LIGNITE OCCURRENCES ON THE COAL RIVER, NORTHERN BRITISH COLUMBIA (94M/10)

By Barry D. Ryan

KEYWORDS: Coal River, lignite, coal, peat, clay, energy resource, leonardite.

INTRODUCTION

Coal River flows south to join the Liard River approximately 150 kilometres east of Watson Lake and 40 kilometres south of the Yukon border (Figure 1). The area has subdued topography and elevations range from about 550 to 600 metres. The river crosses the Alaska Highway at kilometre 858. Coal was first reported in the area by McConnell (1891). At the mouth of Coal River, he found lignite boulders which he describes as being of inferior quality, and spent part of a day traversing up the river to try and find the source. A walk of several miles failed to locate it. He describes Coal River as a "small clear stream about 100 feet wide". The author prefers to describe it as a fast-flowing river, 100 metres wide, which he traversed in a jet boat. McConnell also mentions lignite in an unnamed creek which enters the Liard from the south and is 11 kilometres beyond (west?) of Hyland River. McConnell's account is repeated by Dowling (1915) who did not visit the location and provides no additional data.

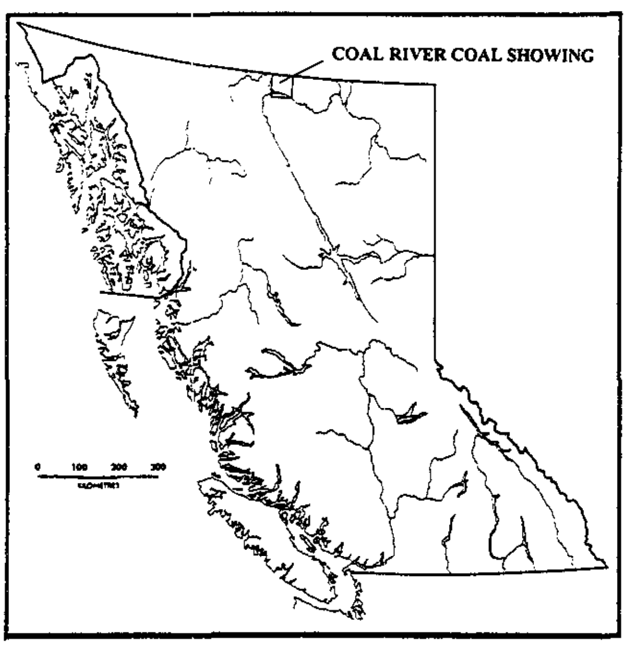

Figure 1. Location map for Coal River.

The source of the lignite was located by Williams and DeLeen prior to 1944 (Williams, 1944) about 10 kilometres (6 miles) as the crow flies up river from the Alaska Highway. At about the same time, crews building the Alaska Highway were using lignite boulders, washed down from the outcrop, for heating in an army camp. Williams found an outcrop of fifteen feet (4.6 metres) of lignite dipping to the southwest at about 25° on the west bank of the river. He states that "the footwall is not visible". Part of the seam was on fire and he describes foul smelling gases and the presence of tar at the surface. The burning area is described as small. He quoted local reports that led him to believe that the lignite extended for several kilometres up river to a falls, but he gave no estimate of the resource. He analyzed a sample of the lignite and also mentioned the extensive deposits of white clay that outcrop on the west side of the river (Photo 1). A test of the clay indicated a cream to grey colour after firing, but no mineral analysis was made.

MacKay (1947) mentions Coal River in a table and assigns it a possible mineable tonnage of 5 million tonnes based on an assumed aereal extent of 0.5 square miles. This assumption is very conservative when compared to the present mapping.

A partial map of the area published by McLearn and Kindle (1950) who outlined an area of about 50 square kilometres possibly underlain by Tertiary lignite-bearing sediments. The area was mapped in 1958 and 1960 by Hugh Gabrielse (1962) who mapped a small area of Tertiary lignite-bearing sediments on Coal River but found no other occurrences in the general vicinity. The area to the north, in the Yukon, was mapped by Douglas and MacLean (1963). According to Campbell (1967) there is the potential for coal in the Watson Lake - Hyland River area but no potential along Coal River in the Yukon. Since 1962 there has been little mapping activity in the area.

