EDMONTON GEOLOGICAL SOCIETY

Fourth Annual Field Trip

Guide Book

PEACE RIVER

August 1962

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PREFACE

Welcome to the land of Twelve Foot Davis, and to the fourth annual field trip of the Edmonton Geological Society.

Perhaps not since 1793, when Alexander Mackenzie became the first white man to ascend these waters, has an expedition of this magnitude embarked on this upstream journey. Your committee and our outfitters have worked hard to make this trip possible. Arranging the trip at such a distance from Edmonton has not been easy. We trust you will excuse any minor oversights which may become evident and reflect instead on the ease and comfort of the journey in comparison with the struggles of the Klondikers up this same river in 1898.

Your guide book provides you with what we believe to be the most comprehensive summary available on the geology of the foothills and mountains of northeastern British Columbia. It can be said, perhaps, that even in this early stage of our knowledge of the area the nomenclature is more difficult to understand than the geology. Our authors have endeavoured to minimize this problem by careful definition of terminology and by full summaries of existing nomenclature.

For differences of concept or of interpretation which may be evident within the guide book itself, or between the guide book and previous publications, no apology need be made in a science which claims as its most powerful tool the method of multiple working hypotheses. Use of this method will inevitably result in differences of opinion and of interpretation, to the ultimate good of the science. We make no claim of infallibility with respect to the information presented herein; no opposing views need feel slighted by the working hypotheses here advanced.

It has been widely agreed that a guide book is not an appropriate medium for the introduction of new stratigraphic terminology. Two new terms, Besa River Formation and Chowade Group were found to be virtually indispensable to a coherent discussion of the Paleozoic stratigraphy of the area, on which so little has as yet been published. Your editors endorse these two terms and will endeavour to obtain wider publication of the papers proposing them. Other terms, used informally and for purposes of discussion in some of the papers, are not endorsed for formal adoption.

We hope that you will enjoy the trip and that some of the glamor and excitement of this great frontier land will impress itself upon your memory. If this is so, then your committee will feel well rewarded.

E.E. Pelzer, Chairman,
Field Trip Committee.

QUATERNARY GEOLOGY, PEACE RIVER DISTRICT, BRITISH COLUMBIA

By

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Three distinct topographic subdivisions are found in the plains of the Peace River district:

1. 'uplands' developed in preglacial times by subaerial erosion and best preserved on resistant Cretaceous units, notably the Dunvegan formation near Fort St. John, and the Cardium sandstone near Dawson Creek. The uplands are now almost completely covered by a mantle of glacial deposits generally less than 50 feet thick,

2. postglacial stream-cut trenches, which in the case of Peace River is up to 700 feet deep and 2 miles wide from rim to rim, and

3. an intervening 'platform' characterized by subdued topography developed by depositional processes on shale lowlands and over buried Pleistocene river trenches.

Within the mountains the structural control of topography is more obvious than in the plains. Ridges and cuestas are supported by the more resistant sandstone and carbonate formations; valleys are dominantly developed in the weaker shale units. As, in general, resistant rocks are more common low in the stratigraphic succession, anticlines tend to be expressed as topographic highs, synclines as topographic lows. However Peace River valley, either antecedent or superposed from some Tertiary cover, shows virtually no structural control except at the site of the late Pleistocene diversion south of Portage Mountain where it has been in part structurally guided around the southern end of a plunging anticline.

Unconsolidated sediments, as mapped particularly in the Fort St. John area (Mathews, 1954), include a twice-repeated succession of gravels overlain by sands, silts, and clays, and these in turn by tills of eastern origin. Both successions are interpreted as (1) gravels laid down by the ancestral Peace River and/or its tributaries during or at the close of interglacial (and preglacial(?)) intervals, (2) fine sediments laid down in lakes ponded in the Peace River valley by ice advancing from the east or northeast, and (3) till laid down after ice reached the Fort St. John area.

The earlier of the two successions occurs only very locally on a high bedrock bench a few miles west and south of Fort St. John, but the later succession forms an extensive fill occupying buried valleys generally coincident with or paralleling the present trenches of Peace River and its main tributaries.

The bedrock floor of the interglacial buried valley of Peace River lies about 100 feet above the present stream from The Gates, a few miles downstream from Hudson Hope, at least as far east as the mouth of Beatton River, and probably correlates with a buried valley mapped by Henderson (1959, fig. 8) near the town of Peace River, Alberta. If so the gradient of the interglacial channel is very nearly that of the present river and the net easterly tilt in intervening time was probably well under 1 foot per mile.

The buried valleys of at least Peace and Pine Rivers extend westerly into the mountains, but are here much deeper than those of the plains and are filled with a distinct sedimentary succession. Drilling at Commotion Creek on Pine River disclosed 1,081 feet of unconsolidated sediments, and here bedrock was reached 929 feet above sea level. Downstream at Taylor, B.C., the bedrock floor of the present river system lies at an elevation of about 1,280 feet (and that of the interglacial river system at about 1,400 feet). Drilling at The Portage, where the buried valley of Peace River leaves the mountains, showed at least 1,760 feet of fill, with bedrock at an unknown distance below the 480 foot elevation of the bottom of the hole. The gross overdeepening of these two valleys with respect to points downstream cannot be accounted for by stream erosion alone, and an explanation involving combined stream erosion and later downwarping of those parts of the valleys within the mountains is extremely tenuous, especially in view of the evidence of virtually no late Pleistocene tilting in the plains immediately to the east. The overdeepening can best be attributed to glacial scour by confined ice tongues flowing easterly through the mountains. Where these ice tongues reached the plains they fanned out (Glacial Map of B.C., Glacial Map of Canada) and presumably lost the power of entrenching their floors.

The late Pleistocene record in the Fort St. John and Dawson Creek areas includes the strandlines of 2 major stages of ice-dammed Lake Peace (Taylor, 1958), one close to the present 2,750 foot contour from Pouce Coupe to Mile 60 on the Alaska Highway, the other close to the 2,260 foot contour near Fort St. John. These strandlines are marked locally by narrow topographic benches or low ridges, but more commonly they are represented only by horizontal bands of gravelly soil from which the fine fraction has been removed by wave action.

Sedimentary deposits laid down in Lake Peace are dominantly clays, in places varved, with an average thickness of 50 feet over much of the platform areas. The lower part of the clay may be somewhat stony, in which case it closely resembles till. Authigenic crystals of gypsum are common. Silt and sand are present immediately below the strandlines and, curiously also, in some areas remote from former shores. Silt breccias interstratified with clays along Pouce Coupe River record local subaqueous slides.

Both the 2,750 foot and 2,260 foot stages of Lake Peace were dammed somewhere to the east by retreating Laurentide ice. Their western limits are as yet uncertain although careful mapping of surficial deposits on the uplands adjacent to Pine, Moberly, and Halfway Rivers may provide new clues on distribution and on what, if any, later tilting the shorelines may have undergone.

