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GEOLOGY AND ENERGY RESOURCES OF THE ROSLYN-CLE ELUM AREA, KITTITAS COUNTY, WASHINGTON

By

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GEOGRAPHY AND GENERAL DESCRIPTION

The Roslyn-Cle Elum area is located in northern Kittitas County, Central Washington. Population of the county is about 26,200; Cle Elum has 1,735 people and Roslyn about 950. The Roslyn coal field is bounded on the north by Cle Elum Ridge, the Yakima River on the south, Cle Elum Lake on the west, and by the Teanaway River on the east. The area is accessible by Interstate Highway I-90 and by the Burlington Northern railroad. The Cle Elum River has its confluence with the Yakima River about 2 miles west of South Cle Elum.

About 275 square miles were geologically mapped, with the major coal-bearing field occupying about 30,000 acres in the central part of the mapped area. Elevations in the coal-bearing area range from 1,900 feet at the Yakima River to 3,600 feet on Cle Elum Ridge. Fairly gentle slopes are present in the Roslyn-Cle Elum area and become steeper in all directions away from this area. Sasse Mountain is the highest point in the mapped region with an elevation of 5,730 feet.

OWNERSHIP

Mineral rights in the Roslyn coal field are primarily held by Burlington Northern, Inc. with 17,770 acres. The Roslyn-Cascade Coal Co. controls about 850 acres and Boise Cascade Corp. has about 700 acres. The remaining 10,000 acres of coal-bearing land are held in smaller tracts by a number of companies and individuals. Surrounding the Roslyn field, the largest land holders are the U.S. Forest Service, Burlington Northern, Inc., Boise Cascade Corp., and the State of Washington.

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PREVIOUS COAL MINING AND RELATED ACTIVITIES

Coal was first mined from the Roslyn field in 1882 and hauled to Ellensburg. In 1886, the Northern Pacific Railway sent a party into the Cle Elum Valley to

prospect the field. Coal was found, and soon Roslyn mine No. 1 was opened in a draw north of Roslyn; the workings extended up the dip. Mining continued in the field until 1963 when the last operation ceased; approximately 64 million tons of coal had been produced. Of this production, 57 million tons were mined from the Roslyn No. 5 seam, 4 million tons from the Big Dirty No. 1 seam, and the remainder from the 2, 6, 7, and 8 beds. Between about the year 1900 and on up to the present, numerous boreholes were drilled to explore and to develop the coal properties. The Northwestern Improvement Co. (mining subsidiary of the Northern Pacific Railway) drilled 103 holes; Burlington Northern, Inc. drilled 31 boreholes in 1978; Tuck and Boyd in 1966 drilled 6 holes; 3 holes were drilled by Amax Coal Company in 1979; and a number of other holes were drilled by various individuals and companies. Map No. 2 shows the location of most of the boreholes that have been completed in the field.

Map No. 3 illustrates the major haulage ways in the old mine workings and also the strip pit locations. All of the old workings are in the No. 5 seam except in the extreme north and west portions of the field where the lower seams were worked and where the No's. 1 and 2 seams were stripped. Entrance to the coal seams was by drifts or water levels on the coal from outcrops, rock tunnels to the coal, and vertical shafts. The room-and-pillar method of mining was by far the most common practice. Mules were used in the early days for underground haulage, but were largely replaced with steam and electric power by 1910. Both long-wall and short-wall mining methods were attempted in various parts of the field. In the 1950's, coal was strip mined in those areas between outcrop and the older shallow mine workings. In 1961, a study was undertaken to determine the feasibility of hydraulically mining the remaining coal pillars in the field. For this test, a hand-held monitor, operated by one or two men and powered by a pump with a rated capacity of 15 gpm and 3,500 psi, was used. These tests proved to be somewhat successful. All methods considered, the recovery of coal from the field was over 75 percent, well above the average of most underground coal mining operations.

The Washington Division of Geology and Earth Resources, Olympia, has in its files blueline prints of the original mine maps; most of them at a scale of 1 inch equals 100 feet. Map No. 4 is an index to the old mine maps which show workings in the No. 1 seam. Workings in seams 5, 6, 7, and 8 are indexed in Map No. 16.

REGIONAL GEOLOGY

Geologic map No. 1A shows the areal distribution of rock types and the accompanying cross sections illustrate my interpretation of the subsurface geology. This report results from two seasons of field work by me and my assistants, numerous borehole logs, old mine maps, published reports, consultant reports, verbal communications, aeromagnetic survey (Map No. 1B), and a good share of interpretation.

The stratigraphy of the area is fairly straightforward. The oldest unit mapped is the Easton Schist of Mesozoic age (Frizzell, 1979). Most commonly, it is a fine-grained epidote, chlorite greenschist to phyllite, and occasionally a blue amphibolite schist can be found. Quartz veins are common and cut at any angle to the foliation. The formation generally weathers to form a gently sloping topography, although there are exceptions to this. It crops out southwest of Cle Elum and in a small area near the northwest shore of Cle Elum Lake.

Unconformably overlying the Easton Schist to the north of the Yakima River is the Swauk Formation. This sedimentary rock unit was first described by Russell (1900) and many subsequent detailed studies have been conducted on the formation. It is Early Eocene in age (Frizzell, 1979) and consists of nonmarine arkosic sandstones, silts, shales, and rare thin coal beds in the mapped area. Medium- to coarse-grained sandstones predominate in the section. It has been estimated (Frizzell, 1979), that a minimum of 7,500 feet of section is present between the base of the Swauk, in the vicinity of the North Fork of the Teanaway River, and the overlying Teanaway Basalt.

South of the Yakima River are several isolated arkosic units that unconformably overlie the Easton Schist and are thought to belong to the Manastash Formation. This formation is a nonmarine sequence of fine- to medium-grained arkosic sandstones, siltstones, shales, and minor coal. A direct time correlation between the Manastash and Swauk is suggested by their similar stratigraphic relationship to the underlying Easton Schist, gross lithologic similarities, whole rock potassium argon age dates, and leaf palynomorph data. My reason for including these isolated sedimentary units south of the Yakima River in the Manastash Formation rather than the Swauk is based on their finer-grained character and similar mineralogy to the Manastash, which crops out just south of the geologic map boundary in Taneum Creek. Andesite dikes cut the Manastash in section 4, T. 19 N., R. 15 E. and are believed to be associated with the andesitic intrusive that forms Peoh Point. At this location (sec. 4) a sample of dirty coal was taken and analyzed (see sample No. 62 in Appendix).

Miocene basalts unconformably overlie the Manastash Formation. The Swauk Formation is unconformably overlain by the Teanaway Basalt, also of Eocene age (Frizzell, 1979). The Teanaway Basalt, in the mapped area, consists of over 80 percent basaltic pyroclastic material and about 15 percent basalt flows, dikes, and sills. The remaining portion is composed of arkosic sandstones, shales, fresh-water limestones, and subordinate coal. A probably not too extensive coal bed was found at the top of the formation above Dickey Creek. It may be as thick as 20 feet, but very dirty (see sample No. 83 in Appendix). Material of the Teanaway volcanics was fed through the underlying Swauk Formation, which resulted in numerous diabase and basaltic dike swarms. These dikes strike about N. 20° E., are relatively long and less than a quarter mile wide, and form conspicuous ridges. The density of the swarms is greater near Cle Elum Lake and decreases toward the east.

At the north end of Cle Elum Lake a large body of diabasic to almost gabbroic composition is present. It appears concordant with the bedding in the Swauk and may be as thick at 1,200 feet or more. This sill forms Sasse Mountain on the east of the lake and a small hill on the west bank. The age of this sill is not known; it could be related to the Teanaway dikes or could be younger. The latter seems more likely since this body appears to truncate the Teanaway feeder dike swarm.

Above the Teanaway volcanics, and probably conformable with them, is the Roslyn Formation. The formation was first described by Russell (1900), but no type section was noted. Bressler (1951) divided the Roslyn into upper, middle, and lower members based on variations in grain size and the presence of coal beds.

The lower member, arbitrarily defined as situated principally north of the main Teanaway River valley, is about 3,000 feet thick. The lower half of this member, in the area of the North Fork of the Teanaway River, is interbedded with rhyolite flows and tuffs and a small amount of andesitic material. The adjacent sandstone units, in this North Fork area, grade from very tuffaceous to arkosic. Grain size ranges from medium to coarse and commonly to conglomeratic. Rhyolite interbeds have three to four times radiometric background as determined by a scintillation detector. One sample of the rhyolite was found to contain 26 ppm total uranium. Basal clastic beds of the lower member consist of reddish brown, fine- to medium-grained sandstones, spheroidally weathered iron-rich silt and claystones and, occasionally, thin dirty coal beds. Coal from this lower member was sampled at five different locations (see sample No's 36, 58, 68, 74, and 75 in Appendix). The upper half of the member is somewhat finer grained, has

fewer pebbly sandstones, no rhyolite interbeds, and no coal outcrop was found.

The middle member of the Roslyn Formation is bounded on the top by the bottom of the "coal measures," or upper member, and is geographically distributed in an arcuate belt north of Cle Elum Ridge and south of the Teanaway River. This member is as much as 3,000 feet thick north of Cle Elum and appears to thin toward the northwest (see cross sections that accompany Map 1A). Medium-grained sandstones, often poorly indurated, predominate in the middle member. A subordinate amount of pebbly sandstone, siltstone, shale, and coal is present. Coal beds increase in number and thickness upward. These beds were sampled at five separate locations and have been designated sample numbers 47, 48, 49, 50, 51, 52, 53, 57, 59, 60, 61, and 85 (see Appendix).

The upper member or "coal measures" of the Roslyn has at its base the No. 8 or Wright coal seam. Cle Elum Ridge bounds this member on the north and the drainages of the Yakima and Cle Elum Rivers to the south and west. Bressler (1966) notes the unit to be about 1,500 feet thick, with eight more or less important coal beds. I believe the unit to be about 2,400 feet thick and to contain an additional 16 coal beds. I base this conclusion on the presence of the Rothlisberger mine southwest of South Cle Elum. Here a slope was opened on a coal bed dipping 77° to the southwest to a depth of about 320 feet. A horizontal rock tunnel was then driven about 350 feet in a northeast direction across the dip of the beds. Sixteen coal seams, which ranged in thickness from less than a half a foot to 12 feet, were encountered in this tunnel. None of the coal beds found in this tunnel can be correlated across the Yakima River valley to those beds in the main part of the Roslyn field. Therefore, knowing the stratigraphy of the Roslyn Formation across the valley, and knowing that much older rocks crop out just southwest of the Rothlisberger mine, it is concluded that these 16 coal beds are above Bressler's upper member and have since been eroded away in the main part of the field. Cross section D-D', which accompanies Map 1A, shows my interpretation of the upper Roslyn stratigraphy. The generalized stratigraphic composite section through the coal measures also illustrates the probable sequence (fig. 1).

Total thickness of the entire Roslyn Formation is on the order of 9,000 feet and probably spans from Middle to Late Eocene in age (Frizzell, 1979). The source of the nonmarine sediments was an ancestral mountain range to the east. Numerous cross-stratification measurements were taken in the fluvial rocks to determine the paleocurrent directions. These measurements were recalculated to remove regional and local structure and a unimodal paleocurrent pattern flowing almost directly west was developed. This pattern suggests an ancient fluviatile environment

characterized by traction current flow. A sand-shale ratio map (Map No. 18) for an interval of 200 feet above the No. 5 seam illustrates an ancient channel in an east-west direction, flowing through Cle Elum. Natural levees, point bars, and oxbow lakes can be interpreted from the map. A unique aspect of this map is that the coal bed is a time-stratigraphic unit and the 200 feet of sediments probably represent a similar time interval across the field. Ratios as high as 12 are found in the main channel and drop off rapidly away from the channel. Map No. 11 shows contours of the sand-shale ratio for a 200-foot interval above the No. 1 seam, which is about 250 feet above the No. 5 seam. Highest ratio values are 5 in this 200-foot section, compared to 12 over the No. 5 seam, indicating a fining upward sequence. It also shows that the major channel migrated to the north, somewhat, and appears to meander in a wider belt. The fining upward sequence seen here is also true of the entire Roslyn Formation, showing a decrease in paleoslope, or climatic change, or decreasing abundance of the coarser sediments or any combination thereof from beginning to end of Roslyn time.

Unconformably overlying the Roslyn in the southeast part of the mapped area are basalts and volcaniclastics of the Miocene Columbia River Basalt Group. The basalt facies belong to the Grande Ronde Basalt of the Yakima Basalt Subgroup. Probably both flows and sills are present, but were not differentiated in this study. Associated with the Grande Ronde are volcaniclastic rocks of the lowermost Ellensburg, consisting of conglomerates, lahars and lithic tuffaceous to arkosic sandstones.

Quaternary surficial deposits were undifferentiated, but include both alluvium and colluvium as well as loess, till, drift, and glacial outwash.

STRUCTURAL SETTING

The major structural feature in the mapped area is a large reverse fault which I have named the Easton Ridge thrust. This fault trends about N. 50° W. in a very linear manner and is part of the well-known Olympic-Wallowa Lineament (OWL). The OWL was first recognized by Raisz (1945) as a topographic feature that extends from the north side of the Olympic Mountains through the Seattle area, southeastward through the Cle Elum area, to the north side of the Wallowa Mountains in northeastern Oregon.

Bentley (1977) describes the OWL as a crustal weakness zone which locally shows prominent topographic alignment because old basement structures (foliations,

faults, etc.) parallel the lineament and have acted to localize the later vertical movement along the line. In his opinion, all structures along the OWL are formed by vertical movement, most structures are rooted in basement weakness zones, and most structures are monoclinal faults at the surface. This is in agreement with what I have interpreted along the Easton Ridge thrust. As shown in the cross-sections (Map 1A), the fault is nearly vertical (70°-80°), is primarily of dip slip movement, and has increasing displacement toward the southeast. Section line D-D' shows vertical displacement of about 15,000 feet, C-C' about 11,000 feet, B-B' at 3,000 feet, and section A-A' only 500 feet. A major strike slip fault intersects the Easton Ridge fault just to the west of section A-A', and seems to terminate its dip slip motion. To the northwest of the strike slip fault the thrust fault plane simply becomes the axis of what is known as the Domerie Creek syncline.

Outcrops near the Easton Ridge thrust, such as on Bullfrog Road and Tillman Creek Road, exhibit major drag folding, slickensides, brecciation, mylonization, and secondary mineralization. North of the main fault zone, the upper Roslyn has been drag folded into a series of southeast-plunging synclines and adjacent anticlines. Locally, the rocks on either side of the fault dip toward the fault plane, steeply on the north side and fairly gently on the south side.

