Chapter 14

Subsurface Stratigraphic Cross Sections of Cretaceous and Lower Tertiary Rocks in the Southwestern Wyoming Province, Wyoming, Colorado, and Utah

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Volume Title Page

By Thomas M. Finn and Ronald C. Johnson

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By USGS Southwestern Wyoming Province Assessment Team

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Subsurface Stratigraphic Cross Sections of Cretaceous and Lower Tertiary Rocks in the Southwestern Wyoming Province

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Introduction

The stratigraphic cross section presented on plate 1 was constructed as part of a project conducted by the U.S. Geological Survey to characterize and evaluate the undiscovered oil and gas resources of the Southwestern Wyoming Province (SWWP). The primary purpose of the cross section is to show the stratigraphic framework and facies relations of Cretaceous and lower Tertiary rocks in this large, intermontane structural and sedimentary basin, which formed in the Rocky Mountain foreland during the Laramide orogeny (Late Cretaceous through Eocene)(fig. 1). The SWWP encompasses about 25,000 mi^2 and includes most of southwestern Wyoming, part of northwestern Colorado, and a small area in northeastern Utah. The SWWP is structurally bounded on the west by the Wyoming thrust belt, on the north by the Wind River Range and Granite Mountains, on the east by the Rawlins, Sierra Madre, and Park uplifts, and on the south by the Uinta Mountains and Axial Basin uplift. Several intrabasin uplifts are present in the SWWP, including the Moxa arch, La Barge platform, Sandy Bend arch, Rock Springs uplift, Wamsutter arch, and Cherokee ridge (fig. 2). Several of these uplifts subdivide the SWWP into smaller subbasins known as the Washakie, Great Divide, Hoback, Sand Wash, and Green River Basins (fig. 2).

The cross section was constructed from borehole geophysical logs collected from 28 wells drilled for oil and gas exploration and production and includes the stratigraphic interval from near the base of the Cretaceous into the lowest part of the Eocene Green River Formation (fig. 3, pl. 1). In most wells, a gamma-ray log was used in combination with a resistivity or conductivity log to identify and correlate units. If a gamma-ray log was not available, a spontaneous potential log was used. The gamma-ray and spontaneous potential logs were used to differentiate between sandstone and shale; however, in the SWWP the spontaneous potential response commonly is greatly subdued in some sandstone intervals and shows little curve deflection. In areas of greater drilling density, logs from wells located between control wells on the cross section were used to aid in making the correlations. The datum for the cross section is the top of the Upper Cretaceous Ericson Sandstone, a formation in the Mesaverde Group that is easily identified on most well logs and is present throughout most of the SWWP (fig. 3, and pl.1). Sources of stratigraphic data include: Hale (1961), Smith (1961), Keith (1965), Gill and others (1970), Miller (1977), Wach (1977), Tyler (1978), Law and others (1979), Bader and others (1982), Hendricks (1983), Shannon (1983), Roehler (1983), Merewether and others (1984), Weimer (1984), Roehler (1985), Winn and others (1985), Ryer and others (1987), Cobban and Kennedy (1989), Roehler (1989), Perman (1990), Roehler (1990), Dolson and others (1991), Hettinger and Kirschbaum (1991), Roehler (1992), Vincelette and Foster (1992), and Honey and Hettinger (2004).

Because of its large size, the cross section is presented in two segments (see index map on plate 1 for location of cross section). The western segment extends eastward from near the eastern edge of the Wyoming thrust belt across the Moxa arch and Green River Basin to the Rock Springs uplift. The eastern segment extends eastward from the Rock Springs uplift along the Wamsutter arch to the northeast flank of the Washakie Basin. The total distance between wells along the line of section is about 180 miles, and the distance between the ends of the cross section extending along an east-west-trending straight line is about 135 miles. The horizontal scale is about 1 inch = 3.3 miles and the vertical scale is about 1 inch = 600 feet.

Coalbeds were identified by using gamma-ray logs in combination with a density and (or) sonic logs and are shown as a long, heavy black bar on the depth track of each log. In cases where neither a density nor sonic log was available, a resistivity/conductivity log was used, and these coalsbeds are shown as a short, heavy black bar on the depth track. The heavy black bars representing coalbeds only show the position of the coalbed(s) and are not proportional to the true thickness.

In addition to the stratigraphic information, gas shows, gas-producing intervals, perforated intervals, and drill-stem test intervals are also shown on the cross section. This information was compiled from the Wyoming Oil and Gas Conservation Commission Web site (2003), IHS Energy Group (2003) well data, and drilling reports in the U.S. Geological Survey well log files. Tabulated results of production tests and drill-stem tests are shown in the accompanying Appendix. IHS Energy data are used with permission (C.J. Wandry, U.S. Geological Survey, oral comm., 2002).