Relationships between fluctuations of the Laurentide ice on the east and

Cordilleran ice to the west during this period has yet to be fully worked out. However, it seems highly probable that the last advance of Cordilleran ice to a line scarcely 10 miles southwest of Fort St. John (Glacial maps of B.C. and of Canada) occurred after Laurentide ice had withdrawn east of this limit. A notable halt in the retreat of the Cordilleran ice from its climax is recorded by an arcuate morainal ridge in The Portage, and by an ice-contact face 7 miles northeast of Chetwynd in the Pleistocene valley of Pine River. Meltwater streams drained from the ice fronts in both valleys, leaving recognizable channels which terminate a few miles to the east at about the 2,300 foot contour where, probably, they entered Lake Peace. If so, Laurentide ice still effectively dammed Peace River somewhere east of Fort St. John while Cordilleran ice stood at this point. Later a lake evidently still ponded by Laurentide ice flooded back into the Peace River valley to a point about 40 miles west of The Portage moraine where a pitted terrace, built on dwindling remnants of Cordilleran ice, lies slightly above the 2,300 foot level.

The Pleistocene valleys of Peace River through The Portage and of Pine River from Chetwynd via Jackfish Lake and Graveyard Creek (now followed by the Fort St. John branch of the P.G.E. railway) were so choked with morainal debris that new and lower routes were occupied by water flowing from the mountains. In the case of Peace River the new route south of Portage Mountain was sufficiently low that ice-dammed waters backed up through it and, as noted above, ultimately extended some 40 miles west into the mountains. Over much of this length lacustrine and pitted deltaic sediments occur (Beach and Spivak, 1943, p. 368; Mathews, 1946, p. 18) up to about the 2,300 to 2,400 foot contours where a conspicuous terrace still persists, apparently marking the upper limit of the lake. When this lake was drained, presumably as a result of further retreat of Laurentide ice many miles to the east, Peace River flowed over a low point on the lacustrine fill south of Portage Mountain rather than across the morainal belt in the Portage itself. Since that time a considerable part of the lacustrine fill has been removed and the river has cut to a depth of as much as 300 feet on into bedrock, forming the Peace River canyon.

Late-Glacial fill is surprisingly scarce along Peace River valley from Carbon Creek downstream past Gold Bar to the mouth of Dunlevy Creek. It has been suggested (Mathews, 1946, p. 18) that this part of the valley was occupied for a long period by a large but isolated tongue of ice extending above lake level so that no significant volume of sediment could be deposited, whereas in the absence of such a thick mass of ice both upstream and downstream sedimentation could take place unhindered.

A second conspicuous terrace at about the 2,050 foot level is noted along parts of the valley above the canyon associated with kettled outwash of Late Glacial age. This could conceivably coincide with some low stage of Lake Peace east of the canyon, but more likely is a product of rapid fluvioglacial sedimentation at a time when downcutting of the spillway around Portage Mountain was being slowed by first contacts with bedrock.

The postglacial history of the plains is one of the almost uninterrupted cutting by the main rivers. West of The Portage as the relic tongue of ice near Gold Bar melted away a lake may have taken its place, to be in turn gradually eliminated by the down-cutting of Peace River in its canyon and by filling with sediment eroded from Pleistocene deposits upstream. Thus by degrees the topography acquired its present character.

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PLACER MINING IN THE PEACE RIVER REGION

By

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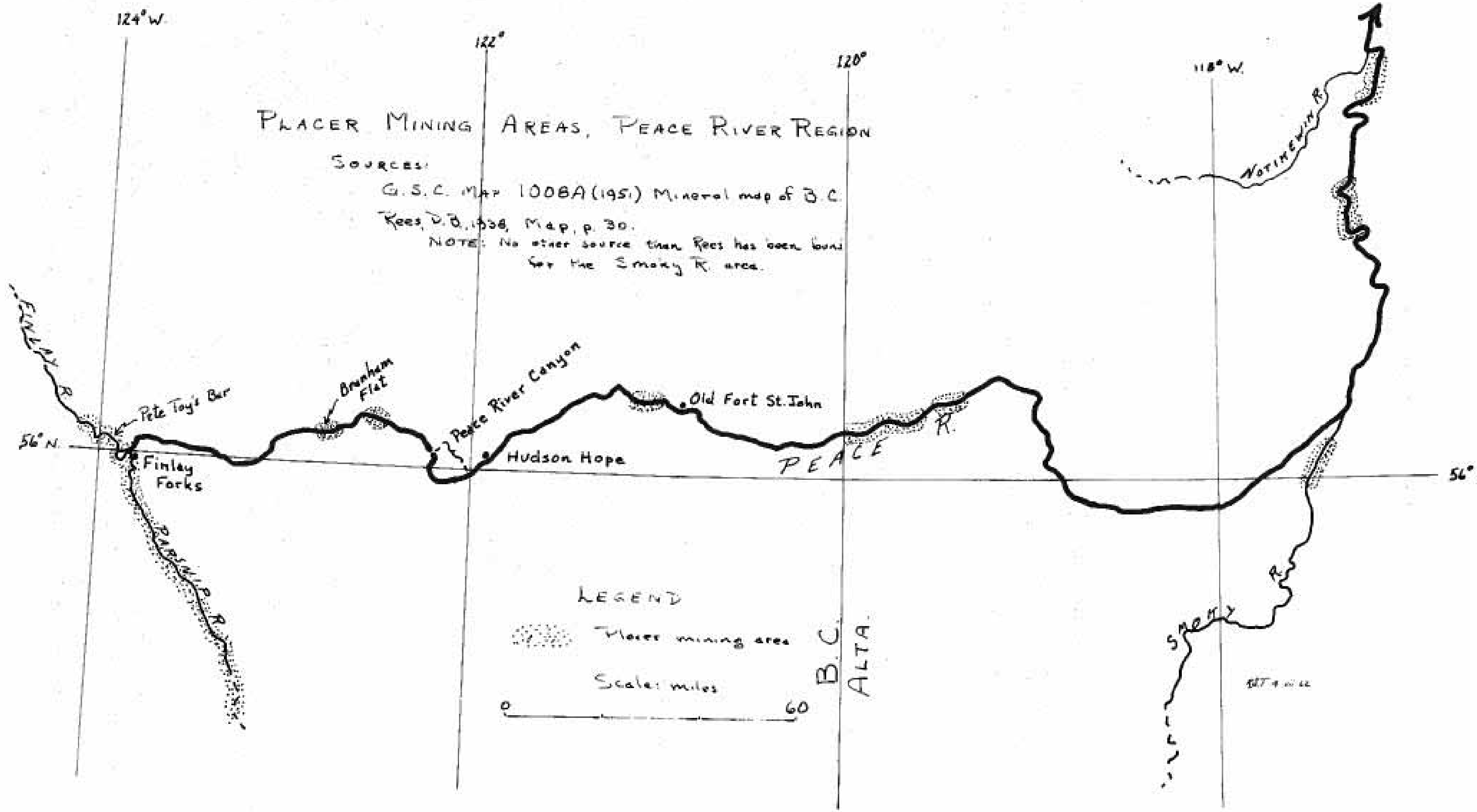
INTRODUCTION

The region discussed extends about 375 miles along the Peace River, from the area close about Finlay Forks (see Map) to just above the mouth of the Notikewin (formerly Battle) River (McConnell, 1890, p. 13-15). Finlay Forks, at the junction of the Finlay and Parsnip rivers, is at the head of the Peace River which here starts its 78 mile reach through the Rocky Mountains.