Faults on the west side of Cle Elum Lake, in the Teanaway and Swauk Formations are normal, up to the north, without major displacement. One fault, which parallels the southwest shore of the lake, and is probably related to the Easton Ridge thrust, brings up a small section of Teanaway volcanics, which are surrounded by younger Roslyn. The rocks on the northeast side of this fault are nearly vertical and strike to the north while the rocks on the other side strike nearly east-west and dip 20° to 30° to the south.

In the Teanaway River area, most faults trend to the northeast, about normal to the Easton Ridge thrust trend. These are normal faults, up to the northwest, with displacements of a thousand feet or less. A horst structure near the confluence of Rye Creek and the Teanaway River exposes about a half a square mile of Teanaway volcanics. The volcanics are also brought to the surface by a fault paralleling Story Creek.

It is interesting to note that drainages above the 100,000-foot north grid line tend to be north-south and those drainages south of the line have a strong orientation northwest-southeast.

Map No. 1B is an enlarged version of an aeromagnetic survey by Western Geophysical Research, Inc., for Washington Public Power Supply System, which was conducted under the direction of United Engineers and Constructors, Inc.,

in 1978. Added to the aeromagnetic contours on the map are geologic contacts, fault traces, and the town sites of Cle Elum, Roslyn, and Ronald. The high-resolution magnetic profiling was done at a nearly constant height of 1,000 feet, with traverse flight lines one-half mile apart oriented N. 40° E., and tie lines spaced 5 miles apart oriented N. 50° W.

Magnetic anomalies can be produced by any one or combinations of several features which include topographic relief, faulting, folding, lithologic differences, and variation in the thickness of magnetic units. A qualitative analysis of these anomalies yields information on the type and presence of the above-mentioned features. Map 1B shows several important features: There is a strong correlation of high magnetic anomalies with the Teanaway volcanics in the unit's crescent-shaped outcrop area. The arkoses of the Swauk and Roslyn Formations, as well as the Easton Schist and the rhyolites interbedded in the lower Roslyn, correlate with magnetic lows. A long magnetic linear occurs along the Easton Ridge thrust fault. Here the magnetically contrasting Roslyn arkose and the Teanaway volcanics are juxtaposed. As stated previously, displacement on the fault plane increases in a southeast direction. However, the magnetic contrasts increase in a northwest direction along the linear. I believe this can be explained by topographic differences and by the fact that the Teanaway volcanic wedge thickens toward the northwest (see cross sections, Map 1A). It is interesting to note that the magnetic linear terminates at the andesite porphyry forming Peoh Point, is offset to the east about a mile and a half, and then continues southeast from there.

Other interpretations have been made from the aeromagnetic map: There appears to be a thickening of the Roslyn near the center of the 121° longitude line and a thinning of the formation to the east at the magnetic high anomaly. This high probably results from a thin veneer of Roslyn over the much higher magnetic Teanaway Formation. The northeast-trending faults in the upper Teanaway River area seem to form over the crests of magnetic lows.

Map No. 1C shows structure contours at the base of the Roslyn Formation. The aeromagnetic map, geologic map, as well as bore hole and mine information were all used to produce the structure contour map. The synclines and anticlines are thought to be more subdued at depth in the Roslyn-Cle Elum area. The Easton Ridge thrust fault plane has migrated southwestward at depth due to slight dip in that direction. Displacements along faults are shown as displacements of contour lines.

DETAILED GEOLOGY OF THE ROSLYN COAL FIELD

This section is primarily concerned with the upper member of the Roslyn Formation, commonly called the "coal measures." In general, the rocks composing the coal measures are a sequence of fluviatile arkosic sandstones, siltstones, claystones, and shales interbedded with some 30 coal seams, each of which is at least one foot thick. Plant fossils composed of carbonized imprints of stems and leaves are common to siltstones and less commonly to shales and claystones. One fossil fresh-water fish species was found while mining the No. 5 seam.

The stratigraphic succession of rock types is very irregular from place to place due to the formation's continental origin. Three major ancient sedimentary environments were present during Roslyn time: (1) Meandering river channels with a floodplain subfacies where thin, discontinuous coal beds could form; (2) ancient fluviolacustrine swamps, which were fairly extensive, occurring on alluvial plains (it is these swamp areas where the thicker, extensive coal seams were formed); and (3) peripheral to the swamps were ancient lakes, probably not too deep in which clays and silts were deposited. These three major sedimentary environments interacted and migrated over each other with time, in response to physical, chemical, and biological factors.

Despite the sedimentary irregularities, both vertically and areally, correlation of the principal coal seams, some of the thinner coal beds, and some of the more persistent sandstone units is possible throughout most of the coal measures. Figure 1 shows a generalized composite section through this stratigraphic unit. Near the top of the section, the 16 coal beds found in the Rothlisberger prospect and only observed at that prospect, cannot be correlated with any of the beds in the Roslyn field across the Yakima River. The stratigraphic placement of the Rothlisberger beds about 800 feet above the No. 1 seam was defended in a previous section of this paper. Also shown in figure 1 are detailed sections of the minable coal beds. Two sections are given for each bed; each representing seam character at different ends of the field.

Map No. 5 is a structure contour map on the top of the No. 1 (Big Dirty) seam. This map, and the other structure contour maps, are based on data from numerous elevations along gangways and slopes in the No's. 1 and 5 seam workings as well as borehole information, and outcrop locations from field work. The structure contours illustrate the drag folding with southeast-plunging synclines. The crests of the larger anticlines are areas where the coal has been removed by erosion. The No. 1 seam crops out below Cle Elum Ridge on the north and is faulted out in the

subsurface on the south. The map also shows the areas which have been mined out, all fairly shallow workings. A small area above Cle Elum was mapped by Beikman and others (1961) to have the No. 1 seam present. Considerable field work by me in looking for the No. 1 seam outcrop was conducted; however, no evidence of this seam's presence was found.

The depth to the No. 1 seam is shown in the overburden isopach map No. 6. It can be seen that the mined-out areas are at depths less than 800 feet. It is noteworthy that between Roslyn and Cle Elum overburden thickness rapidly increases southward from the cropline.

Map No. 7 is an isopach map of both benches of seam No. 1. In this map, as well as the other isopach maps, apparent borehole thickness is used with no correction for true thickness. Coal seam thickness includes partings, bone, and other impure interbeds. The upper bench of the No. 1 seam contains a considerable amount of shale and bone and the coal is fairly dirty while the lower bench is generally much cleaner (fig. 1). Combined thickness of the two benches ranges from about 5 feet in the eastern part of the field to as much as 30 feet or more in the central part of the field. An isopach of the No. 1 seam, lower bench only, is shown in Map No. 8. It is thought that only this lower bench is possibly commercial, due to its somewhat higher quality. This lower bench is thinner toward the east and may be as thick as 10 feet below Roslyn (mined-out area).

Coal quality of the No. 1 seam, lower bench, is shown in map No. 9. It is interesting to note the relationship between mined-out areas and coal ash content and BTU value. Most of the mined coal had an ash content of less than 30 percent and a heating value of greater than 10,000 BTU. It appears the old miners took the best. The eastern half of the No. 1 seam, lower bench, has greater than 50 percent ash and less than 6,000 BTU.

Map No. 10 is a map showing areas of similar dip of the rocks overlying the No. 1 seam. Again, the mined-out areas have the most favorable low dips. South of the crop line between Roslyn and Cle Elum, the rocks dip 20° to 30° or more, making any stripping operation along this line impractical. The lowest dips occur along crests of anticlines and troughs of synclines with fairly steep dips along the flanks of these structures.

The sand-shale ratio for a 200-foot interval above the No. 1 seam is illustrated in map No. 11. The significance of this ratio was previously discussed from a geologic standpoint, but the map may also be useful from a mining standpoint (that is, overburden lithology, etc). Map No. 12 was compiled to aid underground mining of the No. 1 seam. The average lithology of a 20-foot

interval above this seam is shown in two dimensions. The primary lithology is shale or sandy shale, although ancient channels of sandstone near Cle Elum and Roslyn can be seen. Floor lithology below the No. 1 seam is shown in map No. 13. A 10-foot interval was averaged for this map. It can be seen that this interval is somewhat coarser in grain size than the 20-foot interval above the No. 1 seam.

The areal extent and the thickness of the No. 2 seam are shown on map No. 14. The seam is as thick as 6 feet in small areas between Ronald and Cle Elum and thins to less than 2 feet both north and south of this belt. Detailed sections of this bed at two different localities are shown in figure 1. The No. 2 seam underlies the No. 1 seam from less than 30 feet to over 80 feet as shown in map No. 15. This interval shows a general trend of thickening toward the southwest. Fifty feet can be considered an average interval thickness and is composed largely of sandstone.

Seams No. 3 and 4 are on the average about 40 feet stratigraphically separated, mainly by sandstone, from the No. 2 bed, and from each other. Their thickness is very variable, and always less than 3 feet each. These beds are not considered to be commercially important. Seam No. 5, known as the Roslyn seam, has been essentially mined out, therefore also considered not to be economically important. Map No. 16 is an index to the mine maps of workings in seams 5, 6, 7, and 8.

The structure contour map (No. 17) on the top of the No. 5 seam was included because it shows structural detail of a fairly large area and is based on the old mine workings and boreholes, making it a very reliable map. Map No. 18 shows the sand-shale ratio for a 200-foot interval above the No. 5 seam. The geologic and mining implications of this type of map have been previously noted.

The areal extent of the No. 6 seam, seam thickness, structure contours on top of the seam, and ash content of selected samples are all shown on map No. 19. The seam averages about 3 feet in thickness in the central part of the field and thins in the southerly and easterly directions. Extensive mining of the No. 6 seam is restricted to the extreme northwest part of the field. Here the seam contains over 40 percent ash and is about 3 feet thick. This ash content decreases somewhat southward from the mined-out area and increases towards the east. Detailed coal sections of the No. 6 seam at two different locations are shown in figure 1.

Map No. 20 shows the areal extent of the No. 7 seam, ash content of selected samples, and seam thickness. This seam lies about 100 feet below the No. 6 seam and is generally overlain by a fairly thick sandstone. A very small

amount of No. 7 seam was mined, both strip and underground, in the extreme western portion of the field. The seam is thickest, about 3 feet, in an area just northeast of Roslyn and thins in all directions from that area. Ash content of the coal is high, generally over 30 percent.

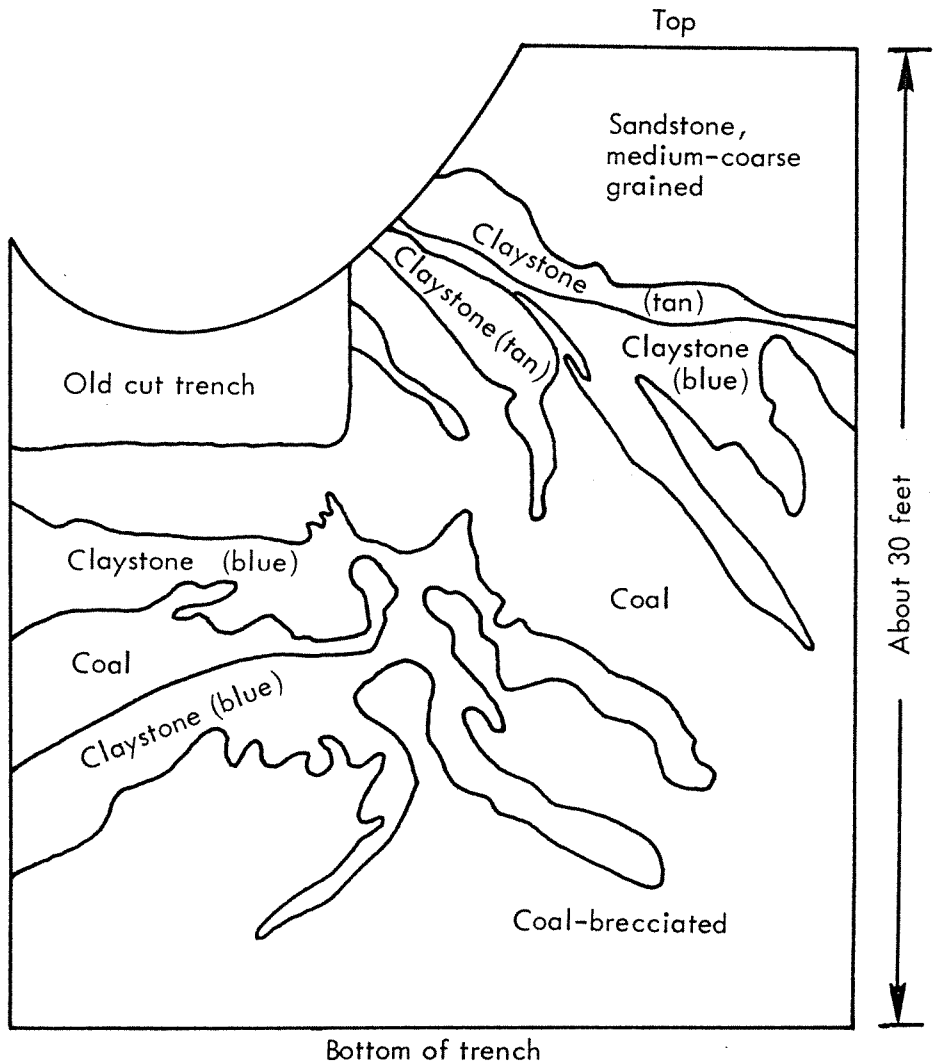
The areal extent, thickness, and ash content of selected samples of the No. 8 seam are shown on map No. 21. This seam reaches a maximum thickness of about 5 feet under the town of Roslyn and thins rapidly to the north and east. Coal sample No. 56 (see Appendix) was taken on the extreme eastern crop line of the No. 8 seam where the bed is just a few inches of carbonaceous shale. About 112,000 tons of coal were mined from the No. 8 seam near its western crop line.

About 100 feet below the No. 8 seam lies a coal bed which I have informally named the "Lanigan seam." Apparently a Mr. Lanigan, in the late 1800's, exposed this seam in a number of small test pits and later mined this bed underground for a short distance. The location of the old mine is in section 30, T. 20 N., R. 16 E., just north of the Cle Elum airport. This seam was also exposed in the SW¼, section 19, T. 20 N., R. 16 E., in a series of exploration trenches that were dug probably 50 or more years ago. Three backhoe pits were dug in this area in 1979 to re-expose the seam. One pit exposed about 18.5 feet of deformed and very brecciated coal. Another pit, less than 100 feet from the first pit, contained about 5 feet of brecciated coal. Obviously, the area is quite structurally complex, and it is assumed that low angle reverse faults are responsible for the greater coal thickness observed in the one pit. A sketch of a wall in one of the pits is presented on page 13.

