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STRATIGRAPHY AND SEDIMENTOLOGY OF SOME COAL SEAMS IN THE CARBONIFEROUS BAY ST. GEORGE BASIN, SOUTHWESTERN NEWFOUNDLAND

by

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GENERAL INTRODUCTION

This report reflects part of a joint research effort between the Mineral Deposits Section of the Department of Mines and Energy and the Department of Earth Sciences of Memorial University to better assess the fossil fuel potential of the Carboniferous Bay St. George Basin in southwestern Newfoundland. Within this larger framework, the purpose of the particular project reported on here is to better evaluate the economic potential of coals in the basin using modern sedimentological methods and thought.

GEOLOGICAL INTRODUCTION

The Barachois Group is the youngest Carboniferous unit in the Bay St. George Basin of western Newfoundland. Surface sections and a 343 m core drilled as part of this study exhibit medium-coarse grained, cross-stratified, fining-upward, erosively based sandstones interbedded with fine grained, ripple cross laminated and massive sandstones and mudstones. This supports the fluvial origin for the Barachois group suggested by Belt (1968) and Knight (1983).

An uppermost coal-bearing section of the Barachois Group underlies the so-called St. George's Coalfield (Baker, 1927; Bryan, 1938), part of which is shown in Figure 1a. There is another coal-bearing section near Stephenville (Figure 1b) that is also included in the Barachois Group (Knight, 1983). Coal was first cited in the literature in 1822 (Baker, 1927) for this part of Newfoundland, and the St. George's Coalfield has been periodically investigated and its coals mined on a very small scale since that first report.

Hacquebard et al. (1961) have dated the coal-bearing units in the St. George's Coalfield as Westphalian A (equivalent to the Riversdalian strata of Nova Scotia). Miospores recovered from the core drilled through the coal-bearing rocks confirm this age. However, Hacquebard et al. (1961) dated the coal-bearing rocks near Stephenville as Westphalian C/D, indicating a correlation with the Pictou Group of Nova Scotia. This has not been confirmed.

The Barachois Group is estimated to be 1500-1600 m thick in the vicinity of the St. George's Coalfield (Hayes and Johnson, 1938). A thickness of approximately 1500 m was measured by one of the authors (Solomon) in the 1984 field season. Gravity measurements carried out by S. Peavey and H.G. Miller of Memorial University in conjunction with this project put an upper limit of about 2 km depth to pre-Carboniferous basement in the vicinity of the borehole, but this depth ranges up to about 7 km elsewhere in the coalfield.

Previous workers have identified seven coal seams in the St. George's Coalfield. The names, stratigraphic order, thicknesses, along with several proximate analyses are presented in Tables I and II for five of the seams from the area of Barachois Brook (Figure 1a). There are appreciable differences in the thicknesses and descriptions given by the various investigators. These differences are due in part to the variability of the exposures. Many exposures lie along ice-scoured rivers which can modify bedrock exposures. In addition, mining operations have removed much of the easily accessible coal. The report by Bryan (1938) contains several measured sections of the coal seams from working faces in the old mines, and these are probably the most reliable measurements. All the adits and shafts have long since collapsed. Core descriptions are presented in Hayes and Johnson(1938), which indicate the poor continuity of coal seams over short distances, but the descriptions are much too general to be of much use in a sedimentological analysis. More recent works are syntheses of data by Hayes (1949) and Knight (1979, 1983), and detailed mapping along Barachois Brook by Howse and Fleischmann (1982).

The most recent field work (Hyde in 1983, Solomon in 1984) has been directed toward measuring the coal-bearing outcrops and detailed descriptions of sections. In all, eight sections and ten coal seams from seven localities are discussed. Seams are lettered from A to J. We use the term seam loosely because the coals can pinch out over very short distances (tens of metres), and can be more akin to lenses. In effect, as used here, seam is synonymous with occurrence.