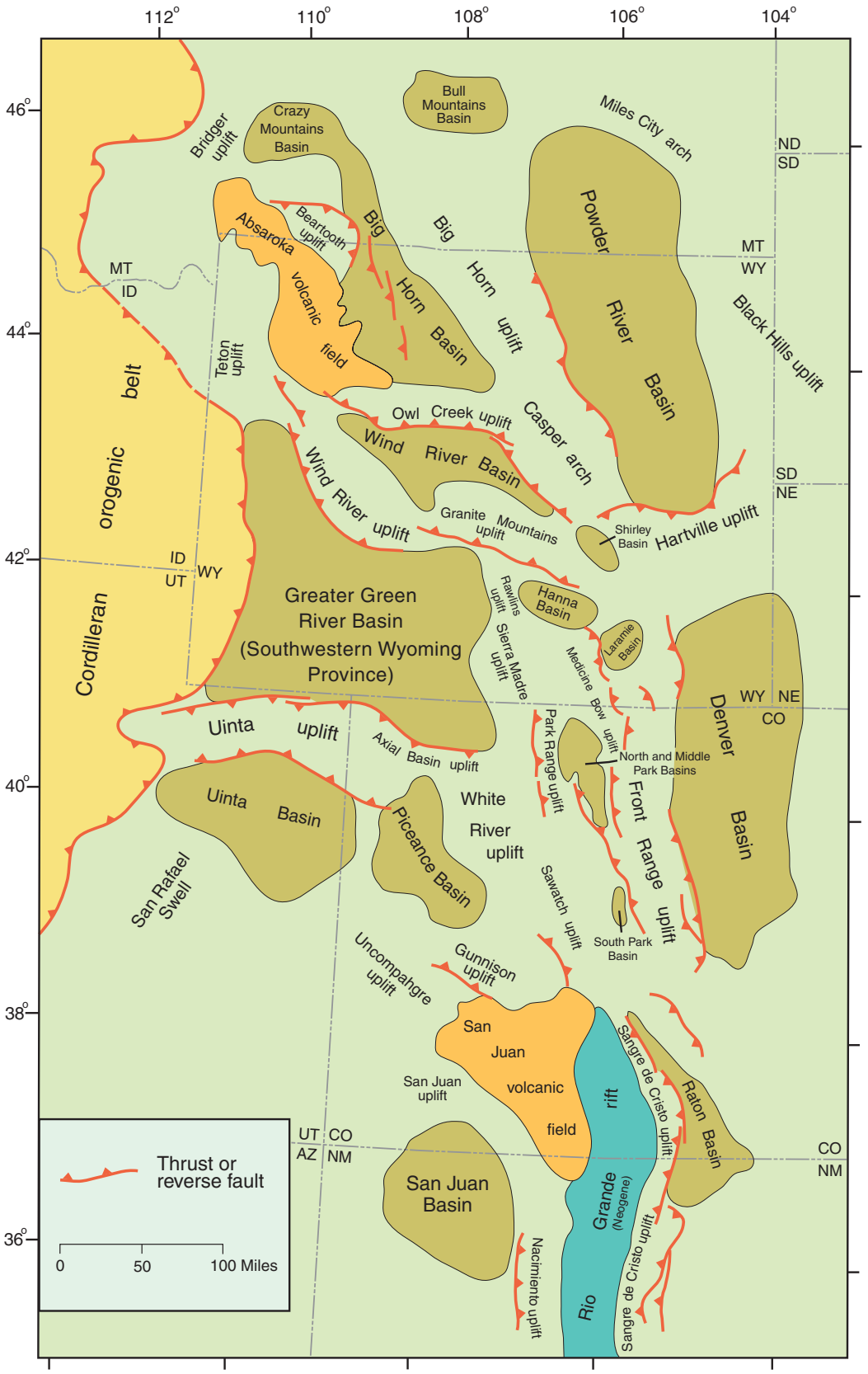

Figure 1. Rocky Mountain region extending from southern Montana to northern New Mexico showing the distribution of Laramide sedimentary and structural basins and intervening uplifts. Modified from Dickinson and others (1988.)

