British Columbia Geological Survey
Geological Fieldwork 1985

GEOLOGY OF THE CARBON CREEK AREA (93O/15)

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INTRODUCTION

The Carbon Creek area is located 30 kilometres west of the W.A.C. Bennett Dam in northeastern British Columbia (Fig. 22-1). Fieldwork in 1985 was directed toward compilation of the geology of the east half of the map sheet and integrating it with 1984 work in the west (Legun, 1985b). The focus of 1985 work was the Carbon Creek syncline which contains more than 70 million tonnes of mineable coal. Previous work in the area includes that of Matthews (1947), Hughes (1964), Stott and Gibson (1980), Stott (1983), Legun (1983, 1984, 1985), Gibson (1985), and personnel of Utah Mines Ltd. and Gulf Canada Resources Inc (1980-1983 assessment reports). The area includes the Carbon Creek licences of Utah Mines Ltd. as well as the former licenses of West Carbon Creek (Utah Mines Ltd.) and Whiterabbit (Gulf Canada Resources Inc.).

Previous work has not adequately resolved the geology or the stratigraphy of the area; particularly areas bounding the two major coal-bearing synclines of Carbon Creek and West Carbon Creek. Figure 22-2 shows the geology based on a 1983 1:125 000 compilation map of NTS 93O by the Geological Survey of Canada (Open File 925). This can be compared to the first draft of a detailed compilation by the writer (Fig. 22-3).

METHOD OF STUDY

The writer, assisted alternately by Pat Desjardins, Paul Elkins, and Hugh Christie, spent 32 field days tracing and mapping geologic units on the periphery of the Carbon Creek syncline. Some work was also done in West Carbon Creek and outside the map-area to the east to solve specific problems of mapping and correlation. Air photographs were used to plot stations as well as to extrapolate geologic contacts between traverses. Fieldwork data was integrated with data from previous maps. In areas of poor exposure, outcrop pattern was predicted by the method of structure contours intersecting topography between two points where the attitude of the geologic contact is known.

Thickness of formations was calculated from air photographs. Scale and adjustments for change in scale with elevation were calculated using the centre areas of air photographs. Further corrections were made for slope and obliqueness to strike of ridges being traversed. Relevant formulas are found in Ragan (1985, p. 22) and Compton (1962, p. 84). Stratigraphic thickness data are presented in Table 22-1.

STRUCTURE

The structure of the map-area consists essentially of a pair of broad synclines separated by a box-like anticlinal structure (Fig. 22-3). This fold sequence is bounded by major faults. To the west the West Carbon Creek syncline is faulted against Triassic limestones on the Pardonet thrust. To the east Fernie shale on the east limb of the Carbon Creek syncline is faulted against Fort St. John Group shales on the Carbon thrust. Both major synclines tighten to the southeast with subsidiary folding and faulting. Both are doubly plunging forming a canoe shape modified by topography. Results of structural and stratigraphic mapping are best discussed in the context of a comparison of old and new maps (Figs. 22-2 and 22-3). The salient changes are as follows:

(1) Extension of Gething Formation coal measures from Carbon Creek to the Beattie Peaks area where they pinch out in a series of tight, faulted folds. The synclinal extension is broader than shown on the Geological Survey of Canada map and additional faults are present.

(2) More extensive distribution of the Bickford Formation in the area of Mount Monach (The Monach).