Wherever possible, channel samples of the thicker seams were collected, meaning that four or five stratigraphically arranged samples may be present for some of the coal beds. These samples were classi-

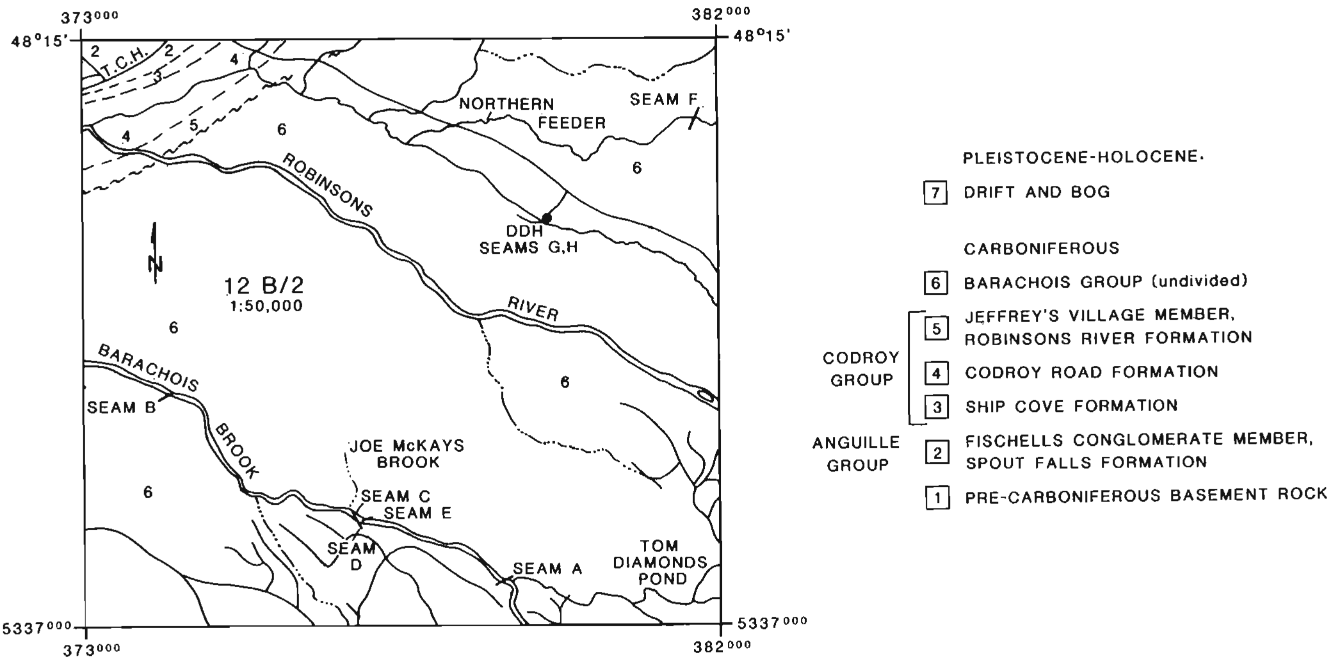

Figure 1a: *Simplified geologic map of Barachois Brook region with seam locations (modified from Knight, 1983).*

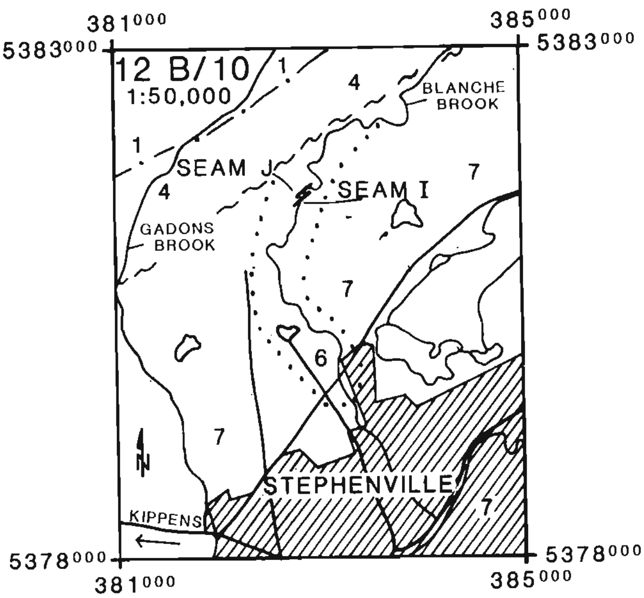

Figure 1b: *Simplified geologic map of Blanche Brook area showing location of coal seams (modified from Knight, 1983).*

fied microscopically (i.e. clarain, durain, etc.) from fresh surfaces. We made no attempt at seam description and classification using polished blocks.

