STATE OF WASHINGTON
DEPARTMENT OF NATURAL RESOURCES
BRIAN J. BOYLE, Commissioner of Public Lands
JAMES A. STEARNS, Department Supervisor

DIVISION OF GEOLOGY AND EARTH RESOURCES
Raymond Lasmanis, State Geologist

GEOLOGY AND COAL RESOURCES OF CENTRAL KING COUNTY, WASHINGTON

by

Timothy J. Walsh

State of Washington
Department of Natural Resources
Division of Geology and Earth Resources
Olympia, Washington 98504

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GEOLOGY AND COAL RESOURCES OF CENTRAL KING COUNTY, WASHINGTON

Introduction

Coal mining has been an important industry in King County for more than 130 years, although it is currently in decline (Phillips and Walsh, 1981). Total production as reported to mine inspectors has been 48,233,705 tons from 1879 through 1983, and there was significant production before the earliest mine inspector's report. As of 1960, the reserves of coal in King County were estimated to be 828 million tons (Beikman and others, 1961). In recent years, coal-bearing lands have undergone extensive residential development, as at Issaquah, rendering development of the coal difficult if not impossible.

In 1980, the Division of Geology and Earth Resources set out to evaluate the potential coal reserves in areas of encroaching urban development. Two such areas are identified in which there may be commercial coal reserves: Grand Ridge to the northeast of Issaquah, and Cedar Mountain in Maple Valley, approximately six miles east of Renton.

GRAND RIDGE

History of Mining

The Grand Ridge coal area is located in sections 13, 14, 23, 24, and 26, T. 24 N., R. 6 E. Little is known of its history. It was prospected in the late 1890's by the Issaquah Coal Company (Landes and Ruddy, 1903) and 591 tons were shipped in 1893 (Edmunds, 1895). In 1909, the Central Coal Company began working seams in the valley of the north fork of Issaquah Creek, section 26, T. 24 N., R. 6 E. Eventually they mined 477,488 tons of coal from six seams before shutting down in 1921 (Livingston, 1971). In 1937, the B&R Coal Company began mining two levels of a seam above these (the Number 9) and produced 74,106 tons of coal in the next five years. To the north, near the common section corner of sections 13, 14, 23, and 24, several small mines were operated between 1921 and 1947 which produced a total of at least 65,644 tons of coal (Livingston, 1971).

Stratigraphy

Maps for these mines (Schasse and others, 1983) indicate that the section contains at least eight coal seams (figure 1) with an aggregate thickness of 39.2 feet of clean coal. Evans (1912) gives a stratigraphic section of the coal measures that is apparently numbered differently from that shown in the mine maps. The interseam thickness used here (figure 1) are therefore estimated from map distances. At least two additional coal seams were encountered stratigraphically above the Number 9. The lower of these was called the Number 4; no thickness was reported.

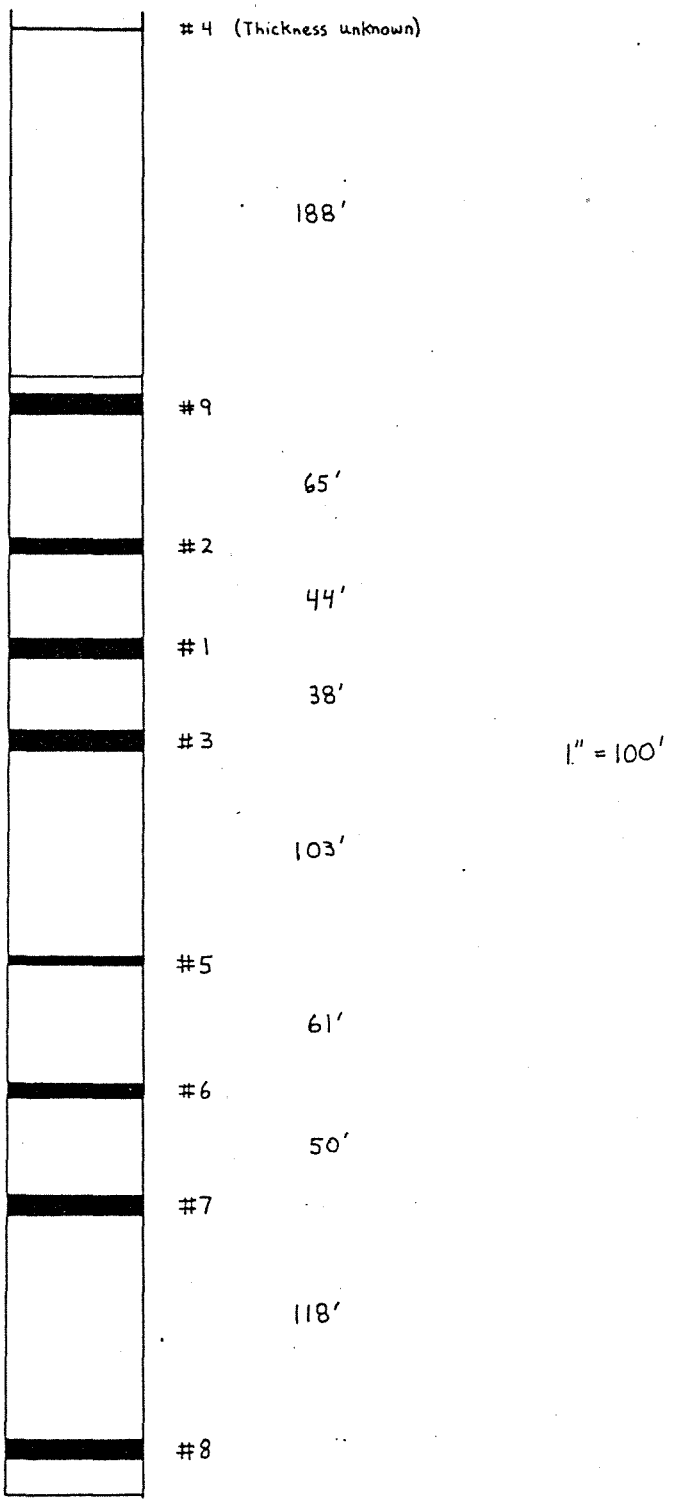


Figure 1 Stratigraphic intervals between Grand Ridge area coal beds

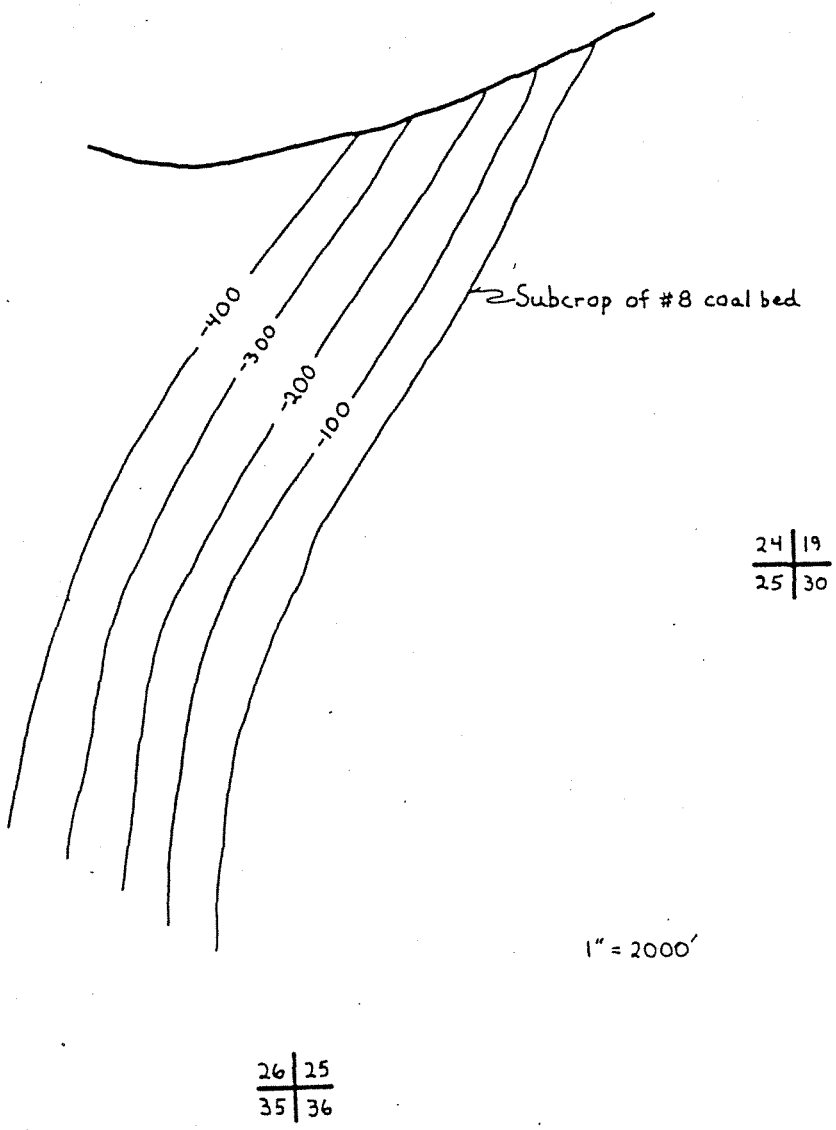


Figure 2 Overburden thickness for Grand Ridge No. 8 coal seam

TABLE 1.

Estimated strippable reserves in the Grand Ridge area (in thousands of tons), by overburden thickness (Highwall elevation, in feet)

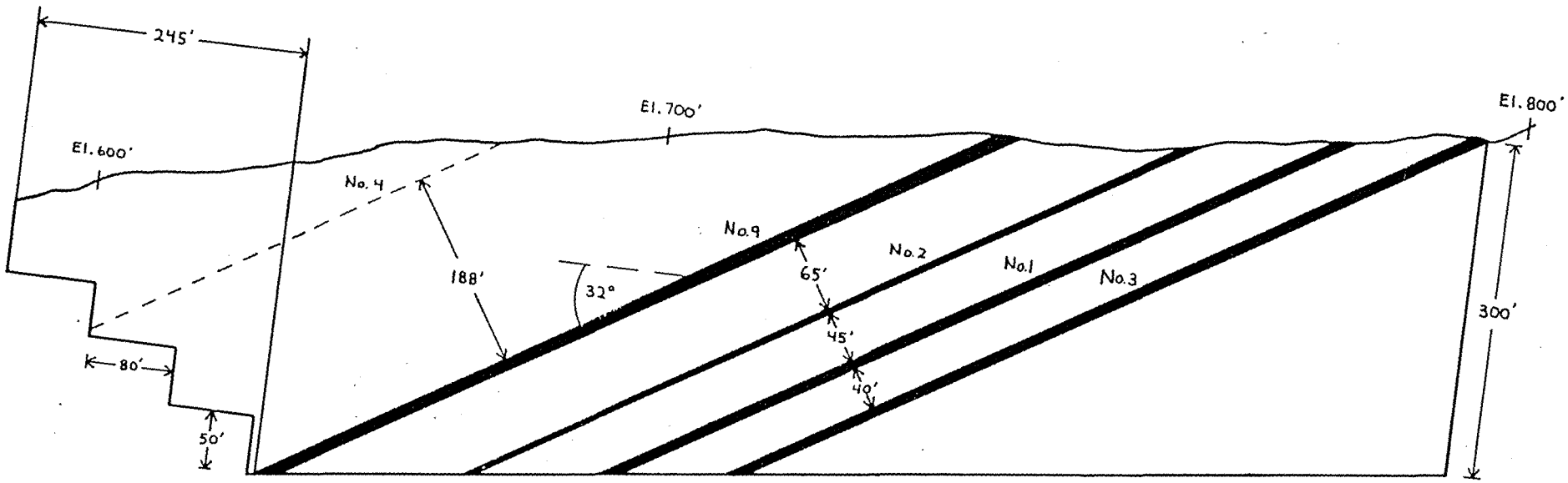
Seam	0-100	100-200	200-300	0-300	
No. 9	703	591	507	1,801	
No. 2	307	321	571	1,199	
No. 1	564	483	1,002	2,049	6,172
No. 3	403	369	351	1,123	
No. 5	103	99	83	285	
No. 6	170	128	146	444	
No. 7	500	438	353	1,291	
No. 8	555	527	584	1,666	
				9,858	

