PEACE RIVER COALFIELD DIGITAL MAPPING PROGRAM (93O/8, 15)

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KEYWORDS: Coal geology, Peace River coalfield, Le Moray Creek, Carbon Creek, stratigraphy, coal rank, structural geology, GIS, computer-aided mapping, coalbed methane.

INTRODUCTION

This project continued the 1:50 000-scale digital mapping and compilation program in the Peace River coalfield of northeastern British Columbia.The area mapped in this ongoing study reflects a continuing interest in the coal-bearing strata and structural relationships found in the Rocky Mountain Foothills. The regional northwest structural trends have necessitated the inclusion of half-map sheets for completeness. The areas mapped this year are located to the west and north of the map sheets completed in previous years (Figure 4-7-1). Two crews, each consisting of a geologist and an assistant, completed the mapping. Peter Jahans and Kevin Yakiwchuk mapped sheets 93P/12 and 93O/9 (Jahans, 1992, this volume). This article will deal with the work done by the authors on the Le Moray Creek (93O/8) and the Carbon Creek map sheets (93O/15).

The goal of the digital mapping and compilation project is to produce geology maps and databases in digital format. This will allow distribution of the computer files containing maps with the edited and refined data, as well as all the original raw data used in drawing the maps. Users will have the option of examining and manipulating the data.

An important aim of this year's study was to integrate the use of geographic information systems (GIS), in this case QUIKMap®, into the field mapping program. The data gathered in the field were combined with information compiled from previous Open File publications, coal assessment reports and petroleum borehole data, into a computer database. This database will be used in conjunction with QUIKMap software and TRIM© base-map data to generate computer-drafted geology maps. The maps will be released

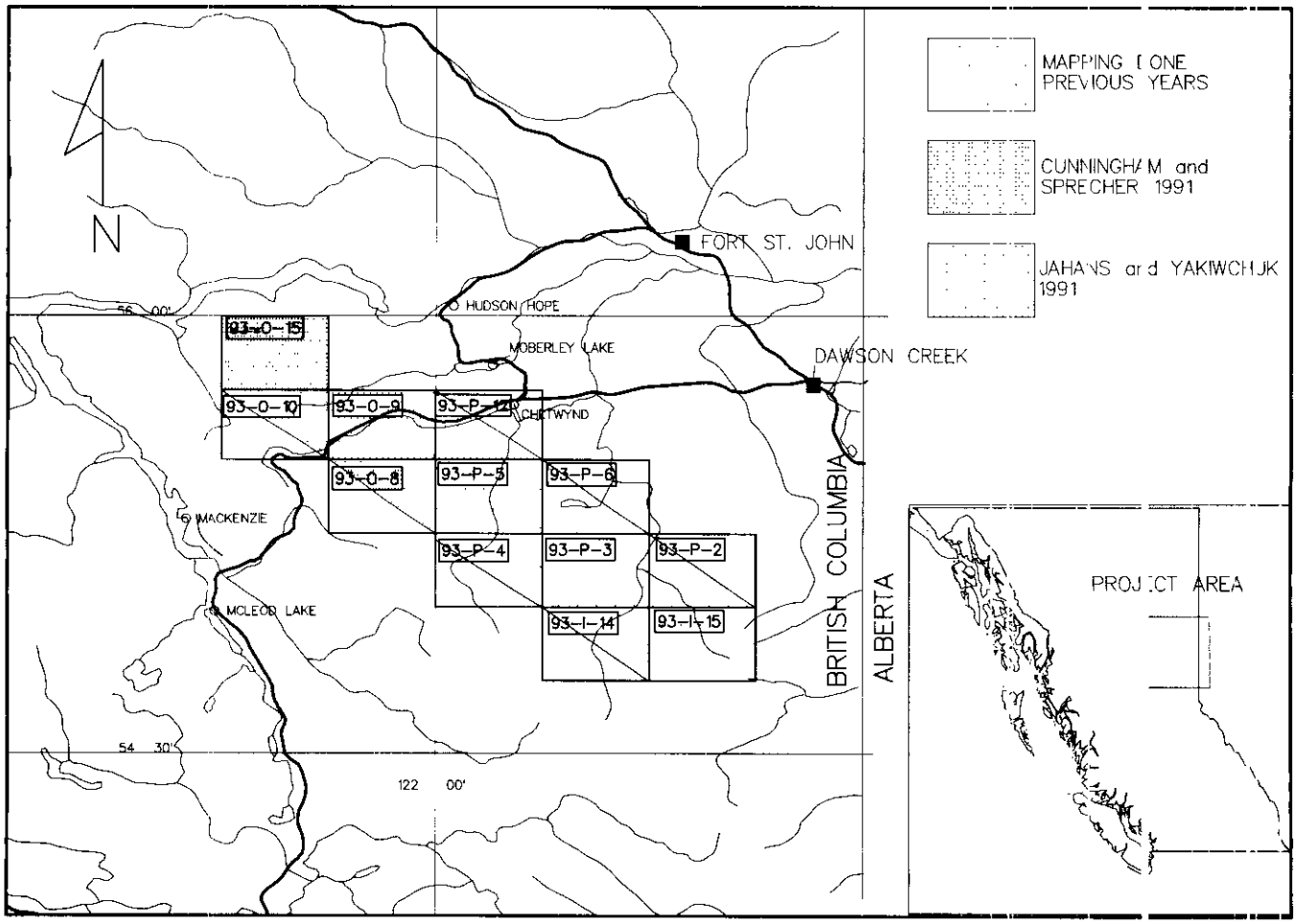


Figure 4-7-1. Location map showing the areas mapped as part of this year's study. Areas mapped in the previous years are also indicated.

