Chapter 26

CHARACTERISTICS OF THE PR SPRING TAR SAND DEPOSIT, UINTA BASIN, UTAH, USA

George F. Dana and Donna J. Sinks* 1984

Abstract

The Laramie Energy Technology Center (LETC) conducted a seven-corehole drilling program in the PR Spring tar sand deposit, southeastern Uinta Basin, Utah, during the summer of 1980. Three main tar sand zones in the southwestern and west-central portion of the deposit were correlated by cross sections, using six of the seven LETC coreholes. The saturated beds and zones are lenticular and discontinuous over both large and small areas. As determined by the LETC cores and twenty eight previously drilled cores in the deposit, from one to twenty seven separate tar sand beds at least one foot thick of continuous saturation exist in the deposit, the thickest of which is 10.7 m (35 ft) thick. Analytical results from the LETC cores and the twenty eight other cores were integrated to further evaluate tar sand characteristics of the deposit. The following general trends were noted: extracted permeability and extracted porosity decrease downdip (northwest); oil saturation decreases to the west-southwest; and water saturation decreases to the east.

INTRODUCTION

The recent search for conventional sources of oil in the United States has resulted in some new discoveries being made, but interest in utilizing alternative sources of fuel has increased sharply, with emphasis on shale oil and tar sands. Drilling in several states, primarily Oklahoma, Texas, California, New Mexico and Utah, has helped in determining the extent of tar sand resources in the United States (figure 26-1).

Utah contains an estimated 81% (20 billion barrels) of the nation's tar sand resources (figure 26-2). Six principal deposits account for 97% of that total. The PR Spring deposit, located in the southeastern portion of the Uinta Basin, encompasses an area of about 435 sq km (270 sq mi) in Uintah and Grand Counties. The PR Spring resources are estimated at 4.5 billion barrels (Minutes, 1980; Ritzma, 1973).

Tar sand deposits in the Uinta Basin have been utilized in the past principally for road paving (Marchant et al., 1974). Some small-scale experimental efforts involving mining and extraction in surface plants have been conducted, but none have been commercially successful. As a result of decontrol of oil prices and recent availability of leases for tar sands, several companies have planned or are designing methods to develop technology for in situ or surface extraction of oil from tar sands. Since most of the tar sand leases containing petroleum in "tar" form are under considerable overburden, future emphasis will be on in situ production or underground mining with subsequent surface extraction.

During the summer of 1980 the Laramie Energy Technology Center (LETC) conducted a drilling and coring program on the PR Spring deposit (core-holes UTS-1 through UTS-6). The LETC-generated information was integrated with other available data to evaluate the deposit. Seven corehole drill sites were selected at varying distances from other coreholes which are sources of data (figure 23-3). Lithologic columns and stratigraphic cross sections are included to illustrate the nature of the saturated strata, including depth of burial, thickness, lateral continuity, porosity, permeability, and oil saturation. These data will hopefully offer encouragement toward the development of the deposit as a source of economically-producible petroleum products.

GEOGRAPHIC AND GEOLOGIC SETTING

The PR Spring deposit encompasses all or parts of Townships 12 S - 17 S and Ranges 21 E - 25 E (figure 26-4). It is centered 241 km (150 mi) southeast of Salt Lake City, Utah, 96 km (60 mi) south of Vernal, Utah, 113 km (70 mi) north of Moab, Utah, and 92 km (57 mi) southwest of Grand Junction, Colorado (Minutes, 1980).

The Uinta Basin was formed during the Eocene Epoch of the Tertiary Period and presently occupies an area 129 km (80 mi) north-south and 209 km (130 mi) east-west. The sediments in which the tar sands are presently found were deposited in semi-fluvial to semi-lacustrine environments, closely followed by and fluctuating with a lacustrine environment. The rate of sedimentation in Lake Uinta was influenced by climatic changes. The major stratigraphic

**Laramie Energy Technology Center, U.S. Department of Energy.*

Figure 26-1. *Tar sand occurrences in the U.S.*

units deposited at this time were the Green River and Wasatch Formations. The oil-impregnated zones are found in the sandstones of the upper Douglas Creek Member of the Green River Formation (figure 26-5; Gwynn, 1977). The coarser sediments were derived from the surrounding drainage areas and the finer sediments by mechanical abrusion and from chemical precipitation. Great amounts of plankton, algae, etc., existed in this shallow, freshwater to slightly brackish lake, providing the organic sources of the kerogen in the oil shales of the basin. Oil shale and tar sands are occasionally interbedded in the PR Spring deposit, but the most common situation is for the tar sands to be found underlying the oil shales at intervals up to approximately 200 feet.

The source of the oil in the sandstone beds is from the overlying organic-bearing oil shales of the Parachute Creek Member of the Green River Formation (Campbell and Ritzma, 1980). Oil migration has probably been over comparatively short distances because of the close proximity of the source and the reservoir rocks. Varying degrees of saturation are found in thirteen principal sandstone zones, which are lensing and discontinuous from area to area. The thickest and most numerous tar sand zones are found in the south-central portion of the deposit where the impregnated beds range from several centimeters to 10.7 m (35 ft) in thickness.

The Uinta Basin is a structurally asymmetric basin with the steeply sloping side to the north-northeast and the gently sloping side to the south-southeast (Cashion, 1967). The west and southwest flanks have varying dips up to 12 degrees east and northeast. Dips on the south flank of the basin are north-northwest 1.5°-3°, providing the gentle dip slopes along which hydrocarbons migrated. Subsequent erosion has exposed the tar sands in the walls of the principal canyons in the area. This erosion also permitted the more volatile components of the hydrocarbons to escape (Ritzma, 1973).

CROSS SECTIONS

Thirty four coreholes penetrated tar sand zones within the boundaries of the PR Spring deposit (table 26-1, figure 26-3). Table 26-2 contains pertinent general information on Utah tar sand deposits (Marchant et al., 1980), and table 26-3 includes analyses of six of the LETC cores. The seventh corehole, UTS-7, contained no tar sand.

Two cross sections (figures 26-6 and 26-7) have been constructed incorporating data on six of the seven LETC coreholes and information available on twenty eight other

