Bitumen-Bearing Deposits of the United States

U.S. GEOLOGICAL SURVEY BULLETIN 1784

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By Bonnie L. Crysdale and Christopher J. Schenk

A summary of the locations, resources,
and petrophysical properties of
bitumen-bearing rocks in the United States

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Abstract

Tar sands, or bitumen-bearing rocks, represent a significant source of hydrocarbons in the United States. This report is a summary, by State, of the locations, resources, and petrophysical data of known bitumen-bearing deposits. Bitumen accumulations are located primarily in Alabama, California, Kentucky, Texas, and Utah. Utah contains the largest resource, with an estimated 28 billion barrels of bitumen, followed by California with 9 billion barrels, and Alabama, with approximately 6 billion barrels. The locations of most bitumen accumulations are well known, although the resources of only the larger deposits have been estimated. Much of the petrophysical, chemical, and mineralogical data are unknown, even for the larger deposits.

INTRODUCTION

The purpose of this report is to summarize the locations and resources of known tar sand deposits in the United States (pls. 1, 2). Tar sand is a generic term for a sedimentary rock or sand containing a heavy asphaltic substance called bitumen (Schramm, 1979), which in its natural state is not mobile at reservoir conditions and cannot be extracted by conventional petroleum recovery methods. Tar, or bitumen, is defined as any hydrocarbon deposit with a gas-free viscosity greater than 10,000 centipoises (cp) measured at original reservoir conditions (Danyluk and others, 1984), and density greater than 1,000 kg/m3 (⟨10° API gravity) at 15.6°C (60°F) at atmospheric pressure. Viscosity data for many of the deposits generally are not available, so bitumen as used in this report is defined by the API gravity cutoff of less than 10°. Bitumen-bearing rocks are known by several other names, such as natural asphalt, tarry oil, bituminous rock, tar sands, oil sands, and rock asphalt. All appear to be used interchangeably. We will use the term bitumen-bearing to describe these accumulations. Host lithologies of the various bitumen-bearing rocks include sandstone, limestone, dolomite, conglomerate, siltstone, and unconsolidated sands. Most of the bitumen-bearing rocks are located on the margins of sedimentary basins, and have outcrop or surface exposures, although they do extend into the subsurface.

Bitumen-bearing rocks have been recognized in the United States since the late 1800's; Ball Associates (1965) listed over 500 occurrences, most of them small, isolated outcrops. Lewin and Associates (1984) reassessed the bitumen resource, estimating the total at 54 billion barrels, with 25 major (greater than 100 million barrels) and 19 minor (10 to 100 million barrels) occurrences. Lewin and Associates (1984) categorized slightly less than half of this amount (22 billion barrels) as reserves and considered the remainder to be speculative resource. Deposits occur primarily in Alabama, California, Kentucky, Texas, and Utah. Utah contains the largest deposits in terms of resource, size, and number, with an estimated 28 billion barrels of bitumen on more than 700,000 acres of land. Accumulations in the tristate area of Missouri, Kansas, and Oklahoma (shown on pl. 1, but not numbered) are estimated to contain approximately 3 billion barrels of petroleum (Lewin and Associates, 1984); however, they are not listed in this report as most of these accumulations appear to consist of heavy oil (Ebanks and Weber, 1984). Crude oils with densities from 934 to 1,000 kg/m^3 (API gravities of 20° to 10°) inclusive are classified as heavy oils (Martinez, 1984). Similarly, the giant Kuparuk deposit on the Alaska North Slope is now known to consist mainly of heavy oil, not bitumen (Werner, 1984), with a resource estimated as high as 40 billion barrels. Lewin and Associates considered 10 billion barrels of the Kuparuk deposit to be bitumen; consequently, their total bitumen resource estimate of 54 billion barrels should be adjusted downward to 44 billion barrels.

Bitumen-bearing rocks were quarried extensively for road-paving material in the United States from the late 1800's through the 1940's, until it became uneconomic to continue mining operations. Bitumen-bearing rocks have been recognized for many years as potential energy sources (Schramm, 1979); however, interest has remained marginal due to (1) unfavorable economic conditions for extracting the bitumen from the rock, (2) limited knowledge of the character of bitumen-bearing deposits, and (3) large, readily available reserves

of conventional petroleum. Recent interest has centered on developing methods of in-situ recovery of the bitumen.

The bitumen deposits summarized in tables 1 through 17 are listed by State and generally coincide with field outlines of major deposits described by Lewin and Associates (1984) and minor deposits characterized by Ball Associates (1965). All map location numbers in the tables refer to plate 1, except the table for Alaska, which refers to plate 2. Descriptions in the tables include the following information: (1) map number located on the plates by State (where numbered 1A, 1B, and so on, the numbers indicate separate occurrences within one outlined area); (2) name of the deposit and its location; (3) geologic formation containing the bitumen, age of the formation, and lithology of the host rock; (4) depth to pay, and pay thickness; (5) number of acres the deposit covers, either measured (by well control and core analysis) or speculative (by tar shows and geologic interpretations); (6) API gravity and viscosity of the bitumen; (7) porosity and permeability of the host rock; (8) water saturation (in percent) and bitumen saturation (either percent or weight percent) of the host rock; (9) sulfur content of the bitumen (bitumens generally contain 3 weight percent or more of sulfur (Danyluk and others, 1984)); and (10) amount of bitumen resource in place, both measured and speculative. Plates 1 and 2 also illustrate the outlines of sedimentary basins in the conterminous United States and Alaska. Basin outlines for the conterminous United States are from Terra Graphics (1977), and basin outlines for Alaska are from Ehm (1983). Data presented here are based on the most reliable published and unpublished information available from various Federal, State and local agencies, private sources, and original field investigations.

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TABLES 1–17

Abbreviations and symbols used in tables

[Leaders (---) indicate no data available; do, ditto; M, measured; S, speculative; T, total; cp centipoise; md, millidarcy; m.b., thousand barrels; mi, mile; wt, weight; res. temp, reservoir temperature; @, at; *, average; ls, limestone; ss, sandstone; sh, shale; sts, siltstone; diat, diatomite; cgl, conglomerate; mds, mudstone; dol, dolomite; cls, claystone; qzt, quartzite; ark., arkose]

Table 1. Summary of bitumen deposits in Alabama

Map number	Deposit name	County	Townships and Ranges	Formation	Age	Lith-ology	Depth (ft)	Pay thickness (ft)
1A	[2]Bangor	Franklin, Lawrence, Morgan	[1]T. 7, 8 S., R. 3, 5, 9 W.	Bangor Limestone	Mississippian	ls	outcrop	---
1B	[2]Hartselle	Colbert, Franklin, Lawrence, Morgan, Marion, Winston, Walker, Cullman	T. 5-13 S., R. 4-15 W.	Hartselle Sandstone	---do---	ss	0-1,000	5-54
2A	[1]Colbert Creek	Colbert	T. 3 S., R. 14 W.	Girkin	---do---	ls	outcrop	---
2B	[1]Cherokee	---do---	T. 4 S., R. 13-14 W.	---do--- Bethel Sandstone	---do---	---	---	3-12
2C	[1]Margerum	---do---	T. 3-5 S., R. 14-15 W.	Girkin	---do---	ls	---	<1-25
2D	[2]Pride Mountain	---do---	---	Pride Mountain	---do---	[3]sh, ls, ss, sts	20-30 mi outcrop	12*

[1]Ball Associates, 1965.

[2]Lewin and Associates, 1984.

[3]Wilson, 1984.