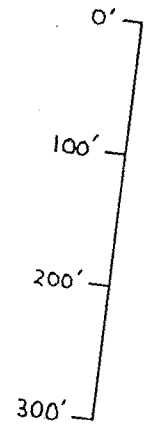
Structure

The strata in section 26 and most of section 23, strike approximately 10° to 30° east of north and and dip 28° to 32° to the west. In the northeastern corner of section 23, across the axis of the Raging River Anticline (Plate 1), the strike turns to 40° to 50° east of north, and the dip steepens to as much as 80° to the northwest. To the south, the strata are covered by Quaternary sediments which cover the axis of the Lake Sammamish Syncline (Plate 1).

Coal Reserves

For reserve calculations, a dip of 32° was used. Reserves were estimated only for a surface mine with a high wall of 300 feet in order to maintain at least a 50-foot thick barrier pillar above the old underground workings. Figure 2 shows the area used for reserve estimates. Areas were estimated using graph paper, and a weight of 1800 tons/acre-foot was assumed (Wood and others, 1983). The estimated reserves are shown in Table 1. The upper four measured seams, the No.'s 9, 2, 1, and 3 are stratigraphically bunched enough to suggest the possibility of a surface mine (figure 1). These seams have an aggregate minimum thickness of 22.8 feet of clean coal, as measured in the Grand Ridge mines. The slope of the hill is in the same direction as the dip the coal, and so lowers the overburden. Figure 3 shows a hypothetical terrace cut mine for these seams measured approximately midway along the strike length of the area for which reserves are estimated. The stripping ratio in this cut, in bank cubic yards/long ton of coal is only 13.9. However, one of the coal seams cut in the rock tunnel above the Number 9 would necessarily be mined through in this plane.





Scale: 1" = 100'

Assumptions

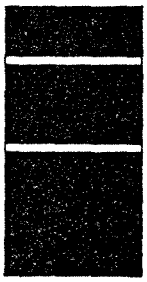
Coal seam dip: 32°
Total seam thickness: 7.7' + 4.0' + 6.3' +4.8' = 22.8'
Interburden thickness: 150'
Weight of coal: 84 lbs/ft^3 [density = 1.35]
Glacial drift assumed to be negligible
Seam slope length: 730 ft
Tons of coal per ft of pit length: 624 long tons
Bank cubic yards per ft of pit length: 8685
Strip ratio per ft of pit length: 13.9

Figure 3. Hypothetical mine plan for a terrace cut surface mine in the Grand Ridge area

TABLE 2.

As-Received-Basis

Seam	Moisture	Volatile Matter	Fixed Carbon	Ash	Sulfur	Btu/lb	Moist mineral-matter-free Btu	Data Source
Grand Ridge No. 9	15.8	32.1	36.2	15.9	.4	9,160	11,064	Snyder & Swingle, 1941
No. 9	17.1	32.5	35.2	15.2	.4	9,040	10,820	Cooper & Abernethy, 1941
No. 1	14.2	30.3	43.8	11.7	.36	10,040	11,498	Smith, 1911
No. 2	13.8	32.4	36.1	17.7	.49	9,140	11,308	Smith, 1911
No. 3	15.9	36.0	38.5	9.6	.49	9,970	11,130	Smith, 1911
No. 4	15.6	33.4	30.4	20.6	2.27	8,390	10,819	Smith, 1911
No. 7	16.5	34.6	36.4	12.5	.38	9,580	11,080	Smith, 1911



1" = 5'

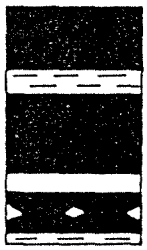
Shale Roof

1'3½" Coal
2½" Shale
2'½" Coal (With ½" shale parting)
1" Shale
3' 4" Coal (With ½" shale parting)

Shale Floor

Total Bed Thickness : 6' 11"
Total Coal Thickness : 6' 7"

Figure 4 No. 1 Bed, Grand Ridge (Smith, 1911)



1" = 5'

Sandstone Roof

1' 7" Coal
9" Shale and Ash
1' 11" Coal
5" Ash
1' 2" Bone
4" Shale

Sandstone Floor

Total Bed Thickness : 6' 2"
Total Coal Thickness : 4'8"

Figure 5 No. 3 Bed, Grand Ridge (Smith, 1911)

1" = 5'

Shale Roof

5" Shale and Coal, Ibd

4' Coal

Shale Floor

Total Bed Thickness 4'5"
Total Coal Thickness 4'0"

Figure 6 No. 2 Bed, Grand Ridge (Smith, 1911)

Shale Roof
4" Carbonaceous Shale
3'1" Coal
Shale Floor
Total Bed Thickness : 3'5"
Total Coal Thickness : 3'1"

1"=5'

Figure 7 No. 4 Bed, Grand Ridge (Smith, 1911)
(No. 5 Bed in this report)

Sandstone Roof
2' Shale
4'6" Coal
¼" Ash Bed
5" Clay
8" Coal
5" Clay
6" Bony Coal
11" Carbonaceous Shale
Shale Floor
Total Bed Thickness : 9'5½"
Total Coal Thickness: 5'7½"

1"=5'

Figure 8 No. 7 Bed, Grand Ridge (Smith, 1911)

Soft Shale Roof
2" Clay
4" Coal
3" Shale
10½" Coal
4¼" Bony Coal
11" Coal
1" Shale
7" Coal
2" Shale
1'10½" Coal
2" Shale
1'8½" Coal
Sandy Shale Floor
Total Bed Thickness: 7'6"
Total Coal Thickness: 6'6"

1"=5'

Figure 9 No. 9 Bed, Grand Ridge (Snyder and Swingle, 1941)

By projection it would have a dip length in this pit of approximately 400 feet and every foot of recoverable coal in the Number 4 would improve the strip ratio by 0.3.

The coal quality of some of these seams is shown in Table 2 and resprentative sections in figures 4-9. All of the coals analyzed are subbituminous A or High volatile C bituminous in rank, depending on their agglomerating properties, which are unknown. Ash ranges from 9.6% to 20.6%.

The current land use of this area is forest. It is bounded on the north by low density housing, on the east by timberland, on the west by two large gravel pits, and on the south by Interstate Highway 90.

CEDAR MOUNTAIN

History of Mining

Coal was first mined at the Cedar Mountain mine in NE/4 section 30, T. 23 N., R. 6 E. in 1884 (Bagley, 1929) on the Cedar Mountain No. 2 seam. The mines operated on both sides of the Cedar River, later including the Cedar Mountain No. 1 seam, which is 365 feet stratigraphically above the Cedar Mountain No. 2, and produced 266,253 tons of coal (mostly on the No. 1) before shutting down in 1906 (Livingston, 1971; Watson, 1887) largely because the seams were faulted out to the southwest. The West Coast Coal Company later drove a slope on the Cedar Mountain No. 1 in NW/4 section 29, T. 23 N., R. 6 E. in 1925. Several operators worked this mine and extended the slope along the axis of a southeast-plunging anticline, eventually working 11 levels (Walsh, 1983; Schasse and others, 1983). They produced and shipped 794,996 tons, bringing the total for the Cedar Mountain mine to just over one million tons.

In 1918, the coal measures were discovered to the west of the fault that had terminated the earlier mines. The first mine here was called the Indian, but was later renamed the New Black Diamond mine. In its heyday, the New Black Diamond was the largest mine in Washington, and produced 1,540,823 tons during its 13 year life. The principal seam in this mine was the Jones, but there were smaller workings in the vicinity on the Discovery, Ryan No. 2 and Ryan No. 1 seams.

Stratigraphy

The Ryan No. 2 and Ryan No. 1 seams were originally correlated with Cedar Mountain No. 2 and Cedar Mountain No. 1 seams by the Pacific Coast Coal Company, and that correlation is adopted here. Figure 10 shows a composite stratigraphic sections for this area. Correlation of the Cedar Mountain No. 2 and No. 1 with the Ryan No. 2 and No. 1 was not made by recent previous workers (Vine, 1969; Beikman and others, 1961) apparently because there is greater stratigraphic separation between the two seams to the northeast. However, inspection of the mine maps of the Ryan No. 2 and