SERIES	GROUP	MAP CODE	FORMATION	THICK (M)	LITHOLOGY
UPPER CRETACEOUS	FORT ST. JOHN	uKCR	CRUISER	150	Dark grey marine shale with sideritic concretions; some sandstone.
LOWER CRETACEOUS	FORT ST. JOHN	K GO	GOODRICH	150	Fine-grained, crossbedded sandstone; shale and mudstone.
	FORT ST. JOHN	K HA	HASLER	300	Silty dark grey marine shale with sideritic concretions; siltstone in lower part.
	FORT ST. JOHN	K BC	BOULDER CREEK	120	Fine-grained, well-sorted sandstone; massive conglomerate; nonmarine sandstone and mudstone and coal.
	FORT ST. JOHN	K H	HULCROSS	100	Dark grey marine shale with sideritic concretions.
	FORT ST. JOHN	K G	GATES	130	Fine-grained, marine and nonmarine sandstones; conglomerate; coal; shale and sandstone.
	FORT ST. JOHN	K M	MOOSEBAR	130	Dark grey marine shale with sideritic concretions; glauconitic sandstone and pebbles at base.
	BULLHEAD	K GE	GETHING	1000	Fine to coarse-grained, brown, calcareous carbonaceous sandstone; coal; carbonaceous shale, and conglomerate.
	BULLHEAD	K CD	CADOMIN	200	Massive conglomerate containing chert and quartzite pebbles and sandstone.
	MINNES	K BI	BICKFORD	200	Sandstone; fine-grained and silty shale, carbonaceous in part; coal.
	MINNES	K MC	MONACH	120	Fine grained argillaceous sandstones; massive fine to coarse-grained quartzose sandstones and quartzites.
	MINNES	K BP	BEATTIE PEAKS	290	Interbedded fine-grained sandstone and silty shales.
	MINNES	JKMT	MONTEITH	320	Fine-grained sandstones; white, fine to coarse-grained quartzose sandstones.
JURASSIC		J F	FERNIE	200	Calcareous and phosphatic shales; rusty weathering shales; glauconitic siltstone; sideritic shales; and in upper part thinly interbedded sandstone, shale, and siltstone.
TRIASSIC		TRS	(UNDIVIDED)	600	Limestone; dolomite; calcareous siltstone and sandstones; some anhydrite.

Table 4-7-1. Stratigraphic Table. Formation thicknesses given are average.

in 1992 as Open File map sheets 93O/15, 93O/9 and half-map sheets 93O/8, 93P/12 and 93O/10.

LOCATION AND ACCESS

The areas mapped on the Carbon Creek and the Le Moray sheets covered approximately 1300 square kilometres in the Rocky Mountain Foothills of northeastern British Columbia. Elevations in the region range from 700 to 2000 metres, with treeline at 1500 to 1600 metres. Vegetation varies from mature stands of pine and spruce to alpine tundra at the higher elevations.

The town of Chetwynd provided a convenient base for the study. The Le Moray Creek map area to the west of Chetwynd was reached by the John Hart Highway (No. 97), and the Carbon Creek map area to the north by Highway 29. In both areas a network of gravel roads, logging roads and old well-roads provides local access using a four-wheel-drive truck. Mountain bikes were used where roads were impassable by truck. Most of the cut lines, seismic lines, creeks and streams could be traversed only on foot.

This was the first year that mountain bikes were used on this project. They proved durable enough to handle the rough terrain and negotiating washouts and deadfalls was easier than with motorized bikes. Mountain bikes appear to be a viable alternative to the use of small four-wheel-drive all-terrain vehicles and motorcycles and they require minimum maintenance, no fuel and have a low impact on the environment.

STRATIGRAPHY

Strata ranging in age from Early Cretaceous to Jurassic are exposed in the map area. Progressively older formations are exposed southwestward. The succession includes both marine and nonmarine sediments of the Fort St. John, Bullhead and upper Minnes groups. These overlie the older, predominantly marine sediments found in the rest of the Minnes Group and the Fernie Formation. Triassic carbonate rocks of the Rocky Mountain Front Ranges are exposed in the southwest half of the Le Moray Creek map area and along the western edge of the Carbon Creek map area. The formations found in the region are summarized in Table 4-7-1.

Previous Work

The stratigraphic nomenclature used for the study area is that of the Geological Survey of Canada and is derived from the work of D.F. Stott (1967, 1968, 1973, 1982). This nomenclature is used to maintain continuity with previous years' mapping on this project (Hunter and Cunningham, 1991a, b; Kilby and Johnston, 1988a, b, c; Kilby and Hunter, 1990; Hunter, 1990; Kilby and Wrightson, 1987a, b, c). Detailed descriptions of the stratigraphy are provided by Stott (1967, 1968, 1973, 1982) and Hughes (1964, 1967). The stratigraphy of the Bullhead Group and younger strata in the area has also been described by Kilby and Wrightson (1987a, b, c), Kilby and Johnston (1988a, b, c) as well as Hunter and Cunningham (1991a). Descriptions of the Gething Formation in the Carbon Creek region can be found in Gibson (1985).

Previous mapping in the Carbon Creek area includes work by Legun (1987, 1988). This mapping covered much of the map sheet, so work in the Carbon Creek area concentrated on areas in the south and west, where new road access provides additional information that was not available to previous workers. Detailed descriptions of the Minnes and Bullhead Groups found in the area are provided by Legun (1987, 1988, 1989).

