SUBSURFACE COAL SAMPLING SURVEY, BOWRON RIVER COAL DEPOSITS, CENTRAL BRITISH COLUMBIA (93H/13)

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KEYWORDS: Coal geology, Bowron River, Tertiary deposits, coal measures, stratigraphy, drilling, sampling, analysis, coalbed methane, desorption tests.

INTRODUCTION

The 1990 coal subsurface sampling survey of the Bowron River coal deposits represents the third year of the program and the second year in which funding was provided jointly by the Institute of Sedimentary and Petroleum Geology and the B.C. Ministry of Energy, Mines and Petroleum Resources. A total of 300 metres of core (diameter 3.5 centimetres) was recovered from three diamond-drill holes. The drilling program was conducted, as in previous years, by Neill's Mining Company using a Prospector 89 drill manufactured by Hydrocore Drills Ltd.

Coal exposures on the west bank of the Bowron River, near the drill sites, were sampled, in addition to all the coal seams and bands recovered from the drill cores. Methane desorption tests were carried out on coal core from several horizons.

EXPLORATION HISTORY

The existence of coal on the Bowron River was first reported by G.M. Dawson in 1871 However, it was not until 1910-11 that development work started, with the construction of an adit and survey of the area. After a 35-year period of inactivity, diamond drilling and trenching was undertaken in 1946 and continued for a three year period. In 1967 work restarted with two exploration adits and several diamond-drill holes completed, and continued in a desultory manner until 1981. A total of about 140 holes, some as deep 1222 metres, were drilled over the entire exploration period from 1946 to 1981. The licenses were forfeited in 1982 and at present none are held in the area.

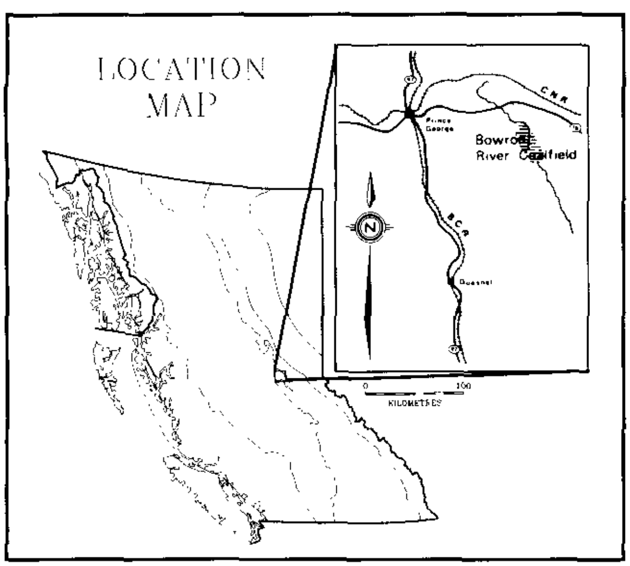

Figure 5-5-1. Location map.

LOCATION OF THE STUDY AREA

The Bowron River coal deposit is within the Interior Plateau, in east-central British Columbia (Figure 5-5-1) 50 kilometres east-southeast of Prince George. Access is via a dirt road 55 kilometres east of Prince George on Highway 16 (Yellowhead Highway). The old adit site is reached by travelling 7 kilometres along this road to the south and a further 7 kilometres eastwards on a good forestry road. The adit is on the west bank of the Bowron River.

GEOLOGICAL SETTING

The Tertiary coal measures of the Bowron River graben overlie and are bounded by Mississippian volcanics and sediments of the Slide Mountain Group, Outcrop is sparse in the immediate vicinity of the graben due to the Quaternary overburden of alluvium and glacial deposits, which varies in thickness from a few metres to 300 metres.

The graben trends in a northwesterly direction. It is 2.5 kilometres wide and about 25 kilometres long. The coal measures occupy the lower 100 to 150 metres of the Tertiary sequence and consist of siltstone, sandstone, conglomerate and coal. The reported average thicknesses of the coal zones are: Upper, 2.4 metres; Middle, 3.4 metres; Lower, 4.0 metres (Borovic, 1980).

The regional strike varies from 325° to 330° and the dips along the western flank vary from 30° to 35° northeast, though dips appear to lessen with depth. The strike of the western boundary fault, as indicated by outcrop and drill-hole data, is roughly parallel to that of the Tertiary sediments. The position of the eastern boundary fault, which probably has a greater displacement, is inferred beneath the extensive overburden. Two minor, subparallel faults down-drop the strata toward the centre of the basin (Figure 5-5-2).

