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MINERAL RESOURCES DIVISION
Geological Survey Branch

STRATIGRAPHY OF THE ELK FORMATION IN THE FERNIE BASIN, SOUTHEASTERN BRITISH COLUMBIA

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ABSTRACT

The Elk Formation is the uppermost formation in the Jurassic-Cretaceous Kootenay Group. It is characterized by a relative abundance of coarse clastics (sandstone and locally conglomerate) and lack of coal, in comparison to the underlying Mist Mountain Formation. Problems encountered in identification of the Elk Formation and its contact with the Mist Mountain Formation prompted this study. Stratigraphic sections from five localities in the Fernie basin (Crowsnest coalfield) and one from the Flathead coalfield were examined and described. Thicknesses of sections are as follows: Coal Creek (type section) - 429.0 metres; Morrissey Ridge north (adjacent to reference section) - 472.7 metres; Morrissey Ridge south - 436.1 metres; Flathead Ridge ("pipeline section") - 327.0 metres; Lodgepole property - 154.5 metres; and Lillyburt property - 67.1 metres were examined, out of a total Elk Formation thickness of approximately 175 metres.

Sections 1 and 2 are characterized by an obvious three-part stratigraphy, in which the lowest and highest divisions are dominated by conglomerate and sandstone, and the middle division by finer grained rock types. Sections 3 and 4 are also divisible into three similar zones or facies, but the zone differentiation is more subtle. Sections 5 and 6 exhibit no such divisions, apparently due to lateral facies changes, including the possible lensing out of the basal coarse clastic facies and possibly part or all of the middle "fine facies". Conglomerate is an important constituent of parts of Sections 1, 2 and 3. Distinctive units informally referred to as "needle siltstone" and "needle coal" occur in Sections 1 through 5, but are restricted to the upper portions in all cases, suggesting the lateral continuity of the upper facies away from the type area.

Elk Formation facies present in the study area are consistent with deposition by braided fluvial systems, in a distal alluvial-fan environment for deposits on the western edge of the Fernie basin (notably Sections 1, 2 and 3), and in a braidplain environment in other areas. Two models are presented to explain the formation's lateral and vertical variations; one based on the wedging out of the lower two divisions noted in Sections 1 through 4, and the other based on lateral transition of these two divisions into contemporaneous strata of the Mist Mountain Formation.

Precise diagnostic criteria to aid in identification of the Elk Formation away from the type area do not appear to exist. Unfortunately, the relatively clearly defined type and reference sections represent a local facies of the formation (distal alluvial fan) and are atypical. At many localities, the Elk/Mist Mountain contact is difficult to define objectively and consistently, because of the nature of the facies changes it represents (braided compared to the Mist Mountain's meandering fluvial systems). When identifying the contact, it is important to consider the relative thicknesses of **both** sandstone units (with or without conglomerate) and coal seams, and not to overemphasize one or the other.

Geologists working in the Kootenay Group are urged to use caution in identifying the Elk Formation and its lower contact, and to give careful consideration to the lateral and vertical facies changes involved.

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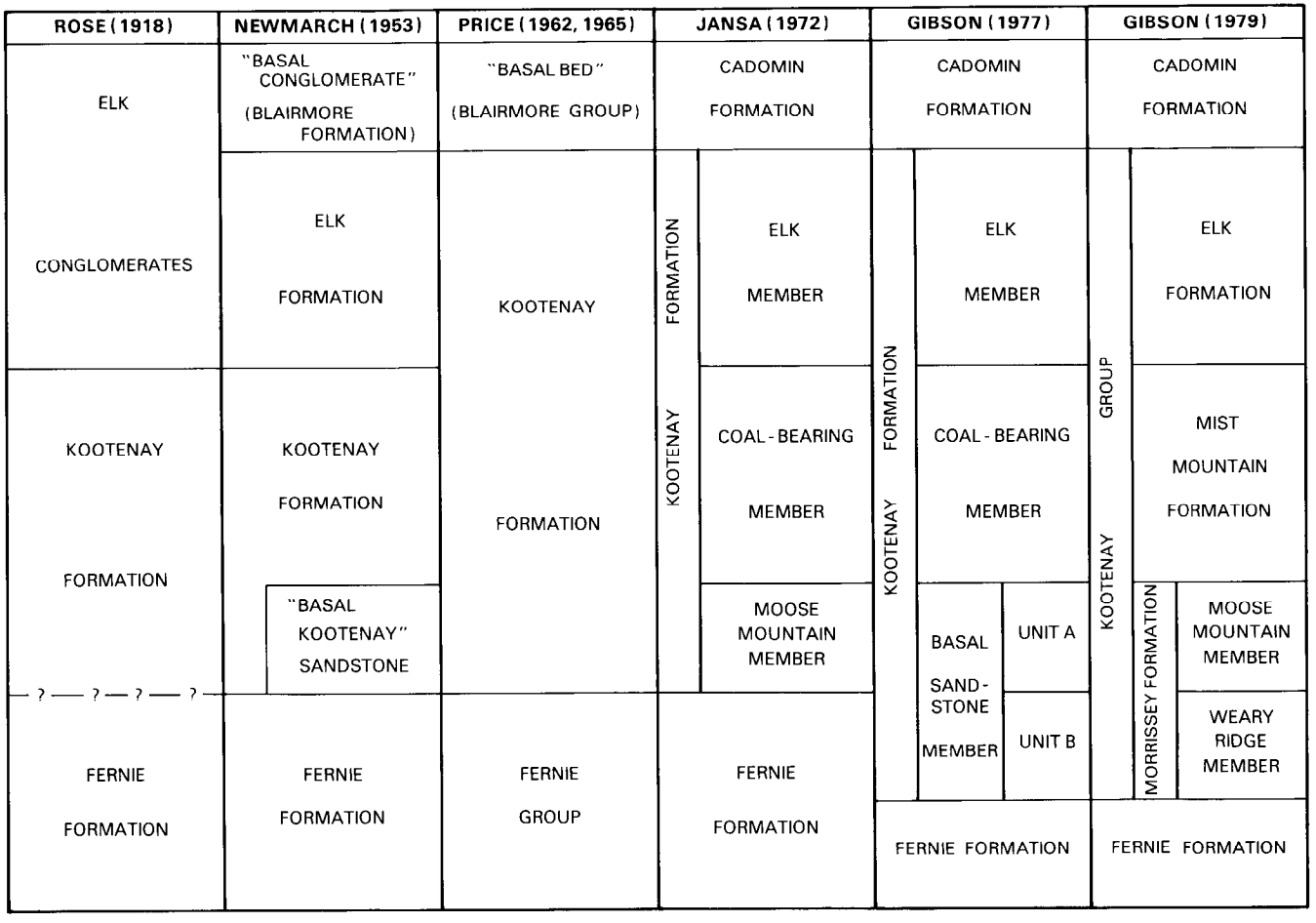

Figure 1. Development of stratigraphic nomenclature in the Fernie basin area

INTRODUCTION

The Elk Formation is the uppermost formation in the Jurassic-Cretaceous Kootenay Group (Figure 1; Gibson, 1979). It is entirely nonmarine and is generally considered to be Early Cretaceous in age (Gibson, 1985; Ricketts and Sweet, 1986), although it may be as old as Late Jurassic in some locations (Gibson, 1985). The Elk is coal bearing, but it contains mainly very thin coal seams and has contributed in only a minor way to coal production in southeastern British Columbia. It conformably overlies the Mist Mountain Formation, the major economic coal-bearing unit of the East Kootenay district and adjacent portions of Alberta. The Elk is overlain by the Cadomin Formation, basal unit of the nonmarine Lower Cretaceous Blairmore Group. In the study area, the Cadomin consists of a conglomerate bed, or a series of conglomerate beds separated by maroon and green mudstones (Ollerenshaw, 1981a), and overlies the Elk essentially conformably, with some subchannel erosion at the contact.

The Fernie basin is a complex synclinorium in the Front Ranges of the Rocky Mountains. It comprises the Crowsnest coalfield, one of three structurally separate coalfields in southeastern British Columbia (Figure 2).

The type section of the Elk Formation is on the north side of Coal Creek in the Fernie basin (Section 1, Figure 3). The base of the type section is characterized by an impressive series of conglomerate beds. Away from the type section, even within the study area, the base of the Elk becomes progressively less distinctive as the conglomerates grade laterally into sandstones, leading to difficulties in identifying the Elk/Mist Mountain contact. Further difficulties in working with the Elk stem mainly from regional and local variations in its lithological character, and the possible lensing out of the lower Elk away from the type section.

These factors prompted us to undertake a more detailed analysis of the Elk Formation, at its type section and in adjacent parts of the southern Fernie

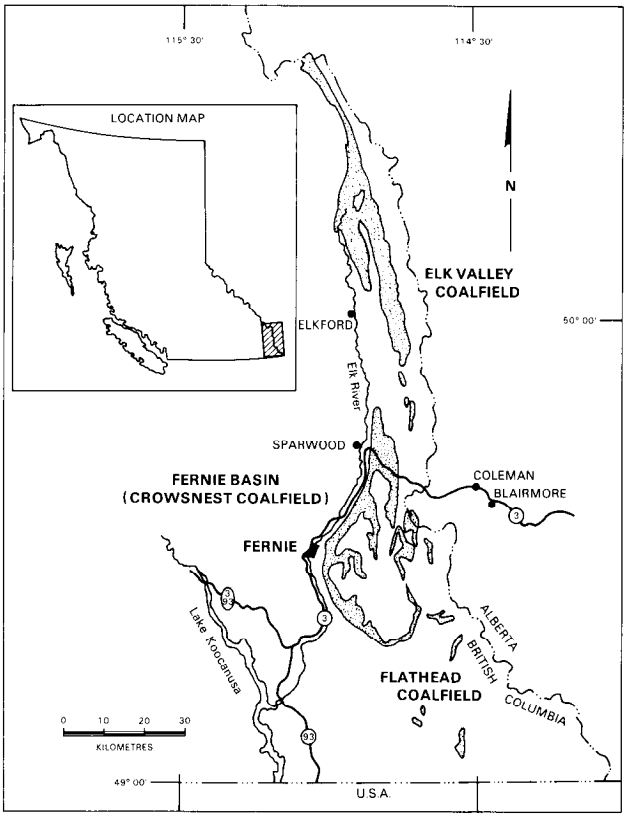

Figure 2. General distribution of the Kootenay Group in southeastern British Columbia. Outcrop of Kootenay Group is stippled.

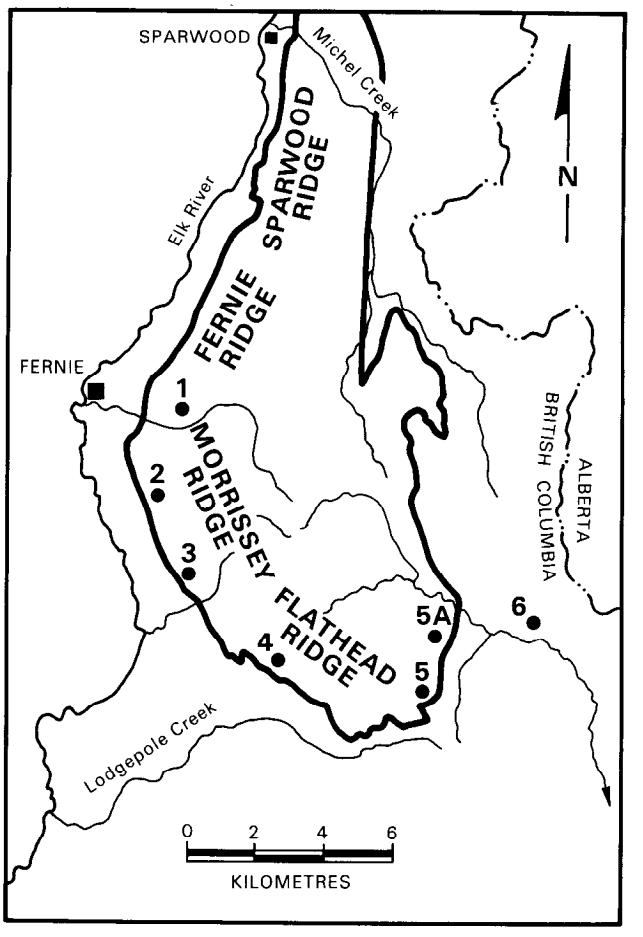

Figure 3. Locations of sections in this study.

basin, in order to document both its variations and consistencies. This study should contribute to the understanding of the Elk Formation and identify some of the problems encountered working with it.

Stratigraphic sections were measured at five localities in the southern part of Fernie basin (Figure 3). Part of one drill core from the Lillyburt coal property in the Flathead coalfield was also described. In our descriptions and discussions we have deliberately concentrated on the coarse clastics (sandstone and conglomerate), coal, and so-called "needle coal" and "needle siltstone", and de-emphasized siltstone, mudstone and shale, in order to focus the study on the distinctive features of the Elk. In discussions of the formation's contacts we have concentrated on the lower contact at the expense of the upper, because we wish to focus on the contact which is of major concern to coal geologists working in southeastern British Columbia, and the one which is, in general, less well documented. For an excellent and up-to-date discussion of the upper contact (the Kootenay-Blairmore transition) on a regional basis the reader is referred to Ricketts and Sweet (1986).

DEVELOPMENT OF STRATIGRAPHIC NOMENCLATURE

The term "Elk" was first applied to strata (within the present-day Kootenay Group) in the early part of the century by McEvoy (1902) and Rose (1918). These early workers defined the "Elk conglomerates" in the western part of the Fernie basin, as the conglomeratic strata overlying the coal measures (present-day Mist Mountain Formation), and thus included both the present Elk and Cadomin formations (Figure 1). The term "Elk conglomerates" was not applied to related strata in any other areas. Newmarch (1953) formally defined the Elk Formation in currently accepted terms, and designated the type section on Coal Creek. Once again, however, there was no intent to apply the term "Elk" to strata outside Fernie basin.

Price (1962, 1965) did not recognize the Elk Formation in his regional mapping, interpreting the unit as a local conglomeratic facies of the Kootenay Formation.

Jansa (1972), in his regional study of the Kootenay in British Columbia and Alberta, reduced the Elk Formation to member status, as the uppermost of three members of the Kootenay Formation. Gibson (1977a, 1977b) upheld this nomenclature, but argued for the return of the Elk to formation status.

Gibson later (1979) formally redefined the Elk as a formation on a regional level, simultaneously elevating the Kootenay to group status (Figure 1). A more accessible reference section on Morrissey Ridge was designated, 6 kilometres south of the type section (Section 2 in Figure 3). The anomalous nature of the conglomeratic facies in the type area was pointed out; nonetheless Gibson (1985) demonstrated that the Elk Formation is a regionally extensive unit.

STRATIGRAPHY OF THE ELK FORMATION

DISTRIBUTION AND ENVIRONMENT

The Elk Formation is an entirely nonmarine succession of interbedded sandstone, siltstone, mudstone, coal, and locally, conglomerate. It comprises a clastic wedge that thins to the east, northeast (Figure 4) and southeast away from the Fernie area and other sites of maximum deposition (that is, in the vicinity of fans), such as Mount Allan in Alberta. The formation varies in measured thickness from 28 to 590 metres (the latter at Mount Allan), and is totally absent east of a line through Blairmore, Turner Valley and Cochrane, Alberta (Gibson, 1985, page 39). The thinning of the Elk is related to the amount of pre-Cadomin erosion and/or stratigraphic thinning or nondeposition eastward (Gibson, 1985; Ricketts and Sweet, 1986).

The Elk is believed to have been deposited on an alluvial plain closer to its western source area than the underlying Mist Mountain Formation, and related to a relative increase in the rate of uplift in the source area (Columbian orogen), accompanied by and possibly causing a drying trend in the foreland depositional basin (Gibson, 1985).

CONTACTS

The conformable contact with the underlying Mist Mountain Formation is placed at the base of the lowest major sandstone or conglomerate unit above the uppermost major coal seam in the Mist Mountain Formation (Gibson, 1985). This stratigraphic position usually corresponds with a topographic break in the weathering profile, the Elk being the more resistant of the two formations. The contact was described as "of the interfingering type" by Gibson (1985, page 27); but also as gradational by Jansa (1972) and Gibson (1985, page 39), and it was mapped as such by Grieve and Fraser (1985).

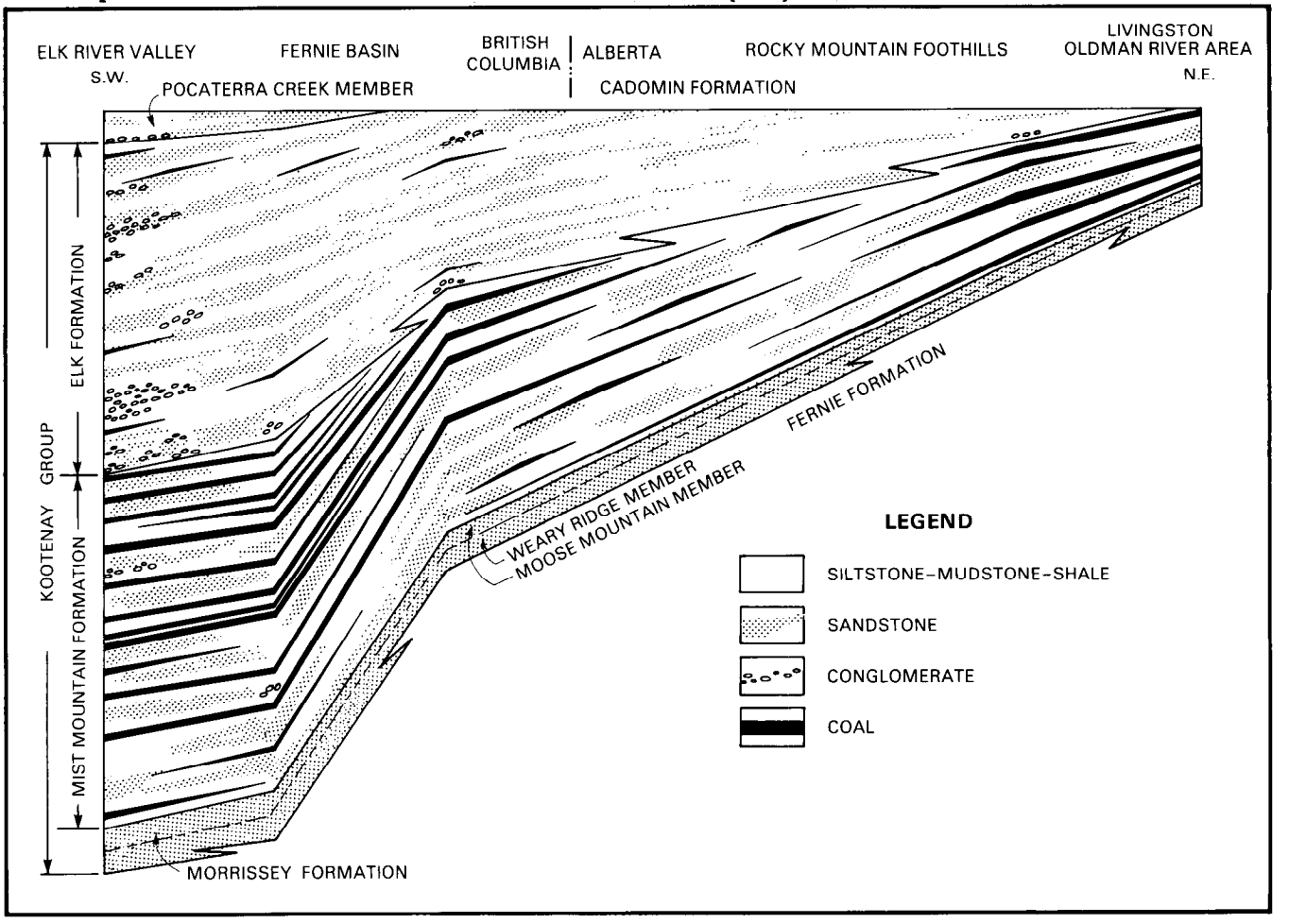

Figure 4. Schematic diagram of the lithofacies and stratigraphic relationships of the Kootenay Group from Fernie northeast. (After Gibson, 1977, Figure 3.)

The Elk's upper contact is placed at the base of the Cadomin Formation, which consists of one or more thick units of conglomerate or conglomeratic sandstone, similar in appearance to Elk Formation conglomeratic units. A series of up to four conglomerate or conglomeratic sandstone units, separated by predominantly green and maroon mudstones, comprise the Cadomin Formation in the western part of the Fernie basin (Ollerenshaw, 1981a), part of the present study area. Although the contact is abrupt and scoured in the western part of the basin, it is probably conformable (Gibson, 1985; Ricketts and Sweet, 1986). A similar situation exists in the Mount Allan area, and possibly elsewhere (Gibson, 1985). Elsewhere, especially in more eastern exposures, the contact between the Elk and Cadomin formations is generally an erosional unconformity, essentially channel eroded at a local level, but probably diachronous regionally.

DISTINGUISHING FEATURES

Several features have been described which characterize the Elk Formation relative to the underlying Mist Mountain Formation, which it otherwise resembles. These include: the small number and thinness of coal seams in the Elk (Gibson, 1985); the presence of sapropelic coals, including "needle coals" (Newmarch, 1953; Gibson, 1977a, 1977b, 1985; Ollerenshaw, 1977, 1981a, 1981b; Pearson and Grieve, 1980); the presence of "needle siltstone" (Gibson, 1977b, 1985; Ollerenshaw, 1981a) in the upper part; the greater abundance, coarseness, resistance, bedding thickness and lateral continuity of sandstones in the Elk (Gibson, 1985); less fine clastic material (Gibson, 1985); the greater abundance of carbonate clasts and carbonate cement in Elk Formation rocks (Jansa, 1972; Gibson, 1985); more brownish weathering colour in the Elk (Jansa, 1972); and greater topographic relief of the Elk Formation (Gibson, 1985). In addition, massive units of conglomerate are characteristic of the formation in parts of the Fernie basin and in the Mount Allan area of Alberta (Gibson, 1985).

ELK FORMATION ROCK TYPES

SANDSTONE

Sandstone, the most common rock type in the Elk Formation, ranges from very coarse to very fine grained, and exhibits various scales of planar and trough crossbedding, lamination and crosslamination (Plates 1, 2 and 3). Basal scour surfaces are common, as are pebbly lenses and stringers, some including mudstone rip-up clasts and some as basal lag deposits. Lenticles of coal associated with large wood and/or plant impressions are common features of coarser grained units and lag deposits. Siltstone laminae and partings are common in finer grained units. Sand framework grains, where identifiable, tend to be predominantly chert and quartz, and the sandstones are commonly limonitic and/or calcareous. Sandstone is generally grey and weathers brownish grey, becoming rust coloured where limonite coated or stained. It exhibits a range of splitting properties from platy or flaggy to massive.

Medium and coarser grained sandstone tends to form thick (3 to 20 metres), fining-upward, resistant beds. Fine-grained sandstone commonly gradationally overlies the coarser units and is transitional to finer rock types (*see* "Fining-upward Sequences", below, for depositional environment). Fine-grained sandstone also occurs in isolation from coarser sandstone deposits, and is closely associated with siltstones, where it probably represents a different depositional environment (overbank or splay?).

CONGLOMERATE

Conglomerate is relatively rare in the Elk Formation, except locally, and where it occurs it is closely associated with the coarser grained sandstone. It is generally clast supported, and contains well-rounded granule to pebble-sized (and occasionally cobble-sized) clasts of chert, quartzite and, to a lesser extent, siltstone (Plate 4) and locally, mudstone rip-up clasts. Conglomerate units are generally coarsest at their bases, where they commonly exhibit scoured surfaces (Plate 2), and fine upward into sandstone. They are generally massive but may contain medium and large-scale trough crossbedding.

SILTSTONE

Siltstone in the Elk Formation is grey in colour and many units are carbonaceous. Siltstone is commonly interbedded, on a 10 to 50-centimetre scale, with fine-grained sandstone, mudstone or coal. Siltstone units exhibit small-scale parallel lamination and crosslamination; they may be rooted and burrowed, and commonly contain plant fossils. A very distinctive type of carbonaceous siltstone in the Elk Formation is the informally named needle siltstone (Gibson, 1977b) (Plate 5). It is a very dark grey rock but weathers very light grey, is well indurated, has a hummocky upper surface and occurs in beds up to 30 centimetres in thickness. It may be rooted and may have imprints of

Plate 1. Crosslaminated sandstone, in an outcrop of the Elk formation on the north-facing slope of Flathead Ridge, west of the pipeline. The scale is a 25-cent coin.