Because previous descriptions of the stratigraphy are quite extensive, only a brief description which highlights the variations in the study area will be provided here.

Fernie Formation

The Jurassic Fernie Formation consists predominantly of dark grey to black marine shales. The upper 25 to 50 metres is composed of interbedded sandstones, siltstones and shales, is more resistant, and is more readily preserved in roadcut outcrops than the rubbly, recessive marine shales below.

Minnes Group

MONTEITH FORMATION

The Monteith Formation is Jurassic to Early Cretaceous in age. It consists of very resistant, massive, clean, fine to medium-grained marine sandstones and quartzites with minor shales and argillaceous sandstones. It forms resistant ridges throughout most of the map area.

BEATTIE PEAKS FORMATION

The Early Cretaceous Beattie Peaks Formation comprises thinly bedded, fine-grained sandstones, siltstones and silty shales. In the Le Moray Creek area it is typically recessive. To the north, in the Carbon Creek map area, the formation consists of cleaner sandstones and quartzites and becomes less recessive.

MONACH FORMATION

The Monach Formation is Early Cretaceous in age and consists of resistant, medium to coarse-grained, clean sandstones and quartzites with minor shale. It forms resistant ridges through much of the map area. In the south, in the Le Moray Creek map area, the upper contact of the Monach is often marked by a white, coarse-grained quartzite.

STRATIGRAPHIC VARIATIONS IN THE LOWER PART OF THE MINNES GROUP

The Monteith and Monach formations often appear very similar in outcrop and sometimes can only be distinguished on the basis of stratigraphic position. Hughes (1967) suggests that the Monach, Beattie Peaks and Monteith not be separated into formations in the western part of the Pine Valley, where there are no thick quartzites to mark the top of the Monach or Monteith, and there is an increasing amount of sandstone in the Beattie Peaks Formation. To some extent, this is apparent in the western half of the Carbon Creek area. Here, it becomes increasingly difficult to distinguish between the three formations, although the Beattie Peaks sandstone beds tend to be more thinly bedded than those found in the Monach or Monteith formations.

BICKFORD FORMATION

The Early Cretaceous Bickford Formation, defined by Stott, consists of fine to medium-grained, brown laminated sandstones interbedded with dark grey shales and silty shales. It is sometimes carbonaceous, with some thin coal seams. In the Le Moray Creek map area, the unit contains numerous coal seams varying from a few centimetres to over a metre thick; woody imprints and fossils are also found. In the Carbon Creek area there is much less coal but some woody fossils and imprints are present. The unit is similar to the Gething Formation, and to the Brenot Formation described by Hughes (1964, 1967). The criteria used by Hughes to define and describe the Brenot Formation may be more suitable for mapping this unit in the Le Moray Creek area.

Bullhead Group

CADOMIN FORMATION

The Cadomin Formation is a resistant conglomerate unit of Early Cretaceous age and consisting predominantly of beds of well-rounded chert-pebble conglomerate, very coarse grained cherty sandstones and grits, together with recessive beds of carbonaceous mudstone, fine-grained sandstone and thin coal seams.

In the Carbon Creek map area, the prominent conglomeratic units of the Cadomin, observed in the Le Moray Creek area to the south, are no longer present. Here the

Cadomin generally consists of thick-bedded, medium to coarse-grained resistant sandstones and gritty to pebbly sandstones, carbonaceous shales, dark grey shales, some grits and minor coal. This unit is similar to the description of the Dresser Formation defined by Hughes (1964). The criteria used to define the Dresser Formation may be more suitable for mapping the unit in this area.

GETHING FORMATION

The Early Cretaceous Gething Formation comprises interbedded fine to medium-grained brown sandstones, dark grey shales, mudstones and siltstones, with carbonaceous shales and coal. It also contains conglomerates and grits. Carbonaceous material, woody fossils and imprints, and leaf fossils and imprints, are locally abundant and are generally found in argillaceous sandstones and sandy siltstones. Coal seams are generally about 1 to 1.5 metres thick, but reach up to 3 metres thick.

STRATIGRAPHIC VARIATIONS IN THE BICKFORD FORMATION AND BULLHEAD GROUP

Hughes (1967) suggests that in the western foothills, especially west of Mount Bickford in the Pine Valley, it becomes difficult and impractical to divide the Gething, Cadomin and Bickford formations. Although the lithological criteria that define the formations in the Le Moray Creek area do not always suffice in the Carbon Creek area, it is possible to separate these units into mappable formations by recognizing the variations in lithology that are present.

The presence of grits and conglomerates in the Gething, together with a decrease in distinct coarse-grained units in the Cadomin, can make it difficult to distinguish between these two units in the Carbon Creek area. Here, the Cadomin can be very similar in appearance to the lower part of the Gething. The contact is marked by some thick, coarse-grained sandstone and pebbly sandstone units near the top of the Cadomin. Conglomerate is found in the upper Gething (Gibson, 1985).

The Bickford Formation is more recessive with less coal than to the south in the Le Moray Creek area. There is a greater proportion of thick sandstones in the Cadomin and it is still more prominent than the Bickford in this area.