The 1981 drilling added little to this general picture, other than the fact that the basement surface below the area east of the Bowron River is very uneven. The lower coal zone has greater lateral continuity than the upper two, in which the coals are discontinuous and variable. Despite the close proximity of the three drill holes to one another along strike, correlation is difficult. A moderately active period of deposition is indicated by rapid facies changes, and flaser-

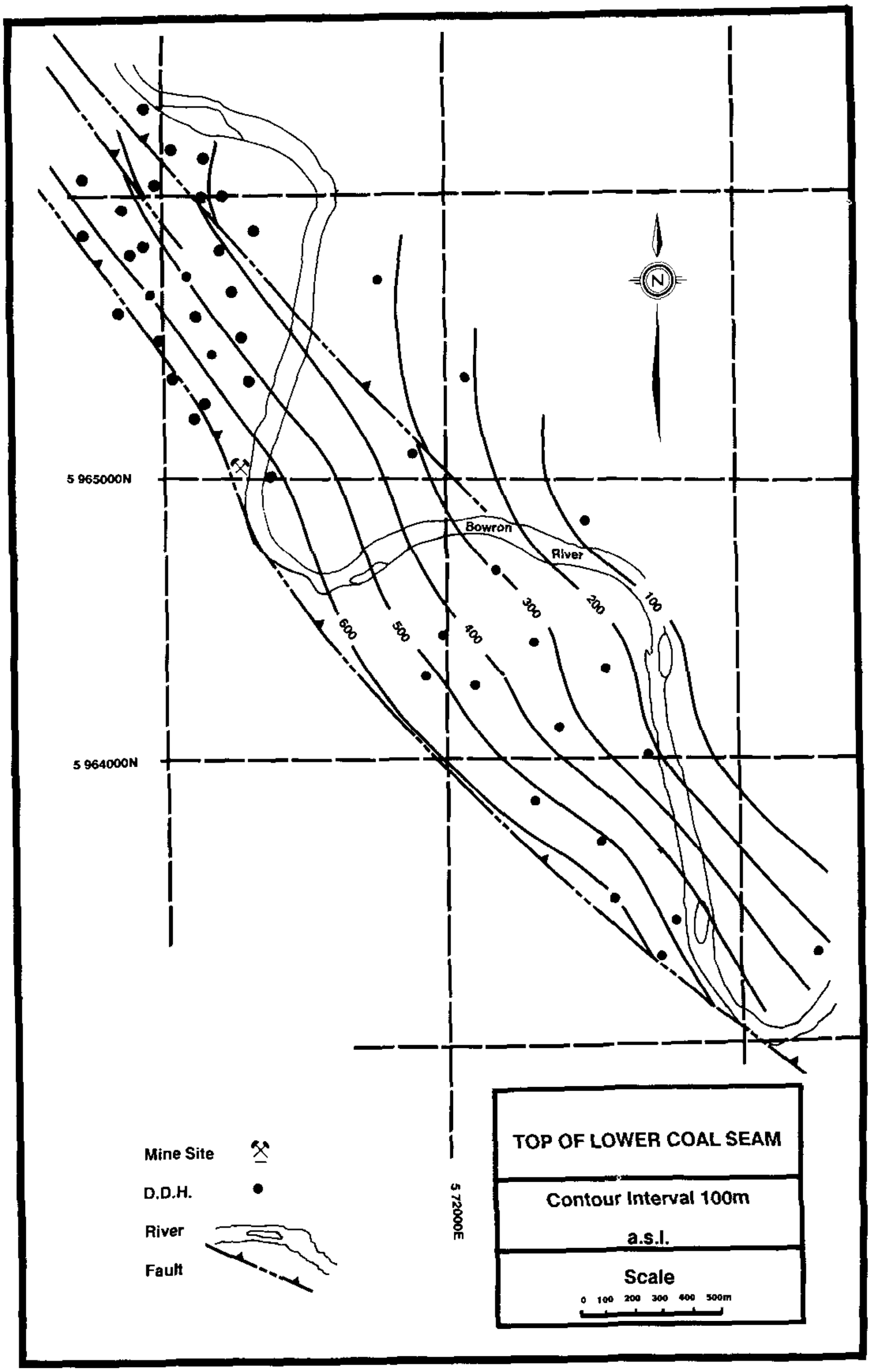

Figure 5-5-2. Contours of the top of lower coal seam.

