70-53

GEOLOGICAL SURVEY OF CANADA

DEPARTMENT OF ENERGY, MINES AND RESOURCES

PAPER 70-53

GEOLOGY, HISTORY AND POTENTIAL OF VANCOUVER ISLAND COAL DEPOSITS

(Report and 17 figures)

J.E. Muller and M.E. Atchison

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ABSTRACT

The economic coal deposits of Vancouver Island occur in the Late Cretaceous Nanaimo Group, which rests unconformably on a basement of late Paleozoic to Jurassic volcanic, sedimentary and intrusive rocks. The coal measures consist of four or five depositional cycles of clastic strata, each ranging from coarse clastic continental nearshore sediments at the bottom to fine-clastic marine sediments at the top. Commercial coal is only found in two limited areas, the Comox and Nanaimo Basins. The former contains Numbers One, Two, Three and Four seams in the first depositional cycle, the latter contains Wellington, Newcastle and Douglas seams in the second depositional cycle. Part of the Comox coals was removed by erosion prior to the second sedimentary cycle.

Deposition of the coal is believed to have occurred mainly in reed-moors, existing in lagoons separated from the sea by sand-bars.

The geological structure of the field consists of gently warped and tilted fault-blocks, separated by normal faults, that in places are splayed into several subsidiary faults. Within the seams local thickening and thinning, called "rolls", is due to intraformational slumping.

Vancouver Island coal mines were the oldest mines in British Columbia and in more than 100 years contributed greatly to the economy. Two mining companies were the main producers: Western Fuel Company Ltd., successor to the Hudson's Bay Company that started mining in the Suquash and Nanaimo areas, and Canadian Collieries Ltd., founded and maintained by Robert Dunsmuir and his heirs. Several other smaller companies operated one or more mines in the Nanaimo region. Although the companies had their share of accidents and strikes, production grew steadily during the later 19th century and came to the all-time peak of 1.8 million tons per year in 1922. From then it declined due to increasing use of fuel oil as well as depletion of reserves. The last mine closed in 1967 after a total production in the combined fields of about 72 million tons of coal.

In the Nanaimo field only one seam has generally been workable in any given area, the Wellington in the west and the Douglas in the east. The latter was mined over a length of outcrop of 9 miles and a down-dip width of up to 2 miles. The thickness, averaging about 5 feet, varies considerably, partly due to "rolls". In this seam the frequent occurrence of "outbursts" imposed in the south part of the field a limit of about 1,000 feet on the depth of operation. The probable mineable reserves of the field are virtually exhausted.

In the Cumberland field Number One, Two and Four seams were mined most extensively, but rarely in overlapping areas. The lowest Number Four Seam is locally missing due to the uneven unconformity surface just below it, and all seams are missing just south of Cumberland due to erosion preceding the second depositional cycle. The Comox field still has coal reserves that perhaps could become economic in the future.

According to latest analyses the coals are High Volatile A Bituminous with 11 per cent to 15 per cent ash and less than 1 per cent sulphur in the Nanaimo field and up to 2 1/2 per cent sulphur in the Comox field.

Compilation maps show the extent of mining and drilling for coal and, stratigraphic sections show the mode of occurrence. Tables of boreholes giving formation tops and the number of seams of various thickness intersected are included.

RÉSUMÉ

Les gisements houillers à valeur économique de l'île Vancouver se trouvent dans le groupe de Nanaïmo du Crétacé supérieur qui repose en discordance sur un socle de roches volcaniques, sédimentaires et intrusives s'échelonnant de la fin du Paléozoïque au Jurassique.

La couche de houille consiste en quatre ou cinq cycles de déposition de strates clastiques, chacun comportant des sédiments clastiques grossiers continentaux à la base, à des sédiments marins clastiques fins au sommet. La houille de valeur commerciale se trouve limitée à deux régions, les bassins de Comox et de Nanaïmo. Le premier renferme les couches numéros un, deux, trois et quatre du premier cycle de déposition et le second renferme les couches de Wellington, de Newcastle et de Douglas du deuxième cycle. L'érosion a enlevé une partie de la houille du bassin de Comox avant le deuxième cycle sédimentaire.

On est d'avis que la houille s'est déposée principalement dans les marais à roseaux qui se trouvaient dans les lagunes séparées de la mer par des cordons littoraux.

La structure géologique du champ consiste en blocs faillés légèrement gondolés et inclinés, séparés par des failles normales, biseautées par endroits en failles secondaires. A l'intérieur des couches, des épaississements et des amincissements locaux appelés ≪rolls≫ sont le résultat de glissements à l'intérieur des formations.

Les mines de houille de l'île Vancouver étaient les plus anciennes de la Colombie-Britannique, et elles ont beaucoup contribué à l'économie pendant plus de 100 ans. Deux sociétés minières étaient les principaux producteurs: la Western Fuel Company, Ltd., successeur de l'Hudson's Bay Company qui a entrepris les premiers travaux d'extraction dans les régions de Suquash et de Nanaïmo, et la Canadian Collieries Ltd., fondée et gérée par Robert Dunsmuir et ses descendants. D'autres sociétés moins importantes ont exploité une ou plusieurs mines dans la région de Nanaïmo. Bien que les sociétés ont eu leur part d'accidents et de grèves, la production a augmenté régulièrement vers la fin du 19e siècle et atteignait un maximum de 1.8 million de tonnes par année en 1922. Ultérieurement, la production a baissé par suite de l'usage croissant du fuel-oil et de l'épuisement des réserves. La dernière mine a été fermée en 1967 après un volume global d'extraction de ses champs d'environ 72 millions de tonnes de houille.

Dans le champ de Nanaïmo, une couche seulement était exploitable dans une région donnée, celle de Wellington dans l'ouest et celle de Douglas dans l'est. Cette dernière était exploitée sur un affleurement de 9 milles de long et de 2 milles de large en inclinaison. L'épaisseur, d'une moyenne de 5 pieds, varie beaucoup, du fait partiellement de la présence des ≪rolls≫. De nombreux dégorgements dans cette couche de la partie sud du champ ont limité la profondeur des travaux à environ 1,000 pieds. Les réserves estimées exploitables du champ sont pratiquement épuisées.

Dans le champ de Cumberland, les couches numéros un, deux et quatre ont fait l'objet d'une exploitation intensive, mais rarement dans des régions de chevauchement. La couche numéro quatre, la plus profonde, disparaît par endroits en raison de la surface discordante sur laquelle elle repose, et toutes les couches disparaissent juste au sud de Cumberland par suite de l'érosion antérieure au deuxième cycle de déposition. Le champ de Comox renferme encore des réserves susceptibles d'être de valeur économique dans l'avenir.

Les dernières analyses ont démontré que les houilles sont de catégorie «A Gras» à teneur en cendres de 11 à 15 p. 100, de moins de 1 p. 100 en soufre dans le champ de Nanaïmo, et de 2 p. 100 en soufre dans celui de Comox.

Des cartes de compilation indiquent l'étendue du forage et de l'exploitation de la houille, et des profils stratigraphiques démontrent le mode de rencontre. Se trouvent également inclus des tableaux de sondages indiquant la partie supérieure des formations et le nombre de couches de diverses épaisseurs.

GEOLOGY, HISTORY AND POTENTIAL OF VANCOUVER ISLAND COAL DEPOSITS

INTRODUCTION

Scope of Report and Acknowledgments

Coal mining, for more than one hundred years a major industry of Vancouver Island, ceased almost entirely with the closing of Tsable River Mine in 1966.

In the course of geological mapping of the Alberni map-area, which contains all the coalfields of the island (except the small "Suquash field" near Port McNeill) a host of mine plans and borehole records became available. The present report is aimed at publishing the essence of this unpublished information, together with already published data relevant to the past development of the mines and to any future evaluation and further exploration of the remaining deposits.

One chapter of the report deals with known geological factors affecting the distribution and character of the coal seams. The following chapter recapitulates the history and experience of exploration and mining and briefly considers the possibility of further extraction.

Thanks are due to officers of the British Columbia Department of Mines and Petroleum Resources and of Canadian Collieries Limited (now incorporated in Weldwood of Canada Limited), the last and final owners of most of the mines, for making many of these data available.

After completion of the manuscript of this report the senior author became aware of another report dealing with the same subject matter and completed at about the same time. It is titled "The coalfields of Vancouver Island" by A. R. C. James, P. Eng., is dated October 1, 1969 and is distributed by the British Columbia Department of Mines and Petroleum Resources. Michael E. Atchison, who contributed a substantial part of the text and illustrations of this report, died unexpectedly on June 30, 1970 of an illness that had its beginning two years earlier but was believed to have been overcome. Mike studied geology at University of British Columbia, Northwestern University, and had just very successfully completed the first year of a Ph. D. program in Marine Geology at the University of British Columbia. He had worked several summers and one winter for the Geological Survey. It is hoped that this report may be some tribute to a young man of engaging personality and of much promise in his chosen field of geology. He will be greatly missed not only by his wife Margo and his parents, but by many friends in the geological community.

Original manuscript submitted: 27 January, 1970
Final version approved for publication: 8 June, 1970

Geographical Setting

Two major coalfields occupy part of the eastern coastal plain of Vancouver Island near the towns of Nanaimo and Cumberland (Fig. 1). The Nanaimo coalfield lies between Lantzville in the north and Ladysmith in the south, a distance of about 15 miles. Its western boundary is defined by the outcrop edge of the lowest (Wellington) seam and varies from 2 miles inland west of Nanaimo to more than 8 miles inland in the vicinity of Extension. The eastern boundary of the Nanaimo coalfield is effectively the coastline of the Strait of Georgia, although some undersea workings were established near Nanaimo.

To the north, the Cumberland coalfield in the Comox Basin is bounded in the north by Brown's River and Tsable River delineates the southern limit. Its eastern margin is the Strait of Georgia and the western boundary is the erosional edge of the Cretaceous coal-bearing strata, beyond which are exposed the older volcanic rocks of the Vancouver Group. Thus, within these boundaries, the Cumberland coalfield occupies a strip approximately 5 miles wide and 15 miles long.

Actual area of workable coal deposits within these two coalfields is very much less than that contained within the limits described above. This is readily apparent from the maps (Figs. 12, 13 in pocket) showing the ultimate distribution of mine workings.

Coal-bearing strata also occur farther north in the Quinsam area southwest of Campbell River, and in the Suquash area between Fort Rupert and Port McNeill. However, seam thicknesses in these regions proved to be uneconomic and apart from small workings at Suquash (about 1850 and again 1920), interest focussed on the Nanaimo and Cumberland fields.

Previous Geological Work

The coal deposits of Vancouver Island have been the subject of intermittent geological investigations since their discovery in the middle of the nineteenth century.

In 1857 J.S. Newberry established the Cretaceous age of the coal-bearing strata on the basis of its plant-fossils. James Hector (1861), on Palliser's exploratory expedition to Western Canada, produced a "Geological Sketch Map of Nanaimo" showing the then known outcrops of Douglas and Newcastle seams in Nanaimo and on Newcastle Island and some marine fossil localities; the fossils again established the Cretaceous age of the beds.

From 1871 to 1876 James Richardson investigated the Vancouver Island coalfields. He divided them into three main areas of deposition: the Comox, Nanaimo and Cowichan Basins (Richardson, 1872, 1873, 1878). He recorded the exploration and mining activities of that time, concerning himself mainly with the Comox Basin where development was in the initial stage. Many detailed sections of the exposed coal-bearing strata were measured and the general stratigraphic relationships were established of these and all overlying formational units of shale and of sandstone and conglomerate, as exposed in the Cumberland area and on nearby Hornby Island. G.M. Dawson (1890) introduced the name "Nanaimo Group" to these beds and he considered the lower units to be correlative with the Chico of the Chico-Tejon Series in California.

By the start of the twentieth century coal mining was well established in the Nanaimo area and technical articles concerning the mines began appearing in the literature (Brewer, 1902; Sutton, 1904).

C.H. Clapp spent the field seasons 1908 to 1913 mapping the geology of southeast Vancouver Island. Of the many detailed reports produced by him that on the Nanaimo Coal Field (1914a) is of most importance to the present report. He mapped the geology and established the stratigraphy of the Nanaimo Group in Nanaimo and Cowichan Basins and introduced a sequence of formational names. He also gave a synopsis of the economic geology and of coal mining of that time in the Nanaimo area.

In the fall of 1910, Clapp made a private report to the Tyee Copper Company regarding coal possibilities on Galiano, Mayne and Saturna Islands. This report was subsequently made public (Clapp, 1914b) when the company ceased prospecting.

During the summers of 1921 and 1922, J.D. MacKenzie studied the stratigraphy of the Comox Basin and continued Clapp's mapping of the southern and eastern parts of Vancouver Island (MacKenzie, 1922, 1923).

Following MacKenzie's death in 1923, T.B. Williams continued work in the Comox area which ultimately was incorporated into an unpublished doctoral dissertation (Williams, 1924). Formational names for the Comox area were introduced in this work and later expanded by Usher (1952).

The extensive work of A.F. Buckham (1947a, b) on the Nanaimo coalfield and other coal-bearing strata has only partially been published. However, some of his accumulated information is contained in J.L. Usher's publication (Usher, 1952).

With the declining production and eventual cessation of coal mining activity, geological publications have become increasingly concerned with regional stratigraphy and biochronology of the Nanaimo Group and correspondingly less attention has been paid to the coalfields.

Thus, publications by Usher (1952), Bell (1957), McGugan (1962, 1964) and Crickmay and Pocock (1963) have dealt with paleontology, paleobotany, micropaleontology, palynology and associated biostratigraphic problems of the Nanaimo Group.

Hacquebard et al. (1967) in a petrographic study of selected Canadian coals analyzed material from the Nanaimo field, elucidating its probable environment of deposition.

An unpublished thesis by M.E. Atchison (1968) also dealt with probable environments of deposition for the coal-bearing strata in the Cumberland area.

Recent regional mapping by J.E. Muller (1963, 1965) together with paleontological studies by J.A. Jeletzky have resulted in joint publications (Muller and Jeletzky, 1967, 1970) detailing the geology of the Nanaimo Group of Vancouver Island and the adjacent Gulf Islands.

GENERAL GEOLOGY

Stratigraphy of Nanaimo Group

The coal-bearing Nanaimo Group comprises a Late Cretaceous succession of strata ranging from Late Santonian through Early Maestrichtian (Muller and Jeletzky, 1970). Lithologies within the group, with the exception of coal seams, are clastic and range from boulder conglomerate to shale with most of the intervening lithologic spectrum represented.

Deposition of the Nanaimo Group appears to have been cyclical. Four units of siltstone and shale, each to about 1,000 feet thick, containing good marine micro- and macrofossils are separated by coarser units of conglomerate and sandstone, commonly containing fossil plants and leaves.

Over large areas, Nanaimo Group rocks rest unconformably on Upper Triassic basic volcanic rocks of the Karmutsen Formation. Elsewhere, this basal unconformity is developed on the cherty, metasedimentary rocks of the Sicker Group (Permian and older ?) or on the younger (Middle Jurassic) granodioritic rocks of the Island Intrusions.

Tertiary intrusions of quartz diorite and dacite porphyry, commonly as sills, are found within the lower units of the Nanaimo Group. In places, these sills have intruded strata adjacent to coal seams, thereby transforming the coal into noncommercial coke.

The Nanaimo Group, together with these Tertiary intrusions, form the youngest rocks on the east coast of Vancouver Island. They mainly underlie the low, eastern coastal plain where overburden of Pleistocene till and alluvium generally restricts the best exposures of the Nanaimo Group to stream channels and coastal shorelines.

Buckham (1947 a, p. 460) distinguished five 'basins of deposition' containing Nanaimo Group sediments: the Suquash, Comox, Alberni, Nanaimo and Cowichan Basins. These outcrop areas however probably do not represent sedimentary basins but rather are disconnected erosional remnants of a larger area of deposition whose present distribution is largely controlled by post-Cretaceous block-faulting and tilting, preserving these sediments in structurally depressed areas (Muller and Jeletzky, 1970).

The Nanaimo Group may be divided into five sedimentary cycles. Each cycle exhibits a progression of facies from (a) fluvial to (b) deltaic and/or (c) lagoonal to (d) nearshore marine and lastly (e) offshore marine (Table 1). Facies a-c, mainly nonmarine sandstone-conglomerate (-shale-coal) sequences form one formation; facies d-e, mainly marine siltstone-shale sequences make up another formation. Thus each cycle consists of two formations, but the coal-bearing lagoonal facies is only found in the first cycle in the Comox Basin and in the second cycle in the Nanaimo Basin (Fig. 2).

Coal seams in the Nanaimo Group are contained within the Comox-type facies (lagoonal), a variant of the Extension-type facies (deltaic). Detailed descriptions of these and the remaining facies of the Nanaimo Group are given by Muller (Muller and Jeletzky, 1970), and are summarized in Table 1.

As can be seen from Figures 2, 3 and 4 coal seams in the Comox Basin occur in the Comox Formation whereas those in the Nanaimo area are found in the younger Extension-Protection Formation. Thus, contrary to earlier beliefs, the coals of Cumberland are not correlative with those of Nanaimo. Their main similarity lies in their environments of deposition.

Detailed Stratigraphy of Coal Measures

Detailed sections of the coal-bearing strata have been recorded in several hundred boreholes and a few may be studied in river and creek exposures. Selected borehole data for the coal measures of the Nanaimo Basin are presented in sections C-C', D-D' and E-E', Figures 5, 6 and 7.

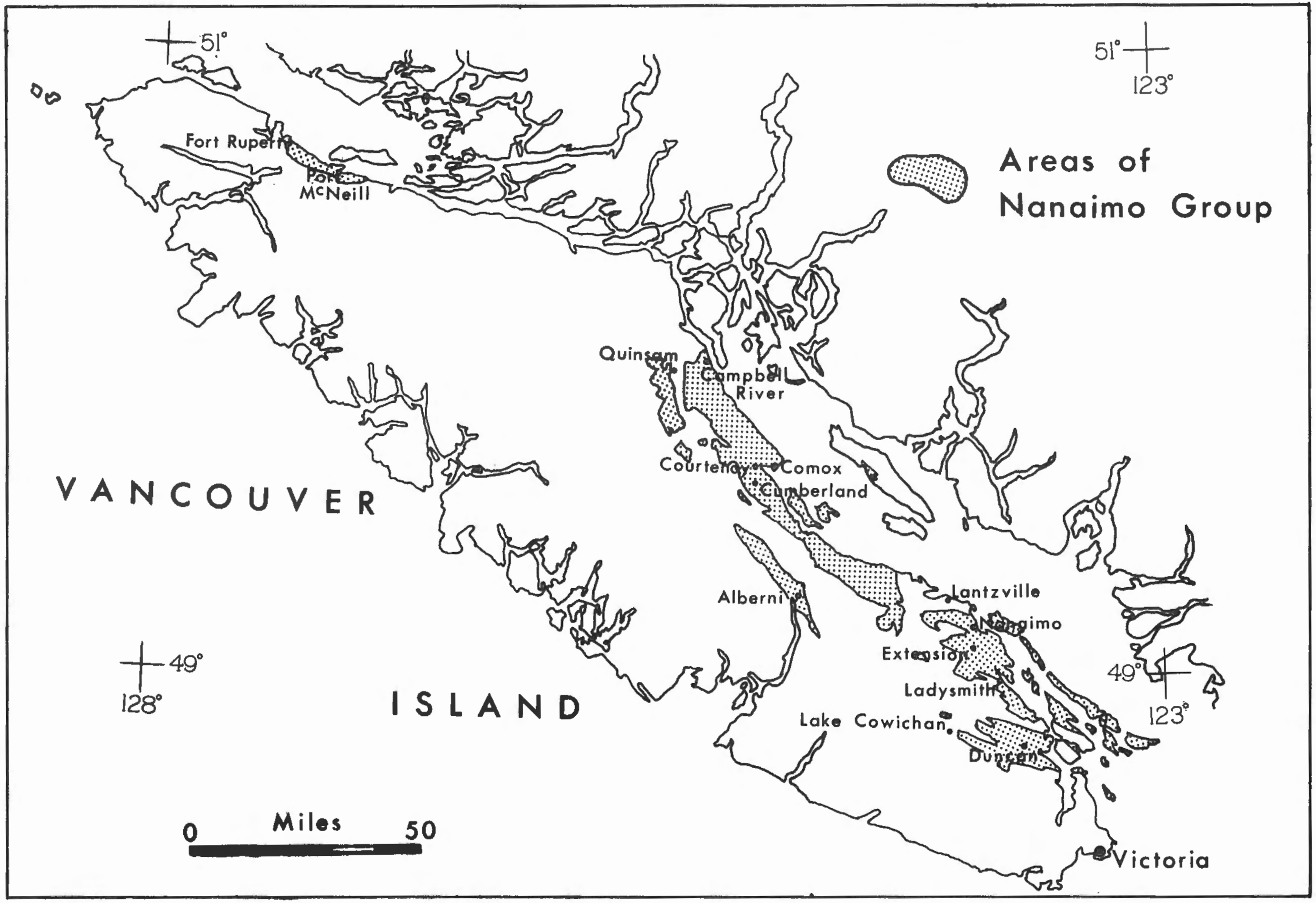


Figure 1. Distribution of Nanaimo Group.