Fort St. John Group

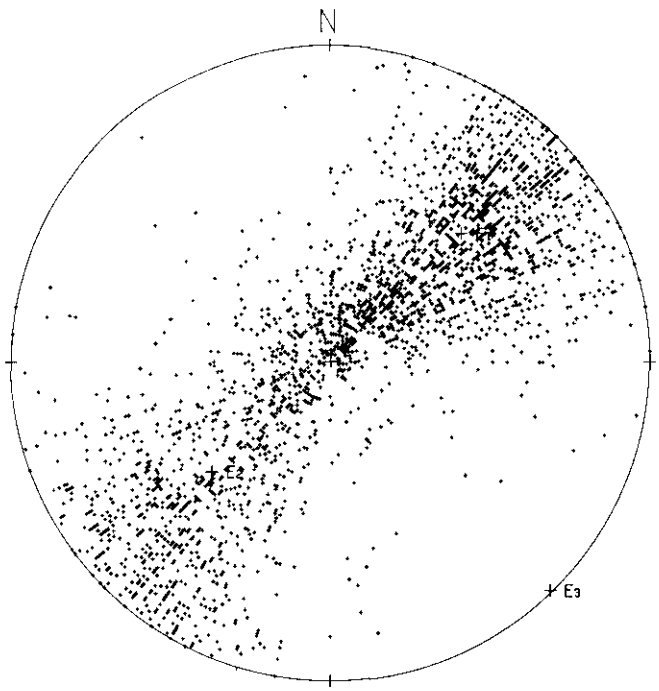
Strata of the Fort St. John Group are exposed only in the northeast corner of the Carbon Creek map area. The Moosebar and Gates formations form most of the outcrops exposed along roadcuts and creeks. No coal or carbonaceous sediments were found in the Gates. The Boulder Creek Formation lacks the massive conglomeratic units seen in the prominent ridges to the south in previous years' mapping. Near the Peace River it consists mostly of sandstone and shale (Stott, 1982).

STRUCTURE

The northwesterly structural trend found in the Rocky Mountain thrust and fold belt is reflected in the study area. Traces of fold axes and faults on the map follow this regional trend.

Most of the areas mapped this summer are within the inner foothills, and the style of structural deformation reflects this. The broad, gentle folds and box folds observed in previous years to be fairly typical of the outer foothills deformational style are not common here. The folding is tighter, with more steeply dipping limbs; it is often associated with the thrust faulting that can be traced at surface. Fold axes trends are very shallow. Eigen vector analysis of all the outcrop orientations was completed using TRIPOD®, an interactive structural analysis package for use on microcomputers, indicating a regional fold axis with a trend of 136° and a very gentle plunge of only about 1° Figure 4-7-2). Fold axes may undulate in gentle waves with wavelengths of several kilometres as plunges change from southwest to northeast and back again, along an axial trace. Initial analysis suggests that the folding is cylindrical in domains limited in scale to several square kilometres.

The Carbon Creek area is dominated by two major synclines that can be traced over much of the map area. The Carbon Creek syncline in the east and the West Carbon Creek syncline in the west, expose significant coal seams in



EQUAL AREA SCATTER PLOT
PI DIAGRAM

NUMBER OF OUTCROPS = 3027

TREND	PLUNGE	EIGENVALUE/3027
45.4	42.0	0.5773
227.0	48.0	0.3765
136.1	0.8	0.0462

Figure 4-7-2. Pi diagram showing poles to bedding for all outcrops in the Carbon Creek - Le Moray Creek database. Distribution of poles and eigen-vector analysis indicate a regional fold axis with trend 136° and 1° plunge.

the Gething Formation. In the Le Moray Creek map area the Goodrich synclinorium exposes coal-bearing Gething in the north-central part of the area and Brenot on the southeast.

Linear fault traces that crosscut topographical contours indicate most faults are steeply dipping. Most of these faults are west-dipping thrusts. The Pardonet fault, along the western edge of the Carbon Creek area, is a the major thrust fault in the region and marks the boundary of the Rocky Mountain Foothills to the east and the Rocky Mountain Main Ranges to the west. Triassic carbonates have been uplifted and exposed in the hangingwall to overlie Lower Cretaceous and Jurassic rocks. The Carbon thrust, east of Carbon Creek, brings Minnes Group and Fernie Formation strata into contact with rocks of the Fort St. John Group. East-dipping thrust faults have been mapped in the north-central Carbon creek area by Legun (1987, 1988). The only major normal fault is the Burnt normal fault in the Le Moray Creek map area.

DATA COMPILATION AND COMPUTER-AIDED GEOLOGIC MAPPING

The data compiled from coal assessment reports (exploration maps, coal boreholes, exploration reports) in COALFILE©, as well as oil and gas drill-hole data obtained through the Petroleum Branch, were entered into a computer database. Formation boundaries and structural traces were also digitized from several coal assessment report maps using QUIKMap so that geological traces could be displayed in conjunction with outcrop data. QUIKMap provided a convenient means to combine, organize, edit and display large quantities of data. The database compiled for the Carbon Creek and Le Moray map areas currently contains over 3700 outcrops and 369 drill holes, including the outcrop data gathered from traverses during this summer's field season (Figures 4-7-3 and 4). TRIM data (produced by the Ministry of Environment, Lands and Parks) provide a digital base-map, including contour, cadastral, drainage and cultural information.

A computer brought into the field was used to combine the compiled data and the TRIM topographic data to plot base-maps used with 1:20 000-scale airphotos for mapping. Outcrop data collected in the field was periodically added to the outcrop database. Using the compiled data and the field data in conjunction with QUIKMap made the microcomputer an on-site, interactive tool integrated into the field mapping process, as opposed to merely an electronic file cabinet for geological data.

The database will continue to be updated until the Open File maps are produced. Eventually the data files and the geology map QUIKMap files produced for the study area will also be made available for distribution. Much of the raw, unedited data that cannot be displayed on the final printed map will also be made available. With the outcrop data, borehole picks, and formation and structural traces stored in digital form, more detailed structural analysis can be carried out using computers.