Acreage	API gravity (degrees)	Viscosity (cp)	Porosity (%)	Permeability (md)	Water sat. (%)	Bitumen sat. (%)	Sulfur (wt %)	Resource in place (m.b.)
---	---	---	---	---	---	---	---	---
M= 534,000 S= 1,500,000 T= 2,034,000	---	---	6-24	1-700	---	35	1.1-2.6	M= 1,760,000 S= 4,500,000 T= 6,260,000
---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	3-14 wt	---	---
---	---	---	---	---	---	5-7 wt	---	---
T= 25 mi^2	---	---	---	---	---	6	---	S= 100,000 T= 100,000

Table 2. Summary of bitumen deposits in Alaska

Map number	Deposit name	Location	Townships and Ranges	Formation	Age	Lithology	Depth (ft)	Pay thickness (ft)
1	[1]Lituya Bay	110 mi west of Juneau	---	---	Tertiary	ss	---	---
2	[1]Cape Kekurnoi (Cold Bay)	West shore of Shelikof Strait	---	---	Late Triassic	ls	outcrop	---
3	[1]Chignik Lagoon	On east side of Alaskan Peninsula	---	Chignik	Cretaceous	ss, cgl	---	120 ss, cgl 200 marine ss and cgl
4	[1]Nation River	On Yukon River, 20 mi. west of Canadian border	---	---	Mississippian	ls	outcrop	---
5	[1]Tiglukpuk Creek	On east side of Tiglukpuk Creek, 50 mi. south of Umiat oilfield	---	Okpikruak, Toruk	Cretaceous	asphalt in (?)	--do---	---
6	[1]Fortress Mountain	Between Ayiyak River and Okak Creek, 65 mi. south of Umiat oilfield	---	Toruk	Early Cretaceous	cgl, ss?	---do---	---
7	[1]Lisburne Ridge	Between Etivluk and Kiligwa River in west Arctic foothills	---	Okpikruak, Shublik, Kiruktagial	Early Cretaceous Triassic Mississippian	ss, ls, cherty asphalt	---	---
8	[1]Utukok River	Near Utukok River on Carbon Cr. anticline	lat 68° 21'24"N long 160° 04'30"W	Kukpowruk	Early Cretaceous	ss	outcrop	---
9	[1]Carbon Cr.	6 mi. west of Carbon Cr.	lat 68° 22'54"N long 159° 59'30"W	Kukpowruk	Early Cretaceous	ss	outcrop	---
10	[1]Omicron Hill	---	lat 69° 29'30"N long 160° 30'30"W	---do---	Early Cretaceous	ss	outcrop	---
11	[1]Kokolik River	42 mi. from river mouth	--	Corwin	---do---	ss	---	7
12	[2]Oily Lake	Mt. St. Elias quad.	T. 21 S., R. 28 E., N1/2 sec. 6	impreg. surface deposits	---	---	---	---
13	[3]Oil Creek	Karluk quad.	T. 29 S., R. 40 W., SE1/4 sec. 10	---do---	---	---	---	---
14	[1]Humphrey	Un-goon Pt., on Arctic coast	---	---	---	ss	---	4

[1]Ball Associates, 1965.

[2]Blasko, 1976a.

[3]Blasko, 1976b.

Acreage	API gravity (degrees)	Viscosity (cp)	Porosity (%)	Permeability (md)	Water sat. (%)	Bitumen sat. (%)	Sulfur (wt %)	Resource in place (m.b.)
---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	---	---	---
---	2.4, 4.6 2.4, 6.7 (4 samples)	---	---	---	---	---	0.29, 0.31, 0.31, 0.28	---
---	8.9	---	---	---	---	---	.24	---
---	4.6	---	---	---	---	---	---	---

Table 3. Summary of bitumen deposits in Arizona

Map number	Deposit name	County	Townships and Ranges	Formation	Age	Lithology	Depth (ft)	Pay thickness (ft)
1A	[1]Black Rock Canyon	Mohave	T. 40 N., R. 13 W., secs. 3, 10; T. 41 N., R. 13 W., secs. 11, 14, 23, 26, 35	Kaibab	Permian	ls	---	---
1B	[1]Southwest Black Rock Canyon	---do---	T. 40 N., R. 13 W., secs. 17, 18	Moenkopi	Triassic	ss(?)	---	---
2	[1]Sedona - Vernon	Coconino, Navajo, Apache	T. 17 N., R. 6 E., to T. 10 N., R. 25 E.	Fort Apache Member of Supai	Permian	---	outcrop	135 mi long
3	[1]St. Johns	Apache	T. 13 N., R. 28 E.	Coconino	---do---	ss	---do---	---
4	[1]Payson	Gila	T. 11 N., R. 10 E., sec. 17	Martin Limestone	Devonian	ls	---do---	---
5	[1]Dragoon Mts. - Tombstone	Cochise	---	---do---	---do---	ls	---do---	---

[1]Ball Associates, 1965.

Acreage	API gravity (degrees)	Viscosity (cp)	Porosity (%)	Permeability (md)	Water sat. (%)	Bitumen sat. (%)	Sulfur (wt %)	Resource in place (m.b.)
---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	---	---	---

Table 4. Summary of bitumen deposits in Arkansas

Map number	Deposit name	County	Townships and Ranges	Formation	Age	Lithology	Depth (ft)	Pay thickness (ft)
1A	[1]Delight	Pike	T. 8 S., R. 24 W.	Trinity	Early Cretaceous	ss	---	3-5
1B	[1]Pike	---do---	T. 7 S., R. 24 W.	---do---	---do---	ss	outcrop	[2]4-12
1C	[1]Murfreesboro	---do---	T. 8 S., R. 25 W.	---do---	---do---	ss, gravel	---do---	---
2	[1]Lebanon	Sevier	T. 8 S., R. 30 W., secs. 1, 11, 8; T. 8 S., R. 29 W., sec. 4	---do---	---do---	ss	---do---	0.16-1.0
3A	[1]Floss	Washington	T. 13 N., R. 32 W.	Hale	Pennsylvanian	ss	---do---	---
3B	[1]Cane Hill	---do---	T. 14 N., R. 32 W.	---do---	---do---	ss	---do---	---
4A	[1]Huntsville	Madison	T. 16, 17 N. R. 26 W., sec. 9	---do---	---do---	ss	---do---	---
4B	[1]Southwest Huntsville	---do---	T. 16 N., R. 26 W. NE1/4SW1/4, sec. 17	Atoka	---do---	ss	---do---	---
5	[1]Deer	Newton	T. 14 N., R. 21 W.	Hale	---do---	ss	---do---	---
6	[1]Batesville	Independence	T. 13 N., R. 6 W.	Batesville Sandsone	Mississippian	ss	---do---	---
7	[1]Fourche Mountain	Scott	T. 1 N., R. 31 W.	Jack Fork Sandstone	Pennsylvanian	ss, sh	---do---	---

[1]Ball Associates, 1965.

[2]Clardy, 1983.

Acreage	API gravity (degrees)	Viscosity (cp)	Porosity (%)	Permeability (md)	Water sat. (%)	Bitumen sat. (%)	Sulfur (wt %)	Resource in place (m.b.)
---	---	---	---	---	---	---	17.2	---
---	---	---	---	---	---	5.06, 16.53, 6.68, 8.86, 4.58	---	---
---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	"high"	---	---
---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	---	---	---

Table 5. Summary of bitumen deposits in California

Map number	Deposit name	County	Townships and Ranges	Formation	Age	Lithology	Depth (ft)	Pay thickness (ft)
1	[2,4,5]Point Arena	Mendocino	T. 12 N., R. 17 W.	Monterey, Vaqueros Sandstone	Miocene	ss	outcrop	1-37
2	[5]Duxburg Pt.	Marin	---	Monterey	---do---	asphalt dike	---	---
3	[6]Santa Cruz (2 locations)	Santa Cruz	T. 11 S., R. 3 W., sec. 12; T. 11 S., R. 2 W., sec. 5	Monterey Vaqueros Sandstone	---do--- ---do---	ss	0-100	1-35
4	[4]Sargent Ranch	Santa Clara	T. 11 S., R. 3 E., sec. 36	Purisima, Monterey	Pliocene Miocene	ss	300	75
5	[2,5]Chalone Cr.	San Benito	T. 17 S., R. 8 E., secs. 32-33	Monterey	---do---	ss, ark	outcrop	20
6	[2]Mylar Quarry (also called) [5]San Lorenzo Creek	Monterey ---do---	T. 19 S., R. 9 E., SE1/4 sec. 15	--- Monterey	Pliocene Miocene	-do- -do-	---do--- ---do---	30 ---do---
7	[2]King City	---do---	T. 19 S., R. 7 E., S1/2 sec. 28, NE1/4 sec. 33, W1/2 sec. 34; T. 20 S., R. 7 E., sec. 3	Santa Margarita	---do---	ss	---do---	---
8	[6]Paris Valley	---do---	T. 22 S., R. 9 E., sec. 4	Ansberry	---do---	ss	---	4-84

[1]Adams and Beatty, 1962.