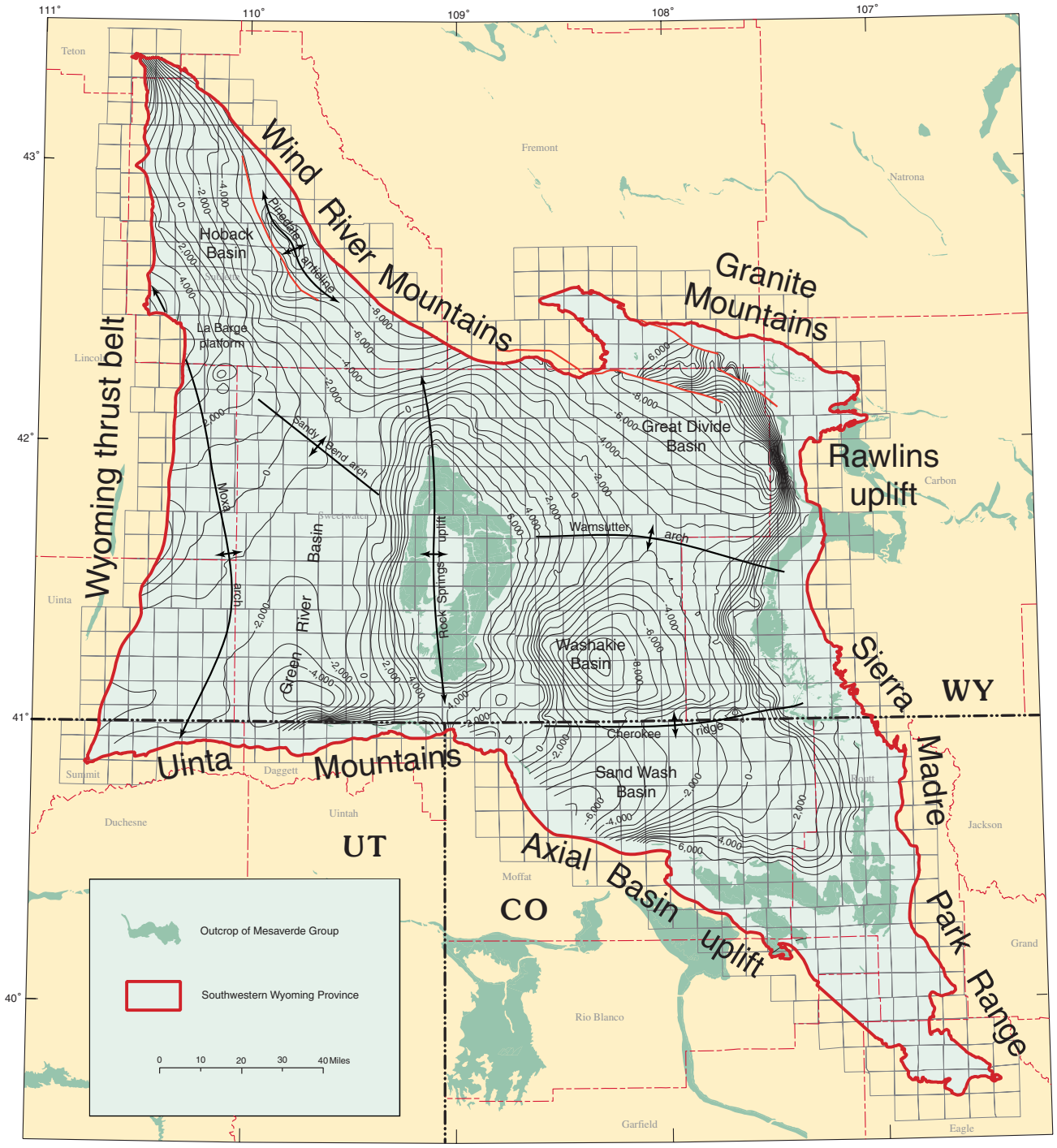

Figure 2. Index map of southwestern Wyoming, northeastern Utah, and northwestern Colorado showing the location of the Southwestern Wyoming Province. Structure contours drawn on top of the Mesaverde Group. Contour interval is 1,000 feet.