Lying about 80 feet below the Lanigan seam is the Patrick seam, named after Archibald Patrick who discovered the seam in 1903 while diamond drilling in section 28, T. 20 N., R. 16 E. Later, in the north-center of this same section, a tunnel was driven 105 feet northwest through sandstone and shale to a 3.5-foot coal seam by a Mr. Decan Gallager. He followed the bed about 220 feet along strike, taking only this amount of coal from the prospect.

I have correlated the Patrick seam to be the same bed which was mined by a Mr. Goodrich in the northern part of section 19, T. 20 N., R. 16 E. Map No. 22 shows the areal extent, coal ash and BTU, seam thickness and structure contours on top of the seam. Unlike the upper coal seams to the west, the Patrick seam increases in thickness and improves in quality in an easterly direction. It is postulated that the bed may be as thick as 4 feet near the Teanaway River, and may even be present under the basalts forming Lookout Mountain to the southeast.

The overburden thickness above the Patrick seam is shown in map No. 23. Since very little borehole data is available to the Patrick seam area, map No's. 22 and 23 are quite conjectural. Figure 1 shows detailed coal sections of the Patrick seam at two different locations.



"Lanigan seam"

COAL QUALITY

The coal remaining in the Roslyn field has, for the most part, an extremely high ash content and varies in rank from high-volatile bituminous to subbituminous. Seams 1, 2, 6, 7, and 8 decrease in quality, primarily from increasing ash content, from west to east. The Patrick seam increases in quality and thickness towards the east.

Figure 2 is a ternary diagram that reflects coal quality of both core and outcrop samples from the various seams. The fixed carbon and volatile matter content are relatively uniform, but ash content is quite variable. Samples with lower ash are mostly from the No. 5 seam, which is almost completely mined out. The other seams have ash contents greater than 25 percent.

The Appendix contains all of the coal sample data and analytical results for coal collected from outcrop in the mapped area. Sample numbers correspond to sample locations shown on map 1A, the geologic map. All of the analytical work was performed by the Department of Energy, Coal Analysis Laboratory, Pittsburgh.

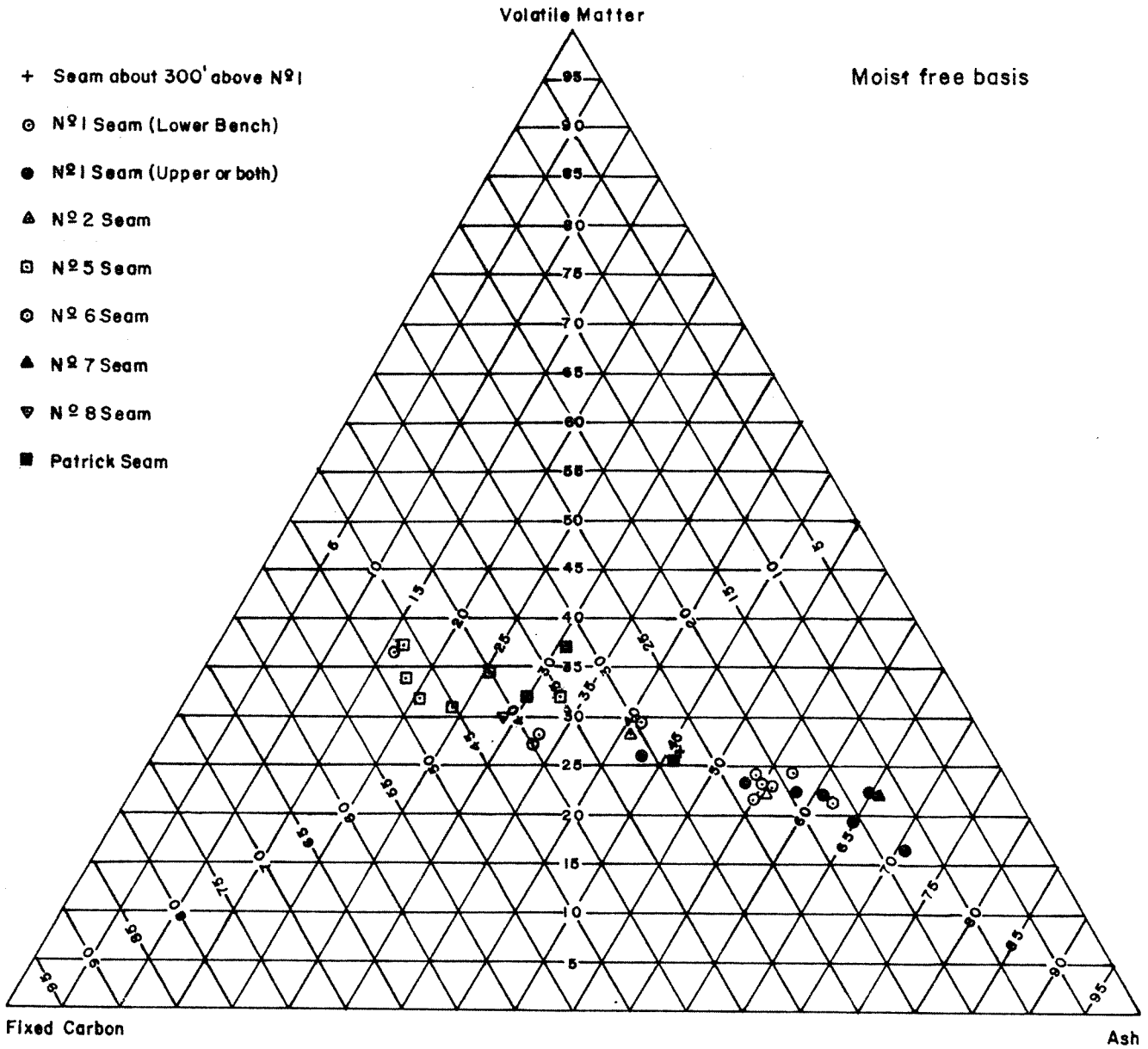
A summary of coal analyses of core from drill holes A, B, C, D, E, and F is shown in table 1 (after Tuck and Boyd, 1966). Because of the high ash content, a sink-float separation of 1.8 specific gravity was made whenever a preliminary ash determination exceeded 35 percent. Tuck and Boyd (1966) believed that this separation insured a greater accuracy in the determinations and also provided some idea of the behavior of the coal in a preparation plant.

FIGURE 2

GEOLOGY AND ENERGY RESOURCES OF THE
ROSLYN-CLE ELUM AREA
KITTITAS COUNTY, WASHINGTON
by
CHARLES W. WALKER
1980

TERNARY DIAGRAM

VOLATILE MATTER-ASH-FIXED CARBON
OF SELECTED ROSLYN FIELD COAL SAMPLES



C Cushman '80

TABLE 1.—Summary of coal analyses of core from Drill Holes A, B, C, D, E, and F (after Tuck and Boyd, 1966)

See Map 2 for borehole locations

Hole	Seam	Sample Thickness	Coal Thickness	Ash-as rec. %	Analysis after 1.8 sp. gravity separation: % Reject	Ash %	Vol. Mat. %	F.C. %	BTU
A	1-upper	63-3/4"	35-½"	39.3	30.6	26.3	32.2	41.5	10,350
A	1-lower	64-3/4"	41-3/4"	42.8	35.9	24.3	33.3	42.4	10,740
E	1-lower	79"				31.2	32.0	36.8	9,640
A	2	35-½"	31"			28.1	32.6	39.3	10,290
E	2	72"	30-½"	62.3	67.0	21.0	33.6	45.4	11,525
F	2	76"	35-½"	66.2	71.4	24.2	32.4	43.4	11.030
A	6	29-¼"	22-¼"	39.9	35.2	18.0	36.8	45.2	12,240
B	6	31-3/4"	15-3/4"			54.7	23.4	21.9	5,890
C	6	48"	26-½"	66.3	65.9	25.1	33.8	41.1	10,860
D	6	70-½"	36-½"	49.9	51.6	18.1	35.7	46.2	11,970
E	6	21"	20"			21.9	35.9	42.2	11,490
F	6-upper	27"	20-¼"			30.1	34.3	35.6	10,120
F	6-lower	16"	11-½"			27.5	31.5	41.0	10,750
A	7	30-5/8"	24-½"			29.9	33.3	36.8	10,390
B	7	28-¼"	18-½"			47.6	27.2	25.2	7,150
C	7	43"	27-½"	57.0	53.4	19.3	37.7	43.0	11,860
D	7	36"	12-3/4"	67.3	69.8	18.0	37.9	44.1	12,180
E	7	31-½"	19-¼"	52.0	51.6	12.6	40.0	47.4	13,420
A	8	34-3/4"	15-¼"	53.3	46.1	27.2	33.1	39.7	10,850
C	8	53-¼"	19-¼"	63.8	65.2	24.9	35.4	39.7	10,960
E	8	46"	31-½"	39.9	31.1	21.0	33.9	45.1	11,860
F	8	48-3/4"	29-3/4"	40.9	38.0	18.5	33.0	48.5	12,160

A study of coal samples from six beds in the Roslyn field was conducted to determine their amenability to the production of high-ash boiler fuel (Geer, 1965). Seams 1, 2, 5, 6, 7, and 8 were channel sampled. Table 2 shows, with reference to section corners, the location at which samples were collected.

TABLE 2.—Location of sampling points[1/] (After Geer, 1965)

Sample	Bed	Mine	Reference corner	Direction	Distance, feet
1.	1	Roslyn No. 9	SW, sec. 29	N 27° E	2,250
2.	1	do.	SE, sec. 20	N 83° W	1,000
3.	1	Roslyn No. 3	SE, sec. 7	N 74° W	1,900
4.	2	do.	SE, sec. 7	N 52° E	2,700
5.	5	Roslyn No. 10	SW, sec. 29	N 65° E	1,300
6.	6	Roslyn-Cascade No. 4	SE, sec. 1	N 64° W	1,130
7.	6	do.	SW, sec. 6	N 66° E	2,430
8.	7	Roslyn-Cascade Strip	NE, sec. 2	S 52° W	1,770
9.	8	Prospect	SE, sec. 2	N 55° W	1,600

[1/] All reference corners in T. 20 N., R. 15 E., W M, except those for No's. 7 and 8 beds which are in T. 20 N., R. 14 E., W M.

It was determined that all of the coals would require some degree of cleaning to meet a maximum 25 percent ash specification. Table 3 summarizes for each coal seam the comparison between the separation of the full size range at 1.80 specific gravity and separation at that specific gravity of the coarser than 3/8 inch material.

TABLE 3.—Comparison of cleaning full size range versus coarse coal only, separation at 1.80 specific gravity

(After Geer, 1965)

Bed	Wash, full size range		Wash, coarse coal	
	Yield, percent	Ash, percent	Yield, percent	Ash, percent
1	77.3	23.0	84.5	26.7
2	89.2	18.4	94.7	20.3
5	86.6	15.6	90.0	17.5
6	65.4	19.2	74.7	25.9
7	84.0	18.3	87.0	19.9
8	74.6	22.5	85.0	28.9

It is now known that the remaining coal in the field is much dirtier than the coal sampled in Geer's experiments. Therefore, lower final yields than those shown in table 3 should be expected.

Chemical analysis of the ash is shown in table 4. As Geer indicates, all of the samples are high in silica and alumina and low in iron content.

TABLE 4.—Chemical analyses of ash, percent (After Geer, 1965)

Sample	Bed	Condition[1/]	SiO_2	Al_2O_3	Fe_2O_3	FeO	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5	MnO
1	1	1	52.3	32.6	4.2	0.04	1.1	3.0	0.49	0.93	1.8	0.59	0.03
		2	52.2	32.4	3.9	.08	1.0	3.8	.42	.98	1.6	.60	.03
2	1	1	52.5	32.8	3.5	.20	.96	2.7	.37	1.1	1.6	.59	.02
		2	51.8	32.6	3.9	.04	1.0	3.3	.41	1.1	1.6	.59	.02
3	1	1	52.4	34.5	3.9	.00	1.4	2.3	.23	.91	1.9	.52	.03
		2	51.7	33.2	4.4	.04	1.4	3.5	.19	.93	1.7	.55	.04
4	2	1	50.4	34.1	4.2	.40	1.6	1.4	.31	1.3	3.2	1.3	.02
		2	49.0	34.5	4.8	.04	1.3	1.6	.30	1.2	3.6	1.5	.01
5	5	1	43.4	24.6	6.9	.04	4.7	7.6	1.3	.49	2.5	3.3	.04
		2	44.0	23.9	6.8	.04	3.3	8.3	1.4	.59	2.3	3.4	.04
6,7	6	1	48.0	30.7	5.6	-	2.2	4.3	.61	1.0	3.5	2.3	.33
		2	50.0	29.2	5.4	-	2.2	3.8	.88	1.0	2.6	1.8	.23
8	7	1	42.8	27.6	4.6	-	1.8	8.8	.51	.81	2.0	6.2	.05
		2	43.7	29.4	4.9	.16	2.1	8.4	.72	.89	2.0	5.9	.05
9	8	1	54.4	31.3	4.4	.12	1.7	2.6	.41	.98	2.2	.90	.04
		2	55.6	31.6	4.3	.08	1.6	2.3	.43	.88	2.0	.74	.04

1/ 1, Float 1.80 specific gravity from 2-inch to 200-mesh size range; 2, Float 1.80 specific gravity from 2- to 3/8 inch size and raw 3/8 inch to 0 coal.

COAL RESERVES

Reserve determinations were calculated by planimetering areas of equal coal thickness from the coal seam isopach maps. For each seam, the volumes for areas of different thickness were summed and converted to acre feet. Thickness calculations were always considered as the lower value, for example, a large area between the 2- and 3-foot contours was assumed 2 feet thick for the entire area. The number of tons of coal was figured using a conversion factor of 1,770 tons per acre foot, the accepted value for subbituminous coal. Seams underlying the cities of Cle Elum, Roslyn, and Ronald were omitted from the reserve calculations, as well as seams less than 12 inches thick.