[2]Ball Associates, 1965.

[3]California Division of Oil and Gas, 1974.

[4]de Chadenedes. 1984.

[5]Jennings, 1957.

[6]Lewin and Associates, 1984.

Acreage	API gravity (degrees)	Viscosity (cp)	Porosity (%)	Permeability (md)	Water sat. (%)	Bitumen sat. (%)	Sulfur (wt %)	Resource in place (m.b.)
---	---	---	---	---	[2]6.5 wt [4]6-13 wt	---	---	[2]M= 1.2 [4]M= 100
---	---	---	---	---	---	---	---	M= minor deposit
---	---	---	---	---	---	10-12	---	[6]S= 10 T= 10 [5]S= 20 T= 20
M= 70 T= 70	10	---	---	---	---		----	T= 400
---	---	---	---	---	---	5.7-13.4 wt	---	---
1,500' long 100' wide	---	---	---	---	---	8.6-14.4 wt	---	---
---	---	---	---	---	---	---	---	---
---	---	227,000, 23,000 @ 87°F (2 lobes)	32	3,700	---	64	1.5	S= 70* T= 70*

Table 5. Summary of bitumen deposits in California—Continued

Map number	Deposit name	County	Townships and Ranges	Formation	Age	Lithology	Depth (ft)	Pay thickness (ft)
9A	[2]San Ardo	Monterey	T. 22 S., R. 9 E., sec. 13 T. 22 S., R. 10 E., secs. 18-20, 29, 32, 33	Santa Margarita, [5]Monterey	Miocene ---do---	ss	5 mi outcrop	125
9B	[3]Lynch Canyon (oilfield)	---do---	T. 22 S., R. 10 E., sec. 24	Monterey	middle Miocene	---	1,800	55
10	[2]Bradley	---do---	T. 24 S., R. 10 E., SW1/4 sec. 35	Salinas Shale	Pliocene, Miocene	ss	outcrop	30
11	[2]McKittrick	Kern	T. 30 S., R. 22 E.	Tulare	Pliocene, Pleistocene	ss, ark, cgl	outcrops to 100	to 100?
12	[6]Edna (Arroyo Grande)	San Luis Obispo	T. 31 S., R. 12, 13 E.	Pismo	Miocene	ss, sts, sh	0-670 0-460 (east area)	---
13	[3]Huasna oilfield	---do---	T. 12 N., R. 33 W., sec. 30	Santa Margarita	early Miocene	---	750-1560	500-1300
14	[3]Guadalupe oilfield	San Luis Obispo, Santa Barbara	T. 10 N., R. 36 W., secs. 1, 2, 11, 12;	Sisquoc	early Pliocene	---	2,700	200
			T. 10 N., R. 35 W., sec. 6; T. 11 N., R. 35 W., secs. 31, 32; T. 11 N., R. 36 W., sec. 36	Monterey-Point Sal	middle Miocene	---	3,000	200

Acreage	API gravity (degrees)	Viscosity (cp)	Porosity (%)	Permeability (md)	Water sat. (%)	Bitumen sat. (%)	Sulfur (wt %)	Resource in place (m.b.)
---	310	---	---	---	---	3.6, 8.9 wt	---	---
M= 140	10	---	---	---	---	---	---	---
---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	13-15 wt	---	[1]M= 4,850,000 S= 4,150,000 T= 9,000,000
Indian Knob M= 1,450 T= 1,450	8*	15,000 @ 100°C	38*	700	---	38*	3-5	M= 230 T= 230
East area M= 2,140 T= 2,140	---do---	---do---	38	---	---	35*	--do--	M= 310 T= 310
M= 40 T= 40	9	---	---	---	---	---	---	---
M= 1,840 T= 1,840	8-14	---	---	---	---	---	---	---
---	12	---	---	---	---	---	---	---

Table 5. Summary of bitumen deposits in California—Continued

Map number	Deposit name	County	Townships and Ranges	Formation	Age	Lithology	Depth (ft)	Pay thickness (ft)
15A	[6]Basal Foxen	Santa Barbara	T. 10 N., 33-35 W.; T. 11 N., 34, 35 W.	Foxen	Pliocene	sts, mds	400-3500	0-120
15B	[2]Graciosa Ridge	---do---	T. 10 N., R. 34 W.	[5]Careaga(?)	---do---	---	---	20-70
16	[6]Casmalia Area 1	---do---	T. 10 N., R. 35 W.	Sisquoc	Miocene-Pliocene	diat	0-790	430*
	Area 2	---do---	T. 9 N., R. 35 W.	---do---	---do---	-do-	---	200*
	Area 3	---do---	T. 9 N., R. 34 W.	---do---	---do---	-do-	---	50*
	Area 4	---do---	---do---	---do---	---do---	-do-	---	50*
	Area 5	---do---	---do---	---do---	---do---	dol	---	50*
17A	[6]Cat Canyon "S" Sands	---do---	T. 9 N., R. 33 W.	---do---	Pliocene	ss	3,500	50*
	Brooks Sands	---do---	T. 9 N., R. 32 W.	---do---	---do---	ss	3,000	145*
	Sisquoc	---do---	T. 8 N., R. 32 W.	---do---	---do---	ss	2,150	120
17B	[3]Santa Maria Valley (oilfield)	---do---	T. 9 N., R. 33 W. sec. 9	---do---	early Pliocene	---	4,480	105
17C	[3]---do---	---do---	T. 9 N., R. 33 W., secs. 8, 9	---do---	Pliocene	---	5,035	575
	Clark area	---do---	---do---	Monterey	Miocene	---	6,725	850

Acreage	API gravity (degrees)	Viscosity (cp)	Porosity (%)	Permeability (md)	Water sat. (%)	Bitumen sat. (%)	Sulfur (wt %)	Resource in place (m.b.)
S= 25,000 T= 25,000	9-17 9.5*	47,000 @ 80°F	25*	300*	---	55*	4-5	S= 1,900 T= 1,900
---	---	---	---	---	---	---	---	---
M= 91 T= 91	---	---	48	<1	---	31*	---	M= 50 T= 50
M= 115 S= 115 T= 230	---	---	50	<1	---	44	---	M= 40 S= 40 T= 80
S= 500 T= 500	---	---	---	---	---	---	---	S= 30 T= 30
S= 700 T= 700	---	---	---	---	---	---	---	S= 40 T= 40
S= 1,000 T= 1,000	---	---	---	---	---	---	---	S= 60 T= 60
M= 6,000 T= 6,000	6*	12,000- 1,000,000 @ res. temp.	32	1,400-5,000	---	52	---	M= 610 T= 610
M= 740 T= 740	---	15,000 @ res. temp.	37	3,450	---	85	---	M= 220 T= 220
S= 1,200 T= 1,200	---	---	31	400-1,700	---	75	---	S= 280 T= 280
M= 120 T= 120	9	---	---	---	---	---	---	---
M= 160 T= 160	8	---	---	---	---	---	---	---
---	9	---	---	---	---	---	---	---