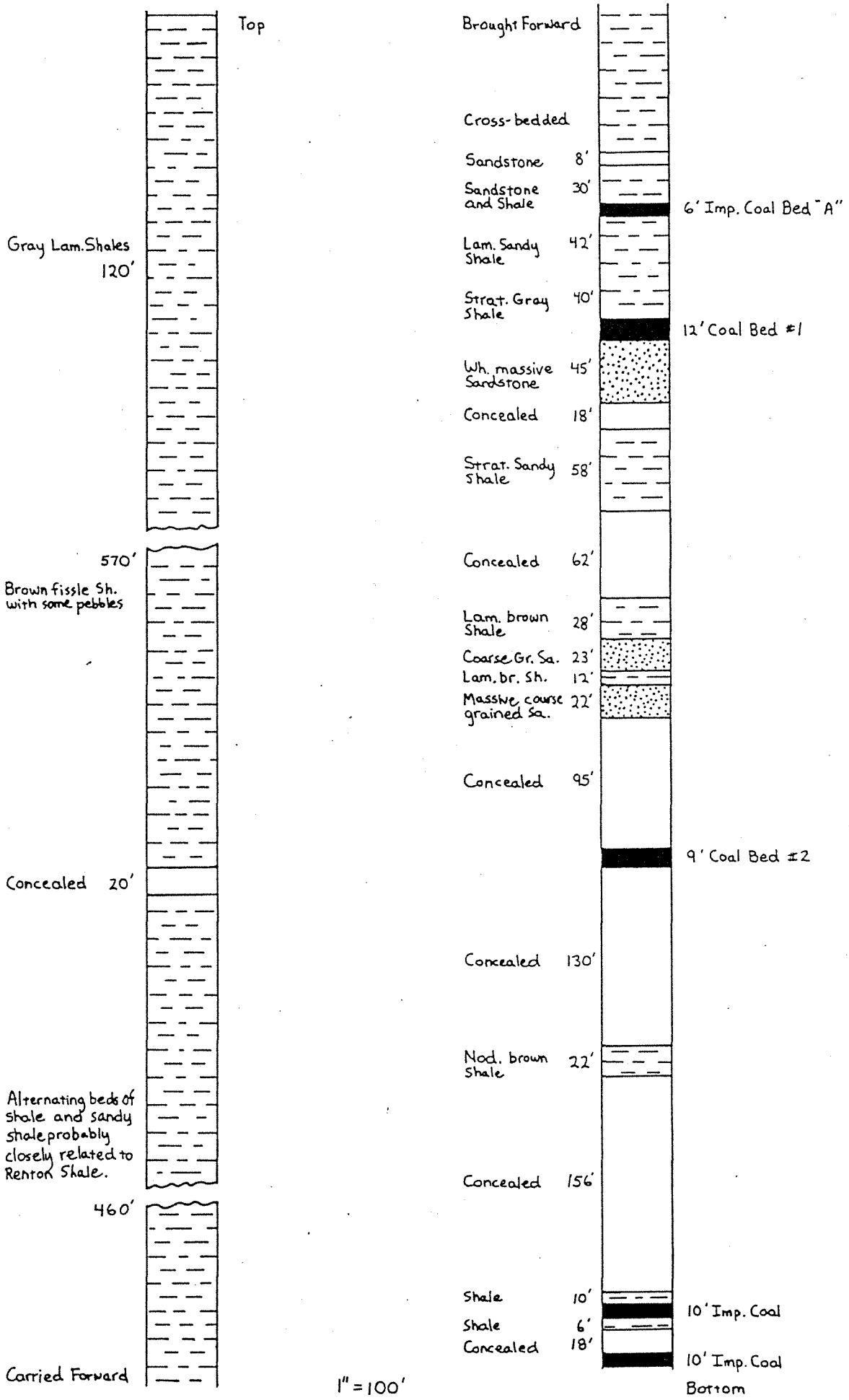


Figure 10 Cedar Mountain coal measures, section measured along new county road (Evans, 1912)

Ryan No. 1 seams (Walsh, 1983; Schasse and others, 1983) shows that in the span of 1,600 feet, the split between them opens up from 185 ft at the southwest to 220 feet at the northeast portion of the mine. The line of section at which the Cedar Mountain section was measured (along Highway 169 in the NE/4 of section 30 and the NW/4 of section 29 T. 23 N., R. 6 E.) is another 5,000 feet along strike to the northeast. If the interburden wedge geometry is constant, then it should thicken to about 330 at the line of the Cedar Mountain section. The exposure there is not continuous, and measured dips range from 15° to 22°. Correcting for the extreme dips yields an interburden of either 310 or 450 feet. Evans (1912) and Vine (1969) both estimated 365, which is similar to the expected split thickness.

The other difficulty with the correlation was the apparent lesser thickness of the Cedar Mountain No. 2. Vine (1969) reports the seam as about 3½ feet thick and Beikman and others (1961) report it in the 2.5 to 5.0 feet category.

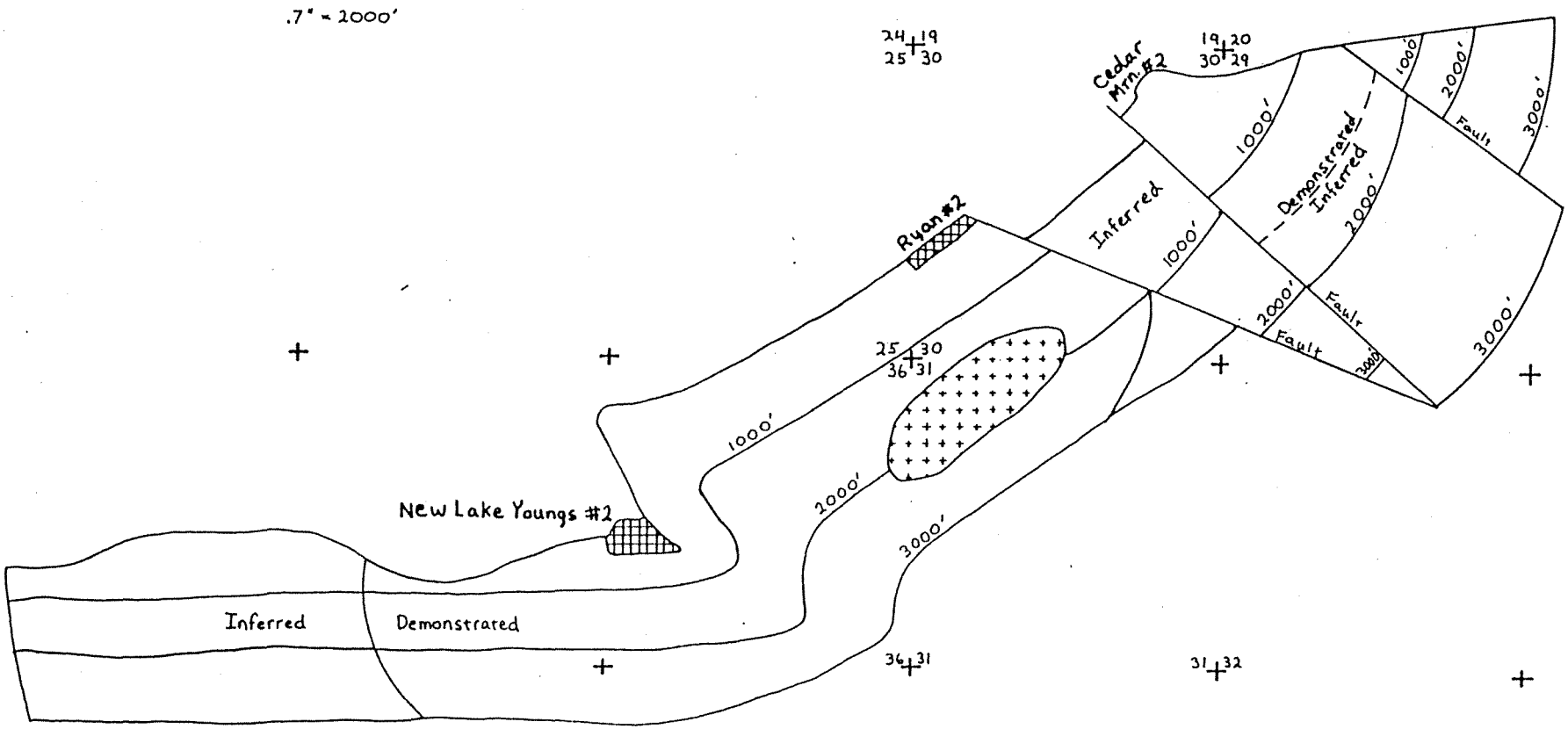
However, the outcrop of the seam, in the NE¼NE¼NE¼ section 30 (Analyzed coal locality (151)2-81 [upper bench] and (152)3-81 [lower bench]) contains 9.8 feet of coal (figure 12). Evans (1912) reports that the Cedar Mountain No. 2 is 9 feet thick. Landes (1902) reports "9 feet of coal with a seam of dirt one foot or more". Pacific Coast Coal Company records (Schasse and others, 1983, index no. K41) show the seam containing 4 feet 11 inches of good coal, 4 feet 10 inches bony coal and 12¼ inches partings in a section measured about one-fourth of a mile west of locality (151)2-81.

The New Lake Youngs No. 2 seam is also herein tentatively correlated with the Cedar Mountain No. 2 (= Ryan No. 2). Reference to the map of the New Lake Youngs mine (Walsh, 1983; Schasse and others, 1983) shows that the seam was actually mined around the nose of an anticline, and that the New Lake Youngs No. 2 dips toward the New Black Diamond mine rather than to the south, as in previous interpretations (Vine, 1969; Beikman and others, 1961). This suggests that the New Lake Youngs No. 2 is one of the upper seams of the series to the north (Plate 2, cross section B-B). DH35-1 (Plate 2) shows what Pacific Coast Coal Co. picked as the Ryan No. 2 with a bony seam 42 feet below. The New Lake Youngs No. 2 is 32 feet below the New Lake Youngs No. 1 (Schasse and others, 1983, index number K-39). It is herein suggested that the Ryan No. 2 split and that the New Lake Youngs Nos. 1 and 2 represent the two splits in DH35-1.

Structure

The strata of the Cedar Mountain area are folded into a cylindrical, southeast plunging anticline (figure 1). Data are sparse to the north of the mines, but the presence of Blakeley Fm. on the Cedar River in sections 16 and 21, T. 23 N., R. 5 E. with northeastern dips and Renton Fm. in the May Creek valley (section 2, T. 23 N., R. 5 E.) suggests that this fold is doubly plunging (plate 2, cross-section B-B[1]).

Figure 11 Structure contour/overburden thickness for the Cedar Mountain No. 2, Ryan No. 2 and New Lake Youngs No. 2 coal seams



Coal Reserves

Coal reserves are estimated for the New Lake Youngs No. 2, the Ryan No. 2, and the Cedar Mountain No. 2 (Table 3). The reserves were calculated only to the northeastern limit of workings in the Cedar Mountain mine. According to Evans (1912) the coal at the ends of the gangways was in a "crushed and broken condition." In addition, the dip in the mine increased suddenly at the end of the gangway from 26° to 41° (Walsh, 1983). If this increase in dip were caused by a down-to-the-north normal fault of small displacement (Plate 2 cross-section A-A^1), and the dip shallowed across it, then the additional potential reserves would be substantially increased, both for the Cedar Mountain No. 2 and the Cedar Mountain No. 1, and also for the A seam. The reserve might be approximately 100 million tons if the coal were contained in a simple open syncline. The current land use of the area is low density residential to the west of the Cedar River. To the east, there are two large gravel quarries and a landfill.

TABLE 3.

Estimated reserves for the
New Lake Youngs No. 2 = Ryan No. 2 = Cedar Mountain No. 2 (in short tons)

T. 23 N., R. 5 E.

Overburden thickness (in feet)	Demonstrated (measured + indicated)	Inferred	Total
0-1000	2,481,436	1,406,207	3,887,643
1000-2000	2,724,971	1,308,206	4,033,177
2000-3000	2,593,186	1,485,976	4,079,162
	7,799,593	4,200,389	11,999,982

T. 23 N., R. 6 E.

0-1000	2,109,131	1,988,064	2,307,195
1000-2000	2,591,636	2,759,076	5,350,712
2000-3000	1,041,380	6,779,741	7,821,121
	5,742,147	11,526,881	15,479,028

TABLE 4.