No map has been found which locates McConnell's second lignite outcrop near Hyland River to the west. There is a mention of coal in Tatsino Creek 10 kilometres east of Hyland River in Hughes and Long (1979). They also mention Coal River in a discussion of Early Tertiary coal deposits in the Tintina Trench.

GEOLOGY

The author visited the area in 1989 for half a day and collected samples of lignite float. When dry the lignite has a density not much greater than that of water, and forms tough, matted blocks that are easily transported down river and deposited high on sand banks. In 1990 two days were spent mapping the showing. Generally, Tertiary outcrops are restricted to the river banks and the rest of the area is covered by trees, swamp and a burn zone. The area adjacent to the river is characterized by large crescent-shaped slumps, presumably where younger sediments have slid on the clay layer (Photo 2).

A number of lignite outcrops were located along the river (Figure 2) and are described briefly in Table 1. The main outcrop is on the west bank where the hangingwall section of the seam is exposed with a shallow apparent dip to the south for a length of over 100 metres (Photo 3). Exposure away from the river banks is effectively zero. The full thickness of the seam was not observed in any of the outcrops and the thickness exposed ranges up to over 8 metres at outcrop 46 (Table 2). Generally 3 to 4 metres of lignite are exposed in the outcrops on the west bank. On the east bank the topography is flatter and outcrops less well developed. The operator of the Coal River Lodge said that his water well, drilled near his buildings, intersected 15 metres of coal at a depth of 15 metres. This may or may not be the same seam that outcrops 10 kilometres up Coal River.

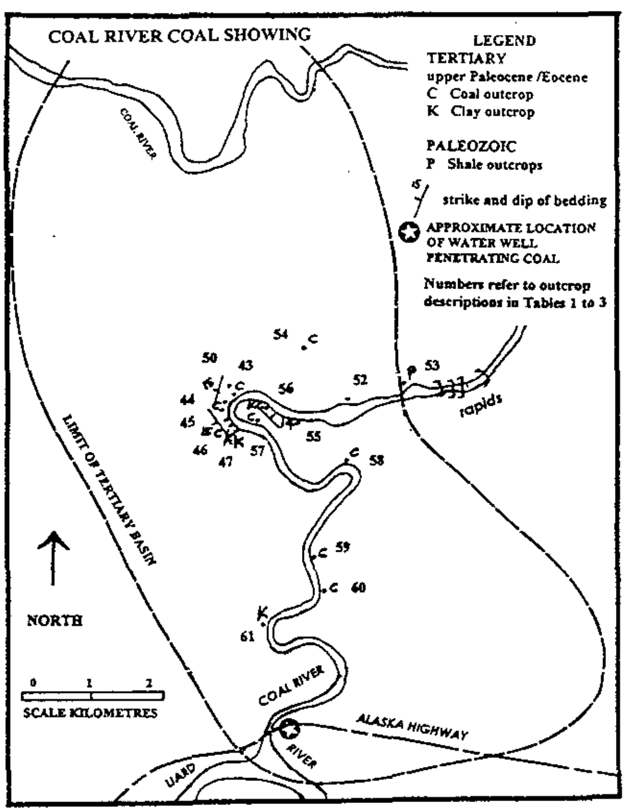

Figure 2. Sketch map of the Coal River lignite showings.

When saturated with water, the lignite has a blocky appearance and is dull, dark brown to black in colour. Resin blebs are visible in some samples. In some outcrops the lignite appears to have dried out and remnants of branches and trunks are visible (Photo 4). These fragments are often aligned and trend 120° to 180°. This orientation may originate with the way the vegetation accumulated in the swamp and is generally quite consistent within a single outcrop.

The lignite is cleated with two sets generally developed. The better developed set scatters but averages an 80° dip to 110°. The second set maintains a very consistent orientation and dips 68° to 033°. Bedding is generally obscure but where visible has a zero to 15° dip, rotating about a northwest-trending axis.

The lignite burning-zone mentioned by Williams is no longer burning and is located on the west bank of the river, near outcrop 44 where lignite is partially coked and overlain by at least 8 metres of baked clay and clinker. In places the ash has melted to form a dark glassy material. The topography in the area is marked by collapse structures were the ground has caved in over the burnt out seam.

On the west bank of the river the lignite is overlain by about 10 metres of white to light grey clay which contains occasional iron-stained surfaces, but otherwise appears to be quite pure. On the east side of the river lignite outcrops are not well exposed and no thickness estimates were made. Here the lignite is underlain by a grey clay. It is assumed, but not proved, that the lignite outcrops on both sides of the river are of the same seam.

Lignite was also located in a borrow pit 0.6 kilometre north of Hyland River on the Alaska Highway. Boulders of lignite up to 1 x 2 metres in size are scattered in a fluvial gravel. Small-sized float was found in the Hyland River below the Alaska Highway

TABLE 2
LITHOLOGICAL SECTION
OUCTROP 46 WEST BANK OF COAL RIVER

fro	to	thick	Description
0	1	0.69	hanging wall, flaky, brown, dull fusain with 1-2 mm resin blebs
1	1.6	0.41	blocky brown dull fusain some resin and plant fragments
1.6	2.1	0.34	as above
2.1	2.3	0.14	striated bark layer
2.3	5	1.86	blocky fusain
5	9.5	3.09	patchy outcrop patially covered by soil
9.5	10	0.34	bark layer
10	12	1.38	blocky fusain, footwall not exposed
total thick = 8.2 metres			thick = true thickness metres
From to measurements are oblique to true thickness section			

TABLE 3

COAL QUALITY DATA: COAL RIVER LIGNITE

OUTCROP	COMMENTS	H_2O% ar	H_2O% ad	VM% ad	Ash% ad	FC% ad	CV ad	TS%	PS%	SS%	OS%
91-44	close to burn zone	42.98	14.27	48.39	4.76	32.58	5301				
			0	56.44	5.55	38	6183				
91-44	mdst band in lignite	8.27	4.42	23.13	62.16	10.29					
			0	24.2	65.03	10.77					
91-46	lignite with resin	42.51	24.66	41.97	5.05	28.32		0.12	0.01	0.02	0.09
			0	55.71	6.7	37.59					
91-46	lignite with bark	10.92	5.81	64.16	2.33	27.7					
			0	68.12	2.47	29.41					
91-46	blocky lignite	21.13	10.43	51.21	7.2	31.16	5436				
			0	57.17	8.04	34.79	6069				
90-14	float sample	ND	10.67	47.39	9.99	31.95		0.19			
			0	53.06	11.18	35.76					
90-15	float sample	ND	5.53	59.4	3.45	31.62		0.48			
			0	62.88	3.65	33.47					
			0	53.9	7.4	38.7	5889				

GSC	Williams (1944)	softening temperature of ash	1366°C

sample	Ash oxide analysis	SiO_2	Al_2O_3	TiO	Fe_2O_3	CaO	MgO	Na_2O	K_2O	P_2O_5	SO_3	UD
91-46	lignite with resin	10.81	19.27	0.24	7.95	46.36	8.32	0.3	0.24	1.49	3.27	1.75

ar	Moisture as-received basis	TS%	total sulphur	SS%	sulphate sulphur
ad	moisture air-dried basis	PS%	pyritic sulphur	OS%	organic sulphur
CV	heat value in calories /gram				

bridge. There are therefore three possible occurrences of lignite in the general area of Hyland River, these being the locations mentioned by McConnell (1889), Hughes and Long (1979) and the one described above.

COAL QUALITY

Samples of the lignite were analyzed by Williams in 1944 and by the Geological Survey Branch in 1990 and 1991. The data are presented in Tables 3 and 4. Vitrinite reflectance measurements were difficult to make because of the very low rank. The average of the five mean maximum reflectance measurements obtained is 0.2%, which classifies the material as a peat and not lignite. This is supported by the average volatile matter on a dry ash-free basis which is 75% (Figure 3) but is not supported by the heat value or the as-received moisture measurements, both of which are characteristic of a coal with higher rank. Hughes and Long (1979) classify the coal occurrences in the Watson Lake area to the northwest as peat, based on reflectance measurements of 0.21% and less, but on the basis of proximate data they classify the coal as sub-bituminous C to lignite A. The Coal River data plot within the Watson Lake cluster outlined on their carbon (daf) *versus* reflectance plot (Figure 4). Other Tertiary deposits in the Tintina Trench are of higher rank.

The calorific value averages about 25.12 megajoules per kilogram (6000 calories/gram) for 7% ash on a dry basis, which is high for a peat or lignite. This contradicts the original comment of McConnell that the lignite is of inferior quality. The heat value of the Coal River samples (average reflectance 0.20%) compares favourably with data from other British

TABLE 4

VITRINITE REFLECTANCE: COAL RIVER LIGNITE

Outcrop	Description	east	north	Elev	Rmax%
91-44	close to burn zone	614875	6619700	512	0.19
91-45	woody fragments	614600	6619475	503	0.2[illegible]
91-46	blocky lignite	614575	6619375	500	0.21
91-51	blocky lignite	614900	6619800	518	0.16
91-54	lignite	615800	6620300	512	0.22

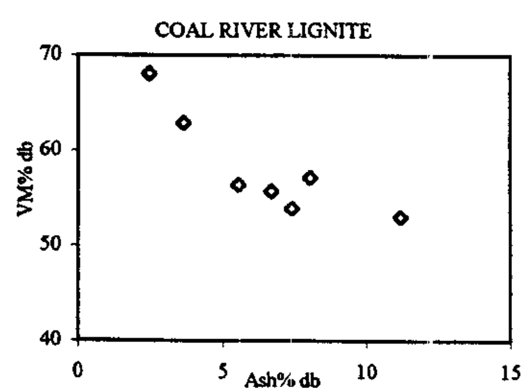

Figure 3. Plot of ash *versus* volatile matter, dry basis, for Coal River lignite data.

Columbian Tertiary deposits such as Tuya River (average reflectance 0.50%, Ryan, 1991), Hat Creek (average reflectance 0.36%; Church *et al.*, 1979) and Rapid River (average reflectance 0.33%, unpublished data, Figure 5). The net calorific value of a Coal River product at 7% ash (dry basis) and 20% moisture would be about 18.6 megajoules per kilogram (4440 calories/gram).

The ash is generally less than 10% on a dry basis, which would be equivalent to less than 15% for a bituminous coal with lower volatile matter. The lignite can therefore be considered to be low in ash. The sulphur averages 0.3% on a dry basis. A single sulphur-forms analysis indicates that about 75% of the sulphur is organic. If all the sulphur is released as SO_2 then this amounts to about 5.5 lbs $SO_2/10^6$ BTU (2.4 kilograms per gigajoule) or, if only the pyrite is responsible for SO_2 release, this reduces to about 1.4 lbs $SO_2/10^6$ BTU (0.6 kilogram per gigajoule).

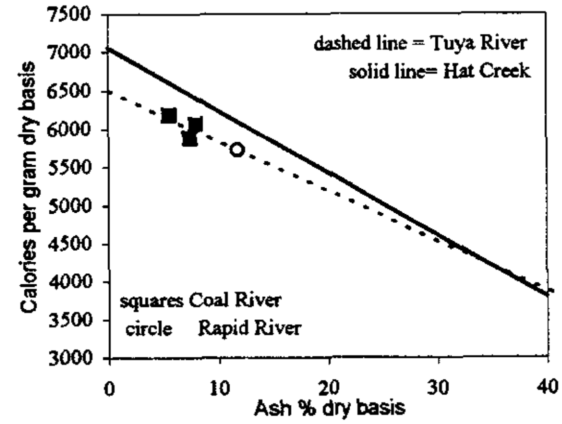

Figure 5. Plot of heat value *versus* ash, dry basis, for a number of Tertiary lignites from British Columbia.