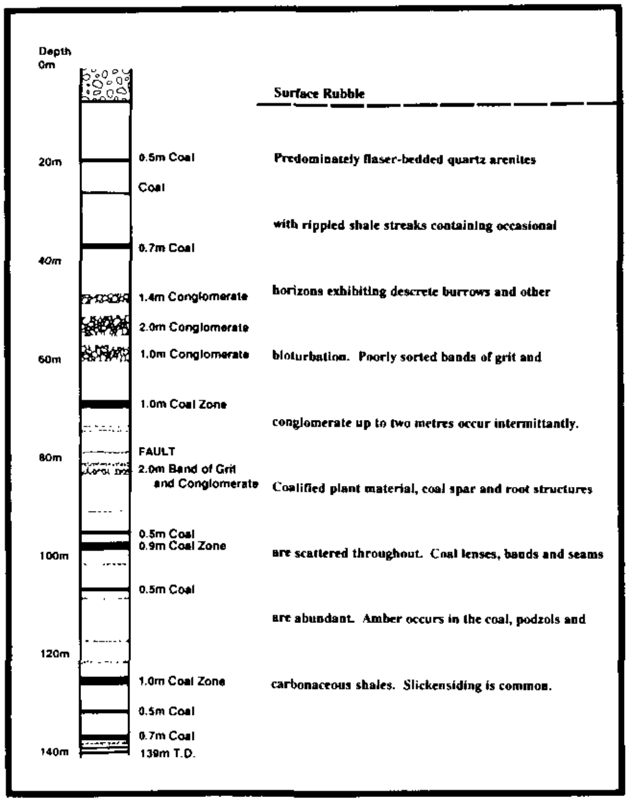

Figure 5-5-3. Simplified stratigraphic log of hole GSB-90-3.

bedded quartz arenites, accompanied by burrowing and other bioturbation. The presence of grits and conglomerates suggests various periods of high-energy sedimentation. Podzols containing distinct root structures and coalified plant remains occur throughout the section (Figure 5-5-3).

COAL QUALITY

The coal is described as a high-volatile B bituminous with an average R_o max of 0.65. A typical proximate analysis on an as-received basis is: moisture, 4.0 per cent; ash, 35.7 per cent; volatile matter, 26.4 per cent; fixed carbon, 33.9 per cent. The Hardgrove grindability index is 53 per cent and the average sulphur content is 1.6 per cent.

In outcrop, the cleat spacing is close (2 to 3 millimetres) suggesting a friable coal. This, however, is not consistant with the low Hardgrove Index. The total resin content is reported to be 8 per cent (Borovic, 1980), composed of 4 per cent Canadian resin-soluble and 4 per cent of insoluble resin. Sulphur bloom is abundant on coal outcrops.

DRILLING AND SAMPLING

The two major constraints regarding the siting of the drill holes were the highly variable thickness of overburden and the depth of the coal zones. Another consideration was the capability of the small drill which, in this instance, penetrated to depths of 140 metres. The coal zones are at their shallowest near the western fault. As a result, the holes were sited along strike, close to the fault (Figure 5-5-4) and the southwest bank of the Bowron River. The spacing was about 100 metres to 120 metres. Depths of the holes are as follows: GSB-90-01, 130.3 metres; GSB-90-02, abandoned in overburden after two attempts; GSB-90-03, 139.0 metres; GSB-90-04, 24.5 metres.

The proximity of the coal zones to the fault decreased with depth in all holes. Coal bands greater than 5 centimetres thick were sampled, and the thicker seams were sampled in about 20-centimetre increments. Five grab samples of outcrop coal, exposed by the river, were taken near the site of GSB-90-04. Seventy samples were taken from GSB-90-01, thirty-five from GSB-90-03 (Figure 5-5-6) and thirty-three from GSB-90-04. All samples were forwarded to the Institute of Sedimentary and Petroleum Geology in Calgary for analysis. Eight samples were used for methane desorption tests.

