Project and Applied Geology

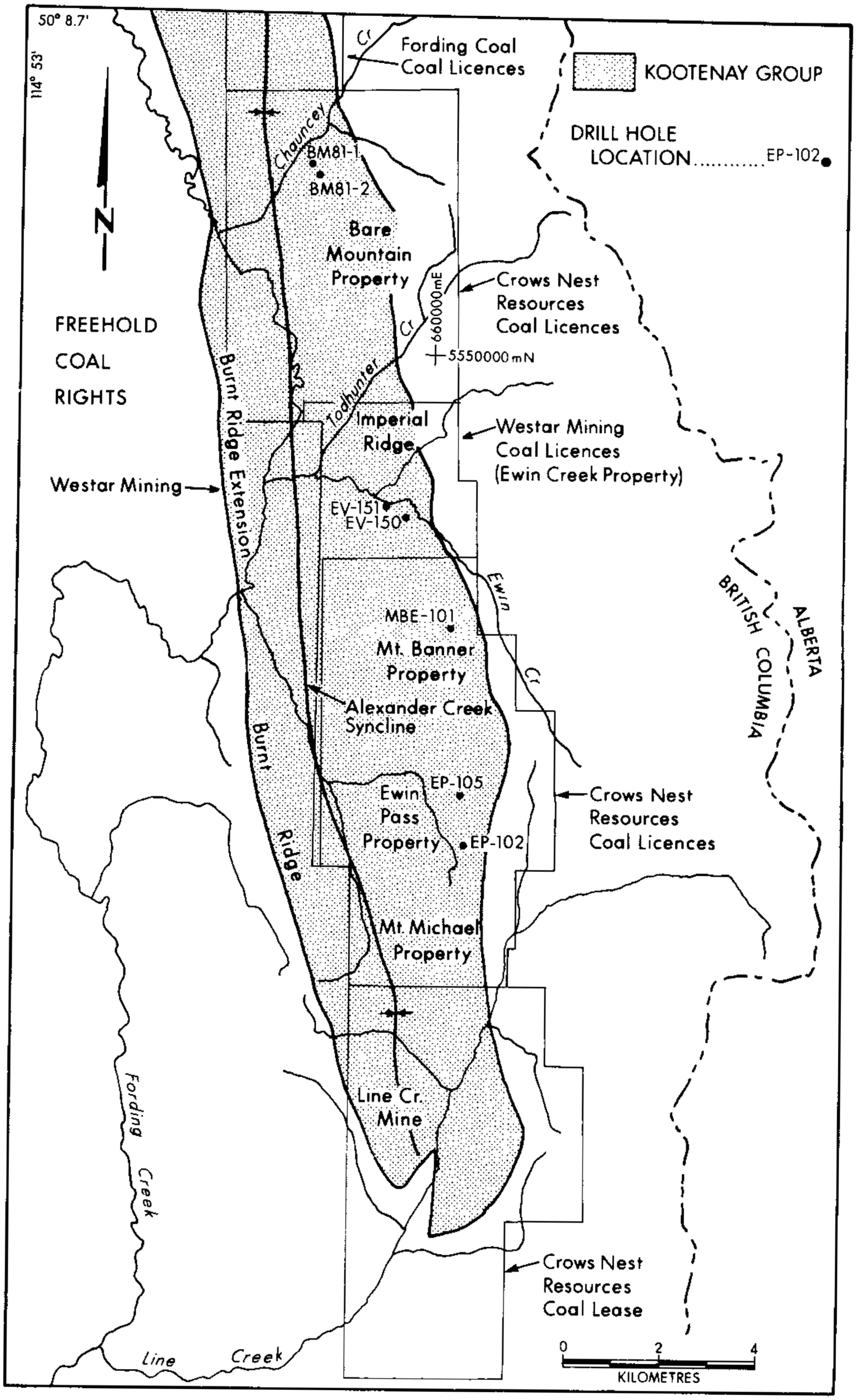

Figure 1-1. Drill hole and property location map for a portion of the Elk Valley Coalfield.

CORRELATION AND COMPARISON OF TWO COAL-BEARING ZONES BETWEEN EWIN PASS AND BARE MOUNTAIN ELK VALLEY COALFIELD SOUTHEASTERN BRITISH COLUMBIA (82G/15, 82J/2)

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INTRODUCTION

Regional correlation methods in the southeastern British Columbia coalfields are not well established. Preliminary conclusions presented here represent the first stage of an attempt to correlate specific horizons throughout the Elk Valley Coalfield. Seven exploration drill cores, spanning a north-south distance of 14 kilometres and representing four exploration properties, were logged in detail. These properties are, from south to north, Ewin Pass, Mount Banner, Ewin Creek, and Bare Mountain (Fig. 1-1).

