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COAL GEOLOGY OF THE BATTLE RIVER COALFIELD, EAST-CENTRAL ALBERTA

F.M. Dawson
A.R. Cameron
T. Jerzykiewicz

Institute of Sedimentary and Petroleum Geology
3303 - 33rd. Street N.W.
Calgary, Alberta
T2L 2A7

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ABSTRACT

Coal within the Battle River coalfield is Late Cretaceous in age and belongs to the Horseshoe Canyon Formation. Ten coal zones spanning a stratigraphic interval of approximately 150 m have been correlated within the study area. The coal zones are commonly split into numerous plys with individual coal seam thicknesses up to 2.0 m observed. Total zone thicknesses up to 6.0 m are present in the subsurface. Of the ten recognizable coal horizons, the Paintearth and Battle-River are the most laterally consistent and economically significant.

Total in-situ resources are estimated at 9 512 megatonnes, to a maximum depth of 150 m. Resources are primarily derived from two coal zones, the Battle-River and Paintearth, with minor contributions from three lesser zones. Mineable coal resources at less than 5:1 bcm/tonne overburden ratio total 392 megatonnes, of which the Paintearth zone accounts for 200 megatonnes. Coal resources for the Battle River coalfield were calculated in 1987. Detailed resource numbers conforming to the newly released Coal Association standards are available through the National Coal Inventory of the Geological Survey of Canada.

Currently, two open pit coal mines are in operation within the Battle River coalfield, producing in excess of 1.5 megatonnes annually for the Alberta Power generating station at Battle River.

Ash values for the Paintearth and Battle-River coal zones range from 8 to 29 percent, with the Battle-River zone generally having a lower range. The coals are of subbituminous C and B rank with calorific values ranging from 20.1 to 24.0 MJ/kg. Sulphur values are low ranging from 0.32 to 0.74 percent for the Paintearth zone and from 0.47 to 1.19 percent for the Battle-River zone. The high sulphur values for the latter appear to be anomalous and are located at the southern end of the study area. Petrographic studies suggest that the coals of the Battle-River coalfield were deposited within a lower delta plain environment. This agrees for the most part with sedimentological observations throughout the project region.

INTRODUCTION

The Alberta plains contain vast resources of subbituminous coal. Current statistics from the Energy Resources Conservation Board of the Alberta government indicate that over 63 000 megatonnes of coal have been defined within the plains region. The Upper Cretaceous Horseshoe Canyon Formation contains approximately 19 500 megatonnes of these defined resources. Thirteen coalfields have been delineated along the subcrop line of the Horseshoe Canyon Formation, and the Battle River coalfield represents the largest of these (Energy Resources Conservation Board Reserves of Coal, ERCB ST 88-31).

This report is the culmination of a multiyear study of the Battle River coalfield by the Coal Subdivision of the Geological Survey of Canada. Several disciplines of coal geoscience have been integrated to produce a detailed examination of the geology and resource potential of the area. Distribution of correlated sequences, sedimentology and depositional settings, coal geology, resource assessment and variations in coal chemistry are all components of this report. Most studies of the Horseshoe Canyon Formation have been very narrow in scope and regional trends were not examined. This study encompasses an area in excess of 3500 km^2 and attempts to provide a more regional perspective.

The Battle River coalfield was chosen as the main study area because of the abundance of geological information available for analysis. Subsurface coal exploration data, in conjunction with surface mapping and coal seam trenching, have provided a large data base upon which the geological studies have been founded.

LOCATION

The Battle River coalfield is situated in east-central Alberta, approximately 140 km southeast of Edmonton and 180 km northeast of Calgary. The study area encompasses Townships 32 to 43, Ranges 13 to 17, west of the 4th Meridian. The total area exceeds 3500 km^2. The topography generally consists of low rolling hills with small creek valleys. In the northern third of the project area, the incised river valley of the Battle River crosses from northwest to southeast. The valley walls are typically barren of vegetation, producing a badland topography similar to the Red Deer River valley near Drumheller. In the southern third of the study area, two large, shallow lakes, Sullivan and Dowling, form the dominant geographical features. Figure 1 illustrates the location of the project area with respect to the subcrop boundaries of the Horseshoe Canyon Formation within the Alberta plains.

PREVIOUS WORK

Coal-bearing strata of Late Cretaceous age were first observed along the banks of the Red Deer River by Tyrrell in 1887. Subsequent geological studies of Tyrrell's (1886) "Edmonton Series" during the early 1900's by Allan (1922), Allan and Sanderson (1945) and Sternberg (1947), examined the coal resources and dinosaur fossils of the area. Irish (1970), elevated the Edmonton Formation to group status and introduced new formation names for the sequence of rocks between the marine Bearpaw Formation and the Paleocene Paskapoo Formation. The name Horseshoe Canyon Formation was applied to the lower 400 m of this stratigraphic interval (Fig. #2). Recent works by Shepheard and Hills (1970), Campbell (1975), Gibson (1977), Rahmani (1981), Hughes (1984), and McCabe (1987), examined the sedimentological variations and depositional setting of the Horseshoe Canyon Formation strata.

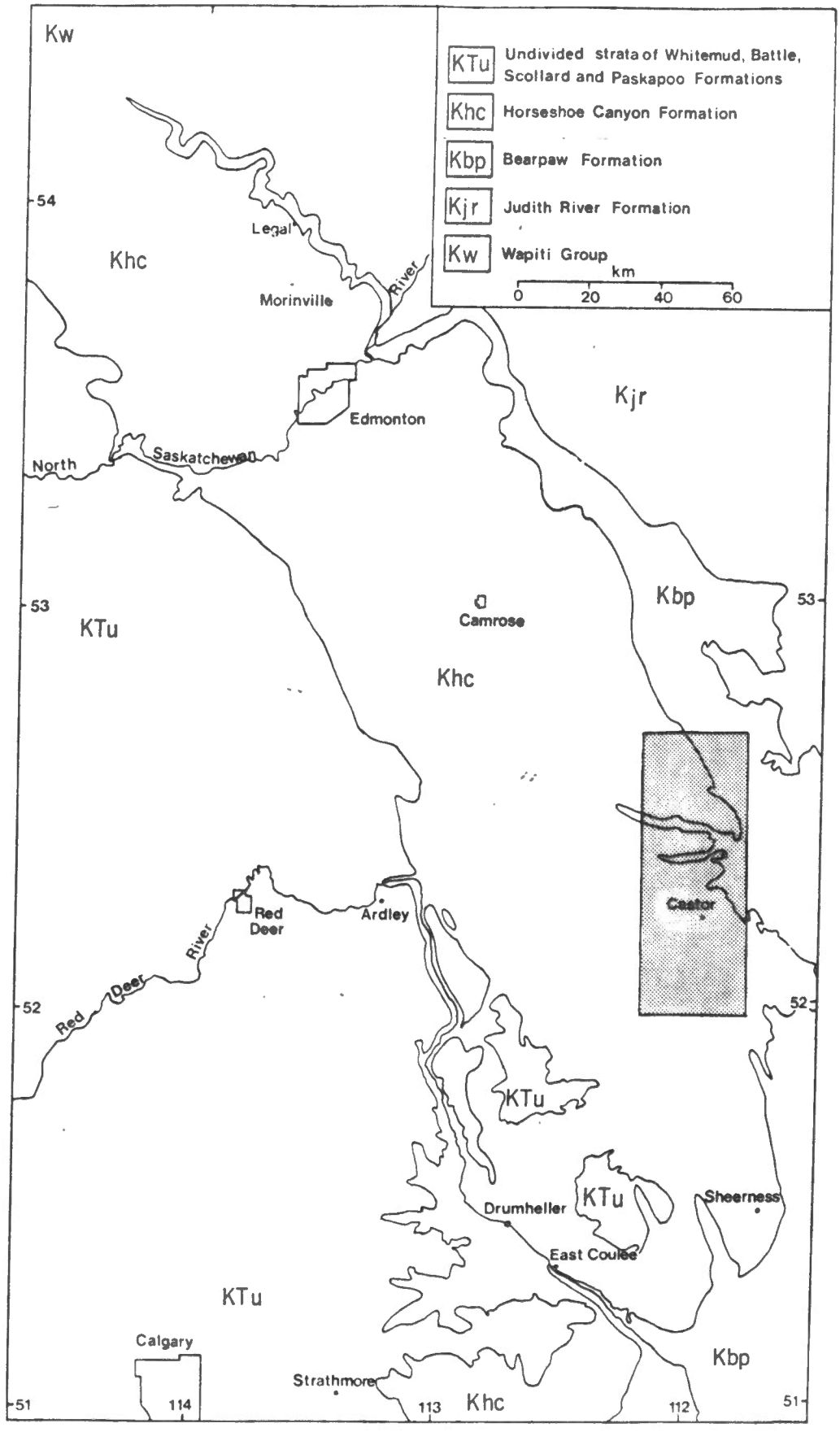


Fig. 1 Location of Project Area

Many of the studies mentioned above concentrated on local study areas, because of the limited availability of good bedrock exposures and subsurface information. The results of these studies are varied; however, all have concluded that the main coal development of the Horseshoe Canyon Formation occurred within a large deltaic complex that formed a series of transgressive - regressive cycles, also visible in the underlying Bearpaw Formation. Detailed interpretations with respect to delta type and localized depositional environments have been proposed, but in most cases, the sizes of the study areas limit any broader conclusions. This report addresses the same stratigraphic interval however, the study area is much larger, allowing a more regional interpretation.

DATA SOURCES AND METHODOLOGY

The primary sources of data for the Battle River coalfield study are coal exploration boreholes. Data consist of geophysical logs and driller's chip-sample descriptions. Borehole data were provided by Luscar Limited, Alberta Power Limited, Esso Resources Canada Limited and Pancanadian Petroleum Limited. Other publicly available borehole data were acquired from the Energy Resources Conservation Board. Information from more than 4400 exploration boreholes was utilized. Borehole distribution is illustrated on Map 1 (in pocket).

To supplement the subsurface data, surface mapping and trenching were conducted throughout the project area. Most of the exposures are concentrated along the valley walls of the Battle River and Paintearth Creek. Sixteen sections were measured, and 27 trenches were completed. Samples from these sections and trenches have been analyzed by coal geoscientists of the Geological Survey of Canada, and the analytical results are presented in Appendices 1 and 2. The locations of the sections and trenches are shown on Map 1.

Geological analysis of the data involved the use of computer mapping systems. Specialized computer programs developed by the Institute of Sedimentary and Petroleum Geology for the interpretation of information stored for the National Coal Inventory were utilized to aid analysis of the geological information. Lithological data were interpreted from all available exploration information and entered into a computer-accessible data base. The Surface II mapping system was used to produce a series of grids for correlated surfaces. Manipulation of these grids allowed various displays to be created and graphically illustrated. Isopach maps, structure contours, and cross-sections were produced by this method. Other computer programs were used to calculate coal resource estimates according to various criteria. The reader is referred to publications by Irvine (1978) and Hughes (1984) for a complete explanation of the computer applications and systems utilized in this study.

REGIONAL STRUCTURE

The study area of the Battle River project lies within the central plains of Alberta, along the eastern edge of the Alberta syncline. Strata generally dip gently to the west at less than 5 degrees. Locally small rolls and normal faults are present. In areas of limited till cover, evidence of bedrock disturbance due to glacial thrusting and folding has been observed. These tectonic elements are localized and appear to be restricted in depth of disturbance. Open cut mining has revealed many small-scale structural features.

REGIONAL STRATIGRAPHY

In the Battle River study area, Upper Cretaceous strata are assigned to the Bearpaw and Horseshoe Canyon formations (Fig. 2). The Bearpaw Formation consists of marine and marginal marine strata that represent the last major transgression of the Cretaceous sea within Alberta. Uplift to the west, as a result of the Laramide orogenic event, provided clastic sediments that were deposited into a rapidly retreating Bearpaw sea to the east, giving rise to the Horseshoe Canyon Formation (Williams and Burke, 1964). The contact between these two formations is gradational and difficult to place. Farther to the west, the Horseshoe Canyon Formation is overlain by the predominantly fluvial and lacustrine sediments of the Whitemud and Battle formations (Irish, 1970). No outcrops of these strata are present within the study area. Figure 2 illustrates the regional stratigraphic nomenclature for the Battle River project.

The Battle River project was initiated to examine the geology of the coal-bearing sequence of the lower Horseshoe Canyon Formation, which is approximately 200 m thick. The lower 50 m represent the gradational contact with the underlying Bearpaw Formation and are informally defined as the "transition zone". The upper 150 m of strata are predominantly continental in origin. True marine strata of the Bearpaw Formation below the "transition zone" were not observed in either borehole logs or outcrop, because of the limited outcrop exposures along the eastern edge of the project area, and the shallow depths of the exploration boreholes.

Up to ten coal zones have been observed within the Horseshoe Canyon Formation within the study area, and six horizons have been correlated (Fig. 3).

Bearpaw-Horseshoe Canyon formations contact

The contact between the underlying Bearpaw Formation and the Horseshoe Canyon Formation is arbitrarily chosen as the highest stratigraphic level at which marine fossils first appear. This stratigraphic position lies immediately below the first or stratigraphically lowest coarsening-upward cycle of sandstone and siltstone of the Horseshoe Canyon Formation. In the Battle River project area, up to five coarsening-upward cycles have been observed in subsurface data; however, only the upper two have been examined in outcrop. In some cases, each cycle is capped by a thin to thick coal, or concretionary bed. Each cycle is approximately 15 to 25 m thick and displays a distinctive gamma-ray geophysical log response (Fig. 4). This distinctive coarsening-upward log response on the gamma-ray or S.P. geophysical logs is characteristic of the basal unit of the Horseshoe Canyon Formation and can be easily recognized in the subsurface throughout central and southern Alberta but the diachronous nature of the strata, coupled with this cyclic pattern, make correlation of individual beds tenuous over long distances.

Member A

The lower 50 m above the Bearpaw / Horseshoe Canyon formation transition zone has been informally defined as Member A. This stratigraphic interval contains up to six coal zones, two of which are considered to be of economic importance. The coal horizons are stratigraphically divided into two major repetitions or cycles, (Fig. 5). Cycle 1 begins with the coarsening-upward sequence of siltstone and sandstone lying above the Ryley marker seam. This interval is approximately 15 m thick and is capped by the regionally extensive Battle-River coal zone, which represents the major economic coal horizon in the study area. Approximately 10 m above this unit is a thin, laterally continuous coal bed defined as the Gadsby seam. This unit can be used as a marker bed throughout much of the project area, and defines the top of the first cycle.

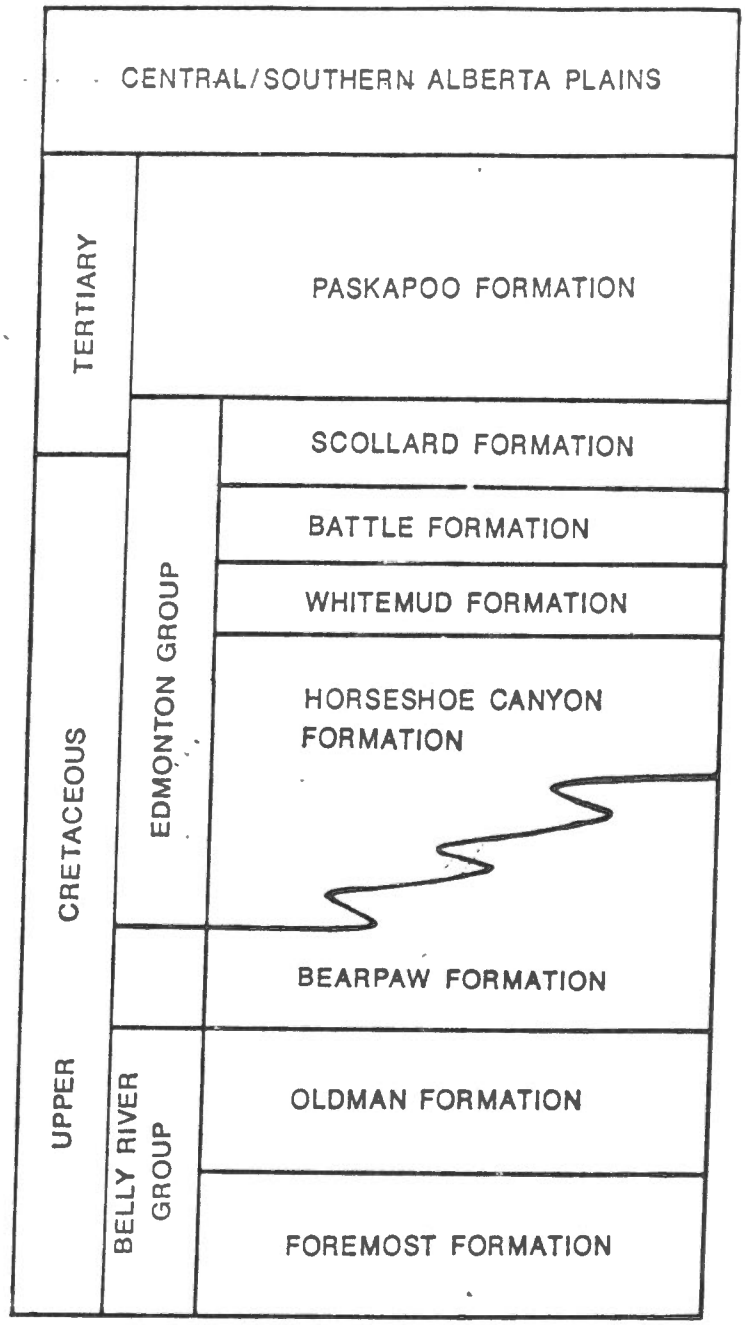


Fig. 2 Regional Stratigraphic Nomenclature

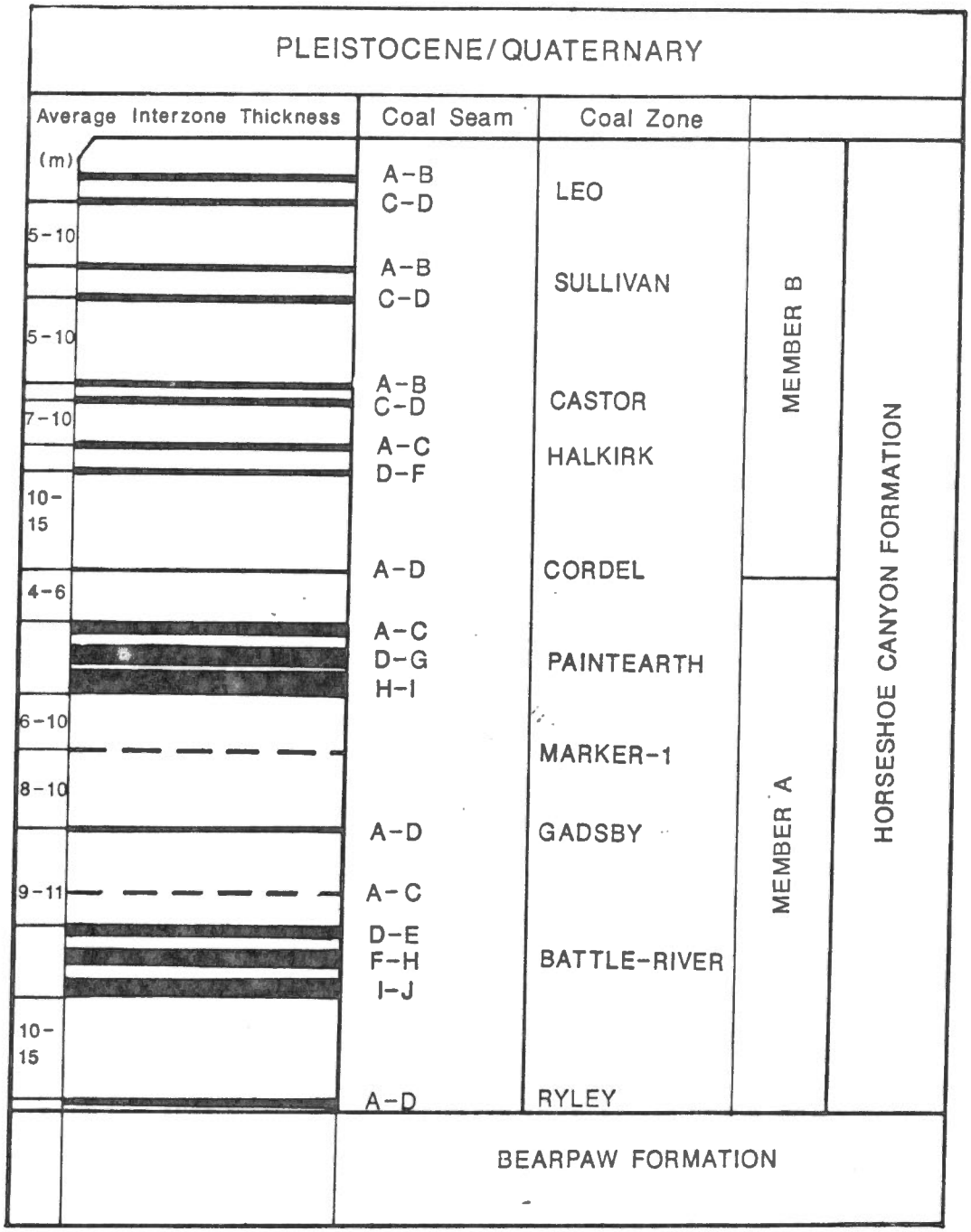


Fig. 3 Detailed Coal Zone Nomenclature of Battle River Coalfield

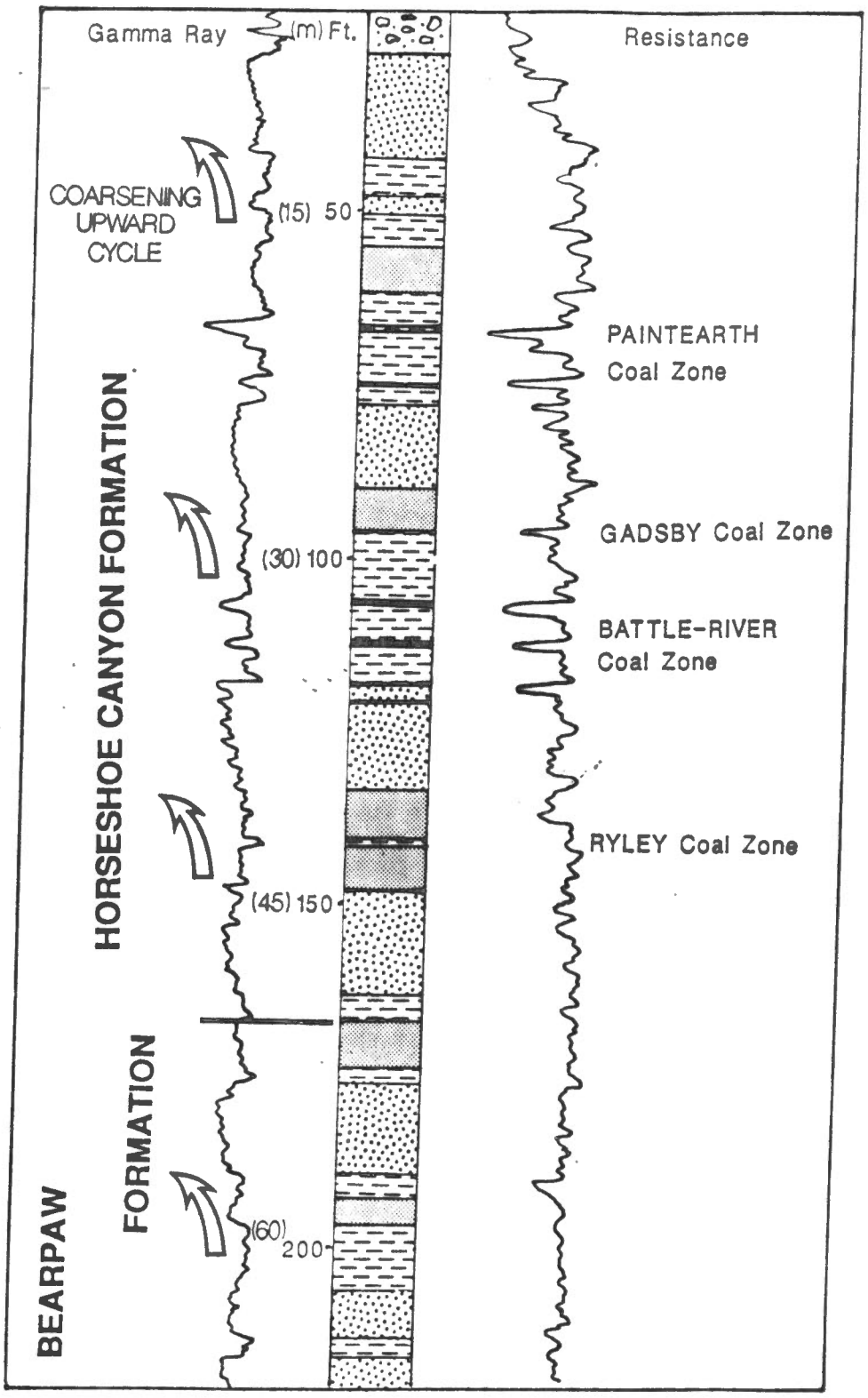


Fig. 4 Typical Bearpaw-Horseshoe Canyon Formation Boundary

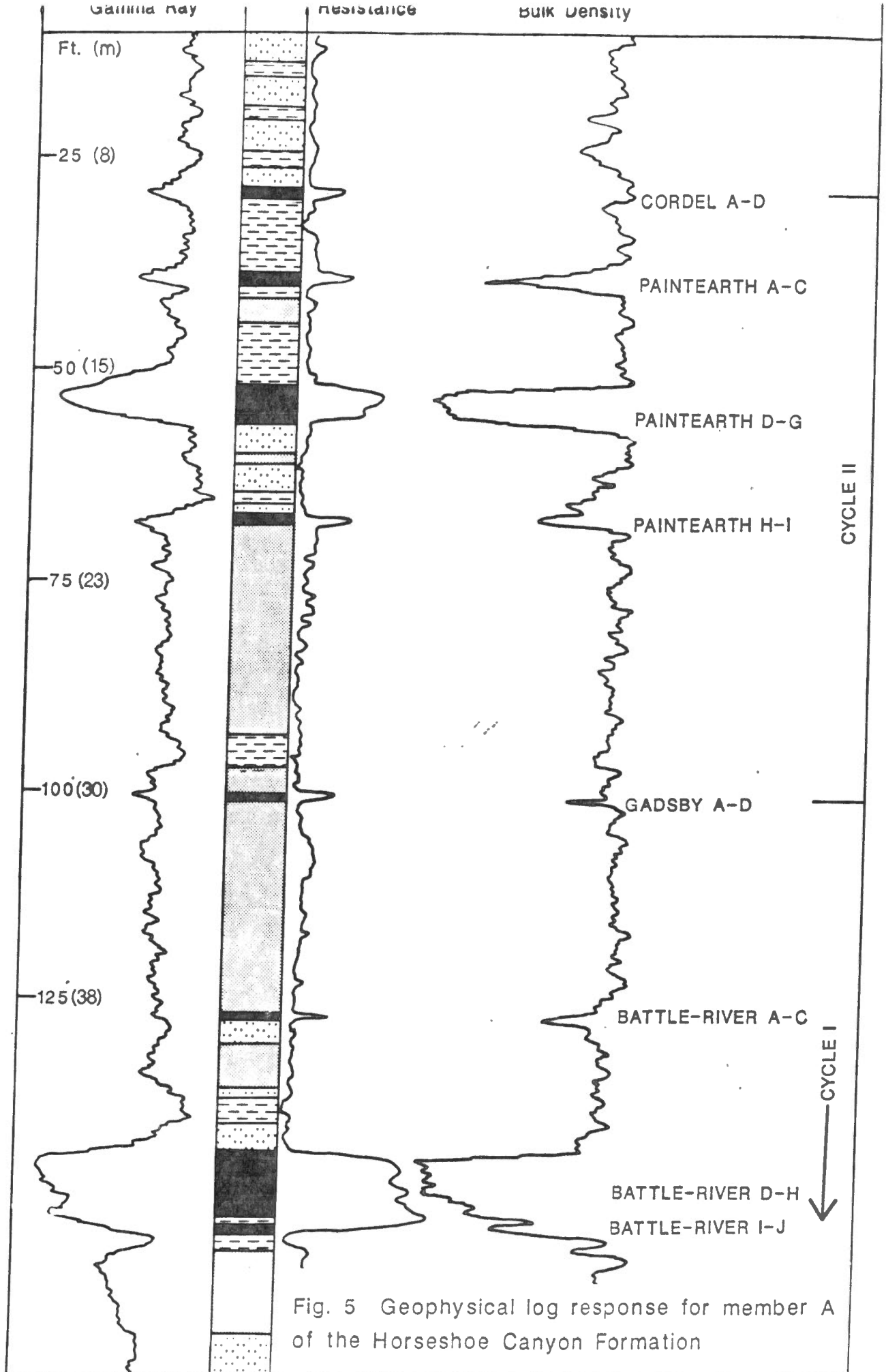


Fig. 5 Geophysical log response for member A of the Horseshoe Canyon Formation

The second cycle begins with another sequence of coarsening-upward siltstone and sandstone, capped by another thick, regionally extensive coal horizon, the Paintearth coal zone. This zone is similar to the Battle-River zone in terms of lateral continuity and seam thickness. As with cycle 1, a thin coal bed (Cordel zone) lies approximately 10 m above the Paintearth horizon. Figure 5 illustrates a typical geophysical log response for the two cycles of Member A of the Horseshoe Canyon Formation.

Member B

In the Battle River study area, Member B of the Horseshoe Canyon Formation is defined as the stratigraphic sequence from the top of Member A to subcrop, an interval of up to 100 m. Four coal zones have been recognized in this interval, of which three contain potentially economic deposits. Unlike Member A, where the coal beds are laterally extensive, the coals in Member B are widely variable in thickness, and are discontinuous. The base of Member B has been placed at the top of the Cordel coal bed. The Halkirk coal zone lies approximately 10 to 20 m above this contact. The three other coal zones that have been correlated within the limits of this project area are the Castor, Sullivan and Leo (Fig. 3). Stratigraphic separation between the horizons is widely variable and is controlled to a large extent by the distribution of channel-fill sandstone bodies. In the Castor coal zone, a laterally persistent kaolinitic mudstone, which can be used as a marker horizon in certain areas, has been recognized. Above the Leo coal zone, several coal beds have been observed, but lack of sufficient data prevented detailed study of these units.

COAL SEAM NOMENCLATURE

Ten coal zones have been correlated within the stratigraphic section examined for the Battle River study. These beds are widely variable in thickness, and are distributed within the lower 150 m of the Horseshoe Canyon Formation. There are coal units above this interval, but erosion limits this study to the lower interval. The stratigraphic nomenclature and sequence of the coal beds is outlined in Table 1.