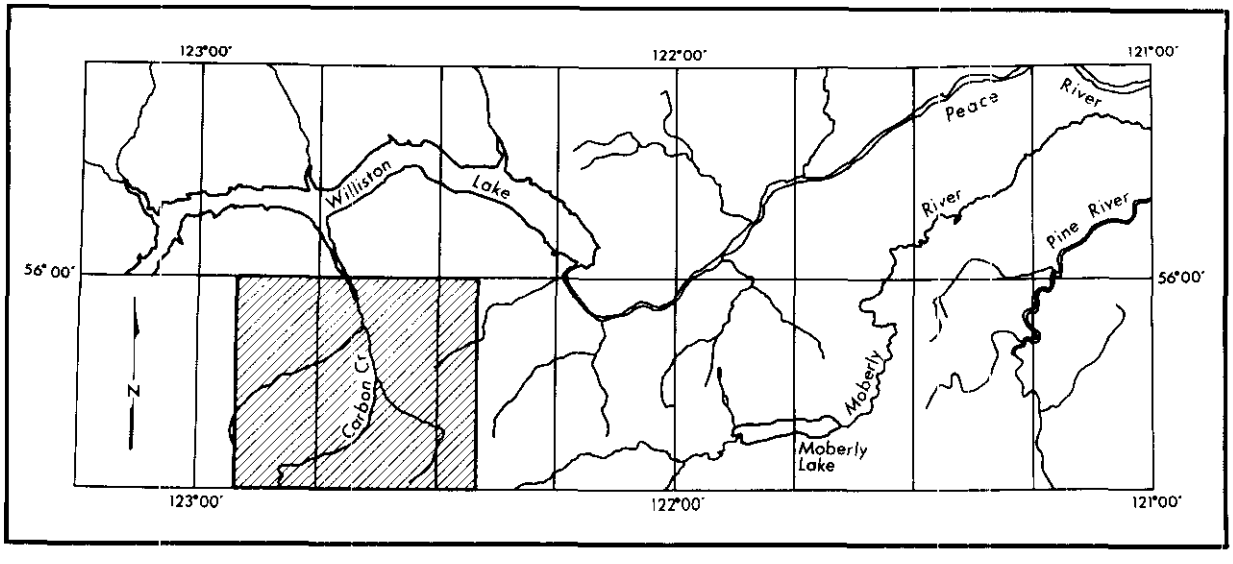

Figure 22-1. Location of the West Carbon Creek map-area.