SAMPLE ANALYSIS

All coal samples will be crushed to -20 mesh. Petrographic rank determinations will be carried out in-house by the vitrinite reflectance method. Analyses will also be made using X-ray defraction on low-temperature ash samples. The following analyses will be carried out by a private laboratory under the joint auspices of the Geological Survey Branch and the Institute of Sedimentary and Petroleum Geology: proximate; ultimate; sulphur forms; calorific value; ash analysis; chlorine, flourine and mercury contents; and ash fusion. At the request of Dr. Fari Goodarzi the remainder of the core, after the coal had been removed, was sent to the Institute of Sedimentary and Petroleum Geology in Calgary, primarily for petrographic examination of the carbonaceous material in the mudstones, siltstones and shales, and trace element determination will be done on the coal using, among other techiniques, neutron activitation.

METHANE DESORPTION TESTS

1990 was the first year that the Geological Survey Branch attempted desorption tests, and we were more concerned with the methodology than the actual assessment of the methane potential of the coal deposit at this stage. Test cannisters were made up from PVC plumbing pipe, with an internal diameter of 3.8 centimetres, and various plumbing accessories (Plate 5-5-1). The cannisters were tested for an air-tight seal by sealing in baking soda and water, then holding them under water to detect any escaping gas. This check was made after the completion of each test. To ensure an effective seal the "O" ring was carefully examined. Teflon tape was wrapped around the thread of the sealing cap and all coal particles, which would prevent an efficient seal, were removed.

There are three components in the measurement of methane gas in coal (McCullough *et al.*, 1980):

- "Lost gas" is the methane which is given off from the time the coal sample is halfway out of the hole until the time it is sealed in the container (A in Figure 5-5-5), as