Seam A (Section A)

Located at 789377 within NTS sheet 12B/2 on the north bank of Barachois Brook (Figure 1a), this seam is thought to represent the Tom Diamond Seam (Table I), judging from the maps of Baker (1927) and Bryan (1938). The seam is poorly exposed to the extent that river alluvium had to be scraped away to see it. Earlier workers (Dowling, 1920; Baker, 1927) reported the Tom Diamond Seam to be about a foot (30 cm) in thickness, but this probably included carbonaceous shale, as Hayes and Johnson (1938) and Bryan (1938) report coal thicknesses less than 1.5 inches (3.8 cm).

Seam A consists of thin (millimetre scale) coaly laminations within a 30 cm thick layer of gray claystone (Figure 2). Beneath the claystone occur several metres of gray to brown claystone and siltstone, with the later containing calcareous nodules. A 2 m thick covered zone is directly above the coal. The remainder of the section consists mainly of mudstones (claystones and siltstones) and sandstones arranged in 1.5-2.5 m thick coarsening-upward sequences. A rare, but significant, lithology in this section is an ostracod-bearing micritic limestone.

It was difficult to obtain large samples of the coal, but from smaller fragments it appears to be mostly vitrain that fractures conchoidally.

TABLE I: STRATIGRAPHY AND THICKNESS OF COALS ALONG BARACHOIS BROOK

(measurements in Imperial feet (') and inches (") as per original reports)

Seams	Jukes (?)	Murray (1873)	Howley (1917)	Dowling (1920)	Baker (1928)	Hayes & Johnson (1938)	Bryan (1938)
Cleary	*	1'5"	2'2"	2'	3'	1'8"	1'10"
Jukes	'3	1'3" coal + 2'3" coal & shale	4'8"	2'6"-3'	4'	1'11"+ 5' coal & shale	21" coal+ 5' coal & shale
Furlong (18")	*	*	1'6"	1'6"	1'7"	1'3"	1'1"
Murray	*	*	5'4" sh +coal	4'	"Thick" coal+sh	none visible	4' thins to 0 in fold
Tom Diamond	*	*	*	1'	1'	seams 1.5"	coal 0.5"

TABLE II: ANALYSES OF COALS

	Moisture	Volatiles	Fixed C	Sulfur	Ash	References
Cleary	3.548	30.897	52.229	3.946	6.380	Howley (1899)
Jukes	3.036	30.344	60.142	1.963	4.515	Howley (1899)
Furlong	2.30	31.49	54.21	4.32	14.30?	Bryan (1938)*
Murray	1.96	35.54	54.20	2.8	10.26?	Bryan (1938)*

* These analyses do not add up to 100%

TABLE III: MODAL PERCENTAGES

Seam	L	V	SF	I	S	A	Points Counted
G	0.6 (0.7)*	86.7 (98.7)	0.6 (0.7)	-	7.5	4.6	345
H	0.3 (0.4)	80.9 (97.7)	1.3 (1.6)	0.3 (0.4)	6.8	10.4	309

L-liptinite, V-vitrinite, SF-semifusinite, I-inertinite, S-sulfide, A-ash

* percentages in parentheses are on a mineral-free basis.