Analyses of coal from the Cedar Mountain area

As-Received-Basis

Seam	Moisture	Volatile Matter	Fixed Carbon	Ash	Sulfur	Btu/lb	Moist mineral-matter-free Btu	Data Source
Cedar Mtn. #1	16.8	33.2	39.3	10.7	.25	9,740	11,015	Snyder & Plein, 1931
	17.0	32.2	39.6	11.2	.3	9,530	10,845	Snyder & Plein, 1931
	23.0	28.6	37.6	10.9	.3	8,750	9,919	Snyder & Plein, 1931
	16.4	31.9	38.8	13.0	.3	9,300	10,822	Snyder & Swingle, 1941
	16.8	31.8	37.5	13.9	.5	9,150	10,771	Snyder & Swingle, 1941
	16.3	43.4	30.0	10.3	-	9,717	10,933*	Evans, 1942
Cedar Mtn. #2	13.3	40.0	36.9	9.8	-	10,060	11,251*	Evans, 1942
	10.1	52.1	32.9	4.9	-	11,780	12,438*	Evans, 1942
Cedar Mtn. A	16.3	37.0	37.8	9.0	-	9,106	10,086*	Evans, 1942
Cedar Mtn. #2 (upper bench)	13.2	33.2	32.7	20.8	.6	7,574	9,771	This report
Cedar Mtn. #2 (lower bench)	12.9	35.3	41.8	10.1	.4	9,199	10,328	This report

* Because sulfur was not measured, this is only an approximation to the Parr formula.

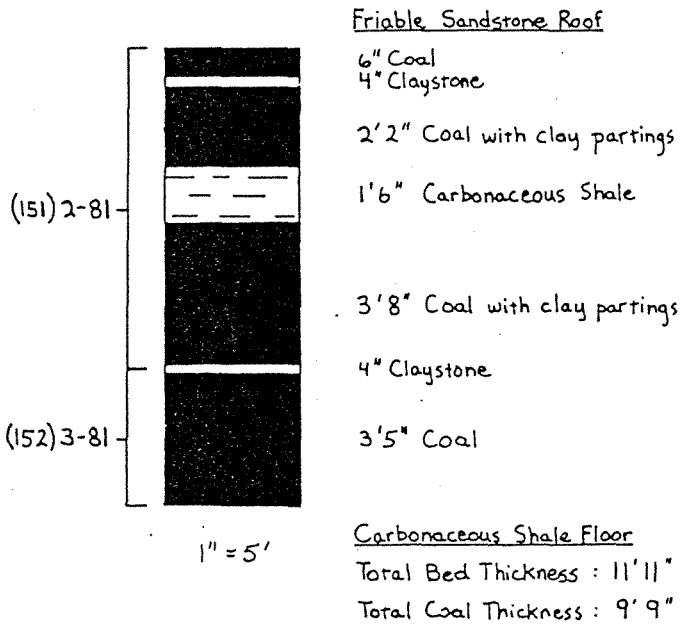


Figure 12 Cedar Mountain No. 2

3'4" Coal

2" Parting

3' Coal

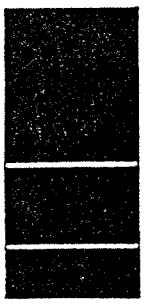
2" Parting

3' Coal

1" = 5'

Total Bed Thickness: 9'8"
Total Coal Thickness: 9'4"

Figure 13 No. 1 Bed, Cedar Mountain (Evans, 1942)



4' Coal

3" Parting

2' Coal

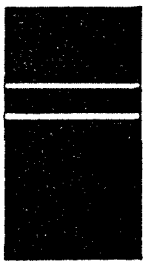
2" Parting

1' Coal

1"=5'

Total Bed Thickness: 7'5"
Total Coal Thickness: 7'0"

Figure 14 No. 2 Bed, Cedar Mountain (Evans, 1942)



2' Coal
2" Parting
6" Coal
2½" Parting

1' 11" Coal
½" Parting (not shown)
1' 10" Coal

1" = 5'

Total Bed Thickness: 6'8"
Total Coal Thickness: 6'3"

Figure 15 "A" Bed, Cedar Mountain (Evans, 1942)

APPENDIX

Gravity Results

The accompanying complete Bouguer gravity anomaly map was compiled from previously published data (Stuart, 1965; Rogers, 1970; Danes and Phillips, 1983) and from previously unpublished sources. Terrain corrections were added using the method of Hammer zones out to Zone G (or M for the Geo-Compu-Graph data. Stations 1-1 through 14-16 were measured by Geo-Compu-Graph for the City of Seattle (Hart Crowser and Associates, 1983) but were tied to an unrecorded local base. In order to use them for this study, two stations, 3-12 and 10-1 were measured twice each in a loop with the North Bend base station (Nilsen, 1976). The values reported here are the averages. Measurements of 3-12 were within 0.12 mgal of each other and the measurements of 10-1 were separated by 0.07 mgal. All of the rest of the Geo-Compu-Graph data are tied to these values.

The remaining stations were measured for this report in order to define a local relative high which was apparent in the Geo-Compu-Graph data at the south end of Rattlesnake Mountain (Plate 3). This high is inferred to be caused by proximity to basement rocks of the North Bend fm. which are faulted against Tertiary andesites of the Rattlesnake Mountain volcanic rocks (plate 1).

PREVIOUSLY UNPUBLISHED GRAVITY PRINCIPAL FACTS

Station Number	Longitude	Latitude	Elevation (feet)	Observed gravity	Complete Bouguer (2.67)	Terrain Correction
N.B. Base	121°46'48"	47°29'49"	442	723.22	-89.71	1.30
3-12	121°45'19"	47°27'22"	763	710.38	-79.98	1.00
10-1	121°45'25"	47°26'51"	933	696.98	-82.23	1.10
11,212	121°50'48"	47°27'49"	1677	659.54	-75.12	2.48
11,213	121°50'12"	47°26'59"	2153	624.51	-80.07	2.75
11,214	121°49'30"	47°26'56"	2170	624.93	-77.32	3.98
11,215	121°49'10"	47°27'25"	2699	591.28	-79.66	4.28
11,216	121°49'15"	47°28'6"	3262	559.48	-71.60	11.38
11,217	121°49'46"	47°29'49"	1394	671.70	-79.26	6.15
11,218	121°49'10"	47°29'24"	1550	662.69	-77.41	7.03
11,219	121°48'27"	47° 30'	434	733.44	-79.75	1.80
11,220	121°47'15"	47°28'56"	451	727.83	-82.04	2.50
1-1	121°45'59"	47°26'20"	932	693.55	-83.85	2.2
1-2	121°46'6"	47°26'18"	963	691.02	-83.98	2.7
1-3	121°46'12"	47°26'15"	993	688.78	-83.86	3.2
1-4	121°46'16"	47°26'19"	998	688.85	-82.99	3.8
1-5	121°46'14"	47°26'24"	1027	687.56	-82.93	3.5
1-6	121°46'16"	47°26'29"	1043	686.87	-82.73	3.6
1-7	121°46'23"	47°26'30"	1075	684.67	-81.81	4.8
1-8	121°46'8"	47°26'30"	1006	689.60	-83.23	2.6
1-9	121°46'8"	47°26'23"	1013	688.63	-83.41	2.8
1-10	121°46'17"	47°26'11"	995	688.16	-83.45	4.0
1-11	121°46'22"	47°26'7"	1003	687.51	-82.82	4.7
2-1	121°45'48"	47°26'14"	930	694.66	-83.04	1.9
2-2	121°45'43"	47°26'8"	954	692.95	-83.06	2.0
2-3	121°45'44"	47°26'3"	967	691.48	-83.5	2.1
2-4	121°45'50"	47° 26'	972	690.12	-84.19	2.4
2-5	121°45'54"	47°25'56"	964	689.88	-84.63	2.6
2-6	121°45'57"	47°25'52"	968	688.91	-85.06	2.8
2-7	121°45'50"	47°25'53"	1019	686.11	-85.07	2.5
2-8	121°45'45"	47°25'52"	1050	684.53	-84.89	2.4
2-9	121°45'39"	47°25'50"	1102	680.87	-85.61	2.2
2-10	121°45'30"	47°25'49"	1168	677.11	-85.54	2.0
2-11	121°45'23"	47°25'47"	1235	672.89	-85.79	1.9
2-12	121°45'25"	47°25'40"	1278	669.44	-86.45	1.95
2-13	121°45'28"	47°25'36"	1323	666.47	-86.53	2.0
2-14	121°45'30"	47°25'31"	1365	663.86	-86.52	2.0

Station Number	Longitude	Latitude	Elevation (feet)	Observed gravity	Complete Bouguer (2.67)	Terrain Correction
2-15	121°45'30"	47°25'25"	1399	661.67	-86.53	2.0
2-16	121°45'33"	47°25'19"	1447	658.89	-86.18	2.1
2-17	121°45'39"	47°25'12"	1493	656.93	-85.20	2.1
3-1	121°45'46"	47°26'22"	916	695.65	-83.30	1.7
3-2	121°45'42"	47°26'27"	915	696.12	-83.08	1.6
3-3	121°45'37"	47°26'30"	919	696.60	-82.63	1.4
3-4	121°45'31"	47°26'34"	925	696.12	-82.97	1.3
3-5	121°45'27"	47°26'39"	932	696.13	-82.79	1.2
3-6	121°45'26"	47°26'46"	932	696.68	-82.46	1.1
3-7	121°45'23"	47°26'54"	931	697.40	-82.03	1.1
3-8	121°45'23"	47°26'59"	918	698.70	-81.65	1.1
3-9	121°45'26"	47°27'4"	898	700.13	-81.51	1.1
3-10	121°45'31"	47°27'9"	873	701.85	-81.41	1.1
3-11	121°45'25"	47°27'14"	817	705.87	-80.88	1.1
3-12	121°45'20"	47°27'22"	763	710.28	-80.04	1.0
3-13	121°45'11"	47°27'22"	788	708.65	-80.24	.9
3-14	121°45'4"	47°27'18"	809	706.97	-80.58	.9
4-1	121°45'40"	47°26'37"	963	693.67	-83.08	1.4
4-2	121°45'42"	47°26'32"	934	695.19	-83.20	1.4
4-3	121°45'49"	47°26'32"	950	693.82	-83.39	1.6
4-4	121°45'59"	47°26'32"	999	690.77	-83.24	1.9
4-5	121°45'59"	47°26'36"	1020	690.16	-82.79	1.8
4-6	121°46'7"	47°26'36"	1024	689.63	-82.65	2.2
4-7	121°46'11"	47°26'32"	1017	689.05	-82.86	2.9
4-8	121°46'19"	47°26'36"	1016	689.43	-82.06	3.5
4-9	121°46'18"	47°26'42"	1016	690.72	-81.08	3.3
4-10	121°46'27"	47°26'33"	1045	686.50	-81.28	5.4
4-11	121°46'28"	47°26'47"	1026	691.38	-79.44	3.8
4-12	121°46'33"	47°26'47"	1040	688.52	-80.80	4.5
4-13	121°46'34"	47°26'40"	1110	682.56	-80.88	6.0
4-14	121°46'40"	47°26'49"	1047	686.75	-81.07	5.6
4-15	121°46'44"	47°26'55"	1046	687.48	-80.69	5.5
4-16	121°46'35"	47°26'57"	1043	690.22	-79.75	3.9
4-17	121°46'44"	47°27'3"	1094	686.64	-80.29	4.0
4-18	121°46'24"	47°26'51"	1040	690.45	-80.18	3.3
4-19	121°46'17"	47°26'53	1035	691.52	-80.24	2.5
4-20	121°46'10"	47°26'50"	1039	690.71	-81.25	2.0
4-21	121°46'10"	47°26'56"	1028	692.11	-80.73	1.9
4-22	121°45'59"	47°26'53"	1036	690.87	-81.74	1.6
4-23	121°45'55"	47°26'56"	1012	692.84	-81.39	1.5