It was hoped, at the outset, that tonsteins would form a conspicuous and common lithology within the drill cores examined. Tonsteins are effective local correlation tools at two Elk Valley Coalfield locations and are postulated to have potential for regional correlation (Grieve, 1984). Unfortunately, only one band was found which is texturally similar to tonsteins described in the previous study; there are also three, kaolinite-rich grey clay bands which are probably also a variety of tonstein. One possible reason for the dearth of these units is that coal zones had been removed from the cores examined.

The study area is in the south half of the Elk Valley Coalfield, which has recently been mapped in detail (Grieve and Fraser, 1985). The Elk Valley Coalfield is one of three separate fields in southeastern British Columbia. The major structure of the coalfield is the north-south-trending Alexander Creek syncline, which persists along the 100-kilometre length of the field. Thus there is great continuity of structure in the Elk Valley Coalfield and consequently excellent potential for regional correlation. The cores examined, for example, represent a continuous belt of strata on the east limb of the Alexander Creek syncline and east of the trace of the Ewin Pass thrust fault.

Economic thicknesses of coal in southeastern British Columbia are contained in the non-marine Mist Mountain Formation of the Jurassic-Cretaceous Kootenay Group. It is underlain by the Morrissey Formation, the basal unit of the Kootenay Group.

To date, five of the seven core logs have been corrected to true thickness and plotted in detailed and generalized form. Several potential marker horizons have been analysed by X-ray diffraction. One new regional coal seam correlation is herein proposed and a stratigraphically well-defined horizon (base of the Mist Mountain Formation) is compared at difference locations.

Petrographic analysis of vitrain samples collected will be carried out at a later date.

METHODS OF STUDY

The core logging system of Research Planning Institute, Inc. (RPI) was utilized in this study (Ruby, *et al.*, 1981). The RPI system uses three-digit codes to represent rock type, composition/colour, and sedimentary structures; suffixes modify sedimentary structures, and identify penecontemporaneous deformation, cement type, and presence of coal banding/spar. This method is readily applicable to Kootenay Group strata and it offers adequate degrees of detail, speed, and consistency.

Individual units within core were measured to the nearest centimetre. Intervals representing sampled coal horizons were taken from company logs. Units thinner than 5 centimetres were not measured separately, with the exception of tonsteins and other very distinctive lithologies. Logs were converted to true thicknesses using core-bedding angles. Sections were first plotted at large scale and then generalized for inclusion here (Fig. 1-2).

DESCRIPTIONS OF COMMON LITHOLOGIES AND INFERRED DEPOSITIONAL ENVIRONMENTS (MIST MOUNTAIN FORMATION)

Depositional environments of lithologies described below are based on core appearances as well as their similarity to units seen in the field and described by Gibson (1985) and Donald (1984).

INTERMIXED SHALES AND SANDSTONES (ISAS)

The most common lithology consists of intermixed shales and sandstones (ISAS) of the RPI system (Ruby, *et al.*, 1981). These range in their proportion of sandstones to shales from 'wavy-bedded sandstone with interbedded shale' (highest ratio, roughly 2:1 to 1:1), to 'lenticular-bedded sandstone streaks in shale' (lowest ratio roughly 1:2). In addition, units of massive, churned, burrowed, or rooted sandy shale exist, in which layering was either not present or not preserved. The sandstone in ISAS units ranges from fine grained in the sandstone-dominant varieties to very fine grained in the shale-dominant varieties. The shales are predominantly siltstones and silty mudstones. ISAS units are commonly burrowed and/or rooted and may be convoluted or slumped. Coal banding is also a common feature.

ISAS units occur as two distinct types, within or overlying thick sandstone units and within generally fine-grained sequences. The first type is believed to represent low energy portions of fluvial point-bar deposits; the other, splay deposits.

SHALE

Lithologies classified as 'shale' in the RPI system include siltstone, silty mudstone, mudstone, and shale. The predominant 'shale' variety encountered in this study is dark grey silty mudstone, which is generally faintly to well laminated, commonly contains coal streaks and bands, and locally is burrowed and/or rooted. Mudstones and shales are generally black in colour, are faintly laminated or massive, and contain coal streaks or bands and roots. They are closely related in position to coal seams. Densely rooted seatearths are uncommon; they do not occur at the base of major coal seams, but rather within fine-grained sequences that underlie carbonaceous shale.