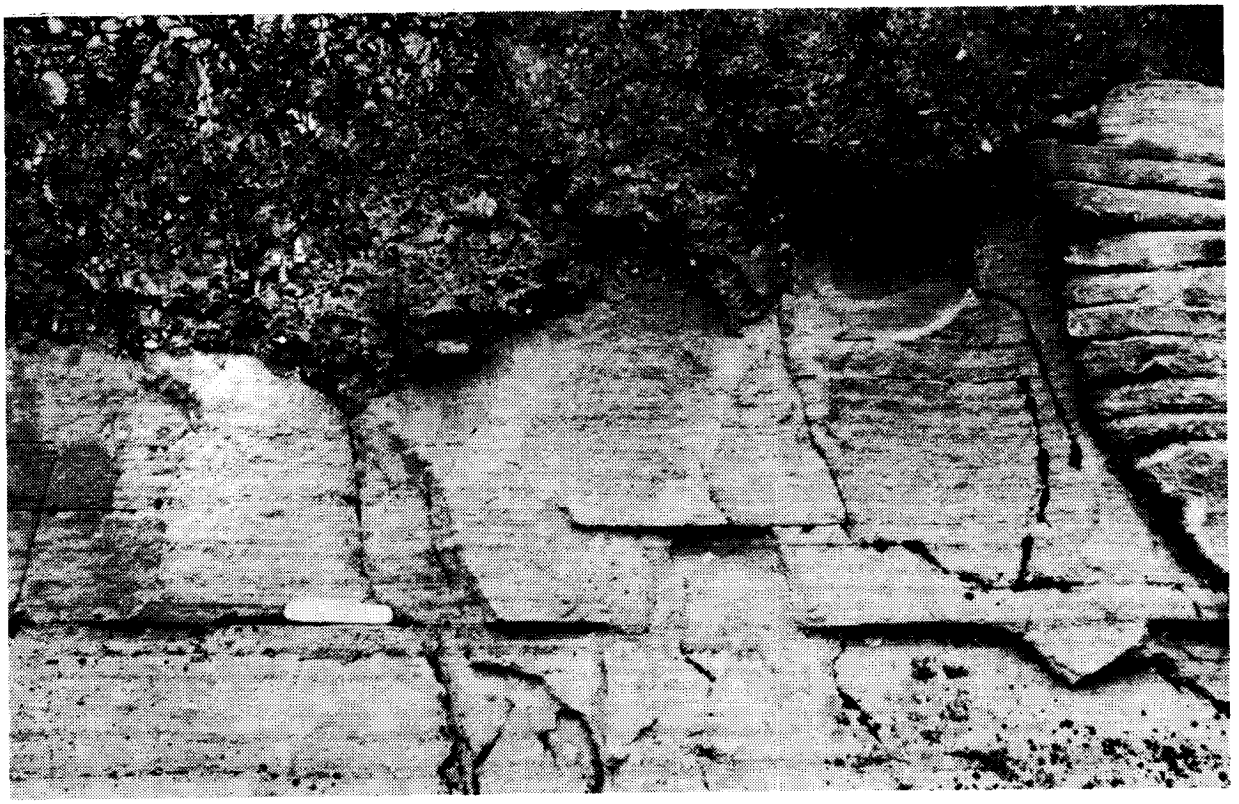

Plate 2. Channel, filled with pebble conglomerate, overlying parallel-laminated sandstone, lower Elk Formation, north side of Coal Creek. The penknife is 7 centimetres long.

Plate 3. Crosslaminated pebbly sandstone overlying pebble conglomerate. approximately 83 to 84 metres above the base of the Elk Formation at Section 1, north side of Coal Creek.

Plate 4. Pebbles on the upper surface of a sandstone unit, Elk formation, "pipeline" section, Flathead Ridge. Scale is a 25-cent coin.

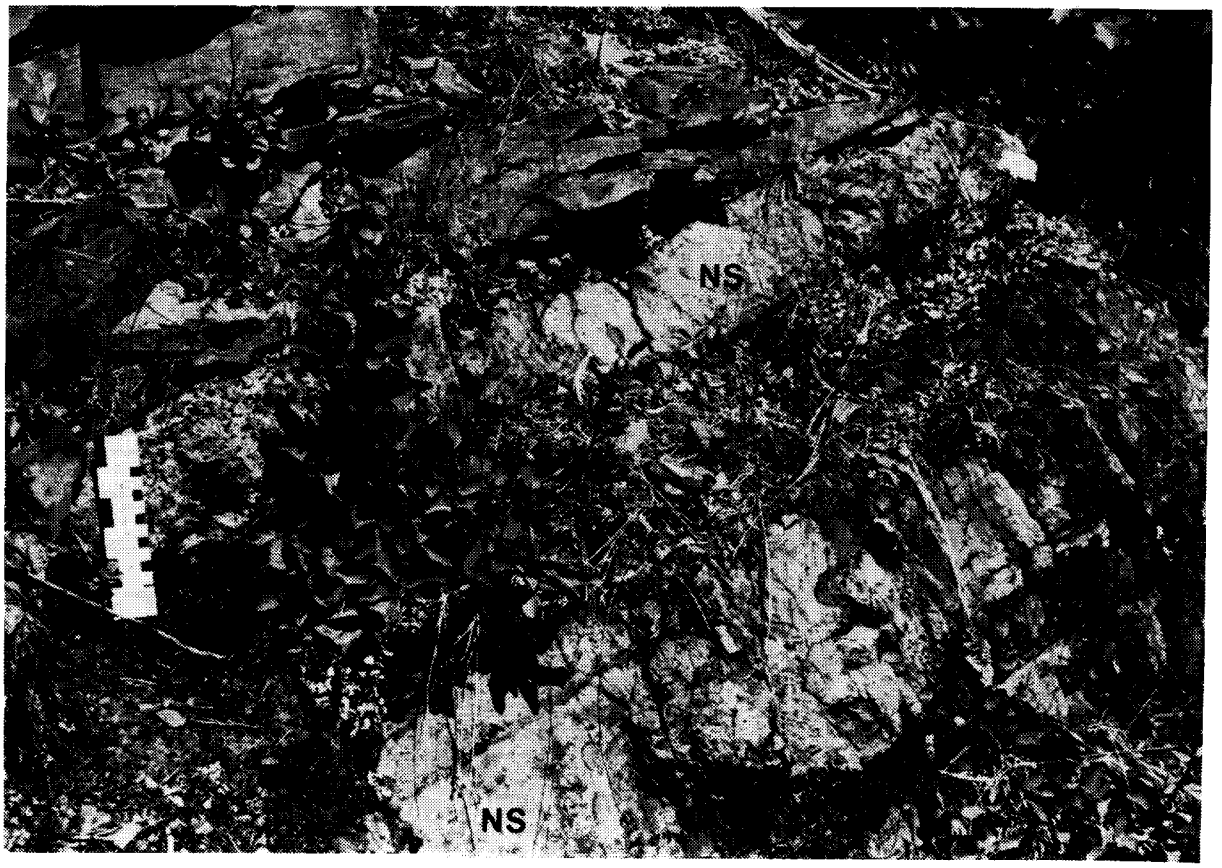

Plate 5. Outcrop of light grey-weathering, needle siltstone beds (NS), on a ridge east of the pipeline and north of McEvoy Creek. Scale in centimetres and inches.

"needles" similar to those of the needle coal lithotype, and it commonly directly underlies coal.

Mudstone and Shale

Mudstone and shale occur both as individual beds or thick units, but are commonly thinly interbedded with siltstone and coal. They are very dark grey to black, a reflection of their carbonaceous content. The finest, most carbonaceous examples tend to be relatively fissile, while the others tend to be somewhat silty and are massive and uniform.

Coal

Coal forms a minor proportion of the Elk Formation and individual seams are generally less than 50 centimetres thick. Coal is associated almost exclusively with fine-grained lithotypes. Individual seams appear to have little lateral continuity. Coal is of two distinct types, humic and sapropelic. The humic coal is vitrain-rich (bright) and forms the thickest seams, occasionally exceeding 1 metre. The sapropelic coal is hard, nonbanded and dull, and tends to occur in seams less than 30 centimetres thick. It includes needle coal (Plate 6) which consists of a felt of coal rodlets 1 or 2 centimetres (occasionally up to 4 centimetres) in length, in beds up to 15 centimetres thick, which commonly overlie needle siltstone. Otherwise identical, hard, dull coal devoid of visible needles evidently represents the other extreme of a textural continuum. The term "Elk coal" has been applied to coals over this entire range of textures (Grieve and Fraser, 1985). Liptinite content in needle coal samples from the Fernie basin exceeds 80 per cent (Kalkreuth, 1982). The needles were originally believed to be algal in origin (Pearson and Grieve, 1980), but recent analyses do not support this theory, and do not offer a definite alternative origin (Snowdon *et al.*, 1986). In general, sapropelic coals are known to represent material deposited in standing water, in this case probably small lakes and ponds.

Plate 6. Needle coal collected at Sparwood Ridge in the Fernie basin from the upper part of the Elk Formation. The sample is coated with ammonium chloride to enchance definition (from Kalkreuth, 1982.)

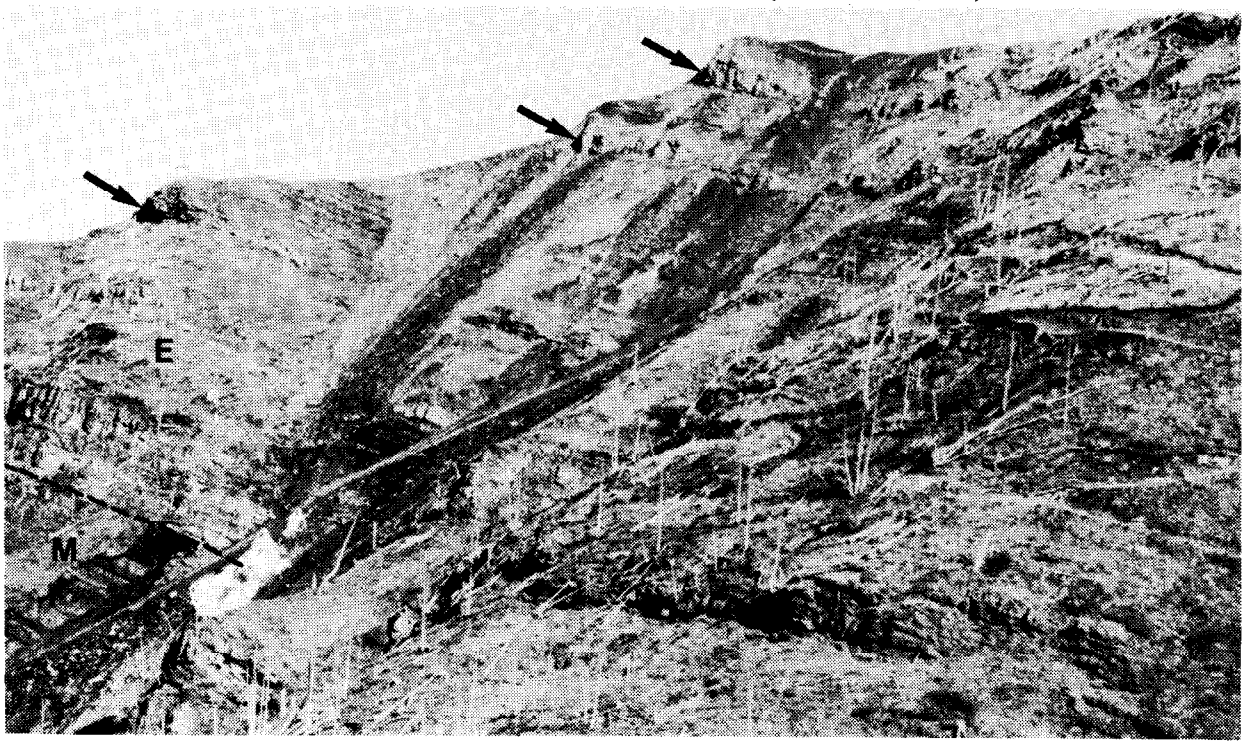

Plate 7. Looking northwest at the section of Elk Formation (E) along the pipeline cut on Flathead Ridge. Mist Mountain Formation (M) is to the bottom left corner of the photo. The bases of three fining-upward sequences are indicated by arrows (*see* text for explanation).

FINING-UPWARD SEQUENCES

The most conspicuous facies sequences observed in the Elk Formation sections studied here are fining-upward sequences (Plate 7). These generally range from 10 to 40 metres in thickness, and each, in general, progresses upward from sandstone (with or without conglomerate) to siltstone and/or mudstone (with or without coal). Within the sandstone/conglomerate portion, average grain size decreases upward. Scour surfaces and lag deposits are associated with the bases of the sequences. Trough-shaped crossbedding is generally associated with the basal portions of sequences, and the scale of all forms of cross-stratification tends to decrease upsequence, with ripple-drift crosslamination associated with the fine-grained sandstone and siltstone.

Based on accepted facies models (for example, Walker and Cant, 1984) such sequences commonly represent gravel and/or sand deposition in fluvial channels and bars, giving way upsection to deposition of finer sediment in floodplain environments. In the case of the Elk Formation sections reported here, the fluvial deposits are generally thicker than the floodplain deposits within any sequence. This is in marked contrast to the underlying Mist Mountain Formation, in which the fluvial deposits tend to be thinner (Gibson, 1985). This suggests that in general the Mist Mountain/Elk transition in the study area represents the upward facies transition from a meandering to a braided fluvial system (Walker and Cant, 1984). This model was proposed by Gibson (1985), and is described at greater length in the section on depositional setting.

NOTES

DESCRIPTION OF SECTIONS

Five complete Elk Formation sections in the southern half of the Fernie basin were measured in this study (Figure 3). These include the type section (Section 1); a section (Section 2) very close to Gibson's reference section at the north end of Morrissey Ridge; a section at the south end of Morrissey Ridge (Section 3); the "pipeline" section on Flathead Ridge (Section 4); and a section on the Lodgepole coal property (Section 5) supplemented by an incomplete section on McLatchie Ridge (Section 5A). In addition, a cored section of part of the Elk Formation from the Lillyburt property in Flathead coalfield was logged (Section 6). The Elk Formation in the study area varies in thickness from a high of 472.7 metres at Morrissey Ridge north to a low of 157.0 metres at Lodgepole.

SECTION 1, COAL CREEK
(TYPE SECTION)
(FIGURE 5; PLATES 3, 8 TO 10)

The Elk type section is 429.0 metres thick. The underlying Mist Mountain Formation is recessive and poorly exposed, and the uppermost units are covered. The base of the Elk Formation is placed at the base of a series of cliff-forming conglomerates and sandstones (Plates 8 to 10). The section is broadly divisible into three parts, with more resistant upper and lower divisions dominated by coarse clastic units, separated by a relatively recessive division in which finer grained clastics predominate.

The first division, representing the lowest 155 metres of section, consists of thick (20 to 55 metres) fining-upward sequences, each of which includes thick units of conglomerate and/or conglomeratic sandstone interbedded with sandstone, overlain by thinner recessive intervals (in most cases at least partly covered) consisting predominantly of siltstone and finer material. The predominant sedimentary structures in the coarse clastics are medium and large-scale planar and trough crossbedding. Conglomerates are composed predominantly of pebble-sized clasts, with some units containing cobbles up to 10 centimetres long. Only one seamlet of humic coal, 20 centimetres thick, was noted.

The overlying or middle division (the interval from 165 to 270 metres above base) is predominantly recessive, with thinner, more widely separated units and beds of sandstone, alternating with thicker units of siltstone and mudstone, commonly with relatively thin bedding. A few fining-upward sequences with sandstone bases are present, generally less than 10 metres in total thickness. Sandstones are predominantly very fine to fine grained, with some medium grained. Crossbedding in the sandstone units is typically small scale. No coal was observed.

The third division, representing the uppermost 160 metres of the section, consists of thick fining-upward sequences (averaging 25 metres in thickness), each with a conglomerate unit at the base and usually at other levels in the lower part. Trough crossbedding and medium and large-scale planar crossbedding are common in the coarse-grained units. Clasts in the conglomerates range from granule to pebble size, with some small cobbles up to 7 centimetres long. Several occurrences of sapropelic coal, predominantly needle coal, were observed, together with a few beds of needle siltstone.

Pebbly coarse-grained sandstone of the Cadomin Formation overlies a relatively recessive, mainly covered interval with small exposures of fine to medium-grained sandstone containing scattered lenses of small pebbles.

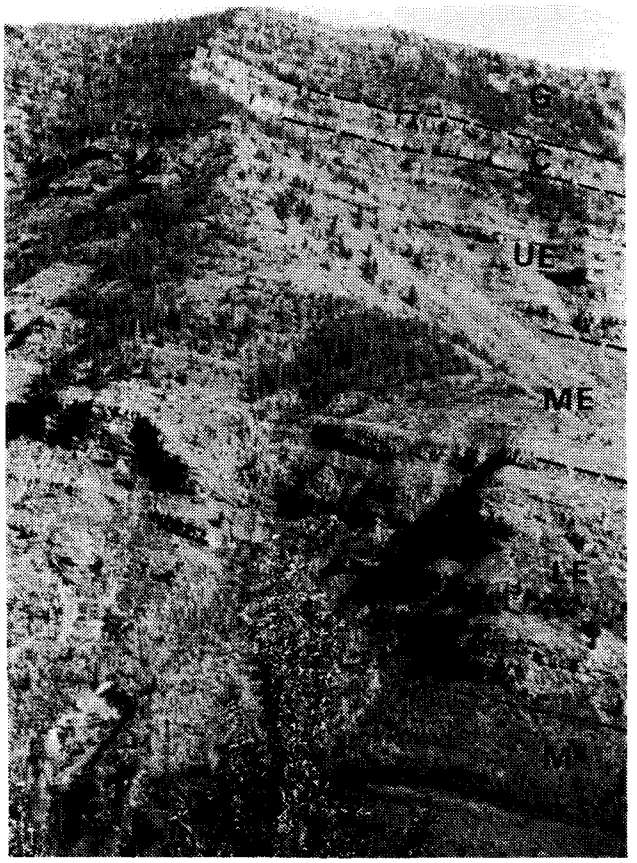

Plate 8. Coal Creek section (Section 1), looking north at the upper Mist Mountain Formation (M), lower Elk (LE), middle Elk (ME), upper Elk (UE), Cadomin (C), and gladstone formation (G).

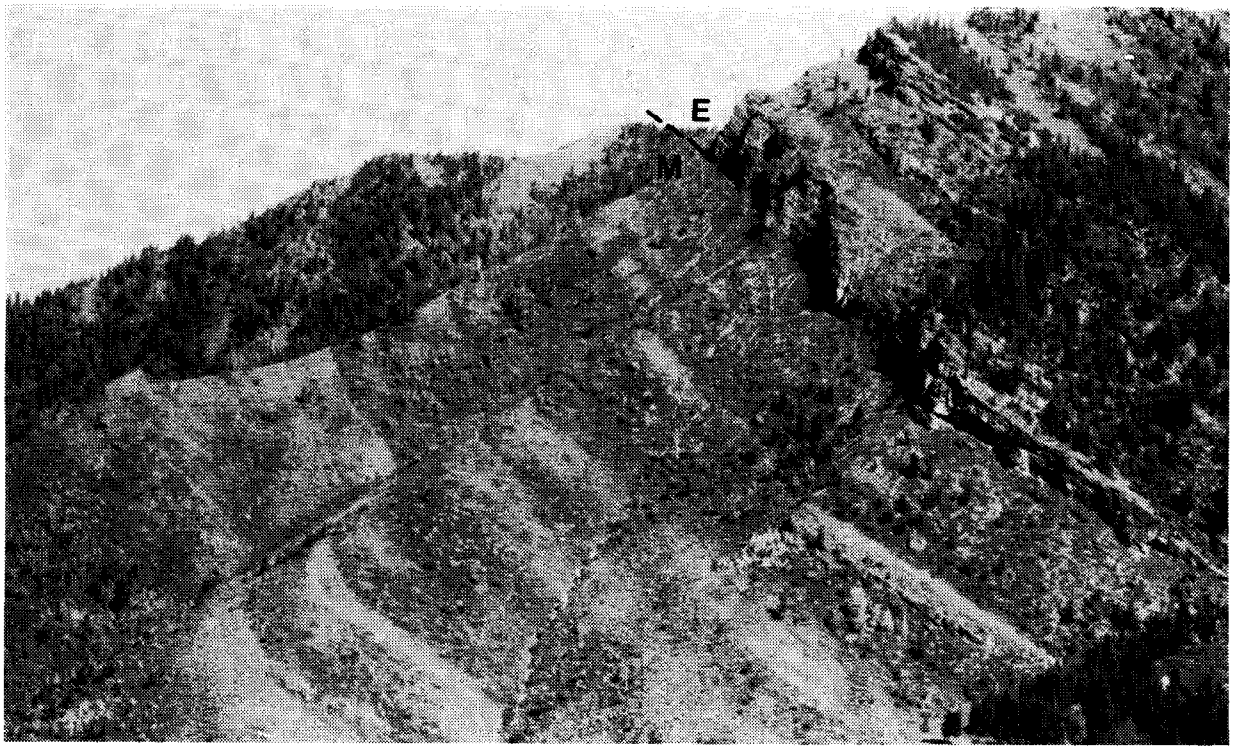

Plate 9. Looking north from the Coal Creek section (Section 1) at the upper Mist Mountain Formation (M), overlain by the cliff-forming units of the lower Elk Formation (E).

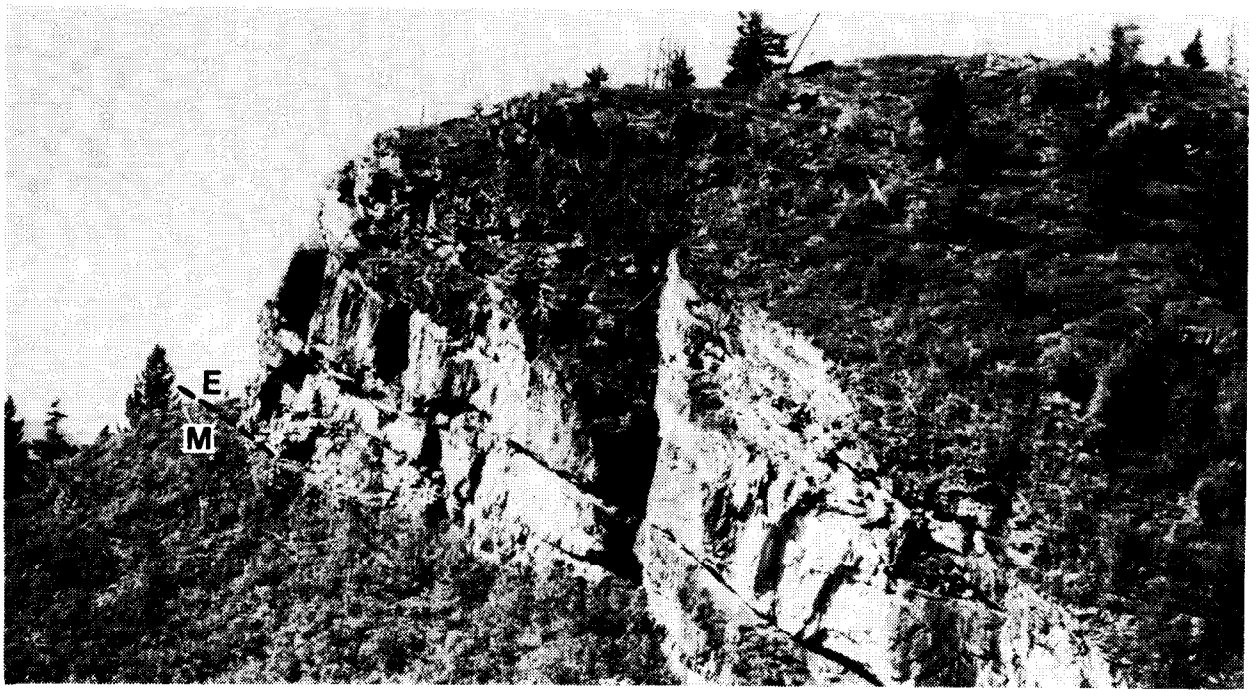

Plate 10. Close-up view of the Mist Mountain (M)/Elk (E) contact on Coal Creek. Looking west from Section 1.

SECTION 2
MORRISSEY RIDGE NORTH
(FIGURE 5; PLATE 11)

Section 2, which is situated 500 metres north of the Elk reference section on Morrissey Ridge, is 472.7 metres thick. The base of the Elk Formation is placed at the base of a 56-metre-thick continuous series of cliff-forming conglomerate, conglomeratic sandstone and sandstone, which directly overlies a coal seam 2.5 metres thick at the top of the Mist Mountain Formation. This basal unit correlates laterally with the base of the Elk in Coal Creek (Pearson and Grieve, 1981), and the underlying coal seam is probably roughly equivalent to the B seam at Coal Creek. As is the case with the Coal Creek section, this section is broadly divisible into three zones, the middle being relatively recessive and the other two relatively resistant.

The lowest division, comprising the basal 210 metres of section, consists of several fining-upward sequences, two containing conglomerate, in addition to the thick, coarse clastic basal unit mentioned above. Clasts in the conglomerates of the basal unit are predominantly pebble sized with some small cobbles, while the other conglomerates in this zone contain granule and pebble-sized clasts. A humic coal seam, 1 metre thick, is exposed in a trench and overlies the lowest fining-upward sequence.

The overlying middle division (the interval approximately 210 to 293.5 metres above base) is relatively recessive, with significant covered intervals. Outcrops of interbedded siltstone and fine-grained sandstone occur throughout, and a few graded fine-grained sandstone to siltstone sequences, with bedding thicknesses of 10 to 100 centimetres, were noted near the top of the zone.

The uppermost 180 metres of section forms the upper, relatively resistant zone of the triad and, like the lowest zone, it is characterized by a continuous series of sandstone and conglomerate units, overlain by three fining-upward sequences, two of which have conglomerate at their bases. Conglomerates in this zone have predominantly pebble-sized clasts. Needle coal and needle siltstone occurrences are restricted to the uppermost 30 metres of the formation.