Station Number	Longitude	Latitude	Elevation (feet)	Observed gravity	Complete Bouguer (2.67)	Terrain Correction
4-24	121°45'57"	47°26'52"	1020	692.14	-81.51	1.5
4-25	121°46'5"	47°26'45"	1036	690.22	-81.97	1.8
4-26	121°46'10"	47°26'41"	1026	690.21	-81.87	2.4
4-27	121°45'55"	47°26'44"	1014	691.58	-82.22	1.5
4-28	121°45'51"	47°26'36"	1008	690.66	-83.40	1.4
4-29	121°45'48"	47°26'41"	1005	691.31	-82.93	1.5
4-30	121°45'38"	47°26'43"	1003	691.71	-82.90	1.3
4-31	121°45'31"	47°26'42"	950	695.17	-82.71	1.2
5-1	121°45'44"	47°26'11"	932	694.38	-83.12	1.9
5-2	121°45'37"	47°26'12"	952	693.22	-83.22	1.8
5-3	121°45'31"	47°26'13"	953	693.22	-83.27	1.7
5-4	121°45'31"	47°26'8"	966	692.18	-83.27	1.8
5-5	121°45'29"	47°26'4"	979	691.34	-83.23	1.8
5-6	121°45'29"	47° 26'	964	691.84	-83.42	1.9
5-7	121°45'29"	47°26'12"	997	690.38	-83.44	1.7
5-8	121°45'29"	47°26'16"	951	693.35	-83.45	1.6
5-9	121°45'29"	47°26'22"	920	695.85	-83.05	1.5
5-10	121°45'34"	47°26'24"	920	696.08	-82.82	1.5
5-11	121°45'41"	47°26'24"	916	696.13	-82.93	1.6
6-1	121°45'58"	47°26'13"	917	694.01	-84.03	2.3
6-2	121°46'2"	47°26'8"	916	693.53	-84.14	2.6
6-3	121°46'5"	47°26'7"	914	693.69	-83.99	2.7
6-4	121°46'8"	47°26'11"	918	693.34	-84.09	2.8
6-5	121°46'17"	47°26'6"	920	692.77	-83.30	3.8
6-6	121°46'5"	47°26'2"	915	693.50	-84.18	2.5
6-7	121°46'3"	47°25'56"	919	692.46	-84.53	2.8
7-1	121°46'27"	47°25'31"	994	687.32	-84.02	3.3
7-2	121°46'21"	47°25'35"	1023	685.48	-84.27	3.3
7-3	121°46'13"	47°25'38"	1004	685.96	-85.06	3.2
7-4	121°46'8"	47°25'41"	1019	684.95	-85.39	3.1
7-5	121°46'1"	47°25'45"	1038	683.77	-85.60	3.0
7-6	121°45'53"	47°25'49"	1050	683.53	-85.51	2.7
9-1	121°45'32"	47°25'53"	1054	684.55	-85.06	2.0
10-1	121°45'28"	47°26'51"	933	697.06	-82.16	1.1
10-2	121°45'32"	47°26'55"	944	696.62	-82.01	1.1
10-3	121°45'39"	47°26'57"	945	696.81	-81.75	1.2
10-4	121°45'46"	47°26'58"	936	697.68	-81.31	1.3
10-5	121°45'52"	47°26'59"	943	697.64	-80.79	1.5
10-6	121°45'57"	47°27'4"	962	697.22	-80.18	1.5
10-7	121° 46'	47°27'8"	981	696.68	-79.60	1.6

Station Number	Longitude	Latitude	Elevation (feet)	Observed gravity	Complete Bouguer (2.67)	Terrain Correction
10-8	121° 46'	47°27'13"	1002	695.62	-79.4	1.7
12-1	121°45'58"	47°25'53"	958	689.77	-84.81	2.8
12-2	121°46'3"	47°25'50"	950	690.12	-84.65	3.0
12-3	121°46'9"	47°25'47"	930	691.29	-84.52	3.1
12-4	121°46'14"	47°25'43"	949	689.97	-84.62	3.1
12-5	121°46'20"	47°25'39"	955	689.69	-84.30	3.2
12-6	121°46'27"	47°25'36"	950	690.17	-84.09	3.2
12-7	121°46'31"	47°25'33"	938	690.97	-83.78	3.3
13-1	121°45'24"	47°26'34"	900	697.85	-82.72	1.3
13-2	121°45'19"	47°26'39"	892	698.72	-82.61	1.2
13-3	121°45'13"	47°26'42"	882	699.69	-82.39	1.1
13-4	121°45'6"	47°26'44"	873	700.25	-82.43	1.1
13-5	121° 45'	47°26'41"	864	700.93	-82.11	1.2
13-6	121°44'53"	47°26'39"	854	701.82	-81.77	1.2
13-7	121°44'47"	47°26'42"	844	702.66	-81.60	1.2
13-8	121°44'41"	47°26'45"	833	703.29	-81.77	1.1
13-9	121°44'35"	47°26'47"	822	704.00	-81.78	1.1
8-1	121°45'21"	47°25'43"	1194	674.93	-86.11	1.9
8-2	121°45'14"	47°25'47"	1161	677.51	-85.72	1.8
8-3	121°45'14"	47°25'52"	1101	682.22	-84.88	1.7
8-4	121°45'9"	47°25'57"	1078	685.10	-83.58	1.6
15-1	121°45'19"	47°26'50"	963	696.59	-82.40	1.1
15-3	121°45'1"	47°26'49"	950	695.58	-82.68	1.0
15-4	121°44'56"	47°26'51"	942	696.08	-82.73	1.0
15-5	121°44'53"	47°26'55"	1004	692.15	-83.10	.9
15-6	121°44'56"	47°27'1"	1066	688.48	-83.20	.9
15-8	121°44'42"	47°27'2"	1064	688.93	-82.92	.9
15-9	121°44'34"	47°27'1"	1040	690.35	-82.93	.9
15-10	121°44'27"	47°27'4"	985	694.01	-82.61	.9
15-11	121°44'21"	47°27'4"	908	698.77	-82.61	.9
15-12	121°44'16"	47°27'1"	894	699.41	-82.49	1.0
14-1	121°45'49"	47°25'55"	1008	687.15	-84.80	2.5
14-2	121°45'42"	47°25'56"	1015	687.53	-84.31	2.2
14-3	121°45'32"	47°25'55"	1023	686.98	-84.53	2.0
14-4	121°45'28"	47°25'54"	1031	686.30	-84.82	1.9
14-5	121°45'21"	47°25'55"	1039	686.54	-84.19	1.8
14-6	121°45'14"	47°25'56"	1048	686.62	-83.63	1.8
14-7	121°45'7"	47°25'58"	1057	686.78	-82.86	1.9
14-8	121° 45'	47°25'59"	1065	686.32	-82.67	2.1
14-9	121°44'53"	47°26'1"	1074	685.92	-82.50	2.2

Station Number	Longitude	Latitude	Elevation (feet)	Observed gravity	Complete Bouguer (2.67)	Terrain Correction
14-10	121°44'48"	47°26'5"	1082	685.08	-82.85	2.3
14-11	121°44'43"	47°26'9"	1091	684.07	-83.29	2.4
14-12	121°44'38"	47°26'12"	1100	683.51	-83.21	2.6
14-13	121°44'31"	47°26'14"	1107	682.55	-83.79	2.6
14-14	121°44'24"	47°26'15"	1116	681.84	-83.99	2.6
14-15	121°44'17"	47°26'15"	1124	681.65	-83.73	2.6
14-16	121°44'11"	47°26'12"	1131	680.76	-84.11	2.6

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PLATE 1

GEOLOGY AND COAL RESOURCES OF CENTRAL KING COUNTY, WASHINGTON

BY

TIMOTHY J. WALSH

1984

STATE OF WASHINGTON
DEPARTMENT OF NATURAL RESOURCES
BRIAN J. BOYLE, Commissioner of Public Lands
ART STEARNS, Supervisor

DIVISION OF GEOLOGY AND EARTH RESOURCES
RAYMOND LASMANIS, State Geologist

Open File Report OF 84-3

R5E | R6E

R6E | R7E

R7E | R8E

T24N – T23N

T23N – T22N

R5E | R6E

Scale 1: 24,000

Miles 0 ½ 1

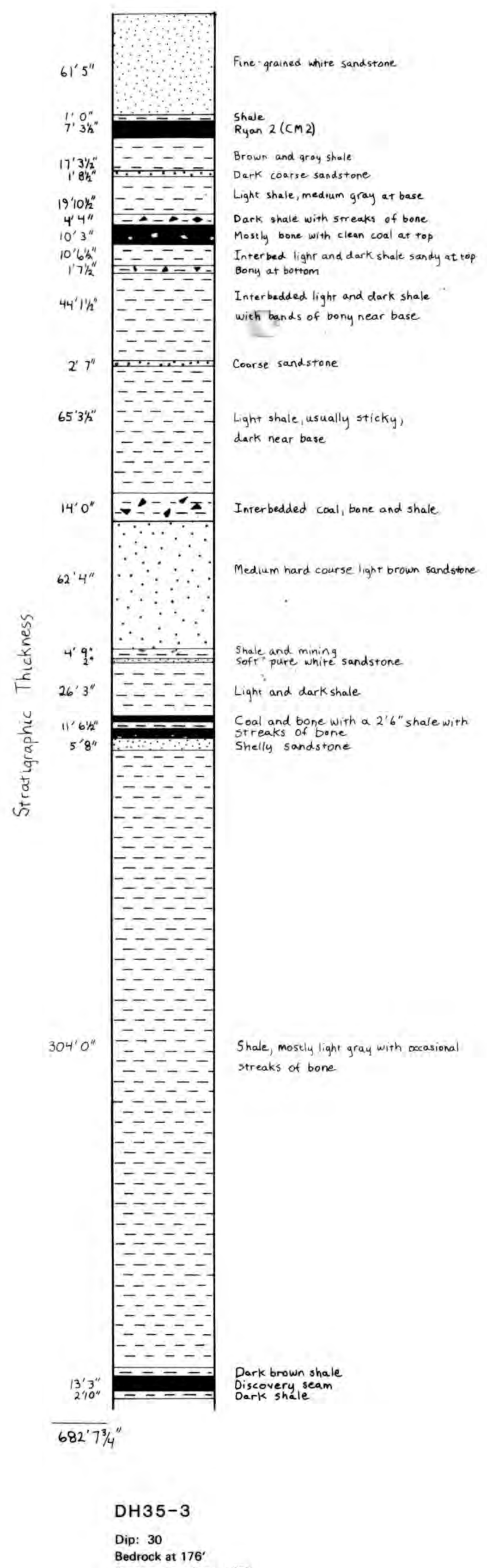
Feet 0 2000 4000

1. Warren and others, 1965 Bedrock
2. Wilson and others, 1962 Unconsolidated
3. Curran, 1965 Unconsolidated
4. Anderson, 1963 Unconsolidated
5. Mullineaux, 1965 Unconsolidated
6. Vine, 1962 Bedrock
7. Reconyan, 1965 Unconsolidated
8. Hammond, 1963 Bedrock
Outside Study Area
7½ minute quad