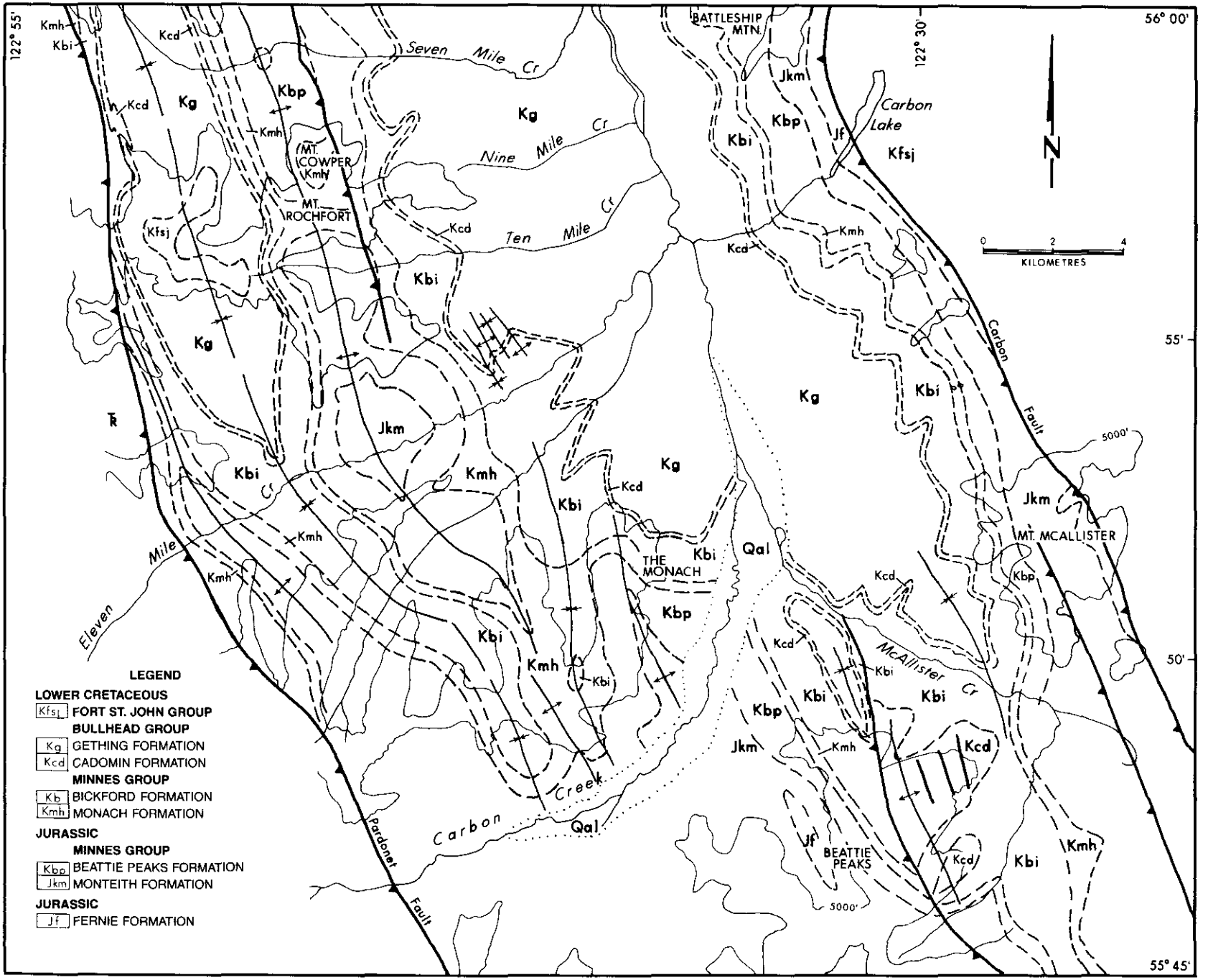

Figure 22-2. Geology of the Carbon Creek map-area (from Geological Survey of Canada Open File 925).