Distinctive, massive, brownish black, hard mudstone units up to several tens of centimetres in thickness were noted in most of the cores, most conspicuously in the upper portion of BM81-1. Two samples polished and examined under reflected light contain uniformly dispersed fine detrital vitrinite. Thus they are carbonaceous

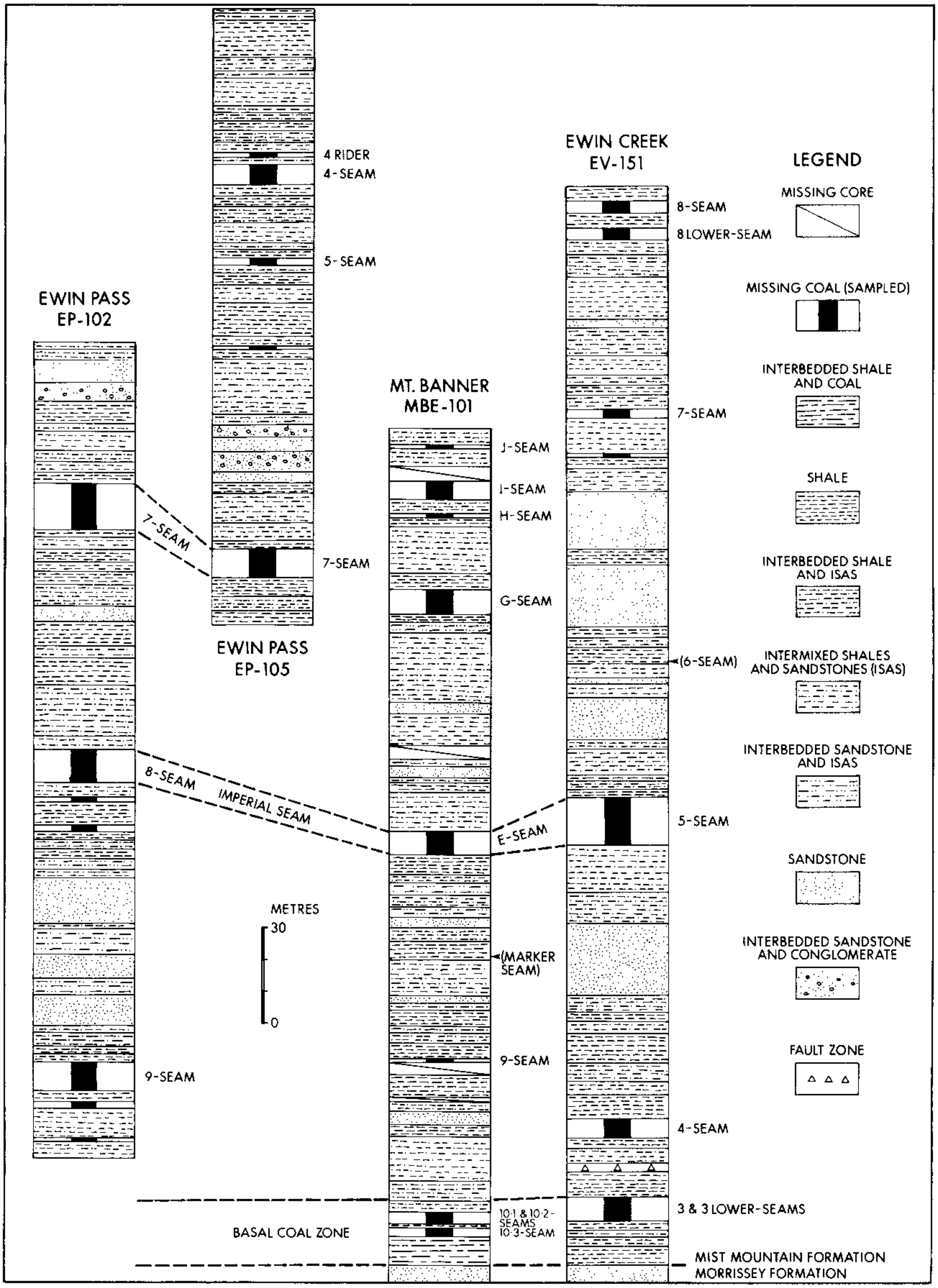

Fig 1-2

Figure 1-2. Generalized drill core logs from Ewin Pass, Mount Banner, and Ewin Creek.

shales but are not related to oil shale, as first thought, because they are devoid of liptinitic material.

Shale units occur either as a thick monotonous series or interbedded with ISAS units or coal seams. They may underlie thick sandstone units but never directly overlie them. They are thought to represent overbank flood deposits; the thickest series of shaly material developed are at relatively large distances from fluvial channels where the influx of sandy splay sedimentation was rare.

SANDSTONE

Sandstone units in the Mist Mountain Formation are predominantly lithic arenites and range from fine grained to very coarse grained and conglomeratic. They display flaser bedding, ripples, and all scales of planar and trough crossbedding. Massive and parallel laminated units are also common. They are frequently carbonaceous, particularly the massive varieties, and have irregular lenticles of coal spar. Mudstone rip-up clasts frequently occur, particularly near the bases of thick sandstone units. The basal contact of sandstone units is always abrupt and frequently scoured.