DRILL HOLE LOGS FROM NEW BLACK DIAMOND MINE AREA

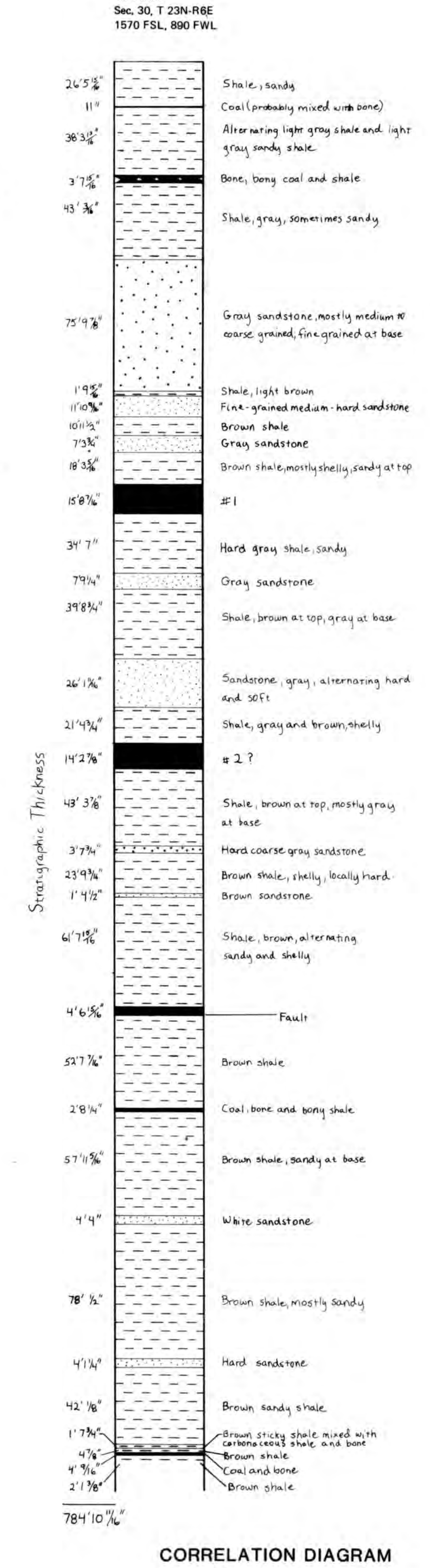
DH35-1

Dip: 30
Bedrock at 55'
Surface elevation: 537'
TD: 843'9"
Sec. 35, T 23N R5E
350 FNL, 150 FEL



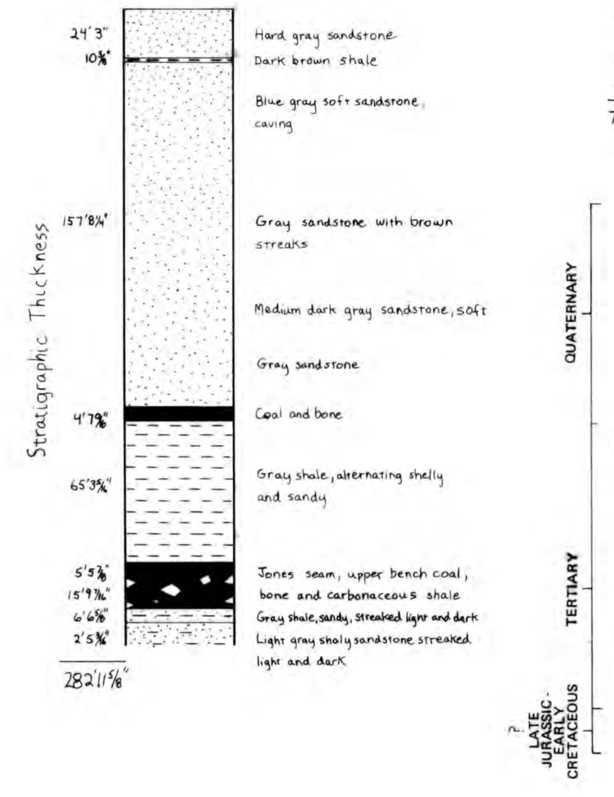
DH30-1

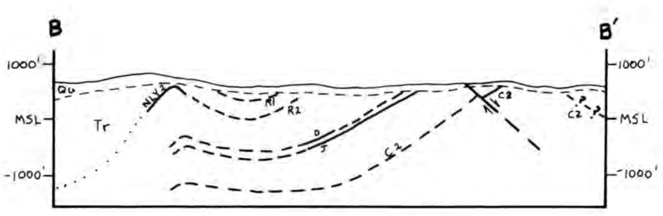
Dip: 24
Bedrock at 51'
Surface elevation: 502'
TD: 925'
Sec. 30, T 23N-R6E
1570 FSL, 890 FWL



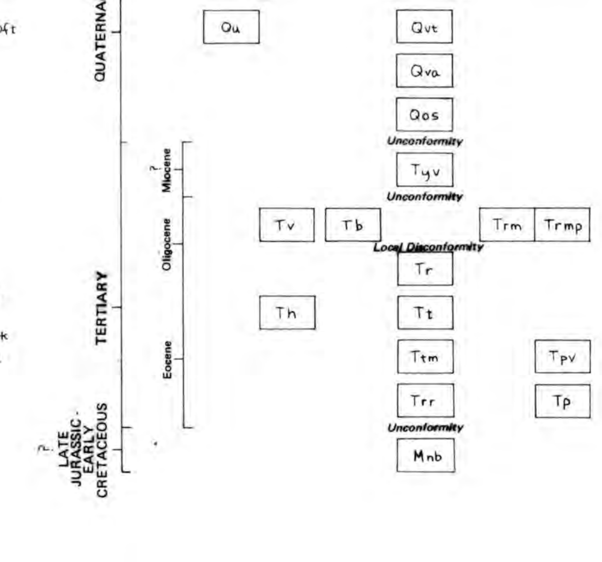
DH35-3

Dip: 30
Bedrock at 176'
Surface elevation: 469'
TD: 494'4"
Sec. 35, T 23N R5E
45 FSL, 133 FWL





CORRELATION DIAGRAM



EXPLANATION

QUATERNARY

Qal — Alluvium
Along Cedar River, consists mostly of well-sorted pebble-to-cobble gravel and sand. Along smaller streams consists of thin deposits of gravel and sand

Qls — Landslides and colluvium
Landslides chiefly formed by failure of incompetent rocks of the Tukwila Fm. Colluvium consists of deformed deposits of mass flowage and alluvium of small intermittent streams

Qp — Peat
Organic sediments deposited mostly in closed depressions. Thickness highly variable, up to 42 feet at Otter Lake (Rosengreen, 1965)

Qvu — Recessional Deposits
Undifferentiated drift mostly thin deposits of outwash sand and gravel overlying discontinous till

Qvs — Stratified drift
Mostly well-sorted, unweathered sand and pebble gravel

Qvic — Ice-Contact sediments
Mostly pebbly sand and pebble-cobble gravel, with occasional boulders. Forms kames, kame terraces and eskers. (Rosengreen, 1965)

Qvd — Deltaic sediments
Well-sorted sand and pebble-cobble gravel. Thickness variable but can be more than 100 feet. Deltaic sediments are actively mined to the northeast of Issaquah and in Maple Valley

Qvl — Lacustrine sediments
Laminated deposits of clayey silt and fine sand. Thickness variable, but generally less than 20 feet (Rosengreen, 1965). Reaches a maximum thickness of 120 feet in Issaquah Creek valley (Luzier, 1969)

Qvo — Outwash
Well-sorted sand and pebble-cobble gravel - Qvo_b - boulder gravel exposed only on intermediate terrace on south side of Cedar River. Boulders range from 6 feet to 20 feet in diameter and are restricted in lithology to peridotite and pyroxenite, often with cumulate texture, and minor graywacke and cataclastic breccia

Qvt — Till
Compact mixture of gravel and occasional boulders in a gray clayey, silty sand matrix. Thickness generally 10 feet to more than 50 feet (Luzier, 1969)

Qva — Advance drift
Pebble and cobble gravel, sand, silt and finely laminated clayey silt. Thickness up to 50 feet but generally less than 20 feet (Rosengreen, 1965)

Qu — Undifferentiated drift
Mostly thin deposits of outwash. Relation to till uncertain

Qos — Older sediments
Includes till, glaciofluvial sand and gravel, and nonglacial sand, clay and thin peat (Mullineaux, 1965)

TERTIARY

Miocene ?

Tyv — Younger volcanic rocks.
Hypocrystalline basalts and basaltic andesite found in isolated, elevated outcrops. In sec. 24, T. 23N. R. 6E. displays rosetted jointing; probably remnants of intracanyon flows

Unconformity

Oligocene

Tv — Unnamed volcanic rocks of Vine (1969).
Volcanic sandstone, conglomerate, breccia, tuff, and basaltic lava flows. Intertongue with upper part of Puget Group. Equivalent to the Enumclaw Volcanic Series of Weaver (1916). In section 35, T. 21N., R.7, these rocks have been dated as at least 35.2 +/- 2.2 MY old using the K-Ar method (Turner and others, 1983) on rocks approximately 500-1000 feet above the base. Rocks about 250 feet above the base have been referred to the Upper Kummerian floral stage (Wolfe, 1968).

Tb — Blakeley? Formation
Conglomerate, tuffaceous sandstone, mudstone, shale, and feldspathic sandstone containing marine fossils. In section 13, T. 24N., R. 5E., contains the Foraminifera *Buccella mansfieldi oregonensis* (Cushman, Stewart, and Stewart) and *Elphidium* cf. *E. Californicum* Cook. This indicates a maximum and probable age of Zemorrian stage, although it could be younger (Rau, 1984, written comm.); these rocks apparently interfinger with Tv near Grand Ridge. May be as much as 8,000 feet thick in the map area.