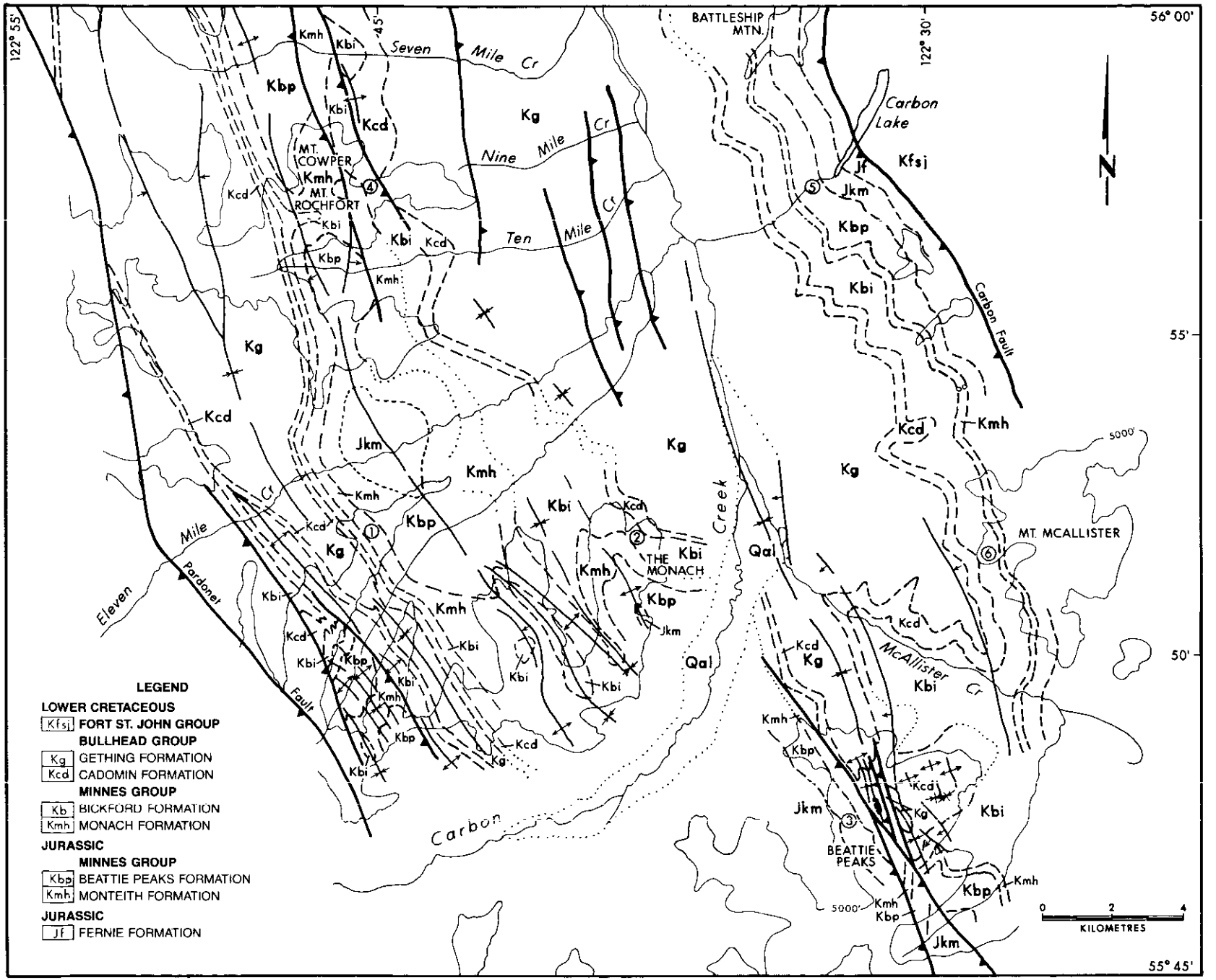

Figure 22-3. Preliminary compilation geology of the Carbon Creek map-area (93O/15).

TABLE 22-1. FORMATION THICKNESS DATA

(*See* Fig. 22-3 for locations.)

Area	Monteith Formation	Beattie Peaks Formation	Monach Formation	Bickford Formation	Cadomin Formation
	Metres	Metres	Metres	Metres	Metres
Ridge south of Mount Wrigley	—	400	442	148	268
Mount Monach	—	—	336	210	—
Beattie Peaks	564	394	—	—	—
Mount Rochfort	—	—	289	349	—
Carbon Lake	612	284	129	331	284
Mount McAllister	—	272	122	256	—
Mount Gething (Interpretation 1)	>626	>119	—	—	—
Mount Gething (Interpretation 2)	>446	90±	90±	>119	—

(3) A fault structure on the west limb of the Carbon Creek syncline near Mount Rochfort and Mount Cowper.
(4) A much greater southern extent of Gething coal measures in the West Carbon Creek syncline and a very different synclinal configuration.

MINNES GROUP

MONTEITH FORMATION

The Monteith Formation consists of two lithofacies:
(1) Clean arenites and quartz arenites that are massive to crossbedded.
(2) Clean to dirty arenites (quartz arenite to wacke) interbedded with siltstone and shale.

In the Carbon Creek area lithofacies (1) is dominant in the upper half of the Monteith and lithofacies (2) is common in the lower half of the Monteith. Shaly recessive intervals in the Monteith can be 50 or more metres thick. The base of the Monteith is transitional into shales of the Fernie Formation. The Monteith Formation is estimated to be 612 metres thick near Carbon Lake.

BEATTIE PEAKS FORMATION

The Beattie Peaks Formation is dominated by dark grey and brown shale with interbeds of siltstone and arenite. Arenite units are fissile and increase in thickness and number toward the top of the Formation. Burrowing is common and bedding surfaces are marked by trace fossils of unknown type. The lower contact of the Beattie Peaks shale with Monteith quartz arenites is sharp and unconformable, easily traced on air photographs. The upper contact with the Monach Formation is gradational. The thickness of the Beattie Peaks is calculated to be 392 metres at Beattie Peaks and 272 metres at Mount McAllister.

MONACH FORMATION

The Monach Formation is typified by units of flaggy, planar to shallow crossbedded arenites, massive arenite, and lesser quartz arenite. The units, which can be 10 metres or more thick, are separated by much thinner intervals of non-carbonaceous shale. Quartz arenites, which may be gritty, form local marker units. The Monach Formation forms the top of a coarsening upward sequence that begins in shales of the Beattie Peaks Formation. The contact between the two formations is arbitrarily placed where arenite units become prominent. Arenite units are thin toward the base of the formation and dominated by horizontal laminations. Units thicken up section and exhibit shallow-angle planar crossbedding, trough crossbedding, and uncommon hummocky cross-stratification. Some arenites show the peculiar feature of grading over a few decimetres into quartz arenite that forms either a cap on the unit or a lens within it.