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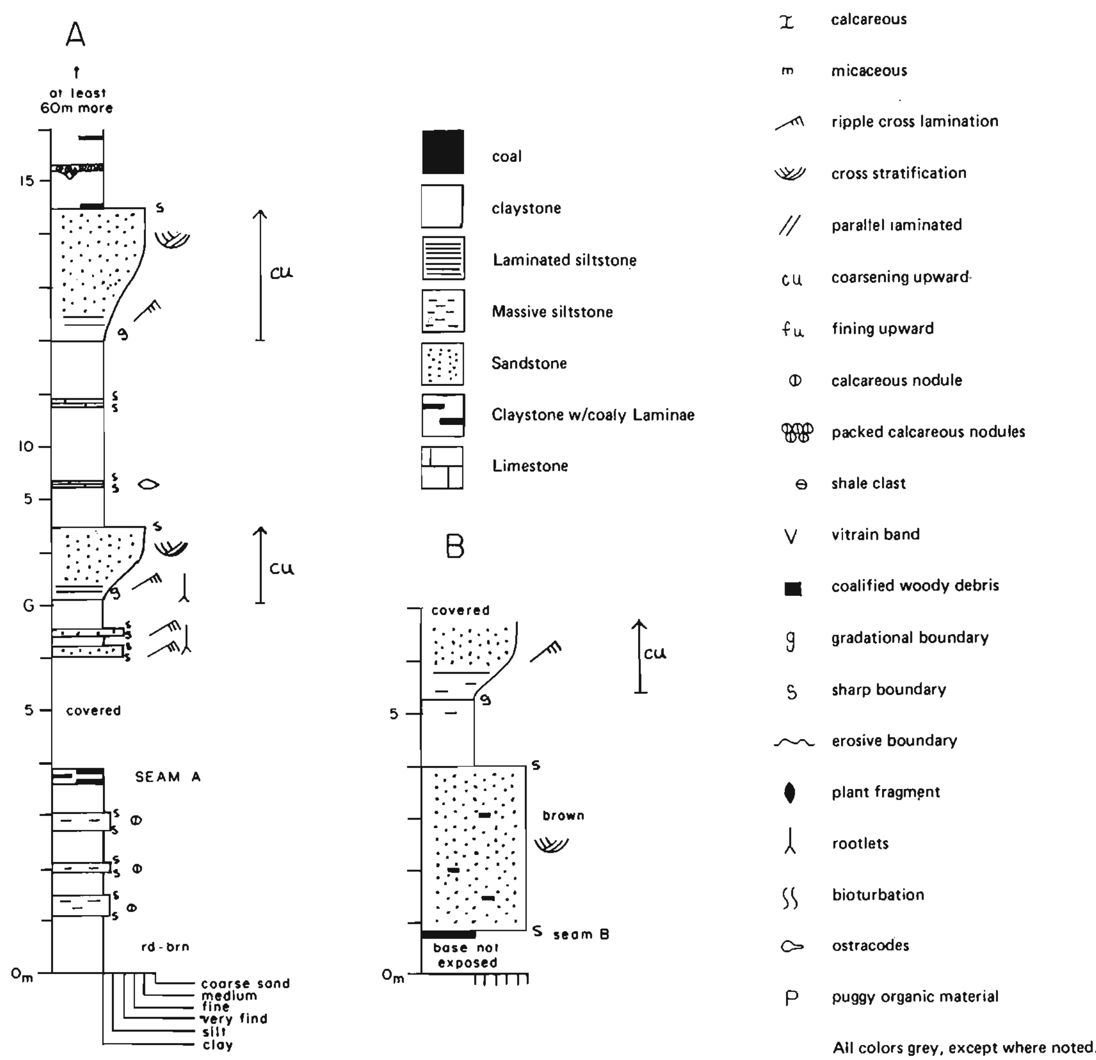

Figure 2: *Measured stratigraphic sections (A and B) containing seams A and B.*

Seam B (Section B)

This seam probably represents what has been termed the Murray Seam (Table I) or Murray No. 1 (Hayes and Johnson, 1938; Hayes, 1949). It is poorly exposed along the south side of Barachois Brook (743403, 12B/2) about 2 m upstream from a small tributary flowing from the south (Figure 1a).

Only about 10 cm of the seam is exposed (Figure 2). The coal appears to be mostly clarain, but with a high ash content (Bryan, 1938, reported 10.26% ash for a grab sample from the Murray Seam, Table II). There also appear to be small lenses of fusain.

This coal seam is sharply overlain by a cross-stratified, coarse sandstone that contains coalified wood debris. This sandstone is overlain by a 1.5 m thick coarsening-upward sequence of gray massive claystone to medium grained ripply cross laminated sandstone.