Trm — Volcanic rocks of Rattlesnake Mtn.
Andesite flows and tuffs with rare tuff breccia and volcanic siltstone. May be the same as Tv or may be the same as the volcanic rocks of Mount Persis (Tabor and others, 1982)

Trm_p — Propylitically altered Trm.
Characteristically composed of as much as 80% chlorite, pyrite, and calcite. Exposed only along the shear zones of the eastern flank of Rattlesnake Mtn. in T. 23N., R. 8E.

Local Disconformity

Eocene

Tr — Renton Formation.
Feldspathic and arkosic micaceous sandstone, carbonaceous claystone, and coal. May be as much as 4,900 feet thick in the KSD No. 1 drillhole in section 4, T. 22 N., R. 5E. Contains plant fossils of the Ravenian and Kummerian stages of Wolfe (1968) and conformably overlies rocks dated as 39.4 +/- 2.4 to 45.7 +/- 2.7 MY old, averaging 42.0 +/- 2.4 MY old (Turner and others, 1983)

Tt — Tukwila Formation.
Andesitic volcanic sandstone, tuffaceous siltstone, tuff breccia, volcanic conglomerate, and lava flows; interbedded locally with arkosic and chloritic sandstone beds designated C, D, E, and F, which are associated with carbonaceous shales, siltstones and impure coals. Lower part interstratified with Tiger Mountain Formation. Thickness locally as much as 6,800 feet. Contains fossil leaves that have been referred to the Ravenian floral stage (Wolfe, 1968). Rocks near the top of the formation at Newcastle have been dated as 39.4 +/- 2.4 to 45.7 +/- 2.7 MY old, averaging 42.0 +/- 2.7 MY old. (Turner and others, 1983)

Th — Hydrothermally altered rock.
Consists of argillically altered Renton, Tukwila, and Tiger Mountain Formations

Ttm — Tiger Mountain Formation.
Arkosic gray micaceous sandstone, carbonaceous siltstone, and coal. Upper part interstratified with Tukwila Formation. Thickness about 2,000 feet. Contains fossil leaves referrable to the Fultonian floral stage (Wolfe, 1968)

Trr — Raging River Formation.
Epiclastic volcanic sandstone, and siltstone, locally containing volcanic and chert pebble conglomerate. Contains abundant marine mollusks locally. Thickness at least 3,000 feet. (Base not exposed) Contains Foraminifera of the *Bulimina* cf. *B. jacksonensis* zone, which correlates with the upper part of the Ulatisian and lowermost part of the Narizian benthic foramineral stages of Mallory (1959) (Armentrout and others, 1983).

Tpv — Puget Group volcanic rocks.
Conglomerate composed of mafic volcanic clasts and pumice fragments, and crossbedded tuffaceous sandstones and tuffaceous siltstones in NE/4 section 23, T. 22N., R. 6E. These rocks are correlated here with similar rocks exposed near Landsburg which appear to belong to the Franklinian floral stage of Wolfe, (1968)

Tp — Puget Group Undifferentiated.
Arkosic, micaceous sandstones with 15-20 feet wide trough crossbeds and minor carbonaceous siltstone. Apparently underlies Tpv and so is considered here to belong to the Franklinian floral stage of Wolfe, 1968. Found only in NW/4 section 22, and section 23, T. 22N. R. 6E.

Unconformity

LATE JURASSIC-EARLY CRETACEOUS ?

Mnb — North Bend formation of Fuller (1925).
Indurated graywacke sandstone containing abundant chert, chlorite and epidote. Also contained a radiolarian identified as *Sethocapsa?* by C. Blome, USGS (pers. comm, 1984) which would suggest a late Jurassic or early Cretaceous age. Also contains argillite and chert pebble conglomerate in a sheared matrix. These rocks are included in the Western Melange Belt of Tabor and others, 1982. The relation with the overlying? Rattlesnake Mountain volcanics is usually covered but is a fault contact where exposed in the SE/4 section 17, T. 23N. R. 8E.

Ti — Intrusive rock.
Igneous rock consisting of aphanitic and porphyritic calcareous andesites or basaltic andesites.

Tip — Phaneritic intrusive rock.
Medium gray fine-to-medium-grained pyroxene diorite with hypidiomorphic granular texture. In SW/4 sec. 23, T. 23N., R. 7E., contains up to 5% quartz and apatite. Contact relations not exposed

Anticline, showing trace of axial plane and direction of plunge. Dashed where approximately located; dotted where concealed

Syncline, showing trace of axial plane and direction of plunge. Dashed where approximately located; dotted where concealed

Contact, dashed where approximately located; dotted where concealed; queried where inferred

Fault, showing upthrown (U) and downthrown (D) sides. Dashed where approximately located; dotted where concealed; queried where inferred; dashed and dotted where identified from aerial photographs (not field checked)

Fault, showing relative movement. Dashed where approximately located; dotted where concealed; queried where inferred

Attitude of axial plane of minor folds

Shear zone, showing attitude of shear

Dry hole, showing Washington State permit number (McFarland, 1983)

Coal exploration hole

Strike and dip of beds

Strike and dip of partings in volcanic rocks

Strike and dip of coal beds in Puget Group. Data from underground mine workings

Datum=250 — Fault, showing relative movement and attitude of fault plane. Datum is elevation of the horizon on which the fault trace is projected. Data from underground mine workings

Water well, showing lithology and depth to bedrock on right and depth to first coal seam and its thickness on left

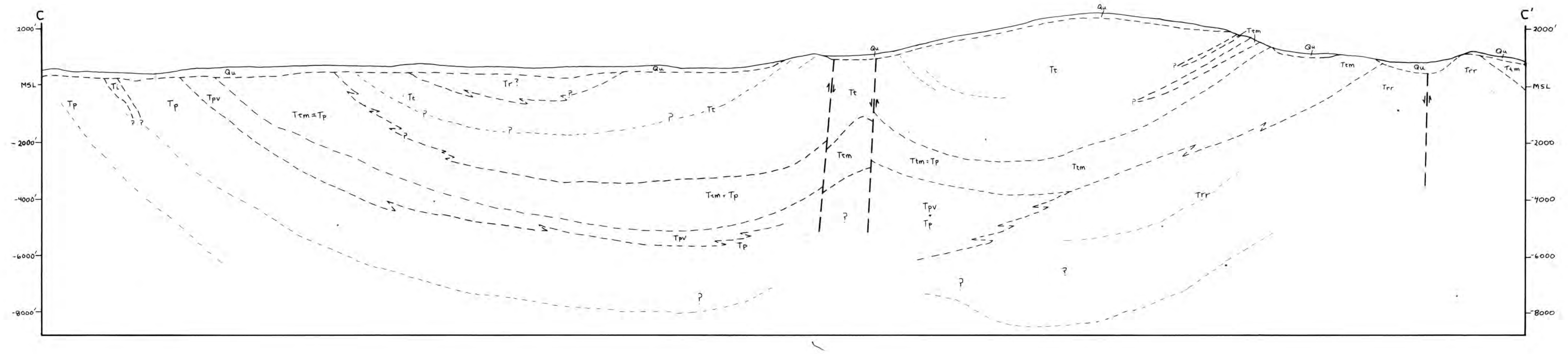
Oil and gas stratigraphic test hole

Deep monitor well for hydrologic studies in Cedar River watershed. Encountered well consolidated brown-purple siltstone at an elevation of 45' above MSL. (Seattle Water Dept., 1980). Probably Tv

Strike and dip of overturned beds

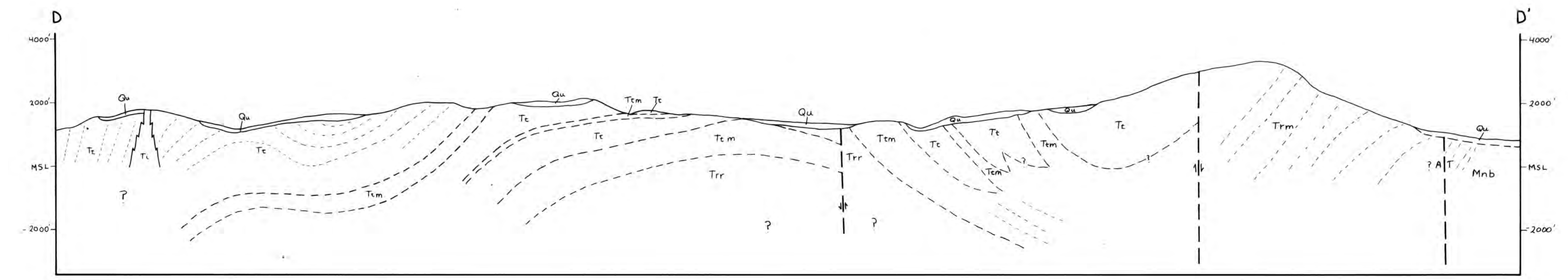
D-2048 Location of coal vitrinite reflectance sample

(135)47-80 Location of analyzed coal sample



COAL SEAMS IN CROSS SECTIONS

NLY2	New Lake Youngs No. 2
CM2	Cedar Mountain No. 2
R2	Ryan No. 2
R1	Ryan No. 1
CM1	Cedar Mountain No. 1
D	Discovery
J	Jones
C2	Cavanaugh No. 2
TM1	Tiger Mountain No. 1
TM3	Tiger Mountain No. 3



WELL DATA AVAILABLE

WC-83-14	Amoco Production Company stratigraphic test; permit 368; well log confidential until mid 1985.
WC-83-17	Amoco Production Company stratigraphic test; permit 374; well log confidential until mid 1985.
219	Intex Piel No. 34; sample description, E logs (McFarland, 1983); vitrinite reflectance. (see table)
232	Geothermal Resources "KSD" No. 1; sample description, E logs (McFarland, 1983); vitrinite reflectance. (see table)
MW-5	Seattle Water Department Monitor Well No. 5; well log (Seattle Water Department, 1980); encountered bedrock at a depth of 660 or an elevation of 45 above sea level.
DH	Pacific Coast Coal (PCC) coal tests; logs supplied courtesy William Kombol, Palmer Coking Coal.
DH 35-1	See graphic log
DH 35-2	did not penetrate bedrock; total depth 664 feet.
DH 35-3	see graphic log
DH 35-4	did not penetrate bedrock; total depth 444 feet.
DH 19-1	dark brown shale from 354 feet to 382 feet.
DH 25-1	soft gray and gray white sandstone from 157 feet to 229 feet.
DH 30-1	see graphic log
DH 30-2	encountered the Ryan No. 1. at 23 feet; penetrated 12 feet 7½ inches coal and 9 partings of shale and bony totalling 1 foot 10 5/8 inches; floor is sandy shale.

