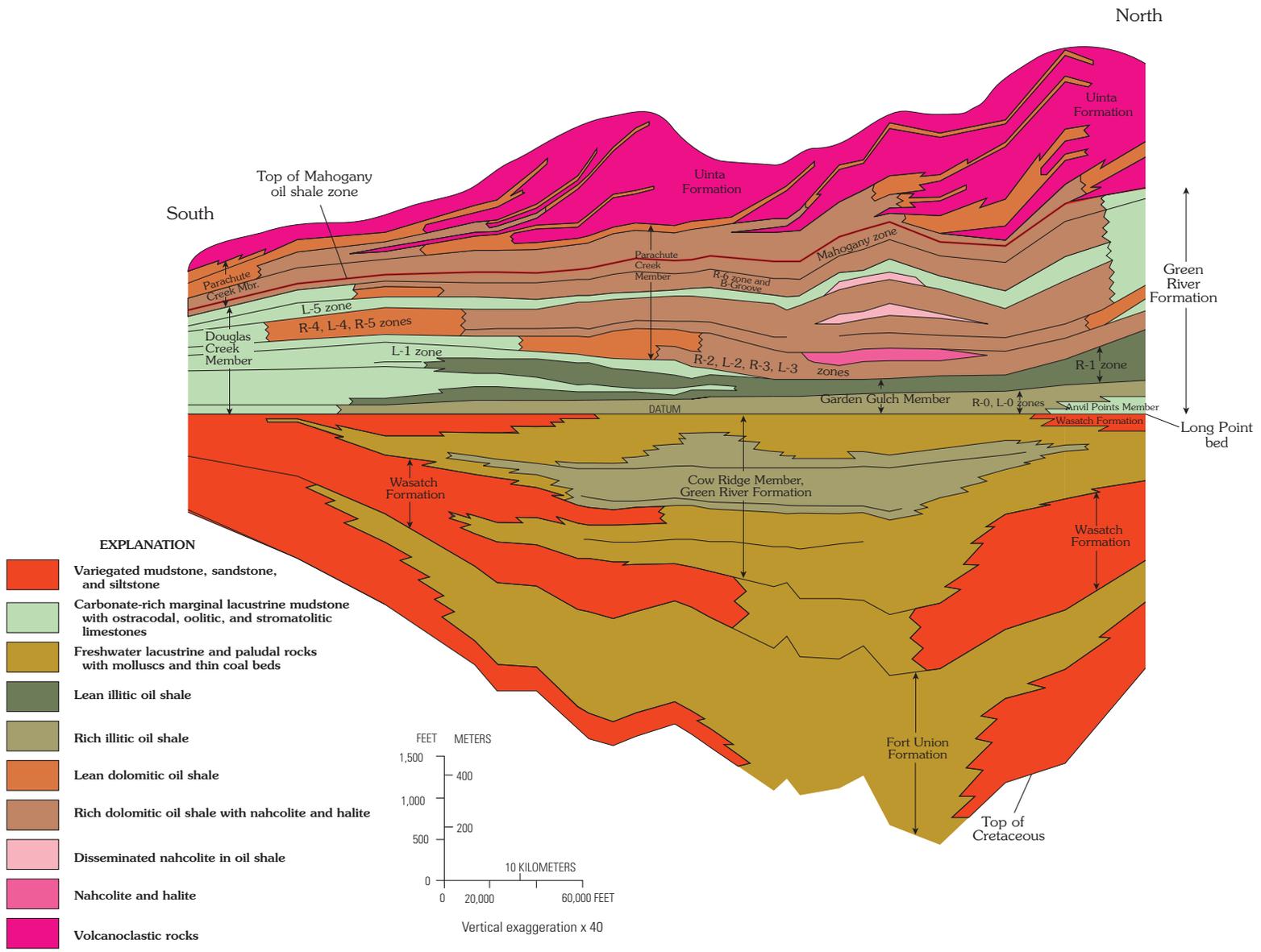


Figure 3. Stratigraphic column for the Piceance Basin, northwestern Colorado, showing the Wasatch, Fort Union, Green River, and Uinta Formations and associated members.