Seam C (Section C)

Seam C is located on the north side of Barachois Brook about 70 m east of the mouth of Joe McKay's Brook (Figure 1a) at 768387 (NTS sheet 12B/2). The seam is normally submerged in the brook along with much of the section. The seam is composite, consisting of two thin layers (about 12 and 5 cm thick, respectively) of either a dark brown cannel coal or oil shale (Figure 3). The distinction between these two rock types is related to the amount of inorganic material; where inorganic material is a major component, the term oil shale is

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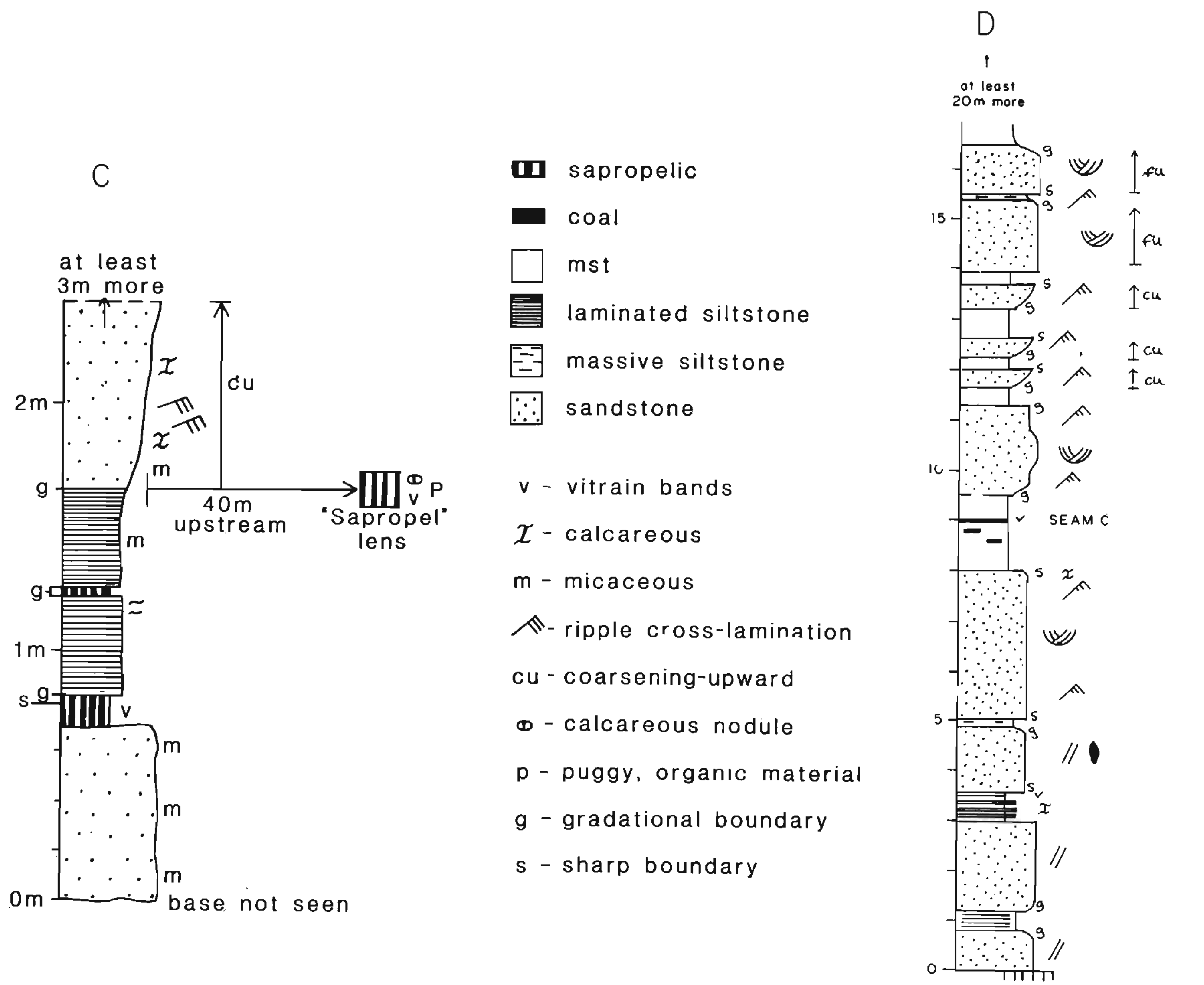

Figure 3: *Measured stratigraphic sections (C and D) containing seams C and D.*

used. A more general term used here in reference to an algal-rich shale is sapropel. Vitrinite bands about 2 cm thick occur within the lower sapropelic layer. Laminated siltstones above the upper sapropelic layer grade upward into a micaceous and calcareous, cross laminated sandstone, thus forming a coarsening-upward sequence.