Cadomin Formation pebble conglomerate overlies recessive, dark grey siltstone of the Elk.

Despite its proximity, Section 2 is 49 metres thinner than the Elk reference section (Gibson, 1985). This discrepancy appears to be accounted for by the fact that strata included by Gibson in the lower part of his section are placed beneath the basal Elk unit in our section. These strata do include a resistant conglomeratic sandstone unit which can be traced northward to Coal Creek, but this sandstone is overlain by a thin recessive zone containing a coal seam 2.5 metres thick (referred to above). We agree with Pearson and Grieve (1981), who placed these strata in the Mist Mountain Formation. We note that Gibson (1985, Figure 5) did not encounter the 2.5-metre coal seam, which doubtless influenced his decision on where to place the contact.

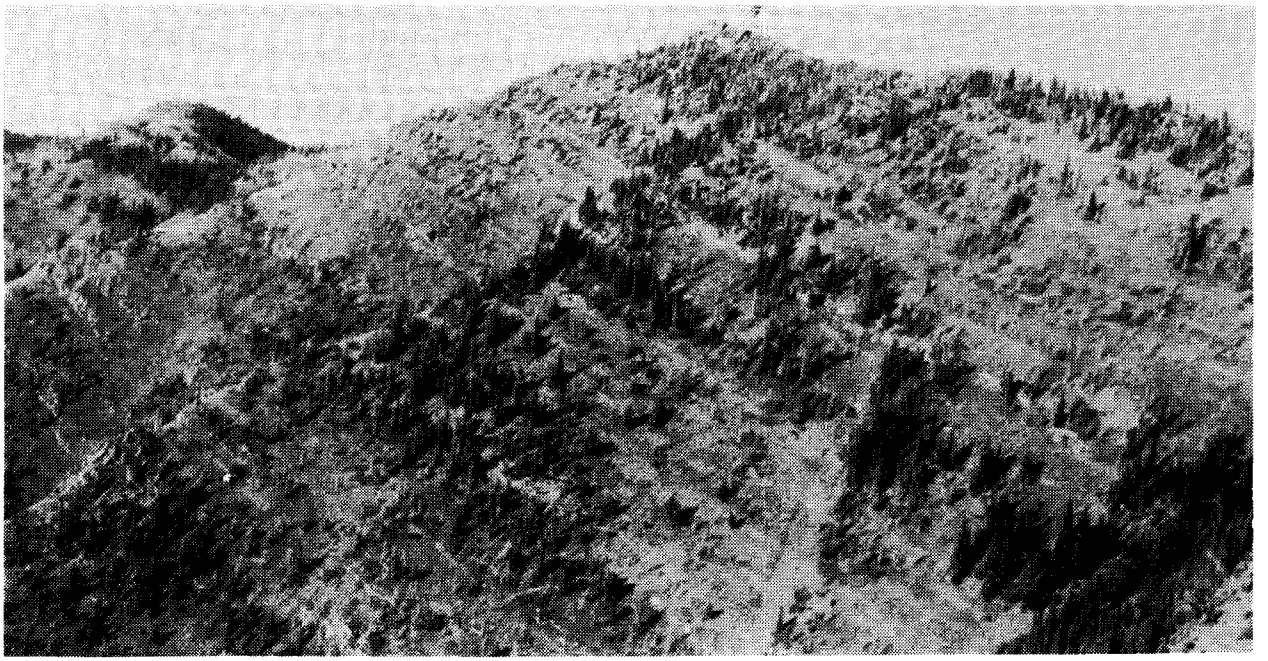

Plate 11. Looking north at the Elk Formation at Section 2 on Morrissey Ridge. The cliff immediately beneath the microwave tower belongs to the Cadomin Formation.

SECTION 3
MORRISSEY RIDGE SOUTH

(FIGURE 5; PLATES 12, 13)

The Elk Formation in Section 3 has a measured thickness of 436.1 metres. The base of the Elk Formation is placed below the base of a thin resistant unit of granule to pebble conglomerate overlain by coarse-grained sandstone. The conglomerate directly overlies a carbonaceous unit 2.1 metres thick, including 1.2 metres of coal, exposed in a trench. Section 3 is not obviously divisible into large contrasting zones or facies. However, the fact that conglomerate units are concentrated in the lowermost 150 metres and uppermost 75 metres of the section shows a less obvious but strong underlying similarity to the tripartite nature of Sections 1 and 2. The main difference here is that major, cliff-forming channel sandstone units occur between 266.5 and 304 metres and are, therefore, within the otherwise relatively recessive middle portion of the section.

Fining-upward sequences are similar to those in Sections 1 and 2. Clasts in the conglomerates are almost exclusively within the granule and pebble size ranges. The predominant sedimentary structures in the coarse clastics are medium and large-scale planar and trough crossbedding. Two humic coal seams 1.2 metres thick occur in the interval between 100 and 115 metres. Needle siltstone occurs in the uppermost 100 metres only, and only one needle coal layer was observed, approximately 20 metres below the top of the formation and closely associated with a humic coal seam 40 centimetres thick.

Cadomin Formation pebble conglomerate, in a unit 10.5 metres thick, overlies an Elk mudstone unit containing thin interbeds of crosslaminated fine-grained sandstone.

The existence of two coal seams in what otherwise appears to be the lower third of the Elk Formation presented problems with placement of the Elk/Mist Mountain contact. Initially we chose a position 130 metres above the base of the section, corresponding with the base of the first major sandstone/ conglomerate unit overlying the two seams. We changed our minds after reconsidering our decision in the light of the definition of the contact, which stresses **both** major sandstone and major coal (Gibson, 1985). Neither of these two coals constitutes a major coal seam, whereas the package of conglomeratic strata underlying them is a major coarse-grained unit, far more appropriate to the Elk Formation than the Mist Mountain. Our decision was made in terms of the relative significance of the two lithological criteria.

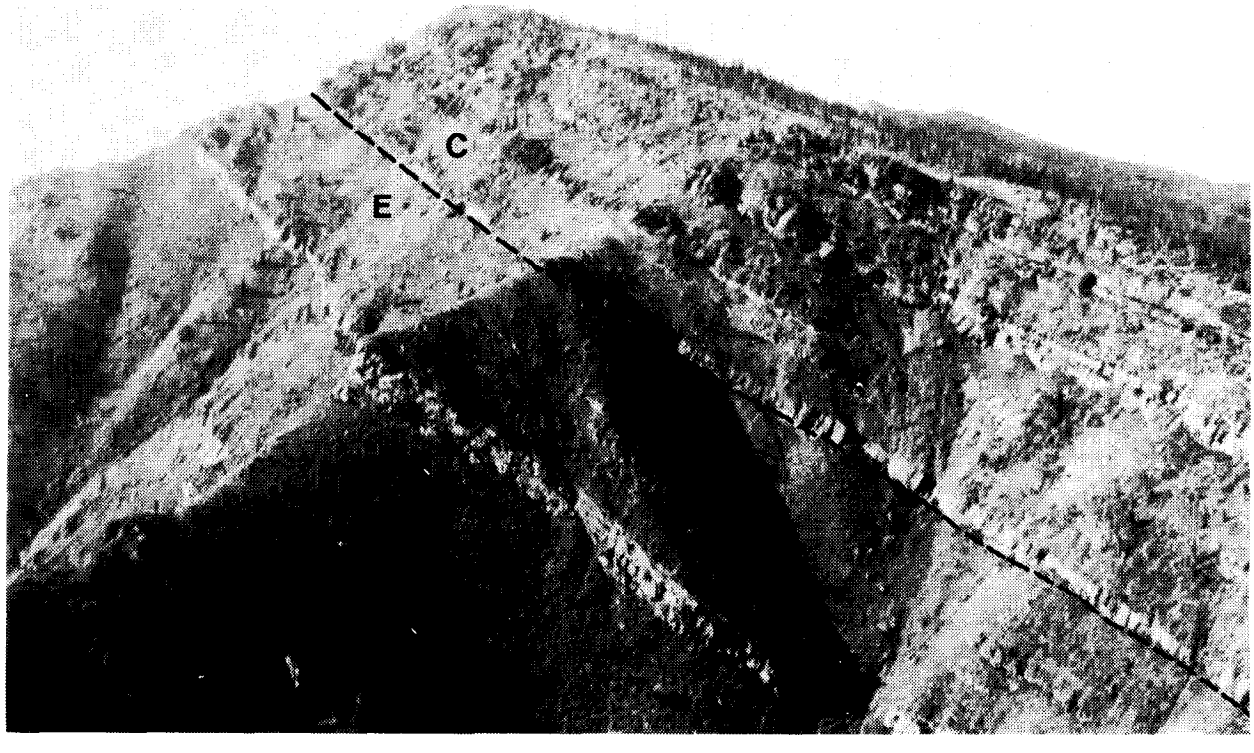

Plate 12. Looking northwest along Morrissey Ridge at the coarse clastic facies of the upper Elk (E) and Cadomin (C) formations, immediately nothwest of Section 3.

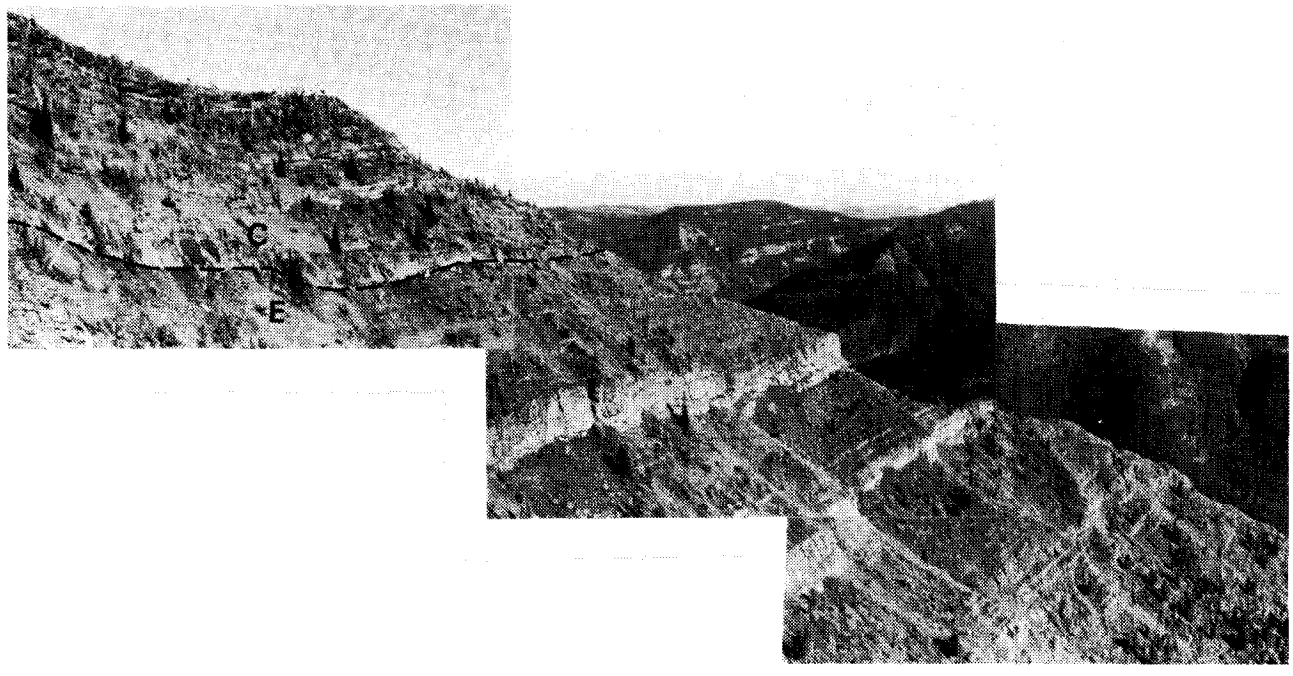

Plate 13. Panorama taken from Section 3, on Morrissey Ridge, looking east at the Elk (E) and Cadomin (C) formations.

SECTION 4, FLATHEAD RIDGE ("PIPELINE" SECTION)

(FIGURE 5; PLATES 4, 7)

Elk Formation strata are very well exposed along the gas pipeline route across Flathead Ridge, and at this locality the formation is 327 metres thick. The base of the Elk Formation is placed below a cliff-forming, medium to coarse-grained, crosslaminated (large-scale) sandstone, with "tree" (branch and stem) imprints and shale rip-up clasts, and directly overlies a recessive unit 6.5 metres thick in which coal predominates. Section 4 does not appear to be readily divisible into large contrasting zones, and there is little obvious evidence of the tripartite zonation noted at Sections 1 and 2. However, the interval between approximately 94 and 216 metres above base is characterized mainly by sandstones occurring in scattered thin beds and by relatively fine grain size and small-scale cross-lamination. This may be analogous to the middle division of the previous sections. Throughout the section the coarse clastics are mainly sandstone, with conglomerate occurring in two relatively minor beds only, approximately 25 and 50 metres below the top of the Elk Formation. Thus, the bases of the fining-upward sequences tend to consist of medium or coarse-grained sandstone, with large or medium-scale crossbedding. Two seams of humic coal, 1.2 and 1.0 metres thick respectively, occur in the interval between 31.0 and 52.0 metres. No sapropelic coals were observed, and needle siltstones occur only in the uppermost 120 metres of the Elk. An interesting bed of mudrock, 1.25 metres thick, is exposed 125.25 to 126.5 metres above the base of the section. This rock has the colour and textural characteristics of a fossil soil profile, complete with carbonized fossil roots.

Cadomin Formation conglomerate containing sandstone lenses overlies a 3-metre-thick covered unit underlain by carbonaceous shale with interbedded needle siltstone. The recessive covered interval is almost certainly part of the Elk Formation, but the Elk/Cadomin contact is not exposed.

As was the case with Section 2, we have chosen a different position for the Elk/Mist Mountain contact than Gibson (1985, Figure 5). In this case, the basal 52 metres of our Elk section was placed in the Mist Mountain Formation by Gibson. At this locality, neither of the two coal seams that occur in the lower Elk by virtue of our placement of the contact constitutes a major seam and, thus, our revision of the contact does not violate the criteria for its definition. Furthermore, as was the case at Section 3, the lower sandstone unit that we have chosen to mark the contact is more prominent than the sandstone, at 52 metres above the base of our Elk section, chosen by Gibson. We considered the sandstone to be a major component and

the coal to be a minor component of the contact placement "equation". We acknowledge that the factors affecting our decision in this case are open to interpretation and that a reversal in the relative thickness of these same units along strike would result in a different placement of the contact.

SECTIONS 5 AND 5A, LODGEPOLE PROPERTY AND MCLATCHIE RIDGE
(FIGURE 5; PLATE 14)

The Elk Formation on the Lodgepole coal property has a measured thickness of 154.5 metres. The base of the Elk Formation is placed at the base of a resistant, medium-grained, medium-scale crosslaminated sandstone, that overlies a carbonaceous shale and mudstone unit 2.5 metres thick, that in turn overlies a coal seam 7.6 metres thick. Compared to the other sections, Section 5 lacks a single "major" sandstone/conglomerate at any point, which makes application of the definition of the Elk/Mist Mountain contact difficult. The Elk Formation at Section 5 does not appear to be divisible into large zones of contrasting character, although much of the upper two-thirds is relatively recessive compared to other sections in this study. Throughout the section, sandstone forms the dominant coarse clastic, with one thin unit of conglomeratic sandstone occurring roughly in the middle of the formation, and one very coarse-grained sandstone with granule-rich layers at approximately 20 metres below the top. Fining-upward sequences tend to have medium-grained sandstone at their bases. Poorly exposed humic coal was observed at about 30 metres above the base of the Elk. Sapropelic coal was not observed, and needle siltstone occurs only in the uppermost 40 metres of the formation.

Cadomin Formation conglomerate overlies, on a scoured surface, medium to coarse-grained, cross-laminated sandstone of the upper Elk.

Section 5A is a supplemental section of uppermost Elk, 24.5 metres thick, exposed on McLatchie Ridge, 4 kilometres north of the Lodgepole section. It consists of three relatively unimpressive, generally medium-grained sandstone units, two of which are conglomeratic at the base, separated by recessive covered intervals. No needle coal or needle siltstone units were observed in place, although some fragments occur in the float. Cadomin Formation pebble conglomerate directly overlies the uppermost sandstone.

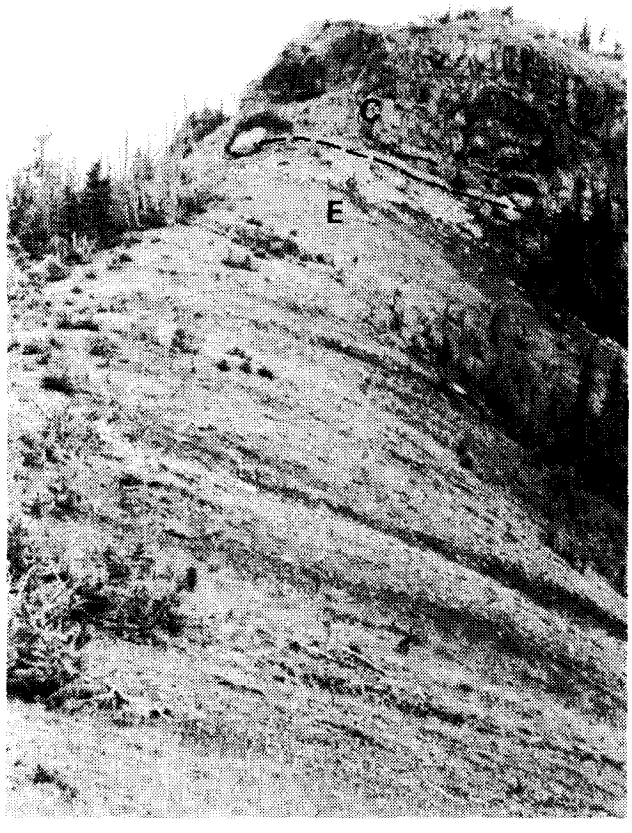

Plate 14. Recessive upper Elk strata (E) overlain by cliff of Cadomin Formation (C) at Section 5 (Lodgepole property).

SECTION 6, LILLYBURT PROPERTY
(FIGURES 5, 6)

A section of upper Elk Formation was described from drill core LB-301 from the Lillyburt coal property. At the time the core was examined we believed that this 67.1-metre section represented the entire Elk Formation. Later examination of the drill logs, however, convinced us that the Elk Formation is actually approximately 175 metres thick. Figure 6 is a representative stratigraphic column of Kootenay Group from the Lillyburt property, which matches drill core LB-301 very closely. Applying the definition of the Elk/Mist Mountain contact to this section leads to the conclusion that the contact is in fact a few metres above "D-seam", and not above "E-seam" as we had originally assumed (hence our 67.1-metre incomplete section), because the significance of E-seam is overshadowed by the size, thickness and spacing of the sandstone units that underlie it. This placement of the contact also corresponds with the point in the section at which a dramatic change in weathering profile occurs.

Sandstone is the dominant rock type within the portion of the Elk Formation that we described, with only one minor unit of conglomerate. The sandstones range from fine to coarse grained, but are predominantly medium grained. Crosslamination ranges from small to medium

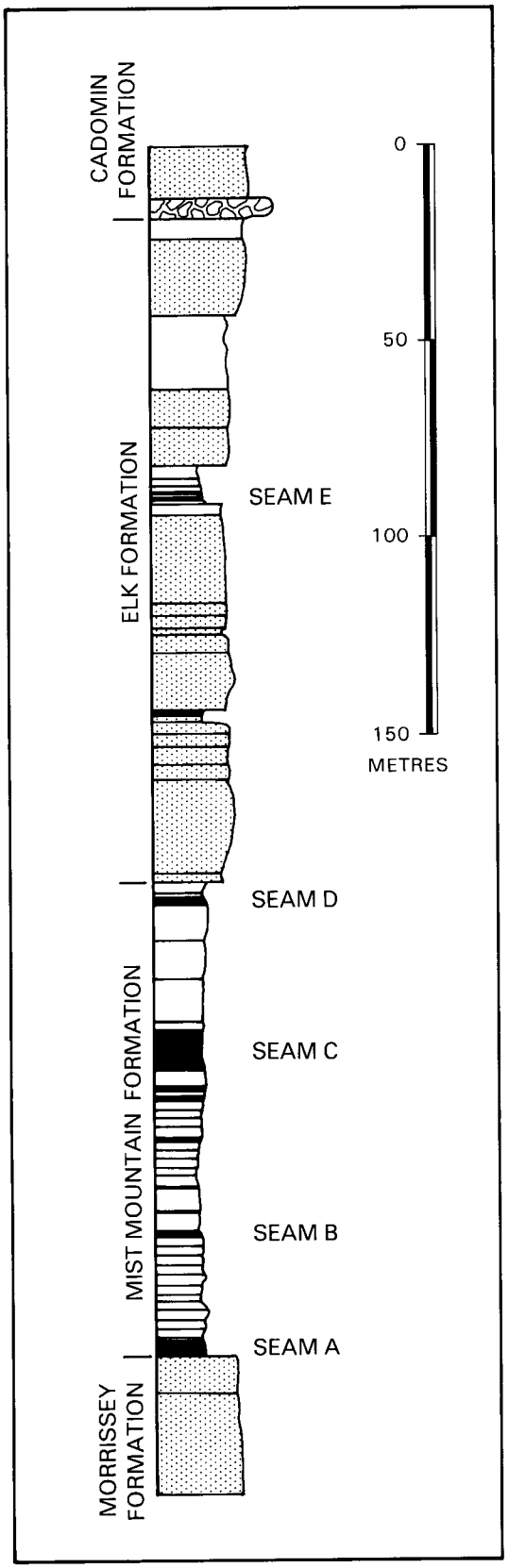

Figure 6. Generalized stratigraphy of the Kootenay Group at Lillyburt. (After McKinstry, Crows Nest Resources Limited.)

scale and some units are massive or parallel laminated. The only coal noted occurs as partings and lenticles in the sandstone, probably corresponding to original plant debris. Needle siltstone was not observed, although it would be difficult to identify on the fresh, unweathered surfaces available in drill core, as the fresh colour of the siltstone is very dark grey to black.

The exact placement of the Elk/Cadomin contact is not clear, but it probably corresponds with the base of a thin, medium-grained sandstone unit containing pebble stringers and rip-up clasts, overlain by 5.5 metres of pebble conglomerate with sandstone interbeds. The sandstone overlies interbedded, very fine-grained sandstone and siltstone, considered to be the top of the Elk.

NOTES

DISCUSSION

DEPOSITIONAL SETTING

Kootenay Group depositional models published to date propose a broad coastal plain system roughly parallel to the uplifted source area to the south and west (*see* Gibson, 1985). Increase in distance from shoreline, and thus decrease in distance to source area, are represented by successively younger strata in the group. Although both the upper Mist Mountain Formation and the entire Elk Formation were deposited on some sort of alluvial plain, the Elk must have been laid down close to the source of the sediments (Gibson, 1985). The possibility of alluvial fan deposition for the Elk type area was raised by Gibson (1985).

The general contrasts between the Elk and Mist Mountain formations are probably related to the specific nature of fluvial deposition in each case. Both Jansa (1972) and Gibson (1985) speculated that the Mist Mountain/Elk transition represents a transition from meandering to braided rivers. This is certainly consistent with the model reiterated above. It is also consistent with the facies observed in the Elk Formation. In particular, the relatively high ratio of channel to floodplain deposits in the study area, together with the apparent greater lateral continuity of individual channel deposits, implies that the Elk, at least in this area, was deposited by braided streams (*see* Walker and Cant, 1984). The very coarse clastic facies found in the type area are suggestive of braided fluvial deposition on the distal part of an alluvial fan (Rust and Koster, 1984), while the type and distribution of strata in the remainder of the study area suggest a braidplain environment.

The six Elk Formation stratigraphic sections described here show certain consistent characteristics and variations that elucidate the interpretation of stratigraphic relationships and depositional environments, at the same time revealing certain problems involved in working with the Elk. To aid discussion, the sections have been generalized and placed in relative geographic position in Figure 7. The stratigraphic distribution of sandstone and conglomerate suggests that coarse clastics form a prominent, if not dominant, fraction of the total stratigraphic thickness in each section. The stratigraphic distribution of conglomerate suggests that concentrations of conglomerate occur in the upper part of the Elk Formation in all cases except Section 5, and in the lower parts of Sections 1, 2 and 3. This reflects the broad tripartite zonation observed in Sections 1 and 2, and, to a lesser extent, 3 and 4 (above). A further consistency noted is that the needle siltstone and sapropelic coals (where they occur) are restricted to the upper part of all the sections in which they were observed.

Contrasts between the sections are also notable. In particular, the thinning of the formation, with the concomitant loss of the conglomeratic portion of the coarse clastics, in a general southeasterly direction away from the type area, is very striking. The rate of thinning, in fact, is much greater than that implied by the schematic cross-section in Figure 4, which indicates the regional trends in both the Mist Mountain and Elk formations. However, the direction of thinning observed in this study (Figure 7) is perpendicular to the regional trend. In other words, the thinning of the Elk Formation observed here is not related entirely to distance from the source, but rather distance from a depositional centre. Given the coincident loss of conglomerate in a southeasterly direction, one reasonable model to explain this stratigraphic thinning is deposition on the distal part of an alluvial fan, as suggested above, with the thinning related to distance from the fan axis. More specifically, the tripartite breakdown of the Elk Formation observed in the type area suggests two fan cycles (upper and lower resistant zones) separated by an interfan sequence (recessive). Section 5, in which no zonation is apparent, probably represents an off-fan site throughout Elk deposition.

Each burst of fan activity may represent a period of uplift in the source area (tectonic influence) or a local shift in the fan sediment distribution system (fluvial or climatic influence). At Coal Creek (Section 1), the Elk Formation consists of the deposits of two stacked distal fan deposits (the lower and upper coarse clastic wedges) separated by "off-fan" sediments (the recessive middle division). On the other hand, individual fining-upward sequences within the fan cycles, at fan or off-fan sites, are certainly not related to specific tectonic events. A series of fining-upward sequences equivalent to one fan cycle would probably coalesce closer to the source area (*see* Figure 8), in portions of the fan not preserved. This emphasizes that the interpreted alluvial fan deposits preserved in the study area probably represent distal positions of the fan, an environment more likely to be subject to shifts in the drainage pattern than proximal parts of the fan.

This interpretation is consistent with Gibson's (1985) interpretation of distal fan deposition for the type area of the Elk and for one other area (Mount Allan). The initial naming of the "Elk Formation" (Newmarch,

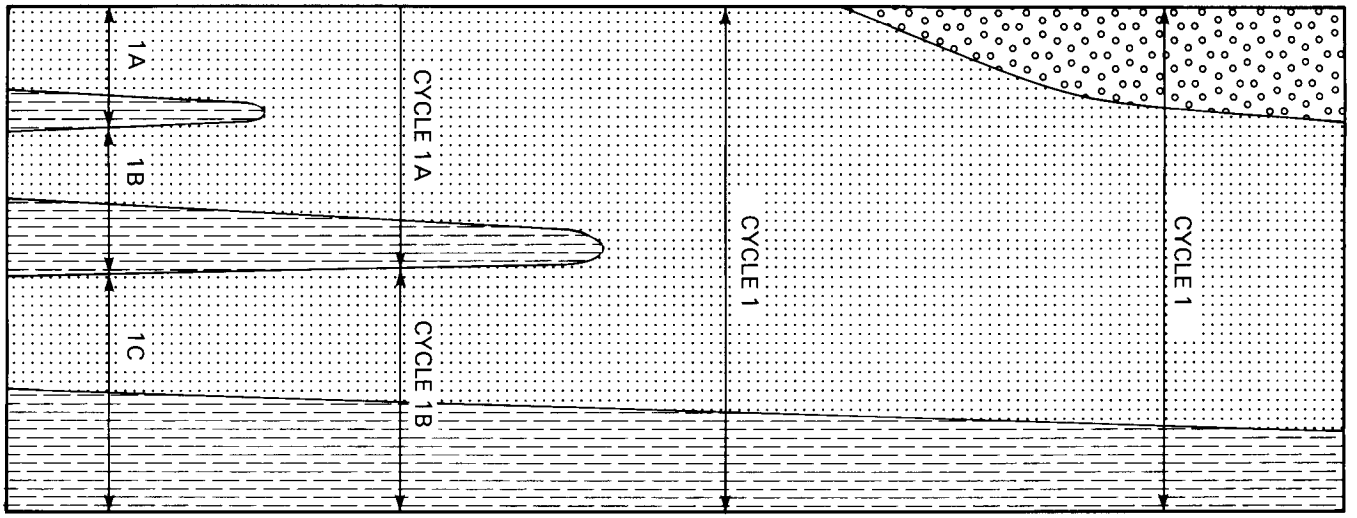

Figure 8. Schematic diagram of the distal increase in the number of fining-upward sequences away from the fan depocentre (on left) with concomitant general decrease in cycle thickness. One cycle on the fan (Cycle 1) may be the time-equivalent of two ore more cycles (Cycles 1a, 1b; 1a, 1b, 1c) away from the fan.

1953) was based on studies in the type area only, and thus, in effect, a formation name was applied to a local facies variant of the upper Kootenay. This is consistent with Price's (1962, 1965) interpretation that the Elk Formation, as defined by Newmarch (1953), lacked regional significance. With the application of the reintroduced term "Elk Formation" throughout the extent of Kootenay occurrence (Gibson, 1979), the formation name has been extended to include both a regional facies (braidplain) and local coarser grained variants (distal fan).

As one of the authors has stressed (Ollerenshaw, 1977, 1981a, 1981b), the needle coals and needle siltstones are restricted to the upper part of the Elk Formation in the areas around the type section (that is, Flathead and Morrissey ridges), in sections that must surely be representative of the most complete if not typical development of the formation. It is therefore worth noting that even in the thinner and reduced sections of the Elk Formation away from the type section (for example, Sparwood Ridge, Lodgepole and McLatchie Ridge) the needle facies is still present. This fact, considered in conjunction with the progressive distal disappearance of the main conglomerate and sandstone facies implies that, in addition to an overall thinning of the Elk Formation east of a northwest-southeast line bisecting the Coal Creek "fan", the lower and perhaps middle divisions of the tripartite sequence at the type section may have lensed out as well as "fined-out", so that only the upper part of the Elk Formation has regional continuity. More evidence is required to substantiate this interpretation, which is shown schematically, in the form of the two most likely possibilities, in Figure 9. These will be discussed further below.

ELK/MIST MOUNTAIN CONTACT

In considering the application of the term "Elk Formation" and the correct identification of the Elk within the Kootenay Group in the light of these environmental considerations, it is critical to consider the definition and identification of its lower contact. The current definition, which stipulates that the contact be placed at the base of the first major sandstone above the last major coal seam (Gibson, 1985), has been shown to be somewhat difficult to apply in this study. In the case of Section 2, a thick conglomerate in the upper Mist Mountain Formation (our usage), which may represent the margin of an earlier fan deposit, led to our choosing a different placement of the contact to that chosen by Gibson (1985). This discrepancy is attributed to the fact that Gibson apparently did not encounter the coal seam that we place at the top of the Mist Mountain. In three other cases (Sections 3, 4 and 6) a coal zone in the Elk (our usage), related to short-term climatic or other environmental change, has created some uncertainty as to the exact placement of the contact. In the case of Section 5, the lack of a single

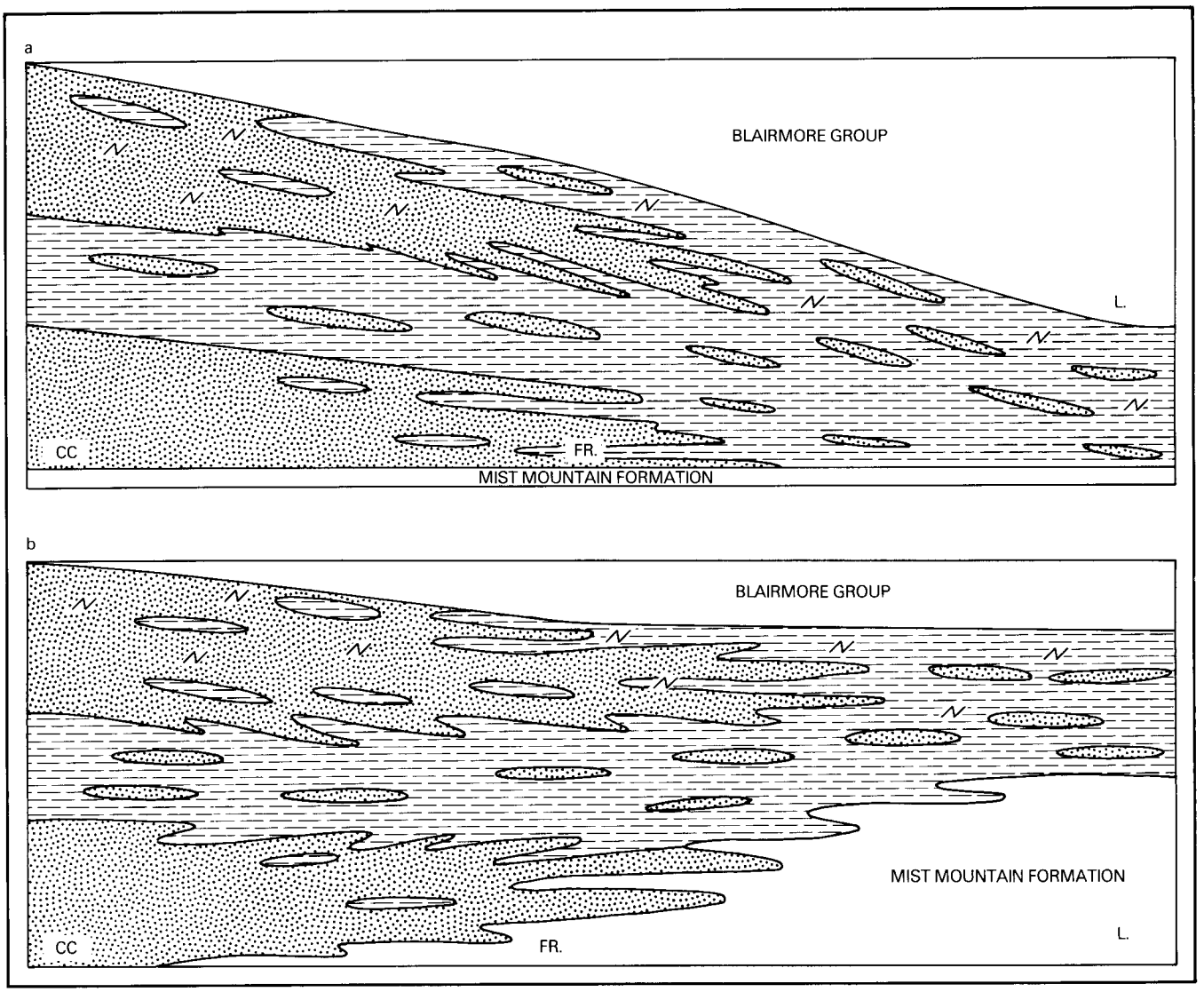

Figure 9. Schematic diagrams showing two possible relationships between the fan margin (Section 1, Coal Creek) and the off-fan (Section 4, Flathead Ridge; and Section 5, Lodgepole) sequences, based on the stratigraphy and the occurrence of the needle coal facies.

(a) A "wedge" model in which the lower and middle parts of the Elk Formation lens out laterally.

(b) An "interfingering" model in which the lower and middle parts of the Elk Formation pass laterally into time-equivalent Mist Mountain strata. CC = Coal Creek; FR = Flathead Ridge; L = Lodgepole; N = needle coal facies.

prominent sandstone bed in the lower Elk has also led to some uncertainty.

In all these examples, the decisions made were inevitably arbitrary ones, as there are no truly objective parameters to apply. In particular, no precise quantitative limits have been placed on the operative term "major" as it pertains to sandstone and coal units in the vicinity of the contact. Unfortunately, we have not been successful in deriving more objective criteria. The only insight we have gained is that it is essential to make a balanced decision, considering both sandstone and coal, and not overemphasizing either. For example, in Section 3, we did not feel justified in putting the two thin coal seams near the base of the section into the Mist Mountain Formation, as this meant placing a very prominent, and relatively more significant sequence of coarse clastics into the Mist Mountain as well. The minor coal units thus become part of the Elk Formation. Even with this balanced, albeit arbitrary, approach it will be necessary to accept inconsistencies in the placement of the contact, related to lateral thickness changes and the pinching out of specific units. Gibson (1985) in fact acknowledges that the contact is an interfingering one, which means that tongues of Elk facies will occur in the Mist Mountain and vice versa.

In summary, the general facies transition

represented by the Elk/Mist Mountain contact does not appear to offer a distinct, clearcut choice of a consistent contact horizon throughout the study area, in spite of the fact that the type area contains a well-defined if anomalous facies of the Elk.

RECOGNITION OF THE ELK

It is also important to consider the question of recognition of the Elk Formation itself. The numerous features that distinguish the Elk Formation from the Mist Mountain Formation were listed on page 6. The results of this study do not refute any of them. However, none appears to be a diagnostic criterion in identifying the Elk. The nearest thing to a single diagnostic criterion is the presence of sapropelic coals and needle siltstones in the Elk. This is inadequate, however, because these rock types are restricted to the upper part of the formation in the study area. Work in the Elk Valley coalfield of southeastern British Columbia (Pearson and Grieve, 1980; Grieve and Fraser, 1985) has indicated that the sapropelic coals occur throughout the Elk Formation in that area. In that coalfield, and perhaps beyond, the needle coal facies may be a useable guide to identifying a minimum Elk lower contact, although it is possible that the Elk Formation in those regions is equivalent to the upper Elk of the type area only. The occurrence of the needle coal facies within 50 to 100 metres of the Cadomin contact in all sections where it has been observed (most sections in the Fernie basin and Elk Valley) suggests that the two possible models of the Elk Formation's lateral and vertical relationships, shown schematically in Figure 9, are more likely than other possibilities. In both cases, (the wedging out of much or all of the lower two Elk divisions, assuming a fairly sudden and widespread change from the Mist Mountain to Elk environments of deposition, as shown in Figure 9a; and the interfingering, more gradual lateral transition from lower and middle Elk into time-equivalent strata of the Mist Mountain Formation, as shown in Figure 9b) it is only the upper part of the Elk that has regional continuity.

A new criterion for identification of the Elk, which cannot be applied generally outside the type area, is the dense stacking of large, distinctive, fining-upward sequences within the fan-related cycles.

The Elk Formation in the study area is characterized by a combination of locally restricted diagnostic and subtle regional features and, while fairly easy to identify as a general entity, the formation is not easy to define precisely or consistently. This is a feature common to many Cretaceous formations not bounded by unconformities or major transgressions and regressions (Gibson, personal communication, 1987).

SUMMARY

RECOMMENDATIONS

Results of this study suggest a few guidelines for explorationists working with the Kootenay Group in southeastern British Columbia.

(1) It is important not to treat the Elk Formation's type and reference sections as typical, and, above all, not to depend on conglomerate in identifying the Elk or its lower contact.

(2) When working with the Elk/Mist Mountain contact it must be remembered that away from the type area it represents a subtle facies boundary. It is necessary to be prepared for some arbitrary decisions and lateral inconsistencies.

(3) It is essential not to jump to conclusions regarding placement of the Elk/Mist Mountain contact or identification of the Elk. Allowance should be made for interfingering and other lateral facies changes, or misidentification, so that potential coal-bearing areas are not written off before they have been evaluated.

CONCLUSIONS

(1) Away from its type area, the Elk Formation thins and loses the conglomeratic portion of its coarse clastic facies in east, northeast and southeast directions at a much greater rate than published regional trends imply. The direction of change documented here is perpendicular to the regional trends and the changes are probably related to distance from an alluvial fan axis.

(2) Elk Formation facies within the study area are consistent with deposition on an alluvial plain, and, locally, on a distal alluvial fan, probably by braided streams.

(3) The type area of the Elk is characterized by a tripartite stratigraphic zonation, in which the lowest and highest zones are dominated by coarse clastics and are relatively resistant, and the middle zone is dominated by fine clastics and is relatively recessive. Each of the resistant zones is composed of stacked fining-upward sequences, with sandstone and conglomerate at their bases, and siltstone or shale at their tops.

(4) The type and reference sections, with their anomalous concentration of fan-derived conglomerates and stacking of fining-upward sequences, are not typical and should not be used for comparison when identifying the Elk Formation.

(5) When applying the definition of the Elk/ Mist Mountain contact, it is important to consider and give equal weight to relative thicknesses and abundance of both the sandstone and coal units. Even then the decision may be somewhat arbitrary and not applicable consistently.

(6) The facies transition represented by the Mist Mountain/Elk contact (meandering to braided fluvial systems) does not appear to offer a clear-cut choice of contact throughout the study area, in spite of the fact that the study area apparently includes an anomalous but distinctive fan facies of the Elk.

(7) Sapropelic coals, including needle coal, and needle siltstone appear to be the most diagnostic criteria for identification of at least part of the Elk Formation (upper Elk in the study area). Otherwise, the formation is characterized by subtle features which do not permit ready identification.

(8) Needle coal and/or needle siltstone are present throughout the Elk Formation in both Fernie basin and Elk Valley coalfield, and elsewhere (Gibson, 1985), but are restricted to the upper part of the formation in the study area. A possible inference from this distribution is that, away from the type section, the lower parts of the Elk lens out and only equivalents to the upper parts of the type Elk have regional continuity (Figure 9a). Alternatively, the off-fan sequence may simply be a thinner lateral equivalent of the entire Elk type section (Figure 9b).

(9) It is essential that areas tentatively identified as being underlain by Elk Formation are not written off as uneconomic until they have been thoroughly evaluated.

ACKNOWLEDGMENTS

D.E. Pearson was involved in the initial proposal and plans for this study. B. McKinstry of Crows Nest Resources Limited permitted and arranged access to Lillyburt property drill core. D.W. Gibson reviewed an earlier version of this paper and made many suggestions to improve it.

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NOTES

SECTION 1
TYPE SECTION, NORTH SIDE OF COAL CREEK

ROCK UNIT	DESCRIPTION	CUMULATIVE THICKNESS (Unit Thickness)
	CADOMIN FORMATION	
CONGLOMERATE:	pebbly coarse sandstone at base	
	ELK FORMATION	
COVERED:	small exposures of sandstone; fine/ medium grained; granule and small pebble stringers; quartzose; non-calcareous; recessive	429.0 - 420.0 m (9.0)
SANDSTONE:	fine/medium grained to coarse; latter has granule stringers; quartzose; non-calcareous; light grey, weathers medium grey; in part faintly laminated; bed thickness roughly 30 cm; semi-resistant	420.0 - 416.0 m (4.0)
COVERED:	semi-recessive	416.0 - 414.0 m (2.0)
PARTLY COVERED:	small exposures of sandstone, conglomerate and siltstone; sandstone very fine grained; light grey weathering, with hummocky bedding surfaces; siltstone light grey weathering; conglomerate with small pebble clasts; overall thin to medium bedded; semi-recessive	414.0 - 411.5 m (2.5)
SANDSTONE:	fine and medium grained; medium grained occupies bottom of unit; fine grained well laminated including ripple-drift crosslaminations; overall medium greyish brown, weathers light/medium grey; resistant	411.5 - 405.5 m (6.0)
COVERED:	small exposures of sandstone and siltstone; sandstone very fine grained; grey-brown, weathers light grey; siltstone dark grey	405.5 - 401.0 m (4.5)
CONGLOMERATE WITH SANDSTONE:	conglomerate with pebble clasts; no distinct bedding; grades into coarse sandstone at top of unit; sandstone coarse grained, occupies top 50 cm; resistant	401.0 - 396.5 m (4.5)
COVERED:	needle coal float; recessive	396.5 - 390.5 m (6.0)
SANDSTONE:	very fine grained; limonitic; slightly calcareous; medium brownish grey, weathers light grey, yellowish grey and pinkish grey; faintly laminated; semi-recessive	390.5 - 388.0 m (2.5)
COVERED:	small exposures of mudstone and needle siltstone; needle coal float; mudstone very dark grey; recessive	388.0 - 378.0 m (10.0)
SANDSTONE AND NEEDLE SILTSTONE:	sandstone fine grained; non-calcareous medium greyish brown, weathers medium brownish grey; bed thickness roughly	378.0 - 375.0 m (3.0)

	20 cm; unlaminated; coalified roots; irregular hummocky weathering surfaces; semi-recessive	
SANDSTONE:	interbedded fine/medium and very fine grained; very slightly calcareous; fine/medium grained is medium grey, weathers light/medium greyish brown with rusty patches; very fine grained is medium/dark grey and weathers light yellowish brown with rusty patches; fine/medium grained contains medium-scale crosslaminations; flaggy overall; bed thicknesses 50 to 100 cm; resistant	375.0 - 371.5 m (3.5)
CONGLOMERATE:	granule to small pebble clasts; medium greyish brown, weathers medium grey; bed thickness 10 to 40 cm; resistant	371.5 - 367.0 m (4.5)
COVERED:	Elk coal in large resistant blocks in float; recessive	367.0 - 363.5 m (3.5)
SANDSTONE:	fine grained; non-calcareous; medium greyish brown, weathers medium brownish grey; unlaminated; bed thickness roughly 20 cm; coalified roots; irregular hummocky weathering surfaces; semi-recessive	363.5 - 362.0 m (1.5)
CONGLOMERATE WITH MINOR SANDSTONE:	conglomerate granule to pebble clasts; chert and quartzite clasts; matrix non-calcareous; matrix medium grey, rock weathers medium grey-brown; bed thickness 10 cm to 1.5 m; sandstone medium to very coarse grained, with rare thin fine grained; non-calcareous; medium/dark grey, light grey weathering; faint to well-defined laminations; bed thickness 10 cm to 1.0 m; plant stem imprints on bedding surfaces; very resistant	362.0 - 352.0 m (10.0)
COVERED:		352.0 - 341.5 m (10.5)
PARTLY COVERED:	exposures of sandstone and needle siltstone; Elk coal float, including good needle coal; sandstone very fine grained; dark grey-brown, weathers light grey, faintly laminated; beds 10 to 30 cm thick; very hard; root structures?; similar to needle siltstone but lacking in carbonaceous content; semi-recessive	341.5-339.0 m (2.5)
COVERED:	mudstone float; dark grey; recessive	339.0 - 333.5 m (5.5)
SANDSTONE:	limonitic; non-calcareous; medium brownish grey, weathers same; well laminated with ripple-drift cross-laminations and well-defined medium-scale crosslaminations; platy to flaggy; semi-resistant	333.5 - 330.0 m (3.5)
CONGLOMERATE WITH SANDSTONE:	conglomerate clasts 3 to 5 cm with 7 cm common, 10 cm minor and 18 by 10 cm rare; matrix non-calcareous; conglomerate beds lenticular, between 15 cm and 1 m thick, with a 3 m bed at the base of the unit; sandstone coarse to medium grained with minor fine; limonitic; slightly calcareous; medium grey, weathers light/medium brownish grey;	330.0 - 324.2 m (5.8)

	locally laminated; beds thin to thick; local plant stem casts; very resistant	
COVERED:	one 20 cm thick fine-grained sandstone bed	324.2 - 318.0 m (6.2)
SANDSTONE AND CONGLOMERATE:	sandstone coarse with some medium grained, pebbly in lower 3.5 m; limonitic; non-calcareous; medium to large-scale crossbedding, some definitely trough-shaped; common laminations; thin, medium and thick-bedded in lower part, flaggy to thin-bedded above; conglomerate clasts generally less than 2 cm, but as large as 7 cm noted; conglomerate generally restricted to lower 3.5 m; large plant-stem impressions on bedding surfaces in lower part of unit; very resistant	318.0 - 307.0 m (11.0)
SANDSTONE:	medium grained, locally fine; limonitic; slightly calcareous; medium grey, weathers medium brownish grey; laminated with medium-scale crosslaminations; trough crossbedding in medium sandstone; flaggy to platy; semi-resistant	307.0 - 303.3 m (3.7)
CONGLOMERATE:	granule to 4 cm pebbles, maximum clast size 12 cm; chert and quartzite; closely packed; massive and uniform; no internal separation; scour surface at base; very resistant	303.3 - 295.5 m (7.8)
MUDSTONE WITH SANDSTONE:	silty mudstone, very dark grey to black; sandstone fine grained; top 0.5 m includes 10 cm of Elk-type coal (needle coal in float) and 30 cm of needle siltstone; needle siltstone light grey weathering with root structures; recessive	295.5 - 291.5 m (4.0)
SANDSTONE:	fine grained; medium in basal 0.5 m; limonitic; very slightly calcareous; dark grey, weathers same; medium sand is laminated with medium-scale crosslaminations; fine sand is uniform and structureless; scattered spherical FeS nodules, 3 to 12 mm; semi-resistant	291.5 - 289.5 m (2.0)
COVERED:	siltstone float; dark grey; recessive	289.5 - 288.0 m (1.5)
SANDSTONE AND CONGLOMERATE:	sandstone medium/coarse, coarse and very coarse grained and in part pebbly; coarser sandstones cherty; locally limonitic; locally slightly calcareous; locally carbonaceous with coalified plant stems; medium grey, weathers medium brownish grey to light/medium yellowish brown; laminations well developed to poor, including local medium-scale crossbedding; beds lenticular, mainly 10 to 50 cm with some up to 1.5 m thick; conglomerate with granules to small pebbles, with pebbly granule conglomerate common; clasts up to 3.5 cm; cherty; non-calcareous; colours and bedding thicknesses same as sandstone; lowest 1.5 m predominantly conglomerate and sandy conglomerate; uppermost 5 m mainly medium/coarse sandstone; generally	288.0 - 271.0 m (17.0)

	variable interbedded units, very little evidence of grading; very resistant	
COVERED:	float of fine-grained sandstone, siltstone and minor mudstone; recessive	271.0 - 257.5 m (13.5)
SANDSTONE:	medium grained; chert and quartz fragments; limonitic; slightly calcareous; medium/dark brownish grey, weathers light/medium yellowish brown; flaggy and platy locally near top, more massive and resistant in lower part; some medium-scale crosslaminations; resistant	257.5 - 251.5 m (6.0)
SANDSTONE:	medium/fine grained; limonitic; calcareous; dark grey, weathers light/medium yellow brown; laminated, locally strongly laminated (1 to 3 mm) with subparallel to medium-scale crosslaminations; flaggy to platy; semi-resistant	251.5 - 249.0 m (2.5)
COVERED:	recessive	249.0 - 219.5 m (29.5)
SANDSTONE:	very fine to fine grained; quartzose; slightly limonitic; non-calcareous; light/medium brownish grey, weathers same; flaggy to platy; small-scale crosslaminations	219.5 - 218.0 m (1.5)
COVERED:	float of siltstone in lower one-half of interval; recessive	218.0 - 180.5 m (37.5)
SANDSTONE WITH MUDSTONE:	sandstone very fine grained; limonitic; slightly calcareous; medium brownish grey, weathers slightly lighter; locally laminated with small-scale crosslaminations; mudstone forms middle one-third of unit; semi-resistant	180.5 - 178.5 m (2.0)
MUDSTONE:	very dark grey; rubbly; recessive	178.5 - 176.0 m (2.5)
SANDSTONE WITH SILTSTONE:	sandstone very fine grained; non-calcareous; medium grey, weathers light grey with rusty patches; faint laminations in lower part only; bedding thickness 5 to 30 cm; siltstone argillaceous; dark grey; 3 to 10 cm blocky beds; semi-recessive; entire unit appears gradational from unit underlying	176.0 - 174.5 m (1.5)
Note:	Next portion of section roughly 0.5 km to south.	
SANDSTONE:	medium grained, locally coarse; limonitic; very slightly calcareous; medium brownish grey, weathers light/medium yellowish brown; laminated, with medium-scale crosslaminations; flaggy to thin bedded	174.5 - 170.0 m (4.5)
MUDSTONE:	in part carbonaceous; non-calcareous; very dark grey to black; shaly; recessive	170.0 - 165.8 m (4.2)
SANDSTONE WITH MUDSTONE:	sandstone very fine grained; limonitic; very slightly calcareous; medium/dark grey, weathers light/medium yellowish brown; small-scale crosslaminations; bed-size 20 to 40 cm; abundant plant	165.8 - 162.3 m (3.5)

	debris, including felts of grass material; mudstone in part carbonaceous, very dark grey to black, and in beds up to 80 cm in thickness; carbonaceous mudstone very brittle; semi-recessive	
SANDSTONE AND MUDSTONE:	sandstone fine grained; limonitic; very slightly calcareous; medium grey, weathers light/medium yellowish brown; laminated with small-scale and local medium-scale crosslaminations in beds separated by 20 to 30 cm; local bioturbation and worm tubes; contains carbonized plant debris; mudstone is dark grey and somewhat shaly; one graded sequence from fine/medium-grained sandstone to mudstone	162.3 - 160.0 (2.3)
SANDSTONE:	fine grained; limonitic; calcareous; dark brownish grey, weathers light/ medium yellow-brown; common fine laminations and small-scale cross-laminations; local medium-scale cross-laminations; mainly no separation, locally flaggy, particularly in upper part; semi-resistant	160.0 - 159.0 m (1.0)
SILTSTONE AND MUDSTONE:	siltstone is non-calcareous; dark grey, light grey weathering, with a bed thickness of 12 to 30 cm; siltstone similar to needle siltstone, with hummocky bedding surfaces; mudstone is dark to very dark grey in 15 to 50 cm beds; semi-recessive	159.0 - 154.5 m (4.5)
Note:	Remainder of section 100 m to south.	
SANDSTONE:	medium/coarse grained in lower part, very fine grained in middle and fine grained in upper part; limonitic; slightly calcareous in upper part; medium brownish grey; moderately well laminated in lower part, with common fine laminations and medium and small-scale laminations in upper part; flaggy; semi-resistant, except for very fine-grained sandstone which is semi-recessive	154.5 - 149.5 m (5.0)
CONGLOMERATE WITH MINOR SANDSTONE:	conglomerate contains pebble clasts up to 10 cm long; massive beds with separation up to 4 m; sandstone beds up to 0.5 m in thickness; very resistant	149.5 - 140.0 m (9.5)
SANDSTONE AND CONGLOMERATE:	sandstone very coarse grained in beds 5 to 12 cm; conglomerate contains pebble clasts up to 7 cm long, in beds 5 to 50 cm; in part well imbricated; bottom contact uneven, with signs of scour; very resistant	140.0 - 139.0 m (1.0)
MUDSTONE AND SILTSTONE:	mudstone black and carbonaceous; siltstone orange-brown weathering	139.0 - 138.2 m (0.8)
SANDSTONE TO SILTSTONE:	sandstone very fine grained and slightly calcareous; siltstone concretionary, calcareous and orange-brown weathering	138.2 - 137.8 m (0.4)
PARTLY COVERED:	small exposures of mudstone and carbonaceous mudstone; dark grey to black; float of silty mudstone; dark grey; recessive	137.8 - 134.0 m (3.8)

PARTLY COVERED:	outcrops of sandstone; fine grained; limonitic; calcareous; medium brown weathering; flaggy and platy; covered portions contain float of very fine-grained sandstone and coarse siltstone; semi-resistant	134.0 - 128.0 m (6.0)
SANDSTONE:	fine grained; limonitic; calcareous; light brown and dark grey laminae (medium brownish grey overall), weathers light/medium brown; laminated and ripple-drift crosslaminated; platy	128.0 - 124.5 m (3.5)
COVERED:	semi-resistant	124.5 - 123.5 m (1.0)
SANDSTONE WITH CONGLOMERATE:	sandstone coarse and very coarse grained, in part containing pebble stringers and lenses; calcareous (one test only); large-scale crossbeds, including some with a 45-degree foreset angle; conglomerate contains granule or pebble clasts in beds of 10 to 40 cm thickness; very resistant	123.5 - 118.0 m (5.5)
SANDSTONE:	medium/coarse grained; contains granule and pebble stringers; limonitic; calcareous; medium brownish grey, weathers light/medium yellowish brown; medium and large-scale crossbeds; flaggy, some platy; very resistant	118.0 - 108.5 m (9.5)
PARTLY COVERED:	predominantly sandstone with siltstone float at top of interval; sandstone fine/medium grained and platy; semi-resistant	108.5 - 104.5 m (4.0)
CONGLOMERATE AND SANDSTONE:	conglomerate has pebble/granule-size clasts; maximum clast size 12 by 20 cm; clasts predominantly chert and quartzite; conglomeratic units up to 3 m thickness; sandstone medium, coarse and very coarse grained with medium to large-scale trough crosslaminations in coarser varieties; basal contact of unit irregular; very resistant	104.5 - 82.5 m (22.0)
COVERED:	abundant float of silty mudstone; dark grey; local small outcrops of thinly interbedded siltstone and fine-grained sandstone; carbonaceous material exposed at top of unit, including 20 cm of hard bright coal; concretionary orange-weathering siltstone occurs right at upper contact	82.5 - 68.3 m (14.2)
SANDSTONE WITH MINOR CONGLOMERATE:	sandstone predominantly fine grained with minor very fine grained; sandstone limonitic, slightly calcareous, dark brownish grey, weathers medium greyish brown, with small-scale low-angle cross-laminations; very fine-grained sandstone forms uppermost 2 m of unit and is orange-brown weathering; sandstones are platy to flaggy; conglomerate forms one 40 cm bed 3 m below top of unit; resistant	68.3 - 61.5 m (6.8)
SANDSTONE:	predominantly medium, locally fine grained; highly limonitic; slightly calcareous; medium to dark brownish grey, weathers medium greyish brown and	61.5 - 55.0 m (6.5)

	brown; strongly laminated with medium-scale planar and trough crosslaminations; platy to flaggy in part; resistant	
COVERED:	float in lower one-third of silty mudstone to argillaceous siltstone; very dark grey to black	55.0 - 42.5 m (12.5)
SANDSTONE:	predominantly fine grained; locally calcareous; medium/dark grey, weathers medium greyish brown; local small-scale crosslaminations; platy to flaggy; resistant	42.5 - 35.5 m (7.0)
SANDSTONE WITH CONGLOMERATE:	sandstone generally coarse to very coarse grained, locally slightly calcareous; sandstone locally has well-developed laminations and medium to medium/large-scale crossbeds; separation 5 to 90 cm; conglomerate and pebbly lenses most abundant in lower part; conglomerate with clasts up to 10 cm in beds 5 to 100 cm thick; plant-stem imprints abundant throughout; very resistant	35.5 - 24.5 m (11.0)
SANDSTONE WITH MINOR CONGLOMERATE:	sandstone fine with local medium and coarse to very coarse grained, including pebble stringers; fine sand is limonitic and calcareous; fine sand is parallel laminated with local ripple-drift cross-laminations and is platy to flaggy; coarse sandstones in lenticular beds up to 1.5 m in thickness; plant-stem imprints abundant locally (including "log-jam" structures) associated with coarsest lithologies; resistant	24.5 - 10.0 m (14.5)
CONGLOMERATE WITH SANDSTONE:	conglomerate clasts granule to pebble-size, with average size between 0.5 to 2 cm and some up to 8 cm, predominantly chert and some quartzite; conglomerate size-layered on a scale of 2 to 30 cm within beds 10 cm to 3 m thick; locally vaguely imbricated; sandstone ranges from fine to very coarse, in lenses from 5 to 40 cm thick with some up to 1 m; finer sandstones are limonitic, locally calcareous, laminated (parallel to crosslaminated); coarser sandstones are non-calcareous, slightly limonitic with abundant dark chert fragments; rapid and wide variation in grainsize throughout, grading seen only locally; plant impressions locally throughout; very resistant	10.0 m - 0.0 m (10.00)
Note:	No exposure below base of section.	

NOTES

SECTION 2
MORRISSEY RIDGE NORTH

ROCK UNIT	DESCRIPTION	CUMULATIVE THICKNESS (Unit Thickness)
	CADOMIN FORMATION	
CONGLOMERATE:	small pebble clasts, generally 0.5 to 1.0 cm in size; clasts generally matrix supported; bed thickness averages 20 cm; rare coarse sand interbeds up to 20 cm in thickness	527.0 - 523.4 m (3.6)
CONGLOMERATE:	continuous with overlying unit; modal grain size 1 cm; well sorted; bedding 10 to 50 cm thick; irregular scoured lower contact; prominent bluff-forming unit; Cadomin Formation	523.4 - 517.0 m (6.4)
COVERED:		517.0 - 499.5 m (17.5)
SNOW COVERED:		499.5 - 481.2 m (18.3)
SANDSTONE:	medium grained; quartzose; light/medium grey; thin bedded; sharp contact with underlying unit	481.2 - 478.7 m (2.5)
CONGLOMERATE:	modal clast size 2 cm; bedding thickness 10 to 50 cm	478.7 - 472.7 m (6.0)
	ELK FORMATION	
SILTSTONE:	dark grey	472.7 - 469.1 m (3.6)
PARTLY COVERED:	sandstone and siltstone interbedded; sandstone fine grained	469.1 - 464.0 m (5.1)
COVERED:	float of sandstone, siltstone, needle siltstone and needle coal; sandstone fine grained; siltstone weathers orange-brown	464.0 - 447.0 m (17.0)
PARTLY COVERED:	exposures of material intermediate between needle coal and needle siltstone; some needle coal in float	447.0 - 445.8 m (1.2)
SANDSTONE, SILTSTONE AND NEEDLE SILTSTONE:	needle coal in top 0.5 m of unit; sandstone fine grained and medium grey; siltstone is dark grey and rubbly; needle siltstone is light grey weathering, well indurated, with an irregular hummocky bedding surface; "needles" up to 2 cm long	445.8 - 442.8 m (3.0)
SANDSTONE:	medium grained at base grades upward to fine grained; former crosslaminated, latter unlaminated	442.8 - 440.8 m (2.0)
CONGLOMERATE AND SANDSTONE:	pebble conglomerate at base grades upward to coarse-grained sandstone	440.8 - 437.8 m (3.0)

SANDSTONE:	coarse grained; local faint laminations; bedding thickness 10 to 25 cm	324.0 - 320.0 m (4.0)
SANDSTONE:	medium grained; thin bedded; parallel laminated; flaggy	320.0 - 308.4 m (11.6)
SANDSTONE:	medium grained; thin to thick bedded; in part parallel laminated; zone of plant imprints and coaly lenses 1 to 3 m above base; bluff-forming	308.4 - 293.5 m (14.9)
SANDSTONE AND SILTSTONE:	sandstone fine grained; graded sequence fine sand to silt in 10 cm to 1 m units; includes one 3 m bed of uniform dark grey siltstone	293.5 - 284.0 m (9.5)
SILTSTONE WITH MINOR SANDSTONE:	latter fine grained	284.0 - 278.8 m (5.2)
SANDSTONE:	fine grained	278.8 - 278.4 m (0.4)
SANDSTONE WITH SILTSTONE:	bedding units 30 to 60 cm; graded sequences over 1 to 2 m intervals	278.4 - 274.0 m (4.4)
PARTLY COVERED:	siltstone; some orange-brown weathering	274.0 - 269.0 m (5.0)
SANDSTONE:	fine grained; thin bedded; small-scale laminations	269.0 - 266.5 m (2.5)
SILTSTONE WITH SANDSTONE:	sandstone fine grained; thin bedded	266.5 - 258.3 m (8.2)
SANDSTONE:	fine grained; thin bedded; locally concretionary	258.3 - 256.6 m (1.7)
COVERED:	siltstone float	256.6 - 251.1 m (5.5)
SANDSTONE:	thin bedded; locally concretionary	251.1 - 248.6 m (2.5)
COVERED:	small exposures of sandstone; fine grained; thin bedded; separated by siltstone; dark greyish brown weathering	248.6 - 226.1 m (22.5)
PARTLY COVERED:	siltstone with sandstone interbeds near base of interval; siltstone dark grey; sandstone fine grained in thin beds	226.1 - 210.1 m (16.0)
SANDSTONE:	coarse and medium grained with thin lag pebble bands near base; fine grained near top; prominent medium-scale ripple-drift crosslaminations near base	210.1 - 202.1 m (8.0)
SILTSTONE:	dark grey; dark greyish brown and orange-brown weathering; latter is concretionary with internal dark cross-laminations; bed thickness up to 1.0 m	202.1 - 191.8 m (10.3)
SANDSTONE:	coarse grained grading into medium grained; latter is crosslaminated and flaggy	191.8 - 187.1 m (4.8)
SANDSTONE AND CONGLOMERATE:	sandstone coarse grained; conglomerate with pebble clasts; bed thicknesses 20 to 100 cm	187.1 - 182.1 m (5.0)

SANDSTONE:	coarse and medium grained; bed thickness 5 to 100 cm; parallel laminated and ripple-drift crosslaminated	437.8 - 434.5 m (3.3)
CONGLOMERATE AND SANDSTONE:	conglomerate clasts small pebble-size; sandstone coarse and very coarse grained; bed thickness up to 1.5 m; lower contact irregular	434.5 - 430.1 m (4.4)
PARTLY COVERED:	sandstone and siltstone interbedded; sandstone fine grained	430.1 - 419.3 m (10.8)
PARTLY COVERED:	siltstone; dark brownish grey and orange-brown weathering	419.3 - 401.8 m (17.5)
PARTLY COVERED:	sandstone and siltstone interbedded; sandstone fine grained; siltstone weathers dark brownish grey and orange-brown	401.8 - 393.6 m (8.2)
SANDSTONE WITH SILTSTONE:	sandstone fine grained	393.6 - 390.6 m (3.0)
SANDSTONE:	medium grained	390.6 - 389.6 m (1.0)
SANDSTONE:	coarse and very coarse grained	389.6 - 387.6 m (2.0)
SANDSTONE:	medium grained; parallel laminated; lower contact is irregular and scoured	387.6 - 384.0 m (3.6)
SILTSTONE WITH SANDSTONE:	sandstone fine grained; gradational sandstone to siltstone sequences(?)	384.0 - 368.4 m (15.6)
SANDSTONE:	medium grained; thin bedded; ripple-drift crosslaminations	368.4 - 367.2 m (1.2)
SANDSTONE AND SILTSTONE:	sandstone fine grained; sandstone right at base of unit; siltstone medium grey weathering	367.2 - 354.8 m (12.4)
SANDSTONE:	coarse grained and very coarse grained with pebble bands at base; fines upward to medium-grained sandstone; latter thin bedded; gradational contact with underlying unit	354.8 - 349.2 m (5.6)
CONGLOMERATE:	modal clast size 2 cm at base of unit; irregular scoured contact with underlying unit	349.2 - 344.2 m (5.0)
COVERED:	siltstone float	344.2 - 338.4 m (5.8)
SANDSTONE:	fine grained; crosslaminated	338.4 - 333.8 m (4.6)
SANDSTONE:	coarse grained grading into medium grained; former has channel crossbeds and is unlaminated; latter is thin bedded and flaggy	333.8 - 330.4 m (3.4)
CONGLOMERATE AND SANDSTONE:	conglomerate clasts granule-size; sand stone very coarse grained; lenticular or broad channel-shaped unit; sharp contact with underlying unit	330.4 - 329.4 m (1.0)
CONGLOMERATE WITH SANDSTONE:	interbeds; conglomerate clasts average 1 cm, some up to 4 cm; base of unit scours into underlying unit	329.4 - 324.0 m (5.4)

PARTLY COVERED:	sandstone and siltstone interbedded; sandstone fine grained; bed thickness 10 to 20 cm	182.1 - 175.6 m (6.5)
SILTSTONE:	dark grey; weathers dark brownish grey and orange-brown	175.6 - 170.6 m (5.0)
SANDSTONE:	medium to fine grained; parallel laminated; thin bedded; flaggy, grades medium to fine grained in upper 2 m	170.6 - 160.3 m (10.3)
SANDSTONE:	continuous with overlying unit; medium grained predominant, some coarse; light brown weathering; distinct parallel laminations, planar crosslaminations and shallow-angle channel crosslaminations; bedding thicknesses 10 to 100 cm; flaggy in part	160.3 - 139.4 m (20.9)
SANDSTONE:	continuous with overlying unit; medium grained; small-scale ripple-drift cross-laminations and medium-scale cross-laminations with 15-degree foreset angle	139.4 - 130.4 m (9.0)
PARTLY COVERED:	small exposures of siltstone; dark grey	130.4 - 118.9 m (11.5)
SANDSTONE:	fine grained; orange-brown weathering; thin bedded	118.9 - 117.9 m (1.0)
PARTLY COVERED:	siltstone	117.9 - 112.6 m (5.3)
SILTSTONE AND MUDSTONE:		112.6 - 105.4 m (7.2)
SANDSTONE:	medium grained; thin to thick bedded; parallel laminations and small-scale ripple-drift crosslaminations	105.4 - 96.5 m (8.9)
PARTLY COVERED:	interbedded sandstone and siltstone; sandstone fine grained; siltstone orange-brown weathering	96.5 - 79.2 m (17.3)
COAL:	in trench	79.2 - 78.2 m (1.0)
SILTSTONE:	argillaceous in part	78.2 - 73.2 m (5.0)
SANDSTONE:	fine and medium grained	73.2 - 64.2 m (9.0)
CONGLOMERATE AND SANDSTONE:	interbedded; conglomerate with granule clasts; sandstone very coarse grained; 50 cm average bed thickness	64.2 - 60.6 m (3.6)
COVERED:		60.6 - 56.0 m (4.6)
CONGLOMERATE:	pebble clasts	56.0 - 54.4 m (1.6)
SANDSTONE:	medium grained; crosslaminations	54.4 - 54.0 m (0.4)
CONGLOMERATE:	pebble clasts	54.0 - 51.5 m (2.5)

SANDSTONE:	medium grained; bed size 2 to 80 cm; planar crosslamination and medium-scale trough-shaped crosslaminations	51.5 - 40.0 m (11.5)
CONGLOMERATE WITH SANDSTONE:	conglomerate with pebble and small cobble clasts; sandstone coarse grained	40.0 - 34.0 m (6.0)
CONGLOMERATE AND SANDSTONE:	conglomerate with granule-sized clasts, minor pebble-sized; sandstone very coarse grained, with some coarse grained	34.0 - 31.0 m (3.0)
CONGLOMERATE WITH SANDSTONE:	conglomerate clast size 1 to 2 cm, with some up to 5 cm; sandstone coarse grained in beds up to 10 cm in thickness; large-scale shallow-angle channel crossbeds	31.0 - 22.7 m (8.3)
SANDSTONE:	coarse and very coarse grained; trough crossbedding in very coarse sandstone (0.5 m amplitude); scour and trough-shaped contacts between very coarse and coarse sandstone; gradational contact with underlying unit	22.7 - 21.2 m (1.5)
CONGLOMERATE:	pebble and small cobble-size clasts	21.2 - 20.2 m (1.0)
SANDSTONE:	very coarse grained, with pebble stringers and small pebble-conglomerate layers	20.2 - 17.5 m (2.7)
CONGLOMERATE:	predominantly small pebble-size clasts (1 to 2 cm) with some up to 10 cm	17.5 - 14.6 m (2.9)
SANDSTONE:	coarse grained with pebble stringers	14.6 - 14.1 m (0.5)
CONGLOMERATE:	pebble-size clasts	14.1 - 13.1 m (1.0)
SANDSTONE AND CONGLOMERATE:	sandstone coarse grained; conglomerate has pebble-size clasts; beds are 15 cm in thickness	13.1 - 10.2 m (2.8)
SANDSTONE:	coarse and medium grained; parallel laminated	10.3 - 9.0 m (1.3)
CONGLOMERATE WITH SANDSTONE:	conglomerate clast size averages 2 cm (pebble) with some up to 5 cm; sandstone coarse and very coarse grained, in beds up to 20 cm in thickness; bluff-forming; basal Elk conglomerate	9.0 - 0.0 m (9.0)

NOTES

SECTION 3
MORRISSEY RIDGE SOUTH

ROCK UNIT	DESCRIPTION	CUMULATIVE THICKNESS (Unit Thickness)
	CADOMIN FORMATION	
MUDSTONE AND SILTSTONE WITH SANDSTONE:	mudstone silty; siltstone argillaceous; mudstone and siltstone light/medium greenish grey; rubbly; sandstone fine grained; limonitic; slightly calcareous; medium brownish grey	454.6 - 446.6 m (8.0)
CONGLOMERATE:	5 to 20 mm clasts; chert clasts predominate, with rare quartzite and quartz; well rounded; matrix poorly sorted coarse sand; medium grey, weathers medium brownish grey; local large-scale crossbeds; pebbles somewhat layered; medium to very thick bedded; contains one lens of dark grey shale, 20 cm by 3 m, about 1.25 m above base; very resistant	446.6 - 436.1 m (10.5)
	ELK FORMATION	
MUDSTONE WITH SANDSTONE:	mudstone dark grey to black; rubbly; sandstone between 1.5 and 3.0 m in uppermost 15 cm; fine to very fine grained; medium brownish grey; thin bedded; small-scale crosslaminated; platy; recessive	436.1 - 431.9 m (4.2)
PARTLY COVERED: (30%):	interbedded sandstone and mudstone; sandstone fine grained in lower part, becoming very fine grained in upper part; limonitic in lower part; medium grey-brown in lower part, very dark grey in upper; weathers medium brown-grey with patches of yellow-orange; flaggy to thin separation; plant-stem debris in lower part; semi-recessive	431.9 - 429.5 m (2.4)
MUDSTONE WITH SILTSTONE:	mudstone dark grey to black; rubbly; sandstone fine grained; recessive	429.5 - 424.7 m (4.8)
SILTSTONE, MUDSTONE AND SANDSTONE:	siltstone carbonaceous with coal flecks; very dark grey; weathers light/medium grey and brownish grey; rootlets common; mudstone silty and sandy in one bed; carbonaceous; vague needles; sandstone very fine grained; very dark grey; light/medium brown-grey weathering; faintly laminated; contains rootlets; semi-resistant	424.7 - 423.6 m (1.1)
MUDSTONE:	dark grey, rubbly; recessive	423.6 - 423.1 m (0.5)

PARTLY COVERED: (40%):	sandstone; very fine grained; quartzose, hard; medium grey and brownish grey; weathers light/medium grey; flaggy to blocky; basal 40 cm bed fine grained; slightly calcareous and limonitic; medium grey-brown; weathers light/medium grey-brown; strongly laminated with some medium-scale low-angle crosslaminations; flaggy; semi-resistant to semi-recessive	423.1 - 420.1 m (3.0)
CONGLOMERATE TO SANDSTONE:	gradational; conglomerate granule-size; chert clasts; very little matrix; sandstone coarse grained at top of unit; both dark grey; weather medium brownish grey; thin to medium separation; semi-resistant	420.1 - 416.4 m (3.7)
PARTLY COVERED: (50%):	mudstone, needle siltstone and coal lower 50%; mudstone dark grey and rubbly; coal humic (one 40 cm seam) and needle (traces)	416.4 - 414.4 (2.0)
SANDSTONE:	very fine grained; hard; dark grey; weathers light grey; roots; wavy base and top (similar to needle siltstone)	414.4 - 414.2 m (0.2)
MUDSTONE:	somewhat carbonaceous; black; recessive	414.2 - 413.6 m (0.6)
SANDSTONE:	very fine grained; quartzose; medium grey; weathers same with rusty surfaces; blocky	413.6 - 413.0 m (0.6)
MUDSTONE:	dark grey; rubbly; recessive	413.0 - 412.2 m (0.8)
SANDSTONE:	very fine grained; non-calcareous; dark slightly brownish grey; weathers medium grey; basal 30 cm is light/medium grey-brown; basal 30 cm is small-scale cross-laminated; thin separation; blocky; resistant	412.2 - 410.2 m (2.0)
CONGLOMERATE:	grading to pebbly sandstone in upper 0.5 m; granule and small pebble framework; medium to coarse sand matrix; chert and minor quartz clasts (latter in matrix); medium grey; weathers medium brownish grey; medium to thick separation; resistant	410.2 - 408.2 m (2.0)
MUDSTONE WITH COAL:	mudstone carbonaceous; dark grey; rubbly; coal 20 to 30 cm thick; bright; recessive; up to 50 cm relief on upper surface	408.2 - 407.2 m (1.0)
SANDSTONE:	fine grained; quartzose; medium to dark grey, with local light grey; weathers light to medium grey; wavy surfaces	407.2 - 406.7 m (0.5)
MUDSTONE:	dark grey; rubbly; recessive	406.7 - 405.2 m (1.5)
SANDSTONE:	very fine grained; non-calcareous; medium grey; weathers same with rusty fracture surfaces; very faint fine laminations; semi-resistant	405.2 - 404.5 m (0.7)