Sandstone has two distinct occurrences, the more common being thick (2 to 20-metre) sequences of predominantly medium-grained sandstone with a gross fining-upward profile that is overlain by ISAS units. These are inferred to represent fluvial point-bar deposits of large meandering channel systems. The other occurrence is as thin (<1 metre) rippled, fine-grained beds within series of ISAS units. These probably represent proximal portions of splay deposits.

COAL

All except the thinnest coal seams had been removed from cores examined. Those observed ranged from bright and banded to dull and massive. Coal seams, thick and thin, are generally closely associated with fine-grained units. They represent swamp and marsh environments (Gibson, 1985).

CONGLOMERATE

Conglomerate was observed only within the sandstone unit above 7-seam on Ewin Pass (cores EP-102 and EP-105). It consists of rounded chert pebbles in a coarse lithic arenite matrix. Individual bands range from stringers of pebbles to beds up to 1.2 metres in thickness. They are inferred to be part of the channel deposits represented by the sandstone unit. Those in which pebbles are in contact and matrix is sparse may be channel lag deposits.

TONSTEINS

Three narrow, 1 to 2-centimetre-thick, bands with distinctive light grey colour and extremely fine grain size were noted. Kaolinite is the dominant mineral in all cases so they are probably tonsteins. One band occurs 6 metres above the base of the Mist Mountain Formation in core BM81-2, the other two occur in the basal 1 metre in cores EV-150 and EV-151 (Fig. 1-3). In EV-151 another 3-millimetre-thick kaolinitic grey clay band overlies the first by half a metre.

In core BM81-1 a 5-centimetre-thick dark brown to black fine-grained unit was noted near the top of the core (core not plotted to date). This band is similar to tonsteins noted previously in southeast coalfields (Grieve, 1984); it is characterized by a blocky fracture with vitreous fracture surfaces and visible graupen (sub-spherical kaolinite bodies) up to 1 millimetre in diameter. It is composed of kaolinite with minor gorceixite. The latter mineral is a constituent of some previously analysed tonsteins in southeastern British Columbia (Grieve, 1984; Grieve, unpubl.). Petrographic analysis of these bands will be carried out.

BRIEF DESCRIPTIONS OF SECTIONS

To date logs from cores EP-102, EP-105, MBE-101, EV-150, and EV-151 have been plotted in detail. These represent the Ewin Pass, Mount Banner East, and Ewin Creek properties (Fig. 1-1). The basal portion of core BM81-2 from Bare Mountain has also been plotted for discussion here. Generalized sections were derived from the five completed detailed sections (Fig. 1-2). In generalizing data for these sections, units less than 2 metres in thickness were not plotted, excepting coal seams and shale partings, for which 1 metre was the minimum thickness. Grouping of units, necessitated by these minimum thicknesses, was somewhat arbitrary, thus the appearance of the sections on Figure 1-2 are partly an artifact of the generalization process; they should not be used for rigorous paleoenvironmental interpretation.

EP-102: This core consists of approximately 265 metres in true thickness (Fig. 1-2). Seven coal zones had been removed for sampling; these range from 1 metre to 15 metres in thickness (Fig. 1-2). The three thickest seams are named 9, 8, and 7-seam, from oldest to youngest, while the other four seams are unnamed (P. Gilmar, personal communication, 1985). This nomenclature represents the company's correlation of seams from Ewin Pass to Line Creek mine. The bottom of the hole was probably about 35 metres above Morrissey Formation (P. Gilmar, personal communication, 1985), therefore the zone corresponding to 10A and 10B-seams at Line Creek was not drilled.

A conspicuous series of three channel sandstone deposits interbedded with probable crevasse splay sandstones and siltstones occurs between 9 and 8-seams. One channel sandstone occurs between 8 and 7-seams and a channel deposit of sandstone interbedded with conglomeratic sandstone and conglomerate occurs above 7-seam, near the top of the hole.

EP-105: This core consists of approximately 194 metres true thickness; the lowest 72 metres overlaps with the strata contained within EP-102. Five seams, ranging from 1 to 9 metres in thickness, had been removed; four are named, from oldest to youngest, 7, 5, 4, and 4 rider. Therefore, 7-seam and the conglomeratic unit overlying 7-seam are common to EP-102 and EP-105. Seams 4 and 4 rider form the most significant coal zone above 7-seam, with a combined thickness of 9 metres. There are no channel deposits above the conglomeratic unit.

MBE-101: This core consists of approximately 290 metres true thickness, of which 30 metres belongs to the Morrissey Formation. Several portions of the core are missing or misplaced, due to vandalism. Thirteen seams had been sampled, ranging from 15 centimetres to 8 metres in thickness; nine seams are 1 metre or more. Six thin seams, numbered 10-6 to 10-1, occur in the basal 14 metres of the Mist Mountain Formation (Fig. 1-3). The other seams are named, from oldest to youngest, 9, marker, E, G, H, I, and J. Channel sandstone units are relatively scarce and thin. Two occur between 9-seam and E-seam and two more occur between E-seam and G-seam.

EV-151: This core consists of a maximum 354 metres true thickness, but contains a 2.5-metre fault zone 44 metres above the base, which probably caused a small but unknown amount of repetition. The base of the core contains 14 metres of Morrissey Formation. Eleven seams were removed for sampling, ranging from 60 centimetres to 15 metres in thickness; seven seams are greater than 1 metre. The thickest seams are named, from oldest to youngest, 3 (consisting of two benches named 3 and 3 lower), 4 (which has a thin unnamed rider), 5, 7, 8 lower, and 8. All the rest are unnamed, with the exception of 6-seam. Prominent channel sandstone units occur between 4 and 5-seams, 5 and 6-seams, and 6 and 7-seams.

EV-150: This core contains 302 metres true thickness of strata, of which 44 metres belongs to the Morrissey Formation. Moreover, the interval between 4 and 5-seams has been thickened by approximately 60 metres as a result of thrust faulting. Consequently, all

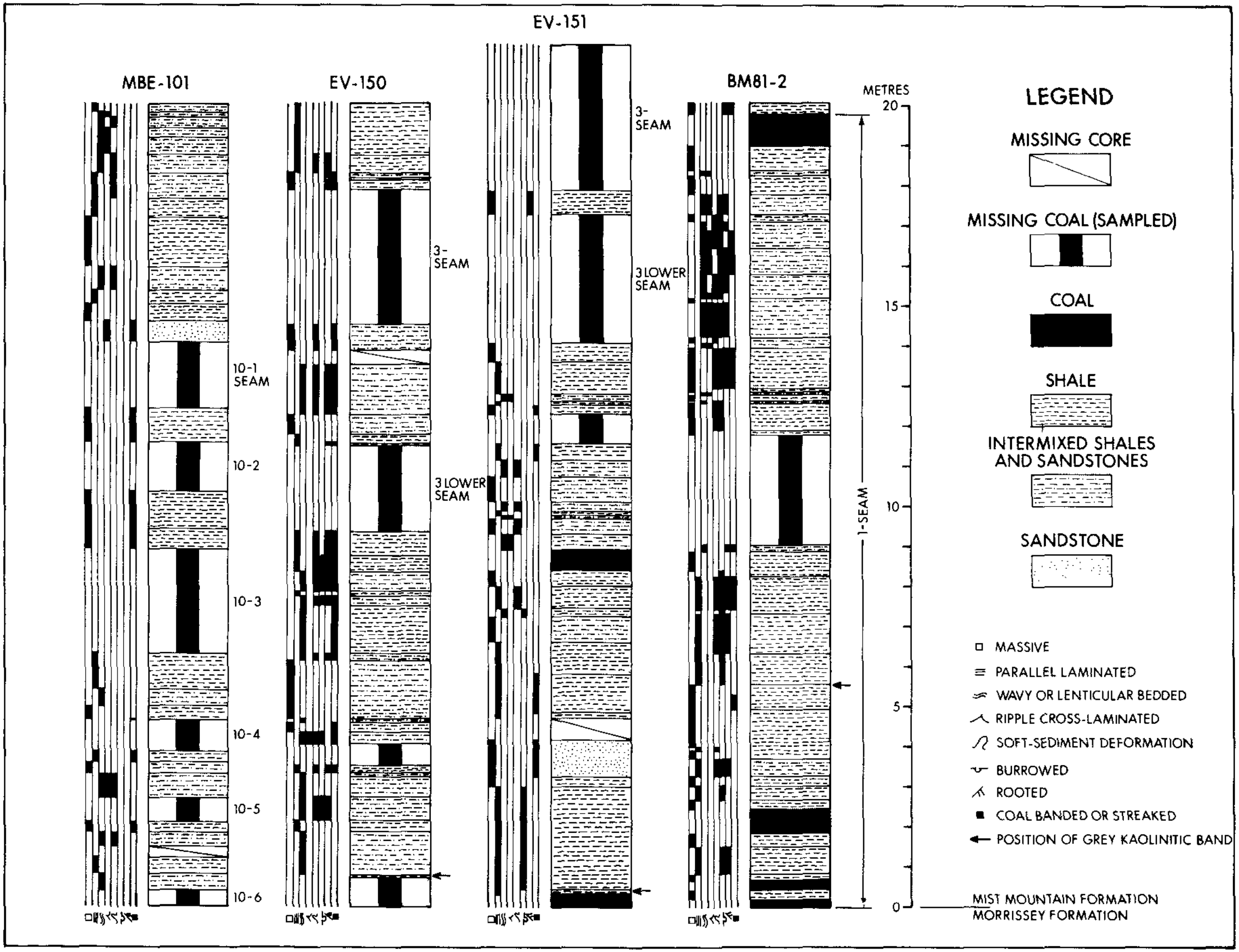

Figure 1-3. Detailed drill core logs of the basal coal zone from Mount Banner, Ewin Creek, and Bare Mountain.