The gold, with one exception, occurs on the bars of the Peace River and in the old valley-bottom deposits of the river below the Forks, and not in tributaries. The exception is the Smoky River where these unimportant placer deposits most probably represent a reconcentration from older glacially-transported Peace River placers. The major primary source of the gold has long been recognized to be the Omineca and Cariboo mountains, with a very minor fraction being supplied by several small tributaries of the Finlay River which flow westward from the flanks of the Rocky Mountains.

In manner of occurrence the very fine gold of the Peace is markedly different from coarser gold that settles down through gravel and sand to bedrock or claypan. Because of its fineness (smallness) the Peace River gold lies in or just below the gravels and sands moved onto the upstream ends of bars during high-water stages. Thus, only shallow materials lying between high and low water levels generally are worked. Blanket boxes (sluices with blanket liners and no riffles) are used rather than sluices with riffles, because of the fineness of the gold. A few more massive deposits of old channel gravels overlain by floodplain sands and silts apparently contain low values throughout thicknesses of 25 or more feet. These latter deposits are not known to have been worked profitably as yet.

The purity of the Peace River gold in the B.C. section is (average) 906 on a scale of 1,000, whereas the average for 173 British Columbia placer streams is 861 (Holland, 1950, p. 12, 47). Some native platinum is recovered with the gold (Allan, 1920, p. 52-53; B.C., Dept. of Mines, 1959, p. 17). The total past production of gold for the region will never be known. In the B.C. part there are no production records prior to 1930, except for one year. An approximate total value for the period 1874-1945 (in part estimated) is $93,755; total recorded production is $73,350 (Holland, 1950, p. 11, 47). Little has been produced since 1945. Production records in Alberta are given mainly for the North Saskatchewan field, not for the whole Province (compare values in Allan, 1920, p. 51 with those tabulated in Allan and Rutherford, 1935, p. 21). Thus, production from the Peace River is not known. However, we do have the definitive statement that the North Saskatchewan River has been the source of practically all of the Alberta placer gold (Allan, 1920, p. 51).



PLACER MINING AREAS, PEACE RIVER REGION
SOURCES:
G.S.C. Map 1008A (1951) Mineral map of B.C.
Rees, D.B., 1938, Map, p. 30.
NOTE: No other source than Rees has been found for the Smoky R. area.
124° W.
122°
120°
118° W.
56° N.
56° N.
FINLAY R.
Pete Toy's Bar
Finlay Forks
PARSNIP R.
Branham Flat
Peace River Canyon
Hudson Hope
Old Fort St. John
PEACE R.
NOTIKEWIN R.
SMOKY R.
B.C.
ALTA.
LEGEND
Placer mining area
Scale: miles
0
60

The size of the gold particles decreases as one goes down the Peace River, and as size decreases the difficulties of recovery increase. Concentration also decreases in the downstream direction. In the Alberta portion of the region, gold particle sizes range down to 450 to 700 colours to the cent (flour gold) and is such as would pass through a 400-mesh screen (Rees, 1938, p. 7, 31). As described to me recently and paraphrased slightly here, the placer gold above Peace River Canyon 'is finer than gnat droppings and below the Canyon it's even worse,' all of which supports the idea that by far the most of the placer gold recovered in the region (97+%?) came from the B. C. portion.

Chronology

Gold was discovered in the Peace River region in 1861 by Edward Carey and W. Crest[1] (Bancroft, 1887, p. 545-546), about 20 miles above the mouth of the Parsnip River. During the high water of June they descended the Peace River, passing through the Canyon / ? /. Returning at low water they prospected all the bars. They recovered $1,000 in dust from a few day's work on the bar (later known as Pete Toy's bar) three miles above the mouth of the Finlay River. Wintering-over in the interior, they returned in 1862 with Pete Toy and two others, recovering $6,000 of dust in 50 days' washing. Five others followed them to the Peace River the same season, while still more came in the following seasons (Bancroft, loc. cit.). According to MacGregor, 2,000 miners were panning the bars between Hudson Hope and Fort St. John in the 1870's (1952, p. 42). If this is so, there must have been a large number working above the Canyon as well, for 'pickings' seem to have been better above the great rapids. The '70's', then, were the times of maximum density of prospectors in the area, for nowhere else in the literature do we encounter figures such as those above.

Little detail is available for the following years. The Edmonton Bulletin, in 1888, reported on the activities of two miners who succeeded in recovering over an ounce of gold a day from a bar near Fort St. John (MacGregor, 1952, p. 212). In the period 1897-1899 over 2,000 Klondikers passed through Edmonton, "The Poor Man's Route to the Yukon"; perhaps two per cent of them made it. Some of those who fell by the wayside wound up panning gold on the Peace River (MacGregor, 1952, p. 310-311, 320). The area also had varied influxes during each recession and depression, for there are always those who would rather work poor ground for themselves and their families than accept relief.

Despite the good luck of a few, the majority of the prospectors found the bars too poor to do more than afford a living. Looking for something better, or quitting altogether, the majority moved on. Later, it was thought possible that some of the gravels could be worked profitably with heavy equipment. In 1918 two steam drills were testing Branham Flat (left bank of the Peace, 26 miles above the Canyon) and across the river (O'Neill and Gunning, 1934, p. 83). The Peace River Gold Dredging Company moved a dragline to Branham Flat in 1922, but operations in 1922-1923 were

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[1] Given elsewhere as Bill Cust (McConnell, 1896, p. 38C; Macgregor, 1952, p. 184; and others).

not profitable. The company also purchased two 14-ton, 125 H.P. boilers for the property in 1922. Both boilers reached Hudson Hope via river steamer, and one was stored there. The other was taken halfway across the 14-mile portage around the Canyon, and left there. So far as I've found out, it's still there in the bush somewhere. In 1922 the company also built a single-bucket dredge on the Peace River near old Fort St. John. Its operations were also unsuccessful, and it was beached on the riverbank opposite the old fort (B.C., Dept. of Mines, 1923, p. A142-A143; illustrations opp. p. A112).

The next effort with heavy equipment was a completely different breed of cat. In 1942 Jack Reschke of Hudson Hope took a home-made, boat-portable, trestle-mounted hand-operated two-winch dragline up to the lower Parsnip River in two boat loads, from above the Canyon. There, he worked the Parsnip gravels shortly below the mouth of the Nation River with a crew consisting of wife, nine-year-old son and 1-1/2-year-old camp tender. They took out 120 ounces of dust in three months (Reschke, personal communication, 1962), and topped this feat off by walking out from Finlay Forks to Hudson Hope in 12 days of 30° below weather.