Table 26-1. *Coreholes penetrating tar sands in the PR Spring deposit*

Map no.	Company and well name	Location and section	Township and range	Elevation in feet (meters)	Total depth in feet (meters)	Tar sand zones depth in feet (meters)	Oil impregnated beds thickness in feet (meters) Ind. beds	Total	Analyses available
1	Utah Geol. &	NE SW NE		6420 Gr.	274	151-156 (46-47.6)	4 (1.2)		yes
	Min. Survey,	34	12S, 24E	(1957)	(83.5)	159-162 (48.5-49.4)	3 (0.9)		
	PR-5					168-172 (51.2-52.4)	4 (1.2)		
						218-222 (66.5-67.7)	4 (1.2)		
						225-228 (68.6-69.5)	3 (0.9)		
						240-242 (73.2-73.8)	2 (0.6)	20 (6.1)	
2	Gulf Oil—	NE SE NE		6540 Gr.		381-392 (116.2-119.5)		11 (3.4)	yes
	Bonanza,	7	12S, 25E	(1994)					
	Corehole #3								
3	Utah Geol. &	SE SW NE		6512 Gr.	417	369-384 (112.5-117.1)		10 (3.0)	yes
	Min. Survey,	7	12S, 25E	(1985)	(127.1)				
	PR-3D								
4	Do	NW NE SW		6302 Gr.	95	39- 65 (11.89-19.8)		26 (7.9)	yes
	PR-3A	8	12S, 25E	(1921)	(29)				
5	Do	NE NW SW		6361 Gr.	158	119-149 (36.3-45.4)		30 (9.1)	yes
	PR-3B	8	12S, 25E	(1939)	(48.2)				
6	Do	SW SW NW		6430 Gr.	317	221-249 (67.4-75.9)		28 (8.5)	yes
	PR-3C	8	12S, 25E	(1960)	(96.6)				
7	DOE/LETC	SW SW SE		6489 Gr.	400	46- 48 (14.0-14.6)	2 (0.6)		yes
	UTS-1	29	13S, 21E	(1978)	(122)	238-246 (72.6-75.0)	8 (2.4)		
						252-253 (76.8-77.1)	1 (0.3)		
						256-257 (78.0-78.4)	1 (0.3)		
						258-263 (78.7-80.2)	5 (1.5)		
						301-303 (91.8-92.4)	1 (0.3)		
						304-306 (92.7-93.3)	1 (0.3)		
						307-310 (93.6-94.5)	2 (0.6)		
						312-313 (95.1-95.4)	1 (0.3)		
						314-315 (95.7-96.0)	1 (0.3)		
						317-318 (96.6-96.9)	1 (0.3)		
						321-324 (97.9-98.8)	3 (0.9)	26 (7.9)	
8	Utah Geol. &	SE SW SW		6707 Gr.	423	162-165 (49.4-50.3)	3 (0.9)		yes
	Min. Survey,	33	13S, 22E	(2045)	(129)	169-173 (51.5-52.7)	4 (1.2)		
	PR-6					176-187 (53.7-57.0)	12 (3.7)		
						192-197 (58.5-60.1)	5 (1.5)		
						230-254 (70.1-77.4)	24 (7.3)		
						262-263 (79.9-80.2)	1 (0.3)		
						267-268 (81.4-81.7)	1 (0.3)		
						277-280 (84.5-85.4)	3 (0.9)		
						295-296 (89.9-90.2)	1 (0.3)		
						299-302 (91.1-92.1)	3 (0.9)		
						323-324 (98.5-98.8)	1 (0.3)		
						326-327 (99.4-99.7)	1 (0.3)		

						330-332 (100.6-101.2)	2 (0.6)		
						338-345 (103.0-105.2)	7 (2.1)		
						350-360 (106.7-109.8)	10 (3.0)		
						373-380 (113.7-115.9)	7 (2.1)		
						383-391 (116.8-119.2)	8 (2.4)		
						411-414 (125.3-126.2)	3 (0.9)	96 (29.3)	
9	Skyline Oil Co., Sweetwater Cr. 26-33	SW SE 26	13S, 23E	6441 Gr. (1964)	254 (77.4)	90-159 (27.4-48.5)		17 (5.18)	yes
10	Utah Geol. & Min. Survey, PR-2	SE SE 29	13S, 23E	6346 Gr. (1935)	202 (61.6)	21- 22 (6.4-6.7)	1 (0.3)		yes
						44- 47 (13.4-14.3)	3 (0.9)		
						51- 56 (15.5-17.1)	5 (1.5)		
						63- 65 (19.2-19.8)	2 (0.6)		
						67- 68 (20.4-20.7)	1 (0.3)		
						78- 95 (23.8-29.0)	13 (3.9)	25 (7.6)	
11	Do PR-1	SW NE SW 6	13S, 24E	6210 Gr. (1893)	326 (77.4)	176-186 (53.7-56.7)	10 (3.0)		yes
						192-195 (58.5-59.5)	3 (0.9)		
						198-199 (60.4-60.7)	1 (0.3)		
						241-247 (73.5-75.3)	6 (1.8)		
						250-264 (76.2-80.5)	14 (4.3)	34 (10.4)	
12	Do PR-4	N/2 SE SW 5	13S, 25E	7187 Gr. (2191)	195 (59.5)	58- 78 (17.7-23.8)		20 (6.1)	yes
13	DOE/LETC UTS-2	SE SE SW 26	14S, 21E	7003 Gr. (2135)	310 (94.5)	93-101 (28.4-30.8)	8 (2.4)		yes
						223-224 (68.0-68.3)	1 (0.3)		
						235-237 (71.6-72.3)	2 (0.6)		
						238-239 (72.6-72.9)	1 (0.3)		
						241-244 (73.5-74.4)	1 (0.3)	13 (3.9)	
14	Geokinetics Corehole W-14	NW NE NE 2	14S, 22E	6721 Gr. (2049)	300 (91.5)	108-111 (32.9-33.8)	3 (0.9)		no
						133-168 (40.5-51.2)	35 (10.7)		
						172-300 (52.4-91.5)		38+ (11.6+)	
15	Skyline Oil Co., Sweetwater Cr. 14-34	SW SE 14	14S, 22E	7101 Gr. (2135)	244 (74.4)	33- 23 (10.1-71.0)		63 (19.2)	yes
16	Skyline Oil Co., Sweetwater Cr. 24-24	SE SW 24	14S, 22E	7130 Gr. (2174)	3010 (917.7)	55-170 (16.8-51.8)		40 (12.2)	yes
17	Skyline Oil Co., Sweetwater Cr. 25-32	SW NE 25	14S, 22E	7162 Gr. (2184)	255 (77.7)	43-255 (13.1-77.7)		71 (21.6)	yes

Table 26-1. *(continued)*

Map no.	Company and well name	Location and section	Township and range	Elevation in feet (meters)	Total depth in feet (meters)	Tar sand zones depth in feet (meters)	Oil impregnated beds thickness in feet (meters) Ind. beds	Total	Analyses available
18	DOE/LETC	NW NW NE		6693 Gr.	230	19- 21 (5.79-6.4)			yes
	UTS-3	8	14S, 23E	(2041)	(70.1)	25- 26 (7.6-7.9)	1 (0.3)		
						27- 30 (8.2-9.1)	3 (0.9)		
						31- 36 (9.5-11.0)	5 (1.5)		
						37- 40 (11.3-12.2)	3 (0.9)		
						49- 50 (14.9-15.2)	1 (0.3)		
						51- 52 (15.5-15.9)	1 (0.3)		
						78- 80 (23.8-24.4)	2 (0.6)		
						81- 82 (24.7-25.0)	1 (0.3)		
						83- 86 (25.3-26.2)	3 (0.9)		
						114- 11 (34.8-35.7)	3 (0.9)		
						119-120 (36.3-36.6)	1 (0.3)		
						122-124 (37.2-37.8)	2 (0.6)		
						127-129 (38.7-39.3)	2 (0.6)	30 (9.1)	
19	Utah Geol. &	SW NW NE		6798 Gr.	212	9- 12 (2.7-3.7)	3 (0.9)		yes
	Min. Survey	14	14S, 23E	(2073)	(64.6)	15- 17 (4.6-5.2)	2 (0.6)		
	PR-7					21- 22 (6.4-6.7)	1 (0.3)		
						24- 43 (7.3-13.1)	19 (5.8)		
						83- 84 (25.3-25.6)	1 (0.3)		
						94-102 (28.7-31.1)	3 (0.9)		
						118-120 (36.0-36.6)	2 (0.6)		
						184-186 (56.1-56.7)	2 (0.6)	33 (10.1)	
20	Do	SW SE		7387 Gr.	242	23- 49 (7.0-14.9)	26 (7.9)		yes
	PRS-3	32	14S, 23E	(2252)	(73.8)	62- 65 (18.9-19.8)	3 (0.9)		
						85- 94 (25.9-28.7)	9 (2.7)		
						96- 98 (29.3-29.9)	2 (0.6)		
						107-110 (32.6-33.5)	3 (0.9)		
						113-114 (34.5-34.8)	1 (0.3)		
						118-120 (36.0-36.6)	2 (0.6)		
						128-134 (39.0-40.9)	6 (1.8)		
						140-142 (42.7-43.3)	2 (0.6)		
						152-157 (46.3-47.9)	5 (1.5)		
						215-216 (65.6-65.9)	1 (0.3)		
						218-220 (66.5-67.1)	2 (0.6)		
						234-235 (71.30-71.7)	1 (0.3)	63 (19.2)	
21	Texaco, Inc.	N/2 SE SW		7500 Gr.	234	20-219 (6.1-66.8)		78 (23.8)	yes
	F.C. Staines #1	35	14S, 23E	(2287)	(71.3)				
22	U.S.G.S.	NW SW NW		7178 Gr.	98	95- 98 (29.0-29.9)		3 (0.9)	no
	Corehole WR-#7	12	15S, 21E	(2188)	(29.9)				
23	DOE/LETC	SE NW NE		7383 Gr.	445	46- 55 (14.0-16.8)	8 (2.4)		yes
	UTS-4	21	15S, 21E	(2251)	(135.7)	56- 62 (17.1-18.9)	6 (1.8)		
						64- 70 (19.5-21.3)	6 (1.8)		