Table 5. Summary of bitumen deposits in California—Continued

Map number	Deposit name	County	Townships and Ranges	Formation	Age	Lithology	Depth (ft)	Pay thickness (ft)
17D	[6]Zaca-Sisquoc; Sisquoc-Laguna Ranch	Santa Barbara	T. 8 N., R. 31 W., secs. 2, 3, 13	Careaga Sandstone	Pliocene	ss	10-340	100*
	Zaca oil field	---do---	T. 8 N., R. 31 W., secs. 29-36	Monterey	Miocene	fract. diat	---	---
	La Brea	---do---	T. 9 N., R. 31 W., sec. 18	---	---	---	---	---
18	[2]Sunset-Maricopa	Kern	T. 11 N., R. 23 W., secs. 18-20; T. 11 N., R. 24 W., secs. 13, 14	---	Miocene	ss	outcrop	<200-300
19	[2]Gaviota (coastal)	Santa Barbara	T. 5 N., R. 32 W.	[5]Sisquoc, Monterey	Miocene-Pliocene	cgl, ss	outcrop	25
20	[2]Goleta; La Paterna Mine	---do---	T. 4 N., R. 28 W.	Monterey	Miocene	sh	---	12
	More's Landing	---do---	---do---	---	Post-Pliocene	ss cliffs	---	60-100
21A	[3]Summerland (oilfield) onshore area	---do---	T. 4 N., R. 26 W., secs. 15, 16, 21, 22	Casitas	Pleistocene	---	140	100
21B	[3]---do--- offshore area	---do---	T. 4 N., R. 26 W., sec. 21	---do---	---do---	---	220	100
22	[2]Carpenteria; Los Conchas Quarry, Higgins Mine	---do---	T. 4 N., R. 25 W.	Monterey	Miocene	sand	10-25	10-15
23A	[2]Punta Gorda	Ventura	T. 3 N., R. 25 W., sec. 1	---do---	---do---	sh	0-100	0.3 veins
23B	[2]Ventura; La Brea Mine Canon Del Diablo	Ventura	T. 3 N., R. 24 W.	Monterey(?)	Miocene(?)	cls, sh	---	0.60-1.3 veins

Acreage	API gravity (degrees)	Viscosity (cp)	Porosity (%)	Permeability (md)	Water sat. (%)	Bitumen sat. (%)	Sulfur (wt %)	Resource in place (m.b.)
M= 620 T= 620	---	---	35*	---	---	40*	---	M= 90 T= 90
M= 580 T= 580	4-6	---	---	---	---	---	---	M= 90 T= 90
---	---	---	---	---	---	---	---	S= 50 T= 50
---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	^{5}16-19 gal/ton	---	---
---	---	---	---	---	---	16 wt	---	---
---	---	---	---	---	---	---	---	---
M= 110 T= 110	7	---	---	---	---	---	---	---
M= 58 T= 58	7	---	---	---	---	---	---	---
---	---	---	---	---	---	19* wt	---	---
---	---	---	---	---	---	28 asphalt	---	---
M= 200 T= 200	---	---	---	---	---	40, 15-22	---	---

Table 5. Summary of bitumen deposits in California—Continued

Map number	Deposit name	County	Townships and Ranges	Formation	Age	Lithology	Depth (ft)	Pay thickness (ft)
24	[2]Sulfur Mtn.	Ventura	T. 4 N., R. 21 W.	Fernando	Pleistocene	cgl, ss	outcrop	---
25A	[6]Loma Verde	Los Angeles	T. 5 N., R. 17 W., secs. 25, 26, 35, 36	Radovich Sandstone	Pliocene	ss	500-2,000	200
25B	[3]"Golden"	---do---	T. 5 N., R. 17 W., sec. 35	Saugus	Pleistocene	---	4,000	40
26	[2]Newhall	---do---	T. 3 N., R. 15 W., secs. 7, 18, 19	Repetto, Pico	Pliocene	ss	outcrop	---
27	[6]Oxnard Vaca Tar sand	Ventura	T. 1 N., R. 20-22 W.	Pico	---do---	ss	1,800-2,500	210*
	Lower Tar sand	---do---	T. 2 N., R. 22 W.	---do---	---do---	ss	---	50*
28	[2]Rancho La Brea and L.A. City	Los Angeles	T. 1 S., R. 14 W.	---	late Pleistocene	alluv. terrace	outcrop	---
29	[3]Gaffey (oilfield)	---do---	T. 4 S., R. 14 W., sec. 35	Repetto	Pliocene	ss	1,500	100
30	[2]Point Ferman	---do---	T. 5 S., R. 14 W.	Franciscan Sandstone	Jurassic	ss	outcrop	75
31	[2]Chino	San Bernardino	T. 2 S., R. 8 W.	---	Overlying Miocene	ss	---	20
32	Richfield	Orange	T. 3 S., R. 9 W., sec. 28, 32	Repetto	Pliocene	ss	2,500-3,200	80*
33A	Newport Bay	---do---	T. 6 S., R. 10 W.	---	---	sand	outcrop	---
33B	Newport (oilfield)	Orange	T. 6 S., R. 10 W. sec. 28	Puenta	early Miocene	---	1,500	300

Acreage	API gravity (degrees)	Viscosity (c)	Porosity (%)	Permeability (md)	Water sat. (%)	Bitumen sat. (%)	Sulfur (wt %)	Resource in place (m.b.)
---	---	---	---	---	---	---	---	---
S= 600 T= 600	---	---	30	1,000	---	45	---	S= 90 T= 90
---	9	---	---	---	---	---	---	---
---	---	---	---	---	---	---	---	---
M= 1,765 T= 1,765	5	500,000 @ 100°F	35	6,000	---	75	6-7	M= 500 T= 500
S= 1,900 T= 1,900	5	---	---	---	---	---	---	S= 160 T= 160
---	---	---	---	---	---	---	---	---
M= 20 T= 20	10	---	---	---	---	---	---	---
---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	---	---	---
---	3_{12}	---	---	---	---	---	---	S= 40 T= 40
---	---	---	---	---	---	---	---	---
M= 25	9	---	---	---	---	---	---	---

Table 6. Summary of bitumen deposits in Colorado

Map number	Deposit name	County	Townships and Ranges	Formation	Age	Lithology	Depth (ft)	Pay thickness (ft)
1	[1]White River Plateau	Garfield	T. 4, 5 S., R. 91-93 W.	Maroon, Weber	Permian	ss	outcrop	43
2	[1]Petrolite Hills	Rio Blanco	T. 2 S., R. 94 W.	Douglas Creek Member of Green River	Eocene	ss	scattered outcrops	6-8*
3	[1]Gray Hills	Moffat, Rio Blanco	T. 2, 3 N., R. 95-96 W.	Wasatch	late Eocene	ss	---do---	0-60
4	[1]Blue Mountain Plateau	Moffat	T. 4, 5 N. R. 100-103 W.; T. 6 N., R. 102 W.	Weber, Shinarump, Navajo, Entrada	Permian, Pennsylvanian, Triassic, Jurassic	ss	---do---	---

[1]Ball Associates, 1965.

Table 7. Summary of bitumen deposits in Kentucky

Map number	Deposit name	County	Carter coordinates	Formation	Age	Lithology	Depth (ft)	Pay thickness (ft)
1A 2A	[2,3]Big Clifty	Edmonson, Warren, Logan, Butler, Grayson, Breckinridge	F-31 - K-41 minor in M-34, 35, N-34, 35	Big Clifty	Mississippian	ss	0-600	10-25*
1B	[2]Hardinsburg	---do---	F-33 - F-40 M-35, N-35	Hardinsburg	---do---	ss	125-440	12*
1C 2C	[2]Tar Springs (2 areas)	Breckinridge, Butler	H, N - Q, 33-36	Tar Springs Member of Lietchfield	---do---	ss	outcrop	25*
1D	[2]Caseyville	Edmonson, Grayson	K - H, 36-40	Caseyville	Pennsylvanian	ss	20-170	5-40
3	[1]Summit, Solway	Hardin	---	Big Clifty	Mississippian	---	---	6
4	[1]Garfield	Breckinridge	2 mi. south of Garfield	---do---	---do---	---	10-20	14
5	[1]Beech Grove	McLean	---	Caseyville(?)	Pennsylvanian	---	---	---
6	[1]Cedar Creek	Nelson	---	"Cornieferous" (prob. Onondaga)	Devonian	ls	---	6
7	[1]Ravenna	Estill	---	---do---	---do---	ss	130	---
8	[2]Paintsville quadrangle	Johnson, Morgan	---	Lee Sandstone	Pennsylvanian	---	[1]60	[1]4-12
9	[2]Soldier	Carter, Rowan	---	---do---	---do---	ss	15-20	5-10

[1]Ball Associates, 1965.