As some of the old timers learned early, certain bars could be worked over ('sniped') profitably every two or three years, and a few bars every year, as they had their shallow fine-gold deposits renewed by successive flood seasons. The two Six-mile Bars and Eight-mile Bar, above the Canyon, are examples of the every-year harvest class. During the World War Two years, nobody was around to do any sniping. In 1947, before any of the local people got around to it, an Edmonton man worked Eight-mile Bar and recovered 27 ounces of dust. This was fortunate, in a way, for 1948 was the year of the big flood and none of the bars have been worth working since then (W. Kruger, personal communication, 1962). It would be interesting to know why the flood should have stripped the shallow gravels with their gold off the bars, without any new gold coming downstream to rebuild the deposits during the last few years.

At present there is very slight activity in the region. A dredge was moved onto Branham Flats two - three years ago, and a dragline was moved in this Spring (R. Beattie, personal communication, 1962). The organization, however, doesn't seem to be doing any regular work on the deposit. There doesn't seem to be any reason this area couldn't be worked profitably, if the old assay data are correct. The deposit, reportedly 40 to 50 feet thick, yielded combined gold and platinum values of 80¢ per yard (1918 prices) (O'Neill and Gunning, 1934, p. 83).

Conclusions

The chance of an individual making any worthwhile strike below the Finlay Forks is remote. Sniping will continue to produce a few ounces per favoured bar per year, after the effects of the 1948 flood have been remedied by nature. It seems probable that some of the older river deposits, such as that of Branham Flat, stand a good chance of supporting a commercial operation using modern large-scale earth-moving equipment.

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UPPER CRETACEOUS, PEACE RIVER AREA, BRITISH COLUMBIA

By

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INTRODUCTION

The Upper Cretaceous escarpments outline the arching of the Peace River nose in British Columbia, leaving a broad triangle of Lower Cretaceous exposed along the Peace River from Hudson Hope to Fort St. John. This transverse nosing is reflected as far south as the John Hart Highway where later Cretaceous beds outline a southern flank by an east-west escarpment running from Pouce Coupe near the Alberta-British Columbia boundary to the Wartenbe Mountain area near East Pine. Post-glacial laking, marked by old beaches which reached a water level of around 3,300 feet elevation, obscured much of the bed rock but Recent incised canyons reveal the Upper Cretaceous stratigraphic succession as follows:

Wapiti Formation, continental sandstone (erosion surface)	3500 feet +
Chinook Formation, brackish sandstone and shale	150 feet
Wapiabi Formation, marine shale	500- 925 feet
Cardium Formation, sandstone and conglomerate	140- 388 feet
Kaskapau Formation, marine shale, some sandstone	1500-3000 feet
Dunvegan Formation, fresh to brackish sandstone	500-1440 feet
Cruiser Shale, marine shale and siltstone	1000 feet ±

The thicker successions are found in the Pine River area.

The Lower-Upper Cretaceous boundary is located within a band of fish-scale-bearing siltstones within the Cruiser Formation, which band is the outcrop expression of the subsurface Colorado "fish-scale" marker beds. These "fish-scale sands" may be seen at the north end of the Alaska Highway bridge on the Peace River. The "fish-scale sands" themselves carry Neogastroplites americanus Reeside and Weymouth and Neogastroplites aff. mclearni Cobban and Reeside, indicating correlation with the Lower Cretaceous portion of the Mowry Shale of Wyoming.

CRUISER SHALE

The Cruiser Formation was originally named in the Pine River Foothills to designate that portion of the Fort St. John Group lying above the Goodrich Sandstone. The fish-scale marker-bed (supra) occurs 150-200 feet above the base and 680 feet below the top of the Cruiser equivalents in the St. John area. In the inner foothills in the upper Pine River valley the marker-bed is at the base of the Cruiser within the top

CORRELATION UPPER CRETACEOUS TERMINOLOGY

	EUROPEAN EQUIVALENTS	COLORADOAN FOSSIL ZONES (Cobban and Reeside, 1952)	PLAINS Central Alberta	SMOKY RIVER Alberta	PEACE, - PINE RIVERS British Columbia	FOOTHILLS Alberta (Stott, 1961)
UPPER CRETACEOUS	CAMPANIAN	MONTANAN	BELLY RIVER	WAPITI	WAPITI	BELLY RIVER
		MONTANAN	LEA PARK		CHINOOK	NOMAD
		MONTANAN	LEA PARK		CHINOOK	CHUNGO
	SANTONIAN	MONTANAN	LEA PARK	PUSKWASKAU	WAPIABI	HANSON
		DESMOSCAPHITES ERDMANNI INOCERAMUS LUNDBRECKENSIS	FIRST WHITE SPECKS	PUSKWASKAU	WAPIABI	THISTLE
		CLIOSCAPHITES CHOTEAUENSIS		PUSKWASKAU	WAPIABI	DOWLING
		CLIOSCAPHITES VERMIFORMIS INOCERAMUS COULTHARDI		PUSKWASKAU	WAPIABI	DOWLING / MARSHY BANK
	CONIACIAN	SCAPHITES DEPRESSUS INOCERAMUS STANTONI		BADHEART	BH / WAPIABI	MARSHY BANK
		SCAPHITES VENTRICOSUS INOCERAMUS UMBONATUS		KASKAPAU	WAPIABI	MUSKIKI
		SCAPHITES. PREVENTRICOSUS INOCERAMUS DEFORMIS		KASKAPAU	WAPIABI	MUSKIKI
	TURONIAN	SCAPHITES CORVENSIS PRIONOCYCLUS AFF. REESIDEI		KASKAPAU	UPPER CARDIUM / BAYTREE	STURROCK
		SCAPHITES NIGRICOLLENSIS PRIONOCYCLUS REESIDEI		KASKAPAU	MID.- CARDIUM	LEYLAND CARDINAL KISKA
		SCAPHITES WHITFIELDI PRIONOCYCLUS WYOMINGENSIS		KASKAPAU	LOWER CARDIUM	MOOSEHOUND / RAM
		SCAPHITES WARRENI PRIONOCYCLUS MACOMBI		KASKAPAU	KASKAPAU	OPABIN
		SCAPHITES CARLILENSIS COLLIGNONICERAS HYATTI		KASKAPAU	NUNKI	HAVEN
		SCAPHITES LARVAEFORMIS COLLIGNONICERAS WOOLGARI	SECOND WHITE SPECKS	KASKAPAU	KASKAPAU	HAVEN / VIMY
		WATINOCERAS REESIDEI INOCERAMUS LABIATUS	SECOND WHITE SPECKS	KASKAPAU	WARTENBE / TUSKOOLA	VIMY
		SCIPINOCERAS GRACILE METOICOCERAS WHITEI		HOWARD CREEK	HOWARD CREEK	SUNKAY
	CENOMANIAN	DUNVEGANOCERAS AFF. ALBERTENSE			POUCE COUPE	SUNKAY
		DUNVEGANOCERAS PONDI METOICOCERAS PRAECOX			DOE CREEK	SUNKAY
		ACANTHOCERAS? sp. A.		DUNVEGAN	DUNVEGAN	SUNKAY
		ACANTHOCERAS? AMPHIBOLUM		DUNVEGAN	DUNVEGAN	SUNKAY
		CALYCOCERAS sp.		SHAFTESBURY	DUNVEGAN	SUNKAY
	ALBIAN	NEOGASTROPLITES WYOMINGENSIS	FISH SCALE BED	SHAFTESBURY	CRUISER	SUNKAY
		GASTROPLITES AMERICANUS	FISH SCALE BED	SHAFTESBURY	CRUISER	SUNKAY