Another lens of sapropelic material was found 40 m upstream and stratigraphically at the transition between siltstone and sandstone (Figure 3). This lens, which is exposed at low water stage, is believed to be the weathered coal seam reported by Howse and Fleischmann (1982) 110 m upstream of Joe McKay's Brook. This sapropelic material hosts the following: 1) two vitrain layers 1-3 cm thick, 2) soft, puggy organic matter (fusain?) as discontinuous layers (less than 1 cm thick) and thicker lenses (2 cm thick), and 3) black, organic-rich calcareous nodules up to 10 cm in long dimension. Density measurements on samples taken from this sapropelic lens yielded values as low as 1.89 g/cm^3, indicating that the samples are very rich in organic matter.

Although the sapropelic material comprising Seam C is exposed in the general vicinity of the so-called Furlong Bed (Bryan, 1938; Hayes and Johnson, 1938; Hayes, 1949), it very unlikely to be the Furlong Bed because the latter is a humic coal according to the earlier literature and, from the large-scale map in Hayes and Johnson (1938, Plate IV), it clearly outcrops higher in the section than those sapropelic layers.

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Seam D (Section D)

This seam is located directly along strike from Seam C (Figure 1a), and outcrops upstream from C, on the south side of Barachois Brook (769386, 12B/2). The exposure is about 10 m upstream from a tributary flowing from the south. Part of Section D, roughly from 7 to 10 m, correlates with Section C.

Seam D consists of thin vitrain bands and coaly stringers within a gray-green mudstone (Figure 4). The mudstone, like that in Section C, grades upward into a sandstone. There are minor vitrain bands lower in the section at 3.5 m. The coaly stringers consist mainly of clarain with an approximately equal number of less than 1 to 2 mm laminations of vitrain and durain.

Seam E (Section E)

This seam is exposed about 8 m above the river on a bluff on the north side of Barachois Brook (Figure 1a) (76953855, 12B/2). It is approximately 50 m upstream from Seam D. Colluvium must be cleared away to see the seam clearly; about 70 cm of coal can be exposed. This is the seam referred to by Howse and Fleischmann (1982) as occurring about 230 m upstream from the mouth of Joe McKay's Brook; it represents either the Jukes or Cleary Seam. The latter possibility is favored since the detailed stratigraphy and thickness of the seam shown in Figure 4 matches closely with the detailed section shown in Bryan (1938, Figure 7) for the Cleary Seam on Barachois Brook. Our mapping also shows the seam to be located at almost the highest stratigraphic level possible; that is, near the axis of a major synclinal fold. This is consistent with the Cleary Seam since it is the stratigraphically highest seam on Barachois Brook. Above the coal, there is a reddish brown sequence that coarsens upward from a mudstone into a cross-stratified sandstone (Figure 4).

The coal consists mostly of clarain and vitrain, with the latter ranging up to 2 cm in thickness. There is one thin shale layer about 1 mm thick near the bottom of the seam. There is also a prominent durain band several millimetres thick at the top of the seam, in addition to some thin pyritic laminations.

Seam F

This seam was located underwater at a bend with a sandy point bar along Northern Feeder at 817442 in sheet 12B/2 (Figure 1a). It is probably what has been called the Shears Seam (Dowling, 1920; Hayes and Johnson, 1938). This seam consists of two coaly layers. The lower layer (F-1) is about 25 cm thick and abundantly pyritiferous. It consists mostly of clarain and, to a lesser extent, vitrain. Durain is minor and occurs mostly near the top and bottom of the layer. Several mudstone bands are also present near the top of the layer. The upper layer (F-2), about 35 cm higher in the section, consists of two vitrain bands (1.5 cm and 0.30 cm respectively).