The fossil bivalve *Buchia* is very common in some locales and less so in others. It may occur as discrete coquina 'beds' within the arenites or as dispersed single shells; the degree of shell fragmentation varies considerably from one bed to another. The thickness of the Monach Formation varies more than previously reported (Legun, 1985b). It is thick in the anticlinal area between Mount Cowper and Mount Monach, reaching 400 metres or more; in addition there is a thick transition zone from the Beattie Peaks Formation. Thickness trends west of the anticlinal structure are uncertain. However, to the east at Mount McAllister or Carbon Lake the Monach Formation is much thinner (120 metres); there is virtually no underlying transition zone and individual arenite units are thinner. The Monach Formation forms a thick, east-tapering lens in the Carbon Creek area.

BICKFORD FORMATION

The Bickford Formation is a sequence of interbedded arenites and shales. The arenites include salt and pepper lithic varieties as well as quartz arenites. The shales include carbonaceous shale, dark grey siltstones, and mudstones. Beds of grit and thin coals are present in some areas. Sedimentary structures include low-angle crossbedding in the arenites, flaser bedding in the shales, symmetric ripples, and vertical and U-shaped burrows *(Diplocriterion)*. Plant debris as well as root casts occur. These features indicate depositional environments ranging from marginal marine to marginal continental; marginal marine is more evident in the east, for example, near Carbon Lake.

The Bickford Formation shows a weak tendency to coarsen upward and thick arenites may directly underlie the Cadomin Formation. The contact with the Cadomin Formation is placed with the appearance of successive units of pebbly arenite, an increase in carbonaceous content, and the general disappearance of flaggy (low-angle crossbedded) and dark coloured lithic arenites. In some locales, such as the east flank of Mount Rochfort, one or more isolated pebbly arenite units, which may be channel deposits, occur below this defined contact; perhaps there is a gradational and continuous change in sedimentation between Bickford and Cadomin deposition. In other areas, for example the Carbon Creek road, the contact is sharp, and burrowed siltstone (marine) and quartz arenite are in contact with pebbly arenite full of log casts (alluvial channel).

The lower contact of the Bickford Formation is placed where interbedded arenite and shale pass into thick successive units of arenite of the Monach Formation with a loss of carbonaceous content. This change can be abrupt or gradual. Where flaggy arenites of the Bickford are exposed and shaly recessive units are covered it is particularly difficult to distinguish the Monach from the Bickford. Careful tracing on air photographs of the lower contact of the Bickford suggests that the lower contact is at the top of different

arenite units from place to place, therefore, Bickford lithologies pass laterally into Monach arenites. As a result calculated thickness for the Bickford is variable. In this context the thickest section of Bickford Formation is found at Mount Rochfort (349 metres); both upper and lower contacts are gradational.

BULLHEAD GROUP

CADOMIN FORMATION

The Cadomin Formation is characterized by up to 10-metre-thick arenite to pebbly arenite units separated by thinner recessive intervals that include siltstone, carbonaceous shale, fine-grained arenite, and coal. The proportion of resistant pebbly arenite units to recessive intervals varies laterally and vertically within the formation. This results in prominent ribbed ridges in some areas and subdued topography in others. On the west side of Mount Wrigley, a lateral facies change occurs and pebbly arenites of the Cadomin pass laterally into coal measures which, lithologically, are basal Gething Formation. The Cadomin Formation thus thins between Mount Wrigley and Mount Rochfort. The impression from mapping throughout the region is that the Cadomin is not a thick continuous sheet deposit but consists of lenticular 'leaves' that are vertically stacked to overlapping. Observed lateral variation in number of 'leaves' suggests that they represent a series of coalescing fluvial fans with preservation of some interfan areas.

Generally, as a geologic unit, the Cadomin Formation maintains a thickness of 200 to 275 metres in the map-area. This value is rather artificial in the west where upper and lower contacts are gradational.