OUTCROP COAL ANALYSES

Location	Bed	As-Received Basis: Proximate: Moisture	VM	Ultimate: FC	Ash	Sulfur	H	C	N	O	Heat Value BTU	Fusibility of Ash (°F) (Red.): Initial Def.	Softening	Fluid T	Mineral-Matter-Free Basis: FC,Dry	BTU-Moist	Lab No.	DGER No.
NE/4NW/4 Sec. 31, T 24 N, R. 6E.	Primrose II?	13.8	32.0	34.2	20.0	1.5	5.7	48.5	1.0	23.5	8,600	2540	2650	2760	53.3	10989	L03312	(103) 15-80
	Primrose II?	14.5	32.5	41.0	12.0	1.1	5.6	54.8	1.0	25.4	9,739	2600	2690	2780	56.8	11204	L03835	(135) 47-80
NW/4NE/4 Sec. 36, T. 24 N, R. 5E.	Newcastle No. 3	12.8	34.2	38.7	14.3	0.4	5.7	54.5	1.2	24.0	9,626	2800	2800	2800+	54.0	11390	L03313	(104) 16-80
SE/4SW/4 Sec. 16, T. 23 N. R. 7E.	Ruffner	10.3	25.4	17.2	47.1	0.5	4.2	31.8	0.6	15.9	5,487	2510	2620	2730	44.4	11180	L03824	(109) 21-80
NW/4SW/4 Sec. 29, T. 23 N. R. 8E.	Unnamed	12.8	13.5	10.5	63.1	0.1	2.6	15.4	0.3	18.5	2,127	2800+	2800+	2800+	55.2	6674	0242693	(150) 01-81
NE/4NE/4 Sec. 30, T. 23 N. R. 8E.	Cedar Mtn. No. 2	13.2	33.2	32.7	20.8	0.6	4.9	54.1	1.3	27.4	7,574	2800+	2800+	2800+	50.9	9771	010967	(151) 02-81
	Cedar Mtn. No. 2	12.9	35.3	41.8	10.1	0.4	5.3	54.3	1.6	28.4	9,199	2800+	2800+	2800+	54.9	10328	0242695	(152) 03-81
NE/4NW/4 Sec. 13, T. 23 N. R. 6E.	Tiger Mtn. No. 2	10.1	19.6	19.0	51.3	1.8	3.1	23.7	0.4	19.7	3,690	2620	2730	2800+	55.9	8256	0242696	(160) 11-81
NW/4NE/4 Sec. 3, T. 22 N. R. 7E.	Unnamed	15.4	12.0	8.0	64.6	0.1	2.7	13.3	0.2	19.2	1,764	2800+	2800+	2800+	54.0	5828	010970	(161) 12-81
SW/4NW/4 Sec. 27, T. 23 N. R. 7E.	Bed C	22.8	14.8	10.2	52.2	0.2	3.9	16.8	0.4	26.5	2,426	2800+	2800+	2800+	49.1	5552	010971	(162) 13-81
SW/4NE/4 Sec. 26, T. 23 N. R. 7E.	Bed C?	8.1	22.9	27.3	41.7	0.3	3.1	35.4	0.6	18.8	5,383	2800+	2800+	2800+	58.4	9796	010972	(163) 14-81
NE/4NW/4 Sec. 16, T. 23 N. R. 7E.	Unnamed	2.4	35.1	47.8	14.8	0.2	4.8	67.7	1.3	8.9	12,321	2130	2320	2430	58.6	14672	72-111912	(172) 23-81
SW/4SE/4 Sec. 27, T. 24 N. R. 5E.	Jones	7.5	21.4	56.0	15.1	0.8	5.4	58.1	1.4	19.3	10,473	2520	2690	2800+	73.8	12532	010973	(191) 42-81

VITRINITE REFLECTANCE–OUTCROPS

Location	Bed	Ave % Ro	Median	S. Dev.	Points Counted	Analysis No.
NE/4NW/4 Sec. 13, T. 23 N., R. 6E.	Tiger Mtn. No. 1	0.42	0.43	0.051	50	D-2048
	Tiger Mtn. No. 2	0.48	0.49	0.045	50	D-2049
	Tiger Mtn. No. 3	0.64	0.65	0.064	50	D-2047
center, Sec. 3, T. 22 N., R. 7E.	Mine dump	0.55	0.56	0.061	50	D-2045
	Mine dump	0.63	0.64	0.058	50	D-2044
NW/4 Sec. 32, T. 24 R. 7E.	Mine dump	1.13	1.14	0.096	50	D-2046
NE/4NW/4 Sec. 31, T. 24 N. R. 6E.	Primrose II	0.39	0.40	0.068	50	D-1634
NE/4NE/4 Sec. 36, T. 24 N. R. 5E.	Newcastle No. 4	0.41	0.42	0.075	50	D-1631
SW/4NW/4 Sec. 24, T. 23 N. R. 7E.	Unnamed	1.89	1.90	0.158	50	D-3927

VITRINITE REFLECTANCE–WELL CUTTINGS

Well Name & Location	Depth Internal	Ave % Ro	Median	S. Dev.	Points Counted	Analysis No.
Piel 34; sec. 10 T. 22 N. R. 5E.	3910-3940	0.51	0.53	0.052	50	D-2447
	4100-4200	0.50	0.52	0.074	50	D-2448
	4500-4600	0.53	0.54	0.074	47	D-2449
	4700-4800	0.48	0.47	0.053	19	D-2450
	5300-5400	0.57	0.57	0.056	45	D-2451
	5740-5780	0.60	0.59	0.069	49	D-2153
	6160-6190	0.57	0.57	0.058	42	D-2455
	6700-6800	0.60	0.59	0.058	25	D-2456
KSD Geothermal Resources No. 1; Sec. 4, T. 22 N. R. 5E.	1220-1260	0.59	0.59	0.044	26	D-3713
	3200-3240	0.58	0.57	0.061	31	D-3723
	4200-4240	0.60	0.59	0.070	20	D-3728
	4600-4640	0.60	0.60	0.065	49	D-3790
	4800-4840	0.59	0.60	0.079	31	D-3731
	5400-5440	0.63	0.64	0.075	27	D-3734
	6000-6040	0.68	0.68	0.074	23	D-3737
	6200-6240	0.69	0.69	0.055	34	D-3738
	6400-6440	0.69	0.72	0.086	31	D-3739
	6600-6640	0.70	0.73	0.057	13	D-3740
	7000-7040	0.76	0.75	0.078	4	D-3742
	8600-8640	0.71	0.73	0.066	13	D-3750
	9000-9040	0.72	0.72	0.114	15	D-3752
	9200-9240	0.76	0.77	0.072	40	D-3753

Vitrinite reflectance data courtesy of T. Hemler, Amoco Production Co.

PLATE 2

GEOLOGY AND COAL RESOURCES OF CENTRAL KING COUNTY, WASHINGTON

BY
TIMOTHY J. WALSH

1984

Open File Report OF 84-3

STATE OF WASHINGTON
DEPARTMENT OF NATURAL RESOURCES
BRIAN J. BOYLE, Commissioner of Public Lands
ART STEARNS, Supervisor

DIVISION OF GEOLOGY AND EARTH RESOURCES
RAYMOND LASMANIS, State Geologist

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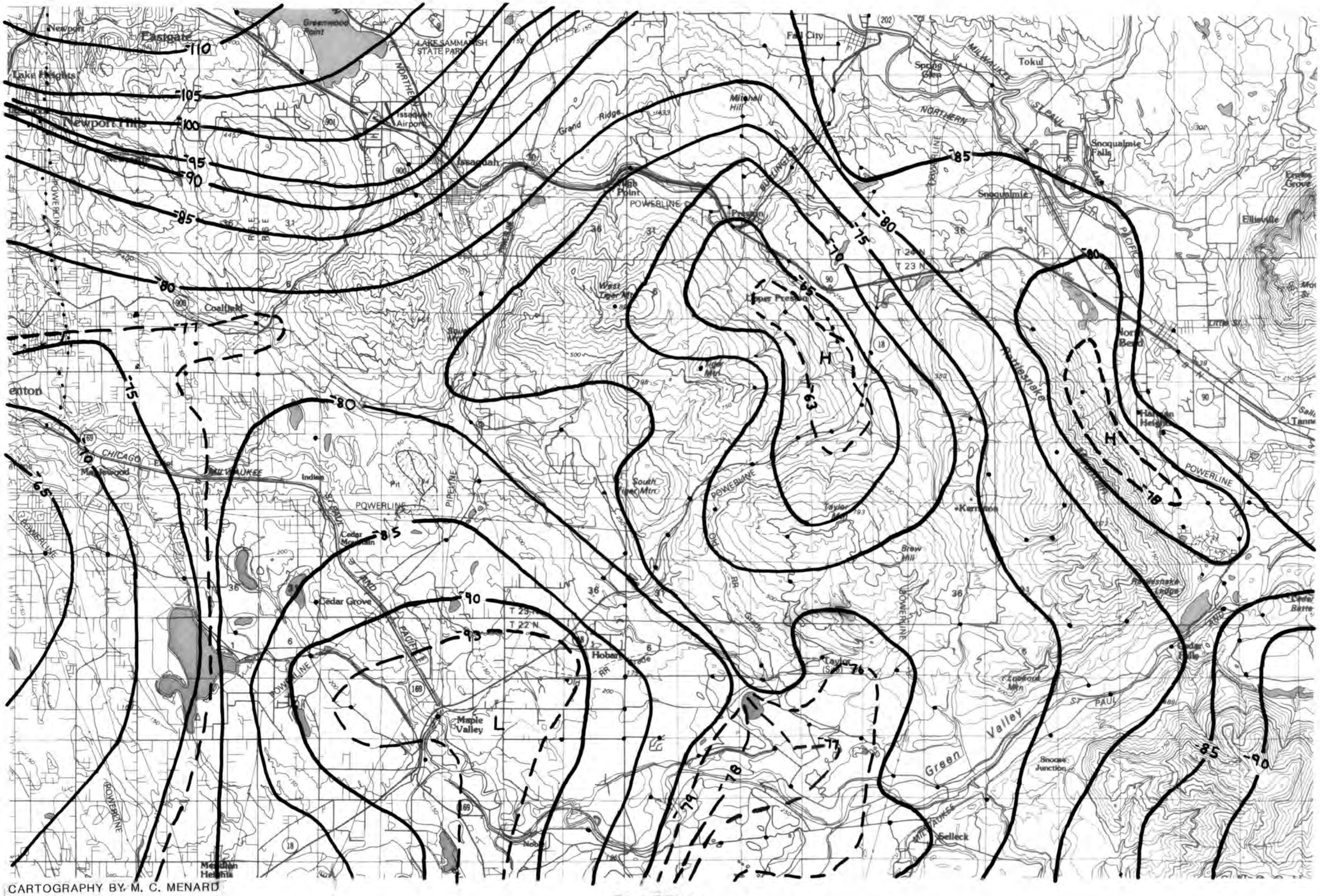

CARTOGRAPHY BY M. C. MENARD

PLATE 3

COMPLETE BOUGUER ANOMALY MAP OF CENTRAL KING COUNTY, WASHINGTON

REDUCTION S = 2.67

BY

TIMOTHY J. WALSH

1984

Open File Report of 84-3

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