The coal zones have been subdivided into individual coal seams, and for correlation purposes, each seam is assigned a letter (seam modifier). Where individual seams coalesce, the corresponding letters are combined, (e.g., Battle-River coal zone, seam D-J). Isopach values for individual seams are determined proportionately based upon the total coal zone thickness. For example, if the Battle-River coal beds have coalesced from the three main seams into one single coal horizon, 3.5 m in thickness, each individual coal bed D to J would be assigned a proportionate thickness of 0.50 m.

TABLE 1
Coal zone nomenclature

	Coal Zone	Seam Modifier
TOP		
	LEO	A-B C-D
	SULLIVAN	A B C D
	CASTOR	A B C D
	HALKIRK	A B C D E F
	CORDEL	A-D
	PAINT-EARTH	A B C D E F G H I
	MARKER-1	
	GADSBY	A-D
	BATTLE-RIVER	A B C D E F G H I J
BOTTOM	RYLEY	A-B C-D

COAL GEOLOGY

Ryley zone

The lowest coal zone observed in the Battle River study area is the Ryley (Fig. 3). In places, this coal horizon splits into two seams, A-B and C-D; generally however, the bed is usually less than 0.5 m thick and consists of coaly shale. The Ryley zone represents the top of the transition zone and is commonly replaced by concretionary beds. Insufficient borehole data prevented further delineation of this unit.

Battle-River zone

The Battle-River coal zone contains more coal than any other zone within the study area. Ten individual beds or combinations of beds have been recognized within the zone, ranging in individual thickness up to 2.8 m. Four seam packages of coalesced beds are commonly developed. The lower three, D-E, F-H, and I-J, are laterally persistent throughout much of the project area. Occasional partings divide these seams into thinner coal beds, but the partings are thin and localized in distribution. In Township 40, Ranges 15 and 16, the three lower coal beds coalesce to form a single coal unit, D-J, up to 4.87 m in thickness. To the southeast and northwest of this location, the coal splits rapidly. In Township 37, Range 13, only one coal seam, (D-E), is present and is less than 0.5 m thick. In Township 42, Range 17, the Battle-River coal zone consists of three splits, (D-E, F-H, and I-J), each less than 0.5 m thick.

Locally, a discontinuous coal seam up to 2.8 m in thickness but averaging less than 0.5 m, is present approximately 2 to 3 m above the main D-E coal seam. This horizon is defined as A-C, is laterally discontinuous, and is poorly developed or absent in much of the project area. In Township 35, Range 17, the Battle- River coal zone is very well developed, and the A-C split has an aggregate thickness of up to 2.8 m in a stratigraphic interval of 9.8 m. It does not appear that the A-C seam coalesces with the lower coal zones within the boundaries of the project area. Figures 8 through 11 illustrate the distribution of the major coal seams for the Battle-River coal zone. Isopach maps of the partings separating the three main seams are presented in Figures 12 and 13.

Gadsby coal zone

The Gadsby coal zone is a thin, carbonaceous stringer that lies approximately 8 to 11 m above the Battle-River D-E coal seam. The zone rarely exceeds 1.0 m in thickness of total coal and is locally split into two main seams, A-B and C-D. The Gadsby coal zone is not considered to be sufficiently thick to be of economic significance, hence no estimate of coal resources has been calculated for this unit. The primary use of the zone is for correlation purposes within the geological model, as it represents the top of the first cycle within Member A of the Horseshoe Canyon Formation.

Paintearth coal zone

The Paintearth coal zone is similar in thickness and distribution to the Battle-River coal zone. The zone consists of up to nine individual coal beds with a cumulative thickness of coal, greater than 5.0 m over a maximum stratigraphic interval of 15 m. Throughout most of the project area, the zone can be divided into two main seam groupings, A-C and D-I. The A-C seam is well developed in Township 40, Range 15, and also in Township 42, Range 17. The seam can be up to 2.4 m thick and coalesces with the underlying D-I seam in Township 42, Range 17. Seam A-C locally contains rock partings, and is usually separated from D-I seam by approximately 1 to 4 m of muddy siltstone.

Lateral distribution and continuity of the D-I coal seam is similar to that of the Battle-River coal zone. The seam is laterally continuous, but coal development and thickness are widely variable. The D-I horizon commonly splits into three coal beds, D-E, F-G, and H-I, separated by thin partings of mudstone and siltstone. In Township 40, Range 16, the individual coal seams coalesce into a thick (> 3.0 m) unit, (D-I). Southeast of this locality, the D-I seam splits into three individual seams that tend to thin and pinch out farther to the south in Township 38, Range 13. Toward the northwest, in Township 42, Range 17, the D-I seam and the A-C seam coalesce and form a single coal bed in excess of 4.0 m thick. Farther to the northwest, in Township 43, Range 17, the D-I seam splits and pinches out rapidly. An intermediate seam, defined as Marker-1, is developed approximately 8 m below the stratigraphic position of the Paintearth coal zone at the far north end of the project area. This coal horizon is very localized and not considered to be of mineable thickness. Figures 14 to 20 illustrate the isopach variations of the individual seams for the Paintearth coal zone, as well as the rock partings separating the main seams.

Cordel coal zone

The Cordel coal zone is a thin discontinuous coaly horizon lying approximately 3 to 7 m above the Paintearth A-C coal seam, similar to the Gadsby zone overlying the Battle-River coal zone. The zone is poorly developed, consisting primarily of carbonaceous shale, and rarely exceeds 0.5 m of coal thickness. In some areas, the zone is represented by sideritic concretions. The Cordel zone represents the top of the second cycle within Member A and also the arbitrarily defined contact between Members A and B of the Horseshoe Canyon Formation. No potentially mineable coal thicknesses have been observed in the Cordel zone within the project area.

Halkirk coal zone

The lowest coal horizon within Member B of the Horseshoe Canyon Formation is the Halkirk coal zone. This unit is commonly split into two main seams, A-C and D-F, separated by a muddy siltstone up to 11.7 m thick. In places, the lower seam, D- F, is split into three beds, each up to a maximum of 0.6 m in thickness. In most cases, the beds coalesce into one unit, with a maximum thickness of 1.5 m observed in Township 37, Range 15. The upper seam, A-C, averages 0.5 m in thickness, with a maximum thickness of 2.0 m in Township 38, Range 16. The Halkirk coal zone

appears to be more laterally discontinuous, and has a wider variability of thickness than the Paintearth or Battle-River coal zones. This variance may be due to a change in depositional setting. The Halkirk coal zone probably formed in a more unstable environment, with greater influence by fluvial depositional systems. Figures 21 to 23 illustrate the isopachs for the A-C and D-F coal seams, as well as the isopach of the interseam parting.

Castor coal zone

Approximately 7 to 15 m above the Halkirk coal zone lies the Castor coal zone. This carbonaceous horizon is similar to the Halkirk beds, in that the zone is split into two main seams, A-B and C-D. In some places, each of these seams splits into two units, individually attaining a thickness up to 1.5 m. Throughout much of the project area, where the Castor coal zone is divided into two main seams, a prominent kaolinitic mudstone unit separates the two. This parting may reach thicknesses of up to 13.26 m. In Township 35, Range 16, the seams coalesce into a single coal unit, A-D, up to 3.0 m in thickness. Figures 24 to 26 illustrate the variability of seam and parting thicknesses.

Sullivan coal zone

The Sullivan coal zone represents the highest correlated unit in the stratigraphic section, and was penetrated in a sufficient number of coal exploration boreholes to allow subsurface mapping. The zone lies approximately 7 to 15 m above the Castor coal zone and is similar in thickness and distribution. Coal seam thicknesses are widely variable, and thick intervals of coal are locally concentrated in small areas. As with the Castor horizon, the Sullivan coal zone is divided into two main seams, A-B and C- D. The rock parting separating these two main units varies in thickness and may be up to 15.85 m thick. Coal seams C and D can be up to 1.37 m in thickness and coalesce to form a thick, single coal bed 2.5 m thick in Township 35, Range 15. Coal seams A and B may be up to 1.55 m and 1.37 m in thickness, respectively, and coalesce to form a single bed, A-B, greater than 2.0 m thick in Township 36, Range 15. Figures 27 and 28 illustrate the variability in thickness of the Sullivan coal zone.

Leo coal zone

The Leo coal zone lies approximately 10 to 15 m above the Sullivan coal sequence. The unit is laterally discontinuous and lies approximately 150 m above the base of the Horseshoe Canyon Formation. The horizon subcrops along the western edge of the project area and hence has not been penetrated in many exploration boreholes. No subsurface maps have been produced for this horizon because of the limited amount of data available.

SEDIMENTOLOGY AND DEPOSITIONAL SETTING

Coal deposition in the Battle River coalfield is largely associated with three types of sedimentary sequences: coarsening-upward sequences (CUS), thick sandstone intervals (TSI), and fining-upward sequences (FUS). Examples of these types are illustrated in Special Figures ST 1 to ST 13. Figure numbers correspond to measured field section numbers in Appendix 1. The accompanying geophysical log response represents the natural gamma-ray and resistance traces for the corresponding intervals from adjacent coal exploration boreholes.

The coarsening-upward sequences (CUS) are generally interbedded with increasing thicknesses of coarse beds upward (ST-1, ST-3, ST-6, ST-7 and ST-13). Claystone, mudstone and siltstone in the lower portions of the coarsening-upward sequences reveal delicate, rhythmic laminae that resemble lacustrine rhythmite facies. Sandstone in the upper portions of the sequences is commonly parallel to subparallel bedded. This bedding may be classified in terms of "heterolithic stratification". It is usually flat, but transitions into inclined heterolithic stratification (Thomas et al., 1979) may occasionally be seen (Fig. 6).

A thick sandstone interval (TSI) below the Paintearth coal seam is illustrated in Figure ST-9. This interval exhibits decimeter-scale trough crossbedding, small-scale cut-and-fill structures, and small channels. Small-scale crossbedding and current ripple laminae are also present in the upper portion of this interval. This several-metres thick interval of medium grained sandstone is overlain by a thin unit of rooted, coaly mudstone and coal. Crossbed paleocurrent data from the sandstone beds indicate a unimodal, northeasterly trend parallel to the trend of elongation of sandstone thickness observed in the subsurface.

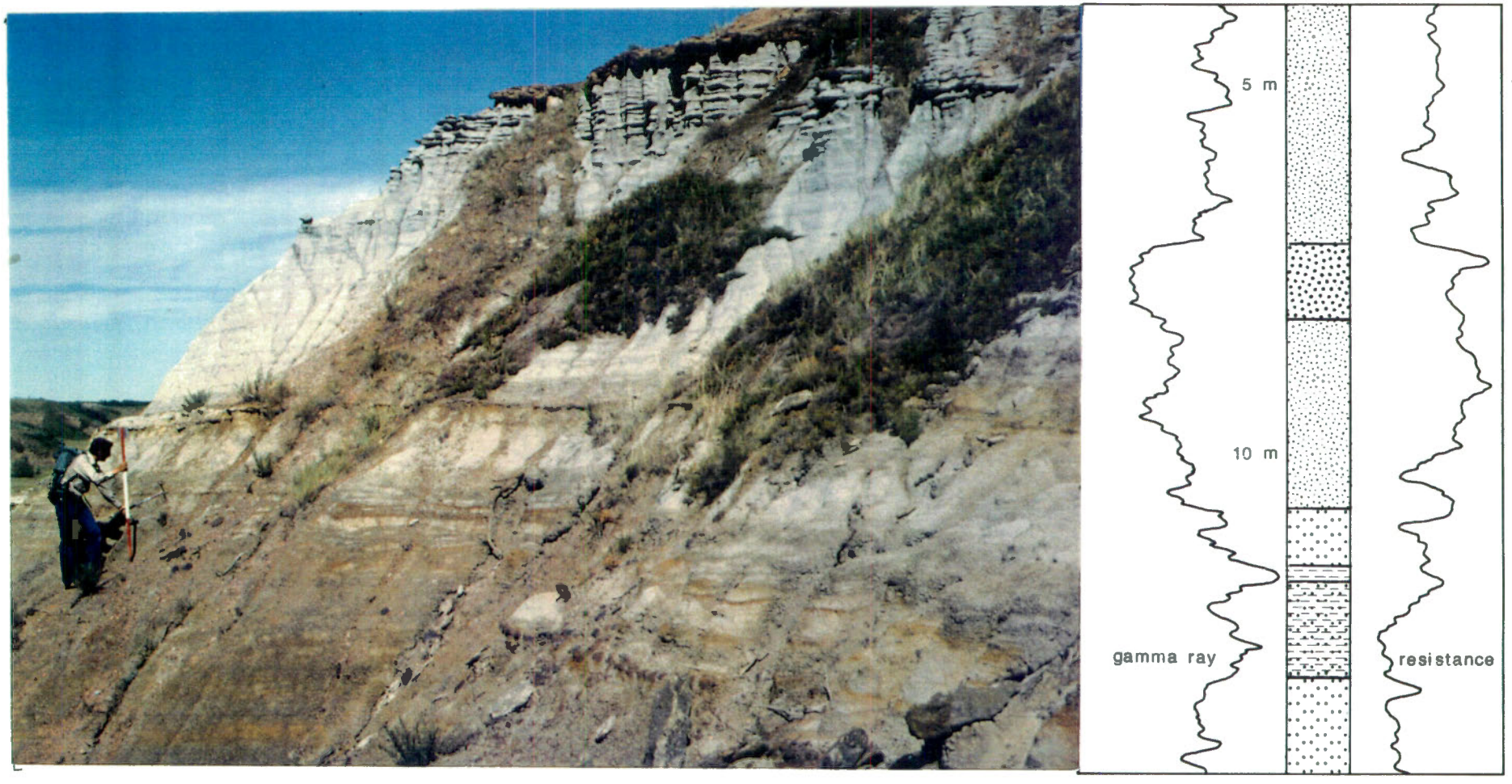
Fining-upward sequences (FUS), grade from medium grained sandstone to coaly mudstone and coal, and occur in the upper part of the lower Horseshoe Canyon Formation (Fig. ST-5)

The sequences described above (CUS, TSI and FUS), may be interpreted as components of one large deltaic environment. In river deltas, the delta plain, comprising the distributary channels and intervening bays, has a wide areal extent (Fisher, 1969; Wright and Coleman, 1973). Modern interdistributary bay sequences resulting from infilling of the bay are very similar to the CUS observed within the lower Horseshoe Canyon Formation.

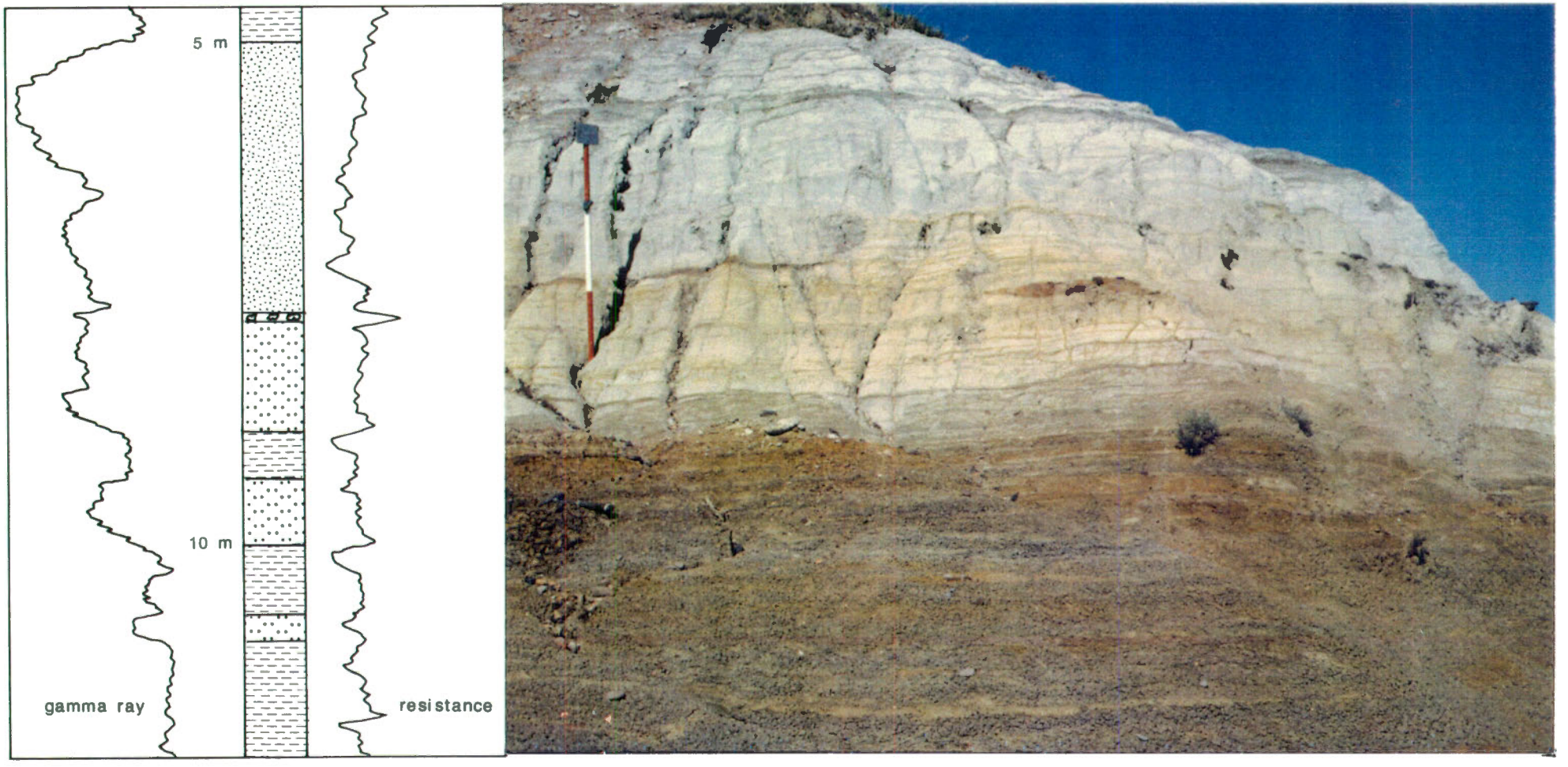
There are three processes by which sediment-laden floodwaters can be transferred to the bay: overbank flooding, crevassing and avulsion.

The process of overbank flooding operates during a single flood event. Sediment-laden waters spill over the channel banks as a sheet flow, with no breaches or crevasse channels (Coleman, 1969). Fine grained, suspended sediment is deposited over the entire bay, and coarser sediment, if supplied, is confined to the bay margins and contributes to levee development. The muds and silts found at the bases of the coarsening-upward sequences result from overbank floods, although in open bays, some of this sediment may by supplied by marine currents. Levee sediments generally comprise rapidly alternating coarse and finegrained beds (Allen, 1965). Each of the coarsegrained beds results from an overbank flood (or crevasse splay), has a sharp base, and grades upward into the fine interval. Farther away from the channel margin, encroachment of the levee into the bay produces a coarsening-upward sequence characterized by interbedding, and increasing thickness of the coarsegrained beds upward (e.g., Fig. ST-3).

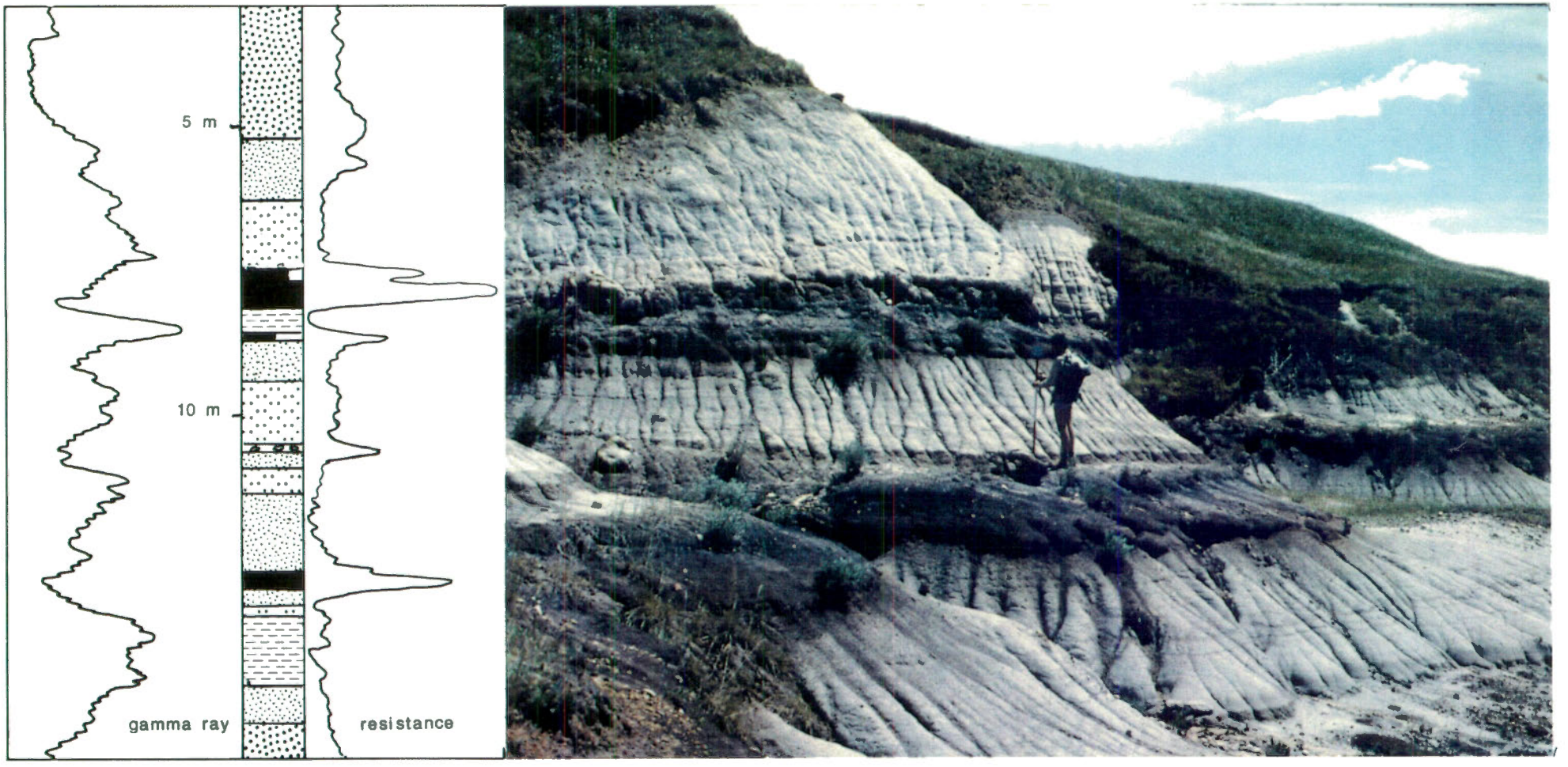
Figure 6 Inclined Heterolitic stratification within the lower Horseshoe Canyon Formation.



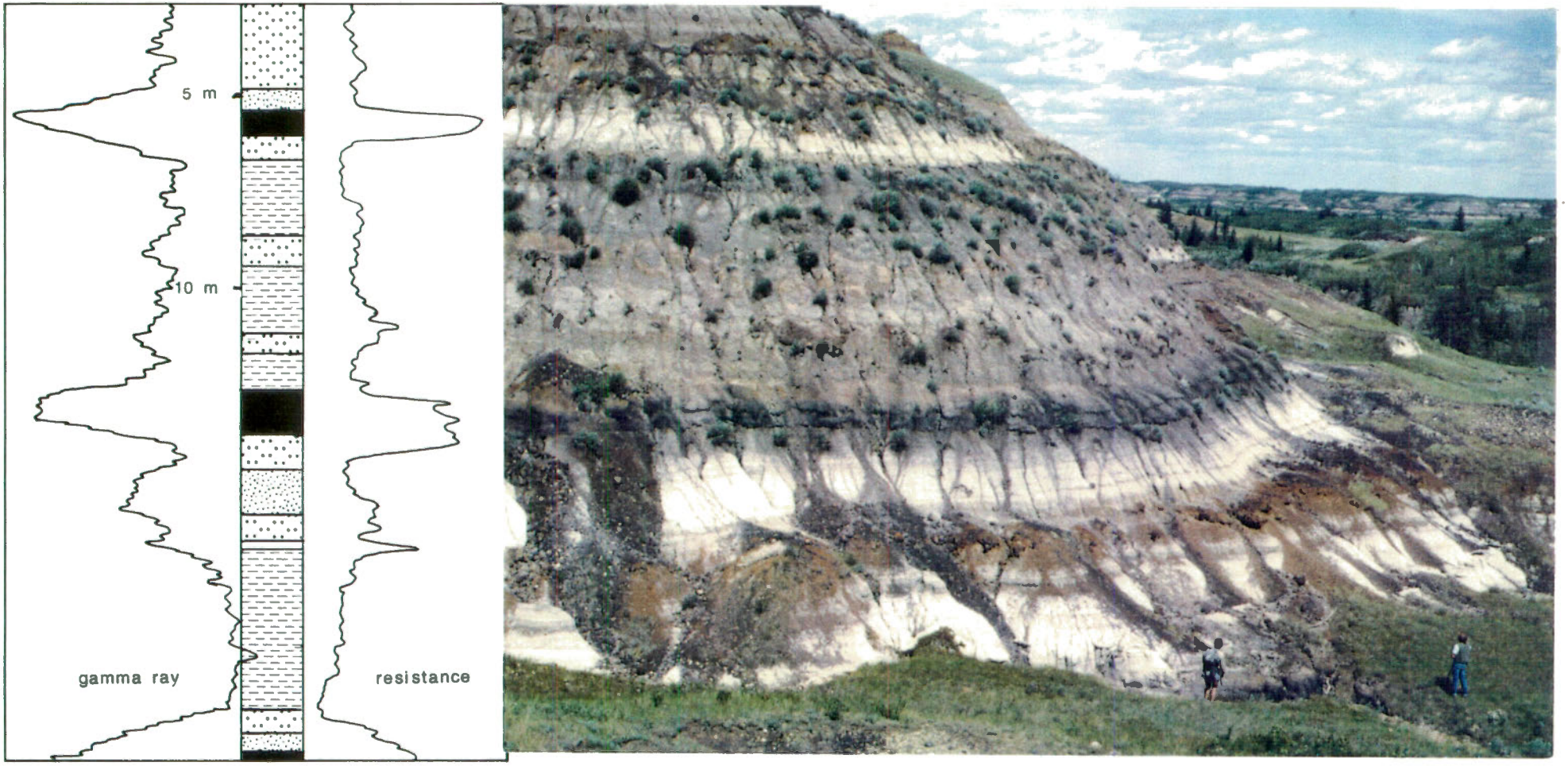
ST – 1. 10 m interval below Paintearth coal zone. Small scale coarsening upward sequences characterized by interbedding with increasing thickness of coarsegrained beds upwards. Probable infilling of an Interdistributary Bay.



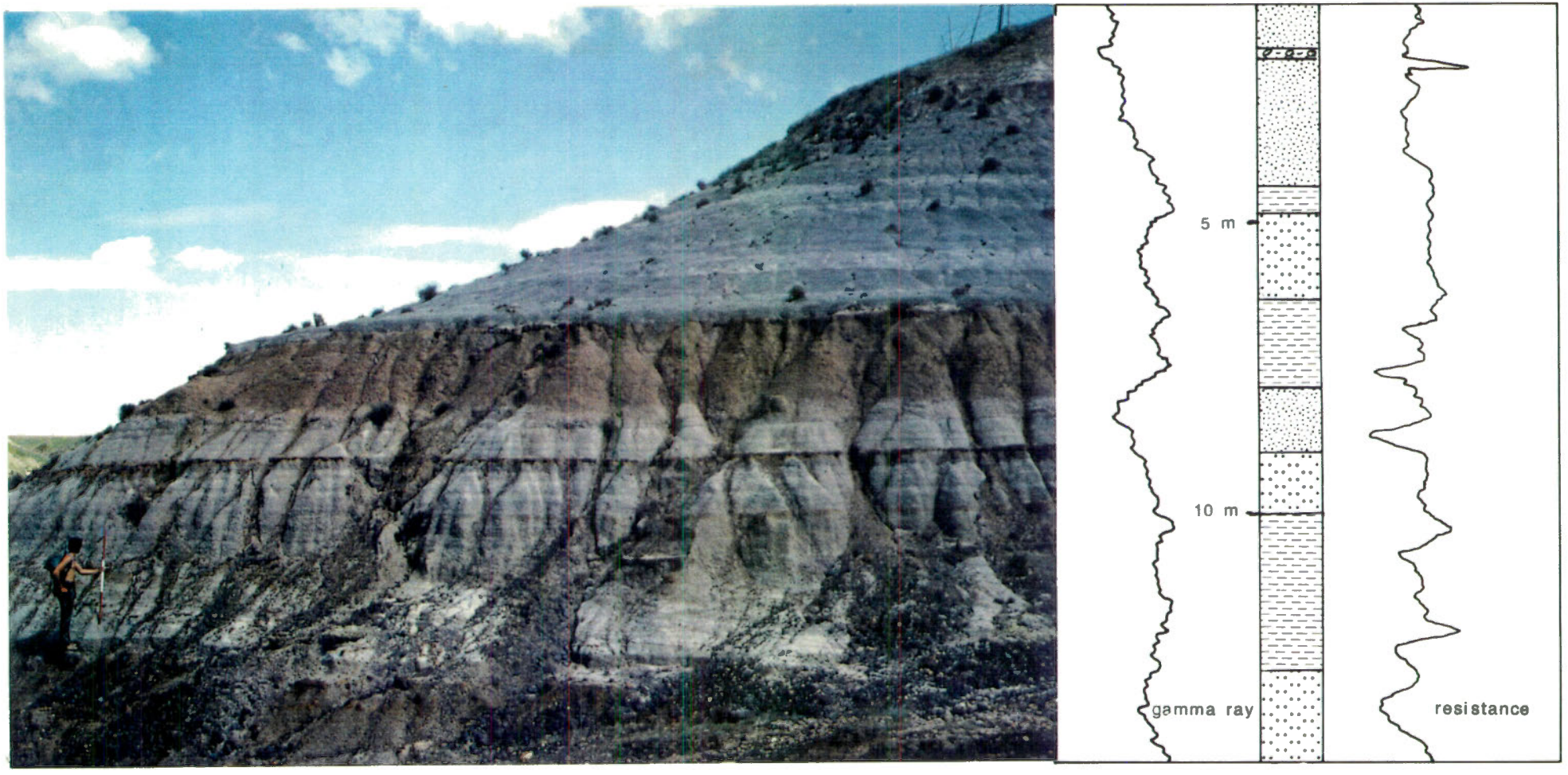
ST – 3. Stratigraphic interval 5 m below Paintearth coal zone, illustrating small scale coarsening upward sequences.