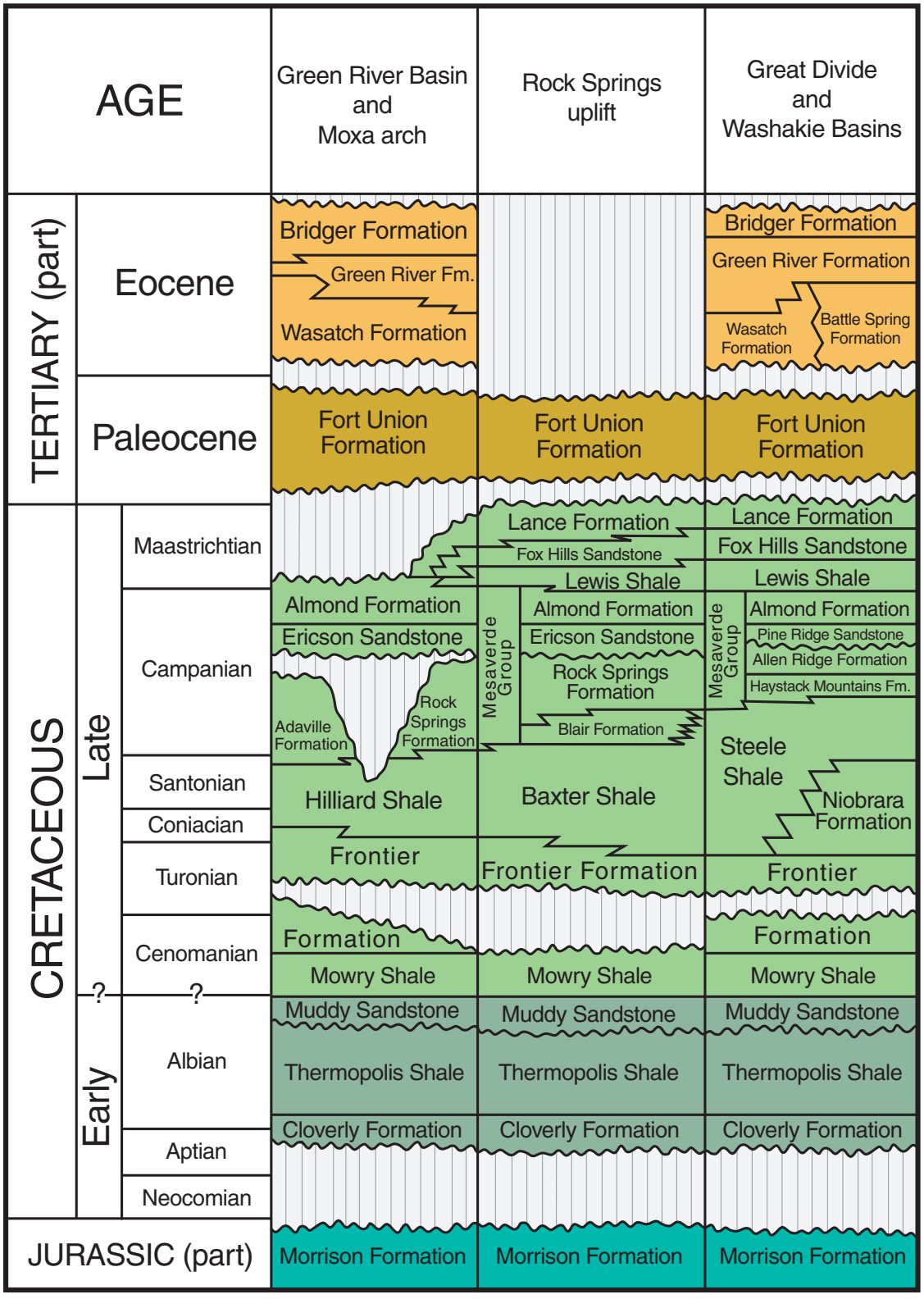

Figure 3. Generalized correlation chart of Cretaceous and lower Tertiary rocks in the Southwestern Wyoming Province. Modified from Ryder (1988.)

Depositional Setting

All but the uppermost Cretaceous rocks in the SWWP were deposited in or adjacent to a broad epicontinental seaway that periodically covered much of the Western Interior of the United States (fig. 4). At its maximum extent, the seaway extended a distance of more than 3,000 mi from the Arctic Ocean to the Gulf of Mexico (Kauffman, 1977). The seaway developed in response to the formation of a subsiding foreland basin east of the tectonically active Cordilleran orogenic belt, and as a consequence of a eustatic sea-level rise (Steidtmann, 1993). Fluctuations in relative sea level and variations in sediment supply along the western shoreline of the seaway during much of Late Cretaceous time resulted in complex intertonguing of marine, marginal marine, and nonmarine deposits. The nonmarine and marginal marine deposits formed clastic wedges of eastward-thinning fluvial-deltaic deposits that generally prograded eastward into the foreland basin (Molenaar and Rice, 1988). The nonmarine deposits consist of sandstone, siltstone, shale, carbonaceous shale, and coal that accumulated in alluvial-plain, coastal-plain, and delta-plain environments adjacent to the western margin of the seaway (Merewether and others, 1984; Ryer and others, 1987; Roehler, 1990; Dolson and others, 1991; Roehler, 1993). The marginal marine or coastal sandstones accumulated in shoreface, delta-front, barrier-bar, and tidal settings along the western coast of the seaway (Merewether and others, 1984; Roehler, 1990; Dolson and others, 1991; Roehler 1993). The marine deposits generally include westward-thinning tongues of shale

Figure 4. Extent of the Cretaceous Western Interior seaway during Campanian time. Green areas show the approximate geographic distribution of land areas. Modified from Gill and Cobban (1973).

and siltstone deposited in shelf and basin environments (Molenaar and Rice, 1988; Perman, 1990). Numerous sandstones are interbedded with the thick, fine-grained marine shale section and, according to Shannon (1983) and Winn and others (1985), many of these sandstones originated as turbidites. In the central and eastern parts of the SWWP, clastic input was minimal, resulting in the accumulation of carbonate-rich sediments (Longman and others, 1998).

Marine deposition ended by the close of the Cretaceous Period (Maastrichtian) as the foreland basin gradually filled in and the western shoreline retreated eastward. The end of the Cretaceous also marks the onset of the Laramide orogeny (Dickinson and others, 1988), a period of crustal instability and compressional tectonics that fragmented the foreland basin into numerous smaller structural basins that were flanked by rising basement-cored uplifts (fig. 1). Basins, such as the Greater Green River Basin (fig. 1), subsided rapidly and became depocenters for thick accumulations of clastic debris eroded from the surrounding rising basement uplifts during latest Cretaceous and early Tertiary time. The uppermost Cretaceous and Paleocene rocks consist of sandstone, siltstone, shale, and coal that were deposited on an extensive alluvial plain within the intermontane basin. Continued subsidence into middle Eocene time resulted in widespread deposition of lacustrine and marginal lacustrine sediments (Sullivan, 1980).