Geographic information systems software like QUIKMap will make it possible to produce a complete geological compilation map by combining and assessing all the information in the database prior to the field season. Such a compilation map would provide a geological base map that would highlight those areas needing further investigation. This would maximize the use of the time available during a short field season, leading to increased productivity. By incorporating the new information gathered each day with the compilation base map, it is now possible to produce a first-draft geology map on the computer while still in the field (Figure 4-7-5).

ECONOMIC GEOLOGY

The only producing coal mines in the Peace River coalfield are at Bullmoose and Quintette, to the south of the areas mapped this summer. The two operations are mining the coal measures of the Gates Formation although the Gething Formation has also attracted exploration attention.

Previous Exploration

CARBON CREEK AREA

The region mapped this year includes several properties that have been explored for their coal potential. Utah Mines Ltd. acquiried the Carbon Creek property in 1971, and the West Carbon Creek property in 1978. The two properties covered the West Carbon Creek and Carbon Creek synclines in the north half of the Carbon Creek map sheet between the Pardonet fault in the west and the Carbon fault in the east. Exploration continued until 1982 and included mapping, trenching and drilling programs. In 1980, Gulf Canada Resources Ltd. acquired the Whiterabbit block, which included the south end of the West Carbon Creek syncline extending across Carbon Creek. Gulf surrendered the coal leases for the Whiterabbit block in 1982.

The primary exploration targets were the coal seams found in the Gething Formation that is exposed in the core of both Carbon Creek synclines.

LE MORAY CREEK AREA

Gulf Canada Resources acquired the Goodrich property in 1979. It covered most of the Le Moray Creek map sheet east of the Le Moray Creek valley and was the target of extensive mapping, trenching and drilling programs. In 1982, a test adit was driven into a Gething coal seam in the Lossan mine area, north of Brazion Creek. Coal seams in the Bickford Formation (the uppermost formation of the Minnes has been mapped as the Brenot by Gulf Canada Resources) were the primary target in the southeast corner of the Le Moray Creek area. Exploration continued until 1984.

Coal Occurrences

Significant coal seams in the area are found in the Gething Formation. Coal seams are also present in the upper Minnes (Bickford), although these tend to be thinner and of less importance than Gething coals. The thin and discontinuous seams of the Cadomin have yet to prove to be of economic interest. Although economic coal seams are found in the Gates Formation to the south, no coal was noted in the Gates Formation exposed in the northeast corner of the Carbon Creek map area.