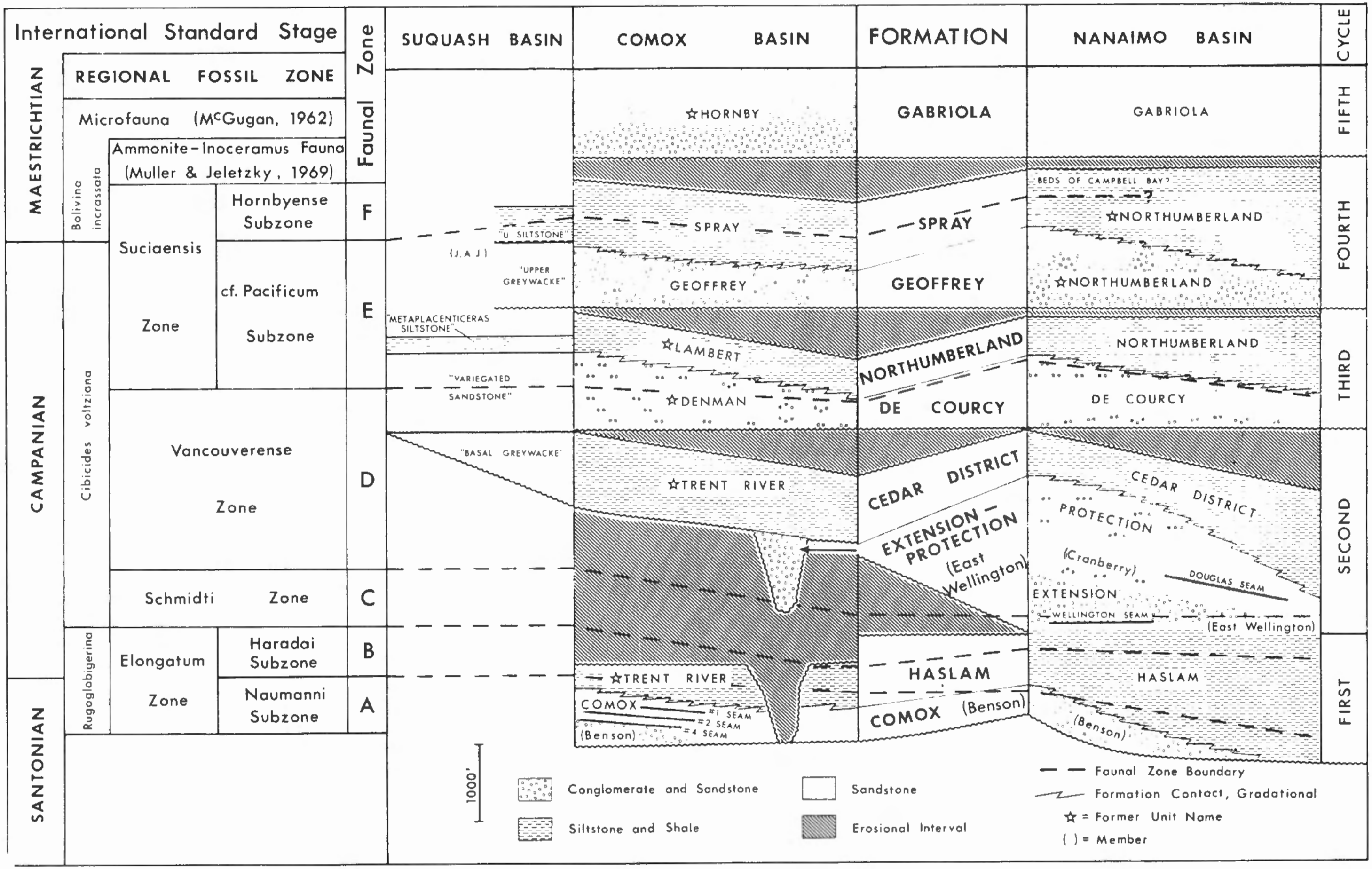


Figure 2. Biochronological and lithological divisions of Nanaimo Group (after Muller and Jeletzky, 1970).

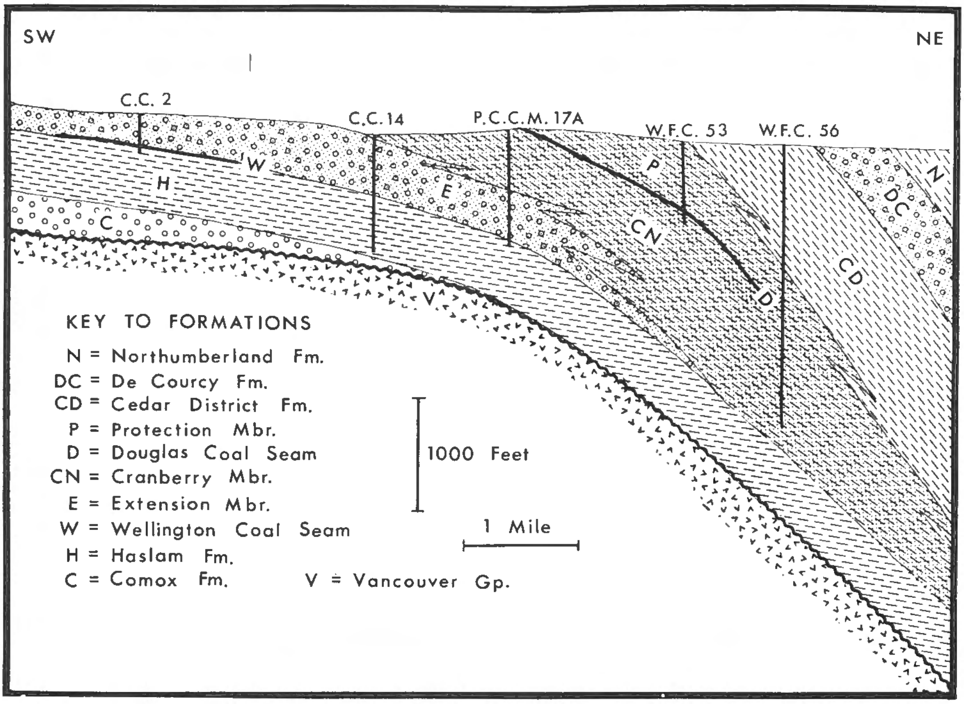


Figure 3. Schematic section through Nanaimo Basin, south part, faults omitted (after Muller and Jeletzky, 1970).

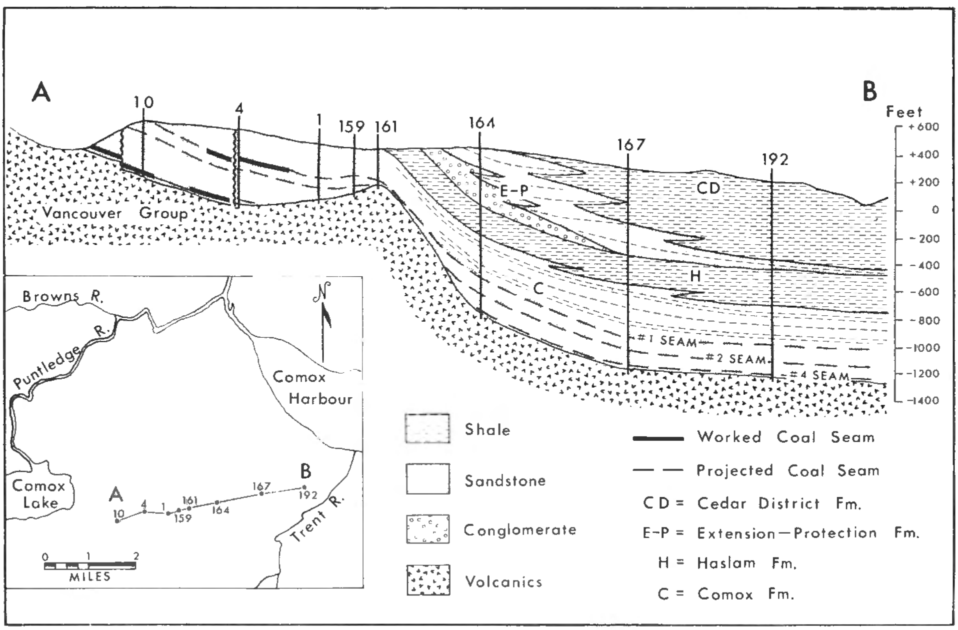


Figure 4. Structural section through Cumberland area of Comox Coal Basin (after Muller and Jeletzky, 1970).

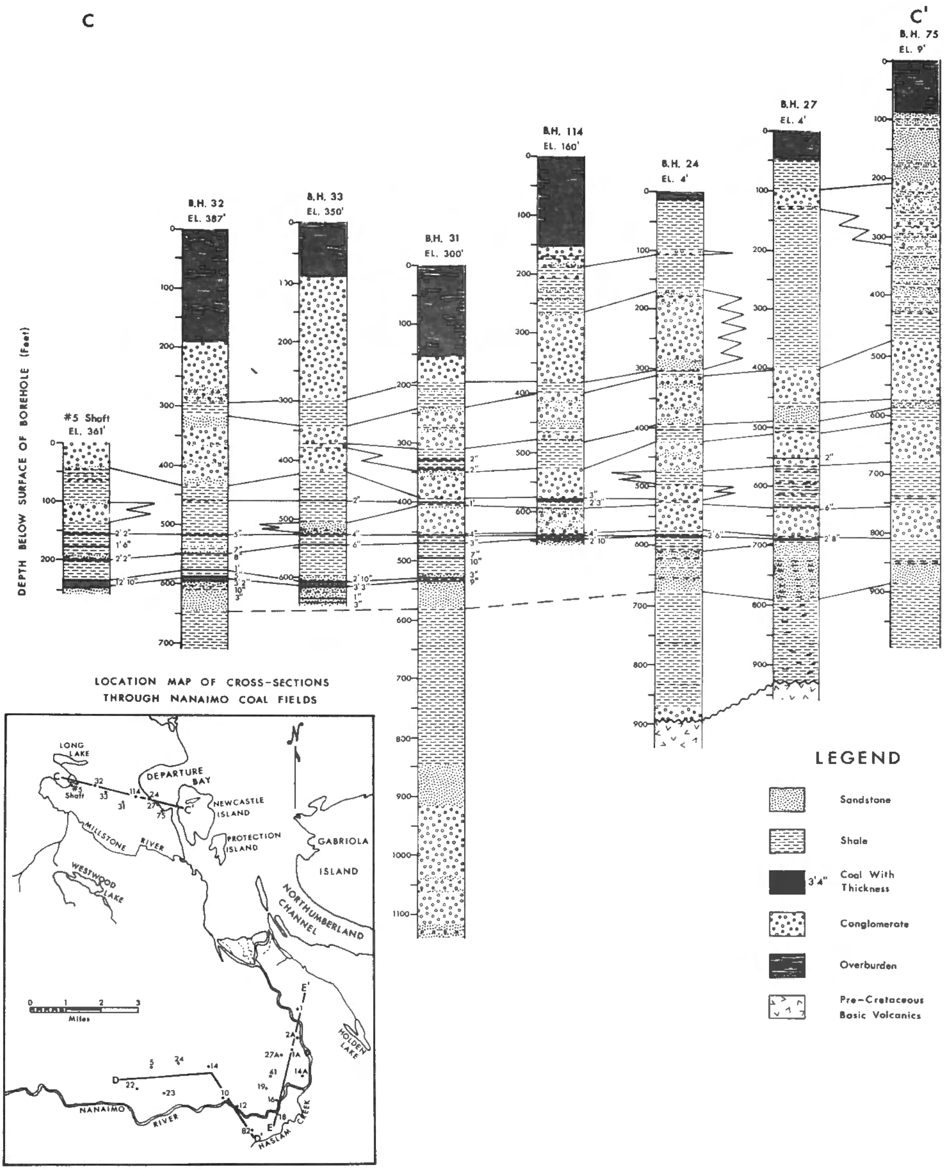


Figure 5. Correlation of boreholes in Wellington Coalfield.

Table 1. Successive Facies in Nanaimo Group Sedimentation Cycles

Position In Cycle	Lithologies Present	Environmental Interpretation	Formations Represented
1.	Fanglomerate (angular, unsorted); Greywacke	Fluvial and coastal deposits	Benson Member
2.	Conglomerate (well rounded, sorted); Grit; Sandstone	Deltaic and shoreline deposits	Geoffrey De Courcy Extension Gabriola
3.	Sandstone; Shale; Coal; (plant fossils)	Shore bar and lagoonal deposits	Protection Wellington Member (regressive phase) Comox
4.	Siltstone; Shale; Sandstone (minor); (many thick-shelled fossils)	Nearshore marine deposits	Spray Northumberland Cedar District Haslam
5.	Thin-bedded siltstone-shale turbidite sequences (few fossils, mainly ammonites)	Offshore marine deposits	

Sections C-C' and D-D' show the stratigraphic relationships between the Wellington seam; the overlying, conglomeratic Extension-Protection Formation; the underlying, sandy East Wellington Member and shales of the Haslam Formation.

Section E-E' depicts the stratigraphic relationships of the Douglas seam within the Extension-Protection Formation.

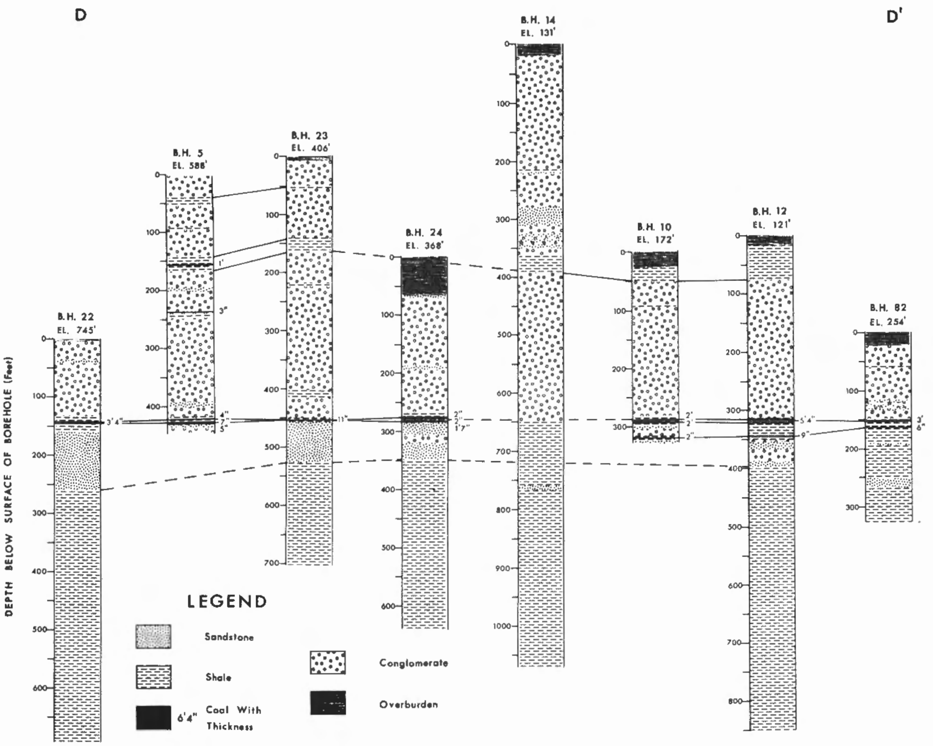


Figure 6. Correlation of boreholes in Extension Coalfield.

The Newcastle seam occurs in the vicinity of Nanaimo and Newcastle Island but a paucity of borehole records prevents its representation in a cross-section. According to Buckham (1947 a, p. 467) it lies about 60 feet beneath the Douglas seam and averages 3 to 4 feet in thickness.

Inasmuch as the Wellington seam occurs lower in the stratigraphic sequence than the Douglas and Newcastle seams, Clapp (1914 a, p. 103) thought that the Wellington "doubtless extends with a variable thickness beyond the outcrop of the Newcastle and Douglas seams, at a depth of 800 to 1,200 feet". However, the few borehole records that are suitably located do not show that there was areal overlap of these seams.

Sections A-A' and B-B' illustrate the lithologic variations of the Comox Formation in the Cumberland area (Figs. 8, 9). The pre-Cretaceous unconformity surface is irregular and the lowest Number Four Seam laps on to it. Coal seams split, merge, and pinch out into shale-units or are replaced by sandstone-units. The detailed sections of Number Two Seam show this complexity on a larger scale.

Mine operators in the Cumberland field distinguished four coal seams by number. Only Number One, Number Two, and Number Four Seams were mined more or less extensively.

The sequence of Tsable River area is thinner than that of the Cumberland area. It contains near the base one workable seam that cannot be correlated with certainty to one of the Cumberland seams.

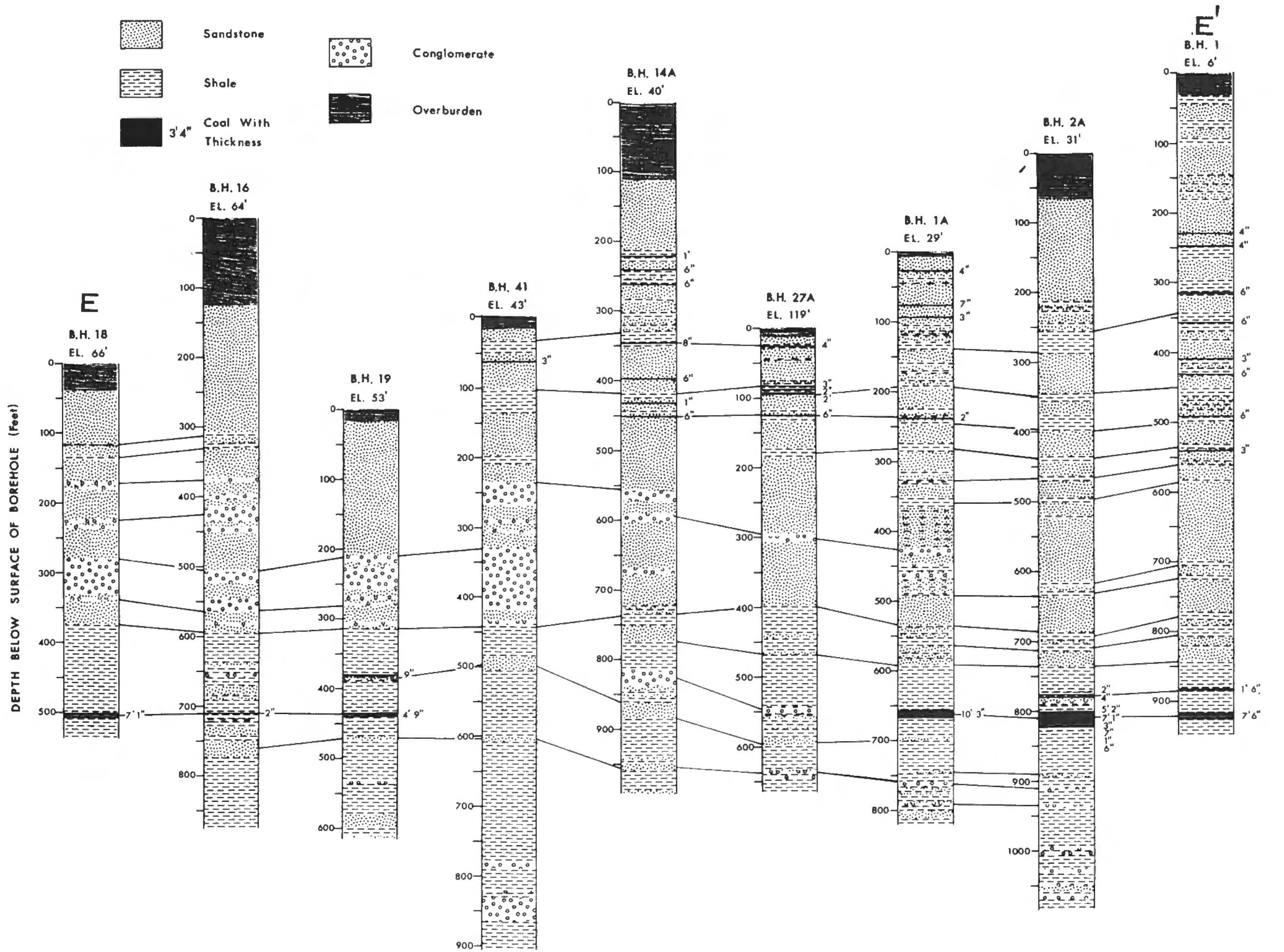
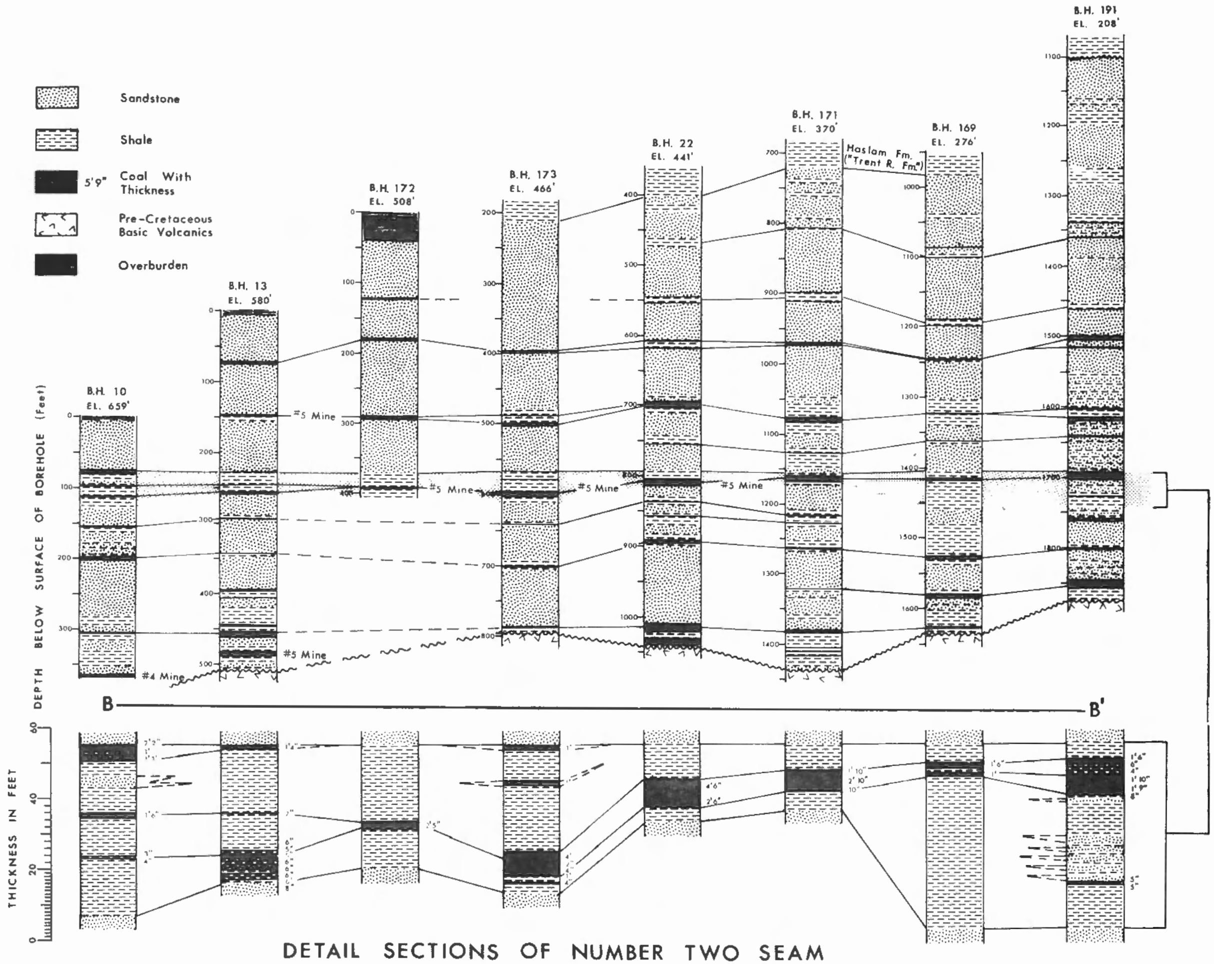


Figure 7. Correlation of boreholes in South Wellington Coalfield.

Figure 8. Southwest-northeast correlation of boreholes through Comox Formation in Cumberland area.



The maps of mine workings in the Cumberland-Tsable River field and of borings in these areas (Figs. 13, 15, 16, 17) show a hiatus in exploration in the vicinity of Trent River. Large thicknesses of conglomerate are present in certain of the boreholes north of the Tsable River workings. This conglomerate (schematically shown on Fig. 2) together with similar material outcropping in Bloedel Creek and in patches north of Trent River, has been interpreted to represent stream channel deposits equivalent to the Extension-Protection Formation (Muller and Jeletzky, 1970). Corroborating evidence for partial removal of the oldest Nanaimo Group sediments prior to deposition of the second sedimentary cycle is the occurrence of sandstone and siltstone blocks in the conglomerate on Bloedel Creek.

An alternative explanation for the presence of the conglomerates found in the boreholes was suggested by Atchison (1968). He proposed that these conglomerates represented wedges of coarse clastic material derived from the steep southern flank of a paleotopographic ridge separating the Cumberland area from the paleotopographically lower Tsable River area.

Depositional Environment of Coal

Depositional environment of peat-bogs, later transformed into coal has a bearing on the physical characteristics of the resulting coal seams and the enclosing strata. The evidence suggests that the Nanaimo Group seams were deposited in a paralic coal-basin (i. e. a coal-basin formed in a coastal lowland area). The environment was probably a lagoon, separated from the sea by sandbars.

In the Cumberland coalfield, the coal-bearing Comox Formation was deposited directly upon the pre-Cretaceous unconformity. Relief on this old erosional surface is significant, of the order of 1,600 feet across a span of five miles and locally as steep as 500 feet per mile (MacKenzie, 1922; Atchison, 1968). This paleotopography exerted a profound influence on the nature and distribution of the immediately overlying sediments.

One such effect was confinement of the Benson (fluvial) conglomeratic facies to paleotopographically low areas, i. e. stream and river channels.

Another effect was localization of coal swamps between emergent land areas and offshore sandbars. Thus in places in the Cumberland field, the lower coal seams are interrupted by paleotopographic 'highs' whereas the upper seams are continuous across these buried hills. This relationship is well illustrated in boreholes 124-20-178 in Section A-A', Figure 9.

As paleotopographic influences were eliminated with burial of the pre-Cretaceous unconformity, the subsequent distribution of sediments must have been the result of other factors.

Atchison (1968) demonstrated that coal seams in the Cumberland field, although usually of limited lateral extent, tended to be thicker and more abundant in the same regions. The recurrence of localized swamp conditions thus implied was attributed to repeated build-up and destruction of marginal sandbars together with the effects of differential compaction. Atchison proposed that periodic spreading of these marginal sand accumulations over the swamps followed by greater compaction of the swamp sediments would lead to re-establishment of sandbars on the margins of subsidence. Thus, new swamps would tend to redevelop above older swamp deposits.

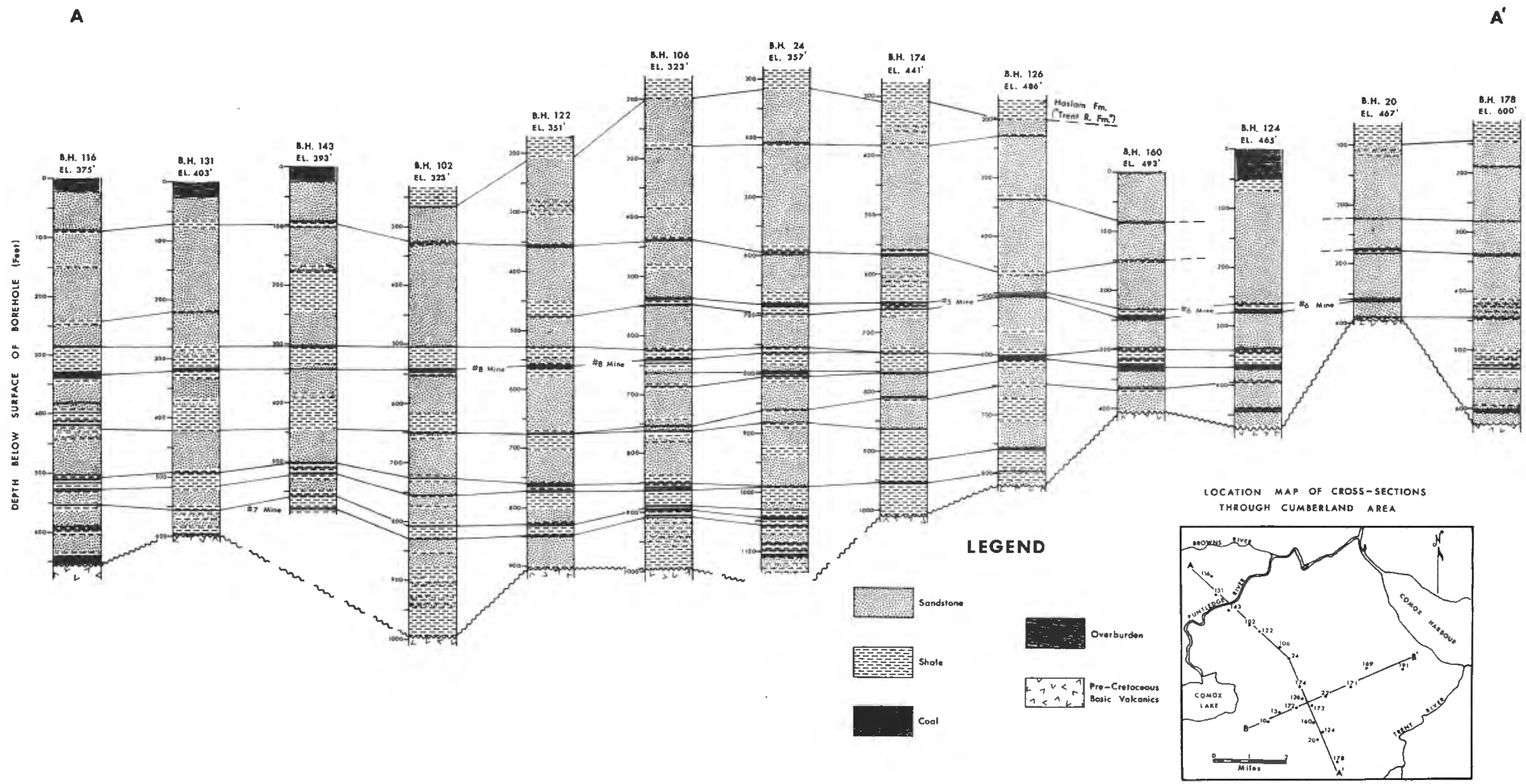


Figure 9. Southwest-northeast correlation of boreholes through Comox Formation in Cumberland area.

Because the coal seams of the Nanaimo coalfield occur within the second cycle Extension-Protection Formation, it is unlikely that paleotopography of the sub-Cretaceous unconformity had much influence over their distribution. More probably their mode of formation resembled that of the higher coal seams in the Cumberland field.

Clapp (1914a, p. 114) cited the lack of underclay and absence of fossil roots as indications that the coal did not result from the "accumulation of vegetable matter in large, coastal plain swamps, with standing timber and luxuriant undergrowth". Instead, he postulated an origin "in peat bogs, which may have been formed in lagoons protected from the outer, marine basin, by bay bars".

A detailed examination of a few as yet accessible coal seams was made by Hacquebard et al. (1967). The petrography of the Wellington Seam coal alternates between a bright coal believed to have originated in a "telmatic forest moor facies" and a semibright coal, formed in a "mixed open moor and reed moor facies". These writers, after comparing a number of general cross-sections of the coal, compiled from borehole-data, found a "remarkable uniformity in deposition of the four Nanaimo coal seams". "Clastic partings of about equal thickness persist over long distances and the true heights of the seams vary but little. Splitting and rejoining of seam benches, so noticeable in certain Sydney (Cape Breton, Nova Scotia) coals, has not been observed here. The considerable variations in seam thickness, which are a peculiar feature of this coalfield, are not due to differences in peat deposition, but are caused by local deformation" (Clapp, 1914).

Structure

The structure of the coal measures of Vancouver Island is generally one of gently warped and tilted fault-blocks. Most fault-blocks in the mining areas are tilted to the northeast and downthrown to the northeast along faults trending northwesterly. In the Nanaimo Basin faults are more closely spaced and have greater throw than in the Comox Basin.

Clapp (1914a) emphasized folds as the major structural elements of the region but Buckham (1947a) more correctly considered faulting the more significant feature. He described a series of near-parallel northwesterly striking faults dissecting the Nanaimo coalfield. He indicated (1947b, p. 466) that near-vertical faulting in the pre-Cretaceous rocks may have resulted in less steeply inclined faults in the Cretaceous overburden. Although he called them "thrusts" they are in the writer's view more aptly defined as rather steep reverse faults. Some of these faults, like the Harbour Fault through Nanaimo Harbour are actually flexures where the strata are more or less continuous along a downthrow of 400 to 500 feet. In addition Muller (in Muller and Jeletzky, 1970; text and Fig. 10) believes that a single fault in the "basement" may also diverge into a zone of several steep fault-slices with repeated sections of steeply dipping Nanaimo beds. An example is the zone of several closely spaced faults through the central part of Saltspring Island, which apparently extends as one or two single faults between the Extension and South Wellington coalfields (see Fig. 10).

These faults effectively limit the coal-measures in a certain area and generally no mine-workings have been developed straddling the major faults.

Within the mine-workings smaller structures have been a greater hindrance to mining. Small faults are not very common, judging by the mine-plans and published accounts. Many reported small faults are probably more like the "rolls" (Fig. 11), described by Clapp (1914 a), Campbell (1924) and Buckham (1947a) and referred to in the sections on Wellington and Douglas seams in this paper. They represent intraformational folds, each only affecting one seam and some of the enclosing strata. They apparently resulted from sliding and buckling of the seam during down-slope movement of a semi-detached deck of sediments over the subjacent beds. In plan they are rather straight lineal structures striking westerly or northwesterly and indicating northward or northeastward sliding. They have resulted in great variations of seam-thickness within short distances. Abnormal local thicknesses up to 25 feet are reported but much of this coal was not mineable due to its extreme fracturing.

ECONOMIC GEOLOGY

History of Mining

Coal mining on Vancouver Island is, together with placer-gold mining in the Cariboo, the oldest mineral industry in British Columbia. Although gold made a more spectacular impact on the development of the mainland there can be no doubt that coal was most important to the settlement and economic growth of Vancouver Island. An outline of the origin, flourishing, and eventual decline of the industry is given here as background to the assembled data on general and economic geology of the coal.

The earliest discovery of coal on Vancouver Island in the Suquash area in 1835 is credited to Dr. W. F. Tolmie of the Hudson's Bay Company at Fort McLoughlin on Milbank Sound after pieces of coal were shown to him by natives.

In similar fashion, Joseph McKay, Hudson's Bay Company clerk in Fort Victoria, learned about the coal deposits in what is now Nanaimo. This was in 1851, and in 1852, McKay obtained orders from Governor Douglas "to proceed with all possible diligence to Winthuysen Inlet, commonly known as Nanymo, and formally take possession of the coal beds lately discovered".

In 1852, the Hudson's Bay Company began mining operations from pits at Nanaimo and in August of that year the first coal shipment of 50 tons highlighted an inspection trip by Governor Douglas.

Meanwhile, attempts to mine coal in the Suquash area had failed, producing only 10,000 tons since 1836. The miners, many of whom had emigrated with their families from Staffordshire to the Fort Rupert settlement, were discontented with working conditions and occasionally plagued by Indian raids. Hence, in 1852, these miners were transferred from the Suquash workings to those at Nanaimo.

The Hudson's Bay Company, through its subsidiary, the Nanaimo Coal Company, continued to operate shaft mines in the Nanaimo area until 1861. Total production from 1852 to 1862 was 55,408 long tons.

In 1861, the mines, areas held as coal lands, townsite and the business establishments of the Hudson's Bay Company were all sold to the Vancouver Coal Company. This new company extended mining operations into Southfield near Chase River, but only on a small scale.

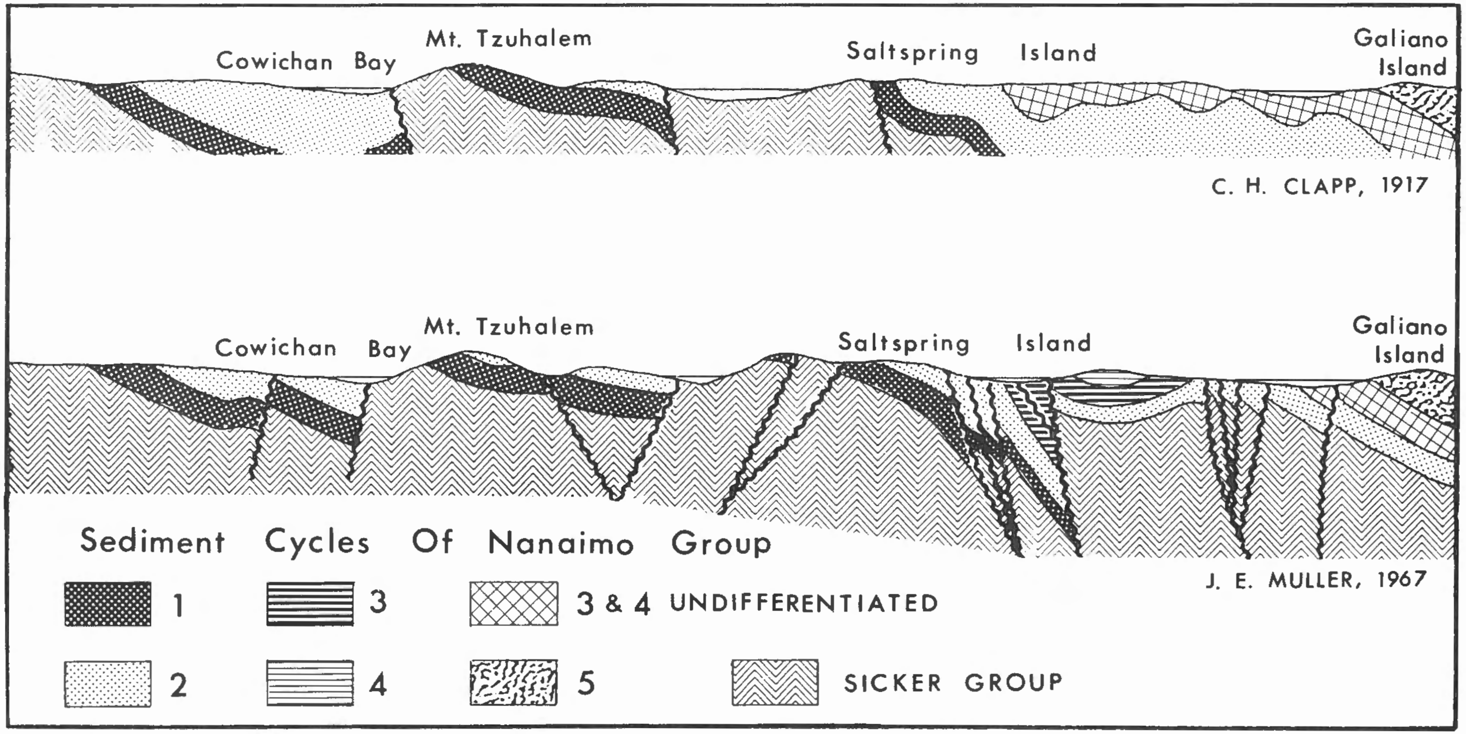


Figure 10. Structural sections, Cowichan to Galiano Islands showing faulting and folding of Nanaimo Group (after Muller and Jeletzky, 1970).

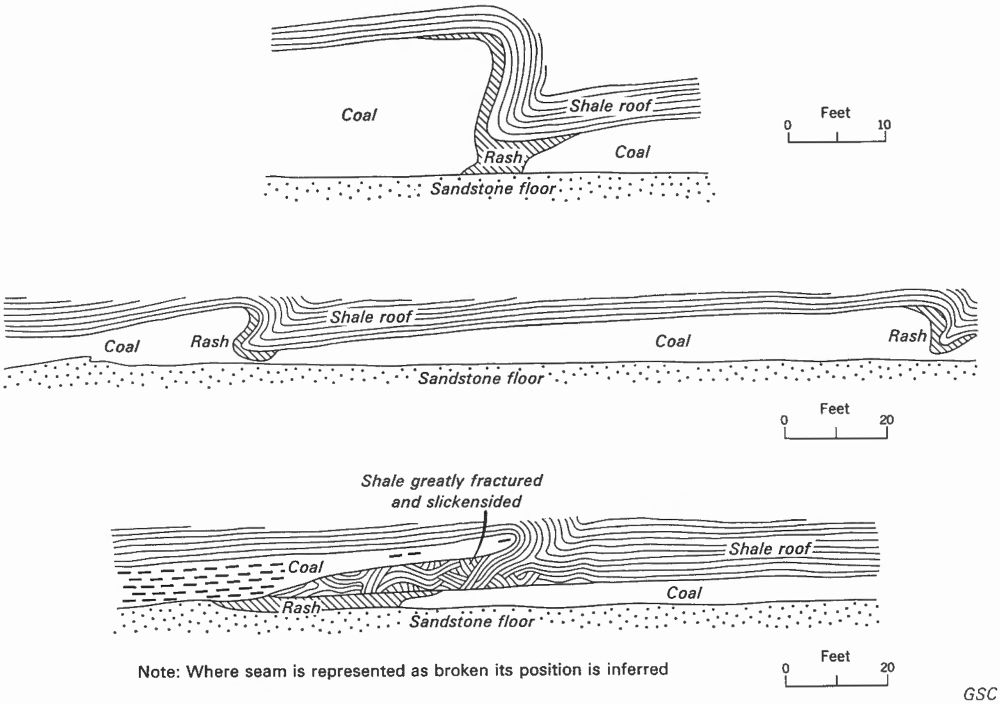


Figure 11. Sections of the Wellington seam near East Wellington (after C. H. Clapp, 1914).

The industry was greatly expanded in 1869 when the Wellington field was discovered by Robert Dunsmuir, a former Hudson's Bay Company miner. He and his descendants became leading figures of the Vancouver Island coal industry. Dunsmuir, in partnership with Admiral Farquhar, Captain Egerton and Lieutenant Diggle of the British Navy's H. M. S. Grappler, formed Dunsmuir, Diggle and Company and in 1871 began operations at Wellington.

From then on there were two major coal mining concerns on Vancouver Island, one born out of the original Hudson's Bay Company holdings and the other started and retained by the Dunsmuir interests. There were, however, several reorganizations of these corporations, leading to a plethora of company names. The two main lineages are described below.

In 1861, The Vancouver Coal Company bought out the holdings of the Nanaimo Coal Company, a subsidiary of the Hudson's Bay Company. Subsequent reorganizations resulted in: the New Vancouver Coal Mining and Land Company in 1889, the Western Fuel Company in 1908, the Canadian Western Fuel Company Limited in 1918, and finally the Western Fuel Corporation of Canada, Limited in 1921.

In 1928, this corporation was purchased by the Dunsmuir interests but continued to operate independently until its final closure in 1939.

The second major coal company in Vancouver Island was that begun by Robert Dunsmuir and maintained by his heirs. In 1883, Robert Dunsmuir became sole owner of Dunsmuir, Diggle and Company and renamed the company as R. Dunsmuir and Sons Limited. In 1899, it was reorganized as

Wellington Colliery Company Limited and from 1910 to 1960, the company has operated as Canadian Collieries (Dunsmuir) Limited. This company also operated all of the large mines in the Cumberland field until their closure in 1953 and still owns much land with mining and timber rights. Recently the company has become part of Weldwood of Canada Limited.

The history of the communities in the Nanaimo and Cumberland areas is intimately associated with the development of the coalfields. In 1874, following the discovery of the Wellington field, the city of Nanaimo was incorporated. From 1880 to 1890, the communities of Chase River and Northfield were established at Vancouver Coal Company sites. The town of Cumberland in the Comox District was the site of the Union Colliery, opened in 1888 by the Dunsmuir syndicate. In 1886, the Esquimalt and Nanaimo Railway was built by the Dunsmuir company to provide access to markets in Victoria. In this same year, the transcontinental railway was completed and the city of Vancouver was established on the mainland, thus providing additional markets for Vancouver Island coal.

Near the turn of the century, with the Wellington mines nearing exhaustion, mining activity moved south. The Extension field was opened by the Dunsmuir interests, resulting in the establishment of the town of Extension, and the shipping port of Ladysmith.

Other towns which originated as coal company towns are Cassidy (Granby Consolidated Mining, Smelting and Power Company) and Lantzville (Nanoose-Wellington Colliery Company), both established in 1917.

Mines operated by the Western Fuel Company (under its various names) were principally in the Douglas seam. The first large mine was the Old Douglas Mine (1852-1886) with workings under the present town of Nanaimo. Other Western Fuel Company mines in the vicinity of Nanaimo were the Newcastle Mine (1876-1877) and the Fitzwilliam Mine (1876-1881) on Newcastle Island, the New Douglas or Chase River Mine (1875-1886) at the south end of Nanaimo, and the Southfield No. 1 to No. 5 Mines (1882-1901) south of the mouth of the Nanaimo River.

One of the most famous was the Number One Mines (1883-1938) which produced a total of 18,000,000 tons of coal. Its workings extended under Nanaimo Harbour, to a depth of 1,700 feet with shafts on the Esplanade in Nanaimo, and on Protection and Newcastle Islands.

The Reserve Mine (1915-1930, 1934-1938) was also operated by the Western Fuel Company, on Indian Reserve land at the mouth of the Nanaimo River.

The Northfield No. 4 or Brechin Mine (1904-1917) was the only major operation in the Newcastle seam. The seam was worked under Newcastle Island from a shaft at Pimbury Point, on the southside of Departure Bay.

A few of the Western Fuel Company's mines were operated in the Wellington seam. One such was the Harewood Mine, southwest of Nanaimo in the Cranberry District, originally discovered by Robert Dunsmuir and operated intermittently between 1864 and 1942. It was noted for an aerial tramway which carried coal to shipping wharves on Cameron Island, now part of downtown Nanaimo.

The Northfield Mine, immediately east of the Dunsmuir's Wellington Colliery was also worked in the Wellington seam from 1889 to 1895, and later these workings were used by the Dunsmuir interests to enter an area of the Upper Wellington seam in their abandoned Wellington No. 5 Mine.

The Wakesiah Mine (1918-1930) was the only other mine owned by the Western Fuel Company that produced from the Wellington seam. It was located at the present site of the Nanaimo High School.

In contrast to the mines operated by the Western Fuel Company, those in the Nanaimo area owned by the Dunsmuir syndicate were primarily in the Wellington seam. The first mines opened by this company were the complex at the Wellington Colliery (1871-1910) with a main slope and six shafts. Later, the Dunsmuir interest opened the Extension Mines (1895-1931) farther south but also in the Wellington seam. Number 1, 2, and 3 Mines in the Extension field originally had separate entrance slopes, but later a mile-long haulage tunnel driven westward from the Extension townsite gave access to all three mines. Extension coal was carried by rail to the newly established port of Ladysmith.

Gradually development of the Wellington seam pushed southward. The Extension No. 4 Mine (1909-1917) was worked southwest of the main Extension field, followed by the Extension No. 8 Mine (1918-1926) south of the Nanaimo River. The Extension Prospect Mine (1940-1947) and the White Rapids Mine (1944-1950) were the last of the Dunsmuir's operations in the Wellington seam. The Extension Prospect Mine was located north of the entrance to the Extension Tunnel, while the White Rapids Mine lay on the north side of Nanaimo River, between the main Extension workings and the Extension No. 8 Mine.

Although most of their mines worked the Wellington seam, the Dunsmuir interests also operated four mines in the Douglas seam. These all lay south of the Western Fuel Company's Southfield workings, the mines being initiated progressively southward along the seam outcrop. Thus, the northernmost, the Alexandra Slope was worked from 1884 to 1885, closed, and reopened from 1896 to 1901. Next was the No. 5 Mine (1918-1934) followed by the No. 10 Mine (1937-1952) and finally the Bright Mine (1950-1953) which was operated south of the Nanaimo River.

In addition to their holdings in the Nanaimo coalfield, the Dunsmuirs operated all of the major mines in the Cumberland area. Work had begun in 1875 in the Comox field when the Baynes Sound Colliery was opened, and much exploration and prospecting was done. Later, in 1888 active mining operations were initiated, when the Dunsmuir syndicate opened the Union Colliery, and built a railway 11 miles in length connecting the mines with shipping wharves at Union Bay.

Eight mines worked three of the Comox coal seams in the Cumberland field, the last being the Number Eight Mine which closed in 1953. Canadian Collieries (Dunsmuir) Limited also operated the Tsable River Mine from 1945 to 1960, after which it was leased to Comox Mining Company until it finally closed in 1967, marking the end of the coal mining era of Vancouver Island.

A coking plant, consisting of 100 beehive-ovens, was built at Union Bay in 1896. The coke was produced mostly from washed fine coal and was among other things used in two small smelters at Crofton and Ladysmith, built to handle copper ores from local mines like the Tyee and Lenora Mines on Mount Sicker near Duncan. It appears that the coking plant was in intermittent operation until about 1922 and could produce 30,000 tons annually.

In the early 1900s there was also a brick-plant at Union Bay using fire-clay from the mines for fire-brick and clay from a local pit for common bricks.

Beside the two large companies (Western Fuel Company and Canadian Collieries (Dunsmuir) Limited), numerous smaller operations ranging from one-man-operations to mines employing dozens of men worked the coal seams, especially in the Nanaimo field. Of these, three that deserve mention are: Pacific Coast Coal Mines Limited (1911-1924), Granby Consolidated Mining, Smelting and Power Company (1918-1924) and Nanoose-Wellington Colliery Company (1916-1941).

The Granby No. 1 Mine operated in the Douglas seam south of Nanaimo River and together with the later Bright Mine marked the southernmost extent of the Douglas workings.

The South Wellington (Fiddick) Colliery (1911-1917) and the Morden Mine (1913-1924), both owned by Pacific Coast Coal Mines Limited, also worked the Douglas seam. The South Wellington Colliery's slopes lay between the Southfield workings of the Western Fuel Company and the Alexandra Slope of the Dunsmuir syndicate. The Morden Mine reached the seam via a shaft, east of the Dunsmuir's No. 5 Mine.

The Lantzville Mine (1916-1941) of the Nanoose-Wellington Colliery Company was located on the north coast of Nanoose Peninsula and the seam is roughly correlative to the Wellington seam.

Coal mining was for more than a century a main industry of Vancouver Island and its long lasting productivity attests to its economic success and importance. However, in any historical account adverse conditions are usually recorded more fully than quiet success. This résumé would be incomplete without reference to the many difficulties encountered by the operators. Apart from the basic problems involved in finding mineable coal, the companies also had to contend with accidents, labour unrest, adverse economic conditions and labour shortages caused by two world wars.

On May 3, 1887 an explosion at the Number One Mine of the Vancouver Coal Company caused the death of 150 miners. Although this single accident took the greatest toll, other disastrous explosions were fairly common throughout the early years.

In later years, flooding became an ever present danger, especially when neighbouring operations broke through into abandoned pits.

The early 1890s saw increased competition from British and Australian coal cutting deeply into markets at San Francisco and resulting in a depression which lasted until 1894.

In 1907, a strike called in an attempt to oust Chinese labourers from underground workings was settled through the efforts of W. L. MacKenzie King, then Deputy Minister of Labour in the Federal Government.

However, the most serious strike in the history of the industry began in the autumn of 1912 and was not settled until after World War I had started. In September 1912, a strike broke out in the Cumberland Mines of the Dunsmuir firm and spread almost immediately to that company's Extension collieries. In May 1913 the United Mine Workers of America joined the strike, thus affecting all other operations in the Nanaimo field. Agreements were reached with the other companies in September 1913 but it was not until October 1914 that the Extension Mine finally reopened.

Much bitter feeling was engendered by the strike and several outbreaks of violence forced the government to call up militia and impose martial law.

The companies resorted to importing Greek strike-breakers, but these men got little or no support from the rest of the European immigrant mine workers.

One outcome of the strike, which had far-reaching effects, was that many consumers were forced to turn to petroleum from California as an alternative fuel.

The Western Fuel Company's Brechin Mine never reopened after the strike, and it was not until the advent of World War I that the recession caused by the strike was dispelled.

By 1916 production had returned to its previous level although employment was less than in 1912. Meanwhile California petroleum continued to make inroads on coal markets.

The period from World War I to 1923 saw the last years of coal mining prosperity on Vancouver Island. This period was followed by a decline in production and employment due to both adverse market conditions and also the approaching exhaustion of the Nanaimo reserves.

When the Great Depression descended on the nation it merely accelerated a process already begun. In 1930 development work on Western Fuel Company's Reserve Mine was suspended. In 1931 Canadian Collieries' Extension Mines were abandoned and in 1932 the Granby Mine at Cassidy finally closed. By this time, mining activity in the Nanaimo field was confined to South Wellington Mine, Number One Mine on the Esplanade, and a few small mines operating in abandoned workings of the larger companies.

In 1934 the Western Fuel Company reopened its Reserve Mine but by 1939 all of this company's operations were shut down.

Coal mining activity survived World War II in the Cumberland area but on a greatly reduced scale. By 1953, all major operations except the Tsable River Mine had closed. The Tsable River operation struggled on until 1966 but its annual production in the last few years never exceeded 50,000 tons and in its final year production barely reached 15,000 tons.

Thus the first mining industry in British Columbia came to an end on Vancouver Island after making an important contribution to its economic growth for more than one hundred years. Fortunately the logging and wood-processing industries have taken up the economic slack resulting from the closure of the mines in the old coalfields. The city of Nanaimo, born as a coaltown, has expanded as a centre of commerce. Metal mining is also taking the place of coal mining as a resource industry on Vancouver Island although for obvious geological reasons in areas other than the old coalfields.

History of Production

Except for a few one-man operations in coal outcroppings, coal mining activity on Vancouver Island has ended. Coal has been mined there since 1836 and total production reached nearly 72 million long (2,240 lb) tons by the end of 1967. Most of the following statistics were taken from the Annual Reports of the British Columbia Minister of Mines.

Prior to the development of the Nanaimo coalfield in 1852, about 10,000 long tons were produced from the Suquash area, but since then essentially all Vancouver Island coal production has been from the Nanaimo and Cumberland-Tsable River coalfields.

The annual production figures in Table 2 reflect the history of the development of the Vancouver Island coal mining industry. This history will be briefly summarized in a later section of this paper.

Some other relevant figures for a few production years follow: In 1900, production was 1,383,376 tons, of which 201,366 were sold to the United States, Australia and Britain; 16,275 tons of coke were sold to the United States. There were 3,701 men employed, including 619 non-whites and 143 boys. Wages were $3.00 to $4.50 for white miners and $1.00 to $1.50 for Chinese and boys. Seventy-seven accidents took place, 14 of these were fatal.

The peak year of production was 1922, when 1,754,656 tons were produced and 366,837 of these originated in the Cumberland area. This was the last year that coke was produced at Union Bay and production amounted to 4,127 tons. The payroll was up to 4,499 men and white miners were paid $6.54 to $9.75, Chinese only $2.27 to $3.05. There were 27 fatal accidents.

In 1950, just before the rapid final decline of coal mining on Vancouver Island, the gross output was 575,228 tons and more than half or 310,756 tons were produced by the Cumberland mines. Only 19,972 were sold in the United States but none elsewhere. Employment amounted to 927 men but no wages are quoted in the Annual Report; there were only 2 fatal accidents.

Nanaimo area

Production in the Nanaimo coalfield was from three major seams. These are, beginning with the lowest; the Wellington, the Newcastle and the Douglas seams.

Wellington Seams

The Wellington seams were worked in two areas forming the eastern portion of the Nanaimo field. They were first mined northwest of Nanaimo in the Wellington District and later to the south in the Extension District, forming a total workable area twelve miles long and averaging one mile in width.

The Main Wellington seam (Wellington No. 1) occurs at the base of the Extension-Protection Formation, and is commonly underlain by sandstone of the East Wellington Member of the Haslam Formation. This sandstone member appears to represent the regressive phase of the Haslam and is taken to mark the beginning of the second depositional cycle of the Nanaimo Group (Muller and Jeletzky, 1970). The roof of the seam may be sandy shale, sandstone or conglomerate.

The Wellington No. 1 seam was by far the main producer of Wellington coal. However some minor workings were established in three upper seams in the northern part of the area. These seams were designated by Buckham (1947a) as: the Wellington No. 2 (also referred to as the Little Wellington), Wellington No. 3 and Wellington No. 4. These three seams rarely exceed two feet in thickness and lie above Wellington No. 1 at intervals of approximately 35 feet, 60 feet and 75 feet, floor to floor.

Shale and "rash" partings are common in the main Wellington seam which, according to Buckham (1947a, p. 468), "varies in thickness from nothing to nearly thirty feet, and averages from four to seven feet... The most conspicuous feature of the seam is its variability in thickness caused chiefly by minor faults, folds, or bands, usually in the roof, the floor being fairly regular although occasionally showing sharp rolls."

Of particular interest are the "rolls" described by Clapp (1914a, p. 105) where a seam "pinches gradually to virtually nothing and then thickens to 10 feet (Fig. 11). Although the floor may be nearly smooth, the roof in passing from the thin to the thick portion of the seam rolls sharply, and often 25 feet in one place. These sharp rolls are locally called "faults". Invariably at the thin places or "pinches" the coal is dirty or slickensided, while in the thick places, or "swells" it is clean, black in colour, with a sub-brilliant lustre, and broken only by a few irregular joints... In some places the coal is clean and unfractured against the upturned roof, but more commonly it is somewhat slickensided and even contorted. The roof at the rolls is always contorted and slickensided. The strike of the rolls corresponds with the strike of the measures, that is northwest to west, and the pinches occur on the northeast or north side of the rolls, with the corresponding swells on the opposite side. Where the seam is overlapped, the overlap is to the northeast or north."

Clapp's (1914a) detailed descriptions of the Nanaimo coal seams include illustrations of these seam structures and analyses of the coals. He gives the rank of the Wellington coal as rather high volatile bituminous. Table 3 gives the results of several analyses of coals from the Nanaimo field.

The petrography of the coal of the Wellington seam was studied in detail by Hacquebard et al. (1967) and the general characteristics observed were described as follows:

"The Wellington seam... consists of a very finely striated humic coal that has a uniform semi-bright appearance. The coal may be classed as a dull clarain, which is practically devoid of associated vitrain bands or stringers. Somewhat duller layers occur occasionally, but do not stand out as distinct durain bands. Small lenses of fusain can be detected upon close observations. Due to its uniformity the coal is fairly hard and strong. It breaks with a hackly fracture into large lumps. Where the seam is contorted in the "swells" the coal looks uniform and is fairly dull in appearance, except on slickensided faces which are brilliantly polished. Bedding cannot be detected in the disturbed coal."

Douglas Seam

The Douglas seam occurs within the Extension-Protection Formation about 60 feet above the Newcastle seam and an estimated 650 to 1,000 feet above the level of the Wellington seam. None of the available borehole records show penetration of both the Douglas and Wellington seams by a single bore. It has been suggested (Muller and Jeletzky, 1970) that perhaps there is very little or no overlap of these seams. Thus the area underlain by the Douglas seam lies east of and parallel to the Wellington workings, forming a north-northwest trending belt, 9 miles long and up to two miles wide, from Nanaimo River to Newcastle Island. The eastward extent of the Douglas seam is undefined, but abandoned undersea workings extend over a mile from shore east of Nanaimo.

The Douglas resembles the Wellington seam in thickness-variability and in structural features. Clapp (1914a, p. 111) states that the thickness varies from virtually nothing to over 30 feet, and averages about five feet, although over larger areas the average thickness of mineable coal is three to four feet.

Structures in the Douglas seam include pinches, swells, carbonaceous shale partings ("wants"), small faults with "rash" along the zone of dislocation, and "rolls" similar to those found in the Wellington seam. However, "rolls" in the Douglas are chiefly associated with irregularities in the floor rather than the roof. Muller (Muller and Jeletzky, 1970) considered the predominantly shale floor of the Douglas in contrast to the sandstone below the Wellington to be the prime factor controlling this different mode of intraformational slumping.

The extreme variability of the Douglas seam often made its extraction difficult to the point of frustration. Buckham (1947a, p. 469) cites a classic example where: "A bore hole had shown eight feet of coal. A slope passed nearby the bore in barren ground. Levels were driven to both the rise and dip sides of the bore, also in barren ground. A cross-cut between the levels, inbye from the bore, was again in barren ground. The mine manager then had a square pillar, 100 feet on a side, all the sides of which were barren of coal, but within which was a bore hole reported to have cut eight feet of coal. This was too much, so a cross-cut was driven to the bore on sights. It was found the bore had cut a pocket of coal, and that, had it been moved twenty feet away in any direction, it would have been in barren ground."

The character of the Douglas coal was described by Clapp (1914a, p. 114) as: "... black with a sub-brilliant to brilliant lustre. It is massive and broken by irregular joints producing an irregular hackly fracture. It is fairly hard and weathers well. As in the Wellington coal, thin films of calcite occur on some of the fractures. In places where the coal has been sheared it develops highly polished, very irregular, slickensided surfaces, between which the coal has a rather dull to sub-brilliant lustre. Except where it is dirty and contains a large amount of ash, it is rarely contorted."

"The Douglas coal is a high volatile bituminous coal, and as may be seen from the analyses (see Tables 3, 5), similar to the Wellington coal. From the analyses it appears as if the coal from Southfield and South Wellington was higher in fixed carbon and lower in ash than that from near Nanaimo, and it also appears to coke more readily."

The Douglas seam has been subject to many "outbursts" in workings at depth greater than 1,000 feet. These were reported in the British Columbia Minister of Mines Annual Reports for 1921 regarding the Granby No. 1 Colliery and for 1943 and 1944 in the adjacent Canadian Collieries Number Ten Mine. The reports observe that the outbursts were encountered by the workings being driven down the pitch of the seam; as the workings advanced downward they increased in violence and magnitude with depth. The first blowouts consisted largely of sudden emissions of gas, and the coal at the working-faces was loosened but not displaced; as the workings proceeded down-dip the loosened coal at the face was pushed out into the roadways; further advances encountered outbursts that projected large volumes, up to several hundred tons of coal into the open workings. The outbursts generally were simultaneous with, or up to five minutes after the firing of a shot in the coal face, and special safety regulations stipulating a maximum of two shots to be fired simultaneously were introduced under the "Coal Mines Regulation Act". The outbursts appear to have been a reason why workings were generally not advanced deeper than one thousand feet, even where good coal was present at lower levels.

Newcastle Seam

The Newcastle seam lies about 60 feet below the level of the Douglas seam and has the most restricted distribution of the three producing seams in the Nanaimo coalfield. It was workable only in the area underlying Newcastle and Protection Islands and beneath the present town of Nanaimo.

Clapp (1914a) believed the seam could be traced in prospect slopes as far as South Wellington with a short continuation south of the Nanaimo River. The eastward extent of the Newcastle seam, like the Douglas, is unknown.

Where it was worked, the Newcastle seam averaged three to four feet in thickness and except in the vicinity of faults or "rolls", does not contain shaly partings (Buckham, 1947a). Clapp (1914a, p. 109) described it as "although thinner, much more regular than the Wellington or Douglas seam."

The Newcastle seam is also high volatile bituminous in character, although perhaps lower in fixed and actual carbon and higher in oxygen and ash content than the Wellington and Douglas. It does not coke readily and was sold mainly as a steam coal.

Cumberland-Tsable River areas

Coal seams have been found in drillholes in the Comox Formation from Quinsam (Oyster River) area in the north to Cowie Creek in the south, but have been mined only in Cumberland and Tsable River areas (see Fig. 13, in pocket). The coal is part of the Comox Formation that rests unconformably on Triassic Karmutsen Formation volcanic rocks, either directly or with a basal conglomerate (Benson Member). The beds represent the lower part of the first depositional cycle of the Nanaimo Group (Muller and Jeletzky, 1970) and are older than the coal measures of the Nanaimo area that are part of the second depositional cycle.

Three seams named (from highest to lowest) Number One, Number Two and Number Four Seams were mined from eight separate shaft- or slope-mines, and only in a few instances the workings in one seam are directly above those of another seam (see Fig. 13). In Tsable River Mine in the lower part of the formation one seam was worked and its correlation with the seams of the Cumberland Mines is doubtful.

MacKenzie (1922, p. 398) believed that the thicker seams were formed near the base of the measures and that higher seams are generally unworkable. He further described the coal as follows:

"Characteristically, the coal is associated with layers of grey or brownish-grey shale. Rarely, a band of clean coal is enclosed between a sandstone roof and floor, ... and frequently the coal is wholly enclosed in shale. Like the seams in other parts of Vancouver Island, these have no trace of anything resembling underclays, nor have rootlets, tree stems, branches, or leaves been observed in association with the coal... Apart from the clay shale associated with the seams, more or less fissile carbonaceous shale, and the brown compact shale known as 'bone', occur interbedded with the coal itself. These impurities vary from a lamina, of paper thinness, to bands occupying most of the thickness of the seam; and instances occur where the seam consists of shale, or of coal so high in sediment as to be unworkable. This is particularly the case where the seam closely approaches the pre-Cretaceous rocks. Neither in the outcrops nor in the bore holes had a clean seam of coal been observed resting directly on the old volcanics, though dirty coal, or shale with coaly streaks, frequently does so...

"The thickness of coal in any given seam may vary from a fraction of an inch to many feet, 25 feet of coal being the thickest obtained in any single seam. This, however, included a band of shale four inches thick, and the coal was soft and shaly. A solid bench of bright hard clean coal exceeding 30 inches in thickness is an unusual occurrence."

Table 4 presents results of analyses of coal from the Cumberland-Tsable River field, quoted by Williams (1924). Table 5 gives more recent analyses of run-of-mine samples, given by Schwartzman and Tibbetts (1953).

Notes on Past and Possible Future Exploration

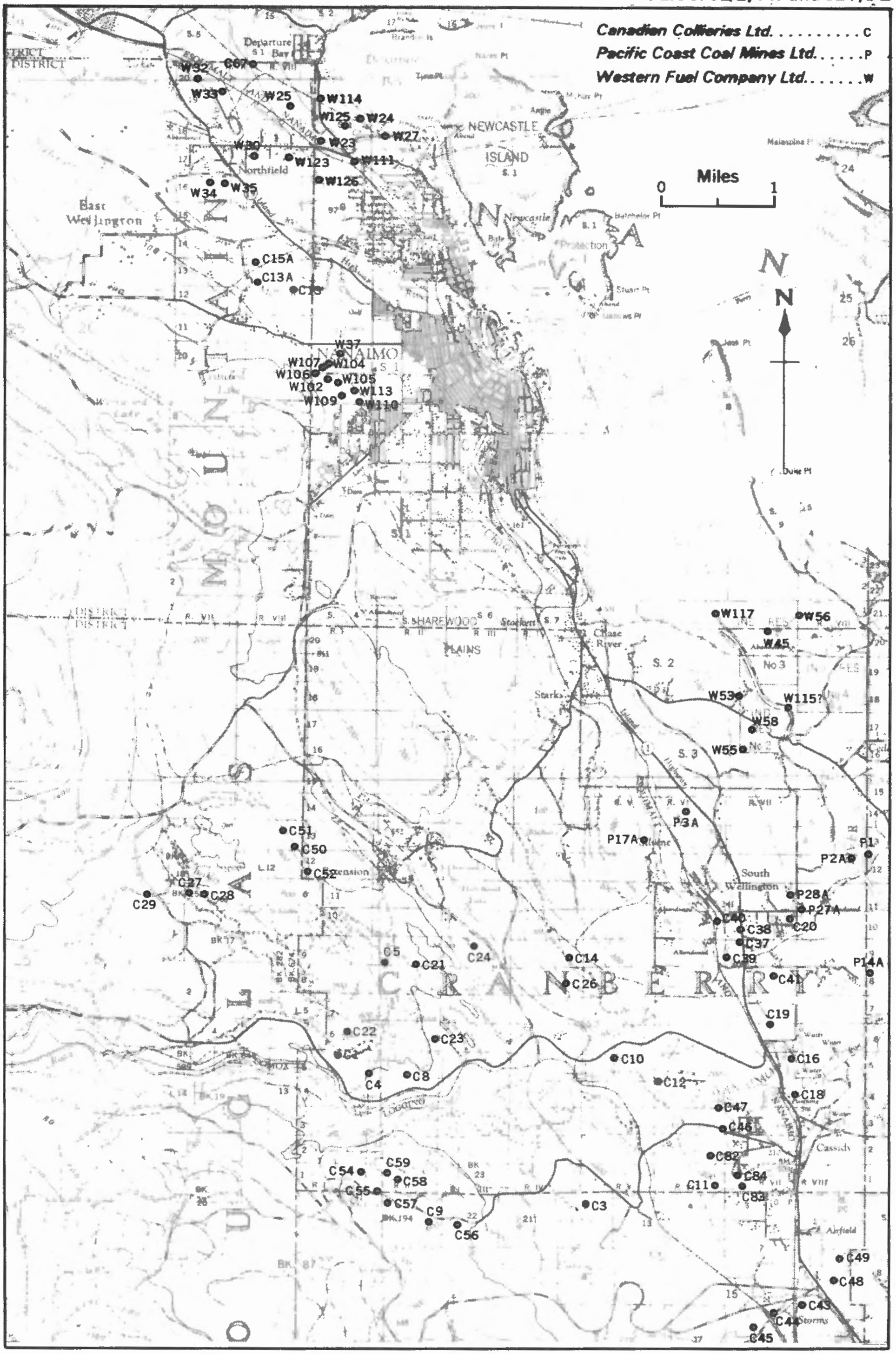
The experience and data gained during past exploration for mineable coal may aid any future exploration on the island.

The oldest mines in Suquash and Nanaimo were on outcropping seams, discovered by natives and worked by Hudson's Bay Company miners from short near-surface adits. Later mines were discovered by the early miners on surface outcrops, starting with the Wellington field, discovered by Robert Dunsmuir. In these mines exploration was done primarily by following outcropping seams along exploratory slopes and levels.

In later years the tracing of seams from known coal-outcrops had to be supplemented and replaced by more or less systematic drilling of areas underlain by Nanaimo Group sediments and near to known coal occurrences. In the Nanaimo field there are no records of drilling after 1924, in the Comox field drilling proceeded to about 1957, latterly mainly in the Tsable River-Cowie Creek and Quinsam areas. Records of many drillings are available, their locations are shown on Figures 14-17, and abbreviated data on Tables 6-11.

Estimates of coal reserves on Vancouver Island by MacKay (1947) using the then available mining- and drilling-data are reproduced in Table 12. No attempt has been made to update these results. At that time the reserves of Canadian coal mines were made in consultation with the local mining engineers, an advantage not available to the present writers. The estimates of probable mineable coal not less than 2 feet thick and to maximum depth of 2,000 feet give totals of 2.3 million tons in the Nanaimo field, 25.9 million tons in the Cumberland field, 14.5 million tons in the Tsable River area and 9.9 million tons in the area between Courtenay and Campbell River. Only half of that tonnage was estimated to be recoverable in the course of mining. Since that time 4.4 million tons have been mined on Vancouver Island and probably a little less than half of that figure in the Nanaimo field. Thus the known probable reserves of the Nanaimo field are apparently almost exhausted, especially if one considers that mining there generally cannot proceed much beyond the thousand-foot-depth on account of outbursts.

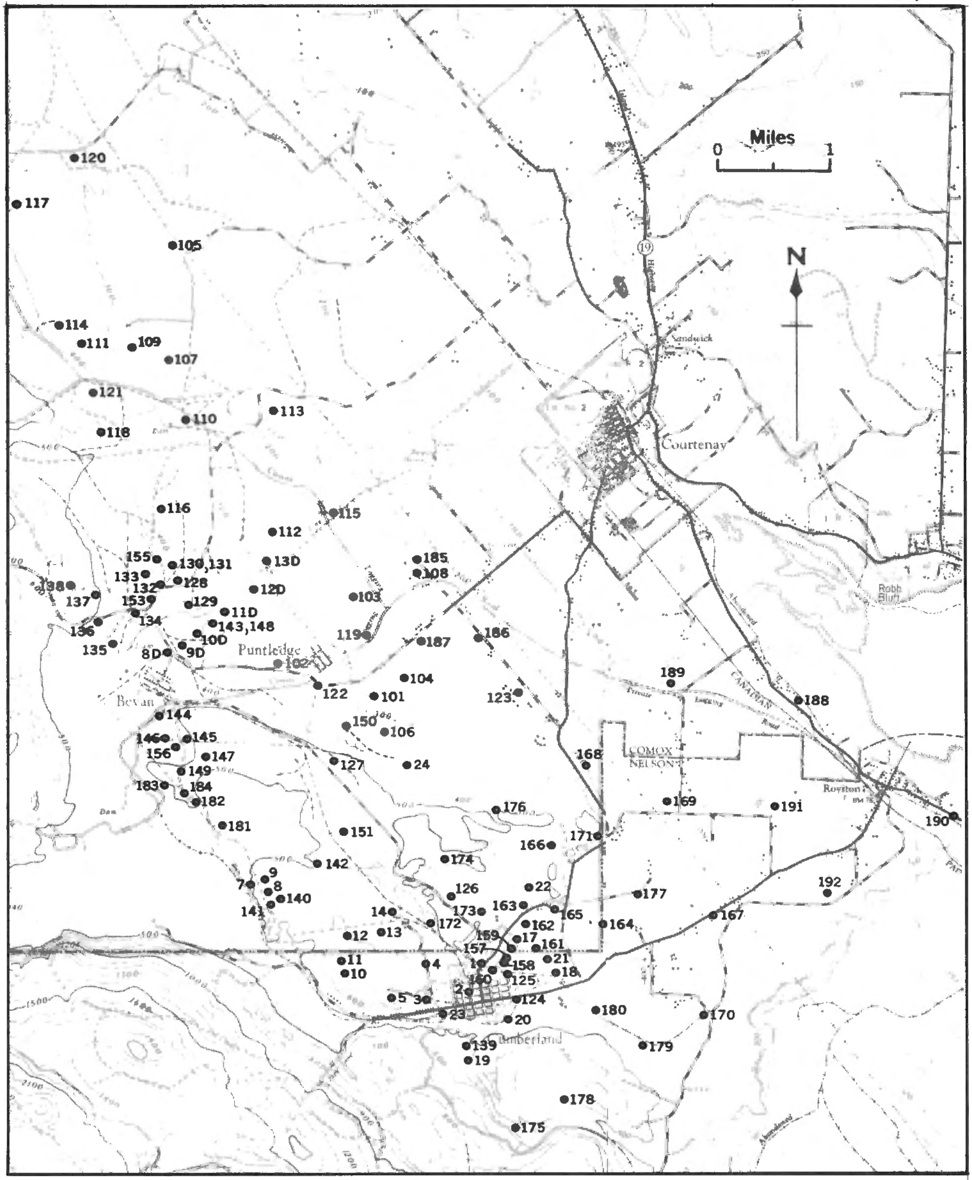
Part of 92 G/4 W and 92 F/1 E



GSC

Figure 14. Borehole locations in Nanaimo Field.

Part of 92 F/11 E and 92 F/10 W



GSC

Figure 15. Borehole locations in Cumberland Field.

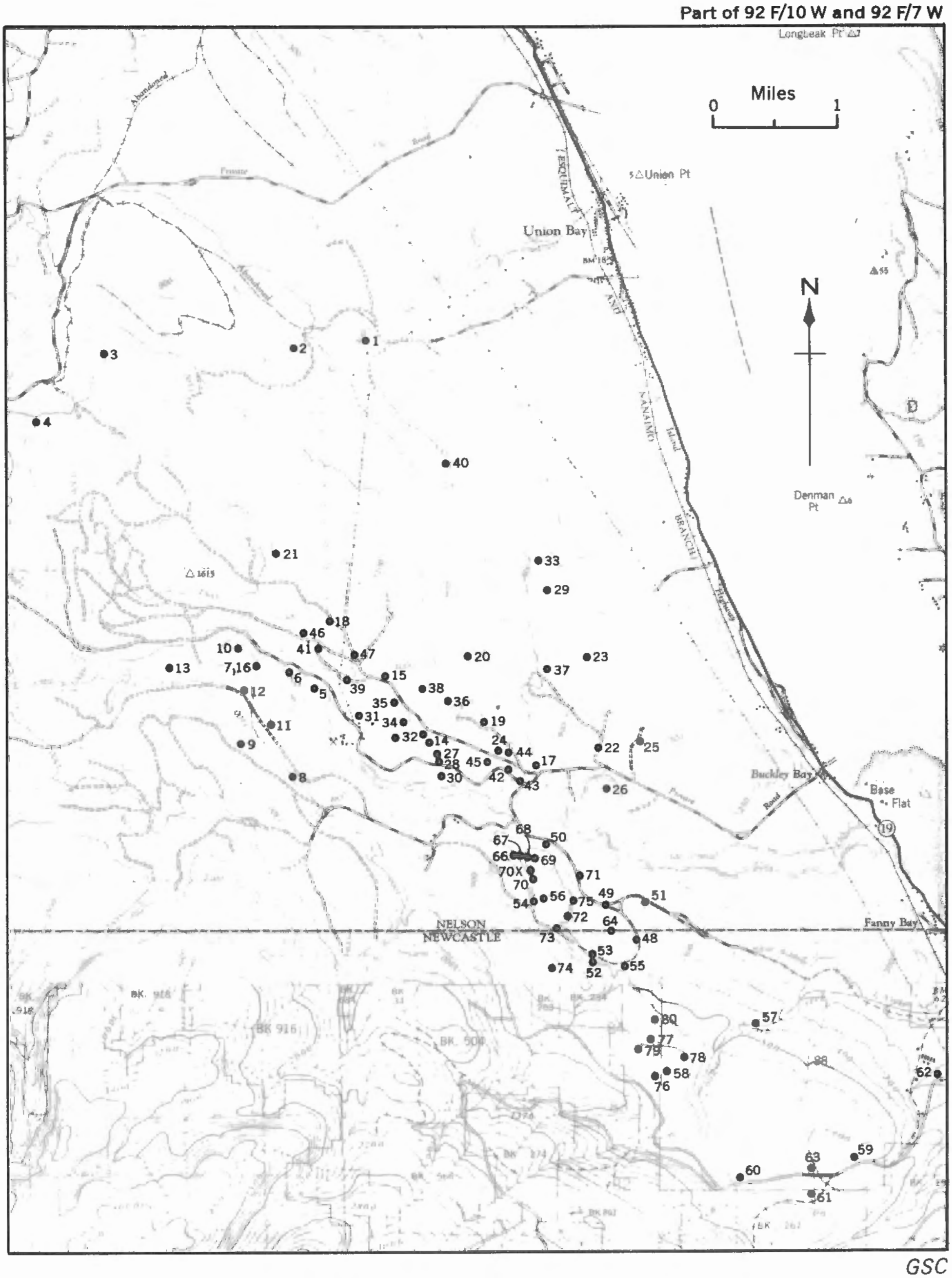


Figure 16. Borehole locations in Tsable River - Cowie Creek Field.

Part of 92 F/14 E, W and 92 K/3 E, W

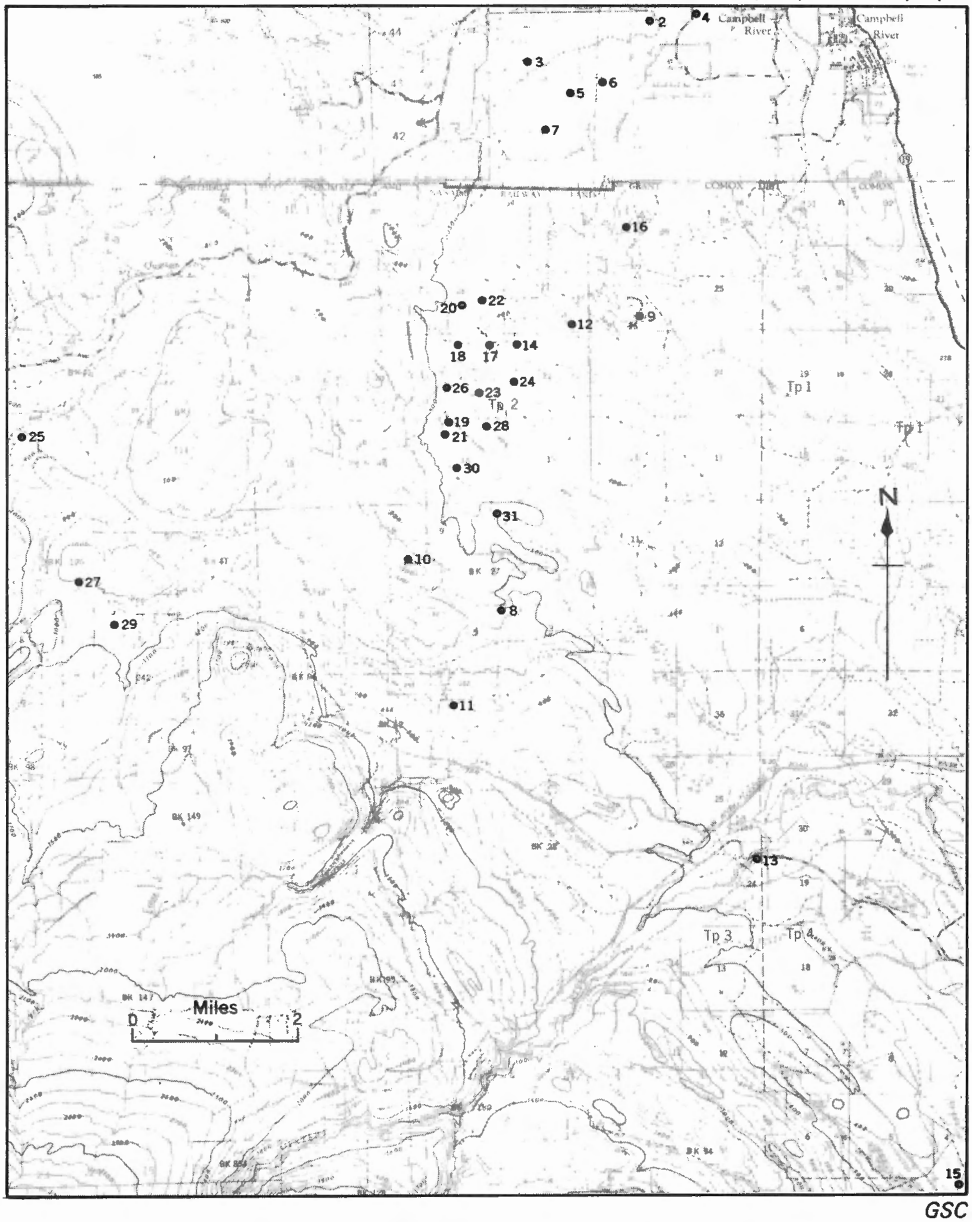


Figure 17. Borehole locations in Campbell River area.

The Comox field is a more promising area for future development. There the 1947 reserve-estimates show considerable acreages of coal more than 2 feet thick and at depth less than 2,000 feet. The available drillholes convey a general impression that seams more than 3 feet thick are present at depths generally between 500 and 1,500 feet. However, as depth increases to the northeast there appears to be also a tendency for the coal seams to "shale out", probably due to a change from lagoonal to nearshore marine deposition. Erosion of parts of the measures that preceded the second depositional cycle is another adverse factor.

Nevertheless the data presently available indicate the presence of additional coal in the Comox field that could perhaps become mineable with improved economic and technical conditions.

REFERENCES

Atchison, M. E.

1968: Stratigraphy and depositional environments of the Comox Formation (Upper Cretaceous), Vancouver Island, B. C.; unpubl. M.Sc. thesis; Northwestern Univ., Evanston, Illinois.

Bell, W. A.

1957: Flora of the Upper Cretaceous Nanaimo Group of Vancouver Island, British Columbia; Geol. Surv. Can., Mem. 293.

Brewer, W. M.

1902: British Columbia coalfields; Eng. Mining J., vol. 73, pp. 408-410.

Buckham, A. F.

1947a: The Nanaimo coal field; Trans. Can. Inst. Mining Met., vol. 50, pp. 460-472.

1947b: Preliminary Map, Nanaimo coalfield; Geol. Surv. Can., Paper 47-22.

Campbell, C. M.

1924: Cassidy and the Douglas Seam; Trans. Can. Inst. Mining Met., vol. 27, pp. 456-477.

Clapp, C. H.

1912a: Geology of Nanaimo sheet, Nanaimo coalfield, Vancouver Island, British Columbia; Geol. Surv. Can., Sum. Rept. 1911, pp. 91-105.

1912b: Note on the geology of the Comox and Suquash coal fields; Geol. Surv. Can., Sum. Rept. 1911, pp. 105-107.

Clapp, C.H. (Cont.)
1913: Geology of the Victoria and Saanich map-area, Vancouver Island; Geol. Surv. Can., Mem. 36.

1914a: Geology of the Nanaimo map-area; Geol. Surv. Can., Mem. 51.

1914b: Coal formation on Galiano, Mayne, and Saturna Islands; B.C. Min. Mines, Ann. Rept. 1913, pp. K 292-299.

Crickmay, C.H. and Pocock, S.A.J.
1963: Cretaceous of Vancouver, British Columbia, Canada; Bull. Am. Assoc. Petrol. Geol., vol. 47, pp. 1928-1942.

Dawson, G.M.
1887: Report on a geological examination of the northern part of Vancouver Island and adjacent coasts; Geol. Surv. Can., Ann. Rept. 1886, vol. 2, Pt. B, pp. 1-107.

1890: Notes on the Cretaceous of the British Columbian region - The Nanaimo Group; Am. J. Sci., vol. 39, pp. 180-183.

Hacquebard, P.A., Birmingham, T.F. and Donaldson, J.R.
1967: Petrography of Canadian coals in relation to environment of deposition: in Symposium on the science and technology of coal, Ottawa, 1967; Mines Branch, Ottawa, pp. 84-97.

Hector, J.
1861: On the geology of the country between Lake Superior and the Pacific Ocean; Quart. J. Geol. Soc. London, vol. XVII, pp. 388-445.

MacKay, B.R.
1947: Coal reserves of Canada; Report of the Royal Commission on coal, 1946; Chapter 1 and Appendix A; Ottawa.

MacKenzie, J.D.
1922: The coal measures of Cumberland and vicinity, Vancouver Island; Trans. Can. Inst. Mining Met., vol. 25, pp. 382-411.

1923: Alberni area, Vancouver Island; Geol. Surv. Can., Sum. Rept. 1922A, pp. 51A-67A.

Matheson, M.H.
1950: Some effects of coal mining upon the development of the Nanaimo area, B.C.; unpubl. M.A. thesis, Univ. British Columbia.

McGugan, A.
1962: Upper Cretaceous foraminiferal zones, Vancouver Island, British Columbia; J. Alta. Soc. Petrol. Geol., vol. II, pp. 585-592.

1964: Upper Cretaceous zone foraminifera, Vancouver Island, British Columbia, Canada; J. Paleontol., vol. 38 (5), pp. 933-951.

Muller, J. E.
1963: Alberni area, British Columbia; Geol. Surv. Can., Map 49-1963.

1965: Comox Lake area; Geol. Surv. Can., Map 2-1965.

Muller, J. E. and Carson, D. J. T.
1969: Geology and mineral deposits of Alberni map-area, Vancouver Island and Gulf Islands, British Columbia; Geol. Surv. Can., Paper 68-50.

Muller, J. E. and Jeletzky, J. A.
1967: Stratigraphy and biochronology of the Nanaimo Group, Vancouver Island and Gulf Islands, British Columbia; in Rept. of Activities, November 1966 to April 1967; Geol. Surv. Can., Paper 67-1, Pt. B, pp. 38-47.

1970: Geology of the Upper Cretaceous Nanaimo Group, Vancouver Island and Gulf Islands, British Columbia; Geol. Surv. Can., Paper 69-25.

Newberry, J. S.
1857: Report on the geology of the route of Williamson's survey in California and Oregon; U.S. Pacific Rwy. Expl., Pt. 2, pp. 5-68.

Porter, J. B. and Durley, R. J.
1912: Coals of Canada, Volume 1: Can. Dept. Mines, Mines Branch, No. 83.

Richardson, J.
1872: Coal fields of the east coast of Vancouver Island; Geol. Surv. Can., Rept. of Prog. 1871-1872, Pt. 2, pp. 73-100.

1873: Coal fields of Vancouver Island; Geol. Surv. Can., Rept. of Prog. 1872-1873, Pt. 4, pp. 32-65.

1878: Coal fields of Nanaimo, Comox, Cowichan, Burrard Inlet and Sooke, British Columbia; Geol. Surv. Can., Rept. of Prog. 1876-1877, Pt. 7, pp. 160-192.

Sutton, W. J.
1904: The geology and mining of Vancouver Island; Trans. Manchester Geol. Mineral. Soc., vol. 28, pp. 307-318.

Swartzman, E., and Tibbetts, T. E.
1953: Analysis directory of Canadian coals; Mines Branch, Ottawa, No. 836.

1955: Analysis directory of Canadian coals, Supplement No. 1; Mines Branch, Ottawa, No. 850.

Usher, J. L.
1952: Ammonite faunas of the Upper Cretaceous rocks of Vancouver Island, British Columbia; Geol. Surv. Can., Bull. 21.

Williams, T. B.
1924: The Comox coal basin; unpubl. Ph.D. diss., Univ. Wisconsin.

APPENDIX

Tables 2-12

Table 2

Annual coal production in long tons from
Vancouver Island coalfields

1836-1852	10,000	Mining in Suquash area.
1852		Governor Douglas sends McKay to Winthuysen Inlet (Nanaimo) to take possession of coal.
1852-1866	181,437	Hudson's Bay Company pits at Nanaimo and Southfield.
1862		Vancouver Coal Mining and Land Company takes over mines from Hudson's Bay Company.
1867	31,239	
1868	44,005	
1869	35,802	Coal discovered at Wellington.
1870	29,843	
1871 1872 1873	148,459	Dunsmuir, Diggle and Co. operations in Wellington field begins.
1874	81,061	
1875	97,644	
1876	140,184	
1877	139,692	First strike (for 0.20/hour increase).
1878	190,848	
1879	232,390	
1880	272,362	
1881	299,514	
1882	288,572	
1883	214,955	Dunsmuir buys out partners.
1884	393,866	
1885	333,024	
1886	335,192	Douglas Mine closed.
1887	434,055	Explosion in Number One Mine kills 150 men.
1888	481,667	Dunsmuirs open Union Colliery in Comox field. Explosion at Wellington kills 77 men.

Table 2 (Cont.)

1889	568,249	
1890	685,345	Strike (for 8-hour work-day).
1891	1,009,131	
1892	836,802	
1893	976,768	
1894	993,418	
1895	914,683	Extension field opened.
1896	894,882	
1897	892,295	
1898	1,126,531	
1899	1,203,199	
1900	1,383,376	
1901	1,312,202	
1902	1,173,893	
1903	860,775	Western Fuel Co. buy Vancouver Coal Mining and Land Co.
1904	1,023,013	MacKenzie King intervenes in strike.
1905	993,899	San Francisco earthquake causes 5-month closure of mines due to lack of demand.
1906	1,178,627	
1907	1,332,009	
1908	1,200,582	
1909	1,414,375	
1910	1,626,030	
1911	1,625,122	
1912	1,558,240	
1913	973,493	All mines closed by strike, Sept. 1912-Sept. 1913.
1914	1,072,314	
1915	1,020,942	
1916	1,492,761	
1917	1,695,721	

Table 2 (Cont.)

1918	1,666,211	
1919	1,699,348	
1920	1,698,254	
1921	1,625,931	
1922	1,754,656	Peak production.
1923	1,574,663	California oil production begins to make inroads on coal consumption.
1924	1,486,322	
1925	1,412,757	
1926	1,293,175	
1927	1,331,325	
1928	1,277,533	Western Fuel Co. sold to Canadian Collieries Ltd.
1929	1,120,805	
1930	988,805	Reserve Mine development suspended.
1931	831,925	Extension Mine abandoned.
1932	749,006	Granby Mine closed.
1933	613,203	
1934	574,508	
1935	630,213	
1936	713,037	
1937	818,447	No. 10 South Wellington Mine opened.
1938	684,398	No. 1 Mine in Nanaimo closed.
1939	717,334	All of Western Fuel operations shut down.
1940	732,659	
1941	647,958	
1942	738,600	
1943	729,989	
1944	689,714	
1945	557,778	
1946	547,468	

Table 2 (Cont.)

1947	493,998	Production started at Tsable River Mine.
1948	399,089	
1949	536,935	
1950	511,953	
1951	479,841	
1952	359,313	
1953	236,230	No. 8 Mine closes - last major mine in Cumberland field.
1954	183,269	
1955	186,708	
1956	178,309	
1957	178,182	
1958	162,251	
1959	133,205	
1960	81,350	
1961	69,696	
1962	72,612	
1963	67,369	
1964	57,307	
1965	37,670	
1966	15,556	
1967	333	Tsable River Mine closed.

Total Production 1836-1967 71,751,696 long tons.

Table 3. Proximate analyses of coals from the Nanaimo field*

	Moisture	Volatile combustible	Fixed carbon	Ash	Sulphur	Fuel ratio	Galorific value B.T.U.
Wellington coal.							
Wellington Mine	2.75	38.03	52.64	6.58	- - -	1.38	12567
Wellington Mine	8.57	25.30	56.40	9.52	0.21	2.22	- - -
Wellington Mine	4.14	36.85	46.16	12.85	0.56	1.25	- - -
Harewood Mine	1.58	33.84	52.17	11.85	0.56	1.53	12238
Extension collieries	1.44	31.40	46.18	20.65	0.33	1.47	11401
Extension collieries	1.52	35.27	57.04	5.85	0.32	1.61	13416
Extension collieries	1.24	36.49	53.72	8.20	0.35	1.47	13261
Extension collieries	1.28	35.26	55.83	7.30	0.33	1.58	13199
Newcastle coal.							
Nanaimo colliery No. 1 shaft	2.86	35.84	54.79	5.5	1.01	1.53	12951
Douglas coal.							
Newcastle island	1.57	38.14	50.84	8.63	0.82	1.33	- - -
Nanaimo colliery No. 1 shaft	1.88	33.27	54.67	9.40	0.70	1.64	12672
Southfield colliery No. 5 shaft	2.08	35.78	56.26	5.60	0.28	1.57	13261
Southfield colliery No. 5 shaft	2.06	34.07	56.94	6.67	0.25	1.67	- - -

* Taken from Clapp (1914a)

Table 4. Proximate analyses of some coals from the Cumberland-Tsable River field

	Volatile combustible	Fixed carbon	Ash	Sulphur[1]	Fuel ratio[2]	Calorific value in B. T. U. /lb
Cumberland coal						
No. 4 Mine, No. 4 Seam	30.2	57.7	12.1	0.9	1.90	13,260
Surface exposure at Hamilton Lake, No. 2 Seam, several benches						
Channel sample, Bench 5	32.3	50.0	17.7	2.7	1.55	12,370
Channel sample, Benches 8-10	31.6	52.9	15.5	2.2	1.70	12,670
Channel sample, Bench 12	31.6	61.1	7.3	0.8	1.95	13,940
Hand sample, Bench 16	31.7	59.9	8.4	0.9	1.90	13,930
No. 5 Mine, No. 1 Seam	35.9	49.9	14.2	3.1	1.40	12,980
Tsable River coal						
No. 2 Seam	32.9	47.1	20.0	0.92	1.43	-
Prospect No. 4, No. 3 Seam						
Bench 5	31.2	56.4	12.4	2.1	1.80	12,650
Bench 7	30.7	57.8	11.5	0.8	1.90	13,440
Bench 9	31.4	50.1	18.5	-	1.60	-
No. 5 Seam, Bench 9	29.4	43.9	26.7	-	1.5	-

All samples dried to 105° C.

Data are from Williams (1924).

[1] Sulphur values obtained from ultimate analyses.

[2] Fuel Ratio = Fixed Carbon/Volatile Matter.

Table 5. Analyses of run-of-mine coal samples from Nanaimo and Comox coalfields (1953)

		Nanaimo field Canadian Collieries (Dunsmuir) Ltd. Wellington No. 10 and Bright Mines Douglas seam					Comox field Canadian Collieries (Dunsmuir) Ltd. Comox No. 5; Comox No. 8; Tsable River Mines Number Two seam, Tsable River seam				
Size		Mine Run	Lump	Nut	Pea	Slack and Washed Smalls	Mine Run	Lump, Egg, Cobble	Nut, Pea, Stoker, Washed Smalls	Slack	Fines
Screen limits at mine	in.		+2 1/2 rd.		3/16 x 7/8 rd.	0 x 1 1/2 or 3/16 rd.				0 x 7/8 rd.	0 x 3/16 rd.
No. of samples		4	48	9	6	12	5	38	29	11	3
Chemical Properties-											
Proximate Analysis (As received)-											
Moisture	%	5.0	3.5	4.0	4.0	6.0	3.5	2.5	4.0	5.5	6.0
Ash	%	13.0	12.7	13.9	13.2	13.5	13.8	11.6	13.8	14.2	15.6
Volatile matter	%	33.2	36.1	36.5	35.7	35.0	31.3	32.2	30.4	30.4	30.2
Fixed carbon	%	48.8	47.7	45.6	47.1	45.5	51.4	53.7	51.8	49.9	48.2
Calorific value (As received)	B.t.u./lb	12,155	12,330	12,185	12,250	11,840	12,320	12,970	12,365	12,115	11,945
Ash softening temperature	°F	2305	2260	2390	2300	2280	2170	2115	2290	2250	2260
Caking Properties -											
Volatile matter residue-950° C.		Fair					Fair to Good				
Caking index (Grey)		45-63					65				
Swelling Properties-											
Swelling index (A.S.T.M.)		1-6					6-8				
Swelling index (F.R.L.)		-60 to 520 (Average 256)					833				
Ultimate Analysis (As received)-											
Carbon	%	68.2					69.1				
Hydrogen	%	4.8					4.5				
Nitrogen	%	1.4					1.0				
Sulphur	%	0.4	0.7	0.5	0.5	0.8	2.4	2.0	2.1	2.5	2.8
Oxygen	%	7.2					5.7				
Classification by Rank-											
A.S.T.M.		High volatile A bituminous					High volatile A bituminous				
S.V.I.		155-Subbituminous					175-Border of Para and Orthobituminous				
Physical Properties -											
Bulk density	lb./cu.ft.		49.7	47.0	48.5	52.0		50.7	48.5-52.0	52.0	
	cu.ft./ton		40.3	42.6	41.2	38.5		39.5	41.2-38.5	38.5	
Grindability index		67.3				75.2	65.0		76.0	67.0	68.6

Analyses of Ash - (Nanaimo field)

	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	MnO	Na_2O	K_2O	P_2O_5	TiO_2	SO_3
%	38.8	20.9	6.8	19.7	4.6	0.08	1.1	0.9	0.8	1.1	3.8

Analyses of Ash- (Comox field)

	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	MnO	Na_2O	K_2O	P_2O_5	TiO_2	SO_2
%	27.5	17.8	16.9	15.7	2.4	0.02	0.6	0.6	0.4	0.8	17.4

From: Schwartzman and Tibbetts, 1953

Tables 6-11: Summary of recorded boreholes in Nanaimo and Comox Regions

Introduction

Several hundred borings have been made in the Nanaimo and Comox Basins in the search for new mineable coal. Many of these rather complete logs are available but the information is too voluminous to be recorded in this report. It is expected that the original records will be preserved by the British Columbia Department of Mines and Petroleum Resources and by the Geological Survey of Canada.

A tabulated summary of the known drillings is given. Series of borings by a particular company in a certain field each have their own set of numbers, generally starting with 1. Each series is tabulated separately and the location of the drillings shown on several index maps.

For each boring geographical data and year of completion are given so far as is known. Tops of formations are given according to the writers' interpretation and the recorded coal-seams are summarized.

The coal shown on the logs is subdivided into seams thicker than three feet, seams one to three feet thick, and seams less than one foot thick, and the number of each category is given. Where shale and coal interbeds are recorded in the logs the aggregate thickness of the coal is taken provided it is greater than the aggregate thickness of interbedded shale. Thus a sequence coal 8"-shale 4"-coal 12'0"-shale 1'0"-coal 6" would be recorded as more than three feet of coal, but a sequence coal 4"-shale 1'2"-coal 9" would be recorded as two seams less than one foot thick. For the seams one to three feet thick and those more than three feet thick the depth of the first seam encountered is also given.

Abbreviations:

Districts, Nanaimo Region:

B = Bright District

C = Cranberry District

CD= Cedar District

D = Douglas District

M = Mountain District

N = Nanaimo District

R = Indian Reserve (southeast of Nanaimo)

Formations:

C = Comox Formation

CD = Cedar District Formation

EP = Extension-Protection Formation

H = Haslam Formation

K = Karmutsen Formation

NP = Not present

Districts, Comox Region

C = Comox District

N = Nelson District

NW = Newcastle District

S = Sayward District

EN = Esquimalt and Nanaimo Land

Table 6. Borings, Canadian Collieries Ltd., Extension field, Nanaimo area

Borehole Number	District	Range	Section or Lot	Year finished	Elevation (feet)	Total depth (feet)	Depth to bedrock	Starts in (formation)	Top of Extension-Protection	Top of Haslam	Top of Comox	Top of Karmutsen	Number of seams >3 feet thick and highest of these	Number of seams 1 to 3 feet thick and highest of these	Number of seams < 1 foot
1	C	1	5	'10	662	149	-	EP	-	-	-	-	1-143	1-115	0
2	C	2	3	'10	313	325	3	EP	-	-	-	-	1-298	2-280	0
3	B	-	9	'10	353	764	26	EP	-	-	-	-	nil	nil	0
4	C	2	5	'10	507	127	0?	EP	-	-	-	-	nil	3-98	0
5	C	2	9	'11	587	442	0?	EP	-	-	-	-	nil	1-154	4
6	C	2	4	'12	308	1475	0?	EP	-	336	-	-	nil	2-296	1
7	C	2	1	'11	545	912	0?	EP	-	366	-	-	nil	nil	0
8	C	2	5	'11	466	108	0?	EP	-	-	-	-	nil	2-66	1
9	B	-	87	'12	519	1572	9	EP	-	1375	-	-	nil	nil	0
10	C	5	5	'11	172	327	28	EP	-	-	-	-	nil	1-294	2
11	C	6	1	'11	?	495	37	EP	-	-	-	-	nil	nil	0
12	C	6	5	'11	121	851	17	EP	-	396	-	-	1-322	nil	1
13	D	8	13	'12	906	673	50	EP	-	484	-	-	nil	1-413	7
13A	D	8	13	-	915	489	26	EP	-	-	-	-	nil	4-357	3
14	C	4	9	'17	131	1076	20	EP	-	650	-	-	nil	nil	0
15	D	7	4	'12	979	723	2	EP	-	427	?	722	nil	3-308	8
15A	D	8	13	-	927	407	-	-	-	-	-	-	4-327	nil	3
16	C	7	5	'12	64	876	120	EP	-	-	-	-	nil	nil	1
17	B	-	87	'12	-	490	4	EP	-	-	-	-	nil	nil	0
18	C	7	4	'12	66	538	39	EP	-	-	-	-	nil	1?-509	0
19	C	7	7	'12	53	614	15	EP	-	-	-	-	nil	1-439	4
20	C	7	10	'12	76	623	40	EP	-	-	-	-	nil	nil	2
21	C	2	9	'13	489	432	2	EP	-	-	-	-	nil	nil	1
22	C	1	6	'18	745	695	2	EP	-	-	-	-	1-146	nil	0
23	C	2	6	'16	406	704	7	EP	-	-	-	-	nil	nil	1
24	C	3	9	'16	368	641	68	EP	-	348	-	-	nil	1-283	2
25	C	3	10	'17	390	551	4	EP	-	411	-	-	nil	nil	1
26	C	4	8	'17	362	411	10	EP	-	-	-	-	nil	nil	0
27	D	-	258	'17	940	759	5	H	-	-	-	-	nil	nil	0
28	D	-	258	'17	937	421	5	H	-	-	-	-	nil	nil	0
29	D	-	258	'17	901	65	0?	H	-	-	-	-	nil	nil	0
31	C	7	11	'17	169	223	6	EP	-	-	-	-	2-200	nil	2
32	C	7	10	'17	156	308	-	EP	-	-	-	-	1-305	nil	1
33	C	7	12	'17	177	408	-	EP	-	-	-	-	nil	1-389	0
34	C	7	11	'17	151	365	-	EP	-	-	-	-	2-319	nil	0
35	C	7	11	'18	150	535	-	EP	-	*	-	-	nil	nil	0
36	C	7	10	'18	100	640	-	EP	-	*	-	-	1-430	nil	0
37	C	7	10	'18	164	256	-	EP	-	*	-	-	1-191	nil	0
38	C	7	9	'18	172	230	-	EP	-	*	-	-	nil	1-178	2
39	C	7	9	'18	168	400	-	EP	-	*	-	-	nil	nil	2
40	C	6	10	'18	101	358	-	EP	-	*	-	-	nil	nil	1
41	C	7	8	'19	-	907	-	EP	-	*	-	-	nil	nil	1
42	C	7	10	'19	136	110	-	EP	-	-	-	-	nil	nil	0
43	B	-	'15	'21	104	1495	-	EP	-	-	-	-	nil	1-1028	4
44	B	-	'15	'21	133	1393	-	EP	-	-	-	-	nil	2-794	1
45	B	-	'15	'22	147	1508	-	EP	-	**	-	-	nil	nil	3
46	C	6	3	'22	246	1122	-	EP	-	**	-	-	nil	1-776	0
47	C	6	3	'22	193	1086	-	EP	-	**	-	-	nil	nil	0
48	B	-	'15	'22	87	1206	-	EP	-	-	-	-	nil	1-917	3
49	B	-	'15	'23	83	1157	-	EP	-	-	-	-	nil	nil	5
50	D	-	'12	'23	718	165	-	EP	-	-	-	-	2-70	nil	0
51	D	-	-	'23	735	319	-	EP	-	-	-	-	nil	nil	0
52	D	-	12	'23	866	372	-	EP	-	***	-	-	nil	1-193	0
54	C	1	2	'24	692	307	-	EP	-	***	-	-	nil	1-233	2
55	C	2	1	'24	683	746	-	EP	-	***	-	-	nil	1-260	1
56	B	-	22	'24	630	405	-	EP	-	-	-	-	nil	nil	0
57	B	-	194	'24	686	84	-	EP	-	-	-	-	nil	nil	0
67	W	8	1	-	275	449	-	EP	-	-	-	-	1-402	nil	2
82	C	6	2	-	255	325	-	EP	-	194	-	-	1-149	nil	1
83	C	7	1	-	100	269	-	EP	-	155	-	-	nil	2-59	7
84	C	7	1	-	147	316	-	EP	-	?	-	-	nil	2-127	7

* These holes ended in shale (Haslam?)
** These holes to shale
*** These holes ended in shale

Table 7. Borings by Western Fuel Company and predecessor companies in Nanaimo field

Borehole Number	District	Range	Section or Lot	Year finished	Elevation (feet)	Total depth (feet)	Depth to bedrock	Starts in (formation)	Top of Extension-Protection	Top of Haslam	Top of Comox	Top of Karmutsen	Number of seams > 3 feet thick and highest of these	Number of seams 1 to 3 feet thick and highest of these	Number of seams < 1 foot
23	N	-	1	'91	239	686	85	EP	-	523	-	-	nil	2-364	1
24	N	-	1	'91	4	935	15	EP	-	822?	-	887	nil	1-578	–
25	M	8	19	'91	263	610	186	EP	-	-	-	-	nil	3-375	3
27	N	-	1	'91	4	941	44	EP	-	792?	-	932	nil	1-692	1
30	M	8	17	'92	338	664	130	EP	-	582	-	-	nil	2-476	3
31	M	8	18	'92	300	1129	155	EP	-	577	842	-	nil	1-403	8
32	M	7	20	'93	387	705	190	EP	-	646	-	-	1-587	1-576	6
33	M	7	20	'94	350	643	190	EP	-	-	-	-	1-603	1-598	4
34	M	7	16	'94	300	458	3	EP	-	427	-	-	nil	3-296	5
35	M	7	16	'94	320	459	3	EP	-	424	-	-	nil	3-282	3
37	N	-	-	–	193	389	6	EP	-	-	-	-	nil	3-314	6
45	R	-	3	–	–	1158	16	CD?	116?	-	-	-	2-947	nil	8
53	N	-	2	–	–	728	17	EP	-	-	-	-	nil	1-578	7
55	R	-	2	–	–	550	22	EP	-	-	-	-	1-455	nil	3
56	R	-	3	–	±0	2594	7	CD	1218	2234?	2326?	-	nil	nil	6
58	R	-	2	–	–	591	5	EP	-	-	-	-	1-488	1-513	3
59	R	-	–	–	–	502	5	EP	-	-	-	-	1-473	nil	2
75/88	N	-	1	'03	9	442	90	EP	-	-	-	-	nil	nil	0
102	N	-	1	–	240	346	68	EP	-	-	-	-	4-299	nil	1
104	N	-	1	–	194	330	6	EP	-	NP?	NP?	330	nil	1-248	4
105	N	-	1	–	208	292	13	EP	-	NP	NP	286	nil	nil	0
106	N	-	1	–	221	325	74	EP	-	-	-	-	1-308	2-255	0
107	N	-	1	–	202	354	32	EP	-	NP?	NP?	349	nil	nil	2
108	N	-	1	–	54	490	26	EP	-	NP?	NP?	-	1-466	nil	1
109	N	-	1	–	232	342	81	EP	-	NP	NP	337	1-329	1-327	3
110	N	-	1	–	203	360	29	EP	-	NP	NP	358	2-330	2-283	1
111	N	-	1	'18	201	421	0	EP	-	383?	-	-	2-288	1-251	4
112	N	-	1	–	195	325	12	EP	-	NP	278?	320	nil	2-253	0
113	N	-	1	–	197	346	7	EP	-	NP	324?	336	2-314	2-236	2
114	N	-	1	'18	159	656	155	EP	-	-	-	-	nil	2-581	2
115	N	-	2	–	16	676	9	EP	-	-	-	-	nil	2-156	5
116	R	-	–	–	01	592	76	EP	-	-	-	-	nil	1-585	7
117	R	-	3	–	7	1401	91	EP	268?	-	-	-	nil	nil	5
123	M	8	17	'22	299	502	101	EP	-	-	-	-	nil	1-366	4
124	M	8	20	'22	192	671	214	EP	-	-	-	-	nil	1-607	1
125	N	-	1	'22	144	662	132	EP	-	-	-	-	nil	1-532	3
126	N	-	1	'23	277	405	47	EP	-	-	-	-	nil	2-216	1

Table 8. Borings by Pacific Coast coal mines, Nanaimo area

Borehole Number	District	Range	Section or Lot	Year finished	Elevation (feet)	Total depth (feet)	Depth to bedrock	Starts in (formation)	Top of Extension-Protection	Top of Haslam	Top of Comox	Top of Karmutsen	Number of seams >3 feet thick and highest of these	Number of seams 1 to 3 feet thick and highest of these	Number of seams < 1 foot
1	CD	1	13	'08	–	1420	36	CD	212	-	-	-	1-1205	1-391	0
1A	C	8	11	–	29	814	5	EP	-	-	-	-	1-658	nil	9
2A	C	8	–	–	30	1080	67	EP	-	-	-	-	1-803	nil	3
3A	C	6	14	'11	181	279	37	EP	-	-	-	-	2-176	nil	2
14A	CD	1	8	'10	–	988	114	EP	-	-	-	-	nil	1-221	6
17A	C	5	13	–	–	1049	20	EP	-	1049	-	-	nil	2-781	1
27A	C	8	11	'11	118	664	12	EP	-	-	-	-	nil	1-92	4
28A	C	8	11	'12	100	613	6	EP	-	-	-	-	nil	1-44	5

Table 9. Borings, Canadian Collieries Ltd., Cumberland area

Borehole Number	District	Township	Section or Lot	Year finished	Elevation (feet)	Total depth (feet)	Depth to bedrock	Starts in (formation)	Top of Extension-Protection	Top of Haslam	Top of Comox	Top of Karmutsen	Number of seams > 3 feet thick and depth of highest of these	Number of seams 1 to 3 feet thick and depth of highest of these	Number of seams < 1 foot thick
1	N	-	24	'89	489	517	4	C	-	-	-	403?	1-229	4-139	8
2	N	-	21	'89	-	533	10	C	-	-	-	-	1? - 84	4-309	7
3	N	-	24	'89	-	528	11	C	-	-	-	-	1-497	4-237	7
4	N	-	24	'89	-	556	3	C	-	-	-	-	nil	5-280	6
5	N	-	24	'90	-	401	7	C	-	-	-	-	nil	3-77	4
6	C	-	-	'90	-	909	40	EP?	-	122?	362?	-	nil	5-398	8
7	C	10	28	'90	-	132	0	C	-	-	-	-	1-40	36	2
8	C	10	27	'90	-	150	5	C	-	-	-	-	2-68	1-62	0
9	C	10	27	'90	-	221	12	C	-	-	-	-	1-189	nil	4
10	N		24	'92	-	369	5	C	-	-	-	-	3-79	5-98	0
11	N		24	'92	-	405	8	C	-	-	-	-	1-371	2? -88	2
12	C	10	27	'93	-	458	5	C	-	-	-	-	1-443	3-49	3
13	C	10	26	'93	-	504	6	C	-	-	-	501	1-481	7-74?	4
14	C	10	26	'93	-	664	10	C	-	-	-	-	1-535	5-148	6
17	C	10	25	'96	456	536	11	H?	-	-	91?	507	2-395	3-296?	4
18	N	-	24	'96	-	549	34	H	-	-	162	543	1-455	5-214	1
19	N	-	3	'96	565	375	23	C	-	-	-	339	nil	6-94	5
20	N	-	3	-	-	412	16	H	-	-	105	394	nil	3-278	1
21	N	-	24	-	445	588	31	H?	-	-	56?	567	1-499	5-242	7
22	C	10	25	'9	441	1056	70	H	-	-	472	1038	4-803	3-608	8
23	N	-	3	'97	485	558	80	C	-	-	-	553	2-158	8-166	1
24	C	10	35	'97	359	-	67	H	-	-	334	-	1-678	11-592	7
8D	C	9	4	-	-	198	-	C	-	-	-	194	1-184	1-127	3
9D	C	9	4	-	-	312	-	C	-	-	-	309	1-287	4-95	4
10D	C	9	4	-	-	637	-	C	-	-	-	617	1-528	5-75	14
11D	C	9	4	'06	-	724	-	C	-	-	-	714	nil	9-87	16
12D	C	9	9	'06	-	882	-	H	-	-	92	881?	1-848	9-332	15
13D	C	9	10	'06	304	991	-	H	-	-	175	990?	1-961	7-266	15
101	C	9	3	'10	286	923	27	H	-	-	209	909	3-449	7-298	4
102	C	9	3	'10	323	1017	39	H	-	-	265	992	1-541	3-265	5
103	C	-	135	'11	269	1367	66	H	-	-	550	1337	3-725	9-550	5
104	C	9	2	'11	260	1177	28	H	-	-	387	1156	1-1054	8-652	12
105	C	9	154	'11	444	1180	89	H	-	-	540	1147	1-950	7-642	9
106	C	10	35	'11	323	1020	20	H	-	-	283	993	2-862	7-435	9
107	C	9	21	'11	267	552	17	H	-	-	45?	530	1-515	1-445	1
108	C	-	227	'11	217	1086	9	H	-	-	643	-	1-1003	3-888	5
109	C	9	20	'11	276	289	36	C	-	-	-	280	1-158	nil	0
110	C	9	16	'11	-	464	10	H	-	-	?	747	1-722	7-182	10
111	C	9	20	'11	-	464	28	C	-	-	-	-	nil	3-117	5
112	C	9	10	'11	-	1077	12	H	-	-	336	1065	1-518	5-685	11
113	C	9	15	'11	-	1160	17	H	-	-	420	1136	2-715	10-548	0
114	C	9	20	'11	-	561	7	C	-	-	-	551	nil	5-72	11
115	C	9	10	'11	-	1198	11	H	-	-	460	1175	nil	2-732	7
116	C	9	9	'11	375	681	22	C	-	-	-	656	2-329	10-89	7
117	C	9	30	'11	-	901	76	C	-	-	-	886	nil	6-310	8
118	C	9	17	'11	-	583	10	C	-	-	-	560	1-492	9-67	1
119	C	-	228	'11	-	1040	27	H	-	-	453	1018	1-1007	3-765	7
120	C	9	29	'11	-	1301	15	H	-	-	258	-	1-862	5-871	5
121	C	9	17	'11	-	640	46	C	-	-	-	629	nil	2-67	7
122	C	9	3	'12	351	920	42	H	-	-	207	901	2-557	6-526	9
123	C	-	233	'12	287	1575	44	H	-	-	813	1547	1-1181	7-1086	7
124	N	-	21	'12	465	500	51	C	-	-	-	470	1-273	2-370	6
125	N	-	24	'12	494	389	10	C	-	-	-	359	1-337	2-246	4
126	C	10	26	'12	486	853	36	H	-	-	200	816	2-600	1-500	4
127	C	10	34	'14	516	791	171	C	-	-	-	785	1-782	6-381	12
128	C	9	9	'14	409	664	39	C	-	-	-	654?	1-337	4-312	5
129	C	9	9	'14	377	614	5	C	-	-	-	-	1-600	2-308	2
130	C	9	9	'14	408	518	24	C	-	-	-	-	nil	1-310	3
131	C	9	9	'14	408	602	25	C	-	-	-	598	nil	nil	7
132	C	9	9	'14	434	500	44	C	-	-	-	491	1-473	3-217	4

Table 9 continued.

Borehole Number	District	Township	Section or Lot	Year finished	Elevation (feet)	Total depth (feet)	Depth to bedrock	Starts in (formation)	Top of Extension-Protection	Top of Haslam	Top of Comox	Top of Karmutsen	Number of seams > 3 feet thick and depth of highest of these	Number of seams 1 to 3 feet thick and depth of highest of these	Number of seams < 1 foot
133	C	9	8	'14	435	481	46	C	-	-	-	479	1-370	3-412	4
134	C	9	5	'15	445	384	38	C	-	-	-	378	1-305	1-199	2
135	C	9	5	'16	461	275	6	C	-	-	-	258	1-33	2-136	2
136	C	9	5	'16	500	305	7	C	-	-	-	283	1-74	2-70	3
137	C	9	8	'16	655	521	11	C	-	-	-	506	nil	2-205	6
138	C	9	8	'16	677	585	9	C	-	-	-	566	2-325	1-475	4
139	N	-	3	'17	563	419	3	C	-	-	-	417	1-42	7-135	0
140	C	10	27	'17	546	120	15	C	-	-	-	-	1-96	1-92	0
141	C	10	27	'17	555	80	8	C	-	-	-	-	1-60	1-50	1
142	C	10	27	'17	514	490	15	C	-	-	-	-	nil	4-93	6
143	C	9	4	'17	393	588	25	C	-	-	-	-	nil	1-500	12
144	C	9	4	'17	494	268	119	C	-	-	-	257	1-143	nil	0
145	C	10	33	'17	496	456	92	C	-	-	-	453	1-249	1-243	4
146	C	10	33	'17	498	310	163	C	-	-	-	297	nil	nil	0
147	C	10	33	'17	516	389	69	C	-	-	-	-	2-266	1-351	3
148	C	9	4	'18	392	574	18	C	-	-	-	-	nil	nil	2
149	C	10	33	'18	507	381	41	C	-	-	-	-	2-107	nil	3
150	C	10	34	'18	372	857	89	C	-	-	-	849	1-798	4-396	10
151	C	10	34	'18	535	787	114	C	-	-	-	-	1-776	5-379	1
153	C	9	9	'19	438	372	32	C	-	-	-	372	1-262	2-336	16
155	C	9	9	'19	436	608	33	C	-	-	-	-	1-439	1-100	7
156	C	10	33	'19	502	183	116	C	-	-	-	183?	1-177	nil	2
157	N	-	24	'21	470	263	10	C	-	-	-	242	nil	nil	5
158	N	-	24	'21	474	342	7	C	-	-	-	336	1-246	3-161	4
159	N	-	24	'21	469	366	8	C	-	-	-	357	nil	1-349	5
160	N	-	24	'21	493	425	4	C	-	-	-	404	2-240	1-147	8
161	N	-	24	'21	456	268	17	C	-	-	-	263	1-258	1-204	0
162	N	-	24	'21	440	756	28	H	-	-	204	750	1-641	3-433	10
163	C	10	25	'21	438	1034	57	H	-	-	348	1031	1-794	7-571	8
164	C	11	30	'21	449	1217	2	EP	-	413	630	1209	2-1061	6-950	6
165	C	10	25	'22	442	1144	20	EP	-	74	453	1134	2-896	3-780	11
166	C	10	25	'22	439	1292	94	EP	-	438	671	1287	1-1057	4-870	10
167	C	11	29	'22	312	1472	38	CD	407	667	891	1471	2-1430	8-973	7
168	C	10	36	'22	339	1862	68	CD	473	763	1030	1858	1-1001	7-1077	12
169	N	-	22	'22	276	1634	13	CD	451	684	983	1628	1-1577	6-1083	5
170	C	10	25	'22	390	1349	135	H	-	-	721	1344	1-1145	5-790	5
171	N	-	79	'22	370	1445	42	CD	81	436	721	1435	1-1160	6-1078	8
172	C	10	26	'23	508	405	38	C	-	-	-	-	1-289	2-120	4
173	C	10	26	'23	466	796	35	H	-	-	213	795	1-596	8-394	0
174	C	10	26	'23	441	1015	65	H	-	-	311	1008	nil	6-648	8
175	N	-	3	'23	563	443	56	C	-	-	-	439	1-428	5-225	0
176	C	10	36	'23	399	1370	91	H	-	-	685	1358	nil	9-731	5
177	N	-	15	'23	322	1399	32	EP	-	441	670	1390	1-1197	9-923	5
178	N	-	344	'23	600	629	15	H	-	-	144	623	2-525	5-280	1
179	N	-	24	'23	440	941	66	H	-	-	460	938	1-925	3-516	1
180	N	-	24	'23	442	738	92	H	-	-	245	736	1-578	4-314	3
181	C	10	33	'26	479	289	13	C	-	-	-	-	1-173	2-256	5
182	C	10	33	'26	497	251	36	C	-	-	-	-	nil	3-115	1
183	C	10	33	'31	452	49	44	K	-	-	-	44*	-	-	-
184	C	10	33	'31	517	201	17	C	-	-	-	-	2-77	1-116	1
185	C	-	227	'40	212	1322	10	H	-	-	623	1303	nil	4-847	20
186	C	-	94	'40	244	1128	68	H	-	-	604	1112	1-1022	4-849	8
187	C	-	94	'41	276	1252	30	H	-	-	550	1246	1-997	8-823	6
188	C	-	82	'41	-	1950	27	CD	766	1002	1155	1948	4-1540	4-1393	6
189	C	-	231	'44	-	1931	23	CD	689	906	1035	1920	1-1555	3-1475	6
190	N	-	6A	'45	-	1651	44	CD	610	780	968	1647	1-1626	5-1356	8
191	N	-	14	'45	-	1879	14	CD	929	1101	1203	1869	3-1613	6-1358	4
192	N	-	29	'46	2187	1455	25	CD	?	?	905	1436	1-1398	3-1228	7

* overburden on Karmutsen.

Table 10. Borings, Canadian Collieries Ltd., Tsable River-Cowie Creek area

Borehole Number	District	Township	Block or Lot	Year finished	Elevation (feet)	Total depth (feet)	Depth to bedrock	Starts in (formation)	Top of Extension-Protection	Top of Haslam	Top of Comox	Top of Karmutsen	Number of seams > 3 feet thick and depth of highest of these	Number of seams 1 to 3 feet thick and depth of highest of these	Number of seams < 1 foot thick
1	N		33	'09	410	1069	9	EP	-	NP	918	999	1-930	nil	0
2	N		33	'09	578	899	4	EP	-	NP	866	899	nil	1-880	0
3	N		93	'10	914	833	10	CD	503?	NP	562?	828	1-675	4-562	7
4	N		93	'09	961	223	8	EP?	-	NP?	153?	195	nil	nil	0
5	N		34	'19	851	420	7	EP	-	-	25	414	2-246	2-126	0
6	N		34	'19	858	636	6	EP	-	NP	154	624	2-394	3-262	0
7	N		34	'19	897	701	17	EP	-	NP	190	698	nil	7-284	2
8	N		34	'19	995	196	26	C	-	-	-	168	nil	1-90	0
9	N		34	'19	1180	240	3	C	-	-	-	194	nil	1-74	3
10	N		34	'19	815	400	18	EP	-	NP	153	388	2-193	3-153	0
11	N		34	'19	895	431	38	C	-	-	-	420	2-44	4-135	0
12	N		34	'19	941	198	43	C	-	-	-	-	nil	1-135	1
13	N		34	'19	868	111	6	C	-	-	-	97	nil	nil	0
14	N		34	'19	770	217	7	C	-	-	-	212	1-204	1-152	1
15	N		376	'20	945	626	8	EP?	-	-	175	612	2-251	2-333	1
16	N		34	'19	793	400	7	C	-	-	-	393	2-44	4-180	0
17	N		S1 L2A	'20	493	362	25	C	-	-	-	350	3-323	3-80	2
18	N		451	'20	1199	1056	10	EP	-	NP	648	1052	1-1029	2-674	0
19	N		32G	'20	657	262	34	C	-	-	-	240	nil	nil	1
20	N		32G	'20	747	444	74	H	-	-	100	435	nil	nil	4
21	N		451	'20	1382	1712	10	CD	230	NP	1578	1707	1-1640	3-1652	0
22	N		33G	'20	351	1471	99	H	-	-	648	1462	4-747	3-851	2
23	N		33G	'20	394	830	89	H	-	-	293	816	3-771	5-378	6
24	N		32G	'20	635	125	6	C	-	-	-	121	1-85	1-116	0
25	N		33G	'20	321	450	188?	H	-	-	-	-	-	-	-
26	N		35G	'20	193	1034	19	H	-	-	528	-	3-897	3-613	2
27	N		324	'21	760	144	36	C	-	-	-	138	nil	1-130	2
28	N		324	'21	713	154	55	C	-	-	-	144	1-134	1-55	0
29	N		33	'21	459	643	85	EP	-	201	376	637	nil	3-408	5
30	N		34	'21	676	141	51	C	-	-	-	131	nil	2-122	0
31	N		324	'21	988	291	-	C	-	-	-	285	1-218	2-103	1
32	N		34	'21	966	150	12	C	-	-	-	142	nil	nil	0
33	N		33	'21	478	850	120	EP	-	262	532	843	1-781	2-677	2
34	N		324	'21	865	90	37	C	-	-	-	-	1-65	nil	0
35	N		324	'21	925	239	19	C	-	NP	34	230	nil	nil	1
36	N		324	'21	794	272	16	C	-	-	-	268	1-257	3-51	0
37	N		32G	'21	487	436	14	H	-	-	52	432	1-420	2-265	3
38	N		324	'21	856	125	48	C	-	-	-	110	nil	nil	0
39	N		324	'21	1016	870	10	EP	-	NP	363	866	1-801	3-452	1
40	N		33	'21	504	1167	82	EP	-	NP	NP	1159	nil	nil	0
41	N		324	'21	1102	1040	10	EP	-	NP	640	1030	2-929	3-675	1
42	N		1G	'43	556	154	0?	C	-	-	-	-	1-93	1-127	0
43	N		1G	'43	523	'87	0?	C	-	-	-	74	nil	3-47	0
44	N		32G	'43	535	140	0?	C	-	-	-	-	1-122	nil	1
45	N		23G	'43	615	36	0?	C	-	-	-	-	1-31	nil	0
46	N		324	*	1143	1184	18	EP	-	NP	727	1154	nil	1-913	0
47	N		324	*	-	1015	20	EP?	-	NP	494?	1007	1-949	2-580	0
48	NW		EN	*	-	796	20	H	-	-	150	790	nil	nil	0
49	N		39G	*	-	763	18	H	-	-	144	755	1-601	nil	2
50	N		1G	*	-	384	0?	C	-	-	-	384	2-74	1-378	0
51	N		39G	*	-	1191	12	H	-	-	401	1186	1-739	2-861	0
52	NW		234	*	519	527	4	C	-	-	-	518	1-336	3-21	5
55	NW		234	*	451	676	32	C	-	-	-	671	1-375	3-98	6
56	N		34G	*	581	629	2	C	-	-	-	629+	2-189	3-51	2
57	NW		88	*	391	922	76	H	-	-	236	922	3-628	1-825	2
58	NW		88	*	684	255	131	C	-	-	-	244	1-175	2-172	0
59	NW		88	*	550	416	306	C	-	-	-	-	1-347	nil	0
61	NW		88	*	-	559	165	C	-	-	-	549	nil	2-270	2
62	NW		88	*	250	1844	182	CD	NP?	627?	1001	1838	2-1639	1-1532	0

* These holes probably drilled 1951-1957

Table 10 continued.

Borehole Number	District	Township	Block or Lot	Year finished	Elevation (feet)	Total depth (feet)	Depth to bedrock	Starts in (formation)	Top of Extension-Protection	Top of Haslam	Top of Comox	Top of Karmutsen	Number of seams > 3 feet thick and depth of highest of these	Number of seams 1 to 3 feet thick and depth of highest of these	Number of seams <1 foot thick
63	NW	-	88	1951 - 1957	600	773	224	C	-	-	-	-	1-688	3-364	5
64	N	-	39G		-	811	2	C	-	-	-	-	2-524	1-53	5
66	N	-	1G		-	193	50	C	-	-	-	181	nil	nil	0
67	N	-	1G		-	200	17	C	-	-	-	-	1-48	nil	1
68	N	-	1G		-	185	14	C	-	-	-	-	1-99	1-113	0
69	N	-	1G		-	236	6	C	-	-	-	-	1-148	1-169	1
70	N	-	34G		-	220	22	C	-	-	-	-	1-44	1-124	0
71	N	-	34G		-	732	48	C	-	-	-	-	3-235	2-322	0
72	N	-	34G		-	528	81	C	-	-	-	-	1-472	1-345	3
73	N	-	34G		-	562	2	C	-	-	-	-	2-251	2-307	3
74	NW	-	263		-	324	7	C	-	-	-	-	1-121	1-43	0
75	N	-	34G		-	639	48	C	-	-	-	-	2-237	1-426	5
77	NW	-	EN		-	522	91	C	-	-	-	517	2-217	nil	2
78	NW	-	88		-	644	221	C	-	-	-	-	2-446	3-293	1
79	NW	-	EN		-	355	7	C	-	-	-	341	2-101	nil	0
80	NW	-	EN		-	667	80	C	-	-	-	663	3-121	4-237	1

Table 11. Borings, Canadian Collieries Ltd. Campbell River area

Borehole Number	District	Township	Section or Lot	Year finished	Elevation (feet)	Total depth (feet)	Depth to bedrock	Starts in (formation)	Top of Extension-Protection	Top of Haslam	Top of Comox	Top of Karmutsen	Number of seams > 3 feet thick and depth of highest of these	Number of seams 1 to 3 feet thick and depth of highest of these	Number of seams <1 foot thick
2	S	-	1476	Probably drilled between 1945 and 1960	62	371	244	C	-	-	-	314	nil	nil	0
3	S	-	707		382	525	344	C	-	-	-	512	1-462	1-478	0
4	S	-	1476		-	658	206	C	-	-	-	638	nil	nil	0
5	S	-	704		245	516	306	C	-	-	-	509	nil	2-452	2
6	S	-	704		222	674	265	C	-	-	-	670	4-580	nil	0
7	S	-	705		363	544	185	C	-	-	-	527	1-509	503	0
8	C	-	27		480	808	20	C	-	-	-	-	1-335	3-327	4
9	C	-	25		270	1055	44	C	-	-	-	1028	1-1016	1-994	2
10	C	-	27		654	231	145	C	-	-	-	188	nil	nil	0
11	C	-	28		-	643	12	C	-	-	-	-	nil	nil	11
12	C	2	27		329	1058	21	C	-	-	-	1056	1-916	3-884	6
13	C	3	24		-	1354	9	C	-	-	-	-	1-1094	5-290	10
14	C	2	22		341	960	90	C	-	-	-	-	nil	3-573	0
15	C	-	29		-	424	27	C	-	-	-	-	nil	2-71	4
16	C	-	25		351	1251	196	C	-	-	-	1198	nil	nil	4
17	C	2	21		376	598	3	C	-	-	-	-	1-373	2-339	0
18	C	2	21		396	409	66	C	-	-	-	88	1-211	3-153	2
19	C	2	16		398	226	52	C	-	-	-	183	nil	nil	1
20	C	2	28		370	178	169	K?	-	-	-	172	nil	nil	0
21	C	2	16		408	194	23	C	-	-	-	-	nil	nil	2
22	C	2	28		370	475	142	C	-	-	-	-	nil	3-219	4
23	C	2	21		364	359	42	C	-	-	-	-	2-155	2-166	2
24	C	2	22		364	604	105	C	-	-	-	-	nil	4-383	1
25	C	-	41		-	683	139	C	-	-	-	-	nil	3-172	11
26	C	2	21		356	86	81	K	-	-	-	81	-	-	-
27	C	-	120		-	646	11	C	-	-	-	? 512	1-270	3-283	6
28	C	2	16		-	625	3	C	-	-	-	-	nil	1-421	2
29	C	-	242		-	667	8	C	-	-	-	-	1-483	2-294	3
30	C	2	16		-	276	24	C	-	-	-	264	1-67	nil	7
31	C	-	27		-	421	23	C	-	-	-	-	nil	1-229	2

Table 12. Reserves of Vancouver Island, British Columbia, based on seams not less than 2 feet in thickness to a maximum depth of 2,000 feet (Thousands of net tons)

District and Area	Name of Seam	Mineable								A.S.T.M. Classification
		Probable			Possible (Additional)			Recoverable		
		Thickness used (feet)	Area (acres)	Tonnage	Thickness used (feet)	Area (acres)	Tonnage	Probable	Possible (additional)	
Nanaimo coalfield -										II 3
No. 10 Mine	Douglas	6.0	93	976				488		
South of Granby Mine	Douglas	6.0	50	526	6.0	150	1,574	263	787	
Cedar	Douglas				5.0	6,592	57,680		28,840	
Chase River	Newcastle				2.0	70	246		123	
Departure Bay	Wellington				2.0	177	620		310	
Little Ash Mine	Newcastle	5.0	4	34				17		
White Rapids Mine	Newcastle	3.0	138	724				362		
White Rapids Mine	Newcastle	2.5	11	48	2.6	85	372	24	186	
Total				2,308			60,492	1,154	30,246	
Comox coalfield -										II 3
Cumberland area										
No. 5 Mine	No. 2	2.6	119	522				261		
No. 8 Mine	No. 2	3.0	750	3,936				1,968		
No. 8 Mine	No. 4	4.0	520	3,640				1,820		
To dip of mine workings	No. 2	3.5	1,100	6,738				3,369		
	No. 4	5.0	1,264	11,060				5,530		
	All seams				6.0	5,642	59,240		29,620	
Total				25,896			59,240	12,948	29,620	
Tsable River										II 3
Upper portion of field	No. 4	2.6	241	1,092				546		
	No. 3	3.4	336	1,940				970		
	No. 2	6.2	485	5,262				2,631		
Lower portion of field	No. 2	11.3	316	6,248				3,124		
Remainder of field	All seams				8.0	4,411	61,754		30,877	
Total				14,542			61,754	7,271	30,877	
Dove Creek and Brown's River					3.5	1,200	7,350		3,675	II 3
Tsolum River	Seams not designated				4.0	11,520	80,640		40,320	
Quinsam		4.0	770	5,396	4.0	4,480	31,360	2,698	15,680	
Campbell River		4.0	650	4,550	4.0	7,000	49,000	2,275	24,500	
Total				9,946			168,350	4,973	84,175	
Grand Total				52,692			349,836	26,346	174,918	