British Columbia Geological Survey
Geological Fieldwork 1989

SUBSURFACE COAL SAMPLING SURVEY, QUINSAM AREA, VANCOUVER ISLAND, BRITISH COLUMBIA (92F)

By Alex Matheson

KEYWORDS: Coal geology, Comox coal measures, Upper Cretaceous, Nanaimo Group, Quinsam, Vancouver Island, drilling tests, x-ray drill, packsack drill, core recovery, coal analysis.

INTRODUCTION

Since the discovery of coal in British Columbia in 1835, three major mining areas have produced substantial quantities of coal. The deposits on southern Vancouver Island were intensively mined until the middle of this century and have recently recommenced production. The Kootenay coalfields of southeast British Columbia, which came into operation at the turn of the century, are currently the largest and most productive in the province. More recently the Peace River area in northeast British Columbia has been brought into production and has potential for large future developments.

Coal deposits occur province-wide and there are many undeveloped areas, such as parts of the Telkwa, Bowron River, Merritt, Tulameen and the Queen Charlotte Islands coalfields, where there is a paucity of coal quality data. Information gathered on these and other lesser known areas would prove invaluable to future exploration projects and assist the government in its management of the province's coal resources. The least expensive method of data gathering is sampling of coal outcrops. However, there are two drawbacks to this method: first, all coal outcrops are oxidized to variable depths which affects some of the analyses; second, several areas have few surface exposures, for example, Princeton and Merritt. Any fieldwork should therefore not only incorporate outcrop sampling but selective diamond drilling as well.

The viability of such a drilling program was assessed during the 1988 field season. The main objective at that time was to examine various small drills and their capabilities with respect to the core recovery of unoxidized representative coal samples for comprehensive analysis. Several suitable drills were identified, but only two were tested, due to lack of availability. An x-ray drill was operated by Neill's Mining Company under contract, and a Packsack drill, leased from The University of British Columbia, was operated by Ministry of Energy, Mines and Petroleum Resources staff.

DESCRIPTION OF DRILLS

THE PACKSACK 4M DRILL

A portable drill driven by a 10-horsepower, two-cycle, air-cooled gasoline engine and utilizing an IEX 25.4 millimetre (1 inch) diameter, single, rigid core barrel, can penetrate to a depth of 15 metres. This hand-held unit (Plate 4-3-1) with variable throttle control is probably the lightest drill on the market. With accessories, but excluding rods, it weighs about 50 kilograms. It can be operated by one person, but two make the work considerably easier. Two holes were drilled with this machine. One was abandoned at 10 metres when the bit mudded in. The second, Hole 88-1B, reached a depth of 8.3 metres and obtained 89 per cent core recovery. The main drawback of the hand-held drill is that with a constantly changing fulcrum, the direction of pressure applied varies, resulting in deviation of the hole.

THE X-RAY DRILL

This drill (Plate 4-3-2) is a very old unit which the suppliers, JKS Boyles Ltd., replaced with the Winkie. It is powered by a 9-horsepower two-cycle, air-cooled gasoline engine, and can penetrate to a depth of over 100 metres. The unit, which is mounted, has two gears and weighs about 75 kilograms without the rods. Hole number GSB88-1 used the

Plate 4-3-1. Packsack 4M drill.

TABLE 4-3-1
AVERAGE PROXIMATE ANALYSIS VALUES ON QUINSAM DRILL-CORE SAMPLES

Coal Seam	Basis	Residual Moisture %	Ash %	Volatile Matter %	Fixed Carbon %	Calorific Value kilojoules per kilogram	F.S.I.
#2	adb	2.3	30.0	30.0	35.0	20934	0.5
	db		31.8	31.8	36.4	21164	
#1 RIDER	adb	2.3	20.0	35.0	42.0	25121	1.0
	db		20.9	36.1	43.0	25615	
#1	adb	2.5	9.5	37	50.0	28629	1.0
	db		10.0	38.3	51.7	29370	

TABLE 4-3-2
SUMMARY OF AVERAGE ULTIMATE ANALYSIS VALUES OF QUINSAM DRILL-CORE SAMPLES

Coal Seam	Basis	Residual Moisture %	Ash %	Carbon %	Hydrogen %	Nitrogen %	Oxygen %
#2	adb	2.65	28.85	51.61	3.88	0.73	12.34
	db		29.64	53.01	3.68	0.75	10.26
#1 RIDER	adb	2.3	20.0	60.18	4.34	0.79	10.57
	db		20.9	61.63	4.18	0.79	8.69
#1	adb	2.76	9.91	69.97	4.81	0.88	13.86
	db		10.19	71.95	4.63	0.91	11.73

TABLE 4-3-3
SULPHUR FORMS

Coal Seam	Pyrite %	Sulphate %	Organic %	Total %
#2	1.99	0.08	0.52	2.59
	2.04	0.08	0.54	2.66
#1 RIDER	2.87	0.16	0.66	3.69
	2.93	0.16	0.67	3.76
#1	0.23	0.01	0.33	0.57
	0.24	0.01	0.34	0.59

TABLE 4-3-4
AVERAGE VALUES OF ASH ANALYSIS ON QUINSAM DRILL-CORE SAMPLES

SEAM	SiO_2 %	AL_2O_3 %	Fe_2O_3 %	MgO %	CaO %	Na_2O %	K_2O %	TiO_2 %	P_2O_5 %	SO_3 %
#2	44.25	30.24	12.33	1.17	5.86	0.63	0.36	2.42	<0.010	4.07
#1 RIDER	36.14	21.34	19.35	0.76	10.49	0.31	0.38	1.82	0.322	9.17
#1	26.63	21.34	07.93	0.68	28.99	0.28	0.12	1.39	0.39	8.72

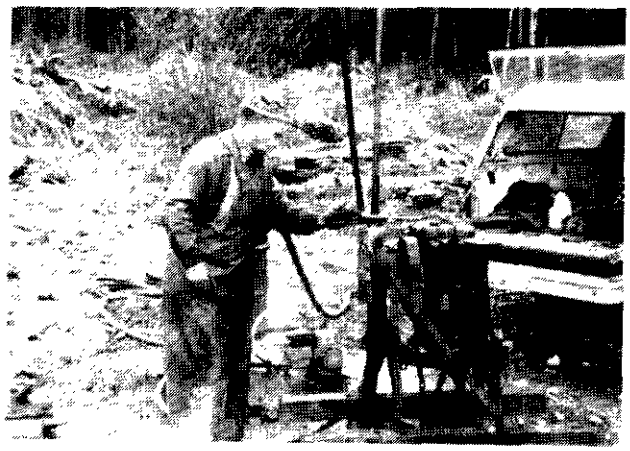

Plate 4-3-2. JKS Boyles Ltd. X-ray drill.

double swivel type of core barrel with an internal diameter of 35.0 millimetres (IAX); average core recovery was 96.6 per cent to depths of 34.25 and 54.25 metres. Hole GSB88-2 was drilled with a double swivel type of core barrel, with an internal diameter of 22.3 millimetres (EX). The core recovery was 89 per cent over a depth of 45.5 metres.

LOCATION OF STUDY AREA

The area chosen for the drilling test was the Quinsam coal mine which provides easy access and abundant water, and where environmental disturbance is minimal. The mine is located some 20 kilometres west of Campbell River on the east coast of Vancouver Island. The three x-ray holes were drilled on Line 82 + 50 of the Quinsam mine grid, and the two packsack holes were sunk near the pit high-wall (Figure 4-3-1).

GEOLOGICAL SETTING

The coal measures, consisting of sandstone, siltstone and mudstone, overlie the Benson basal conglomerate of the Upper Cretaceous Comox Formation of the Nanaimo Group. The sequence is moderately deformed by block faulting and tilting to the northeast. The general strike of the sediments in the vicinity of the No. 2 pit is 305° and the average dip is 7° to the northeast. The regional geology of the area is described by Bickford *et al.* (1989).

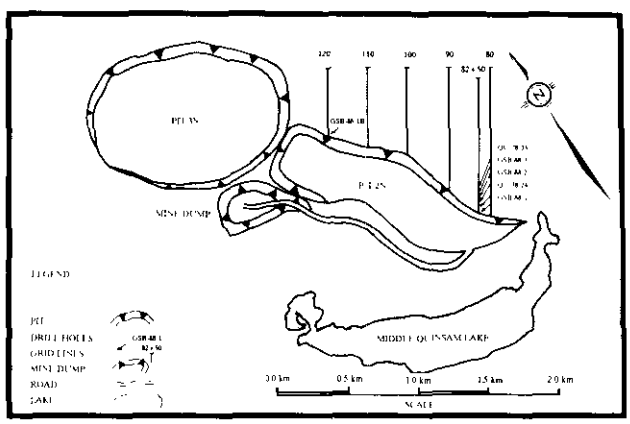

Figure 4-3-1. Quinsam mine site.

SAMPLING AND ANALYSIS

Coal was sampled in 10-centimetre increments; a few of the samples varied from 5 to 15 centimetres. The samples were crushed to -20 mesh. Petrographic rank was determined in-house by the vitrinite reflectance method and the following analyses were conducted by Chemex Laboratories of Vancouver: proximate, ultimate, sulphur forms, calorific value, free swelling index, ash analysis, chlorine, fluorine and mercury contents, and ash fusion.

DESCRIPTION OF COAL MEASURES

A typical section of coal measures, derived from the drill core, is illustrated in Figure 4-3-2. A generalized cross-section, derived from three diamond-drill holes (this study) and two exploration rotary-drill holes, is shown in Figure 4-3-3. Two coal zones, No. 1 and No. 2, occur in a succession of siltstones. The No. 1 coal zone consists of the No. 1 seam, which averages 2.3 metres in thickness, and a rider averaging 0.4 metre thick. The No. 2 zone varies in thickness from 1 to 8 metres with bands of coal up to 0.2 metre.

RESULTS AND DISCUSSION

A summary of analytical results from the 1988 Geological Survey Branch diamond-drill hole sampling program is presented in Tables 4-3-1 through to 7. Values are averages for each of No. 1 seam, No. 1 rider and No. 2 seam.

No. 1 Coal Zone

The fixed carbon content on a dry basis is 51.7 per cent for the No. 1 seam and 43 per cent for the rider. The volatile matter content for the No. 1 seam on a dry basis is 38.3 per cent and 36.1 per cent for the rider (Table 4-3-1). These values coupled with the calorific value, place the rank of the coal in the high-volatile bituminous B category.

The free swelling index is less than 4, placing the seam in the thermal coal category. The ash content seam is low, making the coal suitable for both power generation and cement manufacture. The volatile matter is, however, a little on the high side. The calorific value is acceptable for both applications as it is greater than the minimum of 21 000 kilojoules per kilogram (a.d.b.) required for cement manufacturing (Table 4-3-1).

The hydrogen content of the No. 1 seam, converted to a dry mineral-matter-free basis is 5.5 per cent. Given that the hydrogen range for bituminous coals is 4.5 to 5.5 per cent, clearly there has been little depletion of hydrogen which would normally result in the formation of methane. The oxygen content of the seam, on the same basis, averages 15.87 per cent, indicating that there may have been some depletion of oxygen resulting from a natural aging process. The nitrogen content of most samples ranges from 0.5 to 2.0 per cent. In this case it is reasonably low and as a result, the conversion to oxides (NO_x), a pollutant, is not a serious consideration (Table 4-3-2). In the No. 1 zone the sulphur

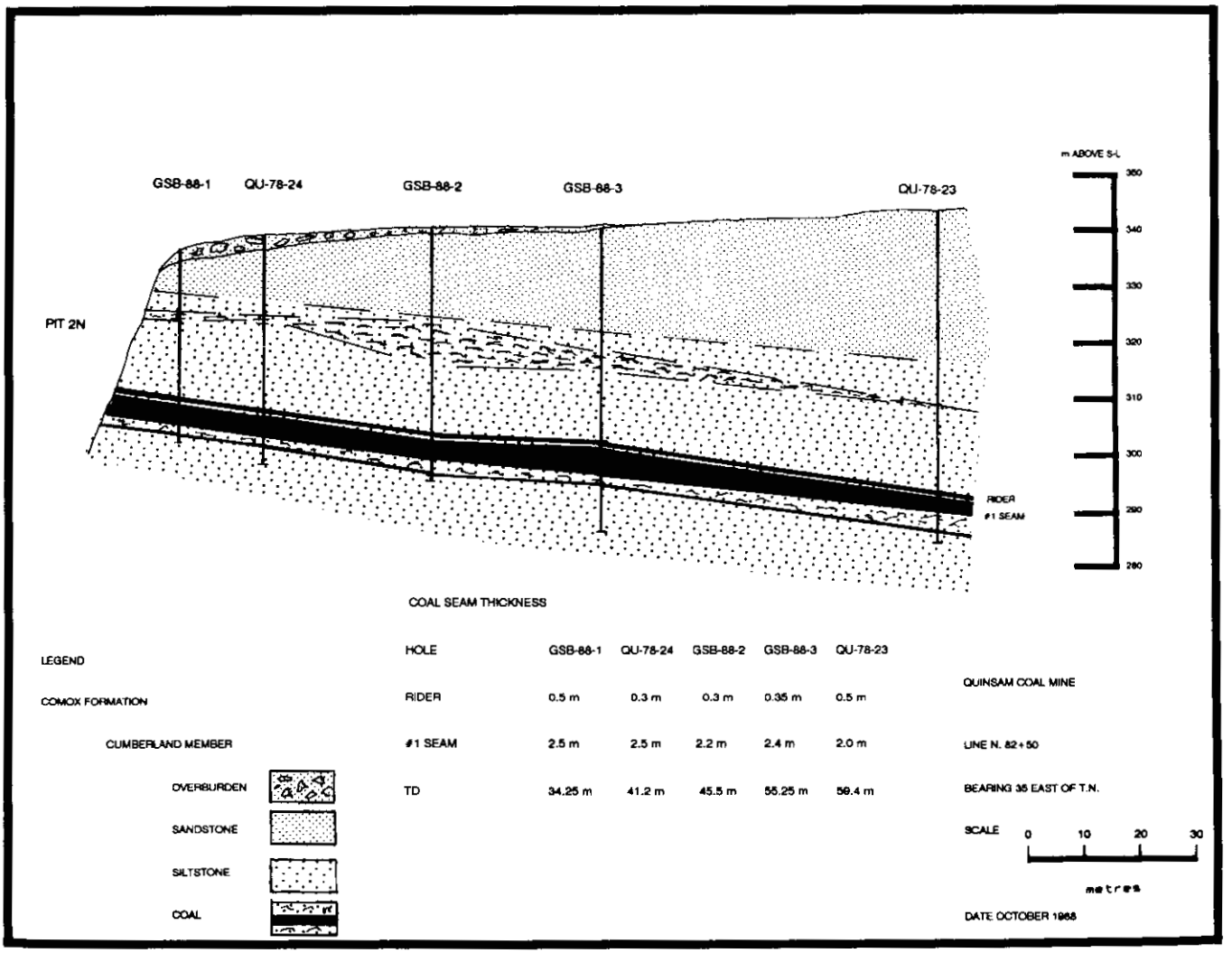

Figure 4-3-2. Type section, Comox Formation coal measures.

(pyritic and total) decreases with depth, with the highest concentrations in the rider; this is typical of a marine incursion subsequent to deposition of the coal. The sulphate content is low (0.01 per cent), unlike that of highly weathered or oxidized coals. In general the total sulphur is well within the acceptable limits for power generation and cement manufacture (Table 4-3-3).

The major components of the ash (Table 4-3-4) are SiO_2 at 26.63 per cent, CaO at 28.99 per cent, Al_2O_3 at 21.34 per cent and Fe_2O_3 at 7.93 per cent for the No. 1 seam. Lime acts as a mild flux and in this case it is noticeably high. The P_2O_5 content is very low at 0.39 per cent, well below the maximum of 1 per cent allowable in clinker for cement manufacture.

Chlorine at 0.017 per cent, is well below the maximum of 0.1 per cent above which it would cause ash fouling in boilers (Table 4-3-5). Fluorine is very low, however in cement manufacture a certain amount is beneficial as it acts as a flux in the burning of clinker. Mercury appears to be higher in parts of No. 1 rider than the main seam.

The ash fusion temperatures fall in the medium range (Table 4-3-6), between 1350 and 1300°C.

The reflectance values place the coals in the high-volatile bituminous category ($R_o$max between 0.50 and 1.12 per cent); the No. 1 rider is generally lower in reflectance values than both the No. 1 and No. 2 seams (Table 4-3-7).

CONCLUSIONS

The subsurface coal sampling program started in 1988 as a pilot project with a modest budget. Three diamond-drill holes were put down using an x-ray drill, one hole recovering EX core and the other two an IAX core. A short fourth hole was drilled using a packsack drill. A total of 138.3 metres was drilled, from which 115 coal samples were taken from an aggregate coal thickness of 11.5 metres. The core recovery was excellent due mainly to the driller's technique, and the character of the coal and the sediments.

As a result of the 1988 project, the Geological Survey of Canada participated in the 1989 field project, doubling the drilling budget and assuming responsibility for all analysis except the reflectance and low-temperature ashing which will be done in-house. The raw analytical data will be published at a later date as an Open File.

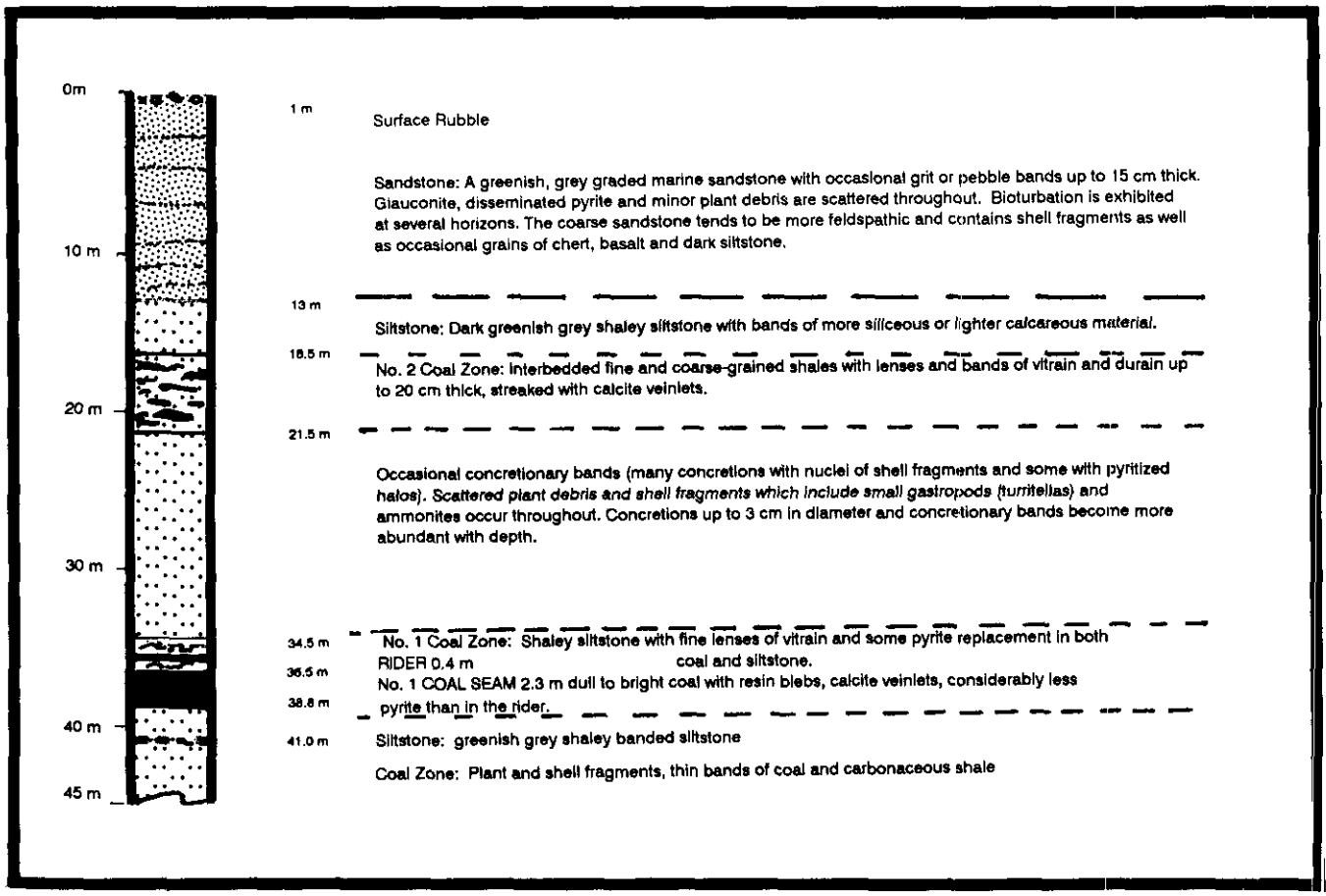

Figure 4-3-3. Cross section, Quinsam mine.

TABLE 4-3-5
AVERAGE VALUES OF CHLORINE, FLUORINE AND MERCURY IN QUINSAM DRILL-CORE SAMPLES

SEAM	Cl %	F ppm	Hg ppb
#2	<0.010	<5	225
#1 RIDER	0.017	<5	263
#1	0.017	<5	175

TABLE 4-3-6
AVERAGE VALUES OF ASH FUSION TEMPERATURE IN *REDUCING ATMOSPHERE FOR QUINSAM DRILL CORES*

Seam	Initial Deformation °C	Spherical °C	Hemispherical °C	Fluid °C
#2	1380	1410	1430	1450+
#1 RIDER	1248	1278	1300	1313
#1	1318	1338	1348	1363

TABLE 4-3-7
AVERAGE AND RANGE OF VITRINITE REFLECTANCE OF QUINSAM DRILL-CORE SAMPLES

Coal Seam	Number of Samples	Mean Maximum Average	Mean Maximum Range	Mean Random Average	Mean Random Range
#2	8	.68	.58–.78	.65	.56–.73
#1 RIDER	14	.54	.47–.69	.52	.45–.67
#1	89	.72	.60–.85	.68	.60–.82

ACKNOWLEDGMENTS

The author would like to extend his appreciation to Stephen Gardner and Dorothy Wilson of Brinco Coal Corporation for their very kind assistance, to Joanne Schwenger for the reflectance measurements, to Sharon Chapman for the sample preparation, to David Grieve and Ward Kilby for their assistance, to my field assistant, Kenneth Neill, and to our very patient typist, Rebecca Arnet.

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NOTES