COLORADO GROUP (Plains, First White Specks to Fish Scale Bed)

SMOKY RIVER GROUP (Smoky River, Puskwaskau to Howard Creek)

KASKAPAU (Peace, - Pine Rivers, Nunki to Pouce Coupe)

ALBERTA GROUP (Foothills): WAPIABI FM. (Nomad to Muskiki); CARDIUM (Sturrock to Ram); BLACKSTONE FM. (Opabin to Sunkay) of the Goodrich sandy wedge. The lower part of the Cruiser Shale carries additional concentrations of fish scales, and fish scales occur sporadically throughout most of the formation. The environment of deposition is, in part, euxinic.

Certain beds may be recognized within the Upper Cretaceous portion of the Cruiser Shale. In the St. John area a second concentration of fish scales with clean lenticular sandstones may be found 160 feet above those "fish-scale sands" that mark the top of the Lower Cretaceous. At 220 feet above the base of the Upper Cretaceous Series the concentration of fish scales sharply lessens, suggesting deeper water environment as a new ammonite assemblage is introduced above this level. Two persistent tuff beds (6 inches +) appear at 300 and 380 feet above the Colorado fish scale marker and numerous thin bentonites may be found throughout the upper portion of the Cruiser Formation. Thin bands of siltstone and ironstones give a bedded appearance on all outcrops but are difficult to trace. Laterally the upper portion of the Cruiser Formation becomes quite sandy and is marked by the introduction of brackish beds anticipating the succeeding deltaic Dunvegan Formation. A cone-in-cone bed about 80 feet below the basal Dunvegan forms a local marker in the St. John area.

An endemic marine fauna of the Upper Cretaceous portion of the Cruiser Shale consists of:

Beattonoceras beattonense Warren and Stelck
B. ontkoi Warren and Stelck
Neogastroplites septimus Warren and Stelck
Neogastroplites sp.
Irenicoceras bahani Warren and Stelck
Forbesiceras sp.
Inoceramus irenensis Warren and Stelck

The brackish fauna occurring at the top carries:

Pleurobema cruiserensis Warren and Stelck
Pleurobema cf. dowlingi (McLearn)
Brachidontes cf. tenuisculpta Whiteaves
Panope sp.

A sparse microfauna also is found with:

Ammomarginulina sp.
Hippocrepina sp.
Hyperamminoides sp.
Haplophragmoides sp.
Gaudryina cf. hectori Nauss
Miliammina sp.
Saccammina sp.
Tritaxia sp.
Trochammina cf. rutherfordi Stelck and Wall
Textularia alcesensis Stelck and Wall

Most of the above faunal elements are endemic, arising from the land-locked Neogastroplites fauna of the late Lower Cretaceous. Diastrophic movements (Omineca intrusive?) in the early Upper Cretaceous brought a flood of coarse clastics from the northwest to create the large deltaic deposits of the succeeding Dunvegan, terminating the isolation of the Cruiser waters, restoring a benthonic fauna, and permitting entry of later Cretaceous Gulf of Mexico faunas. The presence of unconsolidated flow figures and sandstone dikes in the uppermost Cruiser on Beatton River suggests earthquake shocks accompanying the uplift.

The contact between the Cruiser Shale and the Dunvegan Sandstone usually appears transitional and is laterally diachronic. The top of the shaly beds is about 100 feet stratigraphically lower on the Pine River below East Pine than on the Beatton River near St. John, which in turn is about 100 feet below the base as used by Gleddie (1954) for the type area of the Dunvegan in Alberta. In the upper Pine River area the transition zone becomes quite sandy suggesting a further stratigraphic lowering of the contact with the Dunvegan.

DUNVEGAN FORMATION

The Dunvegan Formation forms a wide skirting delta with its source apparently in the Cassiar-Omineca uplift. The type area is usually considered to be at Dunvegan, Alberta, on the Peace River. To the west in the Pine River area additional stratigraphic interval above and below changes into sandy lithofacies and thickening and coarsening of the formation develops. On the Beatton River north of St. John the Dunvegan Formation reveals these main divisions:

a) an upper plant-bearing deltaic sequence, 400+ feet thick
b) a middle conglomeratic and arkosic member, to 300 feet thick
c) a brackish lower member, 200 feet thick
d) a basal sand member, 100 feet thick

The lower members seem to represent the sanding up of the Cruiser area. The arkosic sand member introduces the fluvial phase of the Dunvegan and marks the expulsion of the sea from the St. John area. The arkosic member is known to rest in places with an erosional unconformity upon the brackish member in the area to the west and northwest where conglomerates become common. In the upper Pine River area the arkosic member cuts down into the underlying Cruiser transition zone. The plant-bearing deltaic member is transitional with the overlying Kaskapau shales, although arkosic sands similar to those associated with the conglomeratic member may be found infilling fluvial channels in the uppermost Dunvegan.

In the Peace and Pine River areas of British Columbia the Dunvegan Formation carries a rich dicotyledon flora and a restricted brackish fauna viz:

Brachidontes cf. tenuisculpta (Whiteaves)
Pleurobema cruiserensis Warren and Stelck
Pleurobema dowlingi (McLearn)

Inoceramus dunveganensis McLearn
Cyrena cf. securis Meek
Elliptio cf. sulfuriensis McLearn
Panope sp.

The return to marine conditions at the top of the Dunvegan is transitional through a brackish zone, and from the Alberta-British Columbia boundary to the upper Pine River region the sanding up and freshening leave more and more of the superjacent beds in the Dunvegan lithofacies as the Dunvegan delta was but slowly overwhelmed by the advancing Colorado sea.

In the Wartenbe Mountain area west of East Pine the arenaceous fingers penetrating the overlying Kaskapau shale section led Spieker (1921) to name the Kaskapau Shale equivalents the Sukunka Member of the Dunvegan although all of these sands are marine.

KASKAPAU FORMATION

The Kaskapau Formation (Lower Smoky shale), a thick section of silty shales with some marine sandstones, lies above and interfingers at the base with the Dunvegan Formation. The shales are about 1550 feet thick near the Alberta-British Columbia border and thicken to over 3000 feet to the west in the East Pine area where many sand tongues come into the section along with occasional conglomeratic lenses.