Table 5 shows the estimated coal reserves in the Roslyn field calculated for this report and also reserve estimates by others in the past. My reserve estimates are divided into two categories: (1) measured and indicated reserves are those for which tonnage was calculated in areas where reliable data concerning seam extent and thickness is available, and (2) inferred reserves are those based on areas where coal was thought to be present, but thickness is conjectural. No reserve calculations were made for areas when both seam extent and thickness data are conjectural. Most of the reserves can only be mined underground as there is only a slight possibility for any appreciable amount of strip-minable coal.

Tuck and Boyd (1966) calculated coal reserves in the Roslyn field based on mining thickness and dip of beds. Table 6 summarizes their reserve estimates. Mine and preparation plant losses are deducted from the total reserve tonnage of each seam in this table.

TABLE 5.—Estimated coal reserves (in millions of short tons)

Coal bed	Ford, Bacon and Davis, Inc.[1]	Resources Research, Inc.[2,3]	Beikman, and others[4]	Tuck and Boyd[2,5]	Shannon and Wilson[6]	This report[7] Measured and indicated[8]	This report[7] Inferred[9]
No. 1-Lower bench	N/E	N/E	N/E	N/E	N/E	30.3	N/E
No. 1-Bothbenches	34.13	47.13	74.35	49.43	58.9	99.4	N/E
No. 2	N/E	N/E	N/E	37.15	22.5	20.1	3.0
No. 5	22.61	12.61	54.12	10	N/E	N/E	N/E
No. 6	61.45	90.73	93.11	81.49	32.9	46.3	3.5
No. 7	43.84	N/E	7.07	51.60	19.70	26.5	8.7
No. 8	64.70	80.00	12.68	47.08	36.20	45.1	9.0
Patrick	N/E	N/E	N/E	N/E	N/E	10.8	N/E
TOTAL	226.73	230.42	241.33	276.75	170.2	248.2	24.2
					TOTAL	272.4	

N/E=Not estimated

1/ For the Washington State Power Commission, 1956.

2/ Estimates recalculated for comparison purposes.

3/ For Public Utility District No. 1 of Kittitas Co., 1958.

4/ Includes measured, indicated, and inferred reserves, 1961.

5/ Includes all coal comprising greater than 50 percent of the mining thickness, with a minimum of 18 inches of coal, 1966.

6/ For City of Seattle, 1977. Includes coal whose location, rank, quality, and quantity are known from geologic evidence supported by engineering measurements.

7/ Includes coal greater than 12 inches thick. Areas underlying the cities of Roslyn, Ronald, and Cle Elum omitted.

8/ Estimates based on reliable data for seam extent and thickness.

9/ Estimates where coal thought to be present, but thickness conjectural.

TABLE 6.--Summary of estimated possible coal reserves (after Tuck and Boyd, 1966)

On Slopes less than 18 degrees

Thickness (1) (inches)			Recovery %			Tons (2)		
Seam	Mining	Coal	Mine	Plant	Total	Class A (3)	Class B (4)	Total
No. 1(	72	48-60	75	65	48.75		11,720,000	11,720,000
No. 2(	36	31	75	75	56.25	4,438,000		
(	36	22	75	50	37.50		6,248,000	
(								10,686,000
No. 5(			Almost completely mined out					
No. 6(	42	35	75	75	56.25	6,359,000		
(	42	23	75	60	45.00		21,785,000	
(								28,144,000
No. 7(	36	21.6	75	50	37.50		12,310,000	12,310,000
No. 8(	48	32.4	75	70	52.50		17,791,000	17,791,000
						10,797,000	69,854,000	80,651,000

On Slopes greater than 18 degrees

No. 1(	72	48-60	75	65	48.75			12,381,000
No. 2(	36	22	75	50	37.50			4,720,000
No. 5(		Estimated by others - 7,000,000 to 10,000,000 tons						
No. 6(	42	23	75	60	45.00			9,802,000
No. 7(	36	21.6	75	50	37.50			7,036,000
No. 8(	48	32.4	75	70	52.50			6,933,000
								40,872,000(5)

(1) Minimum mining thickness of 36 inches and minimum coal thickness of 18 inches.

(2) In terms of usable coal containing not more than 25% ash, not less than 10,000 B.T.U.s, and after mine and plant losses.

(3) Coal comprises 75% or more of the mining thickness, with a minimum of 27 inches of coal.

(4) Coal comprises 50 to 75% of the mining thickness, with a minimum of 18 inches of coal.

(5) Does not include No. 5 seam.

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APPENDIX

GEOLOGY AND ENERGY RESOURCES OF
THE ROSLYN-CLE ELUM AREA

KITTITAS COUNTY, WASHINGTON

by

Charles W. Walker
1980

COAL SAMPLE DATA SHEET

Sample Number: (26)
Sample Date: July 19, 1978
Coal Name(s): #8 seam
Geologic Formation: Roslyn
Age: Eocene
Coal Field: Roslyn
Coal-Bearing Area:
Measured Section:
Total Section Measured: 12'
Cover at Sampling Point: 2'
Elevation Top of Sampled Point: 3000'
Strike & Dip: Approx. east-west strike, 15° south

Section: 36
Township: 21 N.
Range: 14 E.
Quadrangle: USGS Kachess Lake

Coal Description: dirty most part
Coal Thickness: variable 0-2.5'
Coal Sampled: Four places
Type of Sample: grab
Sample Condition: probably representative
Exposure Type: road cut - Dingbat Creek
Mine Name:

Air Dry Loss	Coal (As Received)	Coal (Moist Free)	Coal (Moist, Ash Free)
Proximate Analysis			
Moisture (Mod)	14.7	n/a	n/a
Volatile Matter	25.2	29.6	41.7
Fixed Carbon	35.4	41.4	58.3
Ash	24.7	29.0	n/a
Ultimate Analysis			
Hydrogen	5.1	4.1	5.7
Carbon	44.1	51.8	72.9
Nitrogen	1.0	1.2	1.7
Sulfur	.3	.4	.5
Oxygen (Ind)	24.7	13.6	19.1
Heating Value (BTU/LB)	7584	8894	12528
Ash - Initial Deformation	2910+F		
Softening Temp.	2910+F		
Fluid Temp.	2910+F		
Sulfur Forms			
Sulfate	.01	.01	.01
Pyritic	.20	.23	.33
Organic	.10	.12	.16

Miscellaneous Comments:

Four samples were collected along seam. These samples were then mixed together into one composite sample.

GEOLOGY AND ENERGY RESOURCES OF
THE ROSLYN-CLE ELUM AREA

KITTITAS COUNTY, WASHINGTON

by

Charles W. Walker
1980

COAL SAMPLE DATA SHEET

Sample Number: (27)
Sample Date: August 9, 1978
Coal Name(s): #5 seam (Roslyn)
Geologic Formation: Roslyn
Age: Eocene
Coal Field: Roslyn
Coal-Bearing Area: --
Measured Section: No
Total Section Measured: --
Cover at Sampling Point: 0'
Elevation Top of Sampled Point: 2,245'
Strike & Dip: N 44 E 18° SE

Section: S½ NW¼ sec. 12
Township: 20 N.
Range: 14 E.
Quadrangle: USGS Kachess Lake (15')

Coal Description: Blocky
Coal Thickness: Undetermined
Coal Sampled: 1.5'
Type of Sample: Channel
Sample Condition: Relatively fresh
Exposure Type: Abandoned strip pit
Mine Name: None

Air Dry Loss	Coal (As Received)	Coal (Moist Free)	Coal (Moist, Ash Free)
Proximate Analysis			
Moisture (Mod)	30.5	n/a	n/a
Volatile Matter	23.9	34.4	46.1
Fixed Carbon	27.9	40.1	53.9
Ash	17.7	25.5	n/a
Ultimate Analysis			
Hydrogen	5.6	3.1	4.2
Carbon	35.3	50.8	68.2
Nitrogen	1.1	1.6	2.1
Sulfur	.2	.3	.3
Oxygen (Ind)	40.2	18.8	25.2
Heating Value (BTU/LB)	5510	7931	10639
Ash - Initial Deformation	2210 F		
Softening Temp.	2320 F		
Fluid Temp.	2410 F		
Sulfur Forms			
Sulfate	.01	.01	.01
Pyritic	.14	.19	.26
Organic	.04	.05	.07

Miscellaneous Comments:

Could not sample entire seam due to dip of beds. Western limit of Roslyn seam.

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by

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1980

COAL SAMPLE DATA SHEET

Sample Number: (28)
Sample Date: August 9, 1978
Coal Name(s): #5 (Roslyn seam)
Geologic Formation: Roslyn
Age: Eocene
Coal Field: Roslyn
Coal-Bearing Area: Roslyn-Cascade
Measured Section: yes
Total Section Measured: 30'
Cover at Sampling Point: 26'
Elevation Top of Sampled Point: 2880'ASL
Strike & Dip: N 45° W 10° SW

Section: NW¼ NW¼ sec. 7
Township: 20 N.
Range: 15 E.
Quadrangle: USGS Kachess Lake 15'

Coal Description: Blocky
Coal Thickness: 3.9'
Coal Sampled: 3.9'
Type of Sample: Channel
Sample Condition: Fresh
Exposure Type: Abandoned strip pit
Mine Name: Roslyn-Cascade #4 (?)

Air Dry Loss	Coal (As Received)	Coal (Moist Free)	Coal (Moist, Ash Free)
Proximate Analysis			
Moisture (Mod)	2.5	n/a	n/a
Volatile Matter	35.7	36.7	44.0
Fixed Carbon	45.6	46.7	56.0
Ash	16.2	16.6	n/a
Ultimate Analysis			
Hydrogen	5.2	5.1	6.1
Carbon	66.9	68.6	82.3
Nitrogen	1.6	1.6	1.9
Sulfur	.4	.4	.5
Oxygen (Ind)	9.7	7.7	9.2
Heating Value (BTU/LB)	12118	12431	14914
Ash - Initial Deformation	2450 F		
Softening Temp.	2560 F		
Fluid Temp.	2640 F		
Sulfur Forms			
Sulfate	.01	.01	.01
Pyritic	.16	.16	.20
Organic	.20	.20	.24

Miscellaneous Comments:

Best exposure of #5 seam.

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COAL SAMPLE DATA SHEET

Sample Number: (29)
Sample Date: August 10, 1978
Coal Name(s): #5 Roslyn seam
Geologic Formation: Roslyn
Age: Eocene
Coal Field: Roslyn
Coal-Bearing Area: above #5 mine
Measured Section: yes (not enclosed)
Total Section Measured: 40'
Cover at Sampling Point: 0'
Elevation Top of Sampled Point: 2880'
Strike & Dip: --

Section: S½ NE¼ sec. 16
Township: 20 N.
Range: 15 E.
Quadrangle: USGS Cle Elum 15'

Coal Description: Blocky
Coal Thickness: 4.5' (estimated)
Coal Sampled: lower 3.0' of #5 seam
Type of Sample: Channel
Sample Condition: Fresh
Exposure Type: Abandoned strip pit
Mine Name: None

Air Dry Loss	Coal (As Received)	Coal (Moist Free)	Coal (Moist, Ash Free)
Proximate Analysis			
Moisture (Mod)	27.9	n/a	n/a
Volatile Matter	23.2	32.1	48.0
Fixed Carbon	25.1	34.8	52.0
Ash	23.8	33.1	n/a
Ultimate Analysis			
Hydrogen	5.3	3.0	4.5
Carbon	33.0	45.8	68.5
Nitrogen	.7	1.0	1.5
Sulfur	.3	.4	.7
Oxygen (Ind)	36.8	16.7	24.9
Heating Value (BTU/LB)	5273	7316	10934
Ash - Initial Deformation	2320 F		
Softening Temp.	2410 F		
Fluid Temp.	2510 F		
Sulfur Forms			
Sulfate	.01	.01	.02
Pyritic	.10	.14	.21
Organic	.21	.29	.43

Miscellaneous Comments:

Massive channel sands above seam.

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COAL SAMPLE DATA SHEET

Sample Number: (30)
Sample Date: August 10, 1978
Coal Name(s): #5 (Roslyn seam)
Geologic Formation: Roslyn
Age: Eocene
Coal Field: Roslyn
Coal-Bearing Area: --
Measured Section: yes (not enclosed)
Total Section Measured: --
Cover at Sampling Point: 0'
Elevation Top of Sampled Point: 3300'
Strike & Dip: --

Section: Center NW¼ sec. 15
Township: 20 N.
Range: 15 E.
Quadrangle: USGS Cle Elum 15'

Coal Description: Blocky
Coal Thickness: 2.7'
Coal Sampled: Lower 2.7'
Type of Sample: Channel
Sample Condition: Fresh
Exposure Type: Abandoned strip pit
Mine Name: none

Air Dry Loss	Coal (As Received)	Coal (Moist Free)	Coal (Moist, Ash Free)
Proximate Analysis			
Moisture (Mod)	6.3	n/a	n/a
Volatile Matter	29.6	31.6	39.8
Fixed Carbon	44.8	47.8	60.2
Ash	19.3	20.6	n/a
Ultimate Analysis			
Hydrogen	4.9	4.5	5.7
Carbon	56.7	60.6	76.3
Nitrogen	1.2	1.3	1.6
Sulfur	.4	.4	.6
Oxygen (Ind)	17.3	12.5	15.8
Heating Value (BTU/LB)	9950	10623	13387
Ash - Initial Deformation	2610 F		
Softening Temp.	2715 F		
Fluid Temp.	2910+F		
Sulfur Forms			
Sulfate	.01	.01	.01
Pyritic	.25	.27	.34
Organic	.15	.16	.21

Miscellaneous Comments:

Only strip-pit on northeast side of Cle Elum ridge.