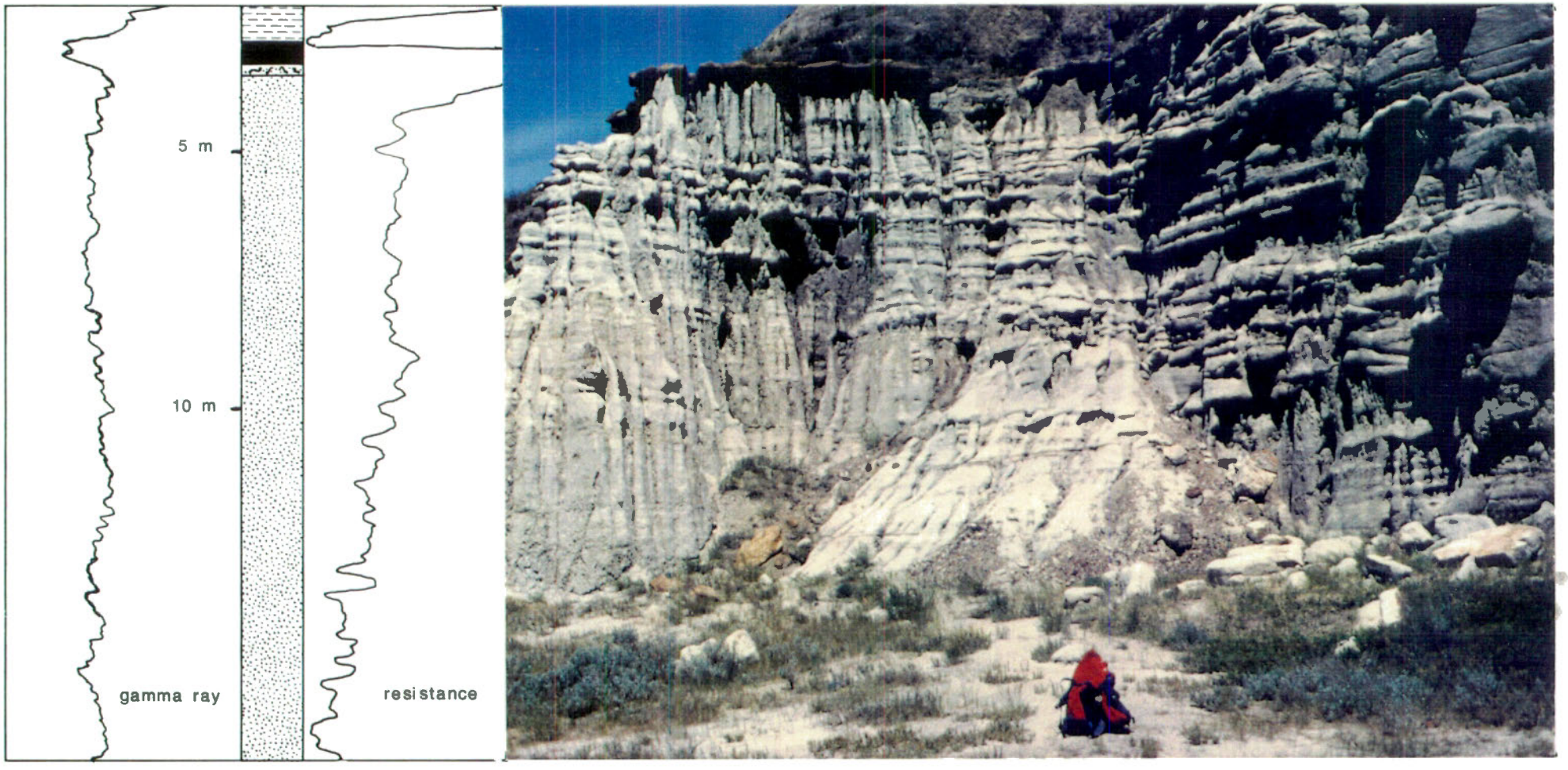
ST - 5. Fining upward sequences associated with the Castor A-B and C-D coal seams. Probable Crevasse Channel.



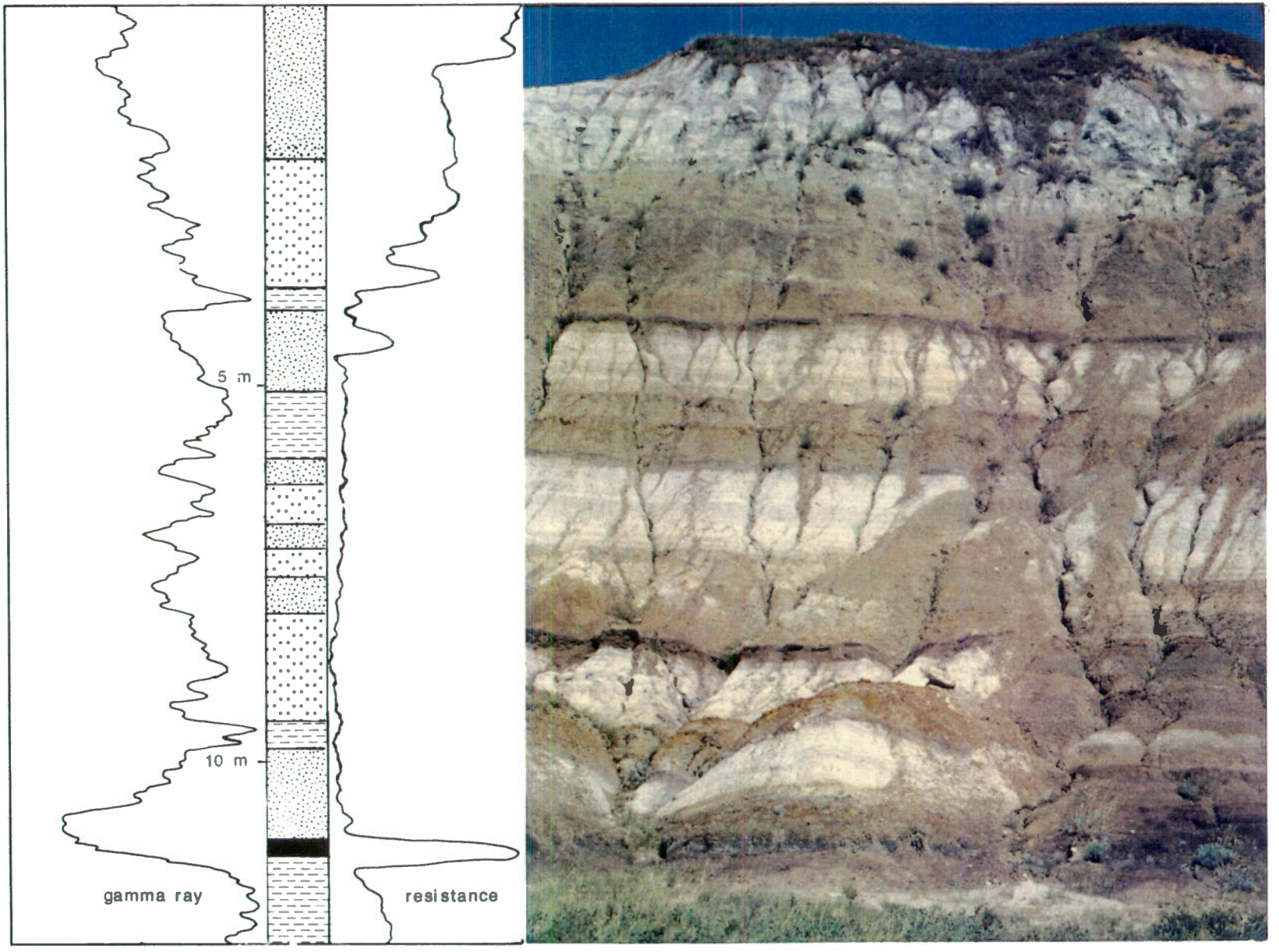
ST - 6. Stratigraphic interval between Paintearth A-C, D-E and F-I coal seams.



ST – 7. Small scale coarsening upward sequences within the stratigraphic interval between the Gadsby and Battle–River coal zones.

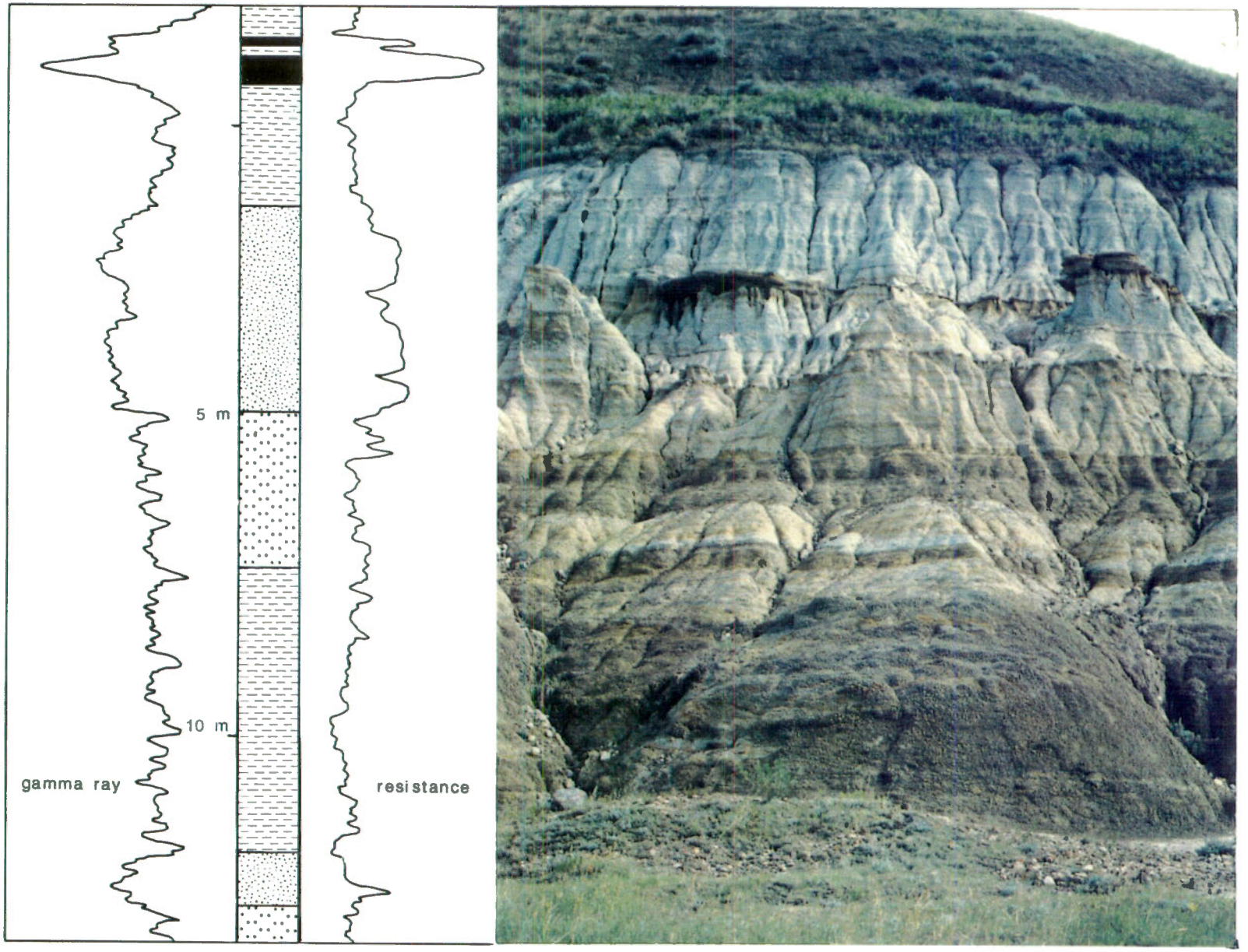


ST - 9. Sandstone unit below Paintearth coal zone. Interval exhibits decimetre-scale crossbedding to current ripple lamination, and is overlain by siltstone, mudstone with rootlets and coal. Probable major Distributary Channel.



ST - 12.

Small scale coarsening upward sequences within the interval between the Paintearth and Gadsby coal zones.



ST – 13. Small scale coarsening upward sequences within the stratigraphic interval below the Battle–River coal zone.

The crevasse splay is caused by a sudden, discrete incursion of sediment-laden floodwaters into a limited area of the bay (average of 2 km in the Mississippi delta bays; Arndorfer, 1973). The sediment may be deposited in numerous, small, anastomosing streams, or, alternatively, the flow may become unconfined farther down the levee slope and acquire the characteristics of a sheet flood. Crevasse splay deposits are generally lobe-shaped sand bodies. The lobes extend across the lower part of the levee and beyond, thus contributing to levee development (Coleman, 1969; Arndorfer, 1973). Crevasse splay lobes (sheet and/or channel varieties) occur at the tops of some CUS of the lower Horseshoe Canyon Formation. The small-scale fining-upward sequences (FUS) that occur in the Castor coal zone (Fig. ST-5), may also be interpreted in terms of crevasse splay channels, although the general increase in grain size of the sediments suggests increased influence by fluvial depositional systems.

The thick sandstone interval (TSI), (Fig. ST-9), corresponds to an elongate sandstone body observed in the subsurface, which trends toward the northeast. The interval is more than 25 m thick and forms prominent cliffs in the region. It is likely that the TSI sequence represents a major distributary channel. Thick coal development of the Paintearth zone in Townships 29 and 40 probably represents the centres of the interdistributary bays on either side of this distributary channel.

Finally, it should be mentioned that the interdistributary bay interpretation for the coarsening-upward sequences at the Bearpaw - Horseshoe Canyon transition is consistent with the general paleogeographic situation across the basin. The nature of the interdistributary bay (coastal lake ? lagoon ?) cannot be defined on a sedimentological basis alone. Further paleontological studies are needed to establish the upper limit of the marginal marine conditions of deposition in the coalfield section. It seems likely that the influence of brackish waters may have extended as high as the uppermost observed CUS in the section. This interpretation is supported by the presence of the stratigraphically younger Drumheller Marine Tongue, located to the southwest of the study area. If this is true, the stratigraphic subdivision of the lower Horseshoe Canyon Formation into members A and B, as defined from subsurface studies, would be supported by sedimentological observations.

COAL RESOURCES

Coal resources for the Battle River coalfield have been estimated based upon five coal zones: Battle-River, Paintearth, Halkirk, Castor, and Sullivan. Of these, the Sullivan and Halkirk zones have very limited potential for significant volumes of surface mineable coal. The Battle-River and Paintearth zones contain most of the coal throughout the study area. Figures 29 to 33 illustrate isopachs of total coal upon which total in situ resource estimates are based. Total coal resources include those defined as both "Immediate" and "Future" Interest.

Total coal resource calculations are based upon the following criteria:

1. Minimum seam thickness	0.15 m
2. Minimum extractable parting thickness	0.15 m
3. 0 - 400 m spacing	Measured resources
4. 400 - 800 m spacing	Indicated resources
5. 800 - 2400 m spacing	Inferred resources
6. Specific gravity	1.35
7. Maximum depth of cover	150 m

Total coal resources are tabulated in Table 2 below. It should be noted that these resource calculations were completed in 1987. Subsequent to this date, new resource criteria have been

published by the Geological Survey and the Coal Association of Canada. The new resource numbers, as they fit into the standardized criteria, and the detailed resource calculations are available from the National Coal Inventory of the Geological Survey of Canada.

TABLE 2
In-place coal resources (megatonnes)

Coal zone	Measured	Indicated	Inferred	Total
Sullivan	60.150	98.500	442.500	601.150
Castor	260.050	231.550	606.300	1 097.900
Halkirk	121.950	192.400	610.750	925.100
Paintearth	651.700	520.050	1 431.500	2 603.250
Battle-River	622.250	707.350	2 955.300	4 284.900
Total	1 716.100	1 749.850	6 046.350	9 512.300

The Battle-River and Paintearth coal zones account for 45 percent and 27 percent, respectively, of the total in situ coal resources for the study area. Although the Battle-River zone contains nearly twice as much total coal as the Paintearth zone, the latter's measured resources are marginally greater. This may be explained by the distribution in exploration boreholes, which penetrated the Paintearth zone, but were not drilled deep enough to intersect the Battle-River zone.

MINEABLE COAL RESOURCES

Although there are in excess of 9 500 megatonnes of coal resources within the Battle River study area, only a portion of that amount is considered mineable based upon present-day mining techniques. The coal is subbituminous C in rank and is utilized for mine mouth power generation. Current economic constraints, coupled with the relatively thin nature of the coal zones, dictate that low overburden ratio opencast mining appears to be the most economical method of extraction. Open pit mining is currently being undertaken by Manalta Coal Limited and Luscar Limited at the Vesta and Paintearth mines, respectively. Map 1 illustrates the location of the mine areas. Both mining operations extract coal from the Paintearth and Battle-River coal zones and ship the coal to the Alberta Power electric generation plant on the Battle River. Overburden is removed by dragline, and the coal is loaded into trucks by both shovel and front end loader. It is anticipated that any future mining developments undertaken within the Battle River study area will utilize similar open pit mining methods.

Mineable coal resources have been calculated based upon several arbitrary mining criteria. These limiting factors are presented below:

1. Minimum mineable seam thickness	0.60 m
2. Maximum nonextractable parting thickness	0.15 m
3. Mining loss for roof and floor	0.15 m
4. Mining loss at contact with extractable parting	0.15 m
5. Maximum depth of overburden	75 m
6. Maximum overburden ratio (bcm/tonnes)	25/1
7. Specific gravity	1.35

Coal resources meeting these criteria are classified as being of "immediate interest", and any coal resources that do not fall into the above stated criteria are classified as resources of future interest. Figure 7 illustrates a typical coal zone mining section and compares the total coal zone to the individual mining zones. Tables 3, 4, and 5 summarize the mineable coal resources for the Battle River coalfield study area.

TABLE 3

Mineable coal resources of immediate interest (>1.0 m)

	Resources (megatonnes)			
Coal zone	Measured	Indicated	Inferred	Total
Sullivan	18.000	21.950	71.350	111.300
Castor	112.150	88.900	174.450	375.500
Halkirk	28.500	45.450	99.200	173.150
Paintearth	317.450	154.900	371.250	843.600
Battle-River	195.300	93.950	263.750	526.000
Total	671.400	405.15	953.000	2 029.550

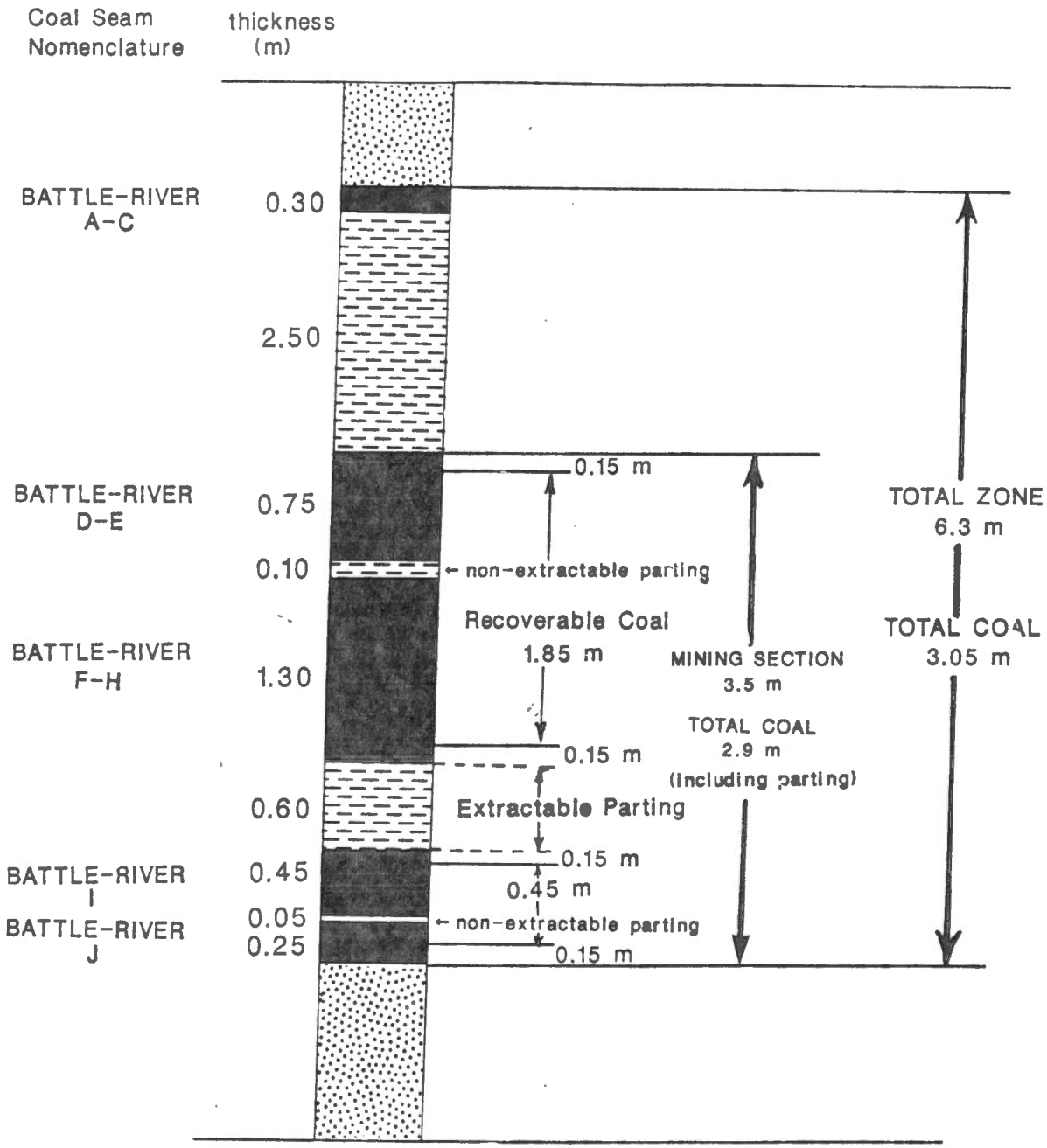


Fig. 7 Schematic Section Illustrating Total Coal Compared to Mineable Coal

* NOTE: Mining loss of 0.15 m of coal at coal/rock contact of extractable parting as well as roof and floor of mining section

TABLE 4

Mineable coal resources of future interest (>0.60 m and <1.0 m)

Coal zone	Resources (megatonnes) Measured	Indicated	Inferred	Total
Sullivan	14.700	29.200	138.050	181.950
Castor	47.450	57.350	229.800	334.600
Halkirk	36.250	75.500	346.050	457.800
Paintearth	106.900	168.250	636.800	911.950
Battle-River	156.000	285.650	1 486.350	1 928.000
Total	361.300	615.950	2 837.050	3 814.300

TABLE 5

Mineable coal resources of immediate interest (maximum depth 50 m)

Coal zone	Resources (megatonnes) Measured	Indicated	Inferred	Total
Sullivan	18.000	20.800	69.200	108.000
Castor	106.500	76.550	104.650	287.700
Halkirk	25.850	35.800	78.000	139.650
Paintearth	283.100	104.400	216.150	603.650
Battle-River	180.300	61.550	135.700	377.550
Total	613.750	299.100	603.700	1 516.550

The application of mineability criteria reduces the total amount of recoverable resources by almost 40 percent, to approximately 5 800 megatonnes. This value assumes that coal beds thicker than 0.60 m, but less than 1.0 m in thickness, are classified as resources of future interest. Coal beds greater than 1.0 m in thickness are classified as resources of immediate interest. Examination of the above qualifying criteria indicates that approximately 20 percent of the total resources are classified as mineable resources of immediate interest. In this category, the Paintearth zone accounts for 42 percent of the resource base, whereas the Battle-River accounts for 26 percent. This reversal in resource distribution may be explained by the coal thickness variations of the two main zones. The

Paintearth zone consists of two major mining horizons, D-I and A-C. The A-C development of the Battle-River zone is very localized. As well, outside of the region where the Battle-River seams coalesce, (Township 40, Range 15), the zone is commonly split, with most of the individual seams being less than 1.0 m in thickness. The Paintearth zone appears to be more laterally consistent in thickness, with large areas containing mineable seams greater than 1.0 m in thickness. The other coal zones contain localized pods of thick coal, with lesser resource potential.

The coal-bearing strata dip to the southwest at approximately 1° to 5o and corresponding overburden depths increase in this direction. Figures 34 to 36 illustrate the depth of overburden for each coal zone upon which resource estimates have been calculated. Table 5 illustrates the impact of implementing a maximum depth criterion for the resource calculations. In this table, the Paintearth zone accounts for a significant component of the resource base, probably as a result of the impact of the Paintearth A-C seam. In Township 42, Range 17, and in Township 40, Range 15, the Paintearth A-C seam lies near the surface and is of mineable thickness. Conversely, the thick coal development of the Battle-River coal seam A-C, occurs at depth, (>50.0 m), in Township 34, Range 17.

ECONOMIC COAL RESOURCES

Mineable coal resources have been further delineated based upon economical overburden ratios (bcm/tonne). In Table 6, three overburden ratio levels have been chosen, upon which resources have been calculated. Mines in the region are currently operating at an overburden ratio of approximately 5:1 bcm/tonne. The Paintearth zone accounts for 51 percent of the economic resources at this ratio. The Battle-River zone accounts for less than half of this value. Coal resources of the other zones can be considered minimal for the Halkirk zone, to limited for the Castor zone. Figures 37 to 41 illustrate the overburden ratios for the coal zones upon which resource calculations have been made.

Where the Battle-River zone is well developed, such as Township 40, Range 15 and 16, multi-seam mining is possible. The stratigraphic interval separating the Battle-River and Paintearth coal zones is approximately 30 m. Interburden ratios between the two mining horizons would be approximately 10:1 to 15:1 bcm/tonne. Currently, multiseam mining is being conducted by Manalta Coal Limited and on a limited basis by Luscar Ltd. In both areas, the Battle-River coal zone is well developed, ranging in thickness from 2.5 to 3.0 m. The Paintearth zone lies at surface, thus presenting an overall overburden ratio of approximately 5:1 bcm/tonne. Where the seams diverge, the economic viability of multiseam extraction diminishes rapidly.

One of the major problems associated with the multiseam mining scenario is highwall and overburden waste stability. In recent years slumping has occurred along the face of the open-pit mine operated by Manalta Coal Limited, due to the low stability of the overburden material. Weak rock mechanics, coupled with a high water table and deep open pit operations have led to serious highwall instability. In some cases, extraction of the Battle-River zone is carried out only in the winter months when the ground is frozen. The geotechnical problems associated with rock stability will probably affect the economic viability of multiseam mining on a widespread basis.

TABLE 6

Mineable coal resources of immediate interest by overburden to coal ratio (megatonnes) (>1.0 thickness)

Coal zone	Overburden ratio (bcm/tonne) 5:1	10:1	15:1
Sullivan	46.200	68.000	78.300
Castor	49.250	125.850	184.450
Halkirk	6.000	18.050	51.250
Paintearth	199.950	396.650	475.300
Battle-River	90.500	199.300	277.450
Total	391.900	807.850	1 066.750

COAL COMPOSITION

As part of the study of Battle River coalfield coals, a series of samples was collected for petrographic and chemical analyses (Fig. 42). Sites selected for sampling included active mines and outcrop sections, so that the resulting sample population consisted of relatively fresh, unoxidized coal along with weathered coal from outcrop exposures. In sampling the outcrop sections, trenches were dug to remove the more obviously weathered material, yet the analytical results, particularly those from the chemical analyses, indicate oxidized coal. The two main coal zones of the area, namely the Paintearth and Battle-River, were sampled, the former at 13 sites and the latter at 9. Of these sites, 4 in the Paintearth and 6 in the Battle-River were in present mine workings. The seams exposed at each site were sampled incrementally, that is, natural sedimentological breaks such as partings or shaly coal beds were used as sample boundaries. These high ash units were sampled separately, but were not analyzed in the present study. Table 7 lists the stations sampled along with location data and the number of samples collected.

Analytical methods

For the chemical characterization of these coals, proximate analyses and determination of total sulphur and calorific value were carried out according to standard ASTM procedures (American Society for Testing and Materials, 1979). Petrographic analyses consisted of maceral determinations on all coal samples, and a selected number of these were chosen for reflectance measurements. The petrographic analyses were performed on material crushed to minus 20 mesh (870 um), moulded in pellets with epoxy resin and polished according to standard procedures (ASTM, 1979). Analyses were carried out in reflected light, using oil immersion on a Leitz Orthoplan microscope with MPV II photometric accessories at a magnification of 625x.

Maceral nomenclature follows that proposed for low rank coals by the International Committee for Coal Petrology (ICCP, 1971). In this classification system, the huminite maceral group

(precursor of vitrinite in higher rank coals) is divided into a variety of maceral types. The most important of these are eu-ulminite (material retaining vestiges of original woody tissue structure), densinite (finely fragmented and partially gelified huminite material) and gelinite (huminite matter in which tissue structure has been virtually destroyed or material which may have passed through a colloidal phase). Inertinite and liptinite macerals were also identified. Diagnostic characteristics for these macerals are essentially the same for both low and high rank coals (ICCP, 1971).

Maceral quantities were determined by point count (500 points per sample) and converted to per cent values. Reflectance measurements were determined in the random mode (Ro random) and the values reported as averages of 50 measurements per sample.

RESULTS AND DISCUSSION

Chemical

Ash and sulphur data are presented in Figures 43 through 45. Average values for both ash and sulphur were calculated for the main part of the Paintearth and Battle-River seams, that is, the thickest and most laterally persistent coal unit in each zone within the study area. The averaged values for each sampling station are recorded on Figures 43 and 44. In terms of these average values, ash content (dry basis) in the Paintearth zone ranges from 8.0 percent (Stn. CQ616) to 29.1 percent (Stn. CQ618; Fig. 43A). Higher values for the Paintearth zone appear to be toward the southern end of the sampled area (Stns. CQ618, 619 and 622). It appears that toward the southern end, a channel interfered with normal peat accumulation in this zone. Sample sites in the Battle-River zone are confined to a smaller area than those in the Paintearth zone. Average ash contents on the main part of the zone are shown in Figure 43B. They range from 8.5 percent to 17.8 percent and indicate no discernable pattern.

Figure 44 (A and B) illustrates average sulphur contents for the Paintearth and Battle-River coal zones, again calculated for the main parts of both coal zones. The Paintearth values range from 0.32 to 0.74 percent whereas the Battle-River values range from 0.47 to 1.19 percent. The two highest values for the Battle-River zone correspond to two samples from the most southerly stations (CQ617 and CQ621).

Figure 45 summarizes ash and sulphur data for the Paintearth and Battle-River zones, by grouping data according to arbitrarily chosen ash and sulphur values and plotting the results in cumulative frequency histograms. For example, Figure 45A shows that of the total thickness of Paintearth coal samples, 11.2 m had ash contents of 10 to 20 percent, whereas for the Battle-River zone, (Fig. 45B), over 8 m of the total sampled had ash contents between 0 and 10 percent. These numbers suggest that the Paintearth zone has overall higher ash values, possibly due to higher frequency of thin rock partings throughout the seam. Sulphur values (Fig. 45C and 45D) are reversed, with the Paintearth zone being lower than the Battle-River zone.