[2]Lewin and Associates, 1984.

[3]Includes Old Jackson and Cypress deposits (McGrain, 1976).

[4]Noger, 1984.

Acreage	API gravity (degrees)	Viscosity (cp)	Porosity (%)	Permeability (md)	Water sat. (%)	Bitumen sat. (%)	Sulfur (wt %)	Resource in place (m.b.)
---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	"low"	---	---
---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	---	---	---

Acreage	API gravity (degrees)	Viscosity (cp)	Porosity (%)	Permeability (md)	Water sat. (%)	Bitumen sat. (%)	Sulfur (wt %)	Resource in place (m.b.)
M= 150,000 S= 200,000 T= 350,000	10	---	15	100	---	45 [1]6-7	---	M= 1,190,000 S= 910,000 T= 2,100,000
[4]M= 66,000 S= 88,000 T= 154,000	[4]10	---	14	10-400	---	40*	---	[4]M= 250,000 S= 180,000 T= 430,000
S= 34,000 T= 34,000	---	---	20	10-100	---	21*	---	S= 340,000 T= 340,000
M= 35,000 S= 44,000 T= 79,000	---	---	[3]19.2*	>100	---	0-60 [3]41*	---	M= 300,000 S= 250,000 T= 550,000
---	---	---	[3]22.7*	[3]160	---	7-8 wt [3]39*	---	---
---	---	---	---	---	---	4-8 wt	---	---
---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	25 vol.	---	---
---	---	---	---	---	---	4-10 wt	---	---
[3]T= <3 mi dia.	---	---	---	---	---	<3	---	---

Table 8. Summary of bitumen deposits in Michigan

Map number	Deposit name	County	Location	Formation	Age	Lith-ology	Depth (ft)	Pay thickness (ft)
1	[1]Rapid River	Delta	Near Rapid River	Trenton Limestone	Ordovician	ls	outcrop	300

[1]Ball Associates, 1965.

Table. 9. Summary of bitumen deposits in Mississippi

Map number	Deposit name	County	Townships and Ranges	Formation	Age	Lith-ology	Depth (ft)	Pay thickness (ft)
1A	[1]Cypress Pond	Tishomingo	T. 5 S., R. 11 E., sec. 17, 18	Bangor Limestone	Mississ-ippian	ls	outcrop	---
1B	[1]Margerum West	---do---	T. 4 S., R. 11 E., sec. 22, 27	---do---	---do---	ls, sh	---do---	---
1C	[1]Southward's Ford	---do---	T. 5 S., R. 11 E.	Hartselle Sandstone	---do---	ss	---do---	---

[1]Ball Associates, 1965.

Table 10. Summary of bitumen deposits in Montana

Map number	Deposit name	County	Townships and Ranges	Formation	Age	Lith-ology	Depth (ft)	Pay thickness (ft)
1	[1]Dupuyer-Sun River	Teton	T. 27 N., R. 8 W. - T. 22 N., R. 8 W.	Colorado Shale	Cretaceous	sh, ls	outcrop	12
2	[1]Butcher Creek	Carbon	T. 6 S., R. 18 E., sec. 32	Fort Union	Paleocene	ss, sh	outcrop	---
3	[1]Red Dome	---do---	T. 7 S., R. 24 E., sec. 17, 18, 20	Chugwater	Triassic	sh(?)	outcrop	20-27

[1]Ball Associates, 1965.

Acreage	API gravity (degrees)	Viscosity (cp)	Porosity (%)	Permeability (md)	Water sat. (%)	Bitumen sat. (%)	Sulfur (wt %)	Resource in place (m.b.)
---	---	---	---	---	---	---	---	---

Acreage	API gravity (degrees)	Viscosity (cp)	Porosity (%)	Permeability (md)	Water sat. (%)	Bitumen sat. (%)	Sulfur (wt %)	Resource in place (m.b.)
---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	---	---	---

Acreage	API gravity (degrees)	Viscosity (cp)	Porosity (%)	Permeability (md)	Water sat. (%)	Bitumen sat. (%)	Sulfur (wt. %)	Resource in place (m.b.)
---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	2.45-6.60	---	---

Table 11. Summary of bitumen deposits in New Mexico

Map number	Deposit name	County	Townships and Ranges	Formation	Age	Lithology	Depth (ft)	Pay thickness (ft)
1	[2]Santa Rosa	Guadalupe	T. 9, 10 N., R. 21, 22 E.	Santa Rosa	Triassic	ss	outcrop to 170 20*	38*
2	[1]Gallup [3](Pinedale)	McKinley	T. 16 N., R. 16 W., sec. 11	Gallup [3]Member of Torrivio Sandstone	Cretaceous	ss	outcrop	3 [3]28

[1]Ball Associates, 1965.

[2]Lewin and Associates, 1984.

[3]Molenaar, 1977.

Table 12. Summaray of bitumen deposits in New York

Map number	Deposit name	County	Townships and Ranges	Formation	Age	Lithology	Depth (ft)	Pay thickness (ft)
1	[1]Rochester	Monroe	Western N.Y.	Niagra Group	Silurian	ls	outcrop	---
2	[1]Rockville	Allegany	Rockville	Chemung Group	Devonian	ss	---do---	---
3	[1]Laona	Chautauqua	2 mi. SE. of Fredonia	Portage Group	Late Devonian	ss	---do---	5

[1]Ball Associates, 1965.

Table 13. Summary of bitumen deposits in Ohio

Map number	Deposit name	County	Townships and Ranges	Formation	Age	Lithology	Depth (ft)	Pay thickness (ft)
1A	[1]Fallsville	Highland	1 1/2 mi. S. of Careytown	Pebbles Member Niagra Series	Late Silurian	dol	exposed in quarry	10
1B	[1]Hillsboro	---do---	2.5 mi. NW of Hillsboro	Lilly Member Niagra Series	Silurian	dol	---do---	20
1C	[1]Brick School	---do---	5 mi. NW of Hillsboro	---do---	---do---	dol	15	"Mod. thick"
2A	[1]Locust Grove	Adams	1/4 mi. SE Locust Grove	Pebbles Member Niagra Series	Late Silurian	dol	exposed in quarry	22
2B	[1]Sinking Spring	Highland	1.5 mi. N of Sinking Spring	---do---	---do---	dol	---do---	3
3	[1]Buckland	Auglaize	T 4 S., R. 5 E.	Waterlime or Helderburg	Devonian	ls	outcrop	---

[1]Ball Associates, 1965.

Acreage	API gravity (degrees)	Viscosity (cp)	Porosity (%)	Permeability (md)	Water sat. (%)	Bitumen sat. (%)	Sulfur (wt %)	Resource in place (m.b.)
M= 6,100 S= 12,000 T= 18,100	12	30,000 @ 60°F	10*	150	---	5*	2.2	M= 130,000 S= 220,000 T= 350,000
---	---	---	---	---	---	---		---

Acreage	API gravity (degrees)	Viscosity (cp)	Porosity (%)	Permeability (md)	Water sat. (%)	Bitumen sat. (%)	Sulfur (wt %)	Resource in place (m.b.)
---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	"high"	---	---
---	---	---	---	---	---	>2	---	---

Acreage	API gravity (degrees)	Viscosity (cp)	Porosity (%)	Permeability (md)	Water sat. (%)	Bitumen sat. (%)	Sulfur (wt %)	Resource in place (m.b.)
---	---	---	---	---	---	<2	---	---
---	---	---	---	---	---	1.5	---	---
---	---	---	---	---	---	2.5	---	---
---	---	---	---	---	---	<1	---	---
---	---	---	---	---	---	<1	---	---
---	---	---	---	---	---	---	---	----