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COAL SAMPLE DATA SHEET

Sample Number: (31)
Sample Date: August 9, 1978
Coal Name(s): #1 (Big Seam)
Geologic Formation: Roslyn
Age: Eocene
Coal Field: Roslyn
Coal-Bearing Area: --
Measured Section: no
Total Section Measured: --
Cover at Sampling Point: 7.8' upper bench
Elevation Top of Sampled Point: 2960'ASL
Strike & Dip: N 80° W., 14° SW

Section: SE¼ NE½ sec. 7
Township: 20 N.
Range: 15 E.
Quadrangle: USGS Kachess Lake 15'

Coal Description: Blocky to slivery
Coal Thickness: 7.25'
Coal Sampled: 5.75' lower bench
Type of Sample: Channel
Sample Condition: Fresh
Exposure Type: Abandoned strip pit
Mine Name: #1 strip pit

Air Dry Loss	Coal (As Received)	Coal (Moist Free)	Coal (Moist, Ash Free)
Proximate Analysis			
Moisture (Mod)	3.8	n/a	n/a
Volatile Matter	25.8	26.8	40.0
Fixed Carbon	38.6	40.2	60.0
Ash	31.8	33.0	n/a
Ultimate Analysis			
Hydrogen	4.3	4.0	6.0
Carbon	50.7	52.7	78.6
Nitrogen	1.2	1.2	1.8
Sulfur	.4	.4	.6
Oxygen (Ind)	11.7	8.6	12.9
Heating Value (BTU/LB)	8974	9329	13929
Ash - Initial Deformation	2910+F		
Softening Temp.	2910+F		
Fluid Temp.	2910+F		
Sulfur Forms			
Sulfate	.01	.01	.02
Pyritic	.18	.18	.27
Organic	.19	.19	.29

Miscellaneous Comments:

Northernmost known outcrop of #1 seam

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COAL SAMPLE DATA SHEET

Sample Number: (32)
Sample Date: August 10, 1978
Coal Name(s): #5 seam (Roslyn)
Geologic Formation: Roslyn
Age: Eocene
Coal Field: Roslyn
Coal-Bearing Area: --
Measured Section: No
Total Section Measured: --
Cover at Sampling Point: 0'
Elevation Top of Sampled Point: 2240'
Strike & Dip: N 45 E 4° SE

Section: SW¼ SW¼ sec. 23
Township: 20 N.
Range: 15 E.
Quadrangle: USGS Cle Elum 15'

Coal Description: Blocky
Coal Thickness: Undetermined (eroded)
Coal Sampled: 3.9' lower bench
Type of Sample: Channel
Sample Condition: Relatively fresh
Exposure Type: Abandoned strip pit
Mine Name: None

Air Dry Loss	Coal (As Received)	Coal (Moist Free)	Coal (Moist, Ash Free)
Proximate Analysis			
Moisture (Mod)	12.4	n/a	n/a
Volatile Matter	29.6	33.8	41.5
Fixed Carbon	41.9	47.8	58.5
Ash	16.1	18.4	n/a
Ultimate Analysis			
Hydrogen	4.5	3.5	4.3
Carbon	53.2	60.7	74.5
Nitrogen	1.2	1.3	1.6
Sulfur	.4	.4	.5
Oxygen (Ind)	24.7	15.6	19.1
Heating Value (BTU/LB)	8857	10115	12399
Ash - Initial Deformation	2910+F		
Softening Temp.	2910+F		
Fluid Temp.	2910+F		
Sulfur Forms			
Sulfate	.01	.01	.01
Pyritic	.19	.22	.27
Organic	.17	.20	.24

Miscellaneous Comments:

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COAL SAMPLE DATA SHEET

Sample Number: (33)
Sample Date: August 9, 1978
Coal Name(s): #1 (big seam)
Geologic Formation: Roslyn
Age: Eocene
Coal Field: Roslyn
Coal-Bearing Area: --
Measured Section: no
Total Section Measured: --
Cover at Sampling Point: 0'
Elevation Top of Sampled Point: 2960'ASL
Strike & Dip: N 80° W, 14° SW

Section: SE¼ NE½ sec. 7
Township: 20 N.
Range: 15 E.
Quadrangle: USGS Kachess Lake 15'

Coal Description: Dirty, boney
Coal Thickness: 7.8'
Coal Sampled: 6.6', upper bench
Type of Sample: Channel
Sample Condition: Fresh
Exposure Type: Abandoned strip pit
Mine Name: #1 strip pit

Air Dry Loss	Coal (As Received)	Coal (Moist Free)	Coal (Moist, Ash Free)
Proximate Analysis			
Moisture (Moa)	10.1	n/a	n/a
Volatile Matter	23.1	25.7	45.1
Fixed Carbon	28.1	31.3	54.9
Ash	38.7	43.0	n/a
Ultimate Analysis			
Hydrogen	3.8	3.0	5.3
Carbon	34.1	37.9	66.5
Nitrogen	.8	.9	1.6
Sulfur	.3	.3	.5
Oxygen (Ind)	22.3	14.8	26.0
Heating Value (BTU/LB)	5884	6545	11487
Ash - Initial Deformation	2910+F		
Softening Temp.	2910+F		
Fluid Temp.	2910+F		
Sulfur Forms			
Sulfate	.01	.01	.02
Pyritic	.15	.17	.29
Organic	.12	.13	.24

Miscellaneous Comments:

Northernmost known outcrop of #1 seam.

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COAL SAMPLE DATA SHEET

Sample Number: (34)
Sample Date: August 10, 1978
Coal Name(s): #5 Roslyn seam
Geologic Formation: Roslyn
Age: Eocene
Coal Field: Roslyn
Coal-Bearing Area: --
Measured Section: yes (not enclosed)
Total Section Measured: 40'
Cover at Sampling Point: 0'
Elevation Top of Sampled Point: 2960'ASL
Strike & Dip: N 70' W, 14° SW

Section: E½ SE¼ sec. 15
Township: 20 N.
Range: 15 E.
Quadrangle: USGS Cle Elum 15'
Coal Description: Blocky, slivery
Coal Thickness: 4.3'
Coal Sampled: 4.3'
Type of Sample: Channel
Sample Condition: Fresh
Exposure Type: Abandoned strip pit
Mine Name: None

Air Dry Loss	Coal (As Received)	Coal (Moist Free)	Coal (Moist, Ash Free)
Proximate Analysis			
Moisture (Mod)	12.0	n/a	n/a
Volatile Matter	27.5	31.2	41.1
Fixed Carbon	39.3	44.7	58.9
Ash	21.2	24.1	n/a
Ultimate Analysis			
Hydrogen	5.1	4.3	5.6
Carbon	50.6	57.5	75.7
Nitrogen	1.1	1.2	1.6
Sulfur	.3	.4	.5
Oxygen (Ind)	21.7	12.6	16.6
Heating Value (BTU/LB)	8726	9912	13055
Ash - Initial Deformation	2910+F		
Softening Temp.	2910+F		
Fluid Temp.	2910+F		
Sulfur Forms			
Sulfate	.01	.01	.01
Pyritic	.19	.22	.29
Organic	.13	.15	.19

Miscellaneous Comments:

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COAL SAMPLE DATA SHEET

Sample Number: (35)
Sample Date: August 9, 1978
Coal Name(s): #1 (big seam, lower bench)
Geologic Formation: Roslyn
Age: Eocene
Coal Field: Roslyn
Coal-Bearing Area: --
Measured Section: yes (enclosed)
Total Section Measured: 19.3'
Cover at Sampling Point: 12.6'
Elevation Top of Sampled Point: 2880'
Strike & Dip: N 80° W, 14° SW

Section: NW¼ SW¼ sec. 8
Township: 20 N.
Range: 15 E.
Quadrangle: USGS Kachess Lake 15'

Coal Description: Blocky
Coal Thickness: 6.7'
Coal Sampled: 5.4'
Type of Sample: Channel
Sample Condition: Fresh
Exposure Type: Abandoned strip pit
Mine Name: #1 strip pit

Air Dry Loss	Coal (As Received)	Coal (Moist Free)	Coal (Moist, Ash Free)
Proximate Analysis			
Moisture (Mod)	3.6	n/a	n/a
Volatile Matter	27.1	28.1	41.8
Fixed Carbon	37.8	39.2	58.2
Ash	31.5	32.7	n/a
Ultimate Analysis			
Hydrogen	4.4	4.1	6.1
Carbon	50.2	52.1	77.4
Nitrogen	1.1	1.1	1.7
Sulfur	.3	.4	.5
Oxygen (Ind)	12.4	9.6	14.3
Heating Value (BTU/LB)	8819	9148	13597
Ash - Initial Deformation	2440 F		
Softening Temp.	2560 F		
Fluid Temp.	2670 F		
Sulfur Forms			
Sulfate	.01	.01	.02
Pyritic	.19	.19	.29
Organic	.15	.15	.23

Miscellaneous Comments:

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COAL SAMPLE DATA SHEET

Sample Number: (36)
Sample Date: September 28, 1978
Coal Name(s): Unknown
Geologic Formation: Roslyn
Age: Eocene
Coal Field: none
Coal-Bearing Area: Roslyn
Measured Section: No
Total Section Measured:
Cover at Sampling Point: none
Elevation Top of Sampled Point: 2240'
Strike & Dip: N 8° W, 85° NE

Section: SE¼ sec. 4
Township: 20 N.
Range: 14 E.
Quadrangle: USGS Kachess Lake 15'

Coal Description: Fairly weathered
Coal Thickness: 1 to 2 feet
Coal Sampled: 1 foot
Type of Sample: Spot grab
Sample Condition: Fair
Exposure Type: Crop along lake
Mine Name:

Air Dry Loss	Coal (As Received)	Coal (Moist Free)	Coal (Moist, Ash Free)
Proximate Analysis			
Moisture (Mod)	5.8	n/a	n/a
Volatile Matter	28.2	29.9	34.7
Fixed Carbon	53.1	56.5	65.3
Ash	12.8	13.6	n/a
Ultimate Analysis			
Hydrogen	5.2	4.8	5.6
Carbon	66.6	70.8	82.0
Nitrogen	1.1	1.2	1.4
Sulfur	.7	.7	.8
Oxygen (Ind)	13.6	8.8	10.2
Heating Value (BTU/LB)	11678	12410	14372
Ash - Initial Deformation	2100 F		
Softening Temp.	2220 F		
Fluid Temp.	2310 F		
Sulfur Forms			
Sulfate	.01	.01	.01
Pyritic	.11	.11	.13
Organic	.53	.57	.66

Miscellaneous Comments:

Coal seam crops along the bank on the SW side of Cle Elum Lake. During high water the seam is inundated.

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COAL SAMPLE DATA SHEET

Sample Number: (46)
Sample Date: November 2, 1978
Coal Name(s): #1 seam (Big Dirty)
Geologic Formation: Roslyn
Age: Eocene
Coal Field: Roslyn
Coal-Bearing Area: Roslyn-Cle Elum
Measured Section: No
Total Section Measured:
Cover at Sampling Point: 8'
Elevation Top of Sampled Point: 2400'
Strike & Dip: N 40° W 16° SW

Section: 17
Township: 20 N
Range: 15 E.
Quadrangle: USGS Cle Elum 15'

Coal Description: Deformed by folding
Coal Thickness: About 18'
Coal Sampled: Lower 1' of upper bench
Type of Sample: Grab
Sample Condition: Good
Exposure Type: Dozer cut
Mine Name: Below #8 Mine Tramway

Air Dry Loss	Coal (As Received)	Coal (Moist Free)	Coal (Moist, Ash Free)
Proximate Analysis			
Moisture (Mod)	3.7	n/a	n/a
Volatile Matter	31.3	32.5	45.4
Fixed Carbon	37.6	39.1	54.6
Ash	27.4	28.4	n/a
Ultimate Analysis			
Hydrogen	4.9	4.7	6.5
Carbon	54.8	56.1	78.4
Nitrogen	1.5	1.6	2.2
Sulfur	.5	.5	.7
Oxygen (Ind)	11.6	8.6	12.0
Heating Value (BTU/LB)	9658	10028	14012
Ash - Initial Deformation	2910+F		
Softening Temp.	2910+F		
Fluid Temp.	2910+F		
Sulfur Forms			
Sulfate	.01	.01	.01
Pyritic	.06	.06	.09
Organic	.40	.42	.59

Miscellaneous Comments:

Coal seam was opened up by dozer. A series of small, overturned, recumbent folds were observed. Most of the deformation is restricted to an approximately 7' thick zone. This zone is bounded on the bottom by a 6 inch bone layer and on the top by a thin-bedded carbonaceous shale.

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COAL SAMPLE DATA SHEET

Sample Number: (47)
Sample Date: May 1, 1979
Coal Name(s): Patrick Seam
Geologic Formation: Roslyn
Age: Eocene
Coal Field: Roslyn
Coal-Bearing Area: Roslyn-Cle Elum
Measured Section: Yes
Total Section Measured: 4'
Cover at Sampling Point: 2'
Elevation Top of Sampled Point: 2900'
Strike & Dip: N 70° W 12° SW

Section: 19
Township: 20 N.
Range: 16 E.
Quadrangle: USGS Cle Elum 15'

Coal Description: Weak cleating
Coal Thickness: 2.2'
Coal Sampled: 2.2'
Type of Sample: channel
Sample Condition: weathered
Exposure Type: crop at drift entranch
Mine Name:

Air Dry Loss	Coal (As Received)	Coal (Moist Free)	Coal (Moist, Ash Free)
Proximate Analysis			
Moisture (Mod)	30.9	n/a	n/a
Volatile Matter	25.5	36.9	53.3
Fixed Carbon	22.3	32.3	46.7
Ash	21.3	30.8	n/a
Ultimate Analysis			
Hydrogen	5.2	2.5	3.6
Carbon	30.8	44.6	64.5
Nitrogen	.8	1.1	1.6
Sulfur	.3	.5	.7
Oxygen (Ind)	41.7	20.5	29.6
Heating Value (BTU/LB)	4626	6699	9686
Ash - Initial Deformation	2560 F		
Softening Temp.	2650 F		
Fluid Temp.	2740 F		
Sulfur Forms			
Sulfate	.01	.01	.02
Pyritic	.03	.05	.07
Organic	.29	.43	.62

Miscellaneous Comments:

Coal seam exposed by shoveling next to old, timbered drift in hillside.

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COAL SAMPLE DATA SHEET

Sample Number: (48)
Sample Date: May 3, 1979
Coal Name(s): Lanigan Seam
Geologic Formation: Roslyn
Age: Eocene
Coal Field: Roslyn
Coal-Bearing Area: Roslyn-Cle Elum
Measured Section: Yes
Total Section Measured: 12'
Cover at Sampling Point: 4'
Elevation Top of Sampled Point: 2500'
Strike & Dip: N 60° W 10-25° SW

Section: 19
Township: 20 N.
Range: 16 E.
Quadrangle: USGS Cle Elum 15'

Coal Description: Deformed & brecciated
Coal Thickness: 5.6'
Coal Sampled: 2.1' (upper)
Type of Sample: channel
Sample Condition: weathered
Exposure Type: crop exposed by shoveling
Mine Name:

Air Dry Loss	Coal (As Received)	Coal (Moist Free)	Coal (Moist, Ash Free)
Proximate Analysis			
Moisture (Mod)	32.4	n/a	n/a
Volatile Matter	26.0	38.4	52.1
Fixed Carbon	23.8	35.3	47.9
Ash	17.8	26.3	n/a
Ultimate Analysis			
Hydrogen	5.8	3.2	4.4
Carbon	32.3	47.8	64.9
Nitrogen	.8	1.2	1.7
Sulfur	.3	.4	.5
Oxygen (Ind)	43.0	21.0	28.5
Heating Value (BTU/LB)	4970	7354	9977
Ash - Initial Deformation	2540 F		
Softening Temp.	2620 F		
Fluid Temp.	2710 F		
Sulfur Forms			
Sulfate	.01	.01	.02
Pyritic	.03	.05	.06
Organic	.23	.34	.46

Miscellaneous Comments:

2.1' of fairly clean coal above 1" thick brown clay parting. Upper surface of coal has been eroded.