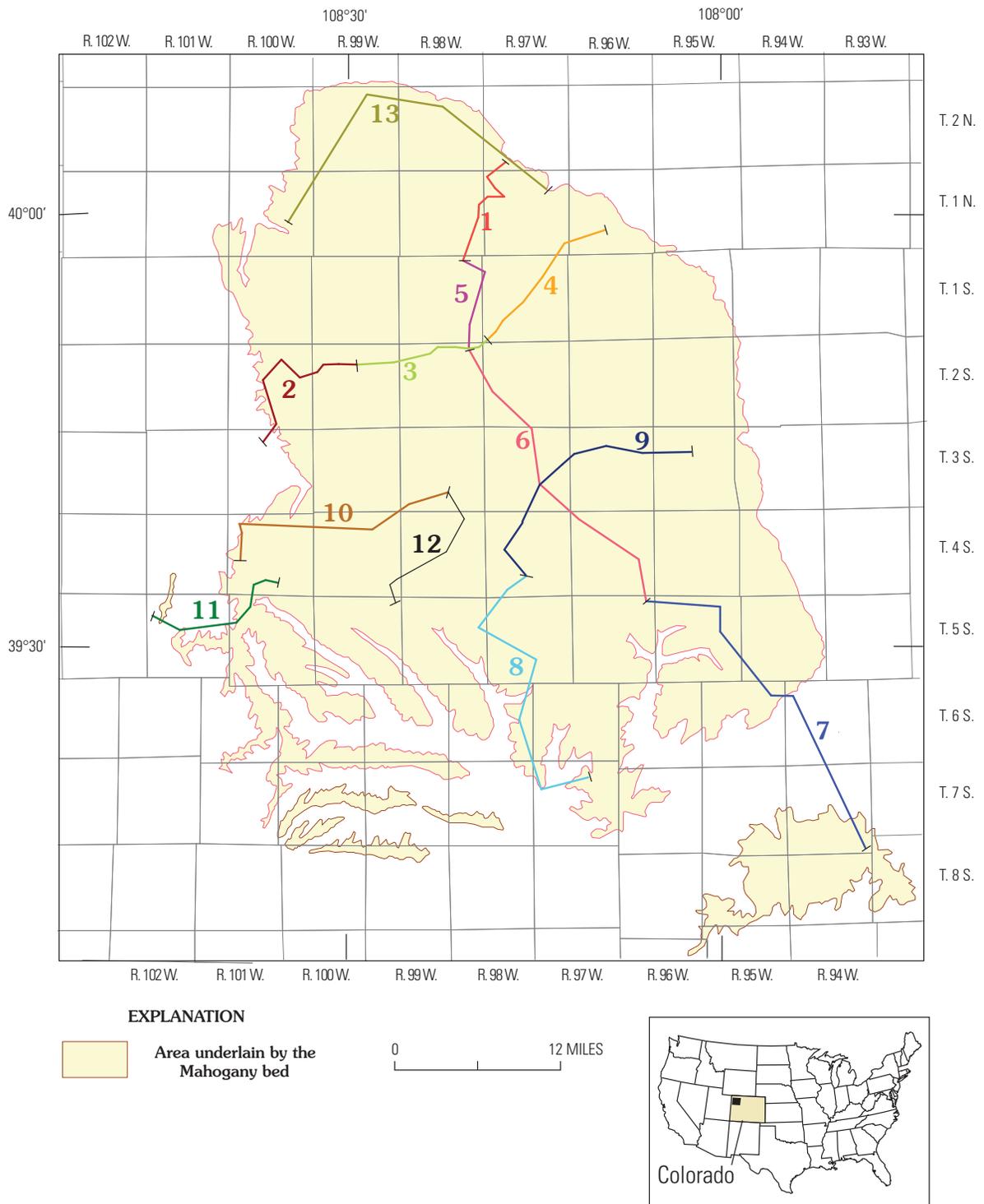


Figure 4. Map showing locations of the 13 stratigraphic cross sections in the Piceance Basin, Colorado.

Table 1. Names and definitions for the column headers for the spatial-data spreadsheet ([Spatial_Information.xlsx](#)).

Column name	Column definition
USGSID	Unique ID assigned by staff geologist
COMPANY	Name of the company or agency that drilled the borehole
NAME	Name of the borehole assigned by the company or agency that drilled it
SECTION	Section
TOWNSHIP	Township
RANGE	Range
LATITUDE	Latitude, in decimal degrees, North American Datum 1927, software-calculated, original record
LONGITUDE	Longitude, in decimal degrees, North American Datum 1927, software-calculated, original record
COUNTY	Name of county in Colorado
DEPTH IN FEET	Total depth of the borehole, in ft
PLATE NUMBER	The Piceance Basin cross section where that piece of data can be found

distances covered and the need for stratigraphic detail. Sources of stratigraphic data include Johnson (1975) for the Long Point measured section, and Johnson and others (1988) for the Douglas Pass, Little Burma Road, and Tommy's Draw sections. Measured sections at Yellow Creek, Spring Creek, and Anvil Points are new and first described in this report.

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