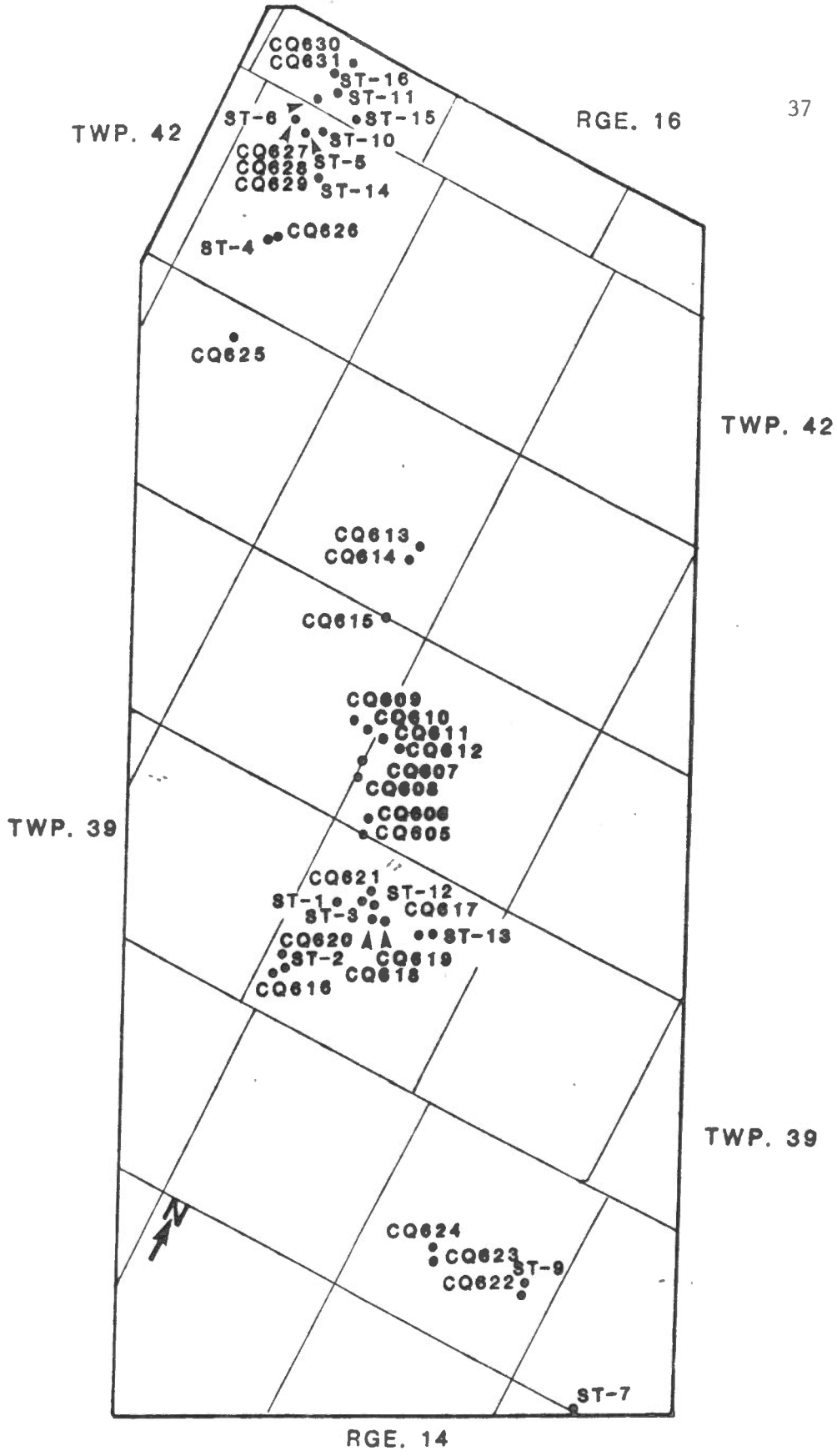


Figure 42. Inset location map, measured sections and sample localities.

Table 7. Location of sample stations - Paintearth and Battle-River coal zones.

Station Number	Northing[1]	Easting	Zone Thickness[2] Net coal thickness (M)	No. of Coal Samples
Paintearth Zone				
CQ605	5807160	421990	2.05 (1.76)	5
CQ606	5807500	421900	0.96 (0.78)	4
CQ608	5809500	421210	2.36 (1.95)	8
CQ612	5811000	421700	2.71 (2.50)	7
CQ616	5799300	422640	2.02 (1.77)	4
CQ618	5804250	424820	2.36 (1.07)	5
CQ619	5804250	424950	1.86 (0.51)	2
CQ622	5790700	439900	1.46 (0.69)	3
CQ625	5824470	405700	1.48 (1.45)	4
CQ626	5829810	405280	2.66 (1.88)	9
CQ629	5834140	404650	2.54 (2.53)	7
CQ630 CQ631	5936010	404040	11.40 (1.49)	4
Battle River Zone				
CQ607	5809700	421120	2.39 (2.20)	6
CQ609	5811040	420170	2.27 (2.11)	5
CQ610	5811020	420590	2.00 (1.68)	4
CQ611	5811020	420960	2.29 (2.29)	4
CQ613	5819500	418600	1.39 (1.36)	3
CQ614	5819350	418650	1.59 (1.58)	6
CQ615	5816000	419870	2 83 (2.37)	6
CQ617	5803900	427520	0 50 (0.50)	1
CQ621	5804300	424580	0 70 (0 46)	2

[1] All in zone 11

[2] Numbers in parenthesis represent net coal

In Figure 46, volatile matter contents and calorific values are also plotted in the form of frequency diagrams. In this figure, the influence of weathering is clearly shown. Outcrop samples for both the Paintearth and Battle-River coal zones show elevated volatile matter contents and reduced calorific values relative to samples from currently active mines. Calorific values (mmf) for unweathered samples in both zones range from 20.1 to 24.0 MJ/kg indicating coal ranks (ASTM) of subbituminous C and B, with some coal layers approaching the subbituminous B/A boundary.

Petrographic

Maceral distribution data for the Paintearth and Battle-River coal zones are plotted on Figure 47. Nearly all samples are uniformly high in huminite, with most of the Paintearth samples and all of the Battle-River samples containing over 80 percent huminite on the mineral-free basis. Liptinite is relatively low in most samples, roughly averaging about 4 percent. Inertinite contents in the majority of samples are below 10 percent. On the basis of gross maceral composition, it is not possible to distinguish between the Paintearth and Battle-River coals. Figure 47 shows that the Battle-River samples form a somewhat more compact population than the Paintearth samples, but it is not clear whether this is a function of fewer Battle-River samples from a smaller area than Paintearth or the fact that a larger proportion of the Paintearth samples are from outcrop, and weathered to varying degrees. Depending on the degree of severity, weathering can hinder proper identification of macerals.

Diessel (1986) proposed a model relating variations in petrographic composition of coal to differences in the swamp types in which the parent peats were deposited. His model is graphically expressed by crossplotting two indices that he called the Gelification Index (GI) and Tissue Preservation Index (TPI). These indices are calculated from maceral distribution data and relate, as their names imply, to the degree to which plant tissue structure is preserved or destroyed through processes of gelification. Good tissue preservation on the one hand or gelification as an alternative are determined by variations in the biological, chemical and physical conditions in the peat swamp and, as Diessel suggested, may be related to different sedimentological settings. Diessel's model was based upon compositional characteristics of Australian bituminous coals. In this report, the model is applied to the subbituminous coals of the Battle River study.

The GI and TPI are calculated from the maceral data (mmf) of the Battle-River coals as follows:

$$GI = (\text{Total Huminite} + \text{Macrinite})/(\text{Semifusinite} + \text{Fusinite} + \text{Inertodetrinite})$$

$$TPI = (\text{Eu-ulminite} + \text{Semifusinite} + \text{Fusinite})/(\text{Densinite} + \text{Macrinite} + \text{Inertodetrinite})$$

These indices were calculated for the main part of each coal zone at each station and the resulting data are displayed on Figure 48. Each point on the diagram represents a sampling station.

Several observations may be made regarding the positions of these points. First it should be noted that the GI is uniformly high, indicating generally wet conditions of deposition for both the Paintearth and Battle-River coal zones. Diessel (1986) suggested that such coals form in a lower delta-plain environment. In general, this interpretation agrees with the sedimentological analyses of the study area. A second point to note is that the Battle-River zone appears to have a somewhat higher TPI than the Paintearth zone. According to Diessel (1986), this indicates a swamp environment of deposition for the Battle-River coals, with more trees than the open-marsh; possibly more herbaceous environment in which the Paintearth coals were formed.

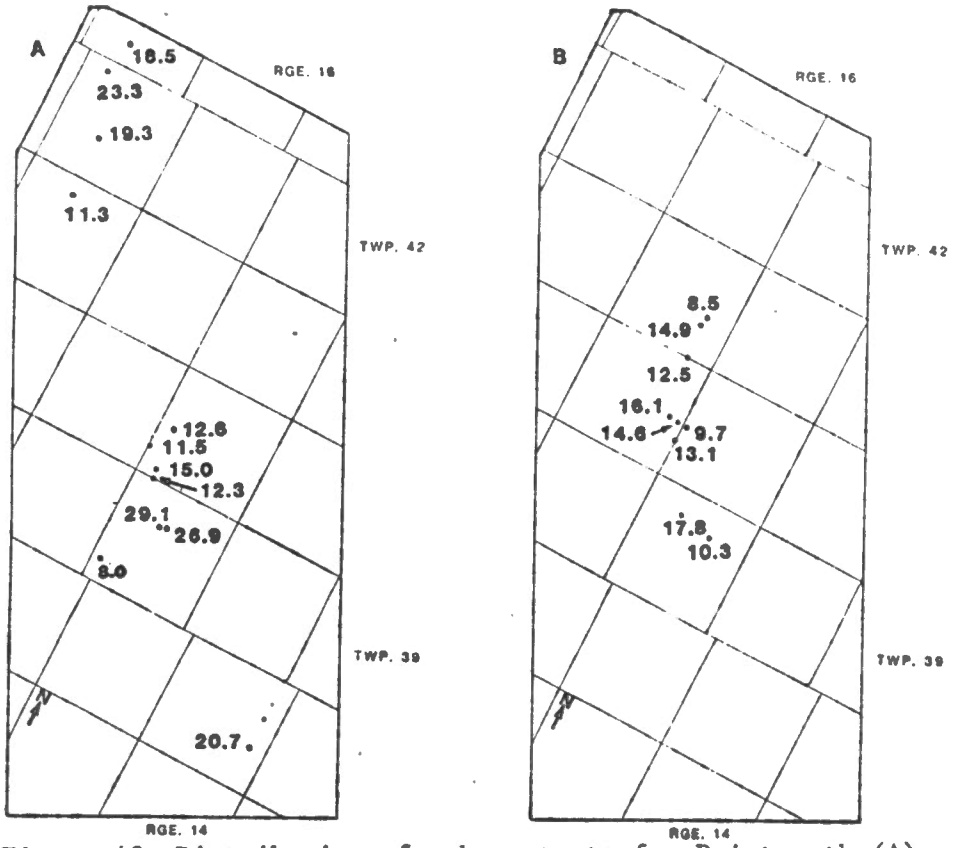


Figure 43. Distribution of ash contents for Paintearth (A) and Battle-River (B) coal zone sample locations.

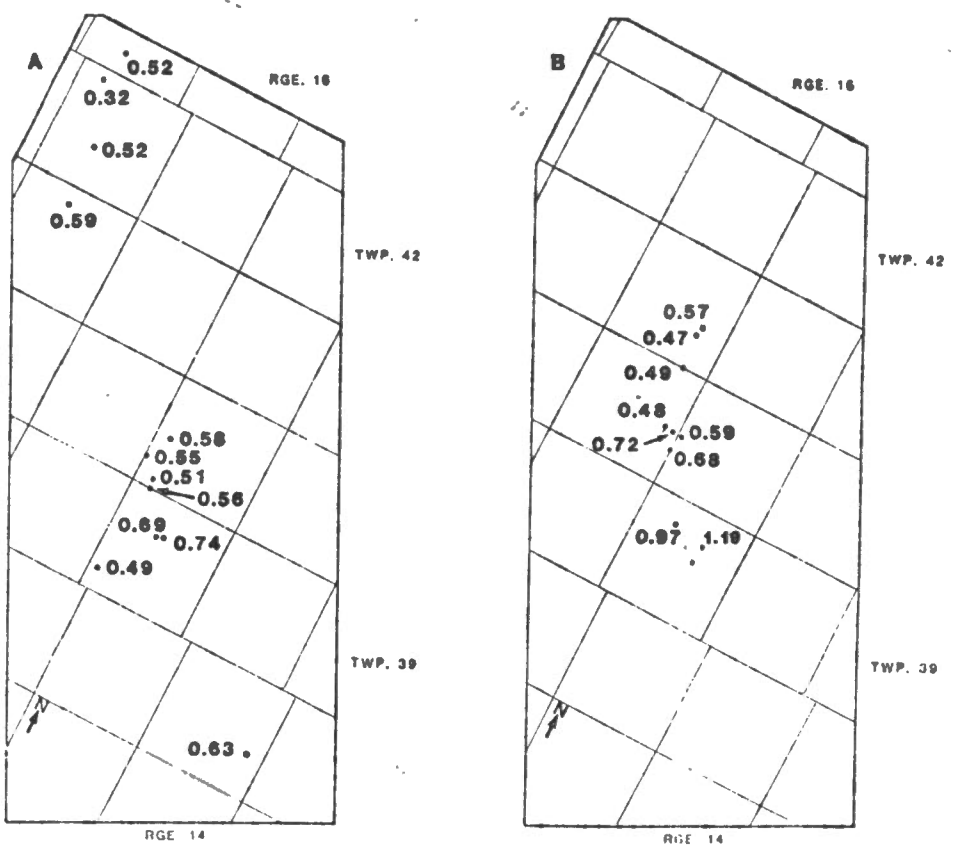


Figure 44. Distribution of sulphur contents for Paintearth (A) and Battle-River (B) coal zone sample locations.

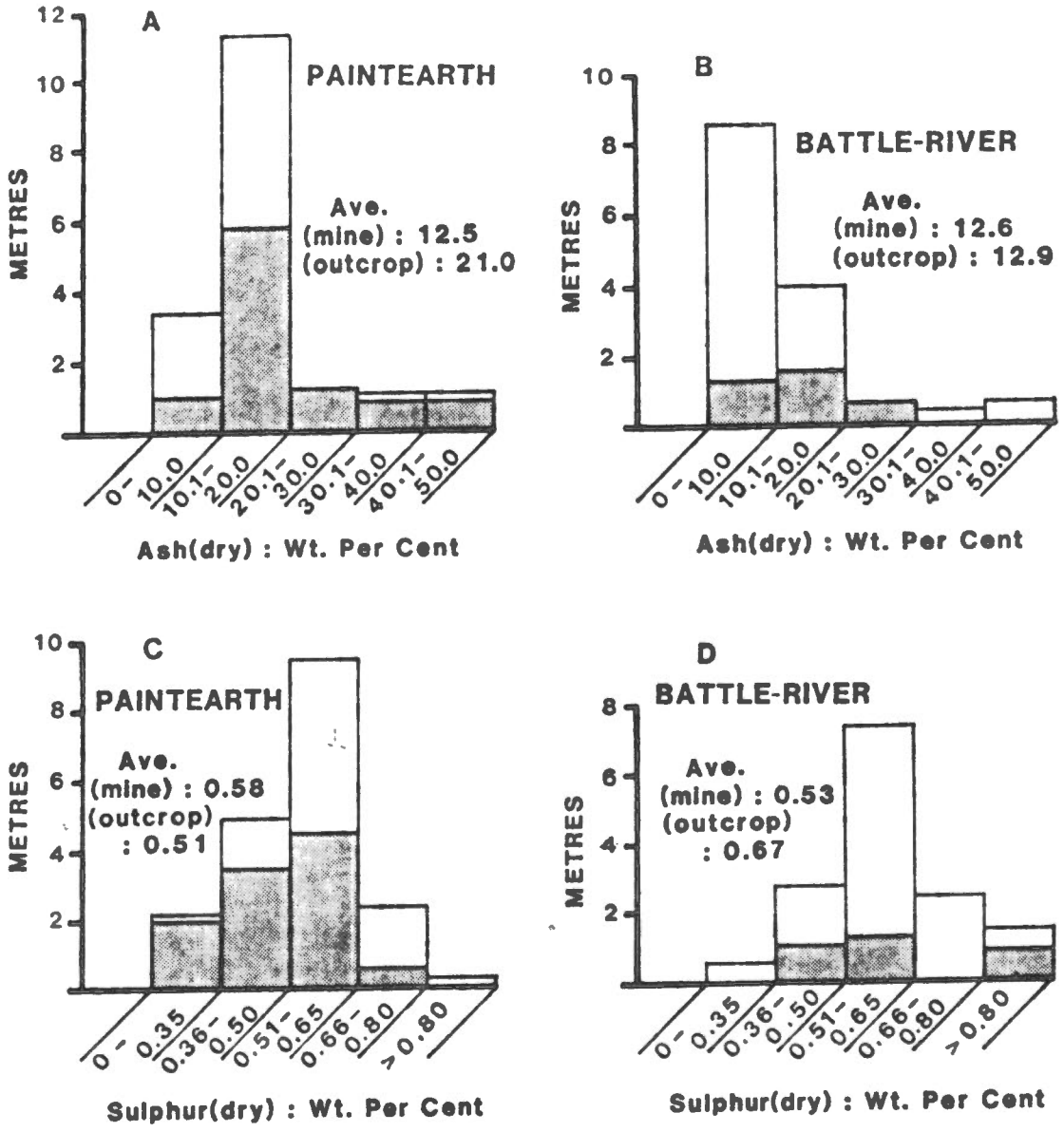
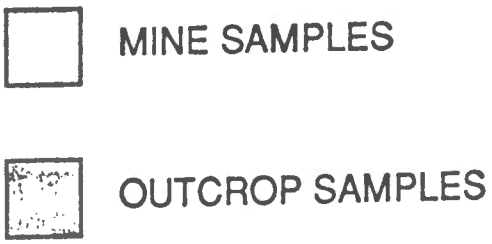


Figure 45. Cumulative thickness plots summarizing ash and sulphur contents of Paintearth and Battle-River coals.



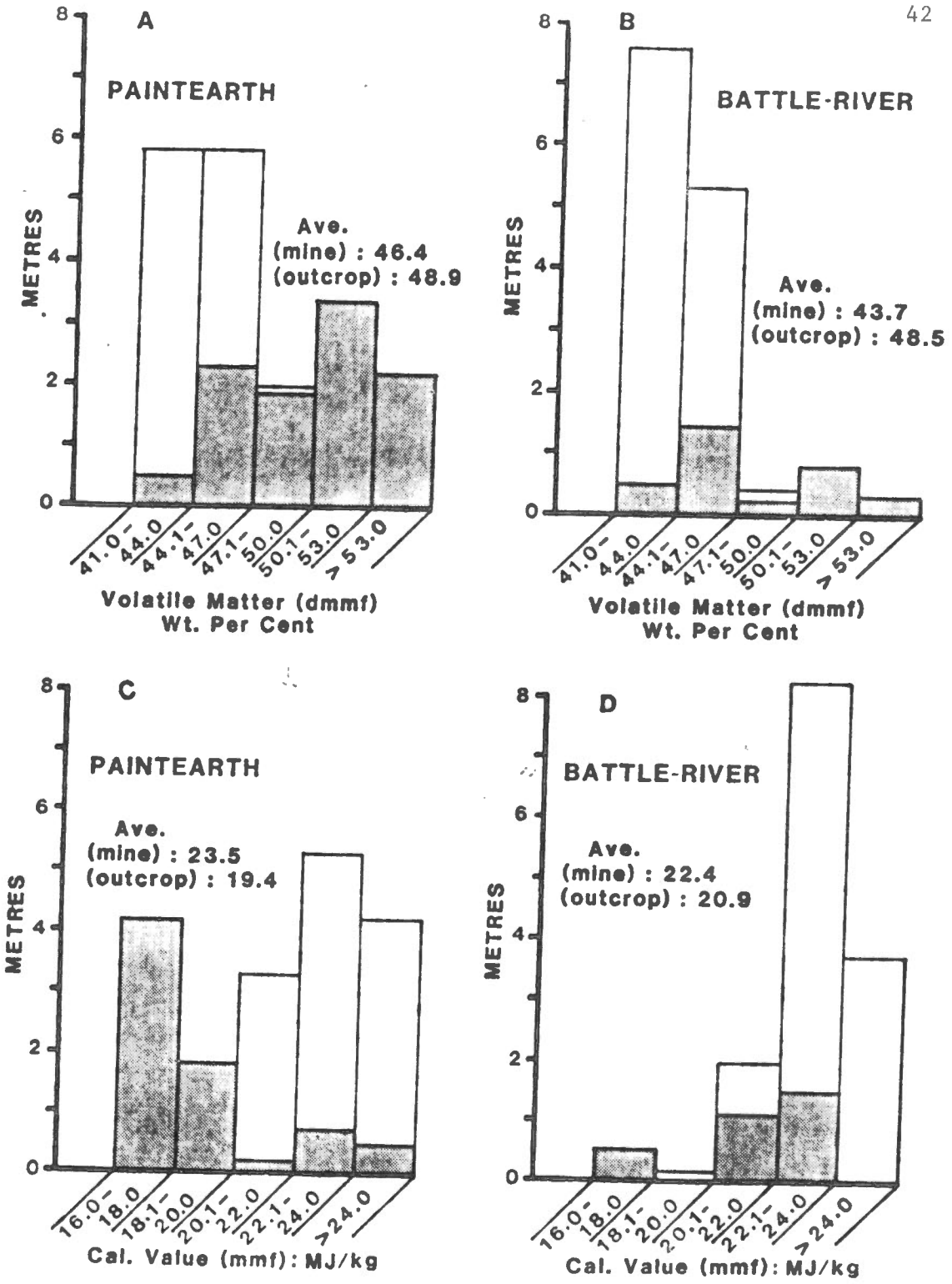


Figure 46. Cumulative thickness plots summarizing volatile matter and heating value for Paintearth and Battle-River coals.

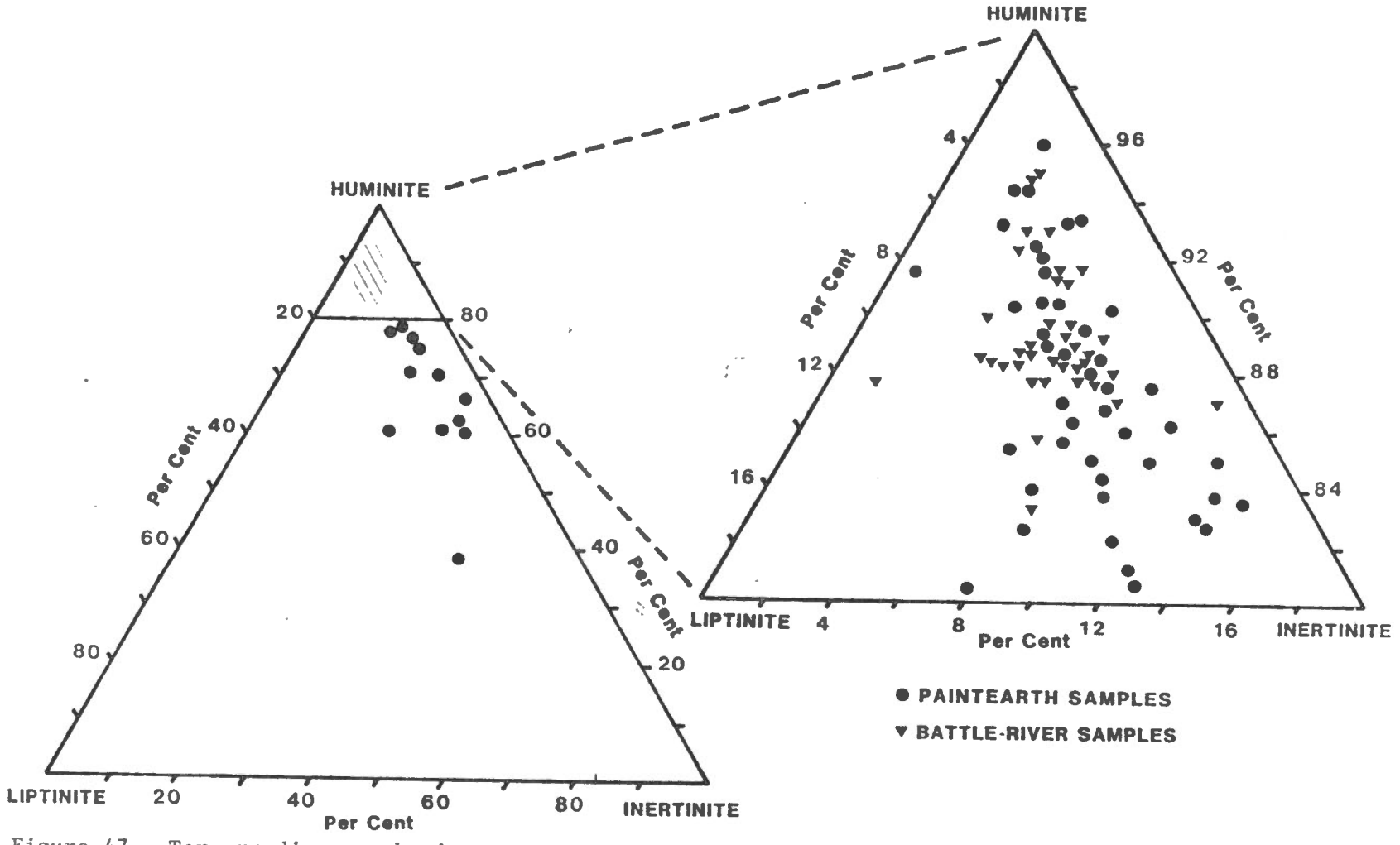


Figure 47. Ternary diagram showing maceral distribution (mineral-free basis) for Paintearth and Battle-River coals.

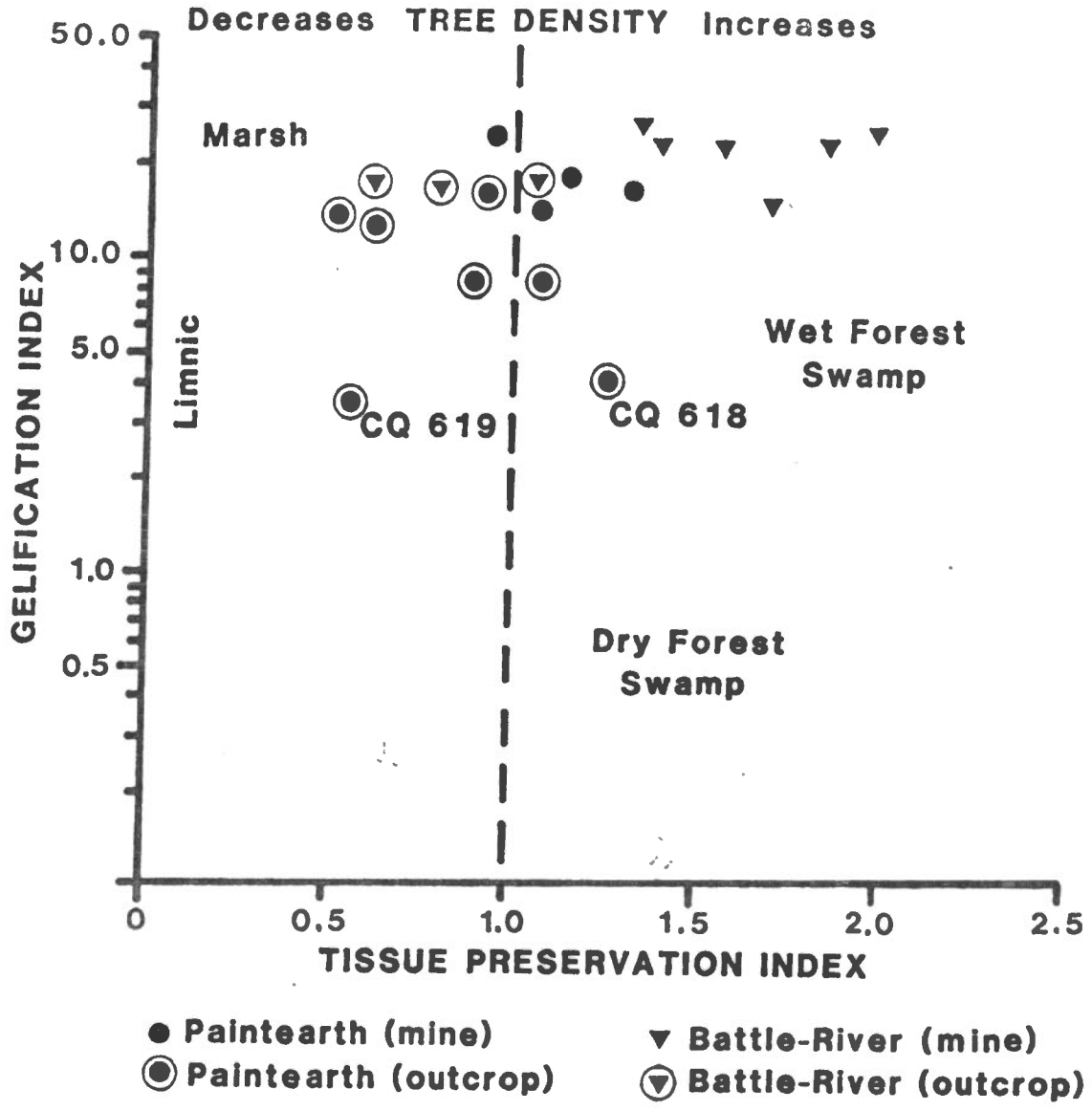


Figure 48. Relationship of maceral composition data to environments of accumulation.

The effect of weathering on the ability to discriminate among macerals during analysis may also be influential in the positioning of points on Figure 48. The outcrop samples in both Paintearth and Battle-River populations show lower TPI values than samples collected from active mines. This means, in part, that lower amounts of structured huminite (eu-ulminite) were detected in the weathered samples, most likely a function of the masking by weathering of fine tissue texture in coal particles. Two sets of Paintearth samples (CQ618 and CQ619) stand out because their GI values (below 4.00) are much lower than the other samples. These two samples suites are high in inertinite. They are located geographically close to each other (Fig. 42) and their positions on Figure 48 indicates formation in somewhat drier conditions than most of the other Paintearth and Battle- River samples. In this case, the inertinite contents are believed to be accurate despite the fact that CQ618 and CQ619 are outcrop sections. Inertinite is more easily identified in weathered coals than are the finer discriminations within the huminite group.