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Appendix. Formation test data.

Abbreviations used for formation test data.

bbls	barrels
BCPD	barrels condensate per day
BOPD	barrels oil per day
BW	barrels of water
BWPD	barrels of water per day
cft	cubic feet
cond	condensate
DST	drill-stem test
FFP	final flow pressure
FP	flow pressure
FSIP	final shut-in pressure
Ft	feet
FWTR	freshwater
GCFWTR	gas cut freshwater
GCM	gas cut mud
GCMW	gas cut mud and water
GIP	gas in pipe
G&MCW	gas and mud cut water
GCW	gas cut water
GTS	gas to surface
HGCM	highly gas cut mud
hr.	hour
IFP	initial flow pressure
ISIP	initial flow pressure
MCFD	thousand cubic feet gas per day
min.	minute
PI	perforated interval
Rec.	recovery
SGCM	slightly gas cut mud
SGCMW	slightly gas cut mud and water
SGCW	slightly gas cut water
SIP	shut-in pressure
VHGCM	very highly gas cut mud
VSGCM	very slightly gas cut mud
W&GCM	water and gas cut mud
WTRCUSH	water cushion

all pressures in pounds per square inch

Compiled from Wyoming Oil and Gas Conservation Commission Web site (2003), and IHS PI/Dwights Plus on CD well summary report (2003).

1. Amoco Prod., Amoco-Champlin 262 B-1: Plugged and abandoned.

PI	13,350-13,386 ft	No flow reported
PI	13,100-13,105 ft	No flow reported
PI	13,106-13,116 ft	No flow reported
PI	12,242-12,249 ft	No flow reported
PI	12,250-12,406 ft	No flow reported

2. Union Pacific Res., 1 Ulysses 4-13: Plugged and abandoned
   No tests reported.

3. Celsius Energy Co., Exit Channel 22-2: Gas, producing interval 11,394-12,066 ft, initial potential 1,485 MCFD, 48 BCPD.

4. Amoco Prod., Amoco F 1 Champlin 186: Gas, producing intervals 12,044-12,078 ft, initial potential 1,500 MCFD; 11,462-11,494 ft, initial potential 413 MCFD, 1 BCPD, 2 BWPD.

5. Amoco Prod., Amoco-Champlin 206 E-1: Gas, producing intervals 12,345-12,536 ft, initial potential 4,000 MCFD; 11,810-12,536 ft, initial potential 1,438 MCFD, 1 BCPD, 7 BW.

6. Amoco Prod., Amoco-Champlin 355 A-1: Oil and gas, producing interval 12,650-12,728 ft, initial potential 37 BOPD, 468 MCFD, 30 BWPD.

7. Amoco Prod., Champlin 157-Amoco 1: Plugged and abandoned, gas show.

DST	8,772-8,855 ft	Rec. 1096 ft SGCM IFP 428-628 FFP 578-703 ISIP 3732

8. Humble Oil, Spider Creek B-1: Plugged and abandoned, gas show.

DST	9,080-9,126 ft	GTS in 30 min@ 4,220 MCFPD Rec. 700 ft GCFWTR IFP 1,305 FFP 1,706 ISIP 4,105 FSIP 3950
DST	9,763-9,774 ft	Rec. 350 ft SGCW 100 ft SGCM IFP 685 FFP 697 ISIP 890 FSIP 845
DST	10,385-10,442 ft	Rec. 1,238 ft SGCW, 270 ft GCW, 90 ft GCM IFP 575 FFP 642 ISIP 1,738 FSIP 1,390
PI	9,090-9,098 ft	115 MCFD, 15 BW

9. Husky Oil, 3-26 Massacre Hills Fed.: Plugged and abandoned, gas show.

DST	8,862-8,876 ft	Rec. 30 ft SGCM IFP 92 FFP 76 ISIP 353 FSIP 892
DST	9,487-9,600 ft	Rec. 650 WTRCUSH IFP 400-375 FFP 458-360 ISIP 708 FSIP 436
DST	10,160-10,212 ft	GTS in 10 min@ 214 MCFD GTS in 15 min@ 243 MCFD GTS in 10 min@ 131 MCFD GTS in 15 min@ 152 MCFD GTS in 35 min@ 214 MCFD IFP 585-513 FFP 585-689 ISIP 3,272 FSIP 3,049
DST	15,706-15,806 ft	Rec. 106 bbls HGCM, misrun.
DST	16,085-16,260 ft	Rec. GCM, 0.2 cft gas, misrun.
DST	16,163-16,363 ft	Rec. 9,966 ft GCM 4,650 ft GIP No pressures reported.
DST	16,180-16,363 ft	Misrun.

Appendix. Formation test data.—Continued.