GETHING FORMATION

The Gething Formation is a coal measure sequence consisting of interbedded arenite, siltstone, mudstone, carbonaceous shale, and coal. Some beds are calcareous or ferruginous. In the Carbon Creek syncline over 100 diamond-drill holes (ddh) and a number of rotary drill holes (rdh) have been drilled by Utah Mines Ltd. in the Gething Formation. Only two penetrated the underlying Cadomin Formation (ddh 75-41, ddh 72-17). Correlation of holes indicates a total Gething thickness of 1 067 metres. There are more than 100 coal seams in this stratigraphic interval; most are lenticular and thin. Less than 10 seams are of economic interest and their individual average thicknesses do not exceed 2 metres. The thickest intersection is 3.5 metres (ddh 71-8). The coals in the Gething Formation are concentrated in the upper half of the stratigraphic interval, particularly the top 200 metres. They range from medium volatile to high volatile bituminous A in rank.

The thickness of the Gething in West Carbon Creek area is comparable to that in the Carbon Creek syncline. Only eight holes have been drilled by Utah Mines Ltd. and no correlation with Carbon Creek coals has been attempted. Seams are even more numerous in West Carbon Creek, but thinner. Utah Mines Ltd.'s thickest coal intersection was 1.8 metres; however, Gulf Canada Resources Inc. trenched a 3-metre seam in the south half of the syncline.

It may be possible to correlate the Gething section at Carbon Creek with that of the Acam property (formerly held by Crows Nest Resources Ltd.) east of the fault. A thick sandstone unit (40 metres) found in both properties may be equivalent (Fig. 22-4). On the Adam property the top of this sandstone is 150 metres below the Moosebar in rdh 79-5, while at Carbon Creek it is 105 metres below the top of the exposed Gething in ddh 81-88. These data suggest that the top of ddh 81-88 is near the Moosebar-Gething contact (Fig. 22-4).

Gibson (1985) argues that strata of the Gething Formation in the Carbon Creek coal basin were deposited in two major deltaic environments; the lower half of the Gething has characteristics of an upper delta plain; the upper half has characteristics of a lower delta plain. Work by Kilby and Oppelt (1985) on volcanic ash bands (tonsteins and bentonites) just east of the study area suggests that coal measure sedimentation continued in the Carbon Creek area at the same time as the Moosebar sea was transgressing in the east.

Utah Mines Ltd. defined three reserve areas on east-facing slopes on the west limb of the Carbon Creek syncline. These lie north of Seven Mile, Ten Mile, and Eleven Mile Creeks respectively (Fig. 22-3). Total mineable reserves are on the order of 70 million tonnes which can be mined by a combination of underground and open-pit methods.