Table 14. Summary of bitumen deposits in Oklahoma

Map number	Deposit name	County	Townships and Ranges	Formation	Age	Lithology	Depth (ft)	Pay thickness (ft)
1	[1]Trinity Group (several loc.)	McCurtain Johnston, Marshall, Atoka, Love	---	Trinity	Cretaceous	ss, ls, cgl	outcrop to (?)	1-15
2	[1]Glenn Group (several loc.)	Carter	T. 3-6 S., R. 1, 2 E., 1, 2, W.	Glenn	Pennsylvanian	ss	outcrop(?)	10-75
3	[1]Ordovician Group (3 occur.)	Murray	T. 1 N., R. 4 E., T. 1, 2 S., R. 1, 2, E.	Simpson, Viola Limestone	Ordovician	ss, ls	outcrop(?)	10-20
4	[1]Permian Group (several loc.)	Comanche, Stevens, Jefferson, Kiowa, Garvin, Carter	---	Redbed, Wichita	Permian	ss	outcrop(?)	2-30
5	[3]Sulphur	Murray	T. 1 S., R. 3 E., sec. 15, 21, 22	Oil Creek Sandstone, Viola Limestone	Ordvician	ss, ls	60*	---
6	[3]Dougherty	---do---	T. 1 S., R. 2 E., sec. 25, T. 1 S., R. 3 E. sec. 30	Viola Limestone	---do---	ls	outcrop to (?)	>100
7	[2]South Woodford [3](Newport)	Carter	T. 3 S., R. 1 W., R. 1 E.	Otterville, Primrose, Lake Ardmore, Overbrook, Rod Club	Pennsylvanian Mississippian	ss --	---do---	[1]45 [4]45-100
8	[2]Overbrook [3](Hewitt)	---do---	T. 5 S., R. 1 E.	Pontotoc, Morrow	Permian, Pennsylvanian	ss	20	30
9	[3]Ardmore	---do---	T. 4 S., R. 1 E.	Des Moines	Pennsylvanian	---	---	10-25

[1]Ball Associates, 1965.
[2]Harrison and Burchfield, 1984.
[3]Lewin and Associates, 1984.
[4]Harrison, et al, 1981.
[5]Williams, 1982.

Acreage	API gravity (degrees)	Viscosity (cp)	Porosity (%)	Permeability (md)	Water sat. (%)	Bitumen sat. (%)	Sulfur (wt %)	Resource in place (m.b.)
---	---	---	---	---	---	2.5-13	---	---
T= 1,650(?)	---	---	---	---	---	8.5-12.5	---	---
---	---	---	---	---	---	<1-11	---	---
---	---	---	---	---	---	2-13	---	T= minor
---	4	---	15-20	---	---	5*	---	[4,5]T= 50,00-800,000
---	4	---	---	---	---	---	3	Do.
T= 1,280	---	---	[2]27*	---	[2]1	11	---	M= 8,000 S= 2,400 T= 10,400
M= 80 T= 80	---	---	---	---	---	5.8*	---	T= 2,900
---	---	---	---	---	---	9-14	---	---

Table 15. Summary of bitumen deposits in Texas

Map number	Deposit name	County	Townships and Ranges	Formation	Age	Lithology	Depth (ft)	Pay thickness (ft)
1	[4]San Miguel D	Maverick, Zavala	---	San Miguel	Cretaceous	ss	0-2,400 [2]1,200-2,300	23* [2]20-80
2	[4]Anacacho	Kinney, Uvalde, Zavala, Medina	---	Anacacho Limestone	---do---	ls	0-500	150*
3	[4]Hensel	Edwards, Real	---	Hensel Sandstone	---do---	ss	1,000	4-40 25*
4	[1]Burnet	Burnet	---	Trinity Group, Glen Rose	Early Cretaceous	ls	---	up to 5
5	[1]Crystal Falls	Stephens	---	Cisco	Pennsylvanian	ss	---	---
6	[1]Gordon Mountain, Sampson Ridge, Meunster	Montague, Cooke	---	Trinity Group [3]Antlers Sand	Early Cretaceous	ss	3-4	[3]3*
7	[1]Fort Worth South	Tarrant	---	Washita Group	---do---	---	outcrop pool	---
8	[1]Jarvis Chapel [3]Palestine	Anderson	---	Queen City	Eocene	---	0-50	0.5-10
9	[1]Rockland	Jasper, Angelina	---	Jackson	---do---	---	outcrops	---

[1]Ball Associates, 1965.

[2]Britton, 1984.

[3]Evans, 1975.

[4]Lewin and Associates, 1984.

Acreage	API gravity (degrees)	Viscosity (cp)	Porosity (%)	Permeability (md)	Water sat. (%)	Bitumen sat. (%)	Sulfur (wt %)	Resource in place (m.b.)
M= 115,000 S= 49,000 T= 164,000	(-2)-10	20,000 - 20,000,000 @ res. temp.	26-30	50-100+ [2]250-1,000	---	40*	10	M= 3,200,000 S= 610,000 T= 3,810,000
M= 8,400 S= 20,000 T= 28,400	---	235,000 @ 70°F 200 @ 150°F	25	0.2-7,000	---	50	3	M= 550,000 S= 400,000 T= 950,000
M= 8,100 T= 8,100	7	450 @ 210°F 75 @ 277°F	29	8,400	---	52	5	M= 120,000 M= 120,000
---	---	---	---	---	---	[3]4.4 wt	---	[3]T= 11
---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	10 wt	---	---
---	---	---	---	---	---	---	---	---
3 deposits M= 198 T= 198	---	---	---	---	---	trace to full	---	[3]T= 550
---	---	---	---	---	---	[3]>27	---	---

Table 16. Summary of bitumen deposits in Utah

Map number	Deposit name	County	Townships and Ranges	Formation	Age	Lithology	Depth (ft)	Pay thickness (ft)
1A	[5]Timpoweap Canyon	Washington	T. 41 S., R. 12 W.	Timpoweap Member of Moenkopi	Triassic	ls	outcrop	---
1B	[5]Gould Ranch	---do---	T.42 S., R. 13 W.	---do---	---do---	ls	---do---	---
1C	[5]Hurricane Cliffs	---do---	---do---	---do---	---do---	ls	---do---	---
1D	[5]North Creek	---do---	T. 41 S., R. 11 W.	Moenkopi	---do---	sh	---do---	---
2	[2]Circle Cliffs (East Flank, West Flank;	Garfield	[5]T. 33-36 S., R. 6-9 E.	---do---	---do---	ss, sts	50-400 some outcrops	[5]5-300
	includes Muley Twist deposit)	---do---	---do---	Chinle	---do---	---	---	---
3	[4]White Canyon Flat	---do---	T. 33 S., R. 7 E.	Chinle	---do---	ss	[5]0-220	[5]5-21
4	[4]Mexican Hat	San Juan	T. 41-42 S., R. 17-19 E.	Rico, Hermosa	Pennsylvanian-Permian, Pennsylvanian	[1]ss ls	---	---
5	[4]White Canyon	---do---	T. 34-35 S., R. 15, 16 E.	Moenkopi, Cutler	Triassic, Permian	[1]ss	---	---
6A	[5]Tar Sand Triangle	Wayne, Garfield	T. 29-33 S., R. 14-17 E.	White Rim, Cedar Mesa, Moenkopi, Chinle	Permian, Triassic	ss, cgl	[2]200-1,500	[2]75*
6B	[5]Tar Sand Triangle (unnamed minor occurrences)	Garfield	T. 32 1/2, 33 S., R. 14, 15 E.	White Rim Member of Cutler	Permian	ss	---	---

[1]Campbell and Ritzma, 1979.
[2]Lewin and Associates, 1984.
[3]Peterson and Ritzma, 1974.
[4]Ritzma, 1968.
[5]Ritzma, 1979.