SANDSTONE:	fine grained; non-calcareous; medium slightly brownish grey; weathers medium brownish grey; laminated and small-scale crosslaminated; flaggy to medium separation; resistant	404.5 - 401.0 m (3.5)
CONGLOMERATE:	granule and small pebble framework; chert framework; medium grey; weathers medium brownish grey; medium separation; resistant	401.0 - 399.3 m (1.7)
COVERED:	semi-resistant	399.3 - 397.8 m (1.5)
SANDSTONE:	fine/medium grained; chert (predominant) and quartz; very dark grey; weathers medium brownish grey; resistant	397.8 - 396.3 m (1.5)
COVERED:	recessive; sandstone possibly laterally correlative	396.3 - 395.8 m (0.5)
CONGLOMERATE:	granule to 20 mm framework; poorly sorted; predominantly chert framework; medium/dark grey; weathers medium brown-grey with rusty patches; medium to thick separation; very resistant	395.8 - 389.8 m (6.0)
SANDSTONE:	fine grained; non-calcareous medium/dark brownish grey; weathers medium brownish grey; faint fine lamination, some small-scale crosslamination; flaggy to platy; resistant (deformed; steeply dipping)	389.8 - 386.3 m (3.5)
COVERED:	recessive; laterally equivalent to much thicker unit of rubbly dark grey carbonaceous mudstone	386.3 - 385.0 m (1.3)
SANDSTONE:	pebbly sandstone interbeds; fine/medium to medium grained, with a bed of fine grained at top; chert and quartz clasts; non-calcareous; medium/dark grey; weathers medium brownish grey; locally laminated; rootlets in uppermost bed; resistant	385.0 - 379.5 m (5.5)
SANDSTONE:	fine grained; non-calcareous dark grey; weathers medium/dark brown-grey; laminated; platy; resistant	379.5 - 378.7 m (0.8)
SANDSTONE:	medium/fine grained; chert and quartz clasts; medium grey; weathers medium brownish grey; thin bedded; faint medium-scale crosslaminations; very thin bed of carbonaceous siltstone near top; resistant	378.7 - 376.7 m (2.0)
COVERED:	semi-recessive; sandstone shows laterally	376.7 - 375.9 m (0.8)
SANDSTONE AND CONGLOMERATE:	lowest 4m mainly conglomerate with medium/coarse sandstone lenses; remainder is medium/coarse-grained sandstone with pebbly sandstone and local conglomerate beds; clasts throughout 50 mm; medium grey; weathers medium brownish grey; thin to thick bedded; minor medium-scale crossbedding; very resistant cliff-former	375.9 - 365.5 m (10.4)

SANDSTONE:	fine grained; non-calcareous; some beds pyritic; medium/dark brownish grey; weathers medium; locally rusty; strong parallel lamination; some medium-scale crosslaminations; platy to flaggy; semi-resistant	365.5 - 363.7 m (1.8)
CONGLOMERATE WITH SANDSTONE:	framework clasts 5 to 30 mm, some up to 50 mm, and rarely up to 9 cm; matrix coarse sand to granules; poorly sorted; chert and quartzite framework; limonitic; medium brownish grey; weathers same with pink tint; massive; imbricated; thin to very thick separation; one medium bed of sandstone just below middle of unit; sandstone fine grained; medium brown-grey; small-scale cross-laminated; similar to units below; platy; unit resistant	363.7 - 360.1 m (3.6)
MUDSTONE:	carbonaceous; one 5 cm vitrain band; black; rubbly; recessive; 10 cm relief on upper contact (scour?)	360.1 - 357.3 m (2.8)
NEEDLE SILTSTONE:		357.3 - 357.1 m (0.2)
MUDSTONE:	carbonaceous; very dark grey to black; rubbly; recessive	357.1 - 355.4 m (1.7)
SANDSTONE:	fine grained; very slightly calcareous; dark brownish grey; weathers medium brownish grey; fern and other plant imprints common; flaggy; semi-resistant	355.4 - 354.6 m (0.8)
MUDSTONE:	dark brownish grey; recessive	354.6 - 354.1 m (0.5)
SANDSTONE:	fine grained; very slightly calcareous; slightly limonitic; medium grey-brown; weathers medium brown-grey; laminated and small-scale crosslaminated; thin to medium separation; semi-resistant	354.1 - 352.6 m (1.5)
SANDSTONE:	fine grained, limonitic; medium greyish brown; weathers light/medium orange-brown; platy to flaggy; semi-resistant; (part of overlying unit in field notes)	352.6 - 351.9 m (0.7)
MUDSTONE:	dark grey; rubbly; recessive	351.9 - 351.2 m (0.7)
SANDSTONE AND SILTSTONE:	sandstone fine grained; very slightly calcareous; medium/dark brown-grey; laminated and small-scale crosslaminated; semi-resistant	351.2 - 349.0 m (2.2)
SILTSTONE:	top 30% interbedded siltstone, mudstone, very fine-grained sandstone, carbonaceous shale and humic coal; siltstone carbonaceous; dark grey to black; rubbly; part contains needles; sandstone in interbedded sequence in 35 cm bed; coal in 30 cm seam about 2 m from top, recessive to semi-recessive (at top)	349.0 - 336.2 m (12.8)
NEEDLE SILTSTONE:	carbonaceous; non-calcareous; dark grey; weathers light grey; possibly rooted	336.2 - 336.0 m (0.2)

MUDSTONE:	dark grey; rubbly; recessive	336.0 - 335.3 m (0.7)
SANDSTONE:	limonitic; very slightly calcareous; dark brownish grey; weathers medium brown-grey; small-scale crosslaminations; flaggy	335.3 - 335.0 m (0.3)
MUDSTONE:	dark grey; rubbly; recessive	335.0 - 333.2 m (1.8)
SANDSTONE:	fine grained; very slightly calcareous; medium brownish grey; weathers same; basal 1 m is strongly parallel laminated and platy to flaggy; remainder is less distinctly or evenly laminated and is flaggy; rootlets possible in upper beds; semi-resistant	333.2 - 329.4 m (3.8)
COVERED:	semi-resistant	329.4 - 327.1 m (2.3)
MUDSTONE:	carbonaceous near top; dark grey (lower) to black (top); rubbly; recessive	327.1 - 320.6 m (6.5)
MAINLY COVERED (60%):	interbedded(?) sandstone and mudstone(?); sandstone fine grained; limonitic; very slightly calcareous; medium grey-brown; weathers same; laminated and small-scale crosslaminated; flaggy; semi-recessive	320.6 - 319.6 m (1.0)
MUDSTONE:	dark grey; rubbly; recessive	319.6 - 317.4 m (2.2)
SANDSTONE:	fine grained; very slightly calcareous; medium/dark brownish grey; weathers medium brownish grey to grey-brown; faint fine laminations and small-scale cross-laminations; flaggy; semi-resistant	317.4 - 315.1 m (2.3)
SANDSTONE AND MUDSTONE:	sandstone fine grained; limonitic; slightly calcareous; medium brownish grey; weathers light/medium orange-brown; thin to medium bedded; small-scale crosslaminated; mudstone very slightly calcareous; dark grey-brown; weathers medium brown; semi-recessive	315.1 - 311.9 m (3.2)
MUDSTONE WITH COAL AND SANDSTONE:	mudstone more or less carbonaceous throughout; dark grey to black; rubbly; coal predominates in lowest 20 cm and a 10 cm seam occurs 30 cm below sandstone bed; sandstone fine grained; platy; 15 cm bed in middle of unit	311.9 - 308.4 m (3.5)
SANDSTONE:	very fine grained; slightly calcareous; medium/dark brownish grey; weathers medium brownish grey; thin to medium bedded; resistant	308.4 - 307.1 m (1.3)
PARTLY COVERED:	intermittent exposures of siltstone; distinctive orange weathering; semi-resistant	307.1 - 305.6 m (1.5)
MUDSTONE WITH SILTSTONE:	mudstone carbonaceous locally; dark grey; rubbly; siltstone dark grey; blocky; recessive	305.6 - 304.0 m (1.6)

SANDSTONE:	fine grained; calcareous and limonitic; light/medium brownish grey; weathers same with local orange-brown; laminated; some small-scale crosslaminations; flaggy to platy; resistant	304.0 - 294.3 m (9.7)
SANDSTONE:	medium grained; slightly calcareous and limonitic; medium brown-grey; weathers same; parallel laminated; local small and medium-scale crosslaminations; flaggy to medium separation; very resistant cliff-former	294.3 - 279.3 m (15.0)
MUDSTONE:	dark grey to black; rubbly; recessive; considerable relief on upper contact	279.3 - 278.7 m (0.6)
SANDSTONE:	predominantly medium/coarse grained; one 12 cm bed of coarse 30 cm below top; slightly calcareous and limonitic; light/medium brownish grey; weathers same; flaggy; coarse sandstone contains shale fragments; resistant	278.7 - 276.7 m (2.0)
COAL WITH MUDSTONE:	mudstone black; recessive	276.7 - 276.2 m (0.5)
SANDSTONE:	very fine grained; hard; non-calcareous; medium/dark brownish grey; fine lamination with some small-scale crosslaminations; platy; resistant	276.2 - 275.2 m (1.0)
COVERED:	recessive	275.2 - 274.8 m (0.4)
SANDSTONE:	very fine to fine grained; slightly calcareous and limonitic; medium/dark brownish grey; weathers light/medium yellow-brown; mainly parallel laminated, some small-scale crosslaminations; platy; resistant	274.8 - 274.0 m (0.8)
SANDSTONE:	calcareous; limonitic; medium grey-brown; weathers light/medium orange-brown; laminated; small-scale cross-laminated; platy; resistant	274.0 - 273.1 m (0.9)
SILTSTONE:	medium to dark grey; rubbly; semi-recessive	273.1 - 271.1 m (2.0)
SANDSTONE:	very fine grained; carbonaceous; non-calcareous; black; weathers medium grey with light grey patches; blocky weathering, almost flaggy; semi-resistant	271.1 - 270.3 m (0.8)
SANDSTONE:	medium/coarse grained; limonitic; slightly calcareous; chert and quartz framework; medium brown-grey; weathers same; laminated and crosslaminated; plant-stem impressions common; resistant	270.3 - 266.5 m (3.8)
COVER:	recessive	266.5 - 265.5 m (1.0)
MUDSTONE:	minor vitrain; part carbonaceous; black and dark brown-grey; recessive	265.5 - 262.5 m (3.0)
PARTLY COVERED:	interbedded siltstone and mudstone(?); siltstone forms 65%; siltstone calcareous; medium brown-grey; weathers light/medium orange-brown; 10 to 30 cm beds; mudstone dark grey; semi-recessive	262.5 - 258.5 m (4.0)

SANDSTONE:	fine grained; calcareous and limonitic; medium brown-grey; weathers light/medium yellow-orange-brown; laminated; flaggy to blocky	258.5 - 257.8 m (0.7)
COVERED:	siltstone float; recessive	257.8 - 257.1 m (0.7)
SANDSTONE:	fine grained; calcareous and limonitic; medium/dark brownish grey; weathers light/medium yellow-brown; finely laminated and small-scale crosslaminated; flaggy; semi-resistant	257.1 - 255.6 m (1.5)
COVERED:	recessive	255.6 - 255.1 m (0.5)
MUDSTONE:	black; rubbly; recessive	255.1 - 254.6 m (0.5)
SANDSTONE:	very fine grained; slightly calcareous; dark brownish grey; weathers light/ medium yellow-brown; local faint fine laminations; flaggy to blocky; semi-resistant	254.6 - 253.8 m (0.8)
COVERED:	showings of dark grey mudstone	253.8 - 252.8 m (1.0)
SANDSTONE:	very fine grained; calcareous; dark brown-grey; weathers light/medium yellow-orange-brown; semi-resistant	252.8 - 252.5 m (0.3)
COVERED:	float of dark grey to black mudstone in top 1 m, brownish mudstone below; local orange siltstone float also; recessive	252.5 - 247.5 m (5.0)
SANDSTONE:	very fine grained; calcareous; dark brown-grey; weathers light/medium yellow-brown; faint fine lamination; small-scale crosslaminations; flaggy; semi-resistant	247.5 - 246.5 m (1.0)
COVERED:	some siltstone float; recessive	246.5 - 245.5 m (1.0)
SANDSTONE:	fine grained; limonitic and slightly calcareous; dark brown-grey; weathers light/medium yellow-brown; laminations and small-scale crosslaminations; thin to medium bedded; semi-resistant	245.5 - 243.8 m (1.7)
COVERED:	mudstone and siltstone float; mudstone dark brown-grey to black (upper part); siltstone orange; recessive	243.8 - 238.3 m (5.5)
SANDSTONE:	fine grained, becoming very fine grained in upper part; limonitic and slightly calcareous, except less so in upper 25 cm; medium grey-brown; except very dark grey in upper 25 cm; weathers light/medium yellow-brown, except light/ medium grey in upper 25 cm; small-scale crosslaminations except in upper 25 cm; platy to flaggy; semi-resistant	238.3 - 237.4 m (0.9)
COVERED:	blocky siltstone nearly in place in lower part; distinctive orange-weathering siltstone float near top; recessive	237.4 - 228.4 m (9.0)

SANDSTONE:	fine grained; non-calcareous; black; weathers medium grey; faint fine parallel lamination; semi-recessive (slight small-scale deformation)	228.4 - 226.4 m (2.0)
SANDSTONE:	limonitic and slightly calcareous; medium dark brownish grey; weathers medium grey-brown; faint lamination; platy to flaggy; semi-resistant	226.4 - 224.8 m (1.6)
COVERED:	apparently laterally correlative with black mudstone; semi-recessive	224.8 - 222.5 m (2.3)
SANDSTONE:	medium grained; calcareous and limonitic; medium brown-grey; weathers same; medium-scale trough crossbedding, related to 50 cm relief in base; mainly flaggy with some medium beds; resistant	222.5 - 217.8 m (4.7)
COVERED:	rubbly dark grey mudstone on surface; recessive	217.8 - 216.6 m (1.2)
SILTSTONE:	very dark grey; weathers light grey; blocky; semi-resistant	216.6 - 215.8 m (0.8)
COVERED:	showings of very dark grey rubbly mudstone	215.8 - 215.0 m (0.8)
SANDSTONE:	medium grained, except coarse grained at base and fine grained at top; calcareous and slightly limonitic; medium brown-grey; weathers same; faint parallel laminations locally; shale chips and plant debris at base; flaggy to medium bedded; resistant	215.0 - 205.3 m (9.7)
SANDSTONE:	very fine grained; limonitic and slightly calcareous; medium dark brownish grey; weathers light/medium brown-grey; laminations and small-scale crosslaminations; flaggy; resistant	205.3 - 203.1 m (2.2)
POOR EXPOSURE:	mudstone; carbonaceous; black; recessive	203.1 - 202.1 m (1.0)
SANDSTONE:	limonitic; very slightly calcareous; dark brownish grey; weathers light/medium yellow-orange-brown; vague laminations; blocky weathering; semi-resistant	202.1 - 201.6 m (0.5)
POOR EXPOSURE:	mudstone; carbonaceous, especially at base; black; recessive	201.6 - 199.9 m (1.7)
COAL:	humic; bright	199.9 - 199.7 m (0.2)
MUDSTONE:	carbonaceous; black; recessive	199.7 - 198.6 m (1.1)
SILTSTONE:	very dark grey; weathers light/medium grey; semi-recessive	198.6 - 198.4 m (0.2)
MUDSTONE:	dark grey; recessive	198.4 - 197.9 m (0.5)
SILTSTONE:	fines upward; dark grey; light/medium grey weathering; uniform texture; blocky to rubbly (at top); semi-recessive	197.9 - 196.9 m (1.0)

SANDSTONE:	medium grained, becoming fine grained toward top; non-calcareous; very dark grey, becoming medium grey toward top; weathers medium grey; massive, except fine faint lamination in upper part; thin to medium bedded (vague); resistant; unit lenses out over short distance to south	196.9 - 194.4 m (2.5)
SANDSTONE:	fine/medium grained; limonitic and slightly calcareous; medium to dark brownish grey; weathers medium brownish grey; parallel laminated; some small and medium-scale crosslaminations; flaggy, except local medium beds; resistant	194.4 - 185.9 m (8.5)
MUDSTONE WITH SILTSTONE:	carbonaceous in upper 50% including vitrain band 50 cm from top; black, except dark brownish grey in basal 1 m; rubbly; recessive	185.9 - 180.9 m (5.0)
SILTSTONE/VERY FINE-GRAINED SANDSTONE:	calcareous, dark brownish grey; weathers light/medium yellow-brown with orange-brown lenses (incipient concretions); semi-resistant	180.9 - 178.4 m (2.5)
SANDSTONE:	coarse grained at base, medium grained at top; slightly calcareous and limonitic, except scattered limonitic and calcareous lenses; medium brown-grey; weathers same, except limonitic calcareous lenses which weather orange-brown; well laminated and small to medium-scale crosslaminated; stem fragments at base in "log-jam" structure; resistant	178.4 - 169.9 m (8.5)
COVERED:	vitrain float; some coal; recessive	169.9 - 168.4 m (1.5)
MUDSTONE:	locally carbonaceous, especially at top, with vitrain band; very dark grey to black; rubbly; recessive	168.4 - 166.2 m (2.2)
SANDSTONE:	very fine grained; very dark grey; weathers light/medium grey; massive; medium bedded; blocky to rubbly; semi-resistant	166.2 - 165.2 m (1.0)
SANDSTONE:	fine grained, except very fine grained in top 0.7 m; slightly calcareous; limonitic; medium brown-grey, except dark brownish grey in top 0.7 m; weathers medium brown-grey; laminated, except in top 0.7 m; flaggy to thin bedded; semi-resistant	165.2 - 162.0 m (3.2)
SANDSTONE:	fine/medium grained, locally coarse; limonitic and very slightly calcareous; medium brownish grey; weathers same; fine parallel laminations; local medium-scale crosslaminations; flaggy to thin bedded; resistant	162.0 - 154.5 m (7.5)
SANDSTONE AND CONGLOMERATE:	sandstone; medium to very coarse grained, some pebbly lenses; medium/dark brownish grey; weathers same; granule and small pebble conglomerate in thin beds and lenses, including basal 0.7 m; chert clasts; resistant	154.5 - 148.5 m (6.0)

SANDSTONE:	medium/coarse grained; limonitic and slightly calcareous; medium/dark brown-grey; weathers medium brown-grey; medium-scale trough crosslaminations and local laminations; flaggy to medium bedded; resistant	148.5 - 144.5 m (4.0)
SANDSTONE:	medium grained; limonitic and calcareous; dark brownish grey ("black and tan"); weathers medium brownish grey; parallel lamination; flaggy to platy; semi-resistant	144.5 - 143.3 m (1.2)
SANDSTONE:	coarse grained, with pebbly sandstone lenses and local scattered pebbles; non-calcareous; medium brownish grey; weathers same; large to medium-scale crossbedding; flaggy to thick bedded; resistant	143.3 - 140.8 m (2.5)
COVERED:	recessive	140.8 - 139.6 m (1.2)
CONGLOMERATE WITH SANDSTONE:	small pebble conglomerate, well-rounded chert and quartzite; sandstone coarse grained; colours similar to underlying; well laminated and crosslaminated; unit thin to medium bedded; top of unit consists of pebble conglomerate lenses in sandstone; resistant	139.6 - 134.1 m (5.5)
SANDSTONE:	medium to medium/coarse grained; light/medium brownish grey; weathers medium brownish grey; medium-scale crossbedded and laminated; flaggy to medium bedded; very resistant; 1.5 m relief on base of unit with small amount of pebbly lag	134.1 - 129.6 m (4.5)
MUDSTONE AND SHALE:	carbonaceous, contains 5 to 10 cm vitrain bands; dark grey; rubbly	129.6 - 125.9 m (3.7)
SILTSTONE AND SANDSTONE:	siltstone calcareous and argillaceous; medium brown; weathers light/medium yellow-orange-brown; flaggy to blocky; sandstone very fine grained; limonitic; small-scale crosslaminated	125.9 - 123.7 m (2.2)
SANDSTONE:	very fine to fine grained; limonitic and slightly calcareous; medium grey-brown; weathers medium brownish grey; common small-scale crosslaminations; possible burrows(?); thin to medium separation; blocky; semi-resistant	123.7 - 120.4 m (3.3)
SILTSTONE:	slightly calcareous; dark brown; weathers medium brown; rubbly	120.4 - 118.9 m (1.5)
SANDSTONE:	fine grained; slightly calcareous; limonitic; medium grey-brown; weathers medium brownish grey; small-scale cross-laminated; flaggy	118.9 - 118.2 m (0.7)
COVERED:	small showings of orange-weathering calcareous siltstone; float of rubbly dark grey and dark grey-brown mudstone; recessive	118.2 - 113.7 m (4.5)
COAL WITH SHALE:		113.7 - 112.5 m (1.2)
MUDSTONE:	dark grey; rubbly; recessive	112.5 - 111.5 m (1.0)

POOR EXPOSURE:	patchy float of rubbly mudstone; small showings of very fine-grained to fine-grained calcareous sandstone in upper portion; semi-recessive	111.5 - 107.0 m (4.5)
COVERED:	rubbly dark grey-brown mudstone at base; recessive	107.0 - 101.0 m (6.0)
COAL:	bright; very recessive	101.0 - 99.8 m (1.2)
MUDSTONE WITH SHALE:	carbonaceous; dark grey; rubbly; recessive	99.8 - 95.3 m (4.5)
SANDSTONE AND SILTSTONE:	thin to medium bedded; sandstone calcareous; dark brownish grey; weathers medium yellow-brown; finely parallel laminated; some small-scale crosslaminations; platy to flaggy; siltstone argillaceous; dark brownish grey; platy	95.3 - 92.8 m (2.5)
SILTSTONE:	argillaceous; slightly calcareous; dark brownish grey; weathers medium brown; platy to rubbly; recessive	92.8 - 92.3 m (0.5)
MUDSTONE:	silty; very dark grey; rubbly; recessive	92.3 - 91.3 m (1.0)
SANDSTONE:	very fine grained with fine-grained interbeds; slightly calcareous; fine grained also limonitic; dark brownish grey; weathers light/medium grey-brown; fine-grained beds laminated and small-scale crosslaminated; platy to flaggy; semi-resistant	91.3 - 87.3 m (4.0)
PARTLY COVERED:	silty mudstone; slightly calcareous; very dark grey-brown; recessive	87.3 - 85.8 m (1.5)
SANDSTONE:	very coarse grained to pebbly with local medium-grained lenses; medium/dark grey; weathers medium grey; thin to medium bedded; resistant	85.8 - 83.0 m (2.8)
SANDSTONE:	medium grained; limonitic; slightly calcareous, except for calcareous lenses (one is 1.5 m by 7 m at top of unit); medium to large-scale trough cross-bedding; platy to flaggy; resistant	83.0 - 78.5 m (4.5)
MAINLY COVERED:	much float of dark grey rubbly silty mudstone; recessive	78.5 - 75.1 m (3.4)
SANDSTONE:	fine to very fine grained; very slightly calcareous; dark brownish grey; weathers medium brownish grey	75.1 - 74.1 m (1.0)
SANDSTONE:	coarse grained with very coarse grained at basal 2 m; chert and quartz framework; limonitic; medium-scale cross-laminations; plant-stem impressions at base ("log jam" structure); plant-stem impressions near top of unit; flaggy to medium bedded; very similar to unit at 65.1 m	74.1 - 68.1 m (6.0)
MUDSTONE AND SANDSTONE:	mudstone beds are 20, 40 and 20 cm thick; recessive; sandstone coarse grained, similar to overlying and underlying units; one sandstone bed is 150 cm thick(?) and is 20 cm above base of	68.1 - 65.1 m (3.0)

	unit; the other is 70 cm thick and is 20 cm below top of unit	
SANDSTONE:	coarse grained; locally medium grained, with minor layers very coarse and slightly pebbly; pebbles include chert and mudstone clasts; sandstone limonitic; in places very slightly calcareous; medium brownish grey; flaggy with minor platy layers; channel at base, with relief of 60 cm; very resistant cliff-former	65.1 - 51.1 m (14.0)
MUDSTONE:	shaly and carbonaceous at top; very dark grey; rubbly; recessive	51.1 - 49.3 m (1.8)
SANDSTONE:	fine grained; limonitic; slightly calcareous; carbonaceous material (coalified rootlets) at top; dark brownish grey; weathers medium brownish grey with brown patches; finely laminated with local small-scale crosslaminations; flaggy to platy; 20 cm siltstone parting at 4.3 m; resistant	49.3 - 44.0 m (5.3)
MAINLY COVERED:	local float of rubbly dark grey mudstone and siltstone at base	44.0 - 39.0 m (5.0)
SANDSTONE:	fine grained; limonitic; slightly calcareous; dark brownish grey; weathers light/medium yellowish brown; small-scale crosslaminations; flaggy to thin bedded; semi-resistant	39.0 - 36.7 m (2.3)
COVERED:	abundant float of very dark grey mudstone in lowest 1.5 m; recessive	36.7 - 32.2 m (4.5)
SANDSTONE:	very fine grained; limonitic and slightly calcareous; medium grey-brown; weathers medium brownish grey; small-scale crosslaminations	32.2 - 32.0 m (0.2)
COVERED:	float of siltstone to fine-grained sandstone	32.0 - 31.0 m (1.0)
SANDSTONE:	fine grained; slightly calcareous; some ironstone concretions 2 m above base; local coalified plant material; finely laminated and medium-scale cross-laminated; local small-scale crosslaminations; flaggy to platy	31.0 - 25.5 m (5.5)
PARTLY COVERED:	showings of dark grey siltstone; recessive	25.5 - 24.5 m (1.0)
SANDSTONE:	fine grained with minor fine/medium grained in lower 1 m; limonitic and slightly calcareous; medium grey and medium brownish grey; weathers light/medium brownish grey; laminated dark grey on brown; small-scale foreset planar crosslaminations and medium-scale channel crossbeds; platy to flaggy; resistant	24.5 - 20.5 m (4.0)
MUDSTONE:	silty; locally carbonaceous; very dark brownish grey; weathers black; rubbly; recessive	20.5 - 19.0 m (1.5)
SANDSTONE:	fine grained with some fine to medium grained in lowest third; very dark grey to black; weathers medium grey; local	19.0 - 16.5 m (2.5)