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COAL SAMPLE DATA SHEET

Sample Number: (49)
Sample Date: May 3, 1979
Coal Name(s): Lanigan Seam
Geologic Formation: Roslyn
Age: Eocene
Coal Field: Roslyn
Coal-Bearing Area: Roslyn-Cle Elum
Measured Section: Yes
Total Section Measured: 12'
Cover at Sampling Point: 6.1'
Elevation Top of Sampled Point: 2500'
Strike & Dip: N 60° W 10-25° SW

Section: 19
Township: 20 N.
Range: 16 E.
Quadrangle: USGS Cle Elum 15'

Coal Description: Deformed and brecciated
Coal Thickness: 5.6'
Coal Sampled: 2.5' (middle)
Type of Sample: channel
Sample Condition: weathered
Exposure Type: crop exposed by shoveling
Mine Name:

Air Dry Loss	Coal (As Received)	Coal (Moist Free)	Coal (Moist, Ash Free)
Proximate Analysis			
Moisture (Mod)	28.1	n/a	n/a
Volatile Matter	25.9	36.0	51.8
Fixed Carbon	24.1	33.6	48.2
Ash	21.9	30.4	n/a
Ultimate Analysis			
Hydrogen	5.0	2.6	3.7
Carbon	32.7	45.5	65.5
Nitrogen	.8	1.2	1.7
Sulfur	.3	.4	.5
Oxygen (Ind)	39.3	19.9	28.6
Heating Value (BTU/LB)	5049	7021	10094
Ash - Initial Deformation	2800 F		
Softening Temp.	2800 F		
Fluid Temp.	2800 F		
Sulfur Forms			
Sulfate	.01	.01	.02
Pyritic	.04	.06	.09
Organic	.22	.30	.43

Miscellaneous Comments:

2.5' of fairly dirty coal above a 2" thick tan clay parting and below a 1" thick brown clay parting.

GEOLOGY AND ENERGY RESOURCES OF
THE ROSLYN-CLE ELUM AREA

KITTITAS COUNTY, WASHINGTON

by

Charles W. Walker
1980

COAL SAMPLE DATA SHEET

Sample Number: (50)
Sample Date: May 8, 1979
Coal Name(s): Lanigan Seam
Geologic Formation: Roslyn
Age: Eocene
Coal Field: Roslyn
Coal-Bearing Area: Roslyn-Cle Elum
Measured Section: Yes
Total Section Measured: 23'
Cover at Sampling Point: 8'
Elevation Top of Sampled Point: 2500'
Strike & Dip: N 50° W 10-25° SW

Section: 19
Township: 20 N.
Range: 16 E.
Quadrangle: USGS Cle Elum 15'

Coal Description: deformed & brecciated
Coal Thickness: 15.4'
Coal Sampled: 4' (upper)
Type of Sample: channel
Sample Condition: weathered
Exposure Type: crop exposed by shoveling
Mine Name:

Air Dry Loss	Coal (As Received)	Coal (Moist Free)	Coal (Moist, Ash Free)
Proximate Analysis			
Moisture (Mod)	33.5	n/a	n/a
Volatile Matter	26.7	40.2	58.5
Fixed Carbon	19.0	28.5	41.5
Ash	20.8	31.3	n/a
Ultimate Analysis			
Hydrogen	5.5	2.6	3.8
Carbon	29.1	43.8	63.7
Nitrogen	.8	1.2	1.7
Sulfur	.2	.4	.5
Oxygen (Ind)	43.6	20.8	30.2
Heating Value (BTU/LB)	4462	6712	9765
Ash - Initial Deformation	2800 F		
Softening Temp.	2800 F		
Fluid Temp.	2800 F		
Sulfur Forms			
Sulfate	.01	.02	.02
Pyritic	.02	.04	.05
Organic	.21	.32	.47

Miscellaneous Comments:

4' of fairly clean coal above a 1" clay parting and below a 1" sandy clay parting.

GEOLOGY AND ENERGY RESOURCES OF
THE ROSLYN-CLE ELUM AREA

KITTITAS COUNTY, WASHINGTON

by

Charles W. Walker
1980

COAL SAMPLE DATA SHEET

Sample Number: (51)
Sample Date: May 8, 1979
Coal Name(s): Lanigan Seam
Geologic Formation: Roslyn
Age: Eocene
Coal Field: Roslyn
Coal-Bearing Area: Roslyn-Cle Elum
Measured Section: Yes
Total Section Measured: 23'
Cover at Sampling Point: 15'
Elevation Top of Sampled Point: 2500'
Strike & Dip: N 50° W 10-25° SW

Section: 19
Township: 20 N.
Range: 16 E.
Quadrangle: USGS Cle Elum 15'

Coal Description: deformed & brecciated
Coal Thickness: 15.4'
Coal Sampled: 0.5'
Type of Sample: channel
Sample Condition: weathered
Exposure Type: crop exposed by shoveling
Mine Name:

Air Dry Loss	Coal (As Received)	Coal (Moist Free)	Coal (Moist, Ash Free)
Proximate Analysis			
Moisture (Mod)	20.0	n/a	n/a
Volatile Matter	27.3	34.1	42.9
Fixed Carbon	36.4	45.5	57.1
Ash	16.3	20.4	n/a
Ultimate Analysis			
Hydrogen	5.8	4.5	5.6
Carbon	49.3	61.5	77.3
Nitrogen	1.0	1.3	1.6
Sulfur	.4	.5	.6
Oxygen (Ind)	27.2	11.9	14.9
Heating Value (BTU/LB)	8675	10839	13609
Ash - Initial Deformation	2800 F		
Softening Temp.	2800 F		
Fluid Temp.	2800 F		
Sulfur Forms			
Sulfate	.01	.01	.02
Pyritic	.03	.04	.05
Organic	.37	.46	.58

Miscellaneous Comments:

Lowest coal exposed in hand dug pit. Somewhat boney.

GEOLOGY AND ENERGY RESOURCES OF
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KITTITAS COUNTY, WASHINGTON

by

Charles W. Walker
1980

COAL SAMPLE DATA SHEET

Sample Number: (52)
Sample Date: May 8, 1979
Coal Name(s): Lanigan Seam
Geologic Formation: Roslyn
Age: Eocene
Coal Field: Roslyn
Coal-Bearing Area: Roslyn-Cle Elum
Measured Section: Yes
Total Section Measured: 23'
Cover at Sampling Point: 8'
Elevation Top of Sampled Point: 2500'
Strike & Dip: N 50° W 10-25° SW

Section: 19
Township: 20 N.
Range: 16 E.
Quadrangle: USGS Cle Elum 15'

Coal Description: deformed & brecciated
Coal Thickness: 15.4'
Coal Sampled: 7.5' (upper)
Type of Sample: channel
Sample Condition: weathered
Exposure Type: crop exposed by shovelin
Mine Name:

Air Dry Loss	Coal (As Received)	Coal (Moist Free)	Coal (Moist, Ash Free)
Proximate Analysis			
Moisture (Mod)	29.5	n/a	n/a
Volatile Matter	23.2	33.0	52.8
Fixed Carbon	20.8	29.5	47.2
Ash	26.5	37.5	n/a
Ultimate Analysis			
Hydrogen	5.4	3.1	4.9
Carbon	28.4	40.2	64.4
Nitrogen	.7	1.0	1.6
Sulfur	.3	.4	.6
Oxygen (Ind)	38.7	17.8	28.4
Heating Value (BTU/LB)	4437	6291	10073
Ash - Initial Deformation	2800+F		
Softening Temp.	2800+F		
Fluid Temp.	2800+F		
Sulfur Forms			
Sulfate	.01	.02	.03
Pyritic	.04	.06	.09
Organic	.21	.30	.47

Miscellaneous Comments:

Composite sample of all coal exposed in hand dug pit.

GEOLOGY AND ENERGY RESOURCES OF
THE ROSLYN-CLE ELUM AREA

KITTITAS COUNTY, WASHINGTON

by

Charles W. Walker
1980

COAL SAMPLE DATA SHEET

Sample Number: (53)
Sample Date: June 6, 1979
Coal Name(s): None
Geologic Formation: Roslyn
Age: Eocene
Coal Field: none
Coal-Bearing Area: Roslyn-Cle Elum
Measured Section: Yes
Total Section Measured: 61'
Cover at Sampling Point: 17'
Elevation Top of Sampled Point: 2300'
Strike & Dip: N 60° W 42° NE

Section: 15
Township: 20 N.
Range: 16 E.
Quadrangle: USGS Cle Elum 15'

Coal Description: deformed & brecciated
Coal Thickness: 1'
Coal Sampled: 1'
Type of Sample: grab
Sample Condition: weathered
Exposure Type: stream cut
Mine Name:

Air Dry Loss	Coal (As Received)	Coal (Moist Free)	Coal (Moist, Ash Free)
Proximate Analysis			
Moisture (Mod)	12.7	n/a	n/a
Volatile Matter	17.3	19.8	73.0
Fixed Carbon	6.4	7.4	27.0
Ash	63.6	72.8	n/a
Ultimate Analysis			
Hydrogen	2.9	.18	6.5
Carbon	13.2	15.1	55.6
Nitrogen	.4	.4	1.5
Sulfur	.2	.2	.7
Oxygen (Ind)	19.8	9.8	35.9
Heating Value (BTU/LB)	1798	2059	7577
Ash - Initial Deformation	2800 F		
Softening Temp.	2800 F		
Fluid Temp.	2800 F		
Sulfur Forms			
Sulfate	.02	.02	.08
Pyritic	.09	.11	.40
Organic	.04	.05	.18

Miscellaneous Comments:

Coal is irregular in thickness and quality. Lower, Middle Roslyn.

GEOLOGY AND ENERGY RESOURCES OF
THE ROSLYN-CLE ELUM AREA

KITTITAS COUNTY, WASHINGTON

by

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1980

COAL SAMPLE DATA SHEET

Sample Number: (55)
Sample Date: June 7, 1979
Coal Name(s): #7?
Geologic Formation: Roslyn
Age: Eocene
Coal Field: Roslyn
Coal-Bearing Area: Roslyn-Cle Elum
Measured Section: Yes
Total Section Measured: 3'
Cover at Sampling Point: 2'
Elevation Top of Sampled Point: 2350'
Strike & Dip: ?

Section: 24
Township: 20 N.
Range: 15 E.
Quadrangle: USGS Cle Elum 15'

Coal Description: dirty & irregular bedded
Coal Thickness: 0.2'-1.0'
Coal Sampled: 1.0'
Type of Sample: grab
Sample Condition: weathered
Exposure Type: road cut
Mine Name:

Air Dry Loss	Coal (As Received)	Coal (Moist Free)	Coal (Moist, Ash Free)
Proximate Analysis			
Moisture (Mod)	11.7	n/a	n/a
Volatile Matter	19.4	22.0	64.6
Fixed Carbon	10.6	12.0	35.4
Ash	58.3	66.0	n/a
Ultimate Analysis			
Hydrogen	3.2	2.2	6.3
Carbon	16.8	19.0	56.0
Nitrogen	.5	.6	1.8
Sulfur	.2	.2	.6
Oxygen (Ind)	21.0	11.9	35.1
Heating Value (BTU/LB)	2527	2863	8424
Ash - Initial Deformation	2800+F		
Softening Temp.	2800+F		
Fluid Temp.	2800+F		
Sulfur Forms			
Sulfate	.01	.01	.04
Pyritic	.07	.08	.22
Organic	.10	.11	.32

Miscellaneous Comments:

GEOLOGY AND ENERGY RESOURCES OF
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COAL SAMPLE DATA SHEET

Sample Number: (56)
Sample Date: June 7, 1979
Coal Name(s): #8?
Geologic Formation: Roslyn
Age: Eocene
Coal Field: Roslyn
Coal-Bearing Area: Roslyn-Cle Elum
Measured Section: Yes
Total Section Measured: 11'
Cover at Sampling Point: 2-3'
Elevation Top of Sampled Point: 2470'
Strike & Dip: ?

Section: 24
Township: 20 N.
Range: 15 E.
Quadrangle: USGS Cle Elum 15'

Coal Description: dirty & irregular bedded
Coal Thickness: 0.1-0.5'
Coal Sampled: 0.5'
Type of Sample: grab
Sample Condition: weathered
Exposure Type: road cut
Mine Name:

Air Dry Loss	Coal (As Received)	Coal (Moist Free)	Coal (Moist, Ash Free)
Proximate Analysis			
Moisture (Mod)	11.1	n/a	n/a
Volatile Matter	14.0	15.8	103.8
Fixed Carbon	--	--	--
Ash	75.4	84.8	n/a
Ultimate Analysis			
Hydrogen	2.7	1.7	11.0
Carbon	3.9	4.4	28.6
Nitrogen	.3	.4	2.4
Sulfur	.1	.1	.5
Oxygen (Ind)	17.7	8.8	57.6
Heating Value (BTU/LB)	271	305	2008
Ash - Initial Deformation	2800 F		
Softening Temp.	2800 F		
Fluid Temp.	2800 F		
Sulfur Forms			
Sulfate	.01	.01	.09
Pyritic	.05	.05	.35
Organic	.00	.00	.03

Miscellaneous Comments:

GEOLOGY AND ENERGY RESOURCES OF
THE ROSLYN-CLE ELUM AREA

KITTITAS COUNTY, WASHINGTON

by

Charles W. Walker
1980

COAL SAMPLE DATA SHEET

Sample Number: (57)
Sample Date: June 7, 1979
Coal Name(s): none
Geologic Formation: Roslyn
Age: Eocene
Coal Field: none
Coal-Bearing Area: Roslyn-Cle Elum
Measured Section: yes
Total Section Measured: 128'
Cover at Sampling Point: 125'
Elevation Top of Sampled Point: 2000'
Strike & Dip: N 55° W 16° SW

Section: 24
Township: 20 N.
Range: 16 E.
Quadrangle: USGS Cle Elum 15'

Coal Description: somewhat dirty, blocky
Coal Thickness: 2-4'
Coal Sampled: 3'
Type of Sample: channel
Sample Condition: weathered
Exposure Type: river cut
Mine Name:

Air Dry Loss	Coal (As Received)	Coal (Moist Free)	Coal (Moist, Ash Free)
Proximate Analysis			
Moisture (Mod)	8.4	n/a	n/a
Volatile Matter	27.0	29.5	54.6
Fixed Carbon	22.5	24.5	45.4
Ash	42.1	46.0	n/a
Ultimate Analysis			
Hydrogen	4.3	3.7	6.9
Carbon	35.4	38.7	71.5
Nitrogen	.8	.9	1.7
Sulfur	.4	.4	.8
Oxygen (Ind)	16.9	10.3	19.1
Heating Value (BTU/LB)	6332	6916	12797
Ash - Initial Deformation	2800 F		
Softening Temp.	2800 F		
Fluid Temp.	2800 F		
Sulfur Forms			
Sulfate	.01	.01	.02
Pyritic	.06	.06	.12
Organic	.32	.35	.65

Miscellaneous Comments:

Coal is in lower Middle Roslyn. Exposed along the Teanaway River.