In the Pouce Coupe River region the basal beds are brackish and two clean sand members, the Doe Creek Sandstone (6 feet thick) and the Pouce Coupe Sandstone (30 feet thick), occur at 190 and 270 feet above the base respectively. In the type area of the Kaskapau along the Smoky River in Alberta this basal stratigraphic portion is missing and in the upper Pine River area it is included in the Dunvegan Formation.

In the East Pine area additional sand members appear at 425 feet (Howard Creek sand), between 819 and 1373 feet (Tuskoola and Wartenbe members and others), and at 2332 feet (Nunki sandstone - new name) above the datum of the Pouce Coupe Sandstone. The sandstone concentrations do not reach much beyond the Murray River (East Pine area).

In the Pine River area the section up to the Pouce Coupe Member becomes generally sandy, coaly, and carries plant remains and a fresh water fauna with occasional oyster bands. On the British Columbia-Alberta boundary this basal section carries the prolific fauna of the Dunveganoceras zone including:

Dunveganoceras albertense (Warren)
Dunveganoceras poucecoupense Warren and Stelck
Barbatia micronema (Meek)
Ostrea soleniscus Meek
Ostrea anomioides Meek

Ostrea aurea (Warren and Stelck)
Ostrea dunveganensis McLearn
Inoceramus corpulentus McLearn
Inoceramus allani Warren
Inoceramus prefragilis Stephenson
Parmicorbula dunveganensis (McLearn)
Elliptio sulfuriensis McLearn
Arctica murrayensis Warren
Exogyra columbella levis Stephenson
Hillites cf. septarianus (Cragin)
Brachidontes cf. filisculptis (Cragin)
Brachidontes cf. arlingtonanus Stephenson

An extensive arenaceous microfauna has also been described by Stelck and Wall (1955) from the Dunveganoceras zone.

The Howard Creek Sand is absent in the Alberta-British Columbia boundary area but seems to develop from local winnowing as the sand is mostly argillaceous in the East Pine area with only 4 feet of clean sand at the top.

The interval between the Pouce Coupe Sandstone and the Howard Creek Sandstone carries an abbreviated marine fauna:

Arctica murrayensis Warren
Camptonectes cf. platessa White
Inoceramus cf. prefragilis Stephenson
Inoceramus tenuiumbonatus Warren
Inoceramus allani Warren
Placenticeras pseudoplacenta Hyatt

This interval likewise carries an extensive arenaceous microfauna described by Stelck and Wall (1954).

The "second white specks" of the Colorado Group in subsurface on the Plains is represented by the sandy interval between the Tuskoola calcareous sandstone and Wartenbe sandstone in the East Pine area. In the Pouce Coupe area silty and sandy shales occur in this same interval. The beds are marine throughout in the area south of the Peace River in British Columbia and the ubiquitous Inoceramus labiatus fauna is found even in the arenaceous lithofacies. The aggregate fauna includes:

Inoceramus labiatus (Schlotheim)
Inoceramus cf. fragilis Hall and Meek
Inoceramus corpulentus McLearn
Placenticeras sp.
Watinoceras reesidei Warren
Watinoceras cf. coloradoense (Henderson)
Vascoceras?
Legumen cf. planulatum (Conrad)

Anatina cf. lineata Stanton
Pinna sp.
Ostrea soleniscus Meek
Siliqua cf. huerfanensis Stanton
Pholadomya cf. goldensis Stephenson
Veniella cf. mortoni Meek and Hayden
Volutoderma clatworthyi
Gyrodes cf. fluvianus Stephenson
Belemnitella sp.

The accompanying microfauna introduces calcareous faunas indicative of deepening water, with calcareous pelagic elements dominant.

The Wartenbe sand carries, locally, conglomerate lenses at the top and there is a sharp drop in faunal content above this horizon although it continues marine with brackish suggestions. A sandstone tongue capping Nini Mountain south of East Pine is herein named the Nunki Sandstone. It is 60 feet thick, cliff forming, and transitional with the underlying and overlying shales. The Nunki Sandstone lies about 500 feet below the base of the Cardium Formation in its type area, but is probably the sand member found directly below the Cardium Formation near Pouce Coupe.

The fauna of the Nunki sand is little known but carried exotic elements.

Exogyra suborbiculata (Lamarck)
Exogyra cf. columbella Meek
Pholadomya cf. goldensis Stephenson
Inoceramus sp.
Nucula sp.
Arctica sp.
Placenticeras sp.
Tragodesmoceras cf. bassi Morrow

The beds of the Kaskapau Formation immediately below the Cardium Formation have yielded very few fossils, but this may be from paucity of outcrop. The contact is known to be transitional in the foothills of the Murray River area.

CARDIUM FORMATION

The Cardium Formation of Northeastern British Columbia carries within its formational limits an erosional unconformity. The formation in the foothills of Alberta usually consists of three members and for British Columbia a top fourth member (Baytree Conglomerate) is included.

In the Wapiti River area, British Columbia, there are 22 feet of Baytree Conglomerate, erosionally overlying 85 feet of the upper sand member, overlying 200 feet of the middle shale member, overlying 81 feet of the lower sand member for a total of 388 feet. The gross thickness of the Cardium lessens toward the northwest to somewhat less than 300 feet south of East Pine. Truncation by the Baytree Member reduces the gross thickness to less than 100 feet in the Pouce Coupe area.

The lower and middle Cardium members are marine but the upper sand member is brackish and often carries plant remains. The Baytree Conglomerate represents the basal conglomerate of the incoming succeeding Wapiabi sea. The line of shingle pebbles (old shore line) may be traced from south of East Pine to the type section of the Baytree northeast of Pouce Coupe in Alberta. This line forms a parallel to the outline of the southern flank of the Peace River nosing. Inasmuch as no Cardium or Kaskapau beds are known from the Liard drainage north of the Peace, the unconformity marked by the Baytree suggests that a regional tilt involved at least 1200 feet of uplift in the Liard area as the basal Wapiabi lies directly on the Dunvegan in that region.

Fossils from the British Columbia Cardium Formation are rare, but include:

Cardium pauperculum Meek
Glycimeris n. sp.
Scaphites nigricollensis var. meeki Cobban
Leptosolen sp.
Inoceramus fragilis prairiensis McLearn

The return of marine conditions with the incoming Wapiabi sea is foreshadowed by the appearance of glauconite within the Baytree Conglomerate and the upper contact is abrupt though transitional.