10. Husky Oil, 11-5 Champlin-Massacre Hills: Plugged and abandoned, gas show.

DST	15,585-15,856 ft	Rec. 2,000 ft GCW
		Rec. 1,000 ft W&GCM
		IFP 1,622-1,605
		FFP 1,552-1,638
		ISIP 2,376 FSIP 3,389
DST	15,575-16,420 ft	GTS @ 52 MCFD
		GTS @ 44 MCFD
		GTS @ 40 MCFD
		GTS @ 50 MCFD
		GTS @ 53 MCFD
		Rec. 3,900 ft G&MCW, 40 ft gas
		IFP 2,122-2,152
		FFP 2,138-2,298
		ISIP 3,180 FSIP 5,119

11. Davis Oil, 1 Dagger Unit: Plugged and abandoned.
No tests reported.

12. Davis Oil, Poitevent Federal 1: Gas, producing interval 15,233-15,265 ft, initial potential.
526 MCFD.

PI	15,319-15,355 ft	Flow 1,575 MCFD

13. Union Oil of Calif., White Mountain 1-C-19: Plugged and abandoned, gas show.

DST	8,287-8,380 ft	Rec. 270 ft VSGCM
		IFP 151 FFP 105
		ISIP 330 FSIP 239
DST	14,469-14,557 ft	Rec. 5,000 ft SGCW
		IFP 2,297 FFP 2,297
		ISIP 2,552 FSIP not reported
DST	14,965-15,156 ft	Misrun.
DST	14,990-15,191 ft	Misrun.
PI	15,087-15,144 ft	200 MCFD
		443 MCFD
PI	14,986-15,024 ft	865 MCFD
		415 MCFD
		499 MCFD
		259 MCFD

14. Columbine Exploration, 4-1 Grace Federal: Plugged and abandoned.
No tests reported.

15. Amoco Prod., Amoco-Champlin 395-B: Plugged and abandoned, gas show.

DST	5,955-6,019 ft	Rec. 4,315 ft SGCW
		IFP 335-488
		FFP 335-794
		ISIP 335 FSIP 794

16. Champlin Petroleum, 36 N Brady 4 C-2: Oil, producing zone in pre-Cretaceous rocks.

17. Duncan Energy, UPRC 1-29: Plugged and abandoned, gas show.

DST	10,978-11,000 ft	Rec. 4,952 ft VHGCM
		IFP 260-2531
		FFP 2,057-2,710
		ISIP 2,531 FSIP 2,710
DST	11,573-11,680 ft	Rec. 5,151 ft GCM
		IFP 715 687
		FFP 1,362-2,587
		ISIP 5,123 FSIP 5,103

18. Champlin Petroleum, Brady Unit 37 N: Oil, producing zone in pre-Cretaceous rocks.

19. Champlin Petroleum, 8N Higgins 13-27: Gas, producing interval 5,840-5,866 ft, initial potential 16 BCPD, 1,234 MCFD, 2 BW.

PI	8,336-8,354 ft	No flows reported.
DST	7,969-8,020 ft	Rec. 200 ft GCM
		GTS in 12 min@ 113 MCFD
		FP 73-88 44-73
		ISIP 1,516 FSIP 1,976
DST	8,523-8,821 ft	GTS in 12 min
		Rec280 ft SGCM
		ISIP 637 FSIP 543
DST	5,830-5,910 ft	Rec. 220 ft SGCM
		FP 97-141 46-70
		SIP 1,028-2,280

20. Texaco Inc., Table Rock Unit 44: Gas, producing interval in pre-Cretaceous rocks.
No tests reported.

21. Union Pacific Resources, Sidewinder 1 H: Gas, open-hole completion in Almond Formation.
No depths or volumes reported.

22. Amoco Prod., 1 Tipton Unit II: Gas, producing interval 9,390-9,398 ft, initial potential.
1,066 MCFD, 23 BCPD.

PI	9,496-9,684 ft	33 MCFD

23. Amoco Prod., Frewen Deep Unit 1: Gas, producing interval 19,054-19,126 ft, initial
potential 4,500 MCFD, 10 BWPD.

24. Amoco Prod., Tierney Unit 2: Gas, producing interval 11,001-11,162 ft (gross), initial
potential 468 MCFD.

DST	9,512-9,634 ft	GTS in 12 min@ 90 MCFD
		Rec.183 ft W&GCM
		IFP 473 FFP 535
		ISIP 4,953 FSIP 5,089
DST	9,793-9,904 ft	GTS in 15 min., not gaged.
		No pressures reported.

Appendix. Formation test data.—Continued.

DST 9,796-9,904 ft
GTS in 20 min@ 8 MCFD
Rec. 100 ft WTRCUSH, 89 ft SGCM
IFP 495 FFP 463

DST 11,134-11,229 ft
GTS in 11 min@ 850 MCFD
GTS in 30 min@ 604 MCFD
GTS in 1 hr25 min., not gaged
Rec. 1,000 ft GCMW, 239 ft cond, 2 cft gas
IFP 552-552
FFP 515-625
ISIP 7,610 FSIP 7,117

PI 11,600-11,618 ft
No flow reported.

PI 11,410-11,430 ft
No flow reported.

25. Amoco Prod., Echo Springs Deep 1: Gas, producing intervals 18,284-18,344 ft, initial potential 7,620 MCFD; 11,762-11,806 ft, initial potential 1,020 MCFD.