Reflectance data on these coals are recorded in Table 8. For the Paintearth samples, these range from 0.42 to 0.62 Ro random. In the unweathered samples, the range is from 0.49 to 0.52 Ro random. Reflectances in the Battle-River samples are roughly similar, ranging from 0.47 to 0.53 Ro random. All reflectance data, except for CQ626 are indicative of subbituminous coal.

ACKNOWLEDGMENTS

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Table 8. Summary of reflectance data for the Paintearth and Battle-River coal zones.

Sample Location	Coal Zone	R_o Random	Standard Deviation
CQ605	Paintearth	0.52	0 04
CQ606	Paintearth	0 49	0 03
CQ608	Paintearth	0.51	0 03
CQ612	Paintearth	0.51	0.04
CQ616	Paintearth	0.49 *	0.04
CQ618	Paintearth	0.42 *	0.04
CQ619	Paintearth	0.46 *	0 04
CQ622	Paintearth	0 48 *	0 03
CQ625	Paintearth	0 52 *	0.03
CQ626	Paintearth	0 62 *	0 05
CQ629	Paintearth	0.50 *	0 03
CQ607	Battle River	0 50	0 04
CQ609	Battle River	0 52	0 03
CQ611	Battle River	0.52	0 04
CQ613	Battle River	0.52	0 04
CQ614	Battle River	0.53	0 04
CQ615	Battle River	0.52 *	0 04
CQ617	Battle River	0.50 *	0 04
CQ621	Battle River	0.47 *	0.03

* Outcrop

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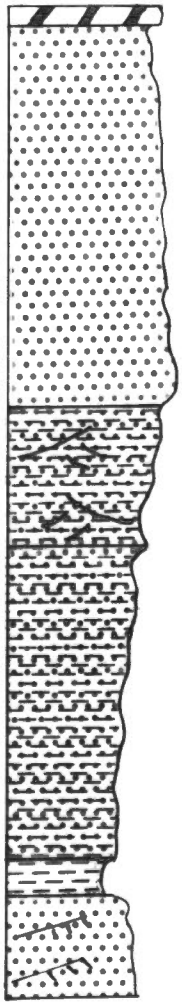
APPENDIX 1

Measured Field Sections



PAINTEARTH Coal Zone

white sandstone; horizontal to very low-angle inclined bedding; some very thin dark mud drapes

small trough cross-bedding

LEGEND

- Bright
- Bright banded
- Dull and bright
- Dull banded
- Dull
- Bone coal
- Carbonaceous claystone
- Mudstone
- Bentonitic mudstone
- Concretion
- Sandstone
- Siltstone

BATTLE RIVER COALFIELD

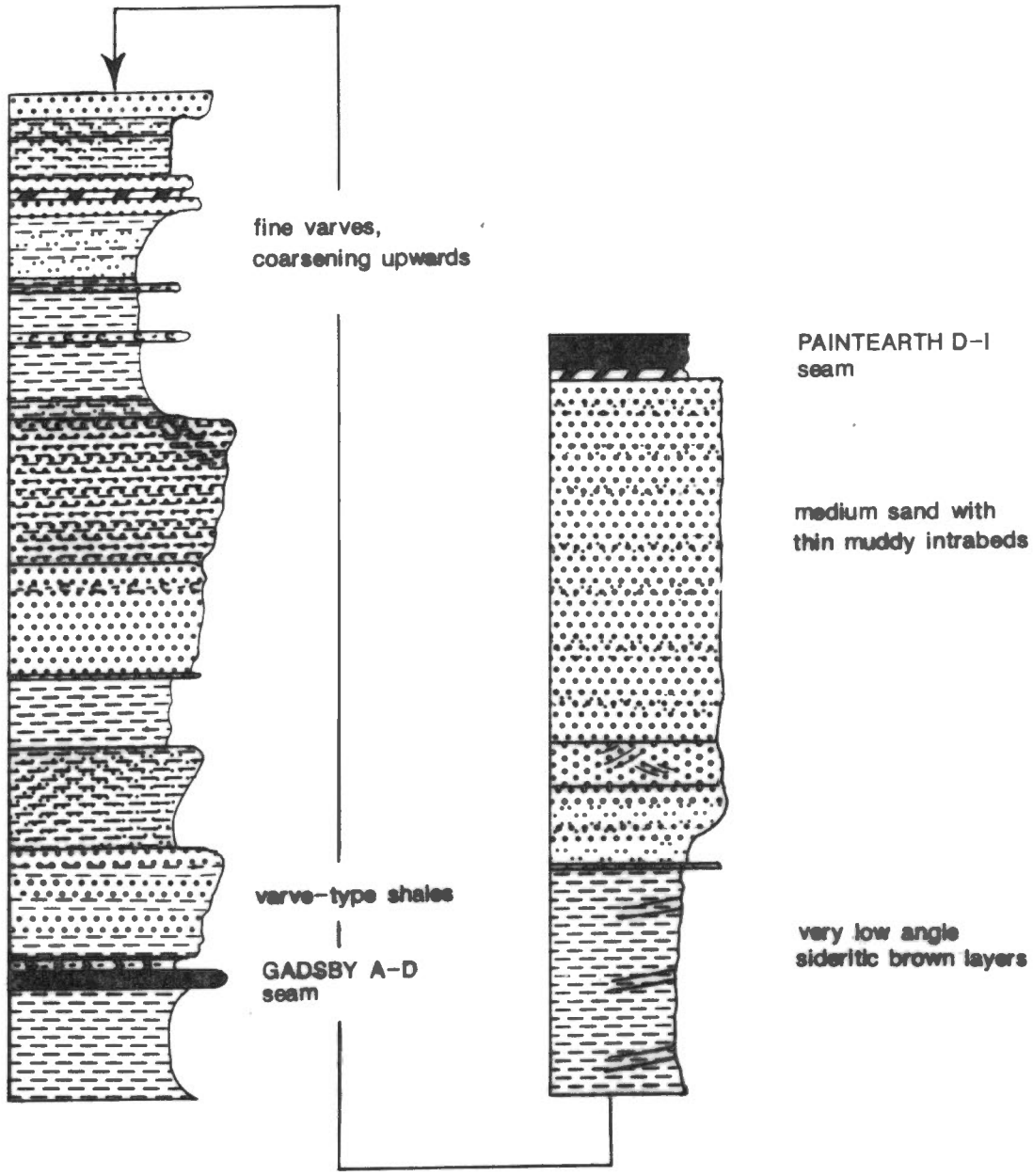
SECTION: ST-1

SCALE: 1:100

LOCATION:

NORTHING 5804000
EASTING 421430
ZONE

LSD.
SEC. 30
TWP. 39
RGE. 15
MER. W4



LEGEND

- Bright
- Bright banded
- Dull and bright
- Dull banded
- Dull
- Bone coal
- Carbonaceous claystone
- Mudstone
- Bentonitic mudstone
- Concretion
- Sandstone
- Siltstone

BATTLE RIVER COALFIELD

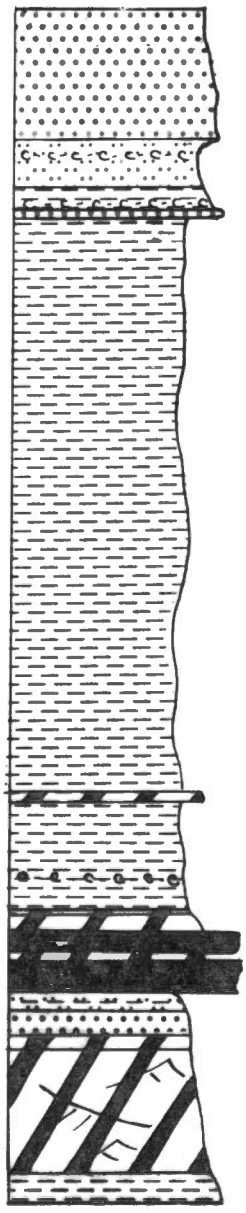
SECTION: ST-3

SCALE: 1:100

LOCATION:

NORTHING 5903875
EASTING 479640
ZONE

LSD.
SEC. 28
TWP. 39
RGE. 15
MER. W4



medium sand with mud layers along trough surfaces

PAINTEARTH A–C seam

PAINTEARTH D–I seam

distinctly laminated mud layers with parallel carbonaceous laminae; epsilon cross–bedding in medium sand

LEGEND

- Bright
- Bright banded
- Dull and bright
- Dull banded
- Dull
- Bone coal
- Carbonaceous claystone
- Mudstone
- Bentonitic mudstone
- Concretion
- Sandstone
- Siltstone

BATTLE RIVER COALFIELD

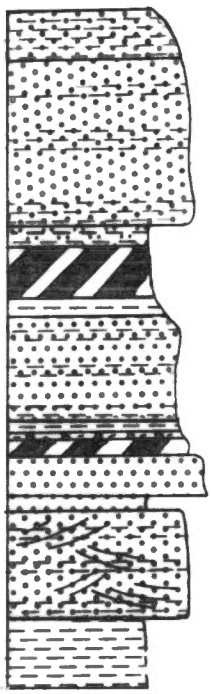
SECTION: ST–4

SCALE: 1:200

LOCATION:

NORTHING 5829125
EASTING 402730
ZONE

LSD.
SEC. 16
TWP. 42
RGE. 17
MER. W4



CASTOR A–B seam
organic rich; gradational

CASTOR C–D seam

medium→fine sand with mud layers showing low angle epsilon cross–bedding; almost horizontal

LEGEND

- Bright
- Bright banded
- Dull and bright
- Dull banded
- Dull
- Bone coal
- Carbonaceous claystone
- Mudstone
- Bentonitic mudstone
- Concretion
- Sandstone
- Siltstone

BATTLE RIVER COALFIELD

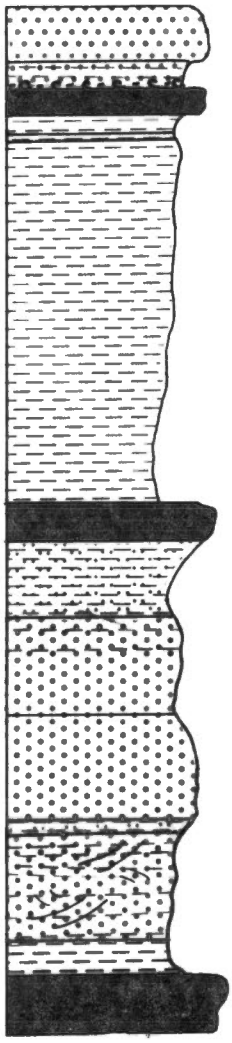
SECTION: ST–5

SCALE: 1:100

LOCATION:

NORTHING 5835375
EASTING 402860
ZONE

LSD.
SEC. 32
TWP. 42
RGE. 17
MER. W4



sandy mudshale; ironstone concretions are in base of unit
CORDEL Coal Zone

PAINTEARTH A–C seam

rich in plant fragments

medium→fine sand with mud layers showing
low angle epsilon cross-bedding

PAINTEARTH D–I seam

LEGEND

- Bright
- Bright banded
- Dull and bright
- Dull banded
- Dull
- Bone coal
- Carbonaceous claystone
- Mudstone
- Bentonitic mudstone
- Concretion
- Sandstone
- Siltstone

BATTLE RIVER COALFIELD

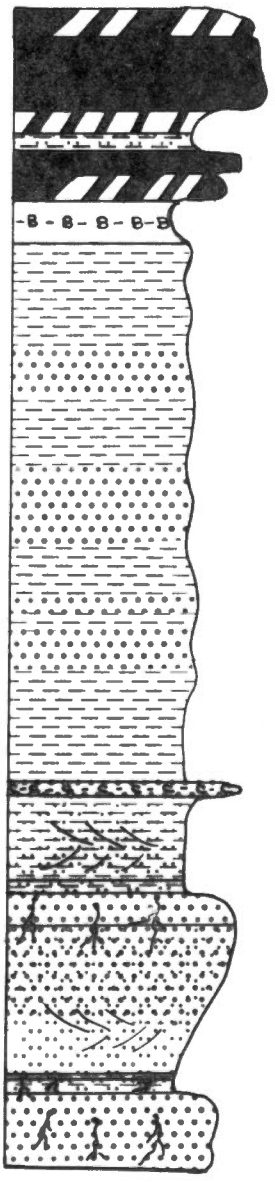
SECTION: ST-6

SCALE: 1:100

LOCATION:

NORTHING 5836125
EASTING 401950
ZONE

LSD.
SEC. 32
TWP. 42
RGE. 17
MER. W4



PAINTEARTH Coal Zone

alternating mudstones and sands; mud is dark grey clayshale to mudshale; sand is fine grained and very white with few black spots

coarsening upwards from silt to fine sand; varve laminated; layers are horizontal with ripple drift cross-bedding internally

very fine sand light olive grey; rich in plant debris (small)

LEGEND

- Bright
- Bright banded
- Dull and bright
- Dull banded
- Dull
- Bone coal
- Carbonaceous claystone
- Mudstone
- Bentonitic mudstone
- Concretion
- Sandstone
- Siltstone

BATTLE RIVER COALFIELD

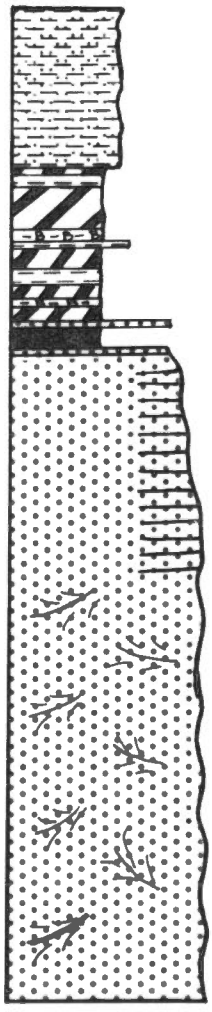
SECTION: ST-7

SCALE: 1:100

LOCATION:

NORTHING 5786500
EASTING 443640
ZONE

LSD.
SEC. 33
TWP. 37
RGE. 13
MER. W4



PAINTEARTH Coal Zone

horizontal laminated bedding

large scale cross-bedding

LEGEND

- Bright
- Bright banded
- Dull and bright
- Dull banded
- Dull
- Bone coal
- Carbonaceous claystone
- Mudstone
- Bentonitic mudstone
- Concretion
- Sandstone
- Siltstone

BATTLE RIVER COALFIELD

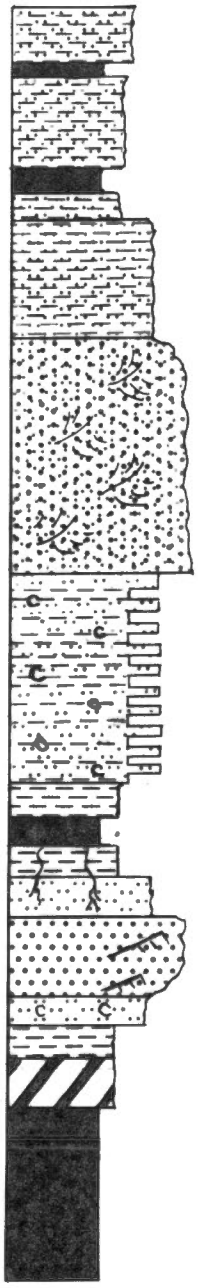
SECTION: ST-9

SCALE: 1:100

LOCATION:

NORTHING 5790500
EASTING 438710
ZONE

LSD.
SEC. 13
TWP. 38
RGE. 14
MER. W4



HALKIRK A–C seam

HALKIRK D–F seam

interbedded mudstone and siltstone, with abundant nodular concretions

PAINTEARTH A–C seam

medium grey fine–grained sandstone, finely laminated; coarsening upwards; low angle cross–bedding; lacustrine

PAINTEARTH D–I seam

LEGEND

- Bright
- Bright banded
- Dull and bright
- Dull banded
- Dull
- Bone coal
- Carbonaceous claystone
- Mudstone
- Bentonitic mudstone
- Concretion
- Sandstone
- Siltstone

BATTLE RIVER COALFIELD

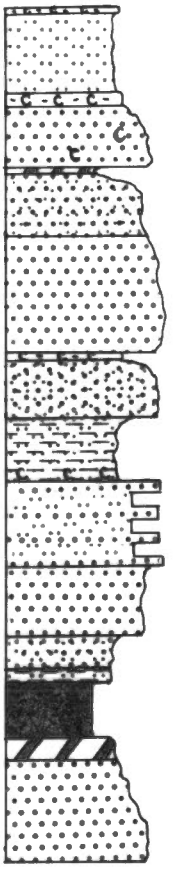
SECTION: ST–10

SCALE: 1:100

LOCATION:

NORTHING 5835375
EASTING 403510
ZONE

LSD.
SEC. 32
TWP. 42
RGE. 17
MER. W4



shaly coal, with abundant amber

medium grey fined sandstone and siltstone, with many carbonaceous plant fragments

PAINTEARTH Coal Seam

light grey fine sandstone; well sorted, fining upwards

LEGEND

- Bright
- Bright banded
- Dull and bright
- Dull banded
- Dull
- Bone coal
- Carbonaceous claystone
- Mudstone
- Bentonitic mudstone
- Concretion
- Sandstone
- Siltstone

BATTLE RIVER COALFIELD

SECTION: ST-11

SCALE: 1:200

LOCATION:

NORTHING 5836375

EASTING 403640

ZONE

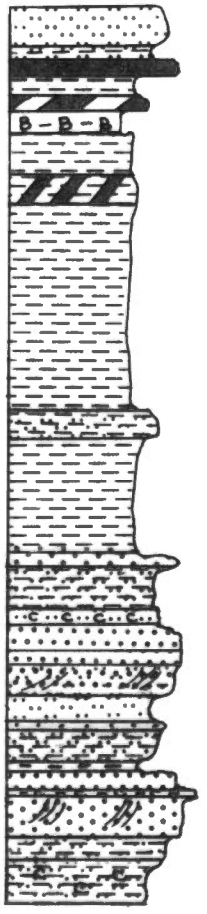
LSD.

SEC. 4

TWP. 43

RGE. 17

MER. W4



PAINTEARTH Coal Zone

dark brown mudstone with minor calcareous bands

interbedded fine grained sandstone and muddy siltstone

interbedded muddy siltstone with fine-grained sandstone
light brown muddy siltstone with frequent siderite concretions

LEGEND

- Bright
- Bright banded
- Dull and bright
- Dull banded
- Dull
- Bone coal
- Carbonaceous claystone
- Mudstone
- Bentonitic mudstone
- Concretion
- Sandstone
- Siltstone

BATTLE RIVER COALFIELD

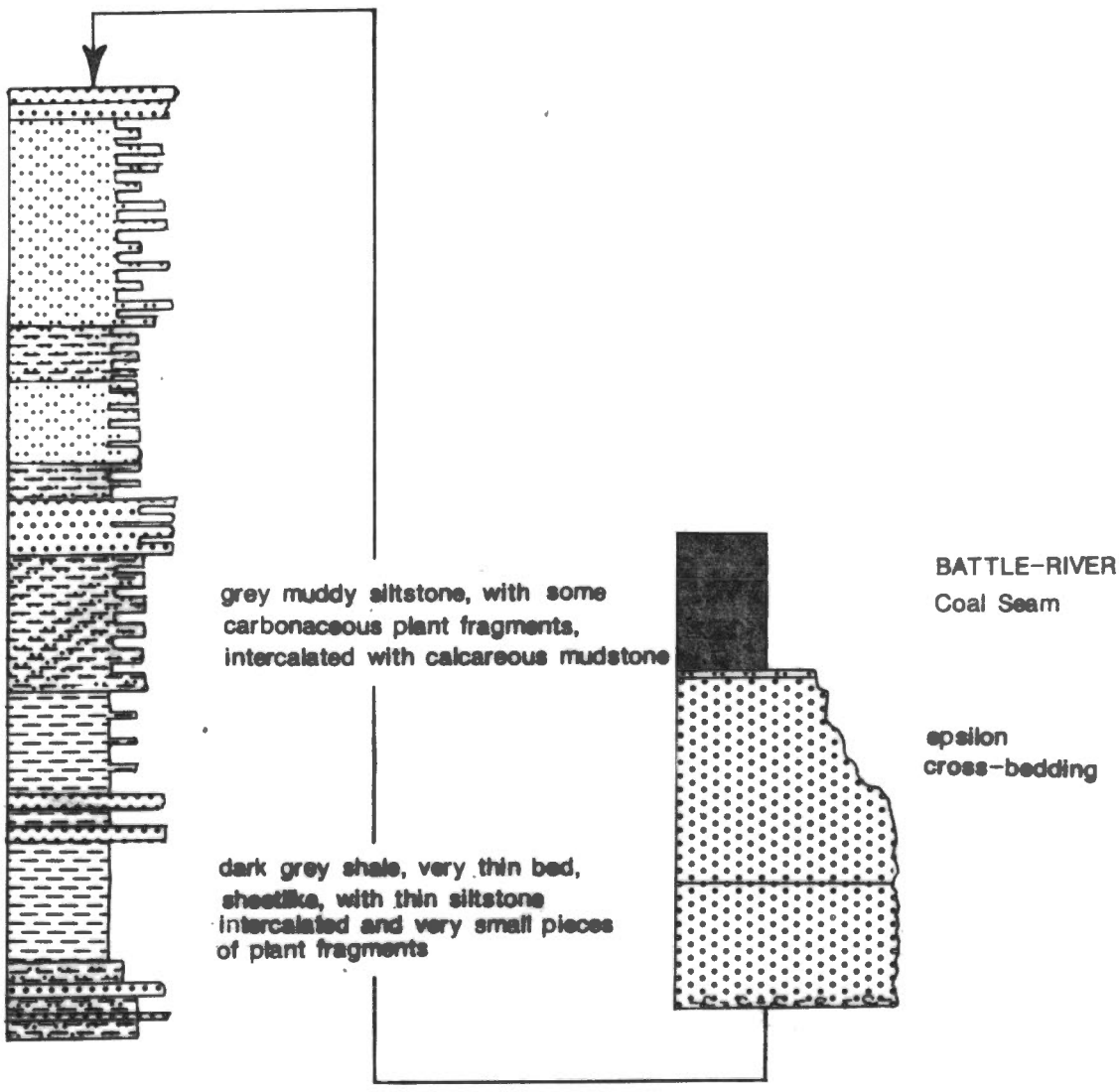
SECTION: ST-12

SCALE: 1:200

LOCATION:

NORTHING 5804125
EASTING 424550
ZONE

LSD.
SEC. 28
TWP. 39
RGE. 15
MER. W4



LEGEND

- Bright
- Bright banded
- Dull and bright
- Dull banded
- Dull
- Bone coal
- Carbonaceous claystone
- Mudstone
- Bentonitic mudstone
- Concretion
- Sandstone
- Siltstone

BATTLE RIVER COALFIELD

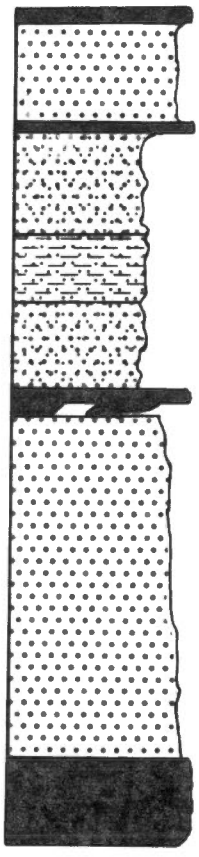
SECTION: ST-13

SCALE: 1:100

LOCATION:

NORTHING 5803750
EASTING 427410
ZONE

LSD.
SEC. 26
TWP. 31
RGE. 15
MER. W4



CASTOR A–B seam

CASTOR C–D seam

HALKIRK D–F seam

PAINTEARTH A–I Coal Zone

LEGEND

- Bright
- Bright banded
- Dull and bright
- Dull banded
- Dull
- Bone coal
- Carbonaceous claystone
- Mudstone
- Bentonitic mudstone
- Concretion
- Sandstone
- Siltstone

BATTLE RIVER COALFIELD

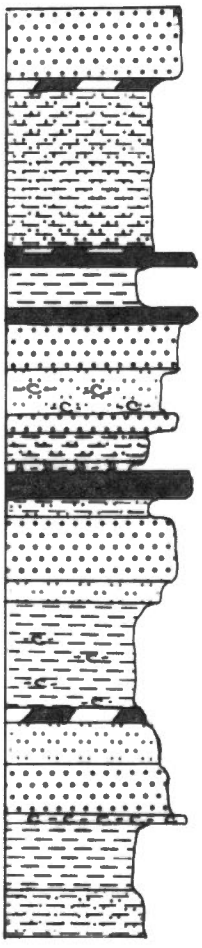
SECTION: ST–14

SCALE: 1:200

LOCATION:

NORTHING 5832625
EASTING 404420
ZONE

LSD.
SEC. 28
TWP. 42
RGE. 17
MER. W4



CORDEL Coal Seam

PAINTEARTH Coal Zone

MARKER-1 Coal Seam

LEGEND

- Bright
- Bright banded
- Dull and bright
- Dull banded
- Dull
- Bone coal
- Carbonaceous claystone
- Mudstone
- Bentonitic mudstone
- Concretion
- Sandstone
- Siltstone

BATTLE RIVER COALFIELD

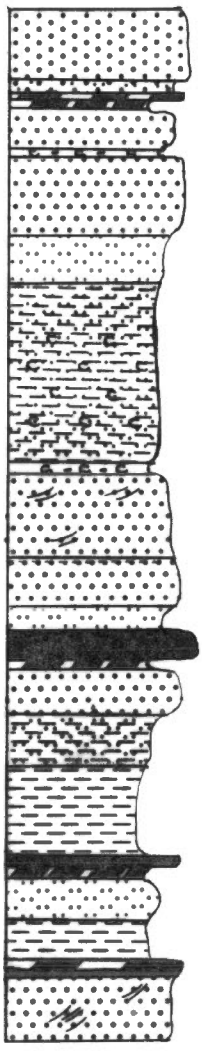
SECTION: ST-15

SCALE: 1:200

LOCATION:

NORTHING 5836375
EASTING 405980
ZONE

LSD.
SEC. 3
TWP. 43
RGE. 17
MER. W4



HALKIRK D-F' seam

PAINTEARTH Coal Zone

LEGEND

- Bright
- Bright banded
- Dull and bright
- Dull banded
- Dull
- Bone coal
- Carbonaceous claystone
- Mudstone
- Bentonitic mudstone
- Concretion
- Sandstone
- Siltstone

BATTLE RIVER COALFIELD

SECTION: ST-16

SCALE: 1:200

LOCATION:

NORTHING 5837875
EASTING 404160
ZONE

LSD.
SEC. 9
TWP. 42
RGE. 17
MER. W4

APPENDIX 2

Measured Coal Seam Trench Data and Analyses

DESCRIPTIVE COMMENTS	COAL ZONE	SAMPLE NUMBER	THICKNESS (metres)	CHEMICAL ANALYSES						PETROGRAPHIC ANALYSES				
				H2O (A.R.B.)	C.V. MJ/Kg (A.R.B. / DMMF)	ASH % (A.R.B. / DMMF)	V.M. % (A.R.B. / DMMF)	F.C. % (A.R.B. / DMMF)	S % (A.R.B.)	Rom	Romax	Total Huminite	Total Inertinite	Total Liptinite
	TOTAL NET COAL		0.83 0.24											
OCCASIONAL BRIGHT COAL BANDS	ROOF													
	PAINTEARTH A-C	N	0.15											
		M	0.24	17.2	20.57 / 22.08	6.1	34.6 / 44.7	42.1 / 55.3	0.46			92.8	1.6	5.6
ABUNDANT BRIGHT COAL LENSES		L	0.08											
ABUNDANT PLANT FRAGMENTS		K	0.36											
	FLOOR													
		J	0.60											
		I	0.33											
	ROOF													
	D-E	H	0.27	12.0	21.37 / 24.32	11.6	34.2 / 43.7	42.8 / 56.3	0.47			88.6	7.6	3.8
		G	0.17	18.1	11.88 / 20.04	24.5	22.9 / 47.9	22.4 / 38.0	0.23					
		F	0.07											
	PAINTEARTH F-G	E	0.30	17.2	18.88 / 22.81	15.6	34.8 / 44.6	36.4 / 55.4	0.40			82.2	11.2	6.6
		D	0.60	14.4	21.31 / 23.88	9.8	34.2 / 44.5	41.6 / 55.5	0.45			83.8	10.2	6.0
		C	0.05											
	H-I	B	0.59	12.4	21.62 / 24.58	10.2	34.9 / 44.3	42.6 / 55.7	0.49			92.2	4.6	3.8
	FLOOR													
NOTE: COAL SAMPLES FROM UNOXIDIZED FACE OF PAINTEARTH MINE	TOTAL NET COAL	A	2.06 1.76											
				COMPOSITE ANALYSES										
				14.2	20.96	10.5	34.0	41.3	0.48			87.8	7.1	5.1

LEGEND

- Bright
- Bright banded
- Dull and bright
- Dull banded
- Dull
- Bone coal
- Carbonaceous claystone
- Mudstone
- Bentonitic mudstone
- Concretion
- Sandstone
- Siltstone

BATTLE RIVER COALFIELD

TRENCH: CQ 605

SCALE: 0 Metres 1

LOCATION:

NORTHING 5807160
EASTING 421990
ZONE 11

LSD. _____
SEC. _____
TWP. _____
RGE. _____
MER. _____

DESCRIPTIVE COMMENTS		COAL ZONE	SAMPLE NUMBER	THICKNESS (metres)	CHEMICAL ANALYSES						PETROGRAPHIC ANALYSES				
					H_2O (A.R.B.)	C.V. MJ/Kg (A.R.B. / MMF)	ASH % (A.R.B.)	V.M. % (A.R.B. / DMMF)	F.C. % (A.R.B. / DMMF)	S % (A.R.B.)	Rom	Romax	Total Huminite	Total Inertinite	Total Liptinite
ROOF OF SEAM NOT EXPOSED		ROOF	F	0.13	15.1	20.13 / 28.46	12.7	38.8 / 45.9	33.8 / 39.1	0.31			84.8	8.8	4.4
			E	0.16											
		PAINTEARTH D-I	D	0.21	14.4	21.13 / 28.81	10.2	38.8 / 45.7	41.8 / 54.5	0.44			84.0	4.6	4.9
			C	0.02											
			B	0.40	16.3	19.69 / 28.24	18.9	32.6 / 45.6	37.3 / 54.4	0.43			90.4	5.0	4.6
		FLOOR	A	0.04	21.9										
NOTE: COAL SAMPLES FROM UNOXIDIZED FACE OF PAINTEARTH MINE		TOTAL NET COAL		0.96 0.78	COMPOSITE ANALYSES										

LEGEND

- Bright
- Bright banded
- Dull and bright
- Dull banded
- Dull
- Bone coal
- Carbonaceous claystone
- Mudstone
- Bentonitic mudstone
- Concretion
- Sandstone
- Siltstone

BATTLE RIVER COALFIELD

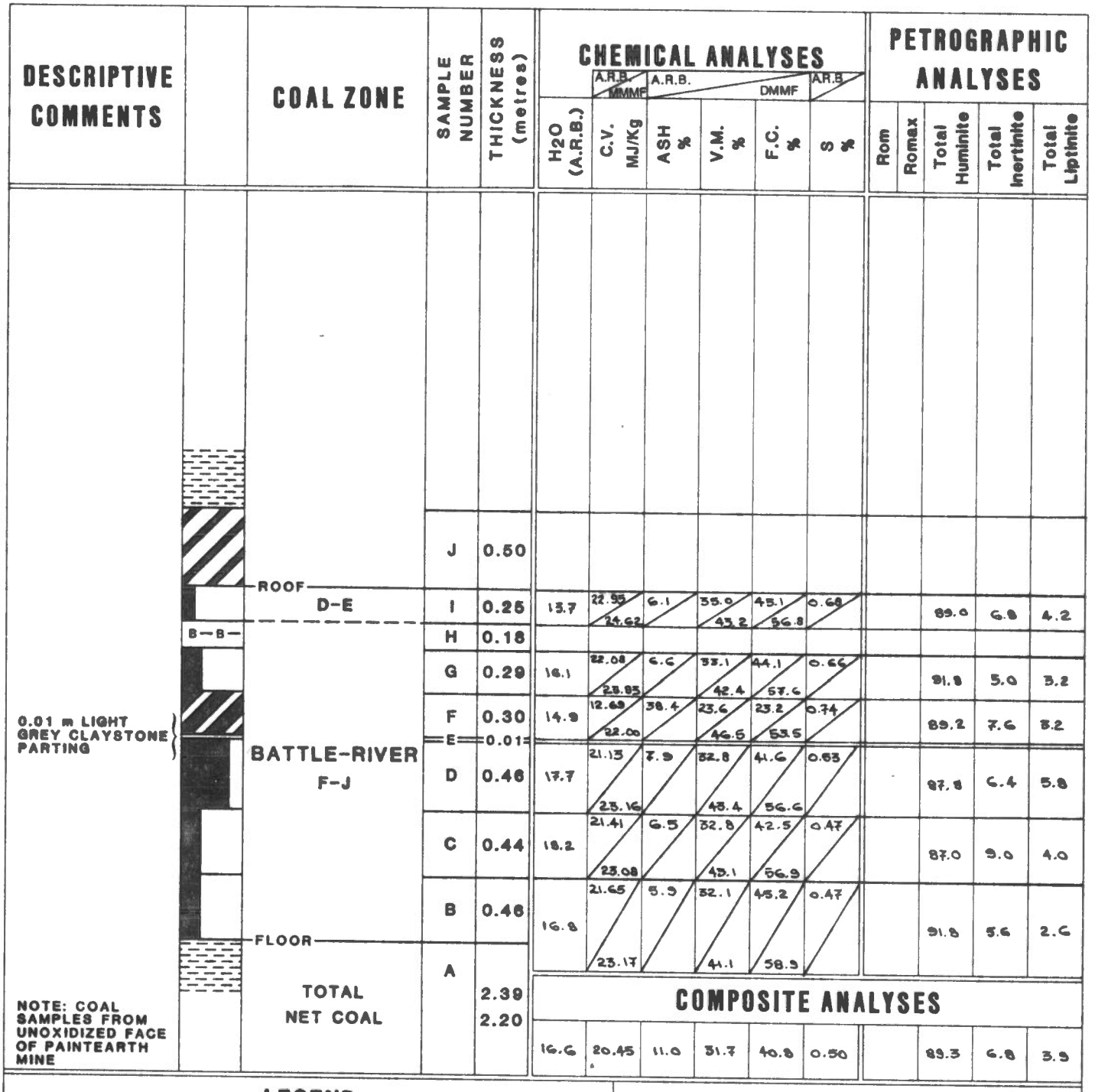
TRENCH: CQ 606

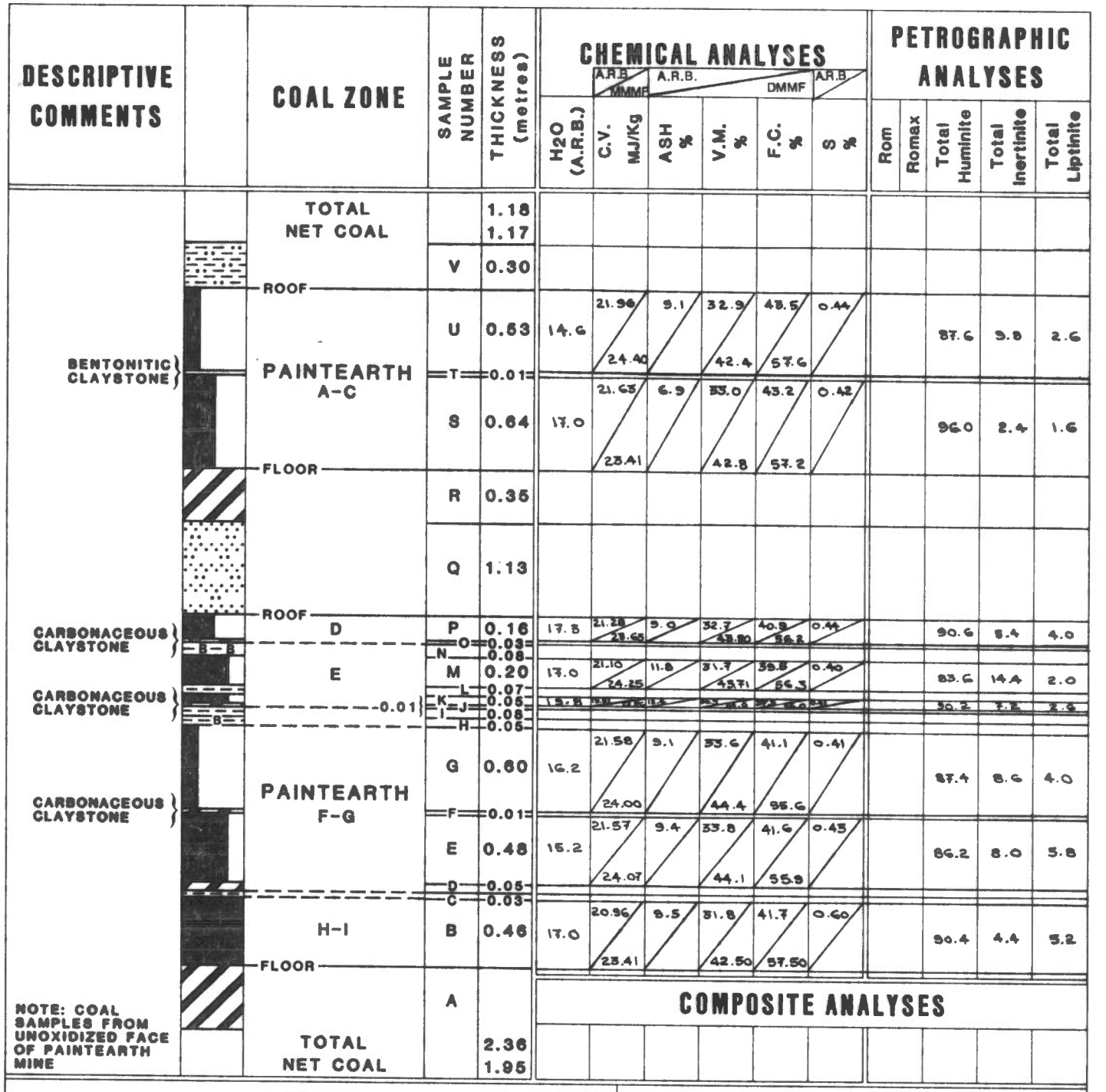
SCALE: 0 Metres 1

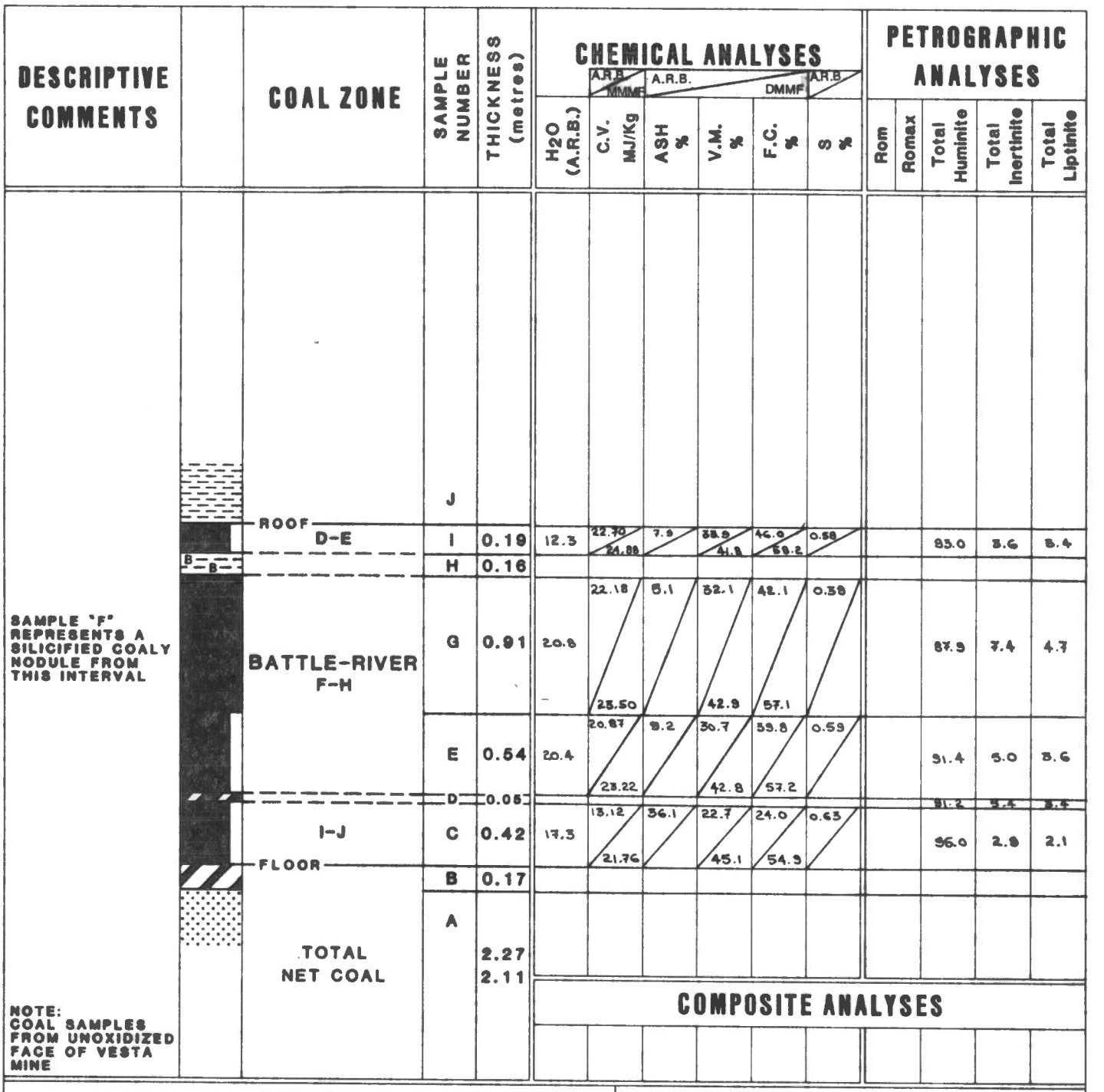
LOCATION:

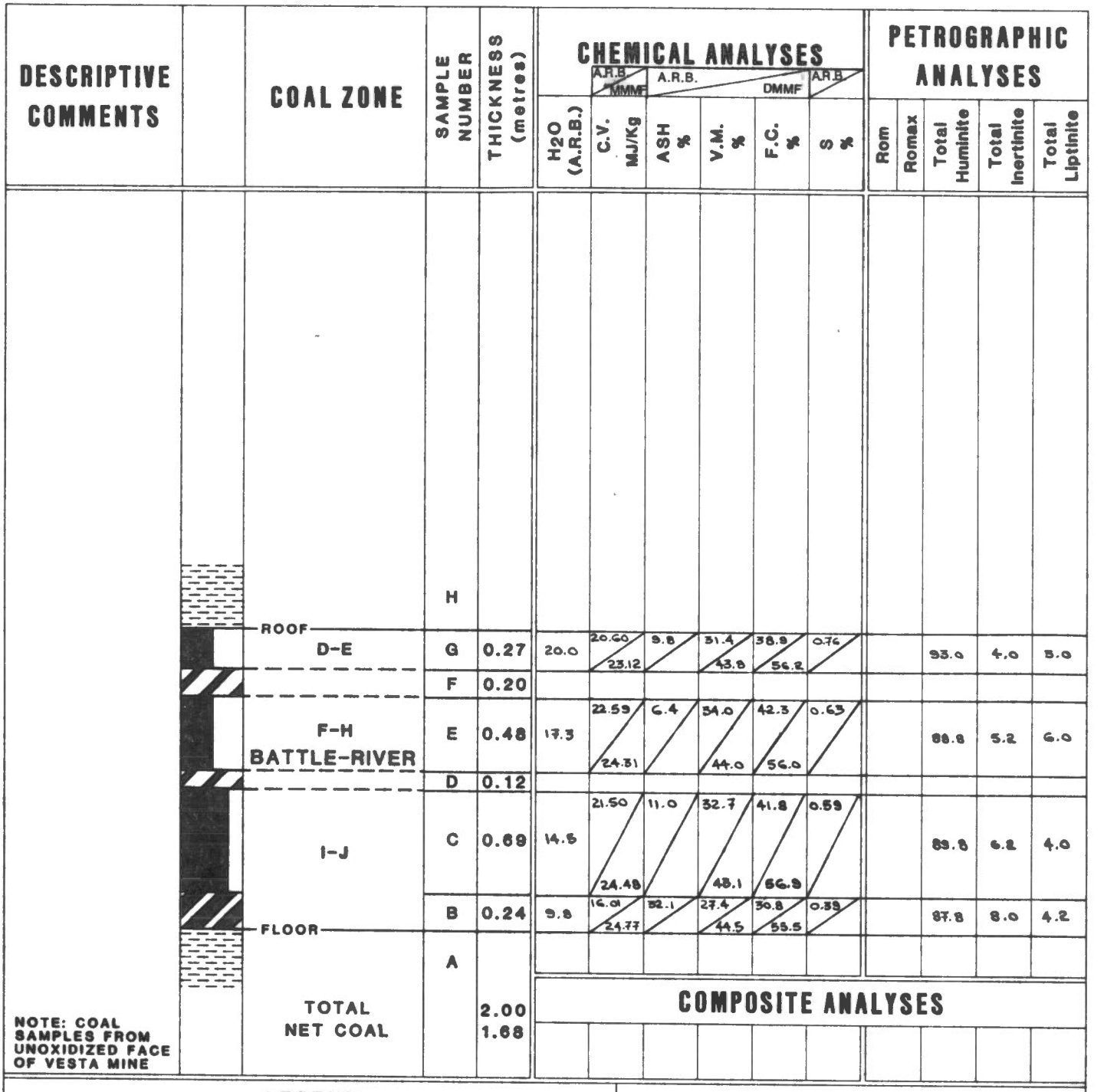
NORTHING 5807500
EASTING 421900
ZONE 11

LSD. _____
SEC. _____
TWP. _____
RGE. _____
MER. _____


DESCRIPTIVE COMMENTS
COAL ZONE
SAMPLE NUMBER
THICKNESS (metres)
CHEMICAL ANALYSES
A.R.B. / MMMF
A.R.B. / DMMF
A.R.B.
H2O (A.R.B.)
C.V. MJ/Kg
ASH %
V.M. %
F.C. %
S %
PETROGRAPHIC ANALYSES
Rom
Romax
Total Huminite
Total Inertinite
Total Liptinite
ROOF
D-E
J 0.50
I 0.25 13.7 22.55 / 24.62 6.1 35.0 / 43.2 45.1 / 56.8 0.68 89.0 6.8 4.2
B-B
H 0.18
G 0.29 16.1 22.08 / 28.85 6.6 33.1 / 42.4 44.1 / 57.6 0.66 91.8 5.0 3.2
F 0.30 14.9 12.69 / 22.00 38.4 23.6 / 46.5 23.2 / 53.5 0.74 89.2 7.6 3.2
0.01 m LIGHT GREY CLAYSTONE PARTING
E 0.01
BATTLE-RIVER F-J
D 0.46 17.7 21.13 / 25.16 7.9 32.8 / 43.4 41.6 / 56.6 0.63 87.8 6.4 5.8
C 0.44 18.2 21.41 / 25.08 6.5 32.8 / 43.1 42.5 / 56.9 0.47 87.0 9.0 4.0
B 0.46 16.8 21.65 / 25.17 5.9 32.1 / 41.1 45.2 / 58.9 0.47 91.8 5.6 2.6
FLOOR
A
TOTAL 2.39
NET COAL 2.20
COMPOSITE ANALYSES
16.6 20.45 11.0 31.7 40.8 0.50 89.3 6.8 3.9
NOTE: COAL SAMPLES FROM UNOXIDIZED FACE OF PAINTEARTH MINE
LEGEND
Bright
Bright banded
Dull and bright
Dull banded
Dull
Bone coal
Carbonaceous claystone
Mudstone
B-B-B Bentonitic mudstone
C-C-C Concretion
Sandstone
Siltstone
BATTLE RIVER COALFIELD
TRENCH: CQ 607
SCALE: 0 Metres 1
LOCATION:
NORTHING 5809700
EASTING 421120
ZONE 11
LSD.
SEC.
TWP.
RGE.
MER.


DESCRIPTIVE COMMENTS
COAL ZONE
SAMPLE NUMBER
THICKNESS (metres)
CHEMICAL ANALYSES
A.R.B. MMMF
A.R.B.
DMMF
A.R.B.
H2O (A.R.B.)
C.V. MJ/Kg
ASH %
V.M. %
F.C. %
S %
PETROGRAPHIC ANALYSES
Rom
Romax
Total Huminite
Total Inertinite
Total Liptinite
TOTAL NET COAL
1.18
1.17
V 0.30
ROOF
BENTONITIC CLAYSTONE
PAINTEARTH A-C
U 0.53
14.6
21.96
24.40
9.1
32.9
42.4
48.5
57.6
0.44
87.6
9.8
2.6
T 0.01
S 0.64
17.0
21.63
23.41
6.9
33.0
42.8
43.2
57.2
0.42
96.0
2.4
1.6
FLOOR
R 0.35
Q 1.13
ROOF
CARBONACEOUS CLAYSTONE
D
P 0.16
17.8
21.28
23.65
9.0
32.7
43.80
40.8
56.2
0.44
90.6
5.4
4.0
O 0.03
N 0.08
E
M 0.20
17.0
21.10
24.25
11.8
31.9
43.71
39.8
55.3
0.40
83.6
14.4
2.0
CARBONACEOUS CLAYSTONE
L 0.07
K 0.05
-0.01
J 0.05
I 0.08
H 0.05
PAINTEARTH F-G
G 0.60
16.2
21.58
24.00
9.1
33.6
44.4
41.1
55.6
0.41
87.4
8.6
4.0
CARBONACEOUS CLAYSTONE
F 0.01
E 0.48
15.2
21.57
24.07
9.4
33.8
44.1
41.6
55.9
0.45
86.2
8.0
5.8
D 0.05
C 0.03
H-I
B 0.46
17.0
20.96
23.41
9.5
31.8
42.50
41.7
57.50
0.60
90.4
4.4
5.2
FLOOR
A
COMPOSITE ANALYSES
NOTE: COAL SAMPLES FROM UNOXIDIZED FACE OF PAINTEARTH MINE
TOTAL NET COAL
2.36
1.95
LEGEND
Bright
Bright banded
Dull and bright
Dull banded
Dull
Bone coal
Carbonaceous claystone
Mudstone
Bentonitic mudstone
Concretion
Sandstone
Siltstone
BATTLE RIVER COALFIELD
TRENCH: CQ 608
SCALE:
0
Metres
1
LOCATION:
NORTHING 5809500
EASTING 421210
ZONE 11
LSD.
SEC.
TWP.
RGE.
MER.


DESCRIPTIVE COMMENTS
COAL ZONE
SAMPLE NUMBER
THICKNESS (metres)
CHEMICAL ANALYSES
A.R.B. / MMMF
A.R.B. / DMMF
A.R.B.
H2O (A.R.B.)
C.V. MJ/Kg
ASH %
V.M. %
F.C. %
S %
PETROGRAPHIC ANALYSES
Rom
Romax
Total Huminite
Total Inertinite
Total Liptinite
ROOF
D-E
I
0.19
12.3
22.70
24.88
7.9
38.9
41.8
46.0
49.2
0.58
85.0
3.6
3.4
B
B
H
0.16
SAMPLE "F" REPRESENTS A SILICIFIED COALY NODULE FROM THIS INTERVAL
BATTLE-RIVER F-H
G
0.91
20.8
22.18
25.50
5.1
32.1
42.9
42.1
57.1
0.38
87.9
7.4
4.7
E
0.54
20.4
20.87
23.22
8.2
30.7
42.8
39.8
57.2
0.59
91.4
5.0
3.6
D
0.05
91.2
5.4
3.4
I-J
C
0.42
17.3
13.12
21.76
36.1
22.7
45.1
24.0
54.9
0.63
96.0
2.8
2.1
FLOOR
B
0.17
A
TOTAL NET COAL
2.27
2.11
COMPOSITE ANALYSES
NOTE: COAL SAMPLES FROM UNOXIDIZED FACE OF VESTA MINE
LEGEND
Bright
Bright banded
Dull and bright
Dull banded
Dull
Bone coal
Carbonaceous claystone
Mudstone
Bentonitic mudstone
Concretion
Sandstone
Siltstone
BATTLE RIVER COALFIELD
TRENCH: CQ 609
SCALE:
0
Metres
1
LOCATION:
NORTHING 5811040
EASTING 420170
ZONE 11
LSD.
SEC.
TWP.
RGE.
MER.


DESCRIPTIVE COMMENTS
COAL ZONE
SAMPLE NUMBER
THICKNESS (metres)
CHEMICAL ANALYSES
A.R.B. MMMF
A.R.B. DMMF
A.R.B.
H2O (A.R.B.)
C.V. MJ/Kg
ASH %
V.M. %
F.C. %
S %
PETROGRAPHIC ANALYSES
Rom
Romax
Total Huminite
Total Inertinite
Total Liptinite
ROOF
D-E
G
0.27
20.0
20.60
23.12
9.8
31.4
43.8
38.9
56.2
0.76
93.0
4.0
3.0
F
0.20
F-H
BATTLE-RIVER
E
0.48
17.3
22.59
24.31
6.4
34.0
44.0
42.3
56.0
0.63
88.8
5.2
6.0
D
0.12
I-J
C
0.69
14.5
21.50
24.48
11.0
32.7
48.1
41.8
56.9
0.59
89.8
6.2
4.0
B
0.24
9.8
16.01
24.77
12.1
27.4
44.5
30.8
55.5
0.38
87.8
8.0
4.2
FLOOR
A
TOTAL NET COAL
2.00
1.68
COMPOSITE ANALYSES
NOTE: COAL SAMPLES FROM UNOXIDIZED FACE OF VESTA MINE
LEGEND
Bright
Bright banded
Dull and bright
Dull banded
Dull
Bone coal
Carbonaceous claystone
Mudstone
Bentonitic mudstone
Concretion
Sandstone
Siltstone
BATTLE RIVER COALFIELD
TRENCH: CQ 610
SCALE:
0
Metres
1
LOCATION:
NORTHING 5811020
EASTING 420590
ZONE 11
LSD.
SEC.
TWP.
RGE.
MER.

DESCRIPTIVE COMMENTS	COAL ZONE	SAMPLE NUMBER	THICKNESS (metres)	CHEMICAL ANALYSES						PETROGRAPHIC ANALYSES				
				H_2O (A.R.B.)	C.V. MJ/Kg (A.R.B. / MMMF)	ASH % (A.R.B. / DMMF)	V.M. % (A.R.B. / DMMF)	F.C. % (A.R.B. / DMMF)	S % (A.R.B.)	Rom	Romax	Total Huminite	Total Inertinite	Total Liptinite
		F	0.40											
	ROOF													
	BATTLE-RIVER D-J	E	0.52	20.5	21.36 / 23.19	7.2 /	32.0 / 43.7	40.3 / 56.3	0.55			88.6	7.0	4.4
		D	0.68	23.0	21.82 / 23.16	5.2 /	31.4 / 43.3	40.3 / 56.7	0.47			88.2	5.0	6.8
		C	0.68	14.4	23.23 / 24.86	5.9 /	35.2 / 43.7	44.5 / 56.3	0.47			88.6	4.2	7.2
		B	0.41	12.8	24.05 / 24.70	17.1 /	32.1 / 44.6	38.0 / 55.4	0.46			88.0	8.4	3.6
	FLOOR	A	0.21	11.3	14.89 / 24.32	33.2 /	27.3 / 48.3	26.8 / 51.7	0.42					
NOTE: COAL SAMPLES TAKEN FROM UNOXIDIZED FACE OF VESTA MINE	TOTAL NET COAL		2.29 2.29	COMPOSITE ANALYSES										

LEGEND

- Bright
- Bright banded
- Dull and bright
- Dull banded
- Dull
- Bone coal
- Carbonaceous claystone
- Mudstone
- Bentonitic mudstone
- Concretion
- Sandstone
- Siltstone

BATTLE RIVER COALFIELD

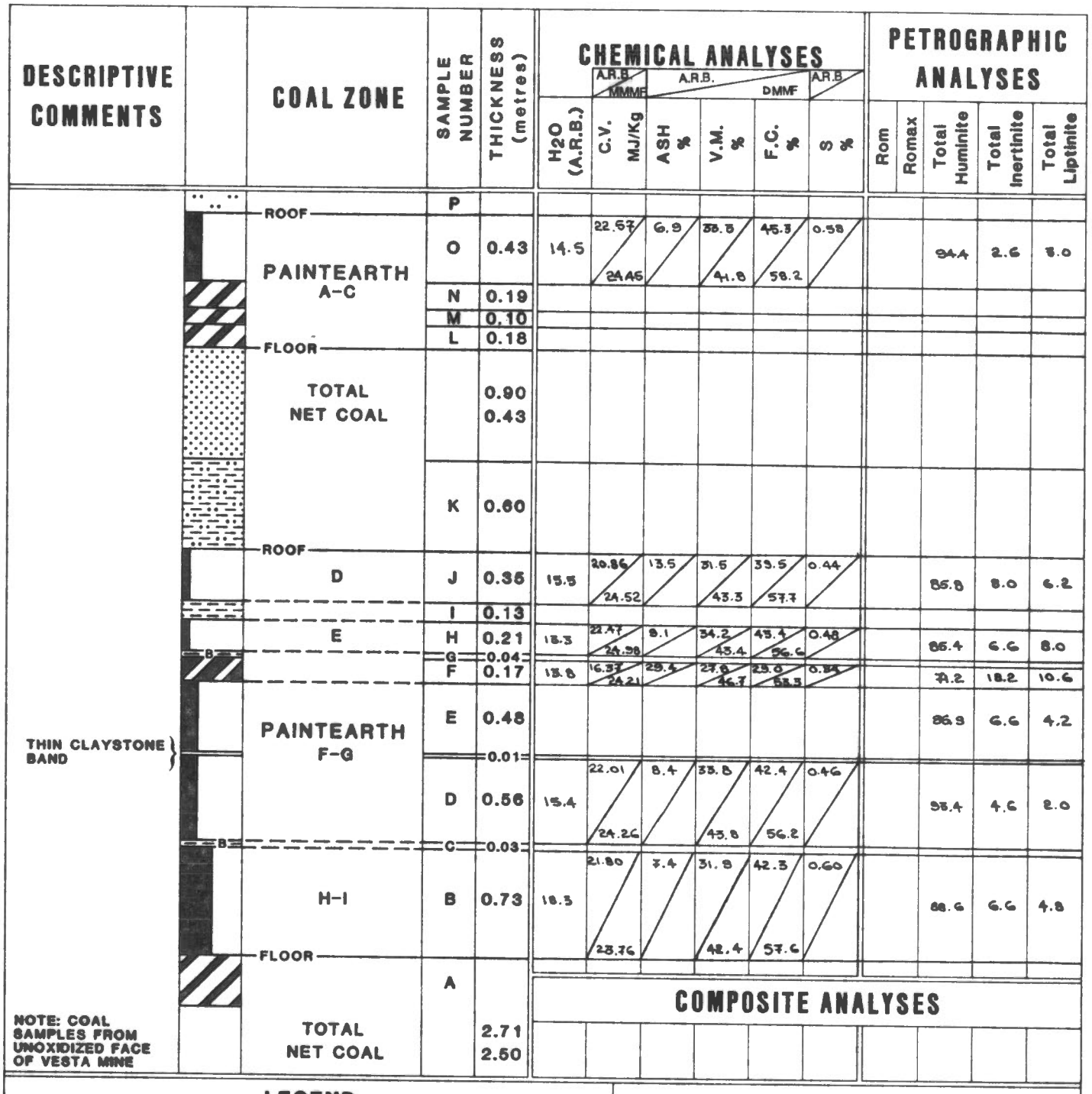
TRENCH: CQ 611

SCALE: 0 Metres 1

LOCATION:

NORTHING 5811020
EASTING 420960
ZONE 11

LSD. _____
SEC. _____
TWP. _____
RGE. _____
MER. _____


DESCRIPTIVE COMMENTS
COAL ZONE
SAMPLE NUMBER
THICKNESS (metres)
CHEMICAL ANALYSES
A.R.B. / MMMF
A.R.B.
DMMF
A.R.B.
H2O (A.R.B.)
C.V. MJ/Kg
ASH %
V.M. %
F.C. %
S %
PETROGRAPHIC ANALYSES
Rom
Romax
Total Huminite
Total Inertinite
Total Liptinite
ROOF
PAINTEARTH A-C
P
O 0.43
N 0.19
M 0.10
L 0.18
FLOOR
TOTAL NET COAL
0.90
0.43
K 0.60
ROOF
D
J 0.36
I 0.13
E
H 0.21
G 0.04
F 0.17
PAINTEARTH F-G
E 0.48
0.01
D 0.56
C 0.03
H-I
B 0.73
FLOOR
A
TOTAL NET COAL
2.71
2.50
THIN CLAYSTONE BAND
NOTE: COAL SAMPLES FROM UNOXIDIZED FACE OF VESTA MINE
COMPOSITE ANALYSES
LEGEND
Bright
Bright banded
Dull and bright
Dull banded
Dull
Bone coal
Carbonaceous claystone
Mudstone
Bentonitic mudstone
Concretion
Sandstone
Siltstone
BATTLE RIVER COALFIELD
TRENCH: CQ 612
SCALE:
0
Metres
1
LOCATION:
NORTHING 5811000
EASTING 421700
ZONE 11
LSD.
SEC.
TWP.
RGE.
MER.