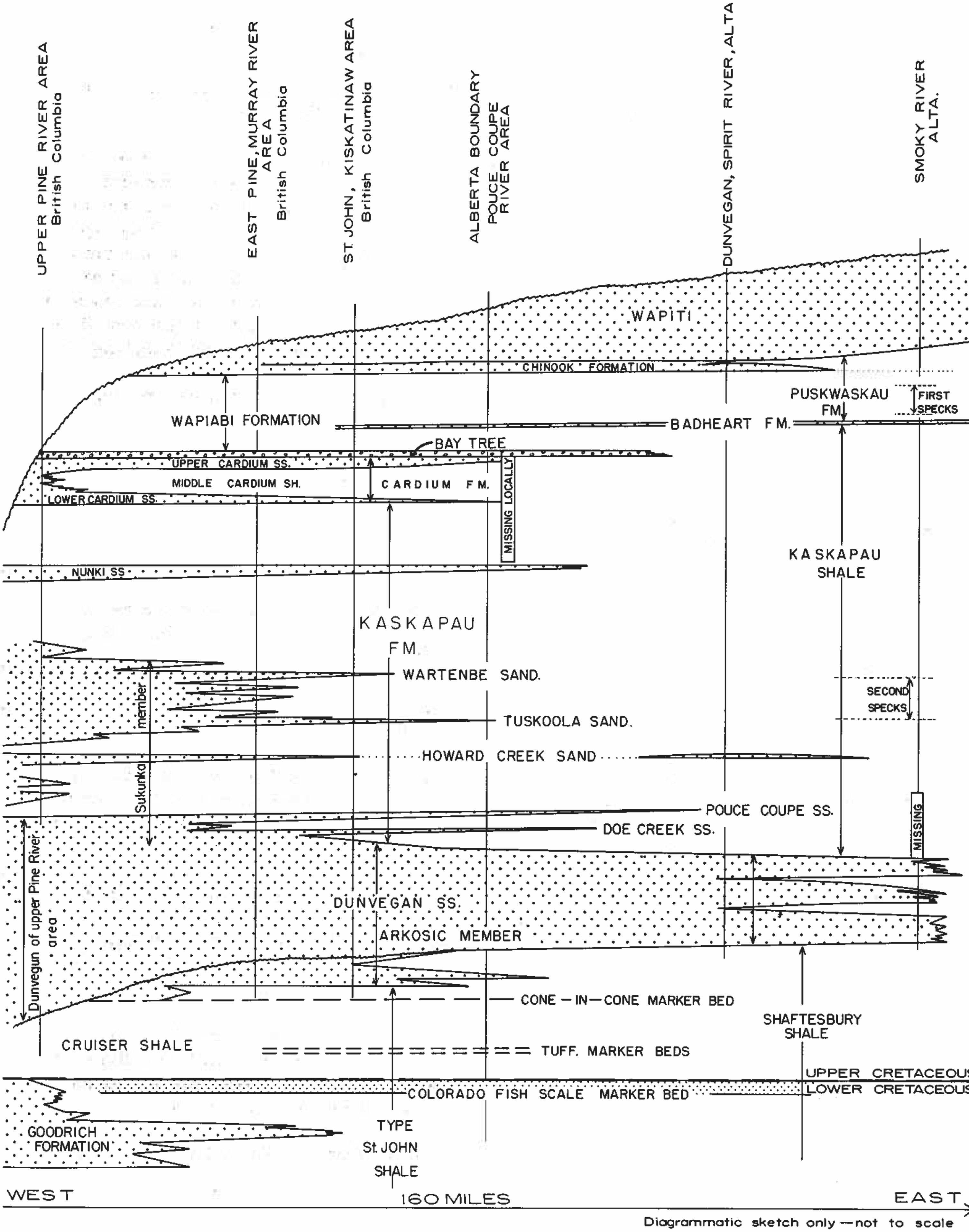
WAPIABI FORMATION

The Wapiabi Formation of northeastern British Columbia consists of fine marine clastics with a total thickness of around 900 feet in the foothills of the Murray River area and around 650 feet in the British Columbia-Alberta boundary area south of Pouce Coupe. The Wapiabi is a soft nodular shale and outcrops rarely.

The basal portion south of Pouce Coupe shows a transitional boundary as pebbles of chert carry on up into the lower portion of the shale. Above the Baytree Conglomerate by about 200 feet is a sandy zone that is referable to the Badheart Formation of the Smoky River area of Alberta. This sand is best developed (50 feet) in the Wapiti River area of British Columbia and poorly expressed farther north.

The "first white specks" horizon of the Colorado Group has not been observed this far northwest by the writer and may not reach Northeastern British Columbia in other than silty shale facies. It should occur just above the Badheart horizon. Similarly latest or post white specks Wapiabi has not been clearly defined.

The following fauna has been collected from the Wapiabi of Northeastern British Columbia south of Peace River:



SCHEMATIC DIAGRAM TO ILLUSTRATE FACIES CHANGES IN UPPER CRETACEOUS STRATA, PEACE RIVER AREA

Scaphites preventricosus Cobban
Scaphites ventricosus Meek and Hayden
Clioscaphites cf. montanensis Cobban
Baculites cf. ovatus Say
Inoceramus undulato-plicatus Roemer
Inoceramus pontoni McLearn
Inoceramus exogyroides Meek and Hayden
Inoceramus selwyni McLearn
Inoceramus lundbreckensis McLearn
Ostrea congesta Conrad

This fauna reappears in part on the Liard drainage within the Kootaneelee Formation.

The microfaunal suites of the Wapiabi have been described by Wall (1960) for the Peace River area of Alberta but there is no similar work for the British Columbia side. The foraminiferal assemblages are dominantly arenaceous on the Alberta side and indicate a shallowing sea above the "first white specks".

CHINOOK FORMATION

A brackish transition zone between the top of the marine Wapiabi shale and the continental Wapiti Formation is established as the Chinook Formation. The type section used by Gleddie (1954) is southeast of Pouce Coupe at Swan Lake and is 153 feet thick. The Chinook consists of silty sandy shales containing glauconite and glauconitic ironstone. It is progressively more sandy toward the base and forms a basal argillaceous sandstone with shaly habit. In the Wapiti River area this lower sandstone becomes relatively clean and entirely marine.

The fauna found south of Pouce Coupe includes:

Liopistha undata Meek and Hayden
Oxytoma nebrascana Evans and Shumard
Inoceramus sp.

The overlying Wapiti Formation appears quite abruptly and may indicate some stratigraphic hiatus at the boundary.

WAPITI FORMATION

The Wapiti Formation is only partially present in British Columbia as only the lower beds cross the border from Alberta where it infills the updip of the Alberta syncline. The basal sand is well exposed in the railway cut south of Swan Lake on the British Columbia-Alberta boundary. North of the Wapiti River area a thickness of 3500 feet of the formation is still present on the British Columbia side. The sandstones are continental, light in colour, cross-bedded, and variable in grain size. Plant remains are found throughout, dinosaur bones have been collected, and coaly beds appear high in the section.

The basal sand bed is usually fairly thick and massive with occasional porosity. The shaly interbeds above the basal member are continental in appearance and sandy. More competent members occur about 1200 to 1500 feet above the base carrying coarse sandstones and some local conglomerates. A second sequence of competent beds about 2300 feet to 2500 feet above the base carry beds of mud conglomerate. These latter are considered to mark the base of the coaly succession.

The flora of the upper succession carries Gingko, Platanus and Cercidophyllum. The freshwater clams Unio cf. danae and Sphaerium have been recovered from the Wapiti Formation and only Belly River equivalents are recognized.

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CRETACEOUS ROCKS OF PEACE RIVER FOOTHILLS[1]

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INTRODUCTION

Cretaceous formations in the Foothills of the Rocky Mountains of northeastern British Columbia (Figure 1) embrace a thick succession of intertonguing marine and continental shales and sandstones. Inasmuch as the Peace River was one of the main canoe routes for early explorations, several pioneer geologists traversed the river and contributed to the early knowledge of the Cretaceous rocks. Furthermore, as a result of those early studies along Peace River, the type sections of many Cretaceous formations are located in that vicinity.

A thick sequence of Lower Cretaceous rocks occurs in the Foothills region where they are commonly faulted and folded. Successively younger beds outcrop eastward and Upper Cretaceous rocks appear near Fort St. John. The Lower Cretaceous rocks have been divided into the Bullhead and Fort St. John Groups. Upper Cretaceous rocks are included in the Dunvegan Formation, the Smoky Group, and the Wapiti Formation. The Wapiti and Smoky rocks do not outcrop along Peace River in the Foothills although basal Smoky shales are present near Fort St. John.

This account is a summary of previous reports and of more recent studies by the author. Some of the major stratigraphic units were established by Dawson (1881) The pioneer work of McLearn (1918, 1923, 1931, 1933, 1945) has served as basis for most of the later studies of Cretaceous stratigraphy. The work of Mathews (1947) in the Carbon Creek basin revealed a previously unknown record of earliest Cretaceous marine rocks in the Peace River region. The studies of Wickenden and Shaw (1943) established a succession of formations which is useful for much of northeastern British Columbia south of Pine River. In the region north of Peace River, Hage (1944) found that the existing terminology was unsatisfactory and proposed new formations. The canyon area was mapped by Beach and Spivak (1944), McLearn and Irish (1944), and Muller (1961). Cretaceous rocks in neighboring areas were mapped recently by Irish (1958), Muller (1961), and Stott (1961a). Unpublished manuscripts by Hughes (1961) and Symons (1960) discuss the stratigraphy of the lowermost Cretaceous rocks. Cretaceous rocks in the Peace River Plains were subdivided by the Alberta Study Group (1954) and their formations have wide application in northeastern British Columbia. A regional stratigraphic study of part of the Cretaceous succession

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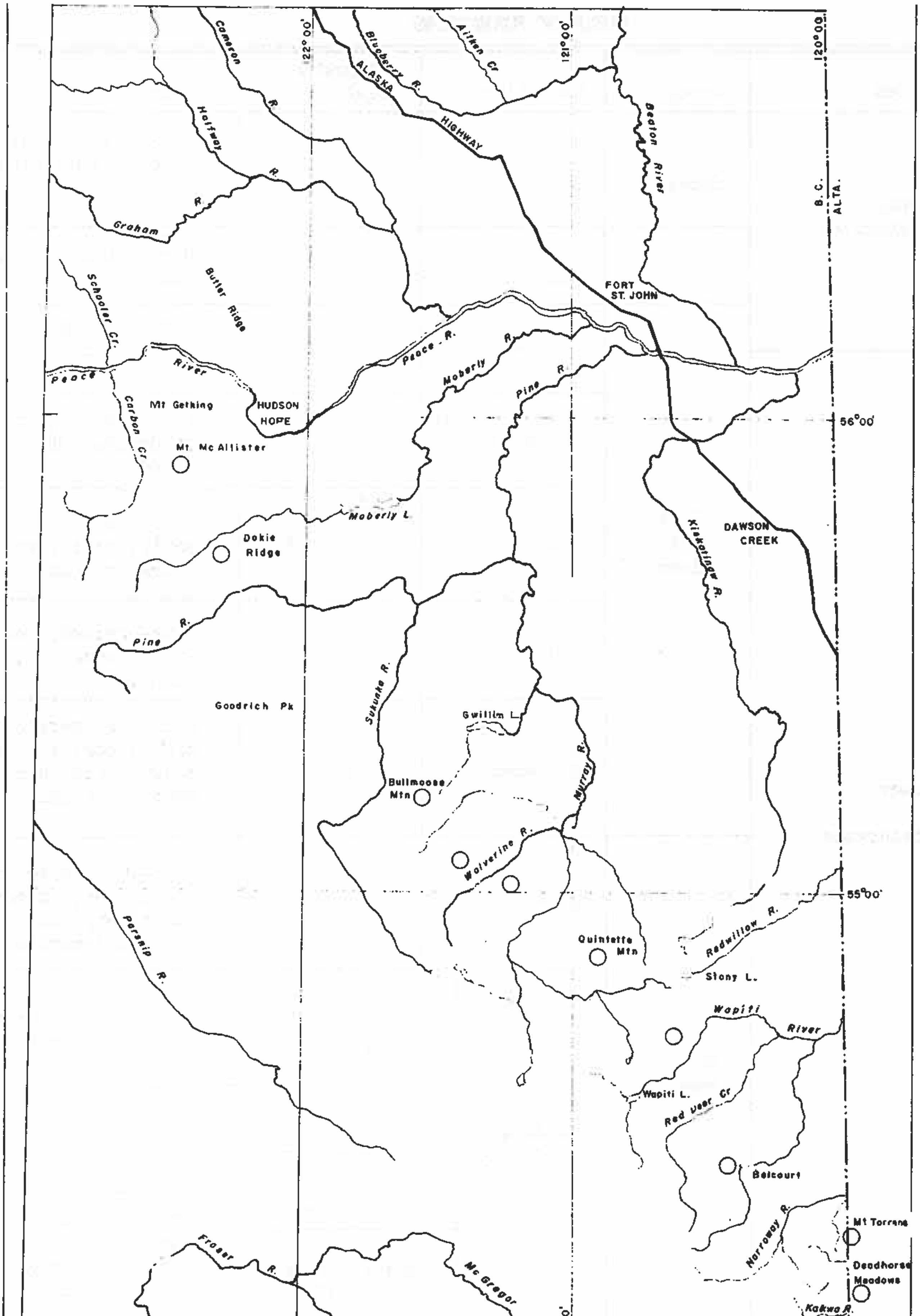

FIGURE: I. INDEX MAP SHOWING LOCATIONS OF MEASURED OUTCROP SECTIONS.

TABLE OF FORMATIONS

Series	Group	Formation	Thickness (feet)	Lithology
Upper Cretaceous	Smoky		1250-3900	Dark grey marine shale and fine grained sandstone
		Dunvegan	300-1200	Marine and non-marine sandstone and shale
	Fort St. John	Cruiser	350-800	Dark grey marine shale with sideritic concretions
Lower Cretaceous		Goodrich	50-1350	Fine grained, cross-bedded sandstone; shale and mudstone
		Hasler	500?-1500	Silty dark grey marine shale; siltstone and sandstone in lower part
		Gates	60?- 220	Fine-grained, marine sandstone; some shale and mudstone.
		Moosebar	100--1000	Dark grey marine shale with sideritic concretions; glauconitic sandