# COAL MEASURES GEOLOGY OF THE QUINSAM AREA (92F)


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## INTRODUCTION

This report is part of an ongoing project begun in 1987 to update critical geological relationships in the Vancouver Island coal deposits. Objectives of this study are to establish the lateral extent of coal-bearing strata and ascertain the structural style of the coal measures in the Quinsam area (Figure 4-4-1).

Coal was first discovered in the area near Middle Quinsam Lake by W. Sutton in 1908. Further mapping was done by J.D. Mackenzie, H.A. Rose and T.B. Williams in 1923 and by A.F. Buckham in 1946. Buckham's work convinced Canadian Collieries Limited to drill three widely spaced holes which indicated potential coal reserves. Development drilling was done from 1974 to 1985 by Weldwood of Canada Limited, Luscar Limited and Brinco Mining Limited. In total, more than 500 holes were drilled in the area. An open-pit mine has since been opened by Quinsam Coal Limited (Figure 4-4-1) and a deposit along Chute Creek was discovered by Can Del Oil Limited in 1981. Subsequent drilling, trenching and mapping was done by Can Del, Sulpetro Oil Limited and Nuspar Resources Limited in the Chute Creek area.

## LOCATION

The study area covers approximately 220 square kilometres in the eastern foothills of the Vancouver Island Ranges, southwest of the town of Campbell River (Figure 4-4-1). The area is accessible by Highway 28 from Campbell River, and by a network of private forestry roads controlled by British Columbia Forest Products Limited, Crown Forest Industries Limited and MacMillan Bloedel Limited. Conditions of these roads vary with logging activity and many are overgrown and accessible only on foot.

Topography is fairly gentle with plateaus and rolling hills separated by narrow valleys aligned in a northeasterly direction. Three major rivers, flowing to the Strait of Georgia, drain the area; Campbell River in the north, Quinsam River in the central area and Oyster River in the south. Isolated lakes are scattered throughout the area.

Most of the study area is covered by till, obscuring bedrock geology, particularly in the low country along the southern shore of Campbell Lake. Exposures are generally limited to rivers, creeks and roadcuts, but a few outcrops occur on steep hillsides which project above the unconsolidated drift. The highwall of the Quinsam coal mine provides an excellent exposure.

Most of the area is covered by dense vegetation, primarily thick second-growth stands of conifers. Older stands of forest have thick underbrush particularly along river and stream banks. The climate is mild and humid but snowfall is heavy at higher elevations.

## FIELDWORK

Geological mapping was done using 1:20 000-scale aerial photographs to plot data which were later transferred to 1:20 000 base maps. Detailed sections were measured where coal beds are exposed. Samples of coal and associated sandstone were taken for petrographic analysis. Geological and geophysical logs of exploratory boreholes, on file with the Ministry of Energy, Mines and Petroleum Resources in Victoria, were examined to establish geological relationships under drift-covered areas. Paleocurrent data were collected to establish the local shoreline configuration during the Late Cretaceous.

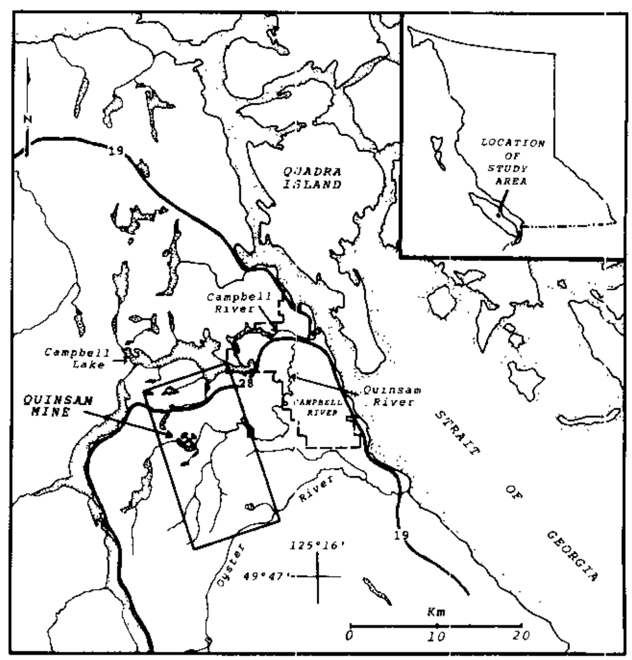


Figure 4-4-1. Location map, Quinsam area.

British Columbia Ministry of Energy, Mines and Petroleum Resources, Geological Fieldwork, 1988, Paper 1989-1.

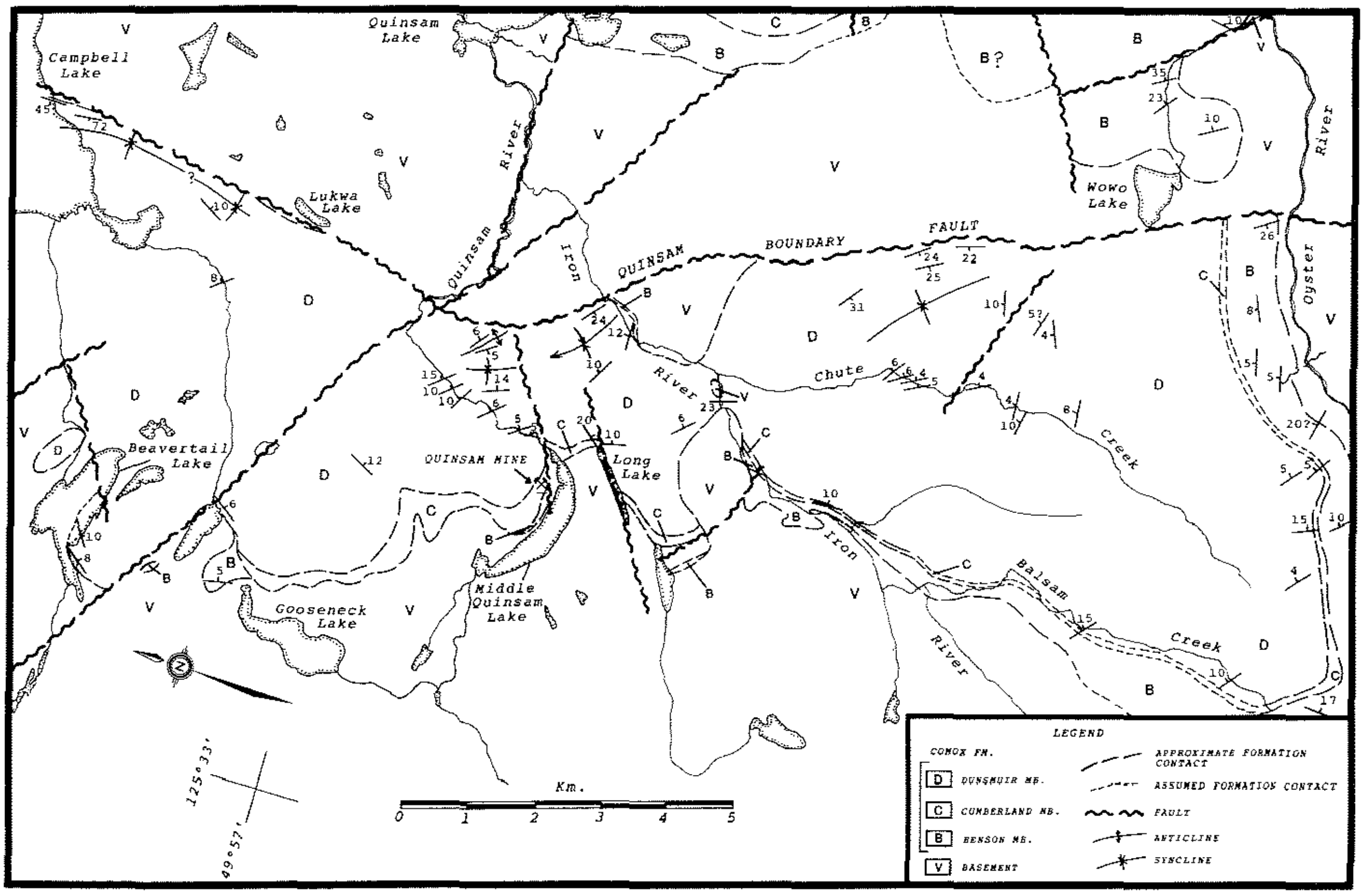


Figure 4-4-2. Geology of the Quinsam area.

A preliminary geological map of the area between Oyster River and Campbell Lake is presented as Figure 4-4-2. Geological interpretation south of Oyster River is not yet complete.

## GEOLOGICAL SETTING

The study area lies in the northwestern corner of the Comox sub-basin of the Late Cretaceous Georgia basin. The Quinsam coal measures are an erosional outlier of the Comox Formation, part of the Nanaimo Group (Table 4-4-1). They may be correlated with the coal measures of the Campbell River, Cumberland and Tsable River coalfields (Bickford and Kenyon, 1988). In comparison with complete sections in adjoining coalfields, the basal one-half to two-thirds of the Comox Formation has been preserved at Quinsam and overlying beds have been removed by erosion. Coal measures are bounded and underlain by basement rocks of Triassic and Jurassic age. Basement lithologies range from basalt, gabbro and volcanic breccia to coarsely crystalline marble, calcareous siltstone, skarn and granodiorite. A detailed discussion of basement geology is contained in Eastwood (1984).

South of the study area, the coal measures are intruded by dykes, sills and pipes of porphyritic dacite of Late Eocene age. Adjacent to these intrusive bodies, the coal measures have been hardened and thermally metamorphosed. Coal rank increases markedly in the altered areas (Kenyon and Bickford, 1989, this volume). While basement rocks have locally undergone intense folding and faulting, the coal measures are usually only gently deformed by block-faulting and tilting along their western erosional margin. On the eastern margin of the basin, the coal measures are locally deformed and dip moderately to steeply westward at the eastern Quinsam boundary fault along which basement has been uplifted (Figure 4-4-2). This fault dips steeply east, and appears to be part of a more extensive strike-slip system. Vertical displacement across the boundary fault is in the order of hundreds of metres. The strike-slip displacement is not yet established but is probably a few kilometres, with dextral movement.

## COAL-MEASURE STRATIGRAPHY

The three members of the Comox Formation, first recognized in the Cumberland coalfield (Bickford and Kenyon, 1988), are readily distinguished in the Quinsam area. The Benson member, which occurs at the base of the section, is conformably overlain by and locally interfingers with the Cumberland member, which is overlain by the Dunsmuir member. The contact of the Dunsmuir member with the underlying sediments is abrupt and locally erosional.

### BENSON MEMBER

This unit consists mostly of dark green and brown conglomerate, with lesser amounts of greenish grey pebbly sandstone and red sandy siltstone. Most of the framework clasts in the conglomerate are volcanic, mainly basalt and andesite

TABLE 4-4-1
STRATIGRAPHIC UNITS OF THE NANAIMO GROUP

| | | |
|---|---|---|
| Maastrichtian | Spray Fm. | Dark shale: COAL |
| Late Campanian | (Boundary within Spray Fm.) | Classic turbidites, mostly shales |
| | Geoffrey Fm. | Conglomerate and sandstone |
| | Northumberland Fm. | Classic turbidites, mostly shales |
| | De Courcy Fm. | Sandstone and conglomerate |
| | Cedar District Fm. | Classic turbidites, mostly shales |
| Early Campanian | Protection Fm. | (Subdivided in Nanaimo coalfield) |
| | McMillan Mbr. | Sandstone and siltstone |
| | Reserve Mbr. | Siltstone and sandstone: COAL |
| | Cassidy Mbr. | Sandstone and conglomerate |
| | Pender Fm. | (Subdivided in Nanaimo coalfield) |
| | Newcastle Mbr. | Shale and conglomerate: COAL |
| | Cranberry Mbr. | Sandstone and siltstone |
| | Extension Fm. | (Subdivided in Nanaimo coalfield) |
| | Millstream Mbr. | Conglomerate: COAL |
| | Northfield Mbr. | Siltstone and sandstone: COAL |
| | East Wellington Fm. | Sandstone (Nanaimo sub-basin only) |
| | Haslam Fm. | Classic turbidites, mostly shales |
| | Comox Fm. | (Subdivided in Comox sub-basin) |
| | Dunsmuir Mbr. | Sandstone: COAL |
| | Cumberland Mbr. | Siltstone and sandstone: COAL |
| | Benson Mbr. | Conglomerate and red beds |

UNCONFORMITY
Older basement rocks, chiefly volcanics

with minor gabbro. Occasional plutonic clasts are present; they are mostly granodiorite but some true granite clasts are found in the Benson conglomerates south of Oyster River. Volcanic clasts predominate in Benson conglomerates, even where the underlying basement is granitic. This feature, first reported in the Tsable River coalfield by Atchinson (1968), may be due to the relative resistance to disintegration of volcanic compared to plutonic rocks. The granitic clasts are often decomposed and soft, due to the alteration of feldspars to clay minerals.

The conglomerates are thick bedded to massive, with large-scale low-angle cut-and-fill structures. Low-angle planar cross-stratification is occasionally present. Framework sorting tends to be fair to good and the conglomerate is usually framework supported with a sparse matrix of medium to coarse-grained sand. Abundant white calcite cement is present in some conglomerates, occasionally comprising up to 20 per cent of rock volume. Imbrication of framework clasts is often well developed, indicating paleoflow to the west and southwest.

The Benson member appears to have been deposited in incised, west to southwest-trending fluvial channels which were locally flanked by fault scarps and alluvial fans. Between major channels the member exists as isolated patches and ribbons, locally up to 10 metres thick; within major channels, as along the north bank of the Oyster River, it may be as thick as 270 metres.

## CUMBERLAND MEMBER

This unit consists of grey sandy siltstone, dark grey mudstone and medium-grained greenish grey sandstone with coal beds which locally attain mineable thicknesses.

Major coals are the Quinsam No. 1 and No. 2 beds which are well exposed in the Quinsam mine highwall (Figure 4-4-3). In the Quinsam area, sandstones of the Cumberland member consist of subequal amounts of volcanic rock fragments, plutonic quartz and kaolinized feldspar. They are lenticular in form, silty and poorly sorted. Siltstones are

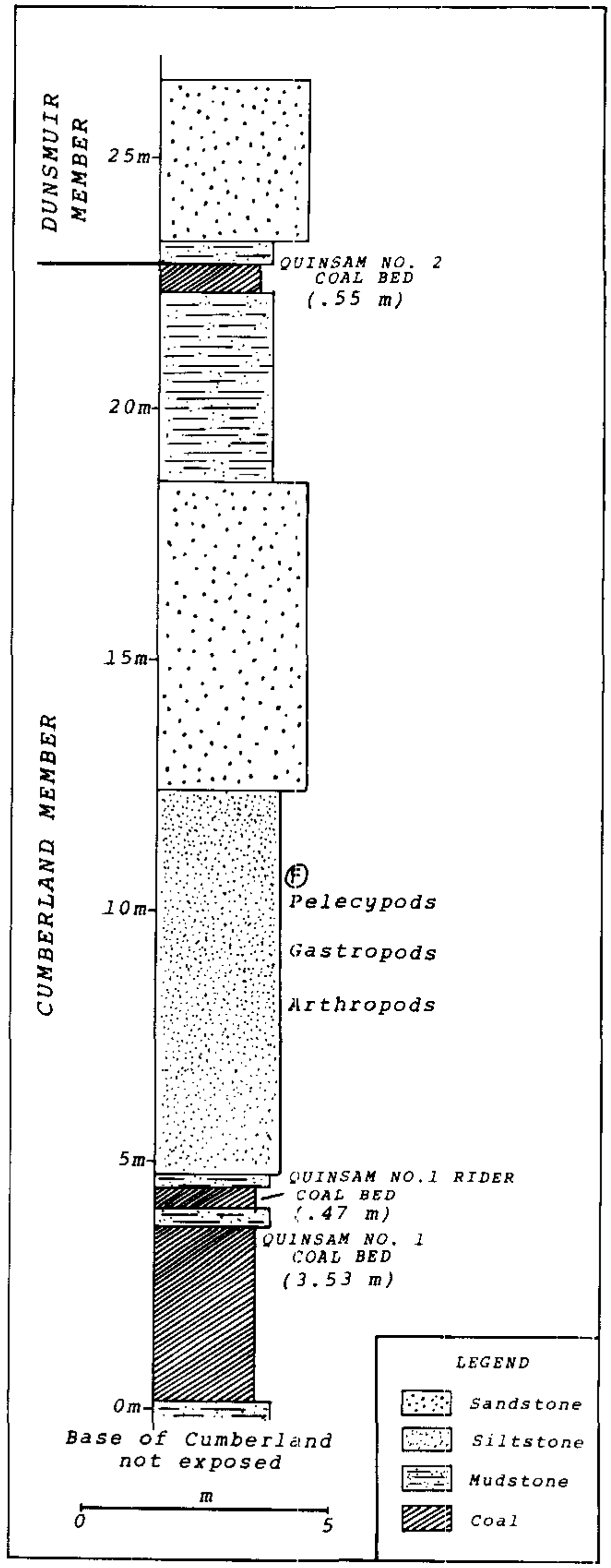

Figure 4-4-3. Measured section of highwall at Quinsam mine.

similar in composition to sandstones, and locally contain shell debris and plant fragments. The mudstones are variably carbonaceous and often contain silty laminae. Coal beds, which are bright banded and clean, contain coaly mudstone partings. Soft, lighter coloured mudstones occur beneath the coals. Near Balsam Creek and Oyster River the Cumberland member consists of distinctively hematitic-weathered, dark grey siltstone and silty mudstone, with minor coaly stringers at the top.

The Cumberland member appears to have been deposited under generally paralic conditions, along a coastal plain which was bounded by rolling hills of basement rocks. The lenticular sandstones were probably deposited by streams crossing the coastal plain, while the coals were deposited in backswamps between the streams. The shell-bearing silty beds between the Quinsam No. 1 and No. 2 coals were probably deposited under estuarine conditions during a brief transgressive drowning of the coastal plain. The hematitic-weathering beds of Balsam Creek and Oyster River which overlie the thick Benson conglomerates were probably laid down in a distal alluvial-fan environment, between proximal alluvial fans of the Benson member and the coastal plain of the Middle Quinsam Lake area.

Thickness of the Cumberland member varies because of basement topography. The greatest thickness, 25 to 45 metres, is found near Middle Quinsam Lake. The Cumberland member thins to 12 metres and locally pinches out towards Beavertail Lake. In exposures along the south shore of Campbell Lake the Cumberland member is absent, indicating that it also pinches out to the north. Isolated deep boreholes, east of Middle Quinsam Lake, indicate that the Cumberland member interfingers with and pinches out within the Benson member. It also pinches out against the flanks of a large basement hill southwest of the confluence of Iron River and Chute Creek. In the Balsam Creek area the Cumberland member is about 20 metres thick but contains no significant coal beds.

### DUNSMUIR MEMBER

This unit consists mostly of medium to coarse-grained, white or light grey to greenish grey sandstone, with lesser amounts of siltstone, mudstone, conglomerate and coal. Major coals are the Quinsam No. 3 and No. 4 beds and the Chute Creek 'A' bed (Bickford and Kenyon, 1988).

Near Middle Quinsam Lake, Dunsmuir sandstones are characteristically white to very light grey, locally weathering to pale yellow or pink tones. They are predominantly granitic in composition, consisting of subequal amounts of plutonic quartz and plagioclase feldspar, with accessory dark minerals such as hornblende and magnetite. Volcanic rock fragments are a minor constituent of these sandstones. Along the ridgeline north of Oyster River, the Dunsmuir sandstones are more volcanic in composition, with quartz and feldspar comprising about 30 per cent of the framework grains. These volcanic-rich sandstones are greenish grey to olive-drab.

In the Quinsam River canyon, northeast of the Quinsam mine, a thin band of heavy-mineral sandstone is exposed. This sandstone contains about 50 per cent magnetite across a thickness of 5 centimetres. It lies within a thicker unit (1.6 metres) of granitic sandstone with about 10 per cent magnetite concentrated within many thin laminae. Similar iron-bearing sandstones have been encountered in boreholes situated to the northwest and southeast of the canyon.

Dunsmuir sandstones contain an abundant trace-fossil assemblage including *Thalassinoides*, *Ophiomorpha* and *Teredolites*, and *Pelecypodichnus*. Body fossils are comparatively rare, but include trigoniid bivalves (Eastwood, 1984), and *Inoceramus*.

Conglomerates within the Dunsmuir member occur as thin bands and stringers. A persistent conglomeratic horizon is found at the base of the member in the roof of the Quinsam No. 2 coal bed. Several thin conglomerate bands occur both above and below the Chute Creek 'A' coal bed, which is higher in the member. Dunsmuir conglomerates are distinguished from Benson conglomerates by an abundance of granitic clasts.

Mudstones and siltstones within the Dunsmuir member resemble but are much less abundant than those of the Cumberland member. Dunsmuir coals are somewhat dirtier than those in the Cumberland.

It appears that the Dunsmuir member was deposited in dominantly marine conditions, along a shallow sandy shelf bordered by a complex of beaches, spits and bars. Isolated hills of basement rocks remained exposed during at least the early stages of deposition. Most of the shelf sandstone was deposited below fairweather wave base but still within range of reworking by storm waves. The iron-rich sandstone likely represents an ancient beach placer. The coals and associated mudstones were probably formed in back-barrier lagoons sheltered from most clastic sedimentation but occasionally subjected to storm surges, resulting in partings of sediment within the coal-forming peats.

The upper part of the Dunsmuir member has been eroded throughout the study area. Its maximum preserved thickness, as indicated by boreholes, ranges from about 150 metres between Middle Quinsam Lake and Iron River, to about 230 metres west of Lukwa Lake.

## ECONOMIC ASPECTS

Quinsam Coal Limited is mining Coal Bed No. 1 north of Middle Quinsam Lake (Figure 4-4-2). Thickness of the coal ranges from 3.3 to 4.2 metres. Local markets include Island pulp and paper mills as well as cement companies on the mainland. Over an 8-month period, February 1988 to September 1988, three trial shipments totalling 88 000 tonnes were sent to Japan. Quinsam Coal Limited forecasts production of 150 000 tonnes in 1988, 250 000 tonnes in 1989 and 500 000 tonnes in 1991. The company is permitted to produce up to 1 million tonnes per year.

The Quinsam area has been intensively prospected for coal by means of closely spaced boreholes followed by test pits. Most of the work done to date has focused on delineation of near-surface coal beds which would be amenable to open-pit mining. Considerable scope exists for both the extension of open-pit mining along strike from the existing site and for underground mining, at depths of 90 to 150 metres, to the north of the open-pit area (Barnstable, 1980). Additional drilling will probably be required to establish the full extent of underground reserves.

In the Chute Creek area, an adit was driven by Nuspar Resources Limited in 1986, in order to obtain unweathered coal for quality studies. Reserves of coal have not been reported by the owners, although they have disclosed the deposit may be suitable for either open-pit or shallow underground mining.

## FURTHER WORK

Geology of the Quinsam area, extending from Oyster River to the south, will be completed. Work is currently being done to produce a deposit model of the Quinsam coal reserves. Vitrinite-reflectance data from samples collected this year will be determined as well as further study of rocks associated with the coal seams.

## ACKNOWLEDGMENTS

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# NOTES