DESCRIPTIVE COMMENTS		COAL ZONE	SAMPLE NUMBER	THICKNESS (metres)	CHEMICAL ANALYSES						PETROGRAPHIC ANALYSES				
					H_2O (A.R.B.)	C.V. MJ/Kg (A.R.B. / MMMF)	ASH % (A.R.B. / DMMF)	V.M. % (A.R.B. / DMMF)	F.C. % (A.R.B. / DMMF)	S % (A.R.B. / DMMF)	Rom	Romax	Total Huminite	Total Inertinite	Total Liptinite
EROSIONAL CONTACT WITH OVERLYING TILL		ROOF	D	0.16	20.60	21.47 / 23.05	6.2	31.8 / 42.8	41.5 / 57.2	0.45			92.4	3.4	4.2
		D-H	C	0.64	21.80	21.64 / 23.35	6.6	32.1 / 44.4	39.4 / 55.6	0.43			88.2	6.8	6.0
CARBONACEOUS CLAYSTONE		BATTLE-RIVER	B	0.03											
		I-J	A	0.56	22.70	21.74 / 23.47	6.6	30.6 / 42.7	40.1 / 57.3	0.46			94.8	2.6	2.6
		FLOOR													
		TOTAL NET COAL		1.39 1.36	COMPOSITE ANALYSES										

NOTE: COAL SAMPLES FROM UNOXIDIZED FACE OF DIPLOMAT MINE

LEGEND

- Bright
- Bright banded
- Dull and bright
- Dull banded
- Dull
- Bone coal
- Carbonaceous claystone
- Mudstone
- Bentonitic mudstone
- Concretion
- Sandstone
- Siltstone

BATTLE RIVER COALFIELD

TRENCH: CQ 613

SCALE: 0 Metres 1

LOCATION:

NORTHING 5819500
EASTING 416600
ZONE 11

LSD. _____
SEC. _____
TWP. _____
RGE. _____
MER. _____

DESCRIPTIVE COMMENTS		COAL ZONE	SAMPLE NUMBER	THICKNESS (metres)	CHEMICAL ANALYSES						PETROGRAPHIC ANALYSES				
					H_2O (A.R.B.)	C.V. MJ/Kg (A.R.B. / MMMF)	ASH % (A.R.B. / DMMF)	V.M. % (A.R.B. / DMMF)	F.C. % (A.R.B. / DMMF)	S % (A.R.B. / DMMF)	Rom	Romax	Total Huminite	Total Inertinite	Total Liptinite
EROSIONAL CONTACT WITH OVERLYING TILL COAL HIGHLY WEATHERED		ROOF													
		D-I BATTLE-RIVER	H	0.14	19.2	18.58 / 21.70	13.9	32.2 / 36.5	35.6 / 42.5	0.42			80.0	3.8	6.2
			G	0.40	15.4	21.86 / 23.66	6.9	34.6 / 44.0	43.1 / 56.0	0.41			88.8	5.4	5.8
			F	0.40	14.5	22.88 / 24.48	5.9	35.7 / 44.3	44.1 / 55.7	0.45			88.4	5.4	6.2
			E	0.33	18.6	20.71 / 23.12	9.4	33.2 / 45.4	38.8 / 54.6	0.36			88.4	6.6	5.0
BENTONITIC CLAYSTONE			D	0.01											
		J	C	0.15	14.6	21.12 / 24.23	12.0	33.0 / 44.2	40.4 / 55.8	0.44			88.4	4.6	7.0
			B	0.16	14.1	8.82 / 21.74	45.8	19.2 / 43.4	16.8 / 52.6	0.22			87.0	12.0	1.0
		FLOOR													
			A												
		TOTAL NET COAL		1.59 1.58											

NOTE: COAL SAMPLES FROM UNOXIDIZED FACE OF DIPLOMAT MINE

COMPOSITE ANALYSES

LEGEND

- Bright
- Bright banded
- Dull and bright
- Dull banded
- Dull
- Bone coal
- Carbonaceous claystone
- Mudstone
- Bentonitic mudstone
- Concretion
- Sandstone
- Siltstone

BATTLE RIVER COALFIELD

TRENCH: CQ 614

SCALE: 0 Metres 1

LOCATION:

NORTHING 5819350
EASTING 418650
ZONE 11

LSD. _____
SEC. _____
TWP. _____
RGE. _____
MER. _____

DESCRIPTIVE COMMENTS		COAL ZONE	SAMPLE NUMBER	THICKNESS (metres)	CHEMICAL ANALYSES						PETROGRAPHIC ANALYSES				
					H_2O (A.R.B.)	C.V. MJ/Kg (A.R.B. / MMMF)	ASH % (A.R.B.)	V.M. % (A.R.B. / DMMF)	F.C. % (A.R.B. / DMMF)	S % (A.R.B.)	Rom	Romax	Total Huminite	Total Inertinite	Total Liptinite
			K												
		ROOF													
		D-E	J	0.20	27.1	14.18 / 17.46	17.0	30.3 / 47.1	25.7 / 52.9	0.44			83.4	8.4	8.2
			I	0.40											
			H	0.21	25.9	19.78 / 26.97	5.1	33.4 / 51.9	35.6 / 48.1	0.36			85.8	7.2	7.0
			G	0.40	22.3	19.81 / 21.33	6.4	33.0 / 54.1	38.2 / 45.9	0.45			89.0	5.6	5.4
		BATTLE-RIVER F-H	F	0.60	20.0	20.64 / 22.05	5.9	34.9 / 53.3	39.1 / 46.8	0.41			89.8	5.6	4.6
			E	0.45	17.4	17.39 / 22.20	19.7	30.1 / 53.7	32.9 / 46.3	0.38			88.2	7.2	4.6
		B	D	0.06											
		I-J	C	0.51	17.4	21.45 / 25.63	8.3	32.9 / 56.3	41.4 / 43.7	0.41			89.2	6.4	4.4
		FLOOR	B	0.09	3.6	5.91 / 25.36	68.6	18.1 / 40.5	8.7 / 59.1	0.18					
			A	0.50											
		TOTAL NET COAL		2.83 2.37											
OUTCROP SECTION					COMPOSITE ANALYSES										

LEGEND

- Bright
- Bright banded
- Dull and bright
- Dull banded
- Dull
- Bone coal
- Carbonaceous claystone
- Mudstone
- Bentonitic mudstone
- Concretion
- Sandstone
- Siltstone

BATTLE RIVER COALFIELD

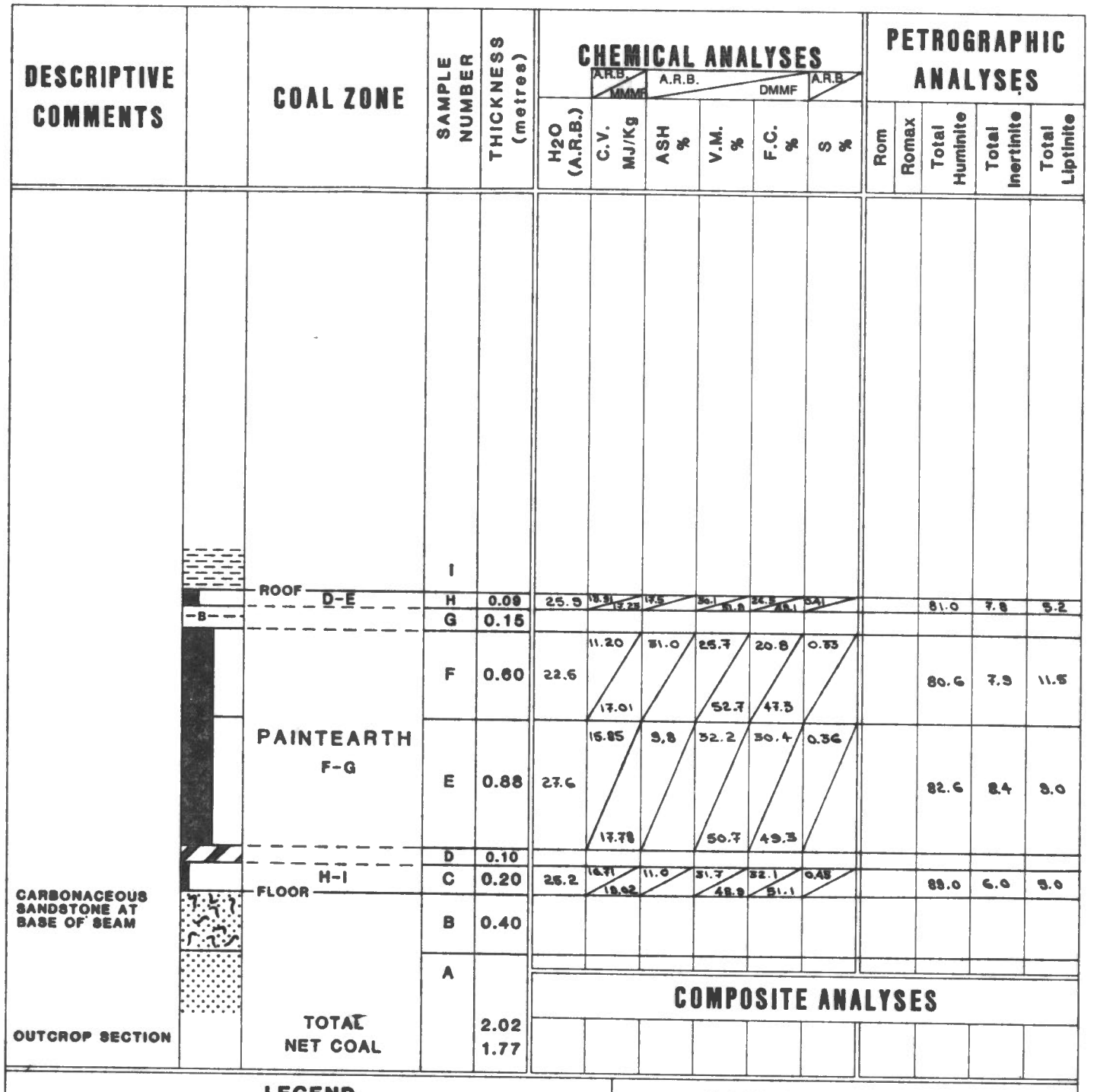
TRENCH: CQ 615

SCALE: 0 Metres 1

LOCATION:

NORTHING 5816000
EASTING 419870
ZONE 11

LSD. _____
SEC. _____
TWP. _____
RGE. _____
MER. _____


DESCRIPTIVE COMMENTS
COAL ZONE
SAMPLE NUMBER
THICKNESS (metres)
CHEMICAL ANALYSES
A.R.B. / MMMF
A.R.B. DMMF
A.R.B.
H2O (A.R.B.)
C.V. MJ/Kg
ASH %
V.M. %
F.C. %
S %
PETROGRAPHIC ANALYSES
Rom
Romax
Total Huminite
Total Inertinite
Total Liptinite
ROOF
D-E
-B-
H-I
FLOOR
PAINTEARTH
F-G
CARBONACEOUS SANDSTONE AT BASE OF SEAM
OUTCROP SECTION
I
H 0.09 25.9 18.91 / 17.28 17.5 36.1 / 31.8 24.8 / 48.1 0.41 81.0 7.8 5.2
G 0.15
F 0.60 22.6 11.20 / 17.01 31.0 25.7 / 52.7 20.8 / 47.3 0.33 80.6 7.9 11.5
E 0.88 27.6 16.85 / 17.78 9.8 32.2 / 50.7 30.4 / 49.3 0.36 82.6 8.4 9.0
D 0.10
C 0.20 25.2 16.71 / 19.92 11.0 31.7 / 48.9 32.1 / 51.1 0.48 88.0 6.0 5.0
B 0.40
A
TOTAL 2.02
NET COAL 1.77
COMPOSITE ANALYSES
LEGEND
Bright
Bright banded
Dull and bright
Dull banded
Dull
Bone coal
Carbonaceous claystone
Mudstone
Bentonitic mudstone
Concretion
Sandstone
Siltstone
BATTLE RIVER COALFIELD
TRENCH: CQ 616
SCALE: 0 Metres 1
LOCATION:
NORTHING 5799300
EASTING 422640
ZONE 11
LSD.
SEC.
TWP.
RGE.
MER.

DESCRIPTIVE COMMENTS		COAL ZONE	SAMPLE NUMBER	THICKNESS (metres)	CHEMICAL ANALYSES						PETROGRAPHIC ANALYSES				
					H2O (A.R.B.)	C.V. MJ/Kg (A.R.B. / MMMF)	ASH % (A.R.B.)	V.M. % (A.R.B. / DMMF)	F.C. % (A.R.B. / DMMF)	S % (A.R.B.)	Rom	Romax	Total Huminite	Total Inertinite	Total Liptinite
ABUNDANT SULPHUR STAINING			C												
		ROOF													
		BATTLE-RIVER D-E	B	0.5	14.7	18.13 / 20.08	8.8	40.1 / 51.8	36.4 / 48.2	0.83			88.0	6.0	6.0
		FLOOR													
			A	0.4											
		TOTAL NET COAL		0.50											
				0.50											
OUTCROP SECTION															

COMPOSITE ANALYSES

LEGEND

- Bright
- Bright banded
- Dull and bright
- Dull banded
- Dull
- Bone coal
- Carbonaceous claystone
- Mudstone
- Bentonitic mudstone
- Concretion
- Sandstone
- Siltstone

BATTLE RIVER COALFIELD

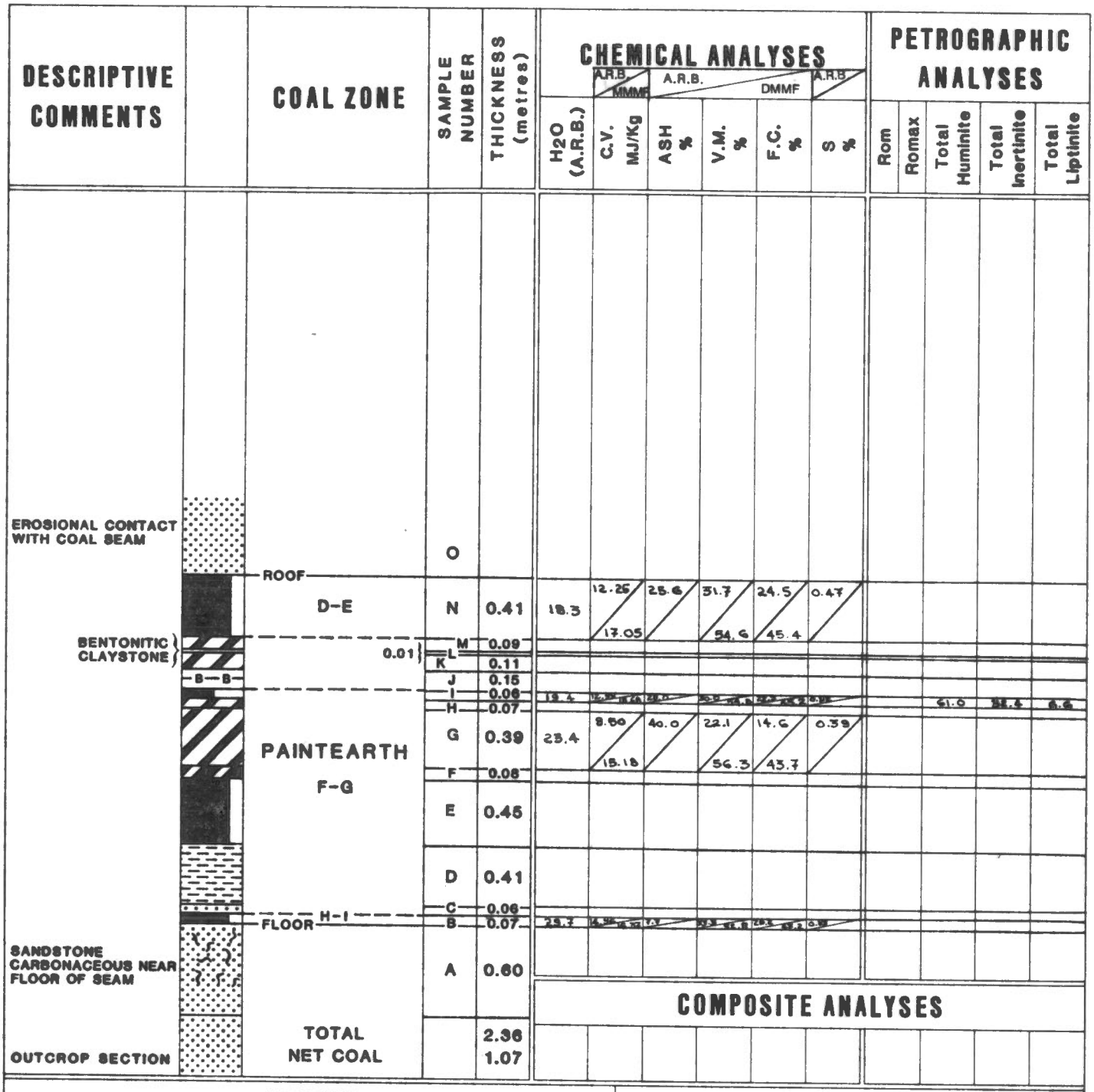
TRENCH: CQ 617

SCALE: 0 Metres 1

LOCATION:

NORTHING 5803900
EASTING 427520
ZONE 11

LSD. _____
SEC. _____
TWP. _____
RGE. _____
MER. _____


DESCRIPTIVE COMMENTS
COAL ZONE
SAMPLE NUMBER
THICKNESS (metres)
CHEMICAL ANALYSES
A.R.B. / M.M.M.F.
A.R.B.
D.M.M.F.
A.R.B.
H2O (A.R.B.)
C.V. MJ/Kg
ASH %
V.M. %
F.C. %
S %
PETROGRAPHIC ANALYSES
Rom
Romax
Total Huminite
Total Inertinite
Total Liptinite
EROSIONAL CONTACT WITH COAL SEAM
O
ROOF
D-E
N
0.41
18.3
12.25
17.05
25.6
31.7
54.6
24.5
45.4
0.47
BENTONITIC CLAYSTONE
0.01
M
0.09
L
K
0.11
B—B
J
0.15
I
0.06
H
0.07
61.0
38.4
6.6
PAINTEARTH
F-G
G
0.39
23.4
8.80
15.18
40.0
22.1
56.3
14.6
43.7
0.39
F
0.08
E
0.45
D
0.41
C
0.06
H-I
FLOOR
B
0.07
SANDSTONE CARBONACEOUS NEAR FLOOR OF SEAM
A
0.60
COMPOSITE ANALYSES
TOTAL
2.36
OUTCROP SECTION
NET COAL
1.07
LEGEND
Bright
Bright banded
Dull and bright
Dull banded
Dull
Bone coal
Carbonaceous claystone
Mudstone
Bentonitic mudstone
Concretion
Sandstone
Siltstone
BATTLE RIVER COALFIELD
TRENCH: CQ 618
SCALE:
0
Metres
1
LOCATION:
NORTHING 5804250
EASTING 424820
ZONE 11
LSD.
SEC.
TWP.
RGE.
MER.

DESCRIPTIVE COMMENTS		COAL ZONE	SAMPLE NUMBER	THICKNESS (metres)	CHEMICAL ANALYSES						PETROGRAPHIC ANALYSES				
					H_2O (A.R.B.)	C.V. MJ/Kg (A.R.B. / MMMF)	ASH % (A.R.B.)	V.M. % (A.R.B. / DMMF)	F.C. % (A.R.B. / DMMF)	S % (A.R.B.)	Rom	Romax	Total Huminite	Total Inertinite	Total Liptinite
			I												
		ROOF													
		D-E	H	0.44	21.7	14.43 / 17.89	17.3	35.7 / 54.1	27.2 / 45.9	0.68			62.2	27.4	10.4
			G	0.10											
			F	0.18											
		PAINTEARTH	E	0.76											
			D	0.20	22.2	2.06 / 5.4	56.2	15.2 / 65.0	6.3 / 37.0	0.20					
			C	0.11											
		H-I	B	0.07	16.2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			38.0	45.0	17.0
		FLOOR	A												
		TOTAL NET COAL		1.86 0.51	COMPOSITE ANALYSES										
OUTCROP SECTION															

LEGEND

- Bright
- Bright banded
- Dull and bright
- Dull banded
- Dull
- Bone coal
- Carbonaceous claystone
- Mudstone
- Bentonitic mudstone
- Concretion
- Sandstone
- Siltstone

BATTLE RIVER COALFIELD

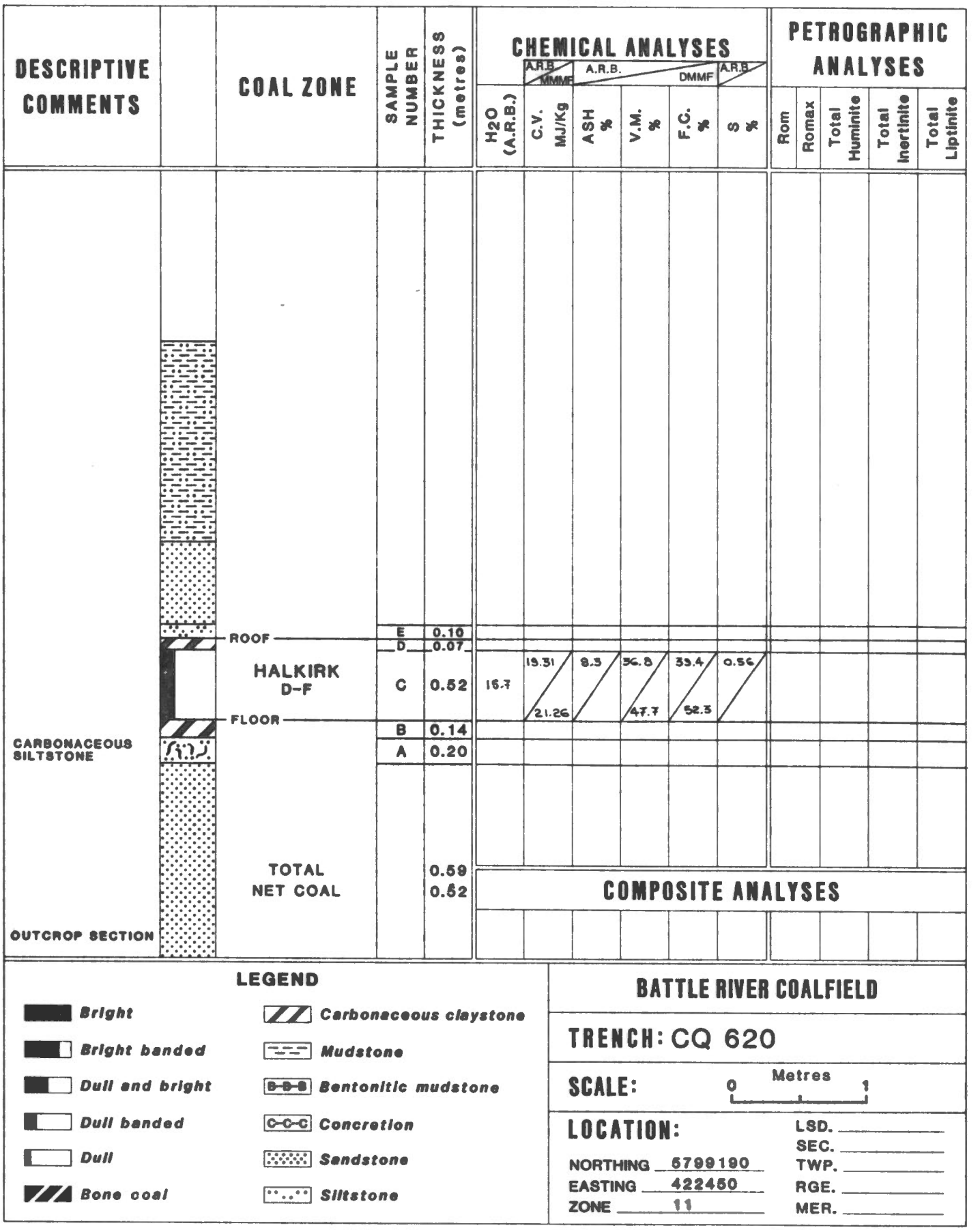
TRENCH: CQ 619

SCALE: 0 Metres 1

LOCATION:

NORTHING 5804250
EASTING 424950
ZONE 11

LSD. _____
SEC. _____
TWP. _____
RGE. _____
MER. _____


DESCRIPTIVE COMMENTS
COAL ZONE
SAMPLE NUMBER
THICKNESS (metres)
CHEMICAL ANALYSES
A.R.B. MMMF
A.R.B. DMMF
A.R.B.
H2O (A.R.B.)
C.V. MJ/Kg
ASH %
V.M. %
F.C. %
S %
PETROGRAPHIC ANALYSES
Rom
Romax
Total Huminite
Total Inertinite
Total Liptinite
ROOF
HALKIRK D-F
FLOOR
CARBONACEOUS SILTSTONE
OUTCROP SECTION
E 0.10
D 0.07
C 0.52
B 0.14
A 0.20
16.7
19.31 / 21.26
8.3
36.8 / 47.7
33.4 / 52.3
0.56
TOTAL 0.59
NET COAL 0.52
COMPOSITE ANALYSES
LEGEND
Bright
Bright banded
Dull and bright
Dull banded
Dull
Bone coal
Carbonaceous claystone
Mudstone
Bentonitic mudstone
Concretion
Sandstone
Siltstone
BATTLE RIVER COALFIELD
TRENCH: CQ 620
SCALE:
0
Metres
1
LOCATION:
NORTHING 5799190
EASTING 422450
ZONE 11
LSD.
SEC.
TWP.
RGE.
MER.

DESCRIPTIVE COMMENTS		COAL ZONE	SAMPLE NUMBER	THICKNESS (metres)	CHEMICAL ANALYSES						PETROGRAPHIC ANALYSES				
					A.R.B. MMMF	A.R.B.			A.R.B. DMMF						
					H_2O (A.R.B.)	C.V. MJ/Kg	ASH %	V.M. %	F.C. %	S %	Rom	Romax	Total Huminite	Total Inertinite	Total Liptinite
		ROOF													
		D-E	D	0.11	13.3	16.65 / 18.35	19.4	35.0 / 32.4	34.8 / 47.6	0.71					
		B-B	C	0.24											
		BATTLE-RIVER F-H	B	0.35	29.3	14.11 / 16.50	13.0	32.5 / 50.10	24.5 / 48.9	0.91					
		FLOOR													
			A												
		TOTAL NET COAL		0.70 0.46	COMPOSITE ANALYSES										
OUTCROP SECTION															

LEGEND

- Bright
- Bright banded
- Dull and bright
- Dull banded
- Dull
- Bone coal
- Carbonaceous claystone
- Mudstone
- Bentonitic mudstone
- Concretion
- Sandstone
- Siltstone

BATTLE RIVER COALFIELD

TRENCH: CQ 621

SCALE: 0 Metres 1

LOCATION:

NORTHING 5804300
EASTING 424580
ZONE 11

LSD. _____
SEC. _____
TWP. _____
RGE. _____
MER. _____

DESCRIPTIVE COMMENTS		COAL ZONE	SAMPLE NUMBER	THICKNESS (metres)	CHEMICAL ANALYSES						PETROGRAPHIC ANALYSES				
					H_2O (A.R.B.)	C.V. MJ/Kg (A.R.B. / MMMF)	ASH % (A.R.B. / DMMF)	V.M. % (A.R.B. / DMMF)	F.C. % (A.R.B. / DMMF)	S % (A.R.B. / DMMF)	Rom	Romax	Total Huminite	Total Inertinite	Total Liptinite
			M												
			L	0.7											
		ROOF													
		D-E	K	0.16	24.8	16.32 / 20.21	8.5 /	38.1 / 48.6	34.1 / 51.4	0.69 /			89.6	6.8	3.6
			J	0.10											
		F-G	I	0.26	22.9	16.96 / 20.91	13.8 /	30.1 / 46.6	35.2 / 53.4	0.49 /			94.6	2.4	3.0
			H	0.06											
		PAINTEARTH	G	0.25											
			F	0.09											
		H	E	0.09											
			D	0.14											
		I	C	0.27	21.6	13.45 / 17.95	22.7 /	29.8 / 51.0	26.3 / 49.0	0.42 /			86.0	11.0	4.0
CARBONACEOUS SANDSTONE		FLOOR	B	0.04											
			A												
		TOTAL NET COAL		1.46 0.69											
OUTCROP SECTION															

COMPOSITE ANALYSES

LEGEND

- Bright
- Bright banded
- Dull and bright
- Dull banded
- Dull
- Bone coal
- Carbonaceous claystone
- Mudstone
- Bentonitic mudstone
- Concretion
- Sandstone
- Siltstone

BATTLE RIVER COALFIELD

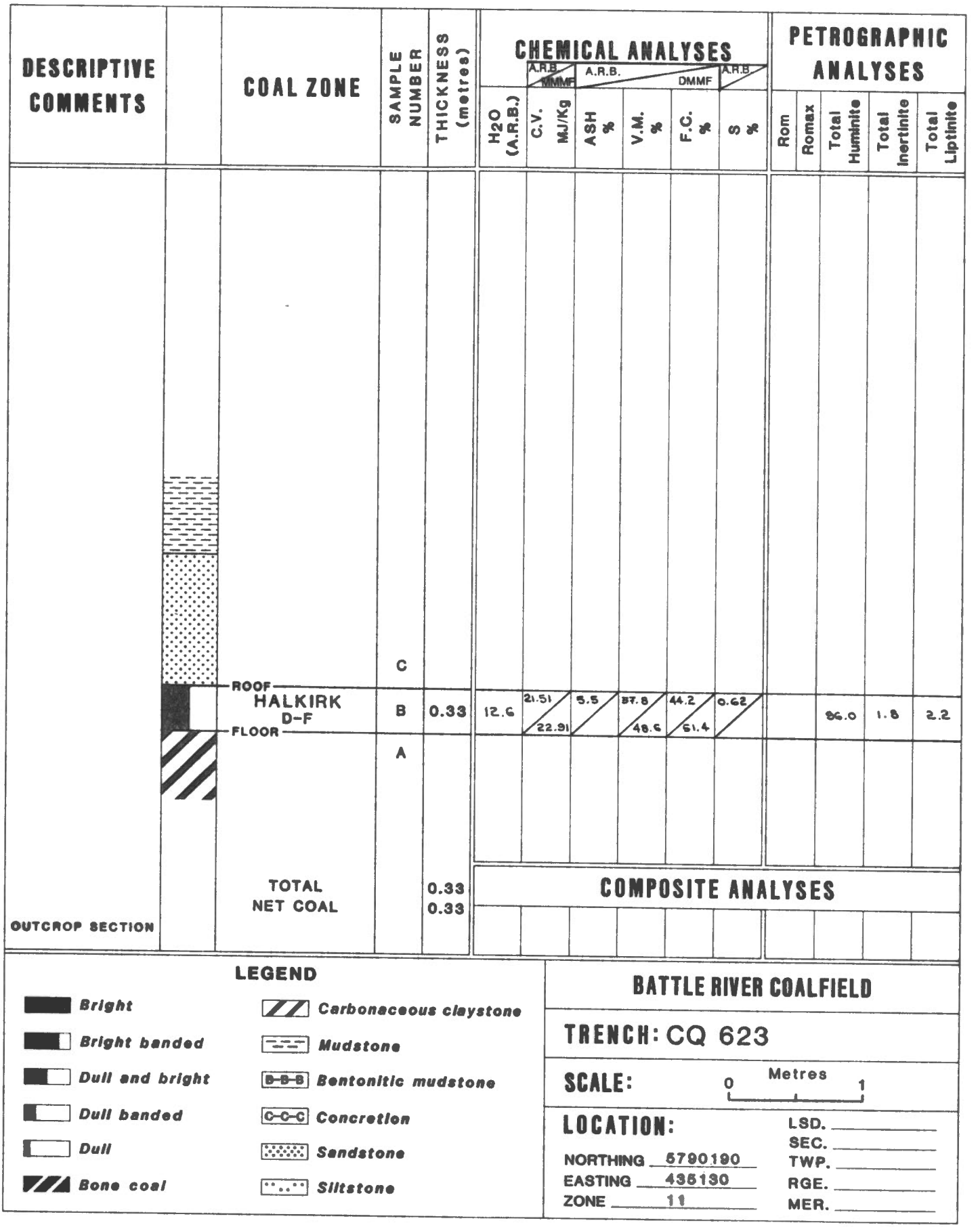
TRENCH: CQ 622

SCALE: 0 — Metres — 1

LOCATION:

NORTHING 5790700
EASTING 439900
ZONE 11

LSD. _____
SEC. _____
TWP. _____
RGE. _____
MER. _____


DESCRIPTIVE COMMENTS
COAL ZONE
SAMPLE NUMBER
THICKNESS (metres)
CHEMICAL ANALYSES
A.R.B. / MMMF
A.R.B. / DMMF
A.R.B.
H2O (A.R.B.)
C.V. MJ/Kg
ASH %
V.M. %
F.C. %
S %
PETROGRAPHIC ANALYSES
Rom
Romax
Total Huminite
Total Inertinite
Total Liptinite
C
ROOF
HALKIRK
D-F
FLOOR
B
0.33
12.6
21.51
22.91
5.5
37.8
48.6
44.2
51.4
0.62
96.0
1.8
2.2
A
TOTAL
NET COAL
0.33
0.33
COMPOSITE ANALYSES
OUTCROP SECTION
LEGEND
Bright
Bright banded
Dull and bright
Dull banded
Dull
Bone coal
Carbonaceous claystone
Mudstone
Bentonitic mudstone
Concretion
Sandstone
Siltstone
BATTLE RIVER COALFIELD
TRENCH: CQ 623
SCALE:
0
Metres
1
LOCATION:
NORTHING 5790190
EASTING 435130
ZONE 11
LSD.
SEC.
TWP.
RGE.
MER.