						142-146 (43.4-44.5)	4 (1.2)		
						149-162 (45.4-49.4)	13 (4.0)		
						164-179 (50.0-54.6)	15 (4.6)		
						184-185 (56.1-56.4)	1 (0.3)		
						186-188 (56.7-57.3)	2 (0.6)		
						200-203 (61.0-61.9)	3 (0.9)		
						252-255 (76.8-77.7)	3 (0.9)		
						265-267 (80.8-81.4)	2 (0.6)		
						290-292 (88.4-89.0)	2 (0.6)		
						298-300 (90.9-91.5)	2 (0.6)		
						305-311 (93.0-94.8)	6 (1.8)		
						357-358 (108.8-109.2)	1 (0.3)		
						360-362 (109.8-110.4)	2 (0.6)		
						377-378 (114.9-115.2)	1 (0.3)		
						380-381 (115.9-116.2)	1 (0.3)	78 (23.8)	
24	Texaco, Inc. R.E. Colbert #2	SW NW NE 26	15S, 22E	7505 Gr. (2288)	335 (102)	20-335 (6.1-102.1)		69 (21.0)	yes
25	DOE/LETC UTS-5	SW SW SE 29	15S, 22E	7472 Gr. (2278)	315 (96)	16- 22 (4.9-6.7)	6 (1.8)		yes
						30- 32 (9.1-9.8)	2 (0.6)		
						38- 40 (11.6-12.2)	2 (0.6)		
						74- 84 (22.6-25.6)	10 (3.0)		
						213-217 (64.9-66.2)	3 (0.9)		
						225-234 (68.6-71.3)	8 (2.4)		
						235-238 (71.6-72.6)	3 (0.9)		
						239-252 (72.9-76.8)	13 (4.0)		
						253-254 (77.1-77.4)	1 (0.3)	48 (14.6)	
26	U.S.G.S. Corehole WR-#5	SW SW SW 34	15S, 22E	7542 Gr. (2299)	103 (31.4)	70- 72 (21.3-22.0)	2 (0.6)		no
						73- 88 (22.3-26.8)	15 (4.6)		
						90- 98 (27.4-29.9)	8 (2.4)	25 (7.6)	
27	Texaco, Inc. R.E. Colbert #1	NW NW SE 35	15S, 22E	7580 Gr. (2311)	250 (76.2)	64- 16 (19.5-49.4)		73 (22.3)	yes
28	Texaco, Inc. E #1	SW NE NE		7650 Gr. (2332)	368 (112.2)	23- 36 (7.0-112.2)		106 (32.3)	yes
29	Texaco, Inc. F.C. Minkler #1	SW SE NW 11	15S, 23E	7750 Gr. (2363)	162 (49.4)	22-162 (6.7-49.4)		45 (13.7)	yes
30	Utah Geol. & Min. Survey PRS-2	NE SE NW 16	15S, 23E	7702 Gr. (2348)	282 (86)	57- 58 (17.4-17.7)	1 (0.3)		yes
						61- 65 (18.6-19.8)	4 (1.2)		
						68- 70 (20.7-21.3)	2 (0.6)		
						76- 82 (23.2-25.0)	6 (1.8)		
						123-124 (37.5-37.8)	1 (0.3)		
						126-129 (38.4-39.3)	3 (0.9)		
						132-133 (40.2-40.5)	1 (0.3)		
						135-138 (41.2-42.1)	3 (0.9)		
						172-180 (52.4-54.9)	8 (2.4)		
						193-217 (58.8-66.2)	24 (7.3)		
						233-234 (71.0-71.3)	1 (0.3)		
						246-247 (75.0-75.3)	1 (0.3)		
						252-255 (76.8-77.7)	3 (0.9)	58 (17.7)	

Table 26-1. *(continued)*

Map no.	Company and well name	Location and section	Township and range	Elevation in feet (meters)	Total depth in feet (meters)	Tar sand zones depth in feet (meters)	Oil impregnated beds thickness in feet (meters) Ind. beds	Total	Analyses available
31	Utah Geol. &	SE NE NE		8010 Gr.	247	27- 33 (8.2-10.1)	6 (1.9)		
	Min. Survey	27	15S, 23E	(2442)	(75)	36- 40 (11.0-12.2)	4 (1.2)		
	PRS-1					42- 52 (12.8-15.9)	10 (3.1)		
						66- 70 (20.1-21.3)	4 (1.2)		
						74- 82 (22.6-25.0)	8 (2.4)		
						90-118 (27.4-36.0)	28 (8.6)		
						159-182 (48.5-55.5)	23 (7.0)		
						199-222 (60.7-67.7)	23 (7.0)	106 (32.4)	
32	Texaco, Inc.	NE SW NE		8023 Gr.	451	76-451 (23.2-137.5)		104 (31.7)	yes
	E.D. White #1	32	15S, 23E	(2446)	(137.5)				
33	Texaco, Inc.	SE SE SW		7660 Gr.	207	39-307 (11.9-63.1)		109 (33.2)	yes
	State of UT	32	15½S, 23E	(2335)	(63.1)				
34	B #1	NW SE SW		8925 Gr.	415	24- 27 (7.3-8.2)	3 (0.9)		yes
	DOE/LETC	33	15½S, 24E	(2529)	(126.5)	38- 49 (11.6-14.0)	11 (3.4)		
	UTS-6					88- 98 (26.8-29.9)	10 (3.0)		
						131-146 (39.9-44.5)	15 (4.6)		
						175-178 (53.4-54.3)	3 (0.9)		
						184-187 (56.1-57.0)	3 (0.9)		
						272-279 (83.9-85.1)	7 (2.1)		
						287-296 (87.5-90.2)	9 (2.7)		
						302-307 (92.1-93.6)	5 (1.5)		
						314-315 (95.7-96.0)	1 (0.3)		
						318-319 (97.0-97.3)	1 (0.3)		
						320-321 (97.6-97.9)	1 (0.3)		
						322-324 (98.2-98.8)	2 (0.6)		
						326-331 (99.4-100.9)	5 (1.5)		
						341-348 (104.0-106.1)	7 (2.1)		
						353-354 (107.6-107.9)	1 (0.3)		
						355-363 (108.2-110.7)	8 (2.4)	92 (28.0)	