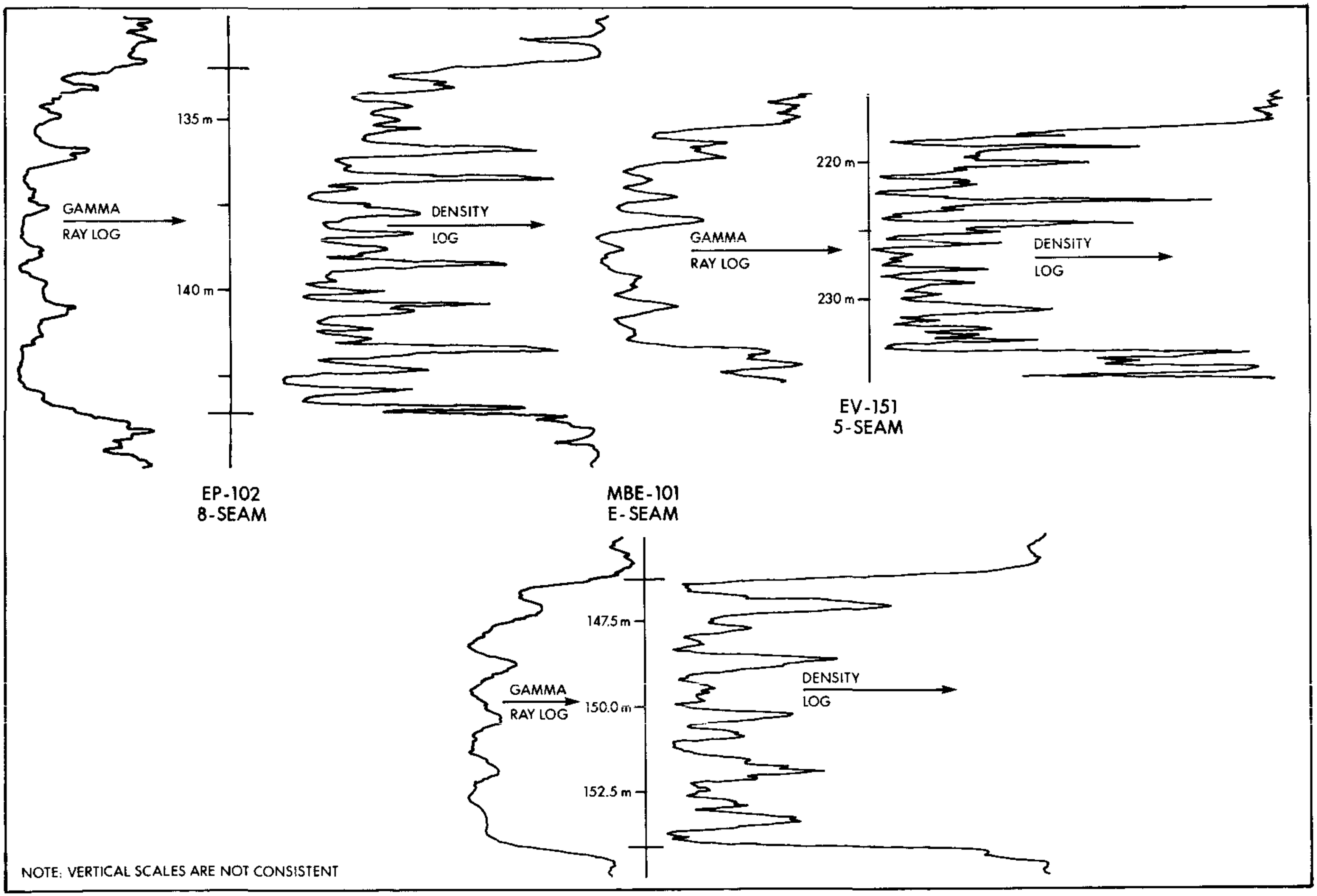

Figure 1-4. Gamma ray and density logs of the Ewin Pass 8-seam, Mount Banner E-seam, and Ewin Creek 5-seam (proposed Imperial seam).

Mist Mountain Formation strata contained in this core are also found in EV-151. However, it serves as a useful basis for comparison of equivalent horizons. For example, 3 and 3 lower-seams are separated by 3 metres of strata in EV-150, compared with 60 centimetres in EV-151.