Acreage	API gravity (degrees)	Viscosity (cp)	Porosity (%)	Permeability (md)	Water sat. (%)	Bitumen sat. (%)	Sulfur (wt %)	Resource in place (m.b.)
---	---	---	---	---	---	---	---	T= 500-1,000
---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	---	---	---
M= 6,400 S= 14,000 T= 20,400	[1](-7) - 2	---	13-17	80	---	---	[1]3.6 [5]3.96	M= 560,000 S= 1,140,000 T= 1,700,000
---	---	---	---	---	---	---	[5]3.5	[5]M= 1,800 S= 1,000 T= 2,800
---	---	---	---	---	---	---	---	T= 400-500
---	---	---	---	---	---	---	[5]2.7	[5]T= 12,000-15,000
[2]M= 93,000 S= 55,000 T=148,000	[1]4.3*	---	[2]22* White Rim 17* Moenkopi	268*	[1]4.7	[2]40	[1]3.8*	M= 2,300,000 S= 10,200,000-13,700,000 T= 12,500,000-16,000,000
---	---	---	---	---	---	---	---	M= 500 S= 2,500 T= 3,000

Table 16. Summary of bitumen deposits in Utah—Continued

Map number	Deposit name	County	Townships and Ranges	Formation	Age	Lithology	Depth (ft)	Pay thickness (ft)
6C	[5]Poison Spring Canyon (near Tar Sand Triangle)	Garfield	T. 31 S., R. 13,14 E.	Moenkopi	Triassic	ss	0-500+	5-24
7	[4]Teasdale [1]Capitol Reef (several loc.)	Wayne	T. 29, 30 S. R. 6, 7, E.	Kaibab, Moenkopi	Permian, Triassic	ls, ss	---	---
8	[5]Thousand Lake Mountain	---do---	T. 28 S., R. 4 E.	Navajo Sandstone	Jurassic	ss	---	---
9A	[4]Sweetwater dome	Emery, Wayne	T. 26 S., R. 14 E.	Entrada, Curtis	---do---	ss	---	---
9B	[2]Nequoia Arch	---do---	T. 25-28 S., R. 13-16 E.	White Rim, Moenkopi	Permian, Triassic	ss	---	35*
10	[2,5]San Rafael Swell (10 occur.)	Emery	T. 20-26 S., R. 9-14 E.	Moenkopi, Moss Back Member of Chinle	Triassic	ss	0-500	14*
11	[1]Ten Mile Wash (near Salt Wash)	Grand	T. 23, 24 S., R. 18, 19 E.	Entrada	Jurassic	ss	[5]0-500+	[5]5-30
12	[1]Salt Wash	---do---	[5]T. 22, 23 S., R. 16, 17 E.	Salt Wash Member of Morrison	Jurassic	---	[5]0-500+	[5]5-30
13	[2]P.R. Spring	Grand, Uintah	T. 12-17 S.,	Green River	Eocene	[5]ss, sts	0-300	39*
14	[2]Hill Creek	Uintah	T. 13-15 S., R. 19-21 E.	---do---	---do---	[5]ss, sts	0-400	25*
15A	[2]Sunnyside	Carbon	T. 12-14 S., R. 13-15 E.	Green River, Colton	---do---	[5]ss, sts	0-500	230*
15B	[2]Cottonwood-Jacks Canyon	Carbon, Duchesne	[5]T. 11-13 S., R. 14-17 E.	Green River	---do---	[5]ss, sts	---	---

Acreage	API gravity (degrees)	Viscosity (cp)	Porosity (%)	Permeability (md)	Water sat. (%)	Bitumen sat. (%)	Sulfur (wt %)	Resource in place (m.b.)
---	---	---	---	---	---	---	---	T= 1,000-1,200
---	---	---	---	---	---	---	----	---
----	---	---	---	---	---	---	4.5	---
---	---	---	---	---	---	---	---	[5]T= 100-120
M= 63,000 S= 39,000 T= 102,000	---	---	---	---	---	---	---	M= 730,000 S= 160,000 T= 890,000
T= 26,000 S= 26,000 T= 52,000	---	---	---	---	---	---	3.6 [1]2.6	M= 300,000 S= 250,000 T= 550,000
---	---	---	---	---	---	---	[5]4.2	[5]M= 1,500 S= 4,500 T= 6,000
---	---	---	---	---	---	---	[5]2.2	[5]T= 200-250
M= 60,000 S= 125,000 T= 185,000	9 [3]9.5	400,000 (at 140°) 1,000,000 (at 77°)	18-30	700	[1]14	52*	[3]0.4	M= 2,100,000 S= 2,200,000 T= 4,300,000
M= 10,000 S= 77,000 T= 87,000	[3]9	---	21-30	100-1,000	[3]17	38	0.4	M= 300,000 S= 600,000 T= 900,000 [5]T= 1,200,000
M= 35,000 S= 44,000 T= 79,000	8	100,000 (at res. temp.)	10-28	800-1,000	[1]21	50*	0.7	M= 4,400,000 S= 1,700,000 T= 6,100,000
---	---	---	---	---	---	---	---	T= 20,000-25,000

Table 16. Summary of bitumen deposits in Utah—Continued

Map number	Deposit name	County	Townships and Ranges	Formation	Age	Lithology	Depth (ft)	Pay thickness (ft)
16	[5]Nine Mile Canyon	Duchesne	T.11 S., R. 14-17 E.	Green River	Eocene	ss, sts	---	---
17A	[2]Willow Creek	Duchesne, Utah, Wasatch	T. 11 S., R. 9, 10 E.; T. 6, 7, S., R. 8, 9, W.	---do---	---do---	[5]ss,	---	---
17B	[2]Minnie Maude Creek	Carbon, Duchesne	[5]T. 11, 12 S., T. 11-13 E.	---do---	---do---	[5]ss, sts, ls	0-500+	[5]5-15
17C	[2]Argyle Canyon	Duchesne	[5]T. 10, 11 S., R. 11-13 E.; T. 7 S., R. 7 W.	---do---	---do---	ss	[5]0-500+	[5]15-60
18	[5]Thistle	Utah	T. 9, 10 S., R. 4, 5, E.	---do---	---do---	ss,	---	---
19	[5]Daniels Canyon	Wasatch	T. 6 S., R. 6 E.	Oquirrh	Permian-Pennsylvanian	ls, qtz	---	---
20	[5]Tabiona	Duchesne	T. 1 S., R. 7 W.	Currant Creek Duchesne River	Paleocene-Eocene, Eocene	ss	0-400	5-150
21	[5]Lake Fork	---do---	T. 1 N., R. 4, 5 W.	Duchesne River	Eocene	ss	0-450	5-70
22A	[5]Spring Branch	---do---	T. 2 N., R. 3 W.	---do---	---do---	ss, cgl	0-350	5-250
22B	[5]Little Water Hills [1](probably an extension of Asphalt Ridge deposit)	Uintah	[1]T. 2 N., R. 1, 2, E.; T. 3 S., R. 19 E.	---do---	---do---	ss, cgl	0-500+	5-90
23	[2]White Rocks	---do---	T. 2 N., R. 1 W., 1 E.	Navajo	Jurassic	ss	14-130	500*
24	[2]Asphalt/ Ridge Asphalt Ridge N.W.	---do---	T. 4-6 S., R. 20-22 E.	Mesaverde Group (Rimrock Sandstone)	Cretaceous	ss	20-600	40*

Acreage	API gravity (degrees)	Viscosity (cp)	Porosity (%)	Permeability (md)	Water sat. (%)	Bitumen sat. (%)	Sulfur (wt %)	Resource in place (m.b.)
---	---	---	---	---	---	---	---	T= 5,000-10,000
---	---	---	---	---	---	---	---	T= 10,000-15,000
---	---	---	---	---	---	---	---	T= 10,000-15,000
---	---	---	---	---	---	8-10	[5]0.3	T= 50,000-75,000
---	---	---	---	---	---	---	1.07	T= 2,200-2,500
---	---	---	---	---	---	---	0.62	---
---	---	---	---	---	---	---	0.23	M= 1,300 S= 3,300 T= 4,600
---	---	---	---	---	---	---	0.45	T= 6,500-10,000
---	---	---	---	---	---	---	0.64	T= 1,500-2,000
---	---	---	---	---	---	---	0.41	T= 10,000-12,000
M= 200 S= 200 T= 400	4-12	---	20*	10-125	---	39*	0.4	M= 60,000 S= 60,000 T= 120,000
M= 29,000 S= 22,000 T= 51,000	10.4	>1,000,000 (no temp.)	27	1,000+	---	48*	0.4	M= 800,000 S= 300,000 T= 1,100,000