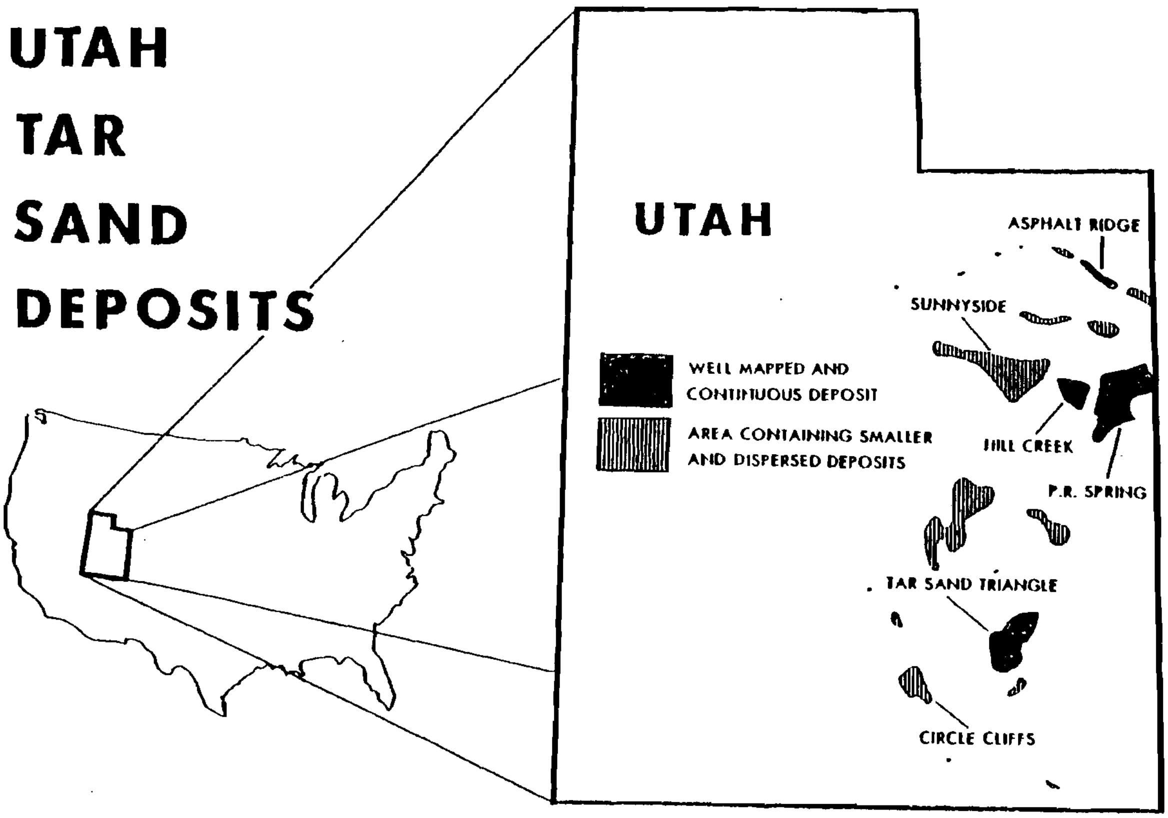

Figure 26-2. *Utah tar sand deposits*

Table 26-2. *Characteristics of some major Utah tar sand deposits*

Porosity	High
Permeability (oil extracted)	High
Permeability (oil saturated)	Low
Oil saturation range	0-100%
Water saturation	Low (oil wet)
Oil gravity range	> 966 kg/m³ (14° API)
Overburden range	0-610 m (0-2000 ft)
Surface mineable	< 15%

coreholes (Cashion, 1981; Peterson, 1975; Peterson and Ritzma, 1974; LETC files). Because it is difficult to graphically represent the coreholes laterally by elevations, these cross sections were constructed to correlate three main tar sand zones. The apparent dip of the tar sand zones in these two figures is not representative of the actual dip of the beds. Although a number of deep oil and gas test wells have been drilled in the area, data from them is insufficient for use in lithologic interpretation.

Variation in the number of individual saturated beds is evident from these cross sections. Correlations of three principal zones are indicated in figures 26-6 and 26-7, providing additional evidence of the discontinuous nature of the reservoir beds. In contrast to work in previous publications (Johnson et al., 1975b, 1975c), the correlation of zones one-three does not include all thinner saturated beds. The correlations herein are based on thicker saturated zones, which could actually be redesignated by the name "bed." However, the lithology of the saturated beds is not homogeneous, thus the term "zone" is used. Corehole UTS-2 contains the least number of saturated beds of those holes drilled by LETC, except for the barren seventh corehole (UTS-7). Located in section 25, T16S, R22E, corehole UTS-7 contained no apparent hydrocarbon staining. The southeastern limit of saturation in the PR Spring deposit is therefore thought to be north and east of this well location. The greatest total thickness of saturation occurs in corehole UTS-6 (map number 34, figure 26-3), the corehole farthest updip among these drilled. This indicates that greater volumes of oil migrated updip when porosity and continuous permeability were sufficient in the host rock.

Table 26-1 contains general information on the thirty four coreholes. It also lists specific beds and zones of saturation, some generalized and some identified by detailed footages, depending upon the availability of data. The raw data on coreholes UTS-1-UTS-6, summarized in table 26-3, is available from LETC upon request.