CORRELATABLE HORIZONS

BASAL COAL ZONE

The Morrissey-Mist Mountain contact is one of only two readily identifiable stratigraphic horizons in the southeast coalfield (the other is the Kootenay Group-Cadomin Formation contact) and, because it marks the base of coal occurrences, it is an extremely important one. The correlation of the coal zone which normally occupies the basal portion of the Mist Mountain Formation in southeastern British Columbia (Gibson, 1985) is therefore self-evident. Economically this zone is extremely important as it accounts for several of the important producing seams in southeastern British Columbia.

Four of the seven cores logged in this study contain the basal coal zone. Large-scale plots of the basal 20 metres of these cores are shown on Figure 1-3. The 20-metre cutoff was chosen arbitrarily, but in all cases this interval contains most of the coal which can reasonably be assigned to the basal zone. The section of EV-151 has been extended slightly to include the top of 3-seam.

A few generalizations about Figure 1-3 can be made. Each section contains four to six separate seams. If 3 and 3 lower-seams in EV-151 are combined, then the thickest individual seam is 7.4 metres thick, with a 60-centimetre shale parting. The remainder of the seams range from 20 centimetres to 3 metres in thickness. In all cases a thin, 20 to 70 centimetres, seam rests directly on the Morrissey Formation sandstone. Direct correspondence of other individual seams between different areas is not obvious.

Interbedded strata within the basal coal zone are mainly shales and shale-dominant varieties of ISAS units. They are massive to well laminated and may be rooted, burrowed, and/or distorted. Coal banding and coal spar are also very common features, especially in proximity to coal seams. One thin carbonaceous sandstone occurs in EV-151 and MBE-101. The strata immediately overlying the basal coal zone are also fine grained and are not distinguishable from clastic rocks within the zone.

Kaolinite-rich grey clay bands at equivalent positions in EV-150 and EV-151 are clearly correlatable (Fig. 1-3). Correlation with a similar band in BM81-2 is possible, as the upper surface of the Morrissey Formation is known to have local relief of several metres.

The depositional environment of the basal coal zone has been described as an interdeltaic coastal marsh and swamp within the lower coastal plain. Initial sedimentation occurred directly on the beach ridge-dune facies of the upper Morrissey Formation (Gibson, 1985).

The basal coal zone described here correlates with the lower part of unit I on Fording Coal Ltd.'s Eagle Mountain property, north of the study area (Donald, 1984). At that locality all the coal within unit I, comprising Fording Coal Ltd.'s 1, 2, and 3-seams, appears to lie well within the basal 20 metres of section and 1-seam rests directly on the Morrissey Formation. Coals of unit I are too thin to form mineable reserves in the current operations area.

At Line Creek mine, on the other hand, the basal coal zone contains 10A and 10B-seams, with the former resting directly on the Morrissey Formation. These seams figure prominently in Crows Nest Resources Ltd.'s current production.

IMPERIAL SEAM

The name Imperial seam was applied to the thickest seam on Imperial Ridge in the Ewin Creek property north of Ewin Creek (Grieve and Fraser, 1985, section A-B). On the ridge summit it attains a thickness of 10.5 metres with very little interbanded shale. It has been traced northward with some confidence in the field from Ewin Creek to Bare Mountain, a strike distance of 5.9 kilometres (Grieve and Fraser, 1985, sheets 8 and 9).

This seam is 5-seam, on the Westar Mining Ltd.'s property, and it was intersected in both EV-150 and EV-151 (Fig. 1-2). The true thickness of the Imperial seam in these holes is 15 metres. According to Huryn (1982) the bottom 12 to 13 metres of this seam contains very little interbanded shale. The roof and floor rocks in EV-151 are black coal-streaked and banded shales, while in EV-150 they are black, coal-banded, laminated shales.

In moving to the south, the Imperial seam is tentatively correlated with E-seam in core MBE-101 (Fig. 1-2). This correlation is based on three lines of evidence:

(1) Relative thickness and position of E-seam with respect to overall stratigraphy.

(2) Similarity of roof and floor lithologies to those in the EV cores.

(3) Similarity of geophysical logs to the EV drill holes (Fig. 1-4).

E-seam in MBE-101 is 7.4 metres in thickness and contains very little interbanded shale. As was the case in the EV cores, the seam here is about 130 metres stratigraphically above the base of the Mist Mountain Formation and between the two most prominent channel sandstone-bearing horizons (Fig. 1-2). Roof and floor rocks are massive, coal-banded, black to dark grey shales.

Moving further southward, the Imperial seam is tentatively correlated with 8-seam in core EP-102. The latter seam is 150 metres above the base of the Mist Mountain Formation and is the first major seam above the most significant concentration of channel sandstone units in the section. The seam is 10.3 metres thick and contains 50 centimetres of shale in 5 interbands (Beavan, 1981). Roof and floor rocks are laminated, black, coal-banded shales. The geophysical response of this seam is similar to that of E-seam in MBE-101 (Fig. 1-4).