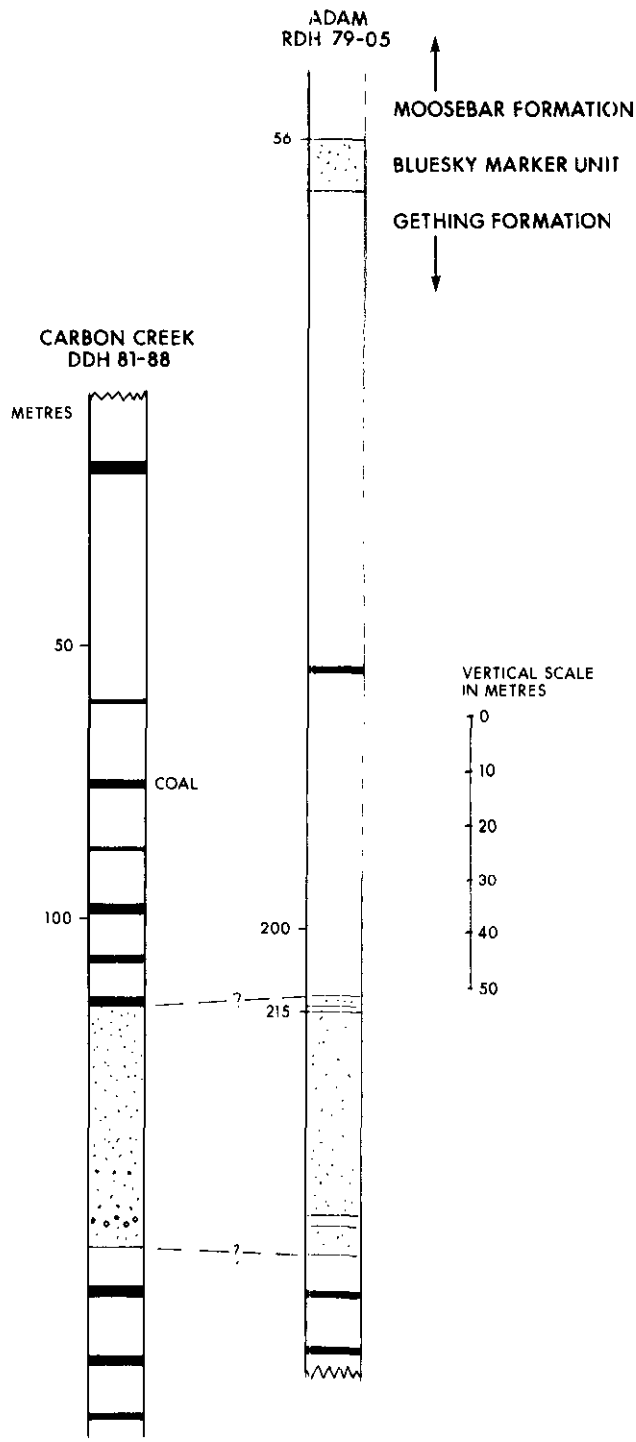

Figure 22-4. Correlation of the Gething Formation.

DISCUSSION OF REGIONAL STRATIGRAPHY

The thickness between the top of the Monteith Formation and base of the Cadomin Formation decreases from more than 1 200 metres in the West Carbon Creek area to 774 metres at Carbon Lake to 650 metres at Mount McAllister on the eastern edge of the map-area (Table 22-1). This appears to be largely due to thinning of the Beattie Peaks and Monach Formations. East of the Carbon fault at South Mount Gething the interval has apparently shrunk to 224 metres with the disappearance of the Bickford Formation. This drastic thinning of the Bickford Formation occurs over a few kilometres and is based on designation of 600 metres of strata below as Monteith Formation by Utah Mines Ltd. (South Mount Gething 1982 assessment report) and Legun (1985a). This thickness of the Monteith Formation is virtually the same as that at Carbon Lake. It is possible that this interval actually comprises the Monteith, Beattie Peaks, and Monach Formation; if this is true, then the overlying unit — mapped as Beattie Peaks — is actually the Bickford Formation; the problem is deciding which shale interval represents the Beattie Peaks. Is it the shale mapped as a recessive internal in Monteith Formation quartzites or the shale that overlies these quartzites? If it is the latter, then east of the Carbon fault the Bickford was probably eroded prior to deposition of the Cadomin Formation. If it is the former, then the Bickford Formation is preserved east of the Carbon fault and some changes are required to Stott's concept of a regional unconformity at the base of the Cadomin and to the interpretations on the preliminary map of the Butler Ridge area (Legun, 1985a). Though not conclusive the stratigraphic position of the bivalve *Buchia inflata* sp. in a measured section at Mount Gething (Petroleum Resources Division, Assessment Report 1870) suggests that the overlying shales are Bickford Formation and that the Beattie Peaks shale is a recessive unit within Monteith quartzites (Table 22-1).

CONCLUSIONS

The geology of the Carbon Creek map sheet is different in detail from that shown on previous maps, particularly in the southern extension of Gething Coal measures in West Carbon Creek and at Beattie Peaks. The maximum thickness of Gething Formation in the Carbon Creek and West Carbon Creek synclines is approximately the same at about 1 100 metres; coal seams are numerous but thin in both synclines. Based on a thick sandstone unit, correlation of Carbon Creek coals with those on the Adam property east of the Carbon fault may be possible. A correlation between Carbon Creek and West Carbon Creek coals has yet to be attempted. The Gething Formation thins eastward to Peace River Canyon where only 550 metres are recognized.

In the study area the Minnes Group consists of two upward-coarsening cycles between the Monteith and Cadomin Formations; the first cycle is more prominent than the second. The first cycle begins with marine shales of the Beattie Peaks and ends with nearshore arenites of the Monach Formation; the second starts with marginal marine arenites and shales of the Bickford Formation and ends with coarse alluvial arenites of the Cadomin Formation.