Gwynn, 1971

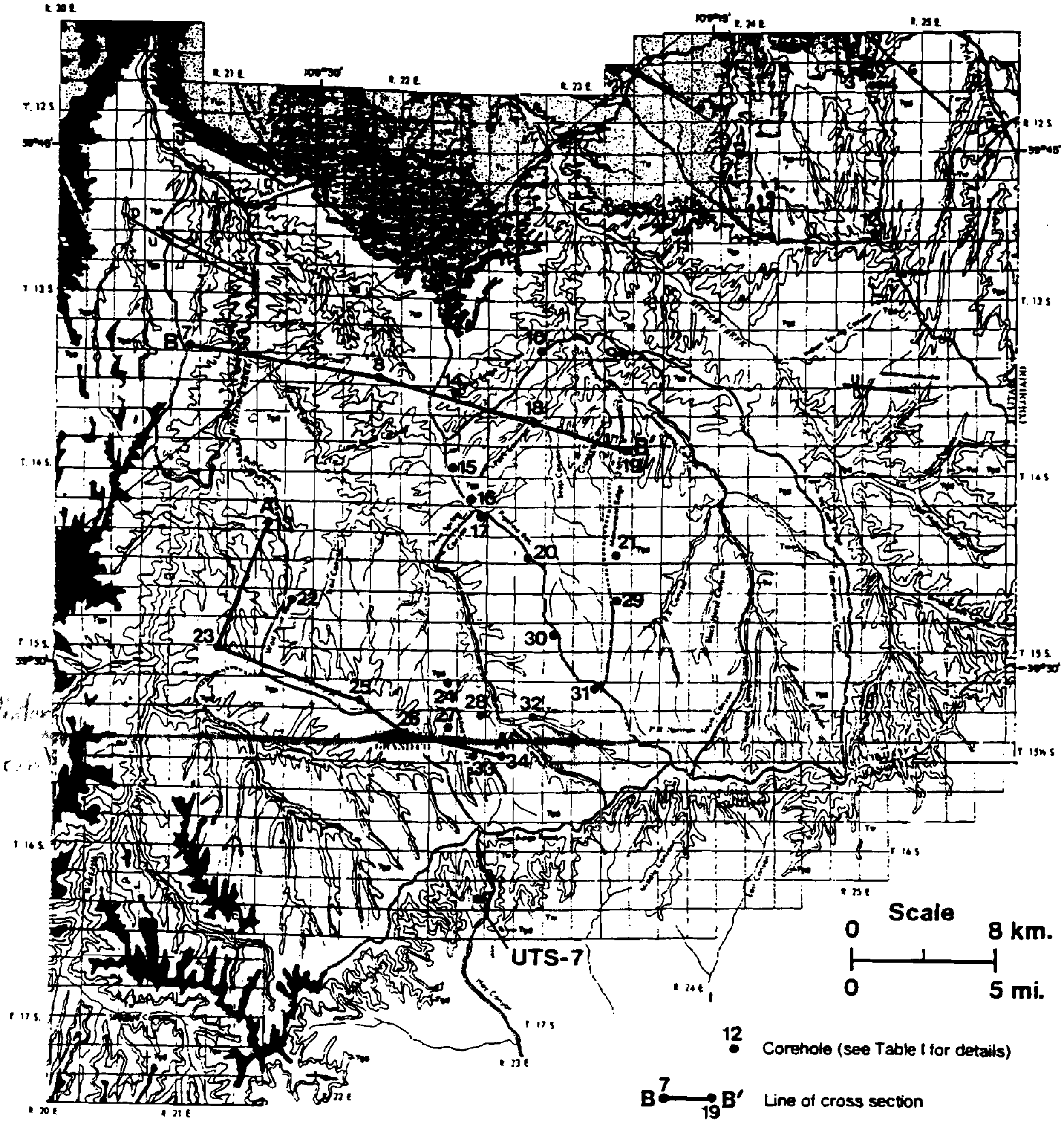

Figure 26-3. *Corehole and cross section locations in the PR Spring deposit*

TAR SAND CHARACTERISTICS

Figures 26-8 and 26-9 are lithologic columns of six of the coreholes drilled by LETC during the exploration phase of the research. Laboratory analyses were completed on these six coreholes (table 26-3). Oil saturations on each of the tar sand zones is represented to the right of the lithologic columns. Every foot of core lithologically described as a tar sand was not necessarily analyzed, explaining the missing actual saturation values in figures 26-8 and 26-9. The zones in figures 26-6 and 26-7 were based on lithologic descriptions and oil saturation analyses. Additional data on various parameters of the analyses are also found in table 26-3.

Table 26-3. *PR Spring tar sand characteristics*

	Corehole UTS-1			Corehole UTS-2			Corehole UTS-3			Corehole UTS-4			Corehole UTS-5			Corehole UTS-6		
	Min	Max	Av	Min	Max	Av	Min	Max	Av	Min	Max	Av	Min	Max	Av	Min	Max	Av
		*37			*13			*41			*82			*50			*92	
Porosity, saturated . . . . . .pct	2.7	16.2	9.13	4.9	16.1	11.36	3.1	19.6	9.95	5.0	24.9	18.11	3.8	23.1	13.29	0.9	22.5	11.36
Porosity, extracted . . . . . .pct	10.4	28.7	18.22	10.0	25.5	19.12	8.1	29.2	21.60	6.3	27.2	22.14	11.7	30.6	23.56	7.7	33.1	24.83
Permeability, saturated. . . .Md	<0.01	298	23.98	0.03	1.8	0.58	<0.01	255	33.88	<0.01	1800	253.19	<0.01	401	57.42	<0.01	6150	351.16
			*36												*49			
Permeability, extracted. . . .Md	<0.01	376	56.6	0.28	660	79.13	0.08	2050	300.41	<0.01	2300	453.67	0.05	8000	1216.86	<0.01	8450	858.48
			*33												*49			
Oil saturation . . . .pct pore vol	3.7	69.6	14.30	2.3	51.9	20.51	3.8	80.9	37.85	0.6	43.7	9.02	0.9	79.7	31.29	1.3	88.4	27.93
Water saturation. . . pct por vol	7.0	62.6	21.9	12.7	39.7	19.85	6.2	29.5	14.8	2.3	33.7	10.05	5.0	28.7	10.66	3.5	34.4	11.38
Bulk density, saturated. . g/cm³	2.61	2.81	2.69	2.12	2.47	2.27	2.03	2.50	2.18	1.96	2.45	2.11	2.02	2.42	2.15	1.89	2.56	2.12
Bulk density, extracted. . g/cm³	2.10	2.50	2.28	1.98	2.41	2.16	1.89	2.48	2.08	1.91	2.39	2.05	1.83	2.40	2.05	1.01	2.56	1.98
Grain density . . . . g/cm³	1.97	2.40	2.20	2.65	2.70	2.68	2.61	2.77	2.66	2.59	2.76	2.66	2.62	2.84	2.73	2.58	2.75	2.63

*Number of samples analyzed.

Table 26-4. *Summary of corehole analyses*

	Min	Max	Av
Saturated permeability (md)	<0.01	6150	120.03
Extracted permeability (md)	<0.01	8450	494.18
Saturated porosity (pct)	0.9	24.9	12.2
Extracted porosity (pct)	6.3	33.1	21.58
Oil saturation (pct pore vol)	0.6	88.4	23.48
Water saturation (pct pore vol)	2.3	62.6	14.76
Saturated bulk density (g/cm^3)	1.89	2.81	2.25
Extracted bulk density (g/cm^3)	1.01	2.56	2.1
Sand grain density (g/cm^3)	1.97	2.84	2.60

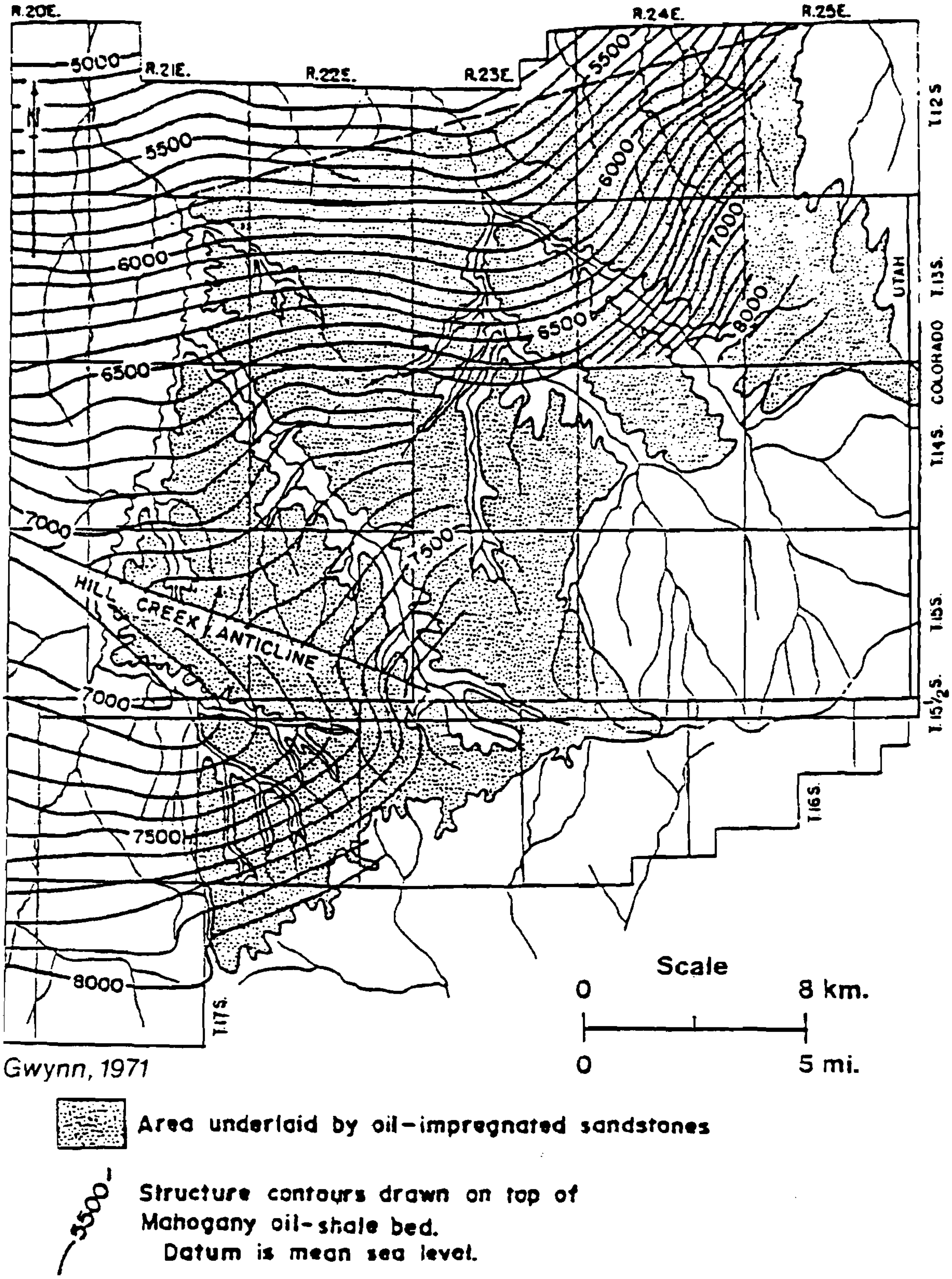

Figure 26-4. *Areal extent of the PR Spring deposit with structural contours on overlying Mahogany oil shale bed*

A number of properties of the saturated zones have been determined before and after extraction of the oil. A summary of the analytical data on the six LETC coreholes is presented in table 26-4.

SUMMARY AND CONCLUSIONS

Numerous tar sand beds are found in cores of the PR Spring deposit. Of the seven coreholes drilled by LETC in 1980, six contained oil-bearing strata in the form of tar sand. The number of individual beds in the six coreholes ranged from two in UTS-2 to eight in UTS-6. Other cores from various parts of the deposit contain from one to 27 individual beds. The most prominent beds are correlated into three principal zones, traceable on cross sections constructed from core data obtained by LETC, the U.S. Geological Survey, and the Utah Geological and Mineral survey.

Table 26-5 contains four analytical parameters of four major Utah tar sand deposits: PR Spring, Hill Creek, Sunnyside, and Tar Sand Triangle. The PR Spring deposit averages highest in extracted permeability of these four deposits, however oil saturation is still low to moderate (about 45%). Extracted porosity is similar for all four deposits, averaging 22.4%. The average oil saturation for these major deposits is 41%. The PR Spring tar sand is considered a "dry" sand; that is, there is very little water occupying pore space in the sandstone.

These same four parameters are compared for nineteen coreholes in the PR Spring deposit (table 26-6). The six

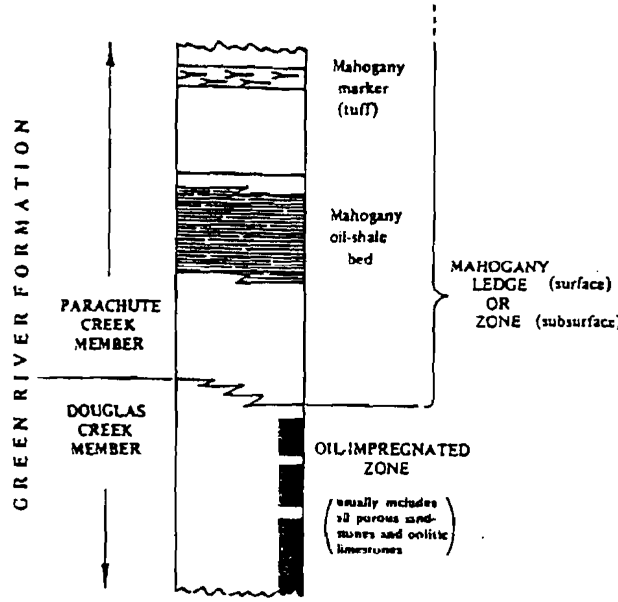

Figure 26-5. *Nomenclature of beds and members of the Green River Formation above and below the contact of Parachute Creek and Douglas Creek Members (Peterson, 1975)*

Table 26-5. *Average analytical data for Utah tar sand deposits*

	PR Spring[a]	Hill Creek[b]	Sunnyside[c]	Tar Sand Triangle[c]
Extracted permeability....... md	1309	323	570	340
Extracted porosity.......... pct	24.4	22.4	23.1	19.8
Oil saturation........pct pore vol	44.8	36.6	51.8	32.2
Water saturation......pct pore vol	7.3	16.8	20.9	4.67

[a]LETC files; Johnson et al., 1975a, 1975b, 1975c; Marchant et al., 1974
[b]Peterson and Ritzma, 1974
[c]Campbell and Ritzma, 1980

Table 26-6. *Average analytical data for coreholes drilled in PR Spring area*

	LETC UTS Coreholes (7, 13, 18, 23, 25, 34)	Threemile Canyon[a] (3, 4, 5, 6)	Asphalt Wash[b] (1, 11, 12)	North Seep Ridge[c] (8, 10, 19)	South Seep Ridge[d] (20, 30, 31)
Extracted permeability....... md	494.2	2855	596	384	2218
Extracted porosity.......... pct	21.6	29.2	24.7	20.9	25.6
Oil saturation........pct pore vol	23.5	67.4	58.1	38.6	36.5
Water saturation......pct pore vol	14.8	6.0	9.1	2.8	3.7

[a]Marchant et al., 1974
[b]Johnson et al., 1975a
[c]Johnson et al., 1975b
[d]Johnson et al., 1975c
Note: The material within parentheses are map numbers on figure 26-3.