26a. Amoco Prod., Amoco-Champlin 278 E-3: Gas, producing interval 8,632-9,019 ft, initial potential 2,176 MCFD, 390 BWPD.

26b. Amoco Prod., Amoco-Champlin 278 E-1: Gas, open-hole completion in the Steele Shale and Niobrara Formation between 12,073-17,672 ft, initial potential 1,000 MCFD.

27. Amoco Prod., Creston Nose 1: Gas, producing interval 12,364-12,374 ft, initial potential 3,600 MCFD.

DST 11,688-11,728 ft
Rec. 2 BBL GCM
IFP 182-324
FFP 332-408
ISIP 607 FSIP 552

28. Mountain Fuel, Hollar Springs 1: Plugged and abandoned, gas show.

DST 5,010-5,148 ft
Rec. 410 SGCMW
IFP 80 FFP 210
ISIP 2,028 FSIP 1,747

DST 6,109-6,135 ft
Rec. 140 ft mud
IFP 42 FFP 85
ISIP 230 FSIP 458

DST 6,763-6,773 ft
Rec. 30 ft SGCM
IFP 30 FFP 30
ISIP 75 FSIP 45

DST 6,995-7,087 ft
GTS in 1 hr22 min@ 7.5 MCFD
Rec. 200 ft GCM
IFP 50 FFP 105
ISIP 609 FSIP 1,008

DST 7,191-7,216 ft
Rec. 90 ft mud
IFP 50 FFP 65
ISIP 572 FSIP 228

DST 7,278-7,313 ft
GTS in 9 min@ 25 MCFD
GTS in 2 hr@ 65 MCFD
Rec. 18 ft GCM
No pressures reported.

DST 7,366-7,381 ft
Rec. 137 ft WCM, 90 ft FWTR
IFP 65 FFP 135
ISIP 3,110 FSIP 2,800

DST 7,579-7,657 ft
GTS in 20 min., not gaged
Rec. 290 ft GCM
IFP 115 FFP 115
ISIP 825 FSIP 735

DST 7,686-7,772 ft
GTS in 4 min@ 14.4 MCFD
Rec. 720 ft SGCM
IFP 535 FFP 535
ISIP 1,135 FSIP 870

DST 7,905-7,970 ft
GTS in 4 min@ 14.4 MCFD
Rec. 180 ft SGCM
IFP 45 FFP 62
ISIP 993 FSIP 812

DST 8,143-8,187 ft
Rec. 15 ft mud
IFP 45 FFP 45
ISIP 245 FSIP 265

DST 8,212-8,240 ft
GTS in 13 min., not gaged
Rec. 30 ft mud
IFP 0 FFP 0
ISIP 446 FSIP 346

DST 8,598-8,643 ft
GTS in 13 min., not gaged
Rec. 90 ft mud
IFP 0 FFP 30
ISIP 570 FSIP 245

DST 8,704-8,757 ft
GTS in 9 min., not gaged
Rec. 238 ft GCM
IFP 75 FFP 95
ISIP 955 FSIP 355

DST 9,194-9,226 ft
GTS in 30 min., not gaged
Rec. 30 ft mud
IFP 0 FFP 20
ISIP 850 FSIP 448

DST 9,794-9,824 ft
GTS in 10 min., not gaged
Rec. 120 ft GCM
IFP 20 FFP 20
ISIP 1,790 FSIP 1,290

Click on image below to bring up high-resolution image of plate 1A.