DESCRIPTIVE COMMENTS		COAL ZONE	SAMPLE NUMBER	THICKNESS (metres)	CHEMICAL ANALYSES						PETROGRAPHIC ANALYSES				
					H_2O (A.R.B.)	C.V. MJ/Kg (A.R.B. / MMMF)	ASH % (A.R.B.)	V.M. % (A.R.B. / DMMF)	F.C. % (A.R.B.)	S % (A.R.B / DMMF)	Rom	Romax	Total Huminite	Total Inertinite	Total Liptinite
			C	0.20											
		ROOF HALKIRK A-C	B	0.41	20.9	16.21 / 18.62	11.7	35.3 / 51.6	32.1 / 48.4	0.41					
		FLOOR	A	0.30											
		TOTAL NET COAL		0.41 0.41	COMPOSITE ANALYSES										
OUTCROP SECTION															

LEGEND

- Bright
- Bright banded
- Dull and bright
- Dull banded
- Dull
- Bone coal
- Carbonaceous claystone
- Mudstone
- Bentonitic mudstone
- Concretion
- Sandstone
- Siltstone

BATTLE RIVER COALFIELD

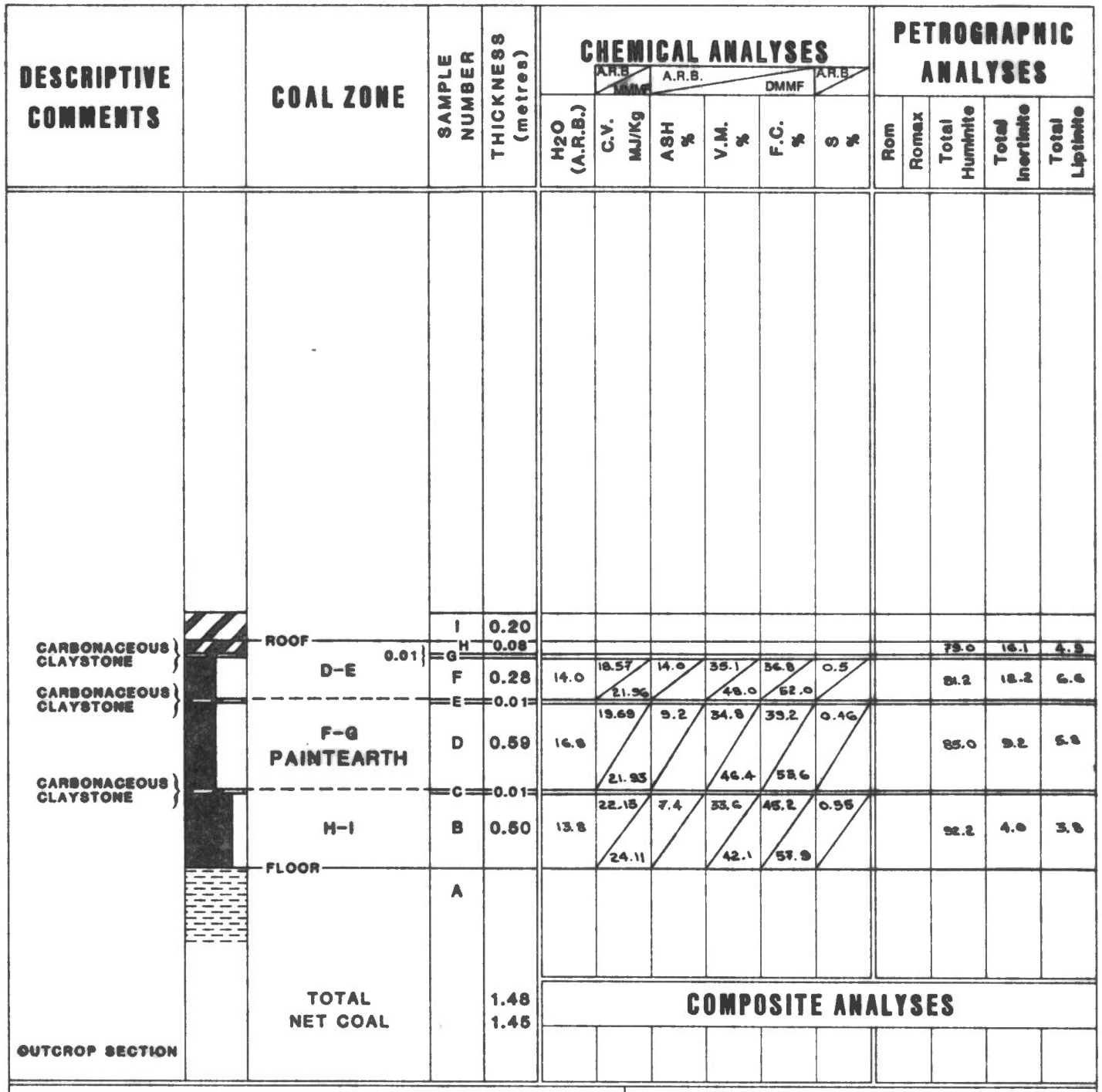
TRENCH: CQ 624

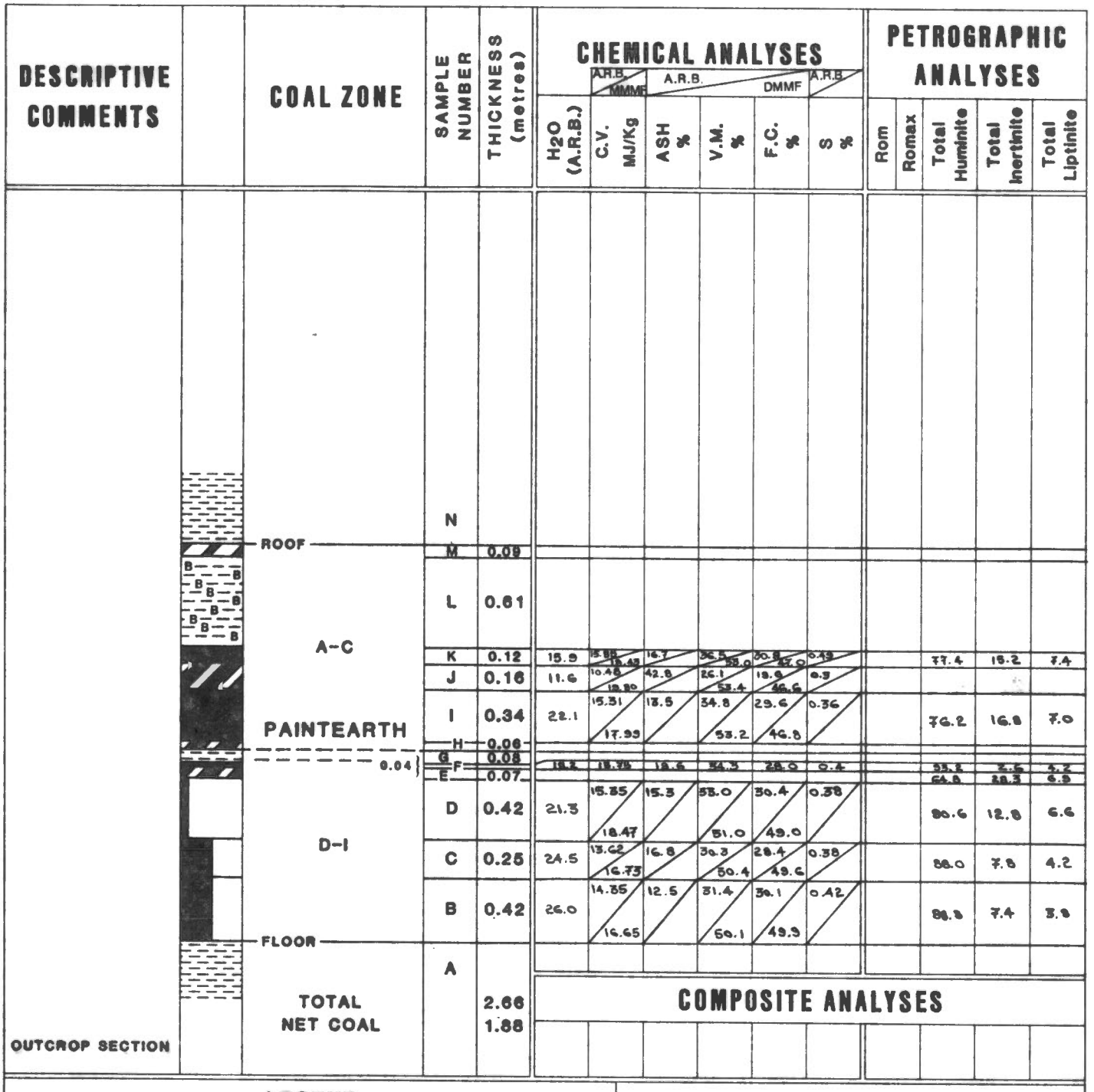
SCALE: 0 Metres 1

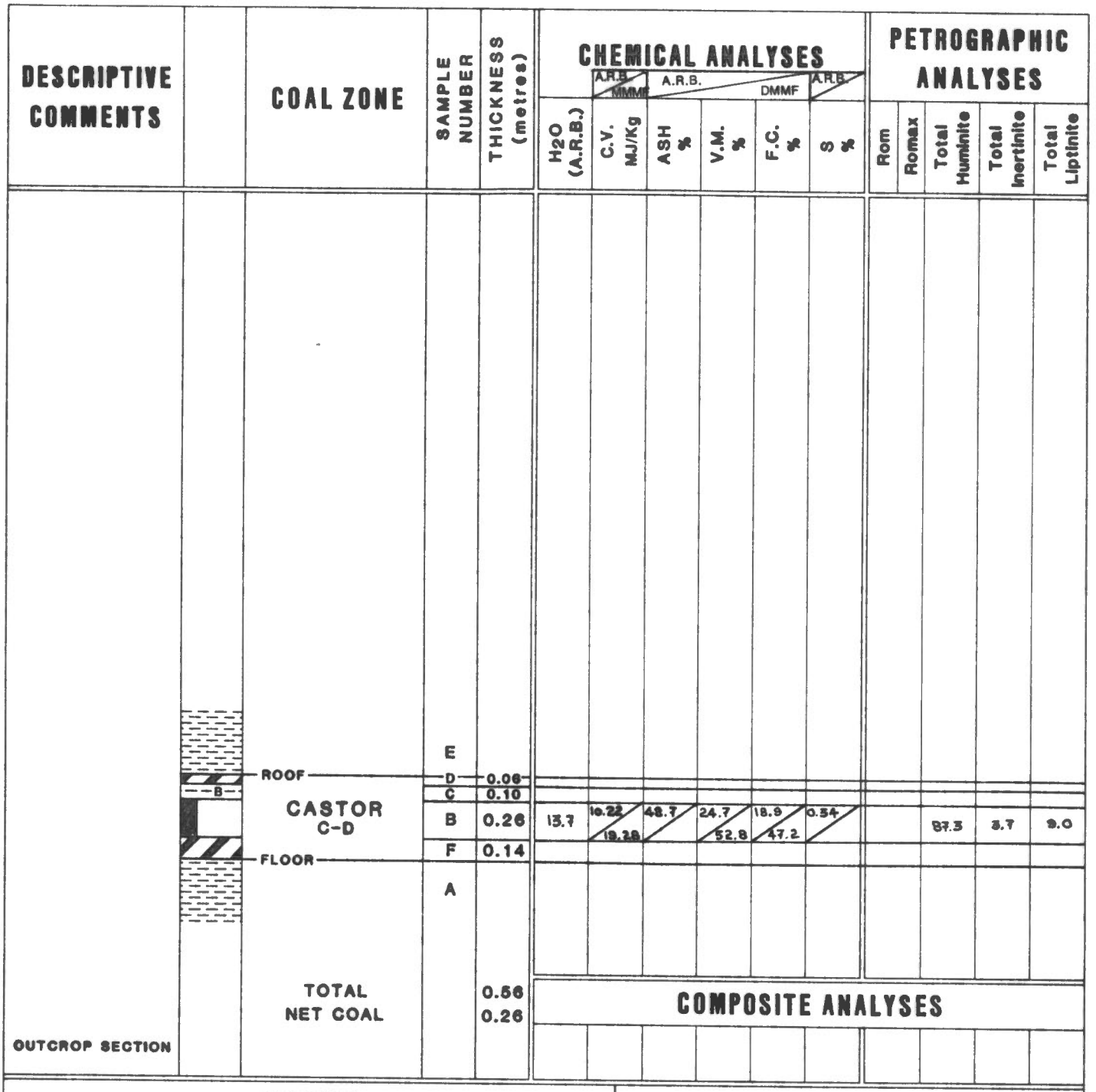
LOCATION:

NORTHING 5790220
EASTING 435090
ZONE 11

LSD. _____
SEC. _____
TWP. _____
RGE. _____
MER. _____


DESCRIPTIVE COMMENTS
COAL ZONE
SAMPLE NUMBER
THICKNESS (metres)
CHEMICAL ANALYSES
A.R.B. / MMMF
A.R.B. / DMMF
A.R.B.
H2O (A.R.B.)
C.V. MJ/Kg
ASH %
V.M. %
F.C. %
S %
PETROGRAPHIC ANALYSES
Rom
Romax
Total Huminite
Total Inertinite
Total Liptinite
CARBONACEOUS CLAYSTONE
ROOF
D-E
CARBONACEOUS CLAYSTONE
F-G
PAINTEARTH
CARBONACEOUS CLAYSTONE
H-I
FLOOR
I 0.20
H 0.08
0.01
G
F 0.28
E 0.01
D 0.59
C 0.01
B 0.50
A
14.0 18.57 21.96 14.0 35.1 48.0 36.8 52.0 0.5
79.0 16.1 4.9
81.2 12.2 6.6
16.6 19.69 21.93 9.2 34.8 46.4 33.2 58.6 0.46
85.0 9.2 5.8
13.8 22.18 24.11 7.4 33.6 42.1 46.2 57.9 0.56
92.2 4.0 3.8
TOTAL 1.48
NET COAL 1.45
COMPOSITE ANALYSES
OUTCROP SECTION
LEGEND
Bright
Bright banded
Dull and bright
Dull banded
Dull
Bone coal
Carbonaceous claystone
Mudstone
Bentonitic mudstone
Concretion
Sandstone
Siltstone
BATTLE RIVER COALFIELD
TRENCH: CQ 625
SCALE:
0 Metres 1
LOCATION:
NORTHING 5824470
EASTING 405700
ZONE 11
LSD.
SEC.
TWP.
RGE.
MER.


DESCRIPTIVE COMMENTS
COAL ZONE
SAMPLE NUMBER
THICKNESS (metres)
CHEMICAL ANALYSES
A.R.B.
MMMF
A.R.B.
DMMF
A.R.B.
H2O (A.R.B.)
C.V. MJ/Kg
ASH %
V.M. %
F.C. %
S %
PETROGRAPHIC ANALYSES
Rom
Romax
Total Huminite
Total Inertinite
Total Liptinite
ROOF
FLOOR
A-C
PAINTEARTH
D-I
TOTAL NET COAL
2.66
1.88
0.04
N
M 0.09
L 0.61
K 0.12
J 0.16
I 0.34
H 0.06
G 0.08
F
E 0.07
D 0.42
C 0.25
B 0.42
A
15.9
11.6
22.1
18.2
21.3
24.5
26.0
15.55
10.48
15.31
17.93
18.75
15.35
18.47
13.62
16.73
14.35
16.65
16.7
42.8
13.5
18.6
15.3
16.8
12.5
36.5
26.1
34.8
53.2
34.3
53.0
30.3
50.4
31.4
50.1
30.8
19.5
29.6
46.8
28.0
30.4
49.0
28.4
49.6
30.1
49.9
0.43
0.3
0.36
0.4
0.38
0.38
0.42
77.4
18.2
7.4
76.2
16.8
7.0
93.8
64.8
3.6
28.3
4.2
6.9
80.6
12.8
6.6
88.0
7.8
4.2
88.8
7.4
3.8
OUTCROP SECTION
COMPOSITE ANALYSES
LEGEND
Bright
Bright banded
Dull and bright
Dull banded
Dull
Bone coal
Carbonaceous claystone
Mudstone
Bentonitic mudstone
Concretion
Sandstone
Siltstone
BATTLE RIVER COALFIELD
TRENCH: CQ 626
SCALE:
0
Metres
1
LOCATION:
NORTHING 5829810
EASTING 405280
ZONE 11
LSD.
SEC.
TWP.
RGE.
MER.


DESCRIPTIVE COMMENTS
COAL ZONE
SAMPLE NUMBER
THICKNESS (metres)
CHEMICAL ANALYSES
A.R.B.
A.R.B. MMMF
A.R.B.
DMMF
A.R.B.
H2O (A.R.B.)
C.V. MJ/Kg
ASH %
V.M. %
F.C. %
S %
PETROGRAPHIC ANALYSES
Rom
Romax
Total Huminite
Total Inertinite
Total Liptinite
E
ROOF
D 0.06
C 0.10
B
CASTOR C-D
B 0.26
13.7
19.22 / 19.28
48.7
24.7 / 52.8
18.9 / 47.2
0.54
87.3
3.7
9.0
F 0.14
FLOOR
A
TOTAL NET COAL
0.56
0.26
COMPOSITE ANALYSES
OUTCROP SECTION
LEGEND
Bright
Bright banded
Dull and bright
Dull banded
Dull
Bone coal
Carbonaceous claystone
Mudstone
Bentonitic mudstone
Concretion
Sandstone
Siltstone
BATTLE RIVER COALFIELD
TRENCH: CQ 627
SCALE:
0
Metres
1
LOCATION:
NORTHING 5834200
EASTING 404400
ZONE 11
LSD.
SEC.
TWP.
RGE.
MER.

DESCRIPTIVE COMMENTS		COAL ZONE	SAMPLE NUMBER	THICKNESS (metres)	CHEMICAL ANALYSES						PETROGRAPHIC ANALYSES				
					H_2O (A.R.B.)	C.V. MJ/Kg (A.R.B. / MMMF)	ASH % (A.R.B.)	V.M. % (A.R.B. / DMMF)	F.C. % (A.R.B.)	S % (A.R.B. / DMMF)	Rom	Romax	Total Huminite	Total Inertinite	Total Liptinite
		ROOF													
		CASTOR A-B	E	0.36											
			D	0.32	15.7	19.54 / 21.22	7.2	37.0 / 47.5	40.1 / 52.5	0.27			89.0	6.4	4.6
			C	0.26	7.5	9.21 / 21.39	51.7	23.0 / 51.7	17.7 / 48.3	0.46					
		FLOOR	B	0.17											
			A												
		TOTAL NET COAL		1.11 0.58	COMPOSITE ANALYSES										
OUTCROP SECTION															

LEGEND

- Bright
- Bright banded
- Dull and bright
- Dull banded
- Dull
- Bone coal
- Carbonaceous claystone
- Mudstone
- Bentonitic mudstone
- Concretion
- Sandstone
- Siltstone

BATTLE RIVER COALFIELD

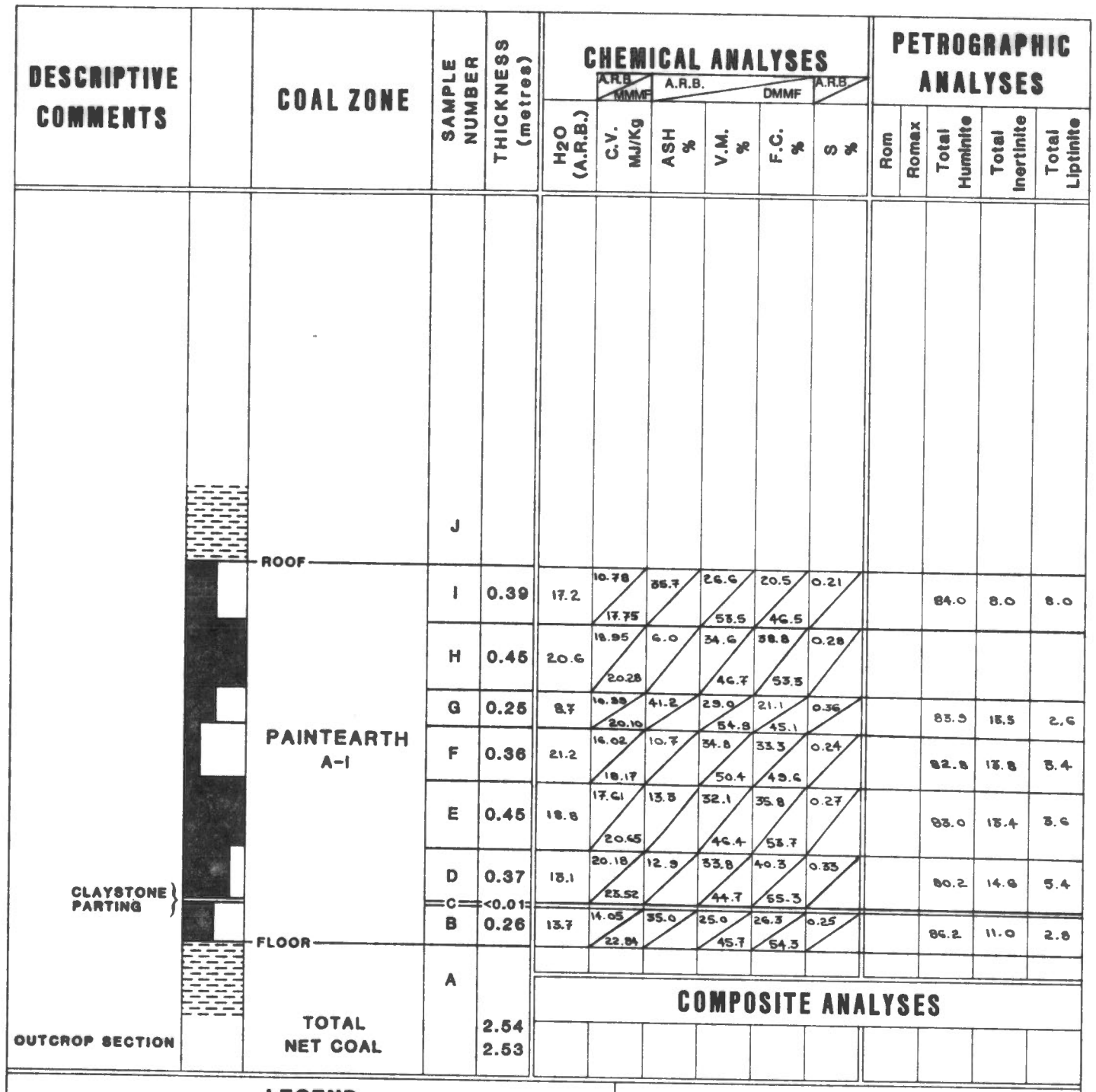
TRENCH: CQ 628

SCALE: 0 Metres 1

LOCATION:

NORTHING 5834200
EASTING 404200
ZONE 11

LSD. _____
SEC. _____
TWP. _____
RGE. _____
MER. _____


DESCRIPTIVE COMMENTS
COAL ZONE
SAMPLE NUMBER
THICKNESS (metres)
CHEMICAL ANALYSES
A.R.B. / MMMF
A.R.B. / DMMF
A.R.B.
H2O (A.R.B.)
C.V. MJ/Kg
ASH %
V.M. %
F.C. %
S %
PETROGRAPHIC ANALYSES
Rom
Romax
Total Huminite
Total Inertinite
Total Liptinite
ROOF
PAINTEARTH A-1
CLAYSTONE PARTING
FLOOR
TOTAL NET COAL
OUTCROP SECTION
J
I 0.39 17.2 10.78 / 17.75 35.7 26.6 / 53.5 20.5 / 46.5 0.21 84.0 8.0 8.0
H 0.45 20.6 18.95 / 20.28 6.0 34.6 / 46.7 38.8 / 53.3 0.28
G 0.25 8.7 19.39 / 20.10 41.2 29.9 / 54.8 21.1 / 45.1 0.36 83.5 15.5 2.6
F 0.36 21.2 16.02 / 18.17 10.7 34.8 / 50.4 33.3 / 49.6 0.24 82.8 13.8 3.4
E 0.45 18.8 17.61 / 20.65 13.8 32.1 / 46.4 35.8 / 53.7 0.27 83.0 13.4 3.6
D 0.37 18.1 20.18 / 25.52 12.9 33.8 / 44.7 40.3 / 55.3 0.35 80.2 14.6 5.4
C <0.01
B 0.26 13.7 14.05 / 22.84 35.0 25.0 / 45.7 26.3 / 54.3 0.25 86.2 11.0 2.8
A
2.54
2.53
COMPOSITE ANALYSES
LEGEND
Bright
Bright banded
Dull and bright
Dull banded
Dull
Bone coal
Carbonaceous claystone
Mudstone
Bentonitic mudstone
Concretion
Sandstone
Siltstone
BATTLE RIVER COALFIELD
TRENCH: CQ 629
SCALE: 0 Metres 1
LOCATION:
NORTHING 5834140
EASTING 404650
ZONE 11
LSD.
SEC.
TWP.
RGE.
MER.

DESCRIPTIVE COMMENTS		COAL ZONE	SAMPLE NUMBER	THICKNESS (metres)	CHEMICAL ANALYSES						PETROGRAPHIC ANALYSES				
					A.R.B. / MMF	A.R.B. / DMMF			A.R.B. / DMMF						
					H_2O (A.R.B.)	C.V. MJ/Kg	ASH %	V.M. %	F.C. %	S %	Rom	Romax	Total Huminite	Total Inertinite	Total Liptinite
			D												
		ROOF													
		PAINTEARTH H-I	B	0.37	17.8	18.59 / 20.62	8.9	35.8 / 48.1	37.6 / 51.9	0.48			86.0	9.8	4.2
			C	0.50	21.6	18.88 / 19.14	15.4	31.8 / 49.5	31.1 / 50.5	0.51			89.2	9.8	4.2
		FLOOR	A												
		TOTAL NET COAL		0.87 0.87	COMPOSITE ANALYSES										
OUTCROP SECTION															

LEGEND

- Bright
- Bright banded
- Dull and bright
- Dull banded
- Dull
- Bone coal
- Carbonaceous claystone
- Mudstone
- Bentonitic mudstone
- Concretion
- Sandstone
- Siltstone

BATTLE RIVER COALFIELD

TRENCH: CQ 630

SCALE: 0 Metres 1

LOCATION:

NORTHING 5936010
EASTING 404040
ZONE 11

LSD. _____
SEC. _____
TWP. _____
RGE. _____
MER. _____

DESCRIPTIVE COMMENTS		COAL ZONE	SAMPLE NUMBER	THICKNESS (metres)	CHEMICAL ANALYSES						PETROGRAPHIC ANALYSES				
					H_2O (A.R.B.)	C.V. MJ/Kg (A.R.B. / MMMF)	ASH % (A.R.B. / DMMF)	V.M. % (A.R.B. / DMMF)	F.C. % (A.R.B. / DMMF)	S % (A.R.B. / DMMF)	Rom	Romax	Total Huminite	Total Inertinite	Total Liptinite
			D												
		ROOF													
		PAINTEARTH D-E	C	0.35	13.8	5.42 / 6.75	60.2 /	16.2 / 33.2	9.9 / 46.8	0.21 /			60.5	21.9	17.6
			B	0.27	17.6	15.11 / 20.42	22.2 /	30.7 / 45.5	28.4 / 50.5	0.46 /			78.6	15.0	8.4
		FLOOR	A												
OUTCROP SECTION					COMPOSITE ANALYSES										

LEGEND

- Bright
- Bright banded
- Dull and bright
- Dull banded
- Dull
- Bone coal
- Carbonaceous claystone
- Mudstone
- Bentonitic mudstone
- Concretion
- Sandstone
- Siltstone

BATTLE RIVER COALFIELD

TRENCH: CQ 631

SCALE: 0 Metres 1

LOCATION:

NORTHING 5936010
EASTING 404040
ZONE 11

LSD. _____
SEC. _____
TWP. _____
RGE. _____
MER. _____