Formations of the Minnes Group thin eastward. The Monach forms a thick lens in the Carbon Creek area and its upper contact with the Bickford varies in stratigraphic position.

East of the Carbon fault Minnes Group stratigraphy is unresolved in spite of previous work; uncertainty has arisen as to which of two shale intervals correspond to the Beattie Peaks. If it is the upper shale then Bickford has probably been eroded east of the fault. If it is the lower, then the Bickford is preserved and the stratigraphy of Stott (1981) and Legun (1985a) east of the Carbon fault requires revision. Critical sections of the Minnes Group at South Mount Gething and Mount Gething will be re-examined during the 1986 field season.

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REFERENCES

Compton, R. R. (1962): Manual of Field Geology, *John Wiley & Sons, Inc.*, 378 pp.

Cowley, P. S. (1981): Report of Exploration Activities on the South Mount Gething Property, *Utah Mines Ltd.*, unpubl. report.

——— (1981-1983): Report of Exploration Activities on the West Carbon Creek Property, *Utah Mines Ltd.*, unpubl. report.

Gibson, D. W. (1985): Stratigraphy and Sedimentology of the Lower Cretaceous Gething Formation, Carbon Creek Coal Basin, Northeastern British Columbia, *Geol. Surv., Canada*, Paper 80-12, 27 pp.

Gulf Canada Resources Inc., Goodrich Coal Project Geological Reports, 1981-1983.

Hughes, J. E. (1964): Jurassic and Cretaceous Strata of the Bullhead Succession in the Peace and Pine River Foothills, *B.C. Ministry of Energy, Mines & Pet Res.*, Bull. 51, 73 pp.

Kilby, W. E. and Oppelt, H. P. (1985): Numerical Depositional Modelling — Gething Formation along the Peace River (93O, 94A, 94B), *B.C. Ministry of Energy, Mines & Pet. Res.*, Geological Fieldwork, 1984, Paper 1985-1, pp. 233-250.

Legun, A. (1983): Stratigraphy and Sedimentology Notes on the Bullhead Mountain-Peace River Canyon, Carbon Creek Area, Northeastern British Columbia (93O/15, 16; 94B/1, 2), *B.C. Ministry of Energy, Mines & Pet. Res.*, Geological Fieldwork, 1982, Paper 1983-1, pp. 93-98.

——— (1984): Butler Ridge Map-area (94B/1), *B.C. Ministry of Energy, Mines & Pet. Res.*, Geological Fieldwork, 1983, Paper 1984-1, pp. 123-130.

——— (1985a): Preliminary Map 57 with Accompanying Notes, Geology of the Butler Ridge Area, NTS 94B/1, *B.C. Ministry of Energy, Mines & Pet. Res.*, 13 pp.

——— (1985b): Geology of the West Carbon Creek Area (93O/15), *B.C. Ministry of Energy, Mines & Pet. Res.*, Geological Fieldwork, 1984, Paper 1985-1, pp. 227-232.

Matthews, W. H. (1947): Geology and Coal Resources of the Carbon Creek-Mount Bickford Map-area, *B.C. Ministry of Energy, Mines & Pet. Res.*, Bull. 24.

Stott, D. F. (1981): Bickford and Gorman Creek, Two New Formations of the Jurassic-Cretaceous Minnes Group, Alberta and British Columbia, *in* Current Research, Part B, *Geol. Surv., Canada*, Paper 81-1B, pp. 1-9.

——— (1983): Mackenzie Map-area, British Columbia, *Geol. Surv., Canada*, Open File 925.

Stott, D. F. and Gibson, D. W. (1980): Minnes Coal, Northeastern British Columbia, *in* Current Research, Part C, *Geol. Surv., Canada*, Paper 80-1C, pp. 137-137.

Ragan, D. M. (1985): Structural Geology, An Introduction to Geometrical Techniques, Third Edition, *John Wiley & Sons, Inc.*, 393 pp.

V. Zay Smith Associates Ltd. and Veezay Geodata Ltd. (Calgary) (1974): Geological Report on the Peace River Area, *Ministry of Energy, Mines & Pet. Res.*, Petroleum Resources Division Assessment Report 1870.