SANDSTONE:	fine grained with a few medium-grained interbeds in basal 25 cm; dark brownish grey; weathers medium grey-brown; platy; resistant	16.5 - 13.5 m (3.0)
SANDSTONE:	medium/coarse grained; limonitic; dark brownish grey; 5 mm to 1 cm laminations and medium to large-scale crosslaminations of darker material; flaggy; resistant	13.5 - 11.5 m (2.0)
SANDSTONE:	sandy conglomerate at base to slightly pebbly sandstone at top; coarse to very coarse grained; chert and quartz pebbles; medium/dark grey; weathers light/medium brownish grey; beds 50 to 100 cm; resistant	11.5 - 7.0 m (4.5)
PARTLY COVERED (30%):	sandstone with mudstone possible at top of unit; very fine to fine grained, locally coarse grained; limonitic and slightly calcareous; coarse sandstone is cherty; medium brownish grey; black parallel laminae up to 1.5 mm; locally small-scale crosslaminated; some plant-stem impressions; flaggy; mudstone very dark grey; semi-resistant	7.0 - 3.0 m (4.0)
SANDSTONE:	coarse grained; similar to underlying unit; parallel laminated; medium-scale crosslaminations; one 1.2 m bed; otherwise flaggy; resistant	3.0 - 1.1 m (1.9)
CONGLOMERATE:	granule to small pebble except granule to very coarse sandstone in uppermost 20 cm; shale fragments near base up to 7 cm; predominantly well-rounded chert clasts; medium/dark grey; weathers light/medium yellowish grey; massive; resistant	1.1 - 0.0 m (1.1)

NOTES

SECTION 4
"PIPELINE" SECTION, FLATHEAD RIDGE

ROCK UNIT	DESCRIPTION	CUMULATIVE THICKNESS (Unit Thickness)
	CADOMIN FORMATION	
CONGLOMERATE:	large cliff-forming unit, sandstone lenses	
	ELK FORMATION	
COVERED:	overlain by large conglomerate (with sandstone lenses) cliff of the basal Cadomin	327.0 - 324.0 m (3.0)
SHALE:	very dark grey to black and carbonaceous, with coal flecks (particularly near the top); rubbly; 25 cm bed of light grey-weathering needle mudstone/siltstone at 320 m, containing minor scattered to locally abundant needles (coaly)	324.0 - 318.0 m (6.0)
SANDSTONE:	quartzose, non-calcareous; very fine grained to silt size; dark grey, weathers light grey with rusty brown patches; very hard; massive; minor shale interbeds; roots; minor local laminae; beds are medium sized	318.0 - 316.0 m (2.0)
SHALE:	partly covered, rubbly, medium brown weathering in lower third, very dark to black in upper two thirds	316.0 - 309.5 m (6.5)
SANDSTONE:	chert and quartz, limonitic; coarse grained; medium brownish grey, weathers same; flaggy to medium and thin bedded; commonly laminated and medium-scale crosslaminated; numerous pebbly layers and conglomerate beds up to 15 to 20 cm thick, with phenoclasts 5 to 40 mm (common) and some up to 80 mm; upper surface is a conglomerate layer and is undulating and hummocky (relief of 60 cm); plant-stem-covered surfaces locally	309.5 - 302.5 m (7.0)
CONGLOMERATE:	chert and sandstone phenoclasts, mainly 5 to 30 mm and one 100 mm sandstone clast at base; some sandstone lenses and size layering, one pebble thick to 30 cm	302.5 - 301.5 m (1.0)
MAINLY COVERED:	top 1 m is very fine-grained sandstone, medium brown in colour (deeply weathered) showings of siltstone below, flaggy as last unit and brown weathering and rubbly 20 to 25 cm bed of needle silt/mudstone at base; dark grey and very light grey weathering; massive; a few scattered needles	301.5 - 298.5 m (3.0)

SHALE:	black and carbonaceous; rubbly; coal flecks	298.5 - 297.5 m (1.0)
SANDSTONE:	quartzose, non-calcareous; fine grained; dark grey, weathers medium grey and has rusty patches; flaggy; plant roots	297.5 - 297.0 m (0.5)
SHALE:	black, carbonaceous; hard and rubbly	297.0 - 294.5 m (2.5)
SANDSTONE AND SHALE:	sandstone: quartzose, non-calcareous; very fine grained; medium and dark grey layers; weathers light/medium grey, with rusty patches; platy shale: black, carbonaceous; forms middle 3/8 of unit	294.5 - 293.8 m (0.7)
SHALE:	hard and finely rubbly; very dark grey to blackish	293.8 - 287.5 m (6.3)
SANDSTONE:	very limonitic, calcareous; very fine grained with some lenticular layers of medium/coarse-grained cherty sandstone; dark grey and orange laminae, weathers medium orange-brown; flaggy	287.5 - 287.0 m (0.5)
SILTSTONE:	argillaceous; recessive; dark grey and medium brown weathering; platy to rubbly	287.0 - 285.5 m (1.5)
SANDSTONE:	dark grey chert and quartz, limonitic, very slightly calcareous; coarse to very coarse grained with a few scattered small pebbles and minor sandy conglomerate lenses; medium/dark grey and weathers medium greyish brown; laminated and medium to large-scale planar cross-lamination; flaggy to medium and thick bedded; local plant-stem-covered surface	285.5 - 277.5 m (8.0)
CONGLOMERATE:	mixed with pebbly sandstone and granule sandstone; some local medium-scale crossbedding; main phenoclast size range is 5 to 30 mm with scattered clasts up to 60 mm; chert and sandstone	277.5 - 276.5 m (1.0)
SHALE:	hard and rubbly, partly carbonaceous (more in upper part); very dark grey and black; top 1 m is covered	276.5 - 273.0 m (3.5)
SANDSTONE:	quartzose, non-calcareous; very fine grained; dark grey, weathers light grey with rust patches; becomes a siltstone in top 15 cm; very hard rock, no lamination (c.f. Foothills Lower Blairmore)	273.0 - 272.3 m (0.7)
MAINLY COVERED:	showings of siltstone and brownish weathering rubbly mudstone	272.3 - 271.0 m (1.3)
SANDSTONE:	slightly calcareous, limonitic; coarse grained in basal 9 m and fine grained in top 3 m; medium/dark brownish grey, weathers medium greyish brown; flaggy, becoming more platy near top; laminated and medium-scale planar crosslamination, with small-scale crosslamination in top 3 m; some plant-stem-covered surfaces	271.0 - 259.0 m (12.0)
PARTLY COVERED:	showings of very dark grey to black mudstone, particularly in lower 5 m, and a 20 cm bed of light grey-weathering	259.0 - 247.0 m (12.0)

	needle siltstone, 1 m above base, with a few scattered needles	
Note:	Followed underlying sandstone unit east along crest for 350 m. Section continues down from that point.	
SANDSTONE:	slightly calcareous, limonitic; medium grained; medium to medium/dark brownish grey, weathers medium brown; laminated (1 to 10 mm), local medium-scale cross-lamination and minor small-scale cross-lamination; some large-scale crossbeds, particularly near base; flaggy to platy, with a general medium to thick-bedded appearance; a remarkably uniform sandstone unit considering its thickness; some surfaces have a layer of criss-crossed plant stems Laterally (westward) the unit is complicated by the appearance of a shale unit (including a light grey weathering siltstone bed) wedging into the sandstone about one-third of the way up and reaching a thickness of 4 to 5 m	247.0 - 216.0 m (31.0)
COVERED:		216.0 - 212.0 m (4.0)
Note:	Moved laterally along ridge crest east. Guessed at 4 m covered. Control is very poor. Probably 1 to 8 m.	
SANDSTONE:	slightly calcareous; limonitic; very fine to fine grained; dark grey; weathers medium brown with some light/medium orange-brown, more limonitic, lenses; flaggy to locally platy; finely laminated and some small-scale cross-lamination; scattered plant stems	212.0 - 209.0 m (3.0)
MUDSTONE:	silty; dark grey, weathers medium brown; rubbly	209.0 - 208.5 m (0.5)
SHALE:	silty, carbonaceous; hard and platy/rubbly; very dark grey to black; contains two 20 to 30 cm beds of light grey weathering siltstone (needle siltstone type) in lower two-thirds; these siltstones have a few roots and rare, scattered needles	208.5 - 206.1 m (2.4)
SILTSTONE:	argillaceous, dark grey, weathers medium greyish brown; blocky to rubbly disintegration; slightly calcareous, very fine-grained, argillaceous sandstone in middle, with some nodular concretions, surrounded by envelopes of liesegang rings; traces of plant debris - small and grass-like	206.1 - 203.9 m (2.2)
SANDSTONE:	limonitic, slightly calcareous; fine to very fine grained; medium grey, weathers light yellow-brown; strongly small-scale crosslaminated (climbing ripples probably); basal 90 cm is fine/medium grained - i.e. this is a fining-upward unit; basal part is laterally very limonitic and orange weathering (lens); massive; lower contact sharp, upper contact gradational	203.9 - 202.5 m (1.4)

SHALE/MUDSTONE:	lower half is very dark grey to blackish shale; upper half is medium grey, medium brown-weathering, rubbly mudstone; the shale grades into the mudstone	202.5 - 201.5 m (1.0)
SILTSTONE:	dark grey; argillaceous; varies to silty mudstone and very fine-grained sandstone (laminated and small-scale crosslamination)	201.5 - 199.5 m (2.0)
Note:	Moved laterally eastwards to next pipeline cut. Correlation of units is a reasoned guess owing to cover and a small fault.	
SILTSTONE:	dark grey, weathers light grey; mud cracks on one surface; traces of roots; massive; plant-stem debris scattered locally; rare sandstone pebbles up to 5 cm in diameter; small sandstone vein; one edge of unit is discordant to bedding and resembles a small bank at margin; traces of possible needles or roots on upper surface. Unit thickens eastwards and is apparently lenticular	199.5 - 198.5 m (1.0)
MAINLY COVERED:	showings of very dark grey, silty and rubbly mudstone and a 15 cm bed of dark grey, light grey and yellow-weathering siltstone containing roots	198.5 - 195.5 m (3.0)
SANDSTONE:	slightly calcareous, limonitic; medium grained; medium grey, deep-weathers to light/medium yellowish to slightly orange-brown; laminated (mainly bedding parallel); flaggy to platy; some mudstone rip-up clasts	195.5 - 194.7 m (0.8)
SANDSTONE:	limonitic, slightly calcareous; medium to coarse grained; dark grey; deep-weathers light/medium yellow-brown; minor lamination (bedding parallel); thin to medium beds; partly covered	194.7 - 193.5 m (1.2)
COVERED:	loose, very dark grey mudstone	193.5 - 191.4 m (2.1)
SANDSTONE:	slightly calcareous and limonitic; coarse grained; medium/dark grey, weathers light/medium brownish grey; strongly laminated and medium-scale crosslaminated; minor slump folds in laminae in basal 0.5 m; basal contact shows minor channeling into carbonaceous shale below; large plant stems, some now vitrinite lenses, in lower part; local lenses of orange-weathering, very limonitic sandstone; flaggy to medium bedded and minor local platy; local surfaces with rip-up clasts	191.4 - 188.7 m (2.7)
MUDSTONE:	dark grey at top, medium grey below; rubbly	188.7 - 187.7 m (1.0)
MUDSTONE AND COAL:	mudstone: carbonaceous and fissile; thinly interbedded	187.7 - 187.2 m (0.5)
SILTSTONE:	upper part carbonaceous and fissile	187.2 - 186.4 m (0.8)
SANDSTONE:	fine/medium grained; small-scale cross-	186.4 - 185.3 m

	laminations	(1.1)
SILTSTONE:	laminated; concretionary weathering	185.3 - 184.3 m (1.0)
SILTSTONE:	black; vitrain partings	184.3 - 183.8 m (0.5)
SILTSTONE:	dark grey; friable	183.8 - 183.1 m (0.7)
SANDSTONE AND SILTSTONE:	sandstone: fine grained; siltstone: rubbly	183.1 - 180.0 m (3.1)
SANDSTONE:	medium grained; faintly laminated and crosslaminated; medium to thick bedded	180.0 - 171.5 m (8.5)
SANDSTONE:	graded coarse to medium grained; shale rip-ups and plant-stem imprints	171.5 - 169.5 m (2.0)
SANDSTONE:	coarse grained; coalified plant stems abundant	169.5 - 166.0 m (3.5)
SANDSTONE:	coarse grained; crosslaminated; plant-stem imprint in growth position	166.0 - 164.5 m (1.5)
SANDSTONE:	fine grained	164.5 - 163.0 m (1.5)
COAL AND SILTSTONE:	siltstone: carbonaceous: coal: bed at base of unit is 20 cm thick; others are 1 to 2 cm	163.0 - 161.2 m (1.8)
SILTSTONE:	carbonaceous; coaly at base; blocky fracture	161.2 - 158.8 m (2.4)
CARBONACEOUS SILTSTONE AND COAL:	coal: bands up to 10 cm thick, individual vitrain bands up to 5 cm; sample D	158.8 - 158.0 m (0.8)
SILTSTONE WITH SANDSTONE:	sandstone: very fine grained and occupies top 0.5 m; blocky fracture	158.0 - 156.2 m (1.8)
MUDSTONE:	in part carbonaceous	156.2 - 155.7 m (0.5)
SANDSTONE:	very fine grained; very dark grey; roots	155.7 - 155.3 m (0.4)
MUDSTONE:	black; carbonaceous; fissile	155.3 - 154.8 m (0.5)
SILTSTONE:	dark grey; roots	154.8 - 153.3 m (1.5)
SANDSTONE AND SILTSTONE:	sandstone: fine-grained fining-upward unit; blocky fracture	153.3 - 152.0 m (1.3)
SANDSTONE AND SILTSTONE:	sandstone; fine-grained fining-upward unit; blocky fracture	152.0 - 150.8 m (1.2)
SANDSTONE:	fine/medium grained; unlaminated; thick bedded	150.8 - 147.0 m (3.8)
SANDSTONE:	medium/coarse grained; well laminated with medium-scale crosslaminations; thick bedded; orange-weathering concretionary layer	147.0 - 146.0 m (1.0)

SANDSTONE:	medium grained; dark grey laminations; thinly parallel laminated; platy	146.0 - 144.6 m (1.4)
SANDSTONE:	coarse grained; slightly calcareous; in part limonitic; orange-brown weathering in limonitic beds; some fine-scale banding; well laminated with medium-scale curviplanar crosslaminations; very thick bedded at base; cliff-forming	144.6 - 140.3 m (4.3)
CARBONACEOUS MUDSTONE:	in part coaly; black; similar to Elk coal; numerous vitrain bands	140.3 - 138.7 m (1.6)
COVERED:		138.7 - 135.2 m (3.5)
SILTSTONE AND SANDSTONE:	sandstone: very fine grained; both small-scale crosslaminated; blocky	135.2 - 133.7 m (1.5)
MUDSTONE:	dark grey; rubbly	133.7 - 133.4 m (0.3)
SANDSTONE:	fine to very fine grained; slightly calcareous; medium grey, weathers light/medium yellow-brown; small-scale crosslaminations	133.4 - 132.1 m (1.3)
COVERED:		132.1 - 129.7 m (2.4)
SILTSTONE:	contains vitrain bands; ironstone concretions 0.5 to 2 cm in diameter; small-scale crosslaminations	129.7 - 129.0 m (0.7)
MUDSTONE:	carbonaceous and shaly, with coal pods	129.0 - 128.5 m (0.5)
SILTSTONE WITH SANDSTONE:	siltstone: carbonaceous and shaly at base and in middle; sandstone: fine grained, uppermost part of unit	128.5 - 126.5 m (2.0)
SANDSTONE:	very fine grained; upper 0.5 m is dark grey, weathers light grey; remainder is slightly calcareous; medium grey; weathers brownish, with fine laminations and crosslaminations; plant-stem fragments in lower part; roots also in lower part; fossil A and B soil horizons?	126.5 - 125.3 m (1.2)
PARTLY COVERED:	siltstone and nodular-weathering mudstone with vitrain bands	125.3 - 124.5 m (0.8)
SANDSTONE:	very fine grained; limonitic; slightly calcareous; medium grey, weathers medium brown and orange-yellow; thinly laminated	124.5 - 123.5 m (1.0)
SILTSTONE:	greenish grey weathering; in part concretionary	123.5 - 123.0 m (0.5)
MUDSTONE:	dark grey; one distinct concretionary layer	123.0 - 121.5 m (1.5)
SILTSTONE WITH ONE SANDSTONE BED:	siltstone: locally calcareous; light/medium brown, weathers grey sandstone: very fine grained, medium grey, orange-brown weathering and laminated, in 0.75 m bed; very sharp contact with underlying unit	121.5 - 119.0 m (2.5)

MUDSTONE WITH SILTSTONE:	mudstone: dark grey siltstone dark brownish grey	119.0 - 115.5 m (3.5)
PARTLY COVERED:	mudstone with coaly horizons	115.5 - 111.8 m (3.7)
SILTSTONE:	dark grey, weathers light grey	111.8 - 111.3 m (0.5)
SANDSTONE AND SILTSTONE:	sandstone: fine grained; distinct orange-brown weathering; small-scale crosslaminations	111.3 - 110.0 m (1.3)
MUDSTONE:	black	110.0 - 109.0 m (1.0)
SILTSTONE:		109.0 - 108.0 m (1.0)
COVERED:	small exposures of siltstone and sandstone; siltstone dark grey; sandstone fine grained; including a 0.5 m bed 3 m above base	108.0 - 102.0 m (6.0)
SANDSTONE:	fine grained; brown weathering	102.0 - 101.0 m (1.0)
COVERED:		101.0 - 94.0 m (7.0)
SANDSTONE:	fine and medium grained; orange-brown weathering; thin bedded; mainly unlaminated	94.0 - 89.0 m (5.0)
SANDSTONE:	coarse grained; medium grey-brown; weathers brown; locally crosslaminated; thick bedded near base; numerous plant imprints near top; thin interbeds of fine-grained sandstone near top	89.0 - 82.0 m (7.0)
COVERED:		82.0 - 81.5 m (0.5)
SILTSTONE:	black; rubbly	81.5 - 81.0 m (0.5)
COVERED:		81.0 - 77.3 m (3.7)
SILTSTONE:	black, blocky; gradational contact with underlying unit	77.3 - 76.3 m (1.0)
SANDSTONE:	medium and fine grained; vitrain lenses; very dark grey and black, weathers light grey; grades from medium to fine grained near top of unit	76.3 - 75.3 m (1.0)
SILTSTONE, MUDSTONE AND MINOR COAL:	mudstone: carbonaceous siltstone: concretionary	75.3 - 73.5 m (1.8)
PARTLY COVERED:	sandstone, siltstone and mudstone interbedded sandstone: very fine grained	73.5 - 67.5 m (6.0)
SANDSTONE:	very fine to fine grained; slightly calcareous; orange-brown weathering	67.5 - 63.0 m (4.5)
SANDSTONE:	very coarse and coarse grained near base, medium to fine grained near top; limonitic; grey-brown weathering near base, brown weathering near top; well	63.0 - 52.0 m (11.0)

	crosslaminated; platy to fissile in upper portion; suggestion of grading between lower and upper portion; mud-chip clasts in lower portion; vitrain lenses and partings in upper portion; current-ripple marks on one surface in upper portion; upper contact faulted?; prominent bluff-former	
SILTSTONE:	medium greyish brown; crosslaminated and blocky near base; unlaminated and rubbly near top	52.0 - 50.0 m (2.0)
COAL AND MUDSTONE:	1 m of coal in middle of unit; mudstone: carbonaceous	50.0 - 48.0 m (2.0)
MUDSTONE AND SILTSTONE:		48.0 - 42.5 m (5.5)
SANDSTONE:	fine grained overlain by very fine grained; former crosslaminated	42.5 - 41.5 m (1.0)
COAL:		41.5 - 41.2 m (0.3)
MUDSTONE:	carbonaceous	41.2 - 41.0 m (0.2)
SILTSTONE WITH MUDSTONE:	siltstone: dark grey and blocky mudstone: rubbly; in part carbonaceous including one coal pod; numerous grassy plant imprints	41.0 - 39.5 m (1.5)
PARTLY COVERED:	exposures of sandstone overlain by siltstone; sandstone fine-grained; individual sandstone-siltstone units up to 40 cm thick	39.5 - 37.5 m (2.0)
COVERED:	silty mudstone float	37.5 - 31.0 m (6.5)
SANDSTONE AND SILTSTONE:	sandstone: fine grained, orange-brown weathering and concretionary; siltstone dark grey	31.0 - 30.0 m (1.0)
SANDSTONE:	medium and fine grained, locally orange-brown weathering, thin and medium bedded	30.0 - 27.0 m (3.0)
COVERED:		27.0 - 25.7 m (1.3)
SANDSTONE:	fine/medium, medium and coarse grained; locally calcareous; orange-brown weathering in certain horizons; bedding units 15 to 120 cm thick, based on sharp contrasts in grain size; striking laminations, including large-scale crosslaminations with up to 20-degree foreset angles; massive to platy; plant imprints common at certain levels, including "log-jam" structures; shale rip-up clasts observed locally; prominent bluff-former	25.7 - 0 0 m (25.7)
Note:	Base of section corresponds with the roof of 6.5 m zone of predominantly coal with carbonaceous mudstone and shale horizons.	