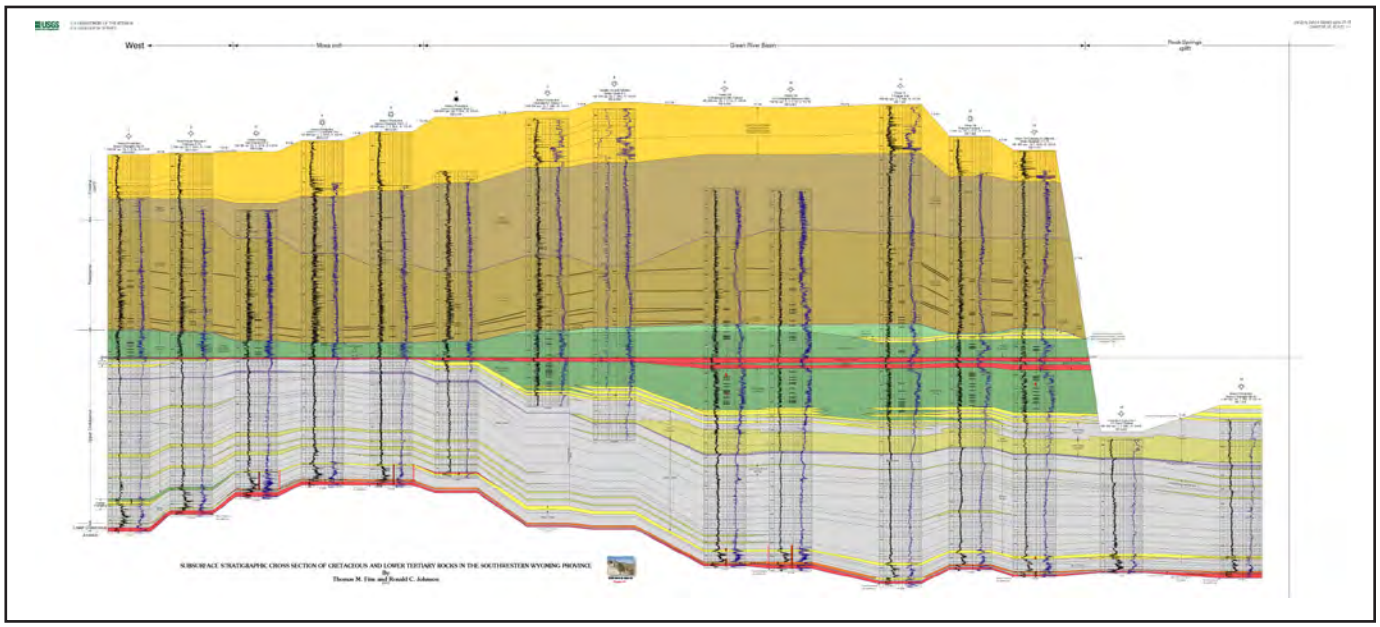

Plate 1A. Subsurface stratigraphic cross section of Cretaceous and lower Tertiary rocks in the Southwestern Wyoming Province–western segment.

Click on image below to bring up high-resolution image of plate 1B.

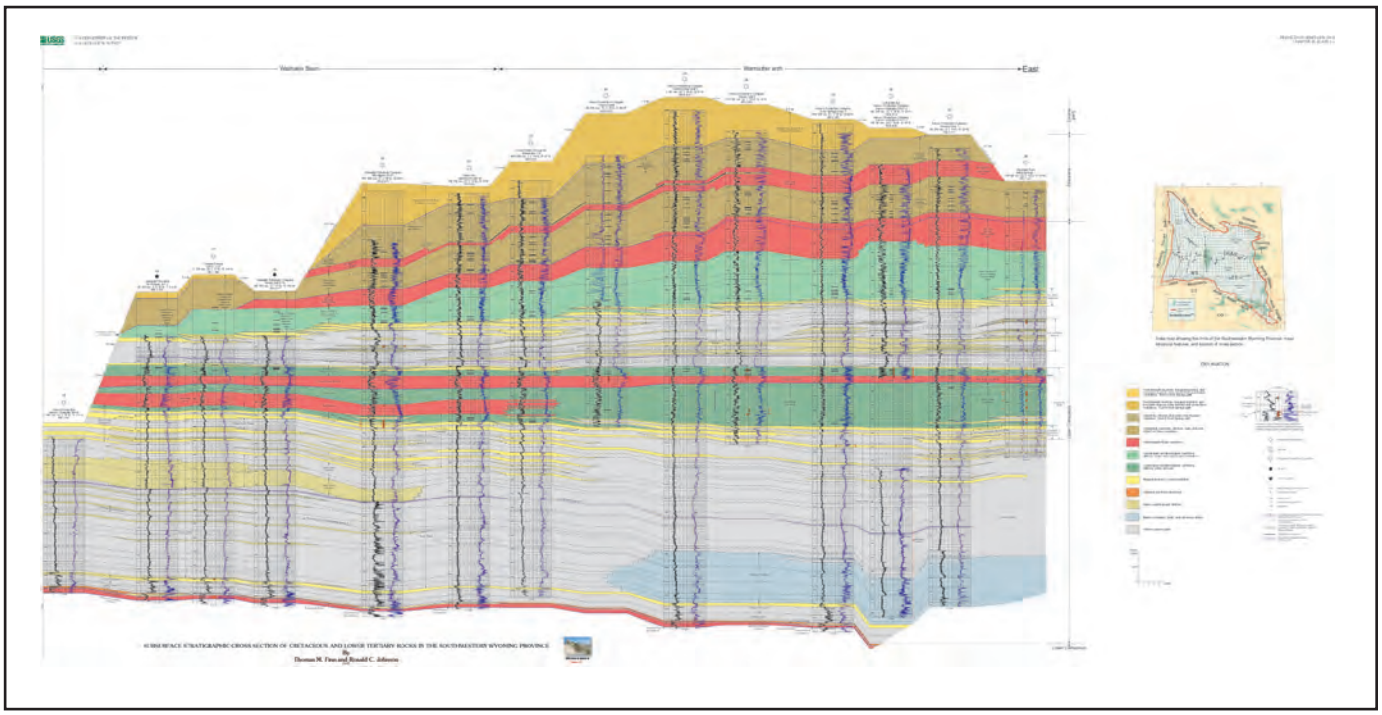

Plate 1B. Subsurface stratigraphic cross section of Cretaceous and lower Tertiary rocks in the Southwestern Wyoming Province–eastern segment.

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