GEOLOGY AND ENERGY RESOURCES OF
THE ROSLYN-CLE ELUM AREA

KITTITAS COUNTY, WASHINGTON

by

Charles W. Walker
1980

COAL SAMPLE DATA SHEET

Sample Number: (58)
Sample Date: June 13, 1979
Coal Name(s): None
Geologic Formation: Roslyn
Age: Eocene
Coal Field: None
Coal-Bearing Area: Roslyn-Cle Elum
Measured Section: Yes
Total Section Measured: 97'
Cover at Sampling Point: 82'
Elevation Top of Sampled Point: 2750'
Strike & Dip: N 75° W 25° SW

Section: 27
Township: 21 N.
Range: 14 E.
Quadrangle: USGS Kachess Lake 15'

Coal Description: Dirty and boney
Coal Thickness: 1.5'
Coal Sampled: 1.5'
Type of Sample: channel
Sample Condition: weathered
Exposure Type: road cut
Mine Name:

Air Dry Loss	Coal (As Received)	Coal (Moist Free)	Coal (Moist, Ash Free)
Proximate Analysis			
Moisture (Mod)	8.8	n/a	n/a
Volatile Matter	13.6	14.9	50.8
Fixed Carbon	13.2	14.5	49.2
Ash	64.4	70.6	n/a
Ultimate Analysis			
Hydrogen	2.8	2.0	6.7
Carbon	18.4	20.2	68.7
Nitrogen	.4	.5	1.7
Sulfur	.2	.2	.6
Oxygen (Ind)	13.8	6.5	22.3
Heating Value (BTU/LB)	3014	3304	11249
Ash - Initial Deformation	2180 F		
Softening Temp.	2270 F		
Fluid Temp.	2390 F		
Sulfur Forms			
Sulfate	.01	.01	.03
Pyritic	.09	.10	.34
Organic	.07	.07	.25

Miscellaneous Comments:

Coal is in the lower part of the lower Roslyn - probably within 1000 ft. of the Teanaway-Roslyn contact.

GEOLOGY AND ENERGY RESOURCES OF
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KITTITAS COUNTY, WASHINGTON

by

Charles W. Walker
1980

COAL SAMPLE DATA SHEET

Sample Number: (59)
Sample Date: June 27, 1979
Coal Name(s): Lanigan Seam
Geologic Formation: Roslyn
Age: Eocene
Coal Field: Roslyn
Coal-Bearing Area: Roslyn-Cle Elum
Measured Section: Yes
Total Section Measured: 20'
Cover at Sampling Point: 4'
Elevation Top of Sampled Point: 2500'
Strike & Dip: N 50° W-variable dip

Section: 19
Township: 20 N.
Range: 16 E.
Quadrangle: USGS Cle Elum 15'

Coal Description: Deformed & brecciated
Coal Thickness: 15.4'
Coal Sampled: 15.4'
Type of Sample: channel (composite)
Sample Condition: partially weathered
Exposure Type: pit
Mine Name:

Air Dry Loss	Coal (As Received)	Coal (Moist Free)	Coal (Moist, Ash Free)
Proximate Analysis			
Moisture (Mod)	12.8	n/a	n/a
Volatile Matter	31.4	36.0	45.5
Fixed Carbon	37.6	43.1	54.5
Ash	18.2	20.9	n/a
Ultimate Analysis			
Hydrogen	5.6	4.8	6.1
Carbon	52.8	60.5	76.4
Nitrogen	1.1	1.3	1.6
Sulfur	.5	.6	.7
Oxygen (Ind)	21.8	12.0	15.2
Heating Value (BTU/LB)	9389	10762	13599
Ash - Initial Deformation	2800+F		
Softening Temp.	2800+F		
Fluid Temp.	2800+F		
Sulfur Forms			
Sulfate	.02	.03	.04
Pyritic	.12	.14	.18
Organic	.35	.40	.50

Miscellaneous Comments:

Pit A dug by backhoe.

GEOLOGY AND ENERGY RESOURCES OF
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KITTITAS COUNTY, WASHINGTON

by

Charles W. Walker
1980

COAL SAMPLE DATA SHEET

Sample Number: (60)
Sample Date: June 27, 1979
Coal Name(s): Lanigan Seam
Geologic Formation: Roslyn
Age: Eocene
Coal Field: Roslyn
Coal-Bearing Area: Roslyn-Cle Elum
Measured Section: Yes
Total Section Measured: 24'
Cover at Sampling Point: 12'
Elevation Top of Sampled Point: 2500'
Strike & Dip: N 50° W-variable dip

Section: 19
Township: 20 N.
Range: 16 E.
Quadrangle: USGS Cle Elum 15'

Coal Description: deformed and brecciated
Coal Thickness: 10' +
Coal Sampled: 10'
Type of Sample: channel (composite)
Sample Condition: partially weathered
Exposure Type: pit
Mine Name:

Air Dry Loss	Coal (As Received)	Coal (Moist Free)	Coal (Moist, Ash Free)
Proximate Analysis			
Moisture (Mod)	17.4	n/a	n/a
Volatile Matter	28.0	33.9	46.6
Fixed Carbon	32.1	38.8	53.4
Ash	22.5	27.3	n/a
Ultimate Analysis			
Hydrogen	5.6	4.5	6.1
Carbon	43.6	52.8	72.6
Nitrogen	1.0	1.2	1.7
Sulfur	.4	.5	.6
Oxygen (Ind)	26.8	13.8	19.0
Heating Value (BTU/LB)	7451	9019	12402
Ash - Initial Deformation	2800+F		
Softening Temp.	2800+F		
Fluid Temp.	2800+F		
Sulfur Forms			
Sulfate	.02	.02	.03
Pyritic	.06	.07	.09
Organic	.30	.37	.50

Miscellaneous Comments:

Pit B dug by backhoe. Bottom of pit still in coal.

GEOLOGY AND ENERGY RESOURCES OF
THE ROSLYN-CLE ELUM AREA

KITTITAS COUNTY, WASHINGTON

by

Charles W. Walker
1980

COAL SAMPLE DATA SHEET

Sample Number: (61)
Sample Date: June 27, 1979
Coal Name(s): Lanigan Seam
Geologic Formation: Roslyn
Age: Eocene
Coal Field: Roslyn
Coal-Bearing Area: Roslyn-Cle Elum
Measured Section: Yes
Total Section Measured: 19'
Cover at Sampling Point: 4'
Elevation Top of Sampled Point: 2500'
Strike & Dip: N 50° W-variable dip

Section: 19
Township: 20 N.
Range: 16 E.
Quadrangle: USGS Cle Elum 15'
Coal Description: deformed and brecciated
Coal Thickness: 13'
Coal Sampled: 13'
Type of Sample: channel (composite)
Sample Condition: partially weathered
Exposure Type: pit
Mine Name:

Air Dry Loss	Coal (As Received)	Coal (Moist Free)	Coal (Moist, Ash Free)
Proximate Analysis			
Moisture (Mod)	23.4	n/a	n/a
Volatile Matter	26.4	34.5	52.3
Fixed Carbon	24.1	31.4	47.7
Ash	26.1	34.1	n/a
Ultimate Analysis			
Hydrogen	5.0	3.1	4.7
Carbon	33.6	43.8	66.5
Nitrogen	.9	1.1	1.7
Sulfur	.3	.4	.6
Oxygen (Ind)	34.2	17.5	26.5
Heating Value (BTU/LB)	5360	7001	10616
Ash - Initial Deformation	2800+F		
Softening Temp.	2800+F		
Fluid Temp.	2800+F		
Sulfur Forms			
Sulfate	.02	.03	.05
Pyritic	.07	.09	.14
Organic	.19	.24	.37

Miscellaneous Comments:

Pit C dug by backhoe.

GEOLOGY AND ENERGY RESOURCES OF THE ROSLYN-CLE ELUM AREA KITTITAS COUNTY, WASHINGTON

by

Charles W. Walker
1980

COAL SAMPLE DATA SHEET

Sample Number: (62)
Sample Date: June 27, 1979
Coal Name(s): None
Geologic Formation: Manastash
Age: Eocene
Coal Field: None
Coal-Bearing Area: South Cle Elum
Measured Section: Yes
Total Section Measured: 25'
Cover at Sampling Point: 10'
Elevation Top of Sampled Point: 2120'
Strike & Dip: N 45° E 15° NW

Section: 4
Township: 19 N.
Range: 15 E.
Quadrangle: USGS Cle Elum 15'

Coal Description: dirty
Coal Thickness: variable, 0.4' at sample pt
Coal Sampled: 0.4'
Type of Sample: grab
Sample Condition: weathered
Exposure Type: road cut
Mine Name:

Air Dry Loss	Coal (As Received)	Coal (Moist Free)	Coal (Moist, Ash Free)
Proximate Analysis			
Moisture (Mod)	13.6	n/a	n/a
Volatile Matter	10.8	12.5	86.4
Fixed Carbon	1.7	2.0	13.6
Ash	73.9	85.5	n/a
Ultimate Analysis			
Hydrogen	2.9	1.6	11.3
Carbon	6.3	7.3	50.4
Nitrogen	.4	.5	3.2
Sulfur	.1	.1	.9
Oxygen (Ind)	16.3	4.9	34.0
Heating Value (BTU/LB)	852	985	6791
Ash - Initial Deformation	2120 F		
Softening Temp.	2230 F		
Fluid Temp.	2340 F		
Sulfur Forms			
Sulfate	.01	.01	.10
Pyritic	.06	.07	.51
Organic	.04	.04	.29

Miscellaneous Comments:

Coal is cut by andesitic dike about 12' north of sample point.

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KITTITAS COUNTY, WASHINGTON

by

Charles W. Walker
1980

COAL SAMPLE DATA SHEET

Sample Number: (68)
Sample Date: June 28, 1979
Coal Name(s): None
Geologic Formation: Lower Roslyn
Age: Eocene
Coal Field: None
Coal-Bearing Area: Roslyn-Cle Elum
Measured Section: Yes
Total Section Measured: 34'
Cover at Sampling Point: 0-60'
Elevation Top of Sampled Point: 2720'
Strike & Dip: N 15° E 8° NW

Section: 5
Township: 21 N.
Range: 16 E.
Quadrangle: USGS Mt. Stuart 15'

Coal Description: Blocky
Coal Thickness: 2.5'
Coal Sampled: 2.5'
Type of Sample: channel
Sample Condition: weathered
Exposure Type: road cut
Mine Name:

Air Dry Loss	Coal (As Received)	Coal (Moist Free)	Coal (Moist, Ash Free)
Proximate Analysis			
Moisture (Mod)	6.1	n/a	n/a
Volatile Matter	17.1	18.2	53.4
Fixed Carbon	14.9	15.9	46.6
Ash	61.9	65.9	n/a
Ultimate Analysis			
Hydrogen	3.2	2.7	7.9
Carbon	20.2	21.5	63.2
Nitrogen	.5	.5	1.5
Sulfur	.2	.2	.6
Oxygen (Ind)	14.1	9.2	26.9
Heating Value (BTU/LB)	3281	3496	10261
Ash - Initial Deformation	2800+F		
Softening Temp.	2800+F		
Fluid Temp.	2800+F		
Sulfur Forms			
Sulfate	.01	.01	.04
Pyritic	.09	.09	.27
Organic	.10	.10	.30

Miscellaneous Comments:

Crop is located near the junction of Jungle Creek and North Fork Teanaway River.

GEOLOGY AND ENERGY RESOURCES OF
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KITTITAS COUNTY, WASHINGTON

by

Charles W. Walker
1980

COAL SAMPLE DATA SHEET

Sample Number: (74)
Sample Date: August 1, 1979
Coal Name(s): None
Geologic Formation: Roslyn
Age: Eocene
Coal Field: None
Coal-Bearing Area: Roslyn-Cle Elum
Measured Section: No
Total Section Measured:
Cover at Sampling Point: None
Elevation Top of Sampled Point: 2880'
Strike & Dip: not determined

Section: SE¼ sec. 7
Township: 21 N.
Range: 16 E.
Quadrangle: USGS Mt. Stuart 15'

Coal Description: Dirty
Coal Thickness: 1.5' and 1.5'
Coal Sampled: 3.0'
Type of Sample: channel
Sample Condition: weathered
Exposure Type: road cut
Mine Name:

Air Dry Loss	Coal (As Received)	Coal (Moist Free)	Coal (Moist, Ash Free)
Proximate Analysis			
Moisture (Mod)	5.0	n/a	n/a
Volatile Matter	6.9	7.2	98.5
Fixed Carbon	.1	.2	1.5
Ash	88.0	92.6	n/a
Ultimate Analysis			
Hydrogen	1.4	.8	11.4
Carbon	3.5	3.7	49.9
Nitrogen	.3	.3	3.6
Sulfur	.1	.1	1.4
Oxygen (Ind)	6.7	2.4	33.2
Heating Value (BTU/LB)	403	424	5765
Ash - Initial Deformation	2290 F		
Softening Temp.	2400 F		
Fluid Temp.	2530 F		
Sulfur Forms			
Sulfate	.00	.00	.06
Pyritic	.08	.08	1.13
Organic	.02	.02	.23

Miscellaneous Comments:

Composite sample of two small seams. Coal is interbedded with sandstones and rhyolite.