The strata containing the coal strike at 010° (almost at right angles to the stream course), and dip about 20° to the southeast. The coals are contained in a dark gray mudstone.

Seams G, H (Sections G, H)

These seams are present in the core recovered from the vertical drilling done as part of this study (drill hole located at 796427, 12B/2, Figure 1a). Seam G occurs at 257 m below surface and consists of 2 cm of vitrain. Prominent fissures in the coal are filled with ash. As shown in Figure 4, the coal is overlain by an ostracod-bearing oil shale that coarsens upward into fine sandstones.

The results of a point-counting analysis on crushed and polished samples of Seam G are shown in Table III. These results show that most of the coal is vitrite. There are only two bands thicker than 50 m in the entire crushed sample where liptinite and/or inertinite exceeded the amount of vitrinite. This crushed sample also contained many fragments of carbonaceous shale.

Seam H occurs at 220 m below the surface, and is 10 cm thick. Polished chips of this coal also showed that most of it is also vitrite, but with a high mineral content. As in Seam G, banding is uncommon; where present, it consists of thin bands of semifusinite and/or fusinite. Sporinite is not common, but it is the main liptinitic component; it is disseminated throughout the homogeneous vitrinitic groundmass.

Seam I

Farther north near Stephenville, two seams were located on Blanche Brook (Figure 1b) (12B/10 sheet). The stratigraphically lower coal is termed Seam I; it is about 25 cm thick and is poorly exposed on the eastern side of the brook at the base of a 30 cm high waterfall. This waterfall is located at 8288155 near a prominent sandy area at the side of the brook. The seam was submerged (though the outcrop containing it extends well above water level), but a few samples were collected.

There is much durain and fusain near the bottom of the seam such that fingers smudge quite readily from handling the samples. Higher in the seam, there is more clarain and vitrain.

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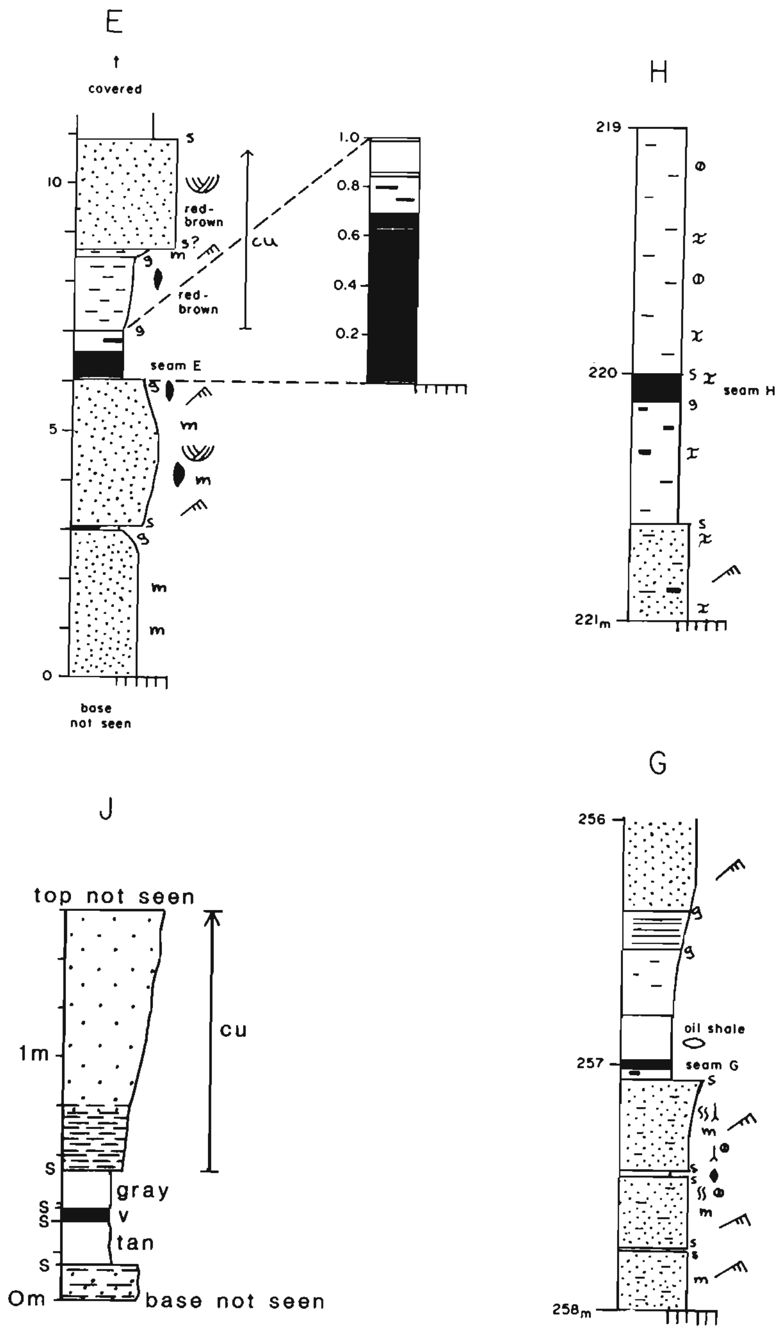