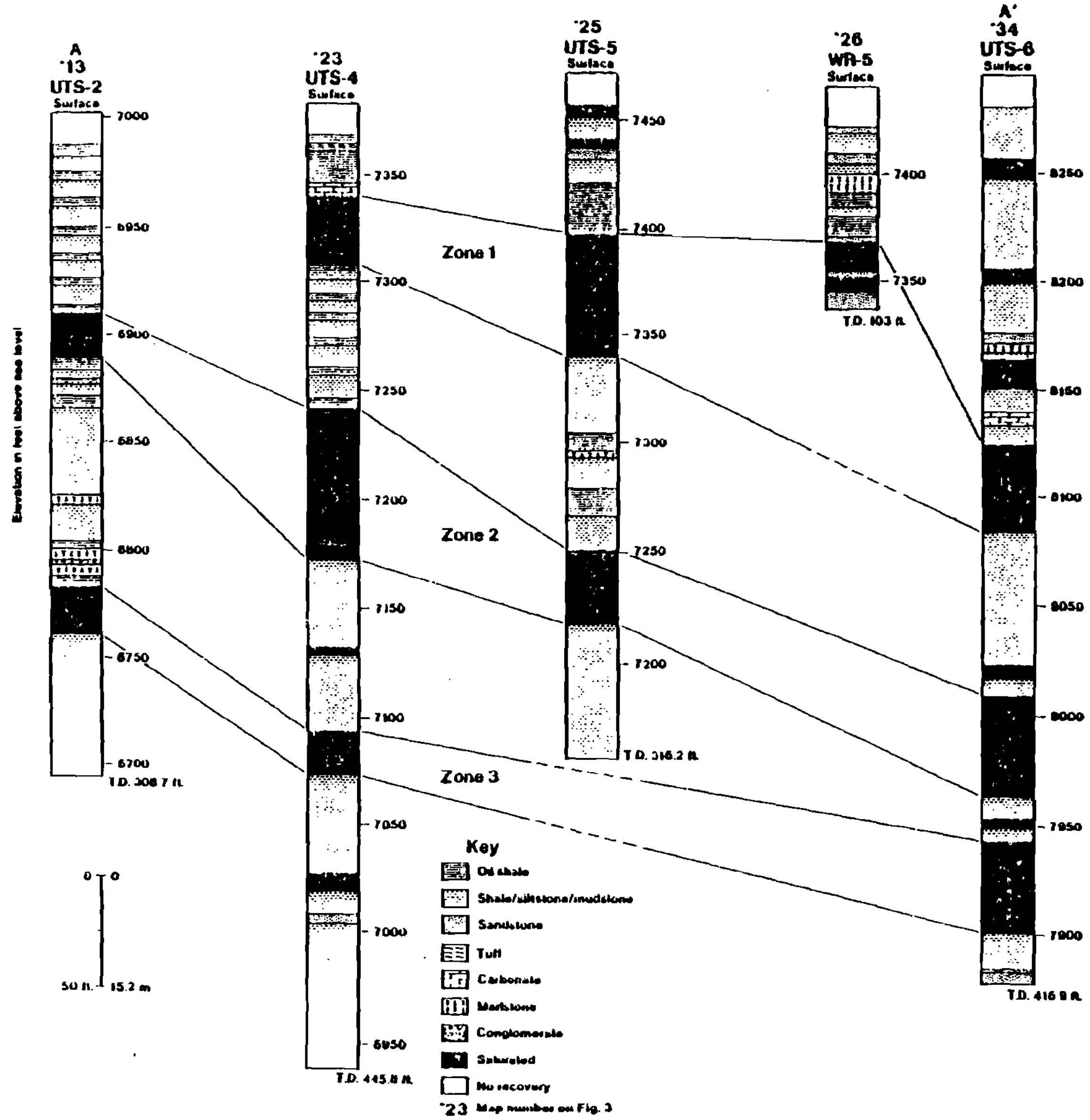

Figure 26-6. *NW-SE cross section A-A'. Cross sectional distance approximately 24 km (14.9 mi)*

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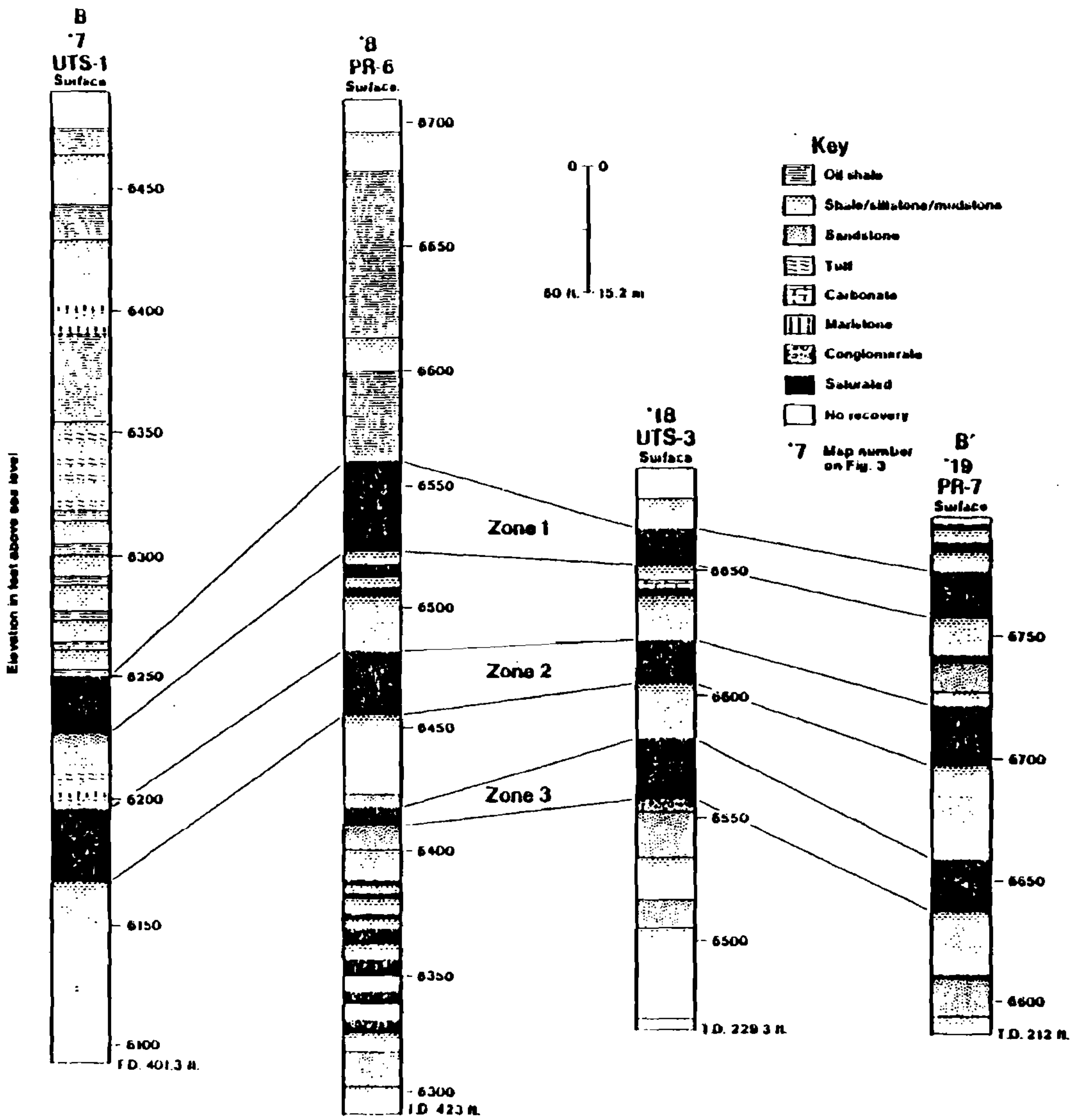

Figure 26-7. *W-E cross section B-B'. Cross sectional distance approximately 23 km (14.3 mi)*