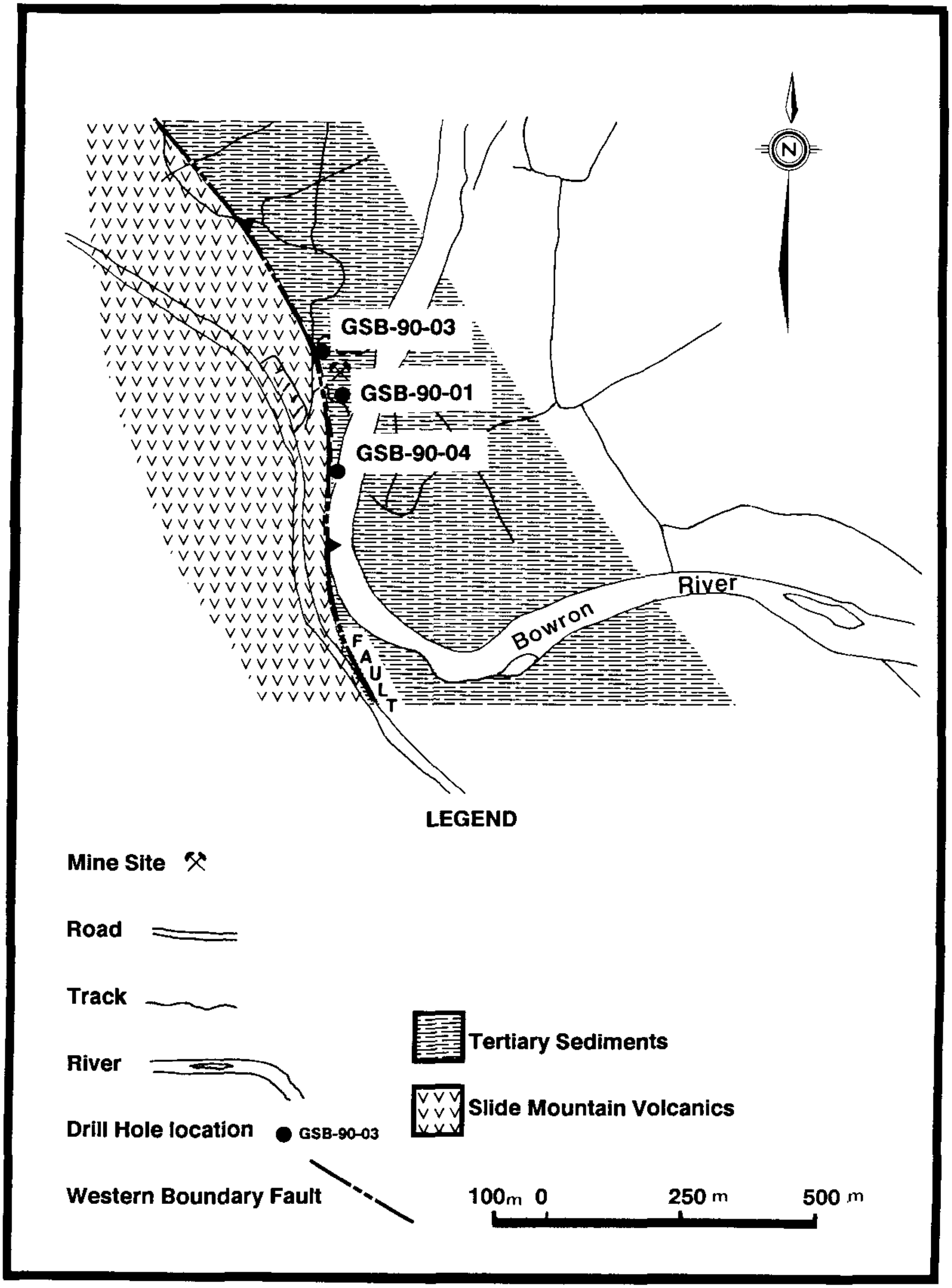

Figure 5-5-4. Location of GSB drill holes.

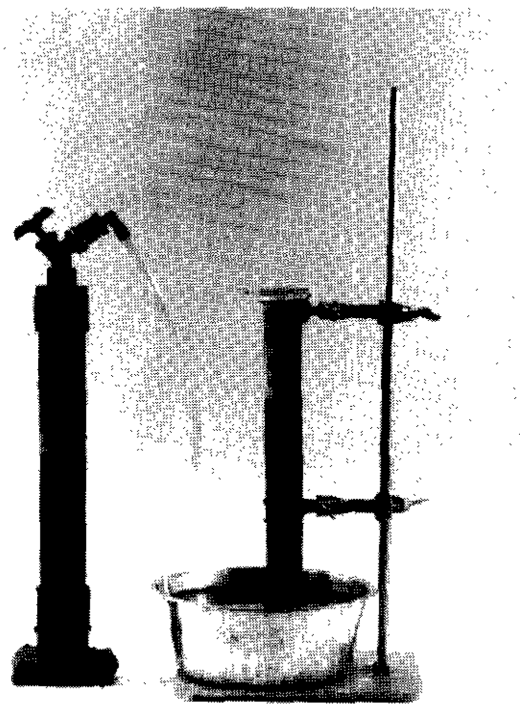

Plate 1. Desorption equipment.

in this case, where water is the drilling medium. If air or mist is used in drilling, it is assumed that the coal begins giving off gas immediately it is penetrated by the drill. This value is calculated by extrapolation back to zero time from the desorbed gas measurements. (*e.g.* Figure 5-5-5. McCullough *et al.*, 1980).

- "Desorbed gas" is the methane given off by the sample while in the cannister, and is the quantity measured as described below.
- "Residual gas" is retained by the coal and depends upon the fracture network that defines coal friability. The quantity is measured, in a sealed box filled with nitrogen, after desorption is completed by crushing in a mechanical grinder to about 200 mesh. This quantity is determined by gas chromatography and was not considered in this study.

Measurements were made of the desorbed methane at regular time intervals by releasing the gas through a valve into an inverted graduated cylinder filled with water (Plate 5-5-1). The volume of water displaced is then determined. Readings for the first two or three hours are taken at 15 minute intervals for an acccurate determination of the lost gas (Figure 5-5-5, Line I) as the subsequent rate of desorption decreases (Figure 5-5-5, Line II). At Bowron River it was minimal, as the water table was just below surface and the hydrostatic pressure inhibited the release of gas during core recovery (Figure 5-5-5, Line I).

There should be a pressure gauge on the cannister to register the build up of pressure, as high pressure also inhibits the release of gas. The samples should be kept at a constant temperature of about 22°C, to allow free desorption. It was not possible to meet this condition in the field

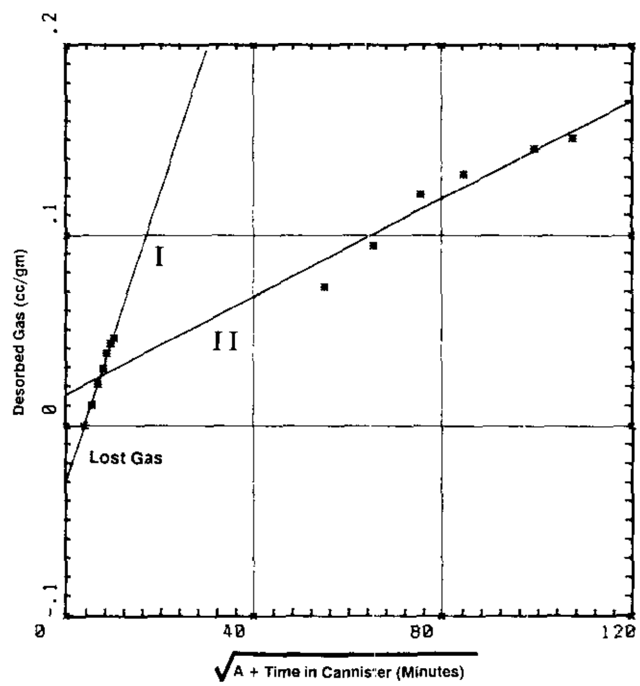

Figure 5-5-5. Desorbed gas and lost-gas calculation.

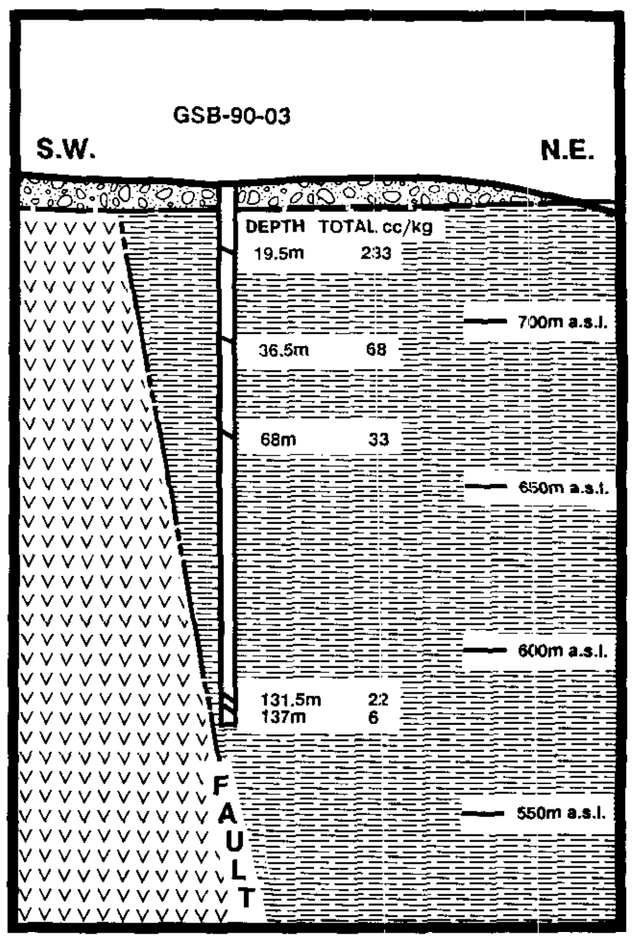

Figure 5-5-6. Section SW-NE through GSB-90-3 showing the coal horizons from which samples were taken for coalbed methane desorption tests and the results.

during the 1990 field season, with noticeable results (Table 5-5-1).

During this period, the night temperatures dropped to about 4°C. The time difference between the first and second reading is 22 hours and 10 minutes. Though the atmospheric temperature for the second reading was 22°C, the sample temperature lagged well below this level and there was no emission of methane. The third reading, taken only two hours later, by which time the temperature of the sample was probably appreciably higher, was 10 cubic centimetres. The same pattern was repeated the next day. Details of the procedures and calculations are given in various reports (McCullough *et al.*, 1980; Diamond and Levine, 1985).

TABLE 5-5-1
METHANE GAS EMMISSIONS INHIBITED BY LOWER SAMPLE TEMPERATURES

Sample #7 Date	Time	Weight of sample 0.37 kg Gas Released	Total Gas	Temperature
21-IX	3:20 p.m.	8 cc	35 cc	22°C
22-IX	1:30 p.m.	0	35 cc	22°C
22-IX	3:30 p.m.	10 cc	45 cc	28°C
23-IX	10:45 a.m.	0	45 cc	23°C
23-IX	3:00 p.m.	4 cc	49 cc	28°C

TABLE 5-5-2
COALBED METHANE DESORPTION TESTS

Samples of coal taken from different coal horizons

GSB-90-03 Depth	Total cc/kg
19.5 metres	233
36.5 metres	68
68 metres	33
131.5 metres	22
137 metres	6

RESULTS

Due to the attitude of the strata, it was necessary to place the holes close to the fault, with predictable results with respect to the methane emitted (Figure 5-5-5; Table 5-5-2). The deeper the coal samples, the closer they were to the fault, and the less the coalbed methane retention, contrary to normal conditions where coalbed methane content increases with depth (Eddy *et al.*, 1982).