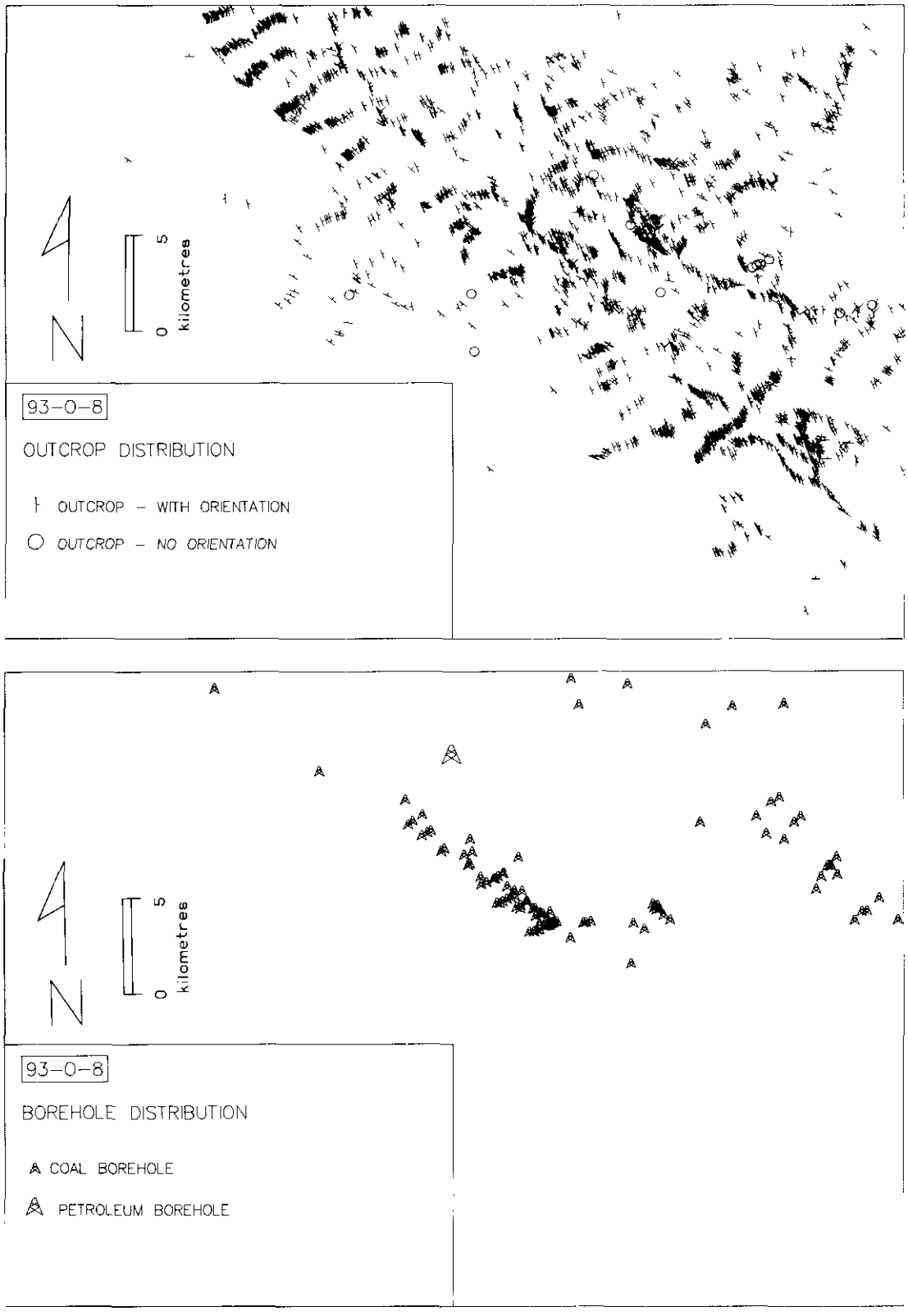


Figure 4-7-3. Distribution of (a) outcrop and (b) coal and petroleum borehole data for the Le Moray Creek map area.

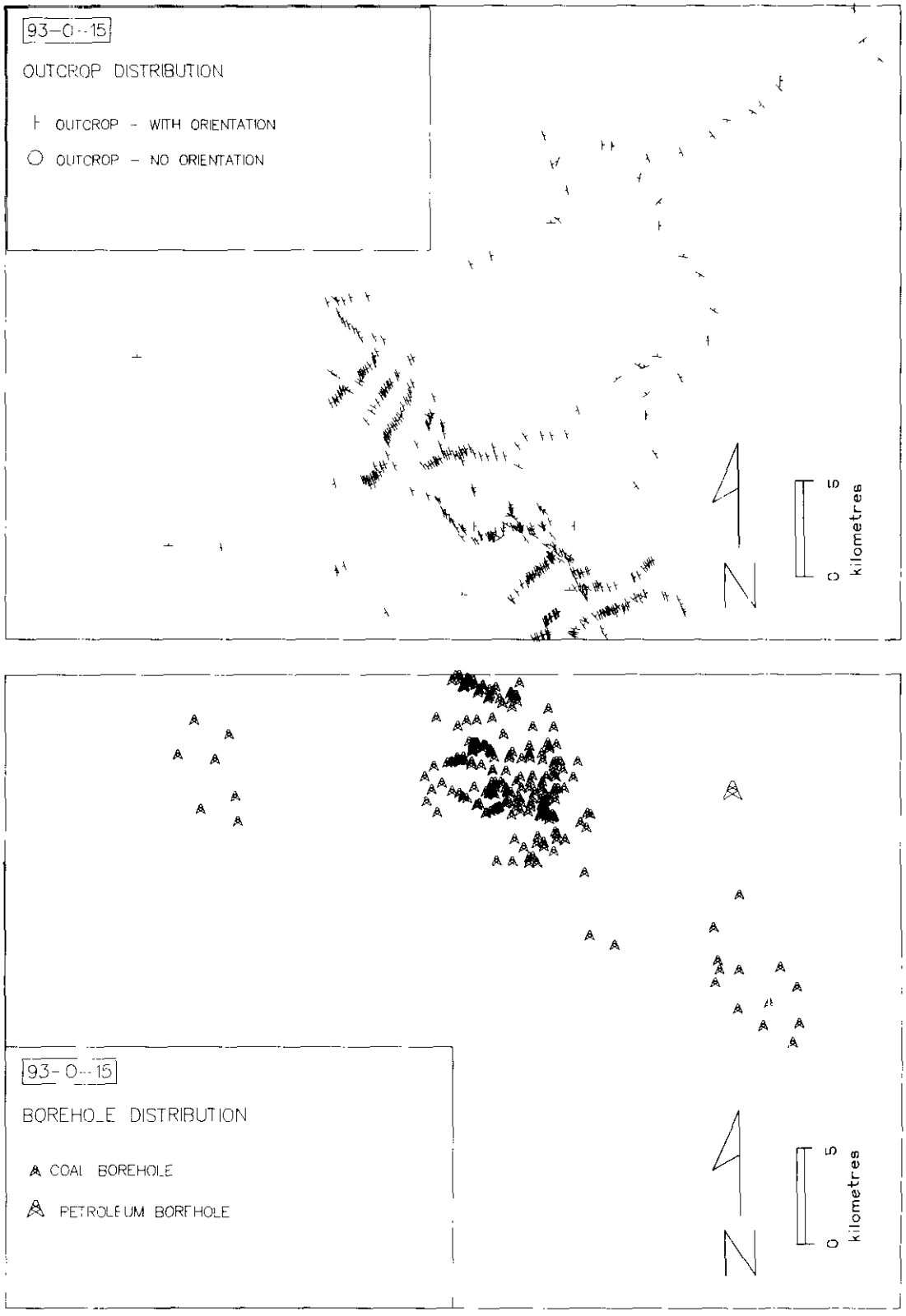


Figure 4-7-4. Distribution of (a) outcrop and (b) coal and petroleum borehole data for the Carbon Creek map area.

Coal samples were taken from seams in outcrops of the Gething and Bickford formations. Samples were prepared and analyzed using the methods outlined by Kilby (1986, 1989). Mean random vitrinite reflectance values (R_m) have been measured on some of the samples and range from 0.99 to 1.65. These samples fall in the high to low-volatile bituminous rank, using the American Standard Testing Materials classification (Stach, 1982).