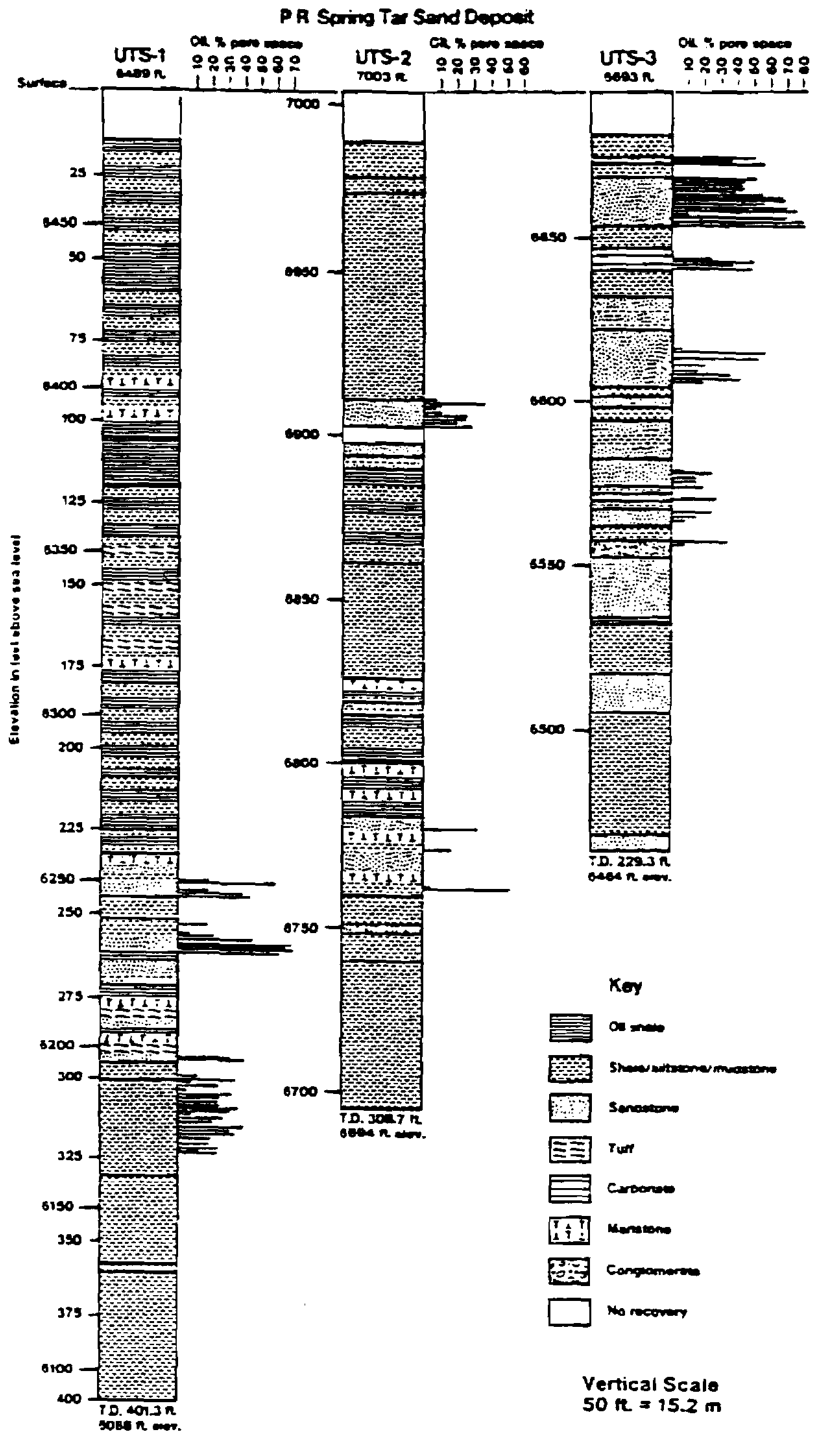

Figure 26-8. *Lithologic columns of UTS-1 through UTS-3 coreholes with oil saturation zones*

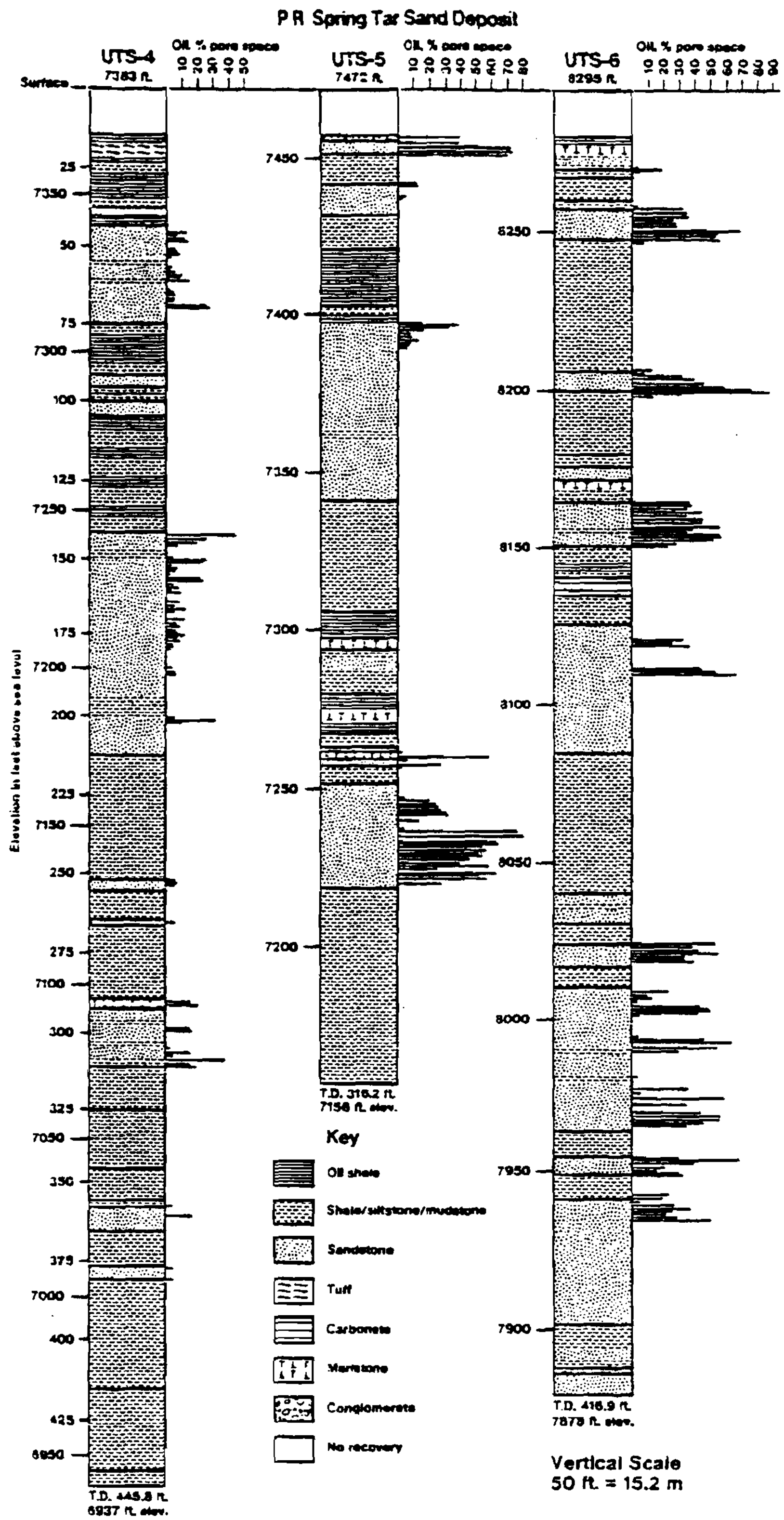

Figure 26-9. *Lithologic columns of UTS-4 through UTS-6 coreholes with oil saturation zones*

LETC coreholes, along with coreholes from four areas of the deposit, are included in this table: Threemile Canyon–extreme northeast; Asphalt Wash–northeast; North Steep Ridge–north central; and South Steep Ridge–south central. By comparing the analytical data on these coreholes, the following general trends are evident for the PR Spring deposit: 1) extracted permeability decreases downdip (northwest), with an anomalous high occurring at the Threemile Canyon area; 2) extracted porosity decreases downdip (northwest); 3) oil saturation greatly decreases to the west-southwest; and 4) water saturation decreases to the east. These are general trends; abnormally high or low values do occur within the deposit and are considered to be from anomalous saturated beds.

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