Table 16. Summary of bitumen deposits in Utah—Continued

Map number	Deposit name	County	Townships and Ranges	Formation	Age	Lithology	Depth (ft)	Pay thickness (ft)
25	[5]Split Mountain	Uintah	T. 4 S., R. 23, 24 E.	Park City	Permian	ls	---	---
26A	[2]Raven Ridge	---do---	T. 6, 7, S., R. 24, 25 E.	Green River	Eocene	[5]ss, sts	[5]0-500+	10 [5]5-48
26B	[2]Rim Rock (NW. Raven Ridge)	---do---	[4]T. 6 S., R. 24 E.	Wasatch, Green River	---do---	ss	[5]0-500+	[5]5-95
26C	[5]Cow Wash	---do---	T. 6 S., R. 24 E.	Green River	---do---	ss, cgl	0-200	5-25
26D	[4]Upper Kane Hollow	---do---	T. 6 S., R. 23 E.	---do---	---do---	[5]ss	---	---
26E	[5]Spring Hollow	---do---	T. 6 S., R. 23 E.	Duchesne River	---do---	ss	---	---
27	[5]Chapita Wells	---do---	T. 8, 9 S., R. 22, 23 E.	Uinta	---do---	[1]ss	0-300	5-30
28	[2]Pariette	Duchesne, Uintah	[5]T. 4 S., R. 2 W. and 1, 2 E.; T. 3 S., R. 19 E.	---do---	---do---	[5]ss, sts	[5]0-300	[5]5-32

	Acreage	API gravity (degrees)	Viscosity (cp)	Porosity (%)	Permeability (md)	Water sat. (%)	Bitumen sat. (%)	Sulfur (wt %)	Resource in place (m.b.)
	---	---	---	---	---	---	---	2.9	---
T=	16,000	---	---	27	---	---	30	[5]0.22* 0.35	[5]T= 75,000-100,00
	---	[3]6.6	---	---	---	---	---	[5]0.39 [3]0.37	T= 25,000-30,000
	---	---	---	---	---	---	---	0.39	T= 1,000-1,200
	---	---	---	---	---	---	---	[5]0.32	---
	---	---	---	---	---	---	---	0.76	---
	---	---	---	---	---	---	---	0.6	T= 7,500-8,000
	---	---	---	---	---	---	---	[5]0.30	T= 12,000-15,000

Table 17. Summary of bitumen deposits in Wyoming

Map number	Deposit name	County	Townships and Ranges	Formation	Age	Lithology	Depth (ft)	Pay thickness (ft)
1	[2]Burnt Hollow (2 areas)	Crook	T. 54, 55 N., R. 63, 64 W.	Minnelusa	Permian	ss	600-1,000	35-45*
2	[1]Rocky Ford, Beulah	---do---	T. 52 N., R. 60, 61 W.	---do---	Pennsylvanian	ss	100	---
3	[1]Oil Butte, Moorcroft	---do---	T. 51, 52 N., R. 67 W.	Muddy Sandstone, Mowry Shale, Dakota Sandstone	Cretaceous	ss, sh	outcrop	---
4	[1]Thornton	Weston	T. 48 N., R. 66 W.	Turner Sandy Member of Carlisle Shale	---do---	ss	---	---
5	[1]Newcastle	---do---	T. 44, 45 N., R. 61, 62 W.	Newcastle	---do---	ss	---	---
6	[1]Salt Creek	Natrona	T. 40 N., R. 79 W.	Shannon	---do---	ss	---	8
7	[1]Tisdale anticline	Johnson, Natrona	T. 41 N., R. 81 W.	Morrison, Sundance, Cloverly	Jurassic Cretaceous	ss	---	6-7
8	[1]Sheep Mtn. Canyon	Big Horn	T. 54 N., R. 94 W.	Madison	Mississippian	ls	---	---
9A	[1]Red Gulch	---do---	T. 52 N., R. 90 W.	Tensleep, Phosphoria	Pennsylvanian-Permian	ss	10 to outcrop	10
9B	[1]Battle Creek	---do---	T. 52 N., R. 89 W.	Tensleep	Pennsylvanian	ss	---	6
10	[1]Ekay Creek	Natrona	T. 38 N., R. 87 W.	Frontier	Cretaceous	ss	---	---
11A	[1]Cedar Ridge	Fremont	T. 39 N., R. 90, 91 W.	Overturned beds along a fault	Cretaceous and Eocene	tuff	---	---

[1]Ball Associates, 1965.
[2]Lewin and Associates, 1984.

Acreage	API gravity (degrees)	Viscosity (cp)	Porosity (%)	Permeability (md)	Water sat. (%)	Bitumen sat. (%)	Sulfur (wt %)	Resource in place (m.b.)
M= 3,500 S= 1,000 T= 4,500	5-9	1,000,000 @ 53°F 10 @ 345°F	25	1,000-2,000	---	51 N. area 34 S. area	06	M= 120,000 S= 25,000 T= 145,000
---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	---	---	---
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Table 17. Summary of bitumen deposits in Wyoming—Continued

Map number	Deposit name	County	Townships and Ranges	Formation	Age	Lithology	Depth (ft)	Pay thickness (ft)
11B	[1]Dry Creek	Fremont	T. 39 N., R. 92, 93, W.	overturned beds along a fault	Eocene	tuff, ss	---	---
12A	[1]Alkalai Butte	---do---	T. 34 N., R. 95 W.; T. 1, 2 S. R. 6 E.	Cody Shale, Mesaverde, Fort Union, Wind River	Cretaceous, Paleocene, Eocene	ss, cgl	outcrop	---
12A	[1]Muskrat	---do---	T. 34 N., R. 92 W., secs. 17, 18	Fort Union	Paleocene	ss, cgl	---	---
13	[2,3]Rattlesnake Hills	Natrona	[1]T. 33 N., R. 86-88 W.	Muddy	Cretaceous	ss, cgl	0-1,400	38*
14	[1]Dutton Basin	Fremont	T. 33 N., R. 90 W., secs. 3, 12, 22, 24	Chugwater, Frontier, Wind River	Triassic, Cretaceous, Eocene	ss	---	---
15	[1]Conant Creek	---do---	T. 32 N., R. 94 W., secs. 2-5, 10, 11	unnamed	Eocene	ss, cgl	---	---
16A	[1]Dallas	---do---	T. 32 N., R. 99 W., secs. 13, 24	Chugwater	Triassic	---	---	---
16B	[1]Little Popo Agie	---do---	T. 31 N., R. 99 W., sec. 8	Phosphoria	Permian	ss	---	5-10
17	[1]Lime Creek	Sublette	T. 38 N., R. 110 W.	---do---	---do---	ss	---	---
18	[1]Muddy Creek	Carbon	T. 17 N., R. 92 W., secs. 3, 10, 15, 16, 22, 27	Fort Union, Wasatch	Paleocene, Eocene	ss, cgl	---	0-50
19	[1]Shell Point	Sweetwater	T. 12 N., R. 97 W., sec. 9	Green River	Eocene	ss	---	(thin)
20	[1]Sierra Madre	Carbon	T. 12-14 N., R. 86, 87 W.	Madison	Missippian	ls	outcrop	patches

Acreage	API gravity (degrees)	Viscosity (cp)	Porosity (%)	Permeability (md)	Water sat. (%)	Bitumen sat. (%)	Sulfur (wt %)	Resource in place (m.b.)
---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	---	---	---
S= 1,500 T= 1,500	---	12,000 at ? temp.	25	1,000	---	41*	---	S= 45,000 T= 45,000
---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	3.2% oil	---	---
---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	---	---	---
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