COAL RESOURCE

The Tertiary basin has a possible area of about 35 square kilometres, as outlined on Figure 2. Most of the lignite outcrops are concentrated in one area on the west side of Coal River but there is a report of a 15-metre intersection of coal in a water well drilled near the mouth of the river. It is possible that the Tertiary basin extends north to cross Coal River above the rapids and outcrop of Paleozoic rocks (Figure 2). This area was not traversed and it should be noted that there are no lignite boulders in the river north of the main outcrops on the west bank. It seems reasonable, based on the thickness data recorded and the possible extent of the basin, to calculate a potential resource by multiplying half the basin area by a lignite thickness of 5 metres. This provides a preliminary resource estimate of about 100 million tonnes of peat/lignite. The indications are that this resource is at shallow depth.

Because of the low calorific value, the lignite would have to be used at source for power generation. Modern integrated gasification combined cycle (IGCC) plants can generate electricity from a wide range of coals (Richards, 1994) with minimum environmental impact.

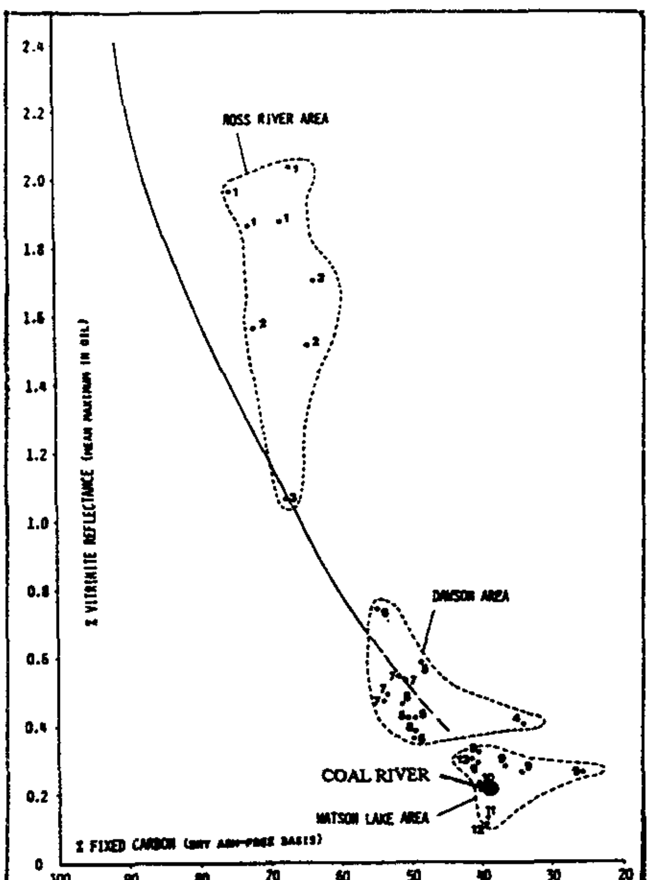

Figure 4. Plot of vitrinite reflectance *versus* fixed carbon from Hughes and Long (1979). Solid line is from McCartney and Teichmuller (1972).

OTHER POSSIBLE RESOURCES

The lignite is overlain by clay which is at least 10 metres thick in two locations and is a near white, plastic clay with occasional iron-stained surfaces. The clay that underlies the lignite is darker, but still plastic. Table 5 presents XRD and oxide analysis results. It appears that the clay at outcrop 61 is composed mostly of quartz and illite with minor amounts of chlorite, feldspars and carbonates. Iron is present in all analyses, ranging from 2% to 6%. Generally, for industrial uses, iron oxide has to be reduced to less than 1%, which might be difficult in this case because the iron is probably present in the mineral chlorite. If used as a pottery clay and fired, the high iron will produce a dark colour, but otherwise will not effect its properties.

No resource estimate is made for the clay above or below the lignite, but based on the size of the basin and the thickness of the bed,a resource of over 10 million of tonnes is possible.

It is possible that a resource of leonardite exists but in the absence of exploration and testing this remains unproved.

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NOTES