SECTION 5
LODGEPOLE PROPERTY

ROCK UNIT	DESCRIPTION	CUMULATIVE THICKNESS (Unit Thickness)
	CADOMIN FORMATION	
CONGLOMERATE:	local 20 cm siltstone layer at lower contact; approximately 30 cm relief over 5 m on contact	
	ELK FORMATION	
SANDSTONE:	medium to coarse grained; medium to very dark grey, weathers medium grey with rusty patches; locally laminated and crosslaminated; medium to thick bedded	157.0 - 152.0 m (5.0)
MUDSTONE:	carbonaceous, especially at top and bottom; dark grey; rubbly	152.0 - 150.5 m (1.5)
NEEDLE SILTSTONE:	carbonaceous; coaly at top of unit	150.5 - 150.0 m (0.5)
MUDSTONE:	very dark grey to black; rubbly	150.0 - 145.0 m (5.0)
SILTSTONE AND SANDSTONE:	siltstone grey, weathers dark brown; sandstone fine grained and platy	145.0 - 138.0 m (7.0)
SANDSTONE TO GRANULE CONGLOMERATE:	sandstone very coarse grained; abundant chert fragments throughout; carbonaceous; in part limonitic; dark brownish grey, weathers light/medium greyish brown; hummocky surface on uppermost bed; carbonized plant debris	138.0 - 132.5 m (5.5)
COVERED:	float of mudstone, siltstone and fine-grained sandstone	132.5 - 130.3 m (2.2)
MUDSTONE:	silty; dark grey; rubbly; 10 cm needle siltstone interbeds near base and top of unit	130.3 - 124.5 m (5.8)
SANDSTONE:	coarse to very coarse grained; chert clasts abundant; medium brownish grey; weathers light/medium greyish brown	124.5 - 122.0 m (2.5)
SANDSTONE:	fine/medium grained; limonitic; carbonaceous; medium greyish brown; weathers light/medium greyish brown; flaggy and rubbly	122.0 - 120.5 m (1.5)
MUDSTONE:	silty; very dark grey; rubbly	120.5 - 118.5 m (2.0)
NEEDLE SILTSTONE AND MUDSTONE:	needle siltstone very dark grey and black, weathers light grey; carbonaceous material forms 1 to 5% of needle siltstone and is occasionally visible on outcrop surface; units of needle siltstone 30 to 50 cm, with internal separation of up to 15 cm with hummocky	118.5 - 114.5 m (4.0)

	bedding plane surfaces; mudstone silty; dark grey	
MUDSTONE WITH SANDSTONE AND NEEDLE SILTSTONE:	mudstone silty; dark grey; carbonaceous uppermost 30 cm; needle siltstone light grey weathering	114.5 - 108.5 m (6.0)
COVERED:	float of sandstone and silty mudstone; sandstone similar to underlying unit; mudstone brown; rubbly	108.5 - 107.5 m (1.0)
SANDSTONE:	very fine grained; limonitic; calcareous; medium brownish grey, weathers light/medium greyish brown with a light brown weathering rind; locally laminated; separation 1 to 5 cm	107.5 - 106.5 m (1.0)
COVERED:		106.5 - 104.3 m (2.2)
SANDSTONE:	very fine grained; non-calcareous; weathers medium brownish grey	104.3 - 103.5 m (0.8)
MUDSTONE WITH SILTSTONE:	mudstone silty; dark grey; rubbly; siltstone grades to very fine-grained sandstone; varies from medium greyish brown to dark grey; siltstone interbeds are 10 to 30 cm thick; recessive	103.5 - 100.0 m (3.5)
COVERED:	sandstone and mudstone float; sandstone float at base, and at intervals throughout; sandstone fine grained, limonitic, semi-recessive	100.0 - 93.0 m (7.0)
COVERED:	mudstone float; dark grey; rubbly; recessive	93.0 - 91.5 m (1.5)
COVERED:	carbonaceous mudstone exposed in pothole; recessive	91.5 - 90.5 m (1.0)
COVERED:	float of silty mudstone and argillaceous siltstone; dark grey; rubbly; recessive	90.5 - 88.0 m (2.5)
COVERED:	float of fine-grained sandstone at base of interval, siltstone and mudstone above; recessive	88.0 - 83.5 m (4.5)
COVERED:	sandstone float; medium grained	83.5 - 82.0 m (1.5)
SANDSTONE:	medium grained and coarse to very coarse grained; coarser portions similar to underlying unit; chert fragments common; medium/dark grey; medium-grained portions limonitic and slightly calcareous	82.0 - 78.5 m (3.5)
SANDSTONE:	coarse to very coarse grained with granules and pebbles up to 12 mm; chert clasts abundant; non-limonitic; non-calcareous; medium to medium/dark grey, weathers medium grey; inconspicuous laminations; coarser clasts in stringers or randomly distributed; separation 15 mm to 40 cm; resistant	78.5 - 77.5 m (1.0)
COVERED:	float of mudstone, siltstone and minor very fine-grained sandstone; siltstone and mudstone are brown to grey; recessive	77.5 - 68.5 m (9.0)
COVERED:	mudstone float; carbonaceous mudstone	68.5 - 63.0 m

	exposed in pothole at base of interval; mudstone rubbly; recessive	(5.5)
COVERED:	float of silty mudstone and lesser siltstone and very fine-grained sandstone; silty mudstone dark grey; rubbly; recessive	63.0 - 58.0 m (5.0)
SANDSTONE:	very fine grained; calcareous; medium dark brownish grey, weathers medium brown; platy	58.0 - 57.5 m (0.5)
SANDSTONE:	fine/medium grained; chert and quartz fragments; limonitic; highly calcareous; medium brownish grey, weathers light/ medium greyish brown with minor brown rind; faint laminations with local more conspicuous laminations (1 to 4 mm); separation 1 to 5 cm, locally 5 to 15 cm	57.5 - 56.0 m (1.5)
COVERED:	siltstone and fine-grained sandstone float	56.0 - 54.0 m (2.0)
SANDSTONE:	fine grained with bed of fine/medium grained at top of unit; predominantly chert and quartz fragments; limonitic; slightly calcareous; surface-weathers light/medium brown, deep-weathers light/ medium to medium brownish grey; locally thinly laminated to laminated; local small-scale ripple-drift crosslaminations; separation 1 to 7 cm, locally to 40 cm; semi-resistant	54.0 - 51.0 m (3.0)
COVERED:	mudstone in float; dark grey; rubbly; recessive	51.0 - 50.3 m (0.7)
SANDSTONE:	fine grained; limonitic; calcareous; surface-weathers light/medium brown, deep-weathers light/medium greyish brown with orange-brown rind; local bed of highly limonitic, soft, weathered sandstone; semi-resistant	50.3 - 48.5 m (1.8)
COVERED:	float of silty mudstone and carbonaceous mudstone; silty mudstone is dark grey and rubbly; recessive	48.5 - 46.5 m (2.0)
MUDSTONE:	carbonaceous; black; fissile to platy; recessive	46.5 - 46.0 m (0.5)
SILTSTONE AND MUDSTONE:	siltstone weathers medium brownish grey; mudstone silty; dark grey; rubbly; unit fines upward; recessive	46.0 - 44.0 m (2.0)
COVERED:	sandstone float close to in-place; fine grained; dark brown, weathers brownish orange; thinly laminated (parallel); semi-resistant	44.0 - 41.0 m (3.0)
SANDSTONE:	medium to medium/coarse grained; predominantly quartz and dark chert fragments; limonitic; slightly calcareous; medium grey, surface-weathers light/ medium brownish grey; deep-weathers light/medium greyish brown; size and colour-laminated (1 to 4 mm); medium-scale crosslaminations; separation 2 to 15 cm, locally up to 25 cm; semi-resistant	41.0 - 33.0 m (8.0)
COVERED:	small outcroppings of silty mudstone	33.0 - 31.0 m

	and coal in lowest 0.5 m; mudstone is carbonaceous and black; semi-resistant	(2.0)
MUDSTONE WITH SILTSTONE:	silty; non-calcareous; dark to very dark grey; siltstone beds at base and top; roots in upper siltstone bed; recessive	31.0 - 30.0 m (1.0)
COVERED:	float of silty mudstone; argillaceous; very dark grey; rubbly and platy; recessive	30.0 - 28.5 m (1.5)
COVERED:	float similar to underlying unit; resistant	28.5 - 27.5 m (1.0)
SANDSTONE:	fine grained; limonitic; calcareous; medium brownish grey, weathers light/ medium greyish brown, distinctive medium brown-weathering rind; thinly laminated; semi-resistant	27.5 - 26.5 m (1.0)
COVERED:	abundant sandstone float; fine to medium grained; semi-resistant	26.5 - 19.0 m (7.5)
SANDSTONE:	fine to medium grained; limonitic; slightly calcareous; medium brownish grey, surface-weathers light/medium brownish grey, deep-weathers light/ medium brown with orange-brown rind; thinly laminated to laminated (1 to 3 mm); medium-scale crosslaminations; separation 1 to 15 cm; semi-resistant	19.0 - 18.5 m (0.5)
COVERED:	recessive	18.5 - 17.5 m (1.0)
MUDSTONE:	in part carbonaceous; non-calcareous; black; platy and rubbly; recessive	17.5 - 16.0 m (1.5)
COVERED:	float of mudstone, lesser amounts of siltstone and fine-grained sandstone; mudstone float dark grey and rubbly; siltstone and sandstone float weathers orange-brown; recessive	16.0 - 9.5 m (6.5)
SANDSTONE:	fine to fine/medium grained; limonitic to very limonitic within certain horizons; locally calcareous; medium grey, surface-weathers light/medium grey to brown, deep-weathers light/medium brown to orange-brown; strongly size-laminated (1 to 4 mm); resistant	9.5 - 7.0 m (2.5)
SANDSTONE:	medium grained with some fine and medium/coarse; predominantly rounded dark chert and quartz fragments; limonitic; non-calcareous; medium grey, surface-weathers light/medium grey, deep-weathers light/medium brown; size-laminated (1 to 8 mm) medium-scale crosslaminations; separation 5 to 40 cm; resistant	7.0 - 2.5 m (4.5)
	MIST MOUNTAIN FORMATION	
COVERED:	semi-resistant	2.5 - 2.1 m (0.4)
MUDSTONE:	in part carbonaceous to coaly; non-calcareous; dark grey, rusty on fractures; uniform; rubbly; recessive	2.1 - 1.1 m (1.0)

SHALE AND COAL:	shale carbonaceous; 20 cm coal at base of unit, 10 cm in middle and two very thin beds in upper part; recessive	1.1 - 0.0 m (1.1)
Note:	Base of section in 8-seam trench on "West Ridge".	

NOTES

SECTION 5A
MCLATCHIE RIDGE

ROCK UNIT	DESCRIPTION	CUMULATIVE THICKNESS (Unit Thickness)
	CADOMIN FORMATION	
CONGLOMERATE:	cliff-forming; pebble-size clasts; contact is subparallel with small-scale relief visible	
	ELK FORMATION	
SANDSTONE:	fine to medium grained; dark grey, weathers rusty brown; channel shape; vague ripple-drift crosslaminations; contains 30 cm lens at top of unit of medium grey, rusty brown weathering, very fine-grained sandstone; laterally equivalent to dark grey, light grey weathering needle siltstone and sandstone	24.5 - 23.3 m (1.2)
SHALE:	very dark grey; friable	23.3 - 22.5 m (0.8)
CONGLOMERATE AND SANDSTONE:	conglomerate: pebble-size clasts; coarse to very coarse sandstone matrix; chert and sandstone framework; sandstone: dark grey; fine grained; occurs at base	22.5 - 22.0 m (0.5)
COVERED:	float of very dark grey rubbly siltstone	22.0 - 17.5 m (4.5)
SANDSTONE:	medium to coarse grained; medium brownish grey with alternating dark grey and light brown laminations; weathers medium grey-brown with rust coloration on fracture surfaces; 1 to 5 mm laminations; planar crosslaminated; plant-stem impressions associated with surfaces of coarser beds	17.5 - 11.0 m (6.5)
SANDSTONE AND CONGLOMERATE:	conglomerate: pebble-size clasts; medium to coarse sandstone matrix; chert and sandstone framework; 2 m lens within sandstone	11.0 - 10.8 m (0.2)
COVERED:	float of siltstone and sandstone; carbonaceous zone, possibly coal, near base	10.8 - 7.0 m (3.8)
SANDSTONE:	medium to medium/coarse grained; limonitic; non-calcareous; more carbonaceous near top; medium brownish grey; weathers medium grey; strongly laminated and medium-scale planar crosslaminated; thin to medium bedded; locally platy; conspicuous macerated plant debris; clay rip-ups common; contains ironstone concretions up to 10 cm in length	7.0 - 0.0 m (7.0)

NOTES

SECTION 6
DRILLCORE LB-301, LILLYBURT PROPERTY

ROCK UNIT	DESCRIPTION	CUMULATIVE THICKNESS (Unit Thickness)
	CADOMIN FORMATION	
SANDSTONE:	coarse grained, and minor very coarse with granule stringers; chert and quartz clasts; non-calcareous; medium grey; medium-scale crosslaminations; pyrite and chalcopyrite on fracture surfaces	83.0 - 81.4 m (1.6)
SANDSTONE:	fine grained and very fine grained; latter is argillaceous; non-calcareous; local parallel laminations and cross-laminations; bioturbation	81.4 - 80.1 m (1.3)
SANDSTONE WITH SILTSTONE:	fine grained; medium/dark grey; well laminated with small-scale cross-laminations; siltstone laminae; vitrain parting at base of unit	80.1 - 78.0 m (2.1)
CONGLOMERATE WITH SANDSTONE:	predominantly pebble-size clasts (5 to 20 mm), but also up to 5 cm and down to granule size; generally chert clasts with minor quartzitic sandstone; conglomerate clasts very close-packed, with small amounts of coarse-grained sand matrix; sandstone coarse grained; in part crosslaminated in beds up to 8 to 10 cm thick; coal stringer at base of unit	78.0 - 72.4 m (5.6)
SANDSTONE:	medium grained with two pebbly sandstone horizons of approximately 20 cm and 5 cm thickness; medium grey; well laminated with large(?)-scale crosslaminations; rip-up clasts(?) in bottom unit (5 cm of pebbly sandstone)	72.4 - 71.9 m (0.5)
	ELK FORMATION	
SANDSTONE AND SILTSTONE:	sandstone very fine grained; non-calcareous; dark grey; thinly size-laminated with parallel and small-scale crosslaminations	71.9 - 71.1 m (0.8)
SANDSTONE WITH SILTSTONE:	fine grained; dark grey; laminated (1 to 12 mm) with small-scale crosslaminations; siltstone laminae	71.1 - 70.6 m (0.5)
SILTSTONE WITH SANDSTONE:	dark grey; predominantly thinly interlaminated; some small-scale crosslaminations; copper staining on fractures	70.6 - 65.8 m (4.8)
SANDSTONE:	fine grained with laminae of siltstone and medium-grained sandstone; medium grey; laminated with small-scale cross-laminations	65.8 - 65.3 m (0.5)
GOUGE(?):	friable, fine grained sandy	65.3 - 65.1 m (0.2)
SANDSTONE:	fine grained with laminae of siltstone	65.1 - 64.9 m

	and medium-grained sandstone; medium grey; laminated with small-scale cross-laminations; identical to unit above gouge zone	(0.2)
SANDSTONE:	coarse to coarse/medium grained, minor very coarse grained with mudstone rip-up clasts; chert and quartz clasts; 15 cm carbonaceous zone 3 m from top of unit; in part unlaminated, in part laminated (1 to 5 mm)	64.9 - 58.1 m (6.8)
SANDSTONE:	fine grained with siltstone laminae and coarse-grained sandstone interbeds; medium grey with dark grey laminae (silty); small-scale crosslaminations; high-angle fault noted with 2 cm normal offset	58.1 - 57.3 m (0.8)
SANDSTONE WITH CONGLOMERATE:	sandstone medium to coarse grained; conglomerate with granule to small pebble clasts in 50 cm bed 2 m above base of unit; overall non-calcareous; scattered coaly partings or lenses; medium/dark grey; laminations pronounced to inconspicuous, including some medium-scale crosslaminations	57.3 - 51.4 m (5.9)
SANDSTONE:	similar to overlying unit; medium grained with interbeds of very fine-grained sandstone to siltstone; dark grey; interbeds 5 mm to 25 cm thick; finer interbeds crosslaminated; high-angle faults noted with 1 cm normal offsets	51.4 - 50.2 m (1.2)
SANDSTONE:	medium/coarse grained; dark grey; faint cross(?) laminations; uniform in terms of composition and texture	50.2 - 46.3 m (3.9)
SANDSTONE:	continuous with overlying unit; contains abundant rip-up clasts of dark grey siltstone up to 10 cm long	46.3 - 44.0 m (2.3)
SANDSTONE:	continuous with overlying unit; contains abundant coal partings and lenses and one 10 cm bed of dark grey silty mudstone 25 cm above base of unit	44.0 - 43.2 m (0.8)
MUDSTONE AND SILTSTONE:	mudstone silty; dark grey; bioturbated	43.2 - 42.5 m (0.7)
SANDSTONE:	medium grained; coaly at base; dark grey, 1 to 5 mm laminations; locally to 15 mm	42.5 - 40.9 m (1.6)
SILTSTONE WITH SANDSTONE:	siltstone argillaceous; carbonaceous and coaly in zone 35 to 55 cm above base of unit; dark grey with medium grey laminae; sandstone medium grained in 10 cm bed 90 cm above base of unit; unit bioturbated; intense local fracturing or brecciation	40.9 - 38.5 m (2.4)
MUDSTONE:	very dark grey; faint irregular bioturbated laminae	38.5 - 36.3 m (2.2)
SILTSTONE AND MUDSTONE:	siltstone argillaceous; medium to dark grey; mudstone silty; dark grey; beds are 0.5 to 7 cm thick; very finely laminated with local small-scale cross-laminations	36.6 - 32.4 m (3.9)

MUDSTONE:	mudstone dark grey; local siltstone laminae; zone 30 to 60 cm above base is highly fractured	32.4 - 29.8 m (2.6)
SILTSTONE WITH MUDSTONE:	mudstone silty; dark grey; overall finely laminated with small-scale cross-laminations; gradational contact with underlying unit	29.8 - 29.5 m (0.3)
SANDSTONE:	medium grained grading to fine grained in top 15 cm; cherty; slightly calcareous; scattered coal partings and lenses, including one with pyrite stringers; dark grey	29.5 - 28.4 m (1.1)
SILTSTONE TO MUDSTONE:	carbonaceous beds at 1.1 and 2.3 m above base; non-calcareous; dark grey; brecciated zones at 0.6 to 1.1 m and 1.8 to 2.0 m above base	28.4 - 23.6 m (4.8)
SANDSTONE:	very fine grained, varying locally from siltstone to sandstone; medium dark to dark grey; faintly and variably laminated; vague bioturbations	23.6 - 18.6 m (5.0)
SANDSTONE:	fine/medium grained; slightly calcareous; dark grey; thinly laminated with darker slightly finer grained laminae; possible medium-scale crosslaminations	18.6 - 17.6 m (1.0)
SANDSTONE AND SILTSTONE:	fine-grained sandstone and in lower part decreasing to siltstone and argillaceous siltstone upward; medium to dark grey; laminated with darker, finer grained laminae; minor fracturing	17.6 - 16.5 m (1.1)
SANDSTONE:	fine to medium grained; argillaceous siltstone bed with abundant coal lenticles 0.4 to 0.75 m above base; finer argillaceous to carbonaceous sandstone laminae throughout; local coal partings or lenses; sandstone slightly calcareous; sandstone dark grey with very dark grey laminae; argillaceous siltstone very dark grey; laminations in sandstone fine irregular to anastomosing	16.5 - 14.6 m (1.9)
SANDSTONE:	fine/medium grained; very slightly calcareous; medium/dark grey; local faint lamination, mainly parallel some cross; uniform texture throughout; gradational contact with underlying unit	14.6 - 8.0 m (6.6)
SANDSTONE:	medium grained; coal parting 1.5 m above base; very slightly calcareous; dark grey; faint local lamination; fairly uniform texture and lack of structure; local fine mud cracks	8.0 - 5.2 m (2.8)
SANDSTONE:	continuous with overlying unit; common coal partings	5.2 - 4.8 m (0.4)
COAL:		4.8 - 4.6 m (0.2)
MUDSTONE:	rare coal partings; non-calcareous; very dark grey; uniform texture and lack of structure; carbonaceous shear glaze 20 cm above base	4.6 - 0 0 m (4.6)
Note:	Roof of coal seam.	

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FIGURE 5
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STRATIGRAPHY OF THE ELK FORMATION IN THE FERNIE BASIN, SOUTHEAST BRITISH COLUMBIA

GEOLOGY BY D. A. GRIEVE AND N. C. OLLERENSHAW

LEGEND

- CONGLOMERATE
- SANDSTONE
- SILTSTONE
- MUDSTONE AND SHALE
- COAL
- CONGLOMERATIC
- COAL LENTICLES AND SEAMLETS
- H — HUMIC
- S — SAPROPELIC
- NEEDLES
- TROUGH CROSSBEDDING
- OTHER CROSSBEDDING: MEDIUM AND LARGE SCALE
- OTHER CROSSBEDDING: SMALL SCALE
- PLANT FOSSILS
- ROOTS
- BIOTURBATION
- BURROW
- SCOUR SURFACE
- MUD CRACKS
- RIP-UP CLASTS
- C — CARBONACEOUS
- CONCRETIONARY
- BRECCIATED (CORE)
- COVERED INTERVAL

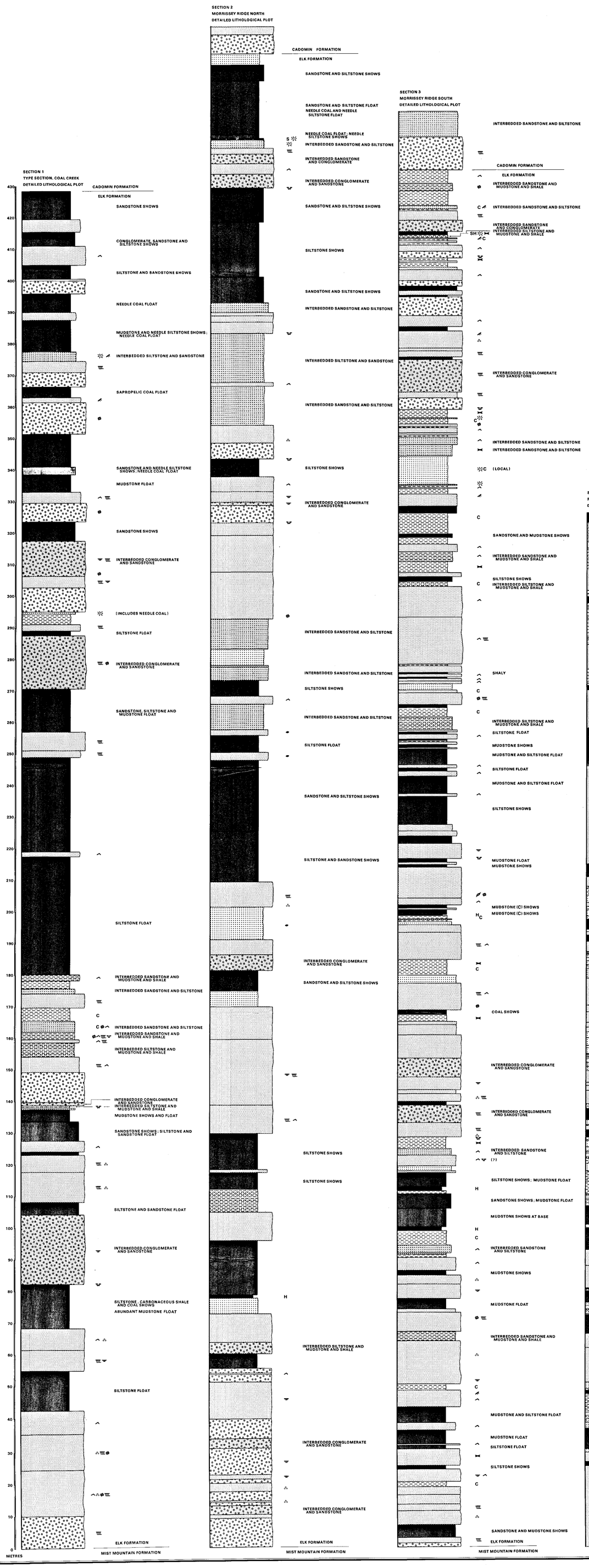

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FIGURE 7
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GENERALIZED DIAGRAM OF ALL STRATIGRAPHIC SECTIONS, PLOTTED IN GENERAL RELATIVE GEOGRAPHIC POSITION
N.T.S. 82G

LEGEND

- PREDOMINANTLY SILTSTONE OR FINER (INC. COAL)
- INTERBEDDED SANDSTONE AND SILTSTONE
- PREDOMINANTLY SANDSTONE
- INTERBEDDED CONGLOMERATE AND SANDSTONE ; CONGLOMERATIC SANDSTONE
- PREDOMINANTLY CONGLOMERATE

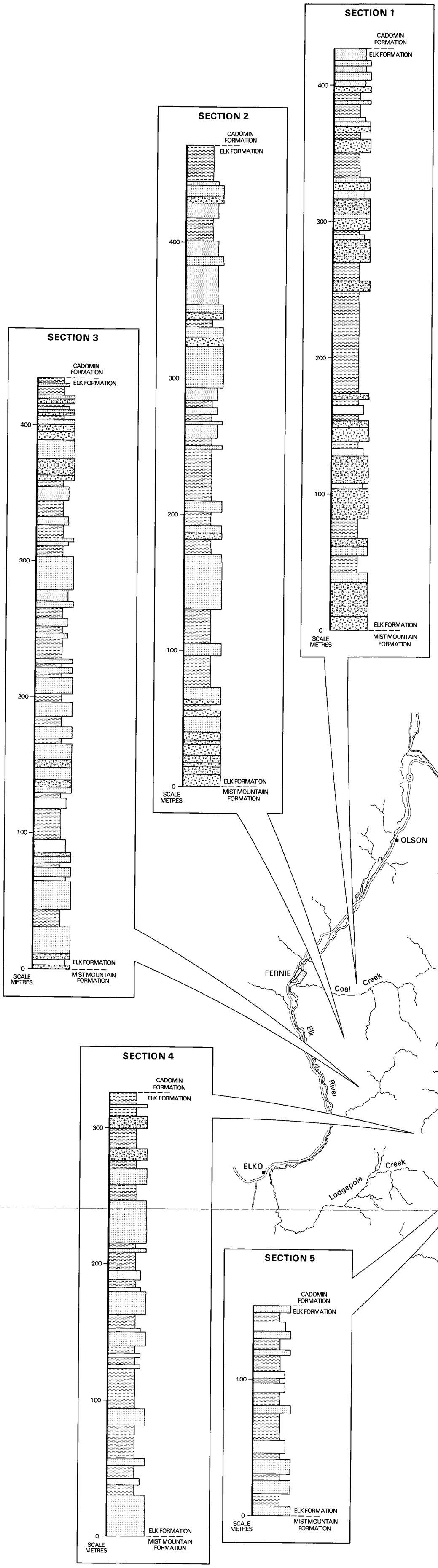

FIGURE 7
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