Existence of the Imperial seam in the BM81 cores to the north has not been established as the logs have not yet been plotted. Given the proximity of these holes to the most northerly mapped outcrop occurrence of the seam, it is expected to be present.

In any event, the proposed correlation of the Imperial seam extends roughly 13.5 kilometres from EP-102 in the south to Bare Mountain in the north. Field mapping of the Ewin Pass 8-seam has already established its continuity between Mount Banner and Ewin Pass and also through the Mount Michael property to the south (Grieve and Fraser, 1985, sheets 5, 6, and 7). Addition of the Mount Michael property extends the proposed correlated extent of the Imperial seam 3 kilometres southward. Even more significantly, if Crows Nest Resources Ltd.'s correlation of 8-seam at Ewin Pass with 8-seam in Line Creek mine is correct then the Imperial seam may account for the major part of reserves and production at the Line Creek mine. If this is the case the name '8-seam' would be preferable to 'Imperial seam' throughout the study area.

DISCUSSION

Preliminary assessment of data has identified two coal zones which can be correlated between Bare Mountain in the north and the Ewin Pass area in the south. In the case of the basal coal zone the correlation is not helpful because the Mist Mountain-Morrissey Formations contact is very easily mapped and also readily identified in core and geophysical logs.

Correlation of the Imperial seam is based on its relative stratigraphic position, its thickness and lack of significant shale interbands, the nature of its roof and floor rocks, the nature of its geophysical response, and the results of geological mapping. None of these criteria, in themselves, are diagnostic, but in combination they offer reasonable precision; in combination with proximate analysis results, they are the ones used by industry to correlate coal seams within individual properties and occasionally between different properties. We have not applied proximate analysis in this case, because of known regional rank variations along strike in the Elk Valley Coalfield (Grieve and Pearson, 1985; Grieve and Fraser, 1985). Between Ewin Pass and Mount Banner, for example, the reflectance of the basal coal zone increases from less than 1.3 per cent to greater than 1.5 per cent ($\bar{R}_o$ max), an increase which will have a significant effect on volatile matter yields and other properties. The possibility of this sort of change should always be taken into consideration.

The grey kaolinitic band in the basal coal zone in cores EV-150, EV-151, and BM81-2 may represent a continuous horizon. In any event, its impact as a correlation tool is severely limited by its position within the only readily correlatable horizon in southeast coalfields.

The tonstein near the top of core BM81-1 occurs in the upper Mist Mountain Formation and is stratigraphically higher than strata contained in other cores in this study. One of the authors (D. A. Grieve) has previously sampled a kaolinitic band from a coal outcrop at a similar stratigraphic position on the Burnt Ridge Extension property and Gibson (1985, p. 26) notes the occurrence of a tonstein in a coal seam in the uppermost Mist Mountain Formation on the Greenhills Range. In general, however, this study has not furthered attempts to correlate strata in southeastern British Columbia using tonsteins.

CONCLUSIONS

Seven drill cores from the east limb of the Alexander Creek syncline in the Elk Valley Coalfield were logged in detail. The Mist Mountain Formation contained in these cores consists of an interbedded series of intermixed shale and sandstone (ISAS) units, shale, sandstone, coal, and minor conglomerate. They encompass a range of non-marine sedimentary environments, with the coarse clastics probably representing fluvial point-bar and channel deposits, ISAS units representing low-energy portions of point bars and splay deposits, and fine-grained units representing floodplain deposits. Coal seams, which were deposited in marsh and swamp conditions, had been largely removed from the core. Conspicuous potential marker bands were generally absent, although kaolinitic bands, probably tonsteins, were found at similar stratigraphic positions in three of the cores. The position of these bands, all within 6 metres of the base of the Mist Mountain Formation, limits their usefulness, because the basal Mist Mountain Formation is a readily identified unit.

The basal Mist Mountain Formation or basal coal zone is a 20-metre-thick interval containing four to six coal seams that range from 20 centimetres to 7.4 metres in thickness; one rests directly on the Morrissey Formation sandstone.

Coal seam 5 on Westar Mining Ltd.'s Ewin Creek property has been tentatively correlated with E-seam on Crows Nest Resources Ltd.'s Mount Banner property and with 8-seam on Crows Nest Resources Ltd.'s Ewin Pass property. The term 'Imperial seam' is applied to this correlated unit because the unit corresponds with the Imperial seam mapped by one of us (D. A. Grieve) on Imperial Ridge and Bare Mountain (Grieve and Fraser, 1985). However, the term '8-seam' may be preferred if correlation by Crows Nest Resources Ltd.'s staff of Ewin Pass 8-seam with Line Creek 8-seam is correct. The latter seam is currently a major product from the Line Creek mine.

Further analysis of results will be carried out to attempt further correlations and comparisons of strata in the Elk Valley Coalfield.

ACKNOWLEDGMENTS

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