Coal samples were taken from the Gething Formation in the Le Moray Creek and Carbon Creek areas. The seams that were sampled were between 0.2 and 1 metre thick. Coal seams in the Gething Formation in the Carbon Creek area are known to vary from a few centimetres to over 4 metres thick, and show marked lateral variations in thickness (Gibson, 1985). In the Le Moray Creek area, Gething coal seams may be up to 5.5 metres thick, however, the average thickness ranges from 0.5 to 1 metre thick over the whole area.

The coal samples from the Gething Formation that have been analyzed have R_m values from 0.83 to 1.57. The samples which showed the least amount of weathering in outcrop had reflectance values of 1.35 to 1.57 (medium-volatile bituminous to low-volatile bituminous rank).

The coals sampled in the Bickford Formation are from the Le Moray Creek map area, north of Brazion Creek. The seams that were sampled are 0.2 to 1 metre thick. Seams as thick as 3 metres can be found here. No significant seams were noted in the Bickford Formation in the Carbon Creek area.

Mean random reflectance values for Bickford coal samples range from 1.17 to 1.65. The single sample with reflectance of 1.17 appeared weathered in outcrop. The other samples varied from 1.46 to 1.65, placing them at the low-volatile bituminous rank, or near the boundary of the medium and low-volatile bituminous rank.

Current Exploration Activity

There is no current exploration for coal in the area. Vitrinite reflectance values in the bituminous range, and the number of coal-bearing formations, suggest this area would be of potential interest for developing coalbed methane production. The thicker seams of the Gething Formation are one possible target, although the thin but numerous seams of the Bickford may also be of interest.

There was a great deal of conventional gas exploration activity in the region this summer. Several wells are already in production, with several more nearing production. New wells are currently being drilled and more are proposed in both the Le Moray Creek and Carbon Creek map areas.

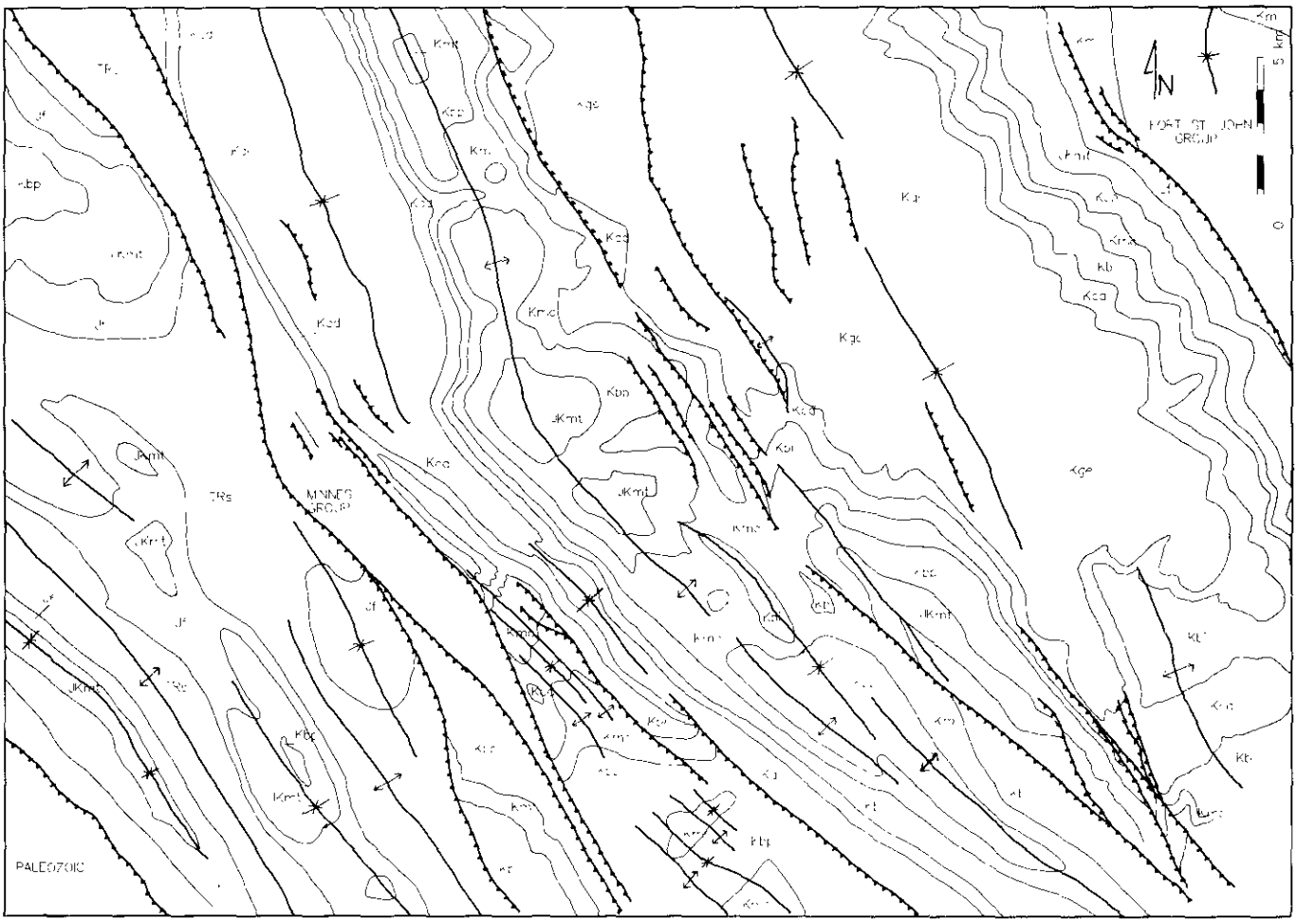


Figure 4-7-5. First draft of geologic map for the Carbon Creek area, combining compiled data and maps with the data collected in the field. Software such as QUIKMap will allow the first-draft maps to be completed on the computer while still in the field.

Targets are generally the deeper Triassic limestones which only outcrop in the Rocky Mountain Main Ranges. Regional mapping can indicate structural trends which may be expressed at deeper levels as structural traps and so be an important consideration in selecting targets for gas exploration.

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REFERENCES

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

Hughes, J.E. (1964): Jurassic and Cretaceous Strata of the Bullhead Succession in the Peace River Foothills; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Bulletin 51.

Hughes, J.E. (1967): Geology of the Pine Valley, Mount Wabi to Solitude Mountain, Northeastern British Columbia; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Bulletin 52.

Hunter, D.J. and Cunningham, J.M. (1991a): Burnt River Mapping and Compilation Project (93P/5, 6); *in* Geological Fieldwork 1990, *B.C. Ministry of Energy, Mines and Petroleum Resources*, Paper 1991-1, pages 407-414.

Hunter D.J. and Cunningham, J.M. (1991b): Geology of the Burnt River and Gwillim Lake (Southwest Half) Areas, Northeast British Columbia, NTS 93P/5, 6; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Open File 1991-4.

Jahans, P.C. (1992): Pine Valley Mapping and Compilation Project (930/9, 10; 93P/12); *in* Geological Fieldwork 1991, Grant, B. and Newell, J.M., Editors, *B.C. Ministry of Energy, Mines and Petroleum Resources*, Paper 1992-1, this volume.

Kilby, W.E. (1986): Biaxial Reflecting Coals in the Peace River Coalfield (93O, P, I); *in* Geological Fieldwork 1985, *B.C. Ministry of Energy, Mines and Petroleum Resources*, Paper 1986-1, Pages 127-137.

Kilby, W.E. (1989): Tectonically Altered Coal Rank, Boulder Creek Formation, Northeastern British Columbia, (93P/3); *in* Geological Fieldwork 1988, *B.C. Ministry of Energy, Mines and Petroleum Resources*, Paper 1989-1, Pages 565-570.

Kilby, W.E. and Hunter, D.J. (1990): Tumbler Ridge, Northeastern British Columbia (93P/2, 3, 4; 93I/14, 15); *in* Geological Fieldwork 1989, *B.C. Ministry of Energy, Mines and Petroleum Resources*, Paper 1990-1, pages 455-459.

Kilby, W.E. and Johnston, S.T. (1988a): Kinuseo Mapping and Compilation Project (93I/14, 15; 93P/3); *in* Geological Fieldwork 1987, *B.C. Ministry of Energy, Mines and Petroleum Resources*, Paper 1988-1, pages 463-470.

Kilby, W.E. and Johnston, S.T. (1988b): Bedrock Geology of the Kinuseo Creek Area, Northeast British Columbia, NTS 93I/15; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Open File 1988-21

Kilby, W.E. and Johnston, S.T. (1988c): Bedrock Geology of the Kinuseo Falls Area, Northeast British Columbia, NTS93I/14; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Open File 1988-22.

Kilby, W.E. and Wrightson, C.B. (1987a): Bullmoose Mapping and Compilation Project (93P/3, 4); *in* Geological Fieldwork 1986, *B.C. Ministry of Energy, Mines and Petroleum Resources*, Paper 1987-1, pages 373-378.

Kilby, W.E. and Wrightson, C.B. (1987b): Bedrock Geology of the Bullmoose Creek Area, Northeast British Columbia, NTS 93P/3; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Open File 1987-6.

Kilby, W.E. and Wrightson, C.B. (1987c): Bedrock Geology of the Sukunka River Area, Northeast British Columbia, NTS 93P/4; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Open File 1987-7.

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); *in* Geological Fieldwork 1982, *B.C. Ministry of Energy, Mines and Petroleum Resources*, Paper 1983-1, pages 93-97.

Legun, A. (1985): Geology of the West Carbon Creek Area, (93O/15); *in* Geological Fieldwork 1984, *B.C. Ministry of Energy, Mines and Petroleum Resources*, Paper 1985-1, pages 227-232.

Legun, A. (1987): Geology of the Carbon Creek Area, NTS 93O/15; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Open File 1987-21.

Legun, A. (1988): Geology and Coal Resources of the Carbon Creek Map Area; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Paper 1988-3.

Stach, E. (1982): Coal Petrology; *Gebruder Borntraeger Publishing*, 535 pages.

Stott, D.F. (1967): The Cretaceous Smoky Group, Rocky Mountain Foothills, Alberta and British Columbia; *Geological Survey of Canada*, Bulletin 132.

Stott, D.F. (1968): Lower Cretaceous Bullhead and Fort St. John Groups between Smoky River and Peace Rivers, Rocky Mountain Foothills, Northeastern British Columbia; *Geological Survey of Canada*, Bulletin 152.

Stott, D.F. (1973): Lower Cretaceous Bullhead Group between Bullmoose Mountain and Tetsa River, Rocky Mountain Foothills, Northeastern British Columbia; *Geological Survey of Canada*, Bulletin 219.

Stott, D.F. (1982): Lower Cretaceous Fort St. John Group and Upper Cretaceous Dunvegan Formation of the Foothills and Plains of Alberta, British Columbia, District of Mackenzie and Yukon Territory; *Geological Survey of Canada*, Bulletin 328.

NOTES