GEOLOGY AND ENERGY RESOURCES OF THE ROSLYN-CLE ELUM AREA

KITTITAS COUNTY, WASHINGTON

by

Charles W. Walker
1980

COAL SAMPLE DATA SHEET

Sample Number: (75)
Sample Date: August 1, 1979
Coal Name(s): None
Geologic Formation: Roslyn
Age: Eocene
Coal Field: None
Coal-Bearing Area: Roslyn-Cle Elum
Measured Section: No
Total Section Measured:
Cover at Sampling Point: None
Elevation Top of Sampled Point: 3480'
Strike & Dip: not determined

Section: NE¼ sec. 14
Township: 21 N.
Range: 15 E.
Quadrangle: USGS Mt. Stuart

Coal Description: Dirty
Coal Thickness: 1.0'
Coal Sampled: 1.0'
Type of Sample: Grab
Sample Condition: weathered
Exposure Type: road cut
Mine Name:

Air Dry Loss	Coal (As Received)	Coal (Moist Free)	Coal (Moist, Ash Free)
Proximate Analysis			
Moisture (Mod)	4.5	n/a	n/a
Volatile Matter	10.3	10.7	105.6
Fixed Carbon	--	--	--
Ash	85.8	89.8	n/a
Ultimate Analysis			
Hydrogen	1.6	1.1	10.8
Carbon	3.2	3.4	33.3
Nitrogen	.2	.2	2.3
Sulfur	.1	.1	.8
Oxygen (Ind)	9.2	5.4	52.9
Heating Value (BTU/LB)	344	360	3542
Ash - Initial Deformation	2800+F		
Softening Temp.	2800+F		
Fluid Temp.	2800+F		
Sulfur Forms			
Sulfate	.02	.02	.22
Pyritic	.03	.03	.31
Organic	.02	.02	.24

Miscellaneous Comments:

Lower Roslyn.

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COAL SAMPLE DATA SHEET

Sample Number: (83)
Sample Date: September 19, 1979
Coal Name(s): None
Geologic Formation: Teanaway Volcanics
Age: Eocene
Coal Field: None
Coal-Bearing Area: Roslyn-Cle Elum
Measured Section: No
Total Section Measured:
Cover at Sampling Point: None
Elevation Top of Sampled Point: App.3200'
Strike & Dip: N 5° E 15° NW

Section: N½ sec. 27
Township: 21 N.
Range: 16 E.
Quadrangle: USGS Mt. Stuart 15'
Coal Description: Baked, dirty w/shale
Coal Thickness: Greater than 15'
Coal Sampled: upper 5'
Type of Sample: channel
Sample Condition: weathered
Exposure Type: hillside outcrop
Mine Name: None

Air Dry Loss	Coal (As Received)	Coal (Moist Free)	Coal (Moist, Ash Free)
Proximate Analysis			
Moisture (Mod)	2.4	n/a	n/a
Volatile Matter	9.0	9.2	60.0
Fixed Carbon	6.0	6.2	40.0
Ash	82.6	84.6	n/a
Ultimate Analysis			
Hydrogen	1.4	1.2	7.5
Carbon	7.6	7.8	50.8
Nitrogen	.2	.2	1.0
Sulfur	.1	.1	.9
Oxygen (Ind)	8.2	6.1	40.0
Heating Value (BTU/LB)	913	936	6094
Ash - Initial Deformation	2800+F		
Softening Temp.	2800+F		
Fluid Temp.	2800+F		
Sulfur Forms			
Sulfate	.01	.01	.05
Pyritic	.03	.03	.20
Organic	.10	.11	.69

Miscellaneous Comments:

Coal is overlain by white rhyolite flows and underlain by shales and pyroclastics.

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COAL SAMPLE DATA SHEET

Sample Number: (85)
Sample Date: October 11, 1979
Coal Name(s): Patrick Seam
Geologic Formation: Roslyn
Age: Eocene
Coal Field: none
Coal-Bearing Area: Roslyn-Cle Elum
Measured Section: no
Total Section Measured:
Cover at Sampling Point: n/a
Elevation Top of Sampled Point: 2152'
Strike & Dip: N 65° E 15° SE at portal

Section: N½ sec. 28
Township: 20 N.
Range: 16 E.
Quadrangle: USGS Cle Elum 15'
Coal Description: Blocky
Coal Thickness: unknown
Coal Sampled:
Type of Sample: grab
Sample Condition: weathered
Exposure Type: none
Mine Name: Gallager(?)

Air Dry Loss	Coal (As Received)	Coal (Moist Free)	Coal (Moist, Ash Free)
Proximate Analysis			
Moisture (Mod)	8.3	n/a	n/a
Volatile Matter	29.3	31.9	45.5
Fixed Carbon	35.0	38.2	54.5
Ash	27.4	29.9	n/a
Ultimate Analysis			
Hydrogen	4.7	4.1	5.9
Carbon	47.9	52.3	74.6
Nitrogen	.9	.9	1.4
Sulfur	.5	.6	.8
Oxygen (Ind)	18.5	12.1	17.3
Heating Value (BTU/LB)	8447	9215	13144
Ash - Initial Deformation	2800+F		
Softening Temp.	2800+F		
Fluid Temp.	2800+F		
Sulfur Forms			
Sulfate	.01	.01	.01
Pyritic	.05	.06	.08
Organic	.48	.53	.75

Miscellaneous Comments:

Coal was picked up outside of the old portal and is presumed to have originated from within the old mine.

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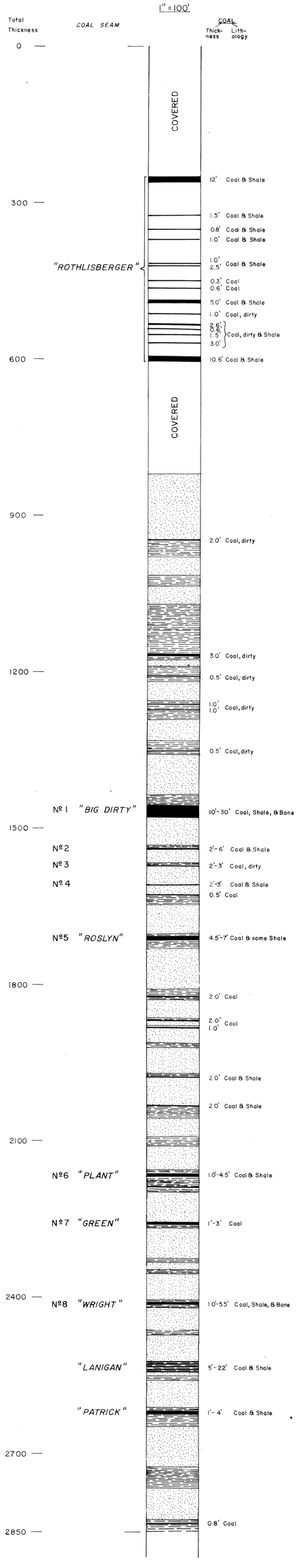
FIGURE 1

GENERALIZED COMPOSITE SECTION THROUGH THE "COAL MEASURES"

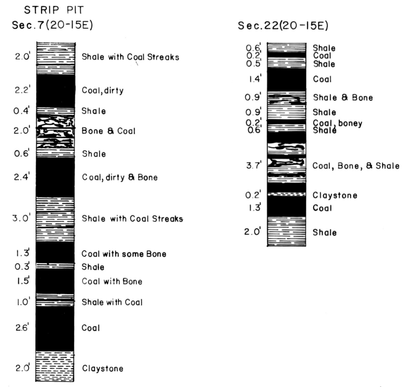
1" = 100'



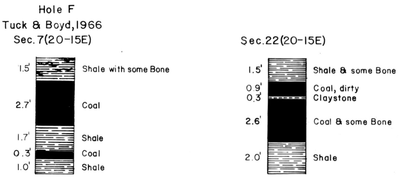
DETAILED COAL SECTIONS

1" = 5'

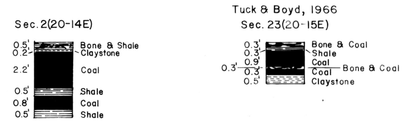
Nº. 1 SEAM – BIG DIRTY



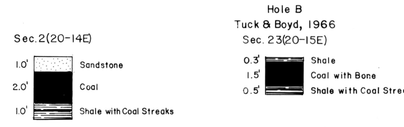
Nº. 2 SEAM



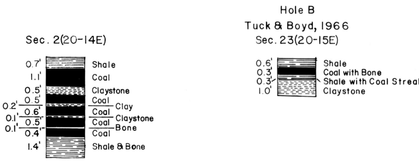
Nº. 6 SEAM



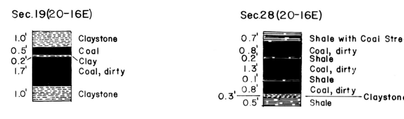
Nº. 7 SEAM

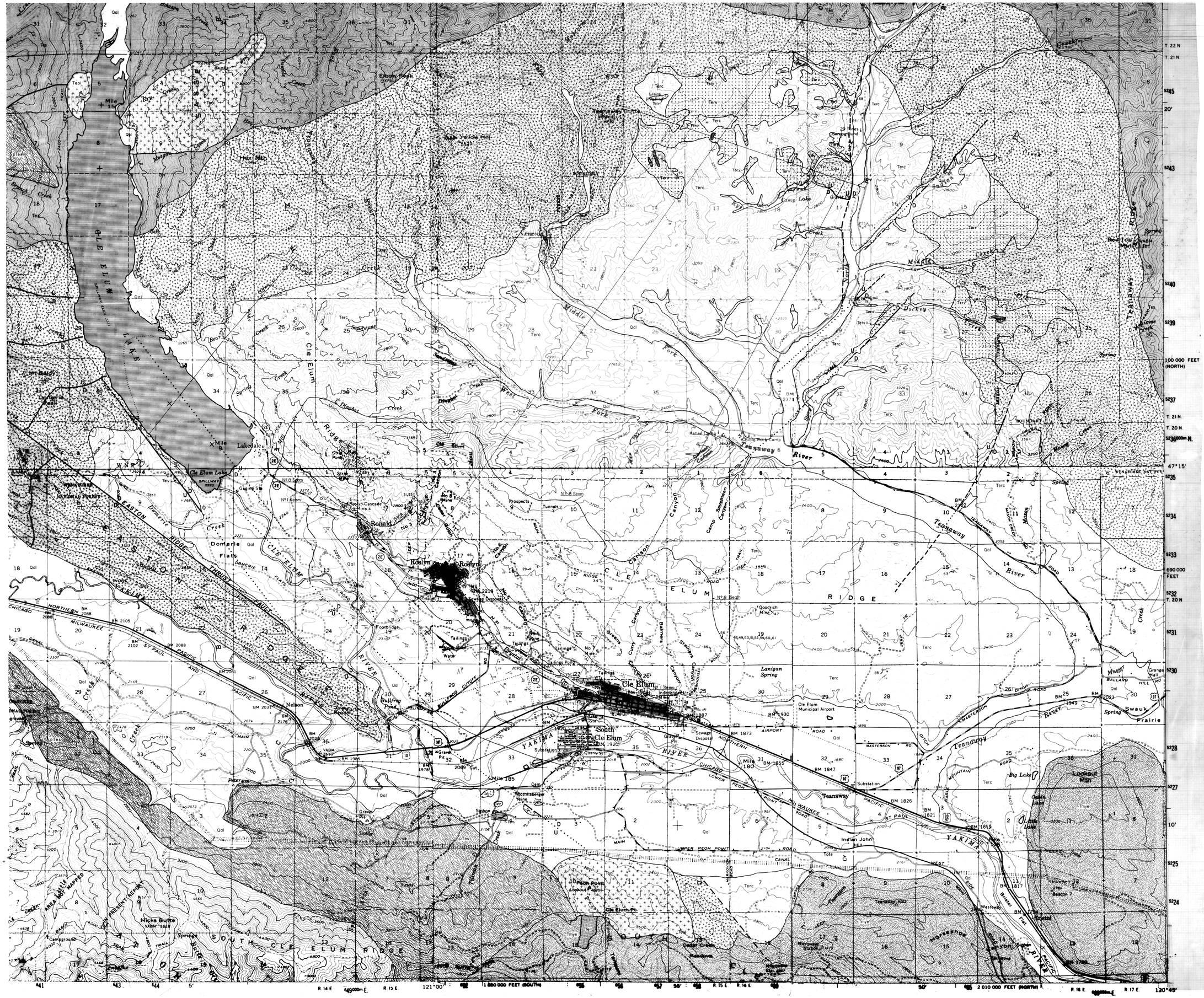


Nº. 8 SEAM



PATRICK SEAM





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GEOLOGIC MAP

MAP Nº 1A

EXPLANATION

		FORMATION	
Quaternary	Qal		Alluvium and colluvium, undifferentiated. Loess, till, outwash, glacial drift, etc. Boulders to clay.
Miocene 5 – 17	Tvy	YAKIMA BASALT	YAKIMA BASALT SUBGROUP and ELLENSBURG GROUP undifferentiated. Primarily basaltic flows and sills with subordinate volcaniclastic sedimentary rocks.
			ANGULAR UNCONFORMITY
Eocene (Paleocene)	Tvpl		Dacite to andesite porphyry. Forms stocks, dikes and sills.
Eocene 40 – 45	Terc	upper middle lower ROSLYN	COAL. Subarkosic fine grain to conglomeratic sandstones, shales, and siltstones. Coal beds in upper unit. Rhyolite flows interbedded with sediments in lower unit. Rhyolite dikes and subordinate andesites.
	Tetv	TEANAWAY VOLCANICS	Primarily basaltic pyroclastic material with subordinate lava flows, sandstones, shales, and coals.
			ANGULAR UNCONFORMITY
Paleocene 48		SWAUK	Subarkosic medium grained to conglomeratic sandstones, with some shales and coals. Cut by Teanaway dikes. Exposed north of the Yakima River.
		MANASTASH	Fine to medium grained sandstones, with siltstones shales, and coals. Exposed south of the Yakima River.
			ANGULAR UNCONFORMITY
Pz. (Triassic) 54		EASTON SCHIST	Greenschist and blue amphibolite schists

CONTACTS

Mapped and inferred

Concealed

FAULTS

Direction of movement

Reverse—Arrow indicates Dip

Inferred

Concealed

BEDDING ATTITUDES
(Some attitudes taken in underground workings)

Measured

From air photos

Bed overturned

Nº 8 Seam — Coal Seam extent (Bounded by fault, outcrop, and pinchout)

29 — Coal Samples (Analyses on file with DGER)

C C' — Cross Section trace

N G
N M
22°

SCALE
1 : 24,000
(1" = 2000')

Base map from USGS 15' Quadrangles:
CLE ELUM, EASTON, KACHESS LAKE, MOUNT STUART

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no.
80-1
Map 1a
copy 1