RESOURCES

It has been postulated that the Tertiary sequence occurs as an asymmetrical syncline (Borovic, 1981). There is little evidence of this in the existing drill-hole data. Assuming, however, that it is not a syncline, the thickness of the Tertiary deposit would be 1200 metres, which is not unreasonable. The beds strike 325° to 330° and dip 30° to 35° northeast near the western fault boundary, but flatten towards the centre of the basin.

The resource calculations are based on the most simple monoclinal structure. The coal resource of the lower coal seam only, assumed to be a constant 4 metres thick, is estimated at 400 million tonnes (SG 1.5) down to a depth of 1200 metres [where drill hole 81-22 (Norco) penetrated the lower coal seam at a depth of 1172 metres]. If the beds are folded into an asymetrical syncline, the figure for the coal resources is not appreciably different, though it would be less for coalbed methane. Table 5-5-3 gives a breakdown of the coal resources for each 200-metre depth increment and two methods of assessing the coalbed methane potential.

CONCLUSION AND RECOMMENDATIONS

Despite the badly broken core and abundant slickensiding, recovery at 95 per cent was good. Further drilling would resolve the structure and delineate the resources. More accurate desorption tests should be carried out on coal

TABLE 5-5-3
BOWRON RIVER COAL DEPOSITS
COAL RESOURCES AND POTENTIAL COALBED METHANE RESOURCE

	GENERALIZED SECTION DEPTH IN METRES						TOTALS
FROM	0	200	400	600	800	1000	0 to
TO	200	400	600	800	1000	1200	1200
			COAL				
TOTAL (million tonnes)	33.75	60.0	64.5	64.5	78.75	91.5	393.0
TOTAL (million cubic feet)			METHANE				
A	4219	9300	12255	13868	18900	23790	82332
B	423	8100	12384	14835	20239	25620	81651

A – Values calculated from Figure 5-5-8 (Ryan, this volume).
B – Values calculated from Equation 2, Table 5-5-1 (Ryan, this volume) R_o max = 0.65.

at greater depths and distance from the boundary fault. Rigorous desorption tests would take several weeks, continuing until the rate is less than 0.05 cubic centimetres per gram for five consecutive days. Indications are that the Bowron River coal is blocky in nature, in which case it would only emit about 60 per cent of its total gas by desorption (McCullough *et al.*, 1980). On the other hand, friable coals emit nearly 96 per cent of the total gas. Hydrofracturing would release most of the residual gas within an area with a diameter of 50 metres to 100 metres, depending upon the severity of the fracturing, virtually converting a blocky coal to a friable coal (personal communication, D. Richardson, 1990).

It is unlikely that the Bowron River deposit is capable of supporting a viable mining operation. An interesting alternative for the exploitation of the existing energy resources may lie in coalbed methane extraction.

ACKNOWLEDGMENTS

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REFERENCES

Borovic, I. (1980): Exploration Report; *Norco Resources Ltd.*

Borovic, I. (1981): Explorations Report, *Norco Resources Ltd.*

Diamond, W.P. and Levine, J.R. (1985): Direct Method Determination of the Gas Content of Coal: Procedures and Results; Report of Investigations 8515, *United States Department of the Interior, Bureau of Mines.*

Eddy, G.E., Rightmire, C.T. and Byren, C.W. (1982): Content of Coal Rank and Depth: Relationship of Methane; Proceedings of the *Society of Petroleum Engineers/ Department of Environment*, Unconventional Gas Recovery Symposium, Pittsburg, Pennsylvania, 10800, Pages 117-122.

McCullough, C.M., Levine, J.R., Kissell, F.N. and Duel M. (1980): Measuring the Methane Content of Bituminous Coal Beds; Report of Investigations 8043, *United States Department of the Interior, Bureau of Mines.*

Ryan, B.D. (1991): Geology and Potential Coal and Coalbed Methane Resource of the Tuya River Coal Basin; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Geological Fieldwork 1990, Paper 1991-1, this volume.

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