Figure 4: *Measured stratigraphic sections (E, G, H and J) containing seams E, G, H and J. Legend the same as for Sections A-D.*

Seam J (Section J)

Seam J outcrops about 60 m upstream from Seam I and is stratigraphically higher. This seam is about 5 cm thick, and is exposed on a bluff on the western side of the brook. Figure 4 shows a short measured section containing the seam. Above the coal, and succeeding a unit of claystone, is a coarsening-upward sequence ranging from greenish-gray siltstone upward to medium grained sandstone. Fresh surfaces of the coal reveal an interlayering of clarain and vitrain. The coal fractures in a cubic pattern.

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DISCUSSION

On the basis of lithological characteristics, biotic elements, and fining-upward sequences, a dominantly fluvial mode of deposition is inferred for the coal-bearing section. The limestones, shales, and oil shales with thin-shelled ostracods and/or molluscs are regarded as freshwater lacustrine deposits, although the fossils require better documentation by specialists. It is within this context that we wish to comment on controls of seam thickness, which have a bearing on exploration decisions and strategies.

One recurring aspect of those portions of the stratigraphic succession close to the seams is the presence of coarsening-upward sequences on a small scale (up to a few metres). In particular, coarsening-upward sequences overlie coal seams in all but two (B and H) of the sections. Small-scale coarsening-upward sequences were clearly shown in the detailed sections of coal seams in the St. George's Coalfield by Bryan (1938). Thus, for these sequences, peat development was followed by deposition of fine grained terrigenous clastic debris.

One way to terminate peat growth is by drowning the bogs by a rise in the water table. This results in the establishment of a shallow pond or lake in which deposition of mud can take place because of enhanced water circulation. Coarsening-upward sequences arise by the formation of minor mouth bars at lake margins where crevasse splay channels terminate (Elliott, 1974; Fielding, 1984). This sequence of events is envisaged for those sections (C,D,G) where lacustrine sediments (in this case oil shales) follow the deposition of peats.

In other sections (e.g., A), coarsening-upward sequences above the coal seams can be explained by deposition of unchannelized lobes of thin crevasse splay sand and mud at crevasse channel terminations. This must be coupled with an approach, either by avulsion or by channel migration, of a main stream channel to account for the coarsening-upward nature of the sequence above the coal. We view the thin sharp-based sandstone units from the 6.0-6.5 m interval in Section A as crevasse splay sandstones. It is not clear if these sandstones were deposited subaerially and directly on top of the peat bog or following submergence of the bog. There is similar ambiguity in other sections (E,J) where evidence for lacustrine versus subaerial deposition is lacking.

We also note that there is only one section (B) in which a seam appears to be partially cut out by an erosively based channel or proximal crevasse splay sandstone. This suggests that the thinness of the Barachois coals is more related to intrinsically unfavorable conditions for the generation of thick peats (related to the position of the paleowater table), than to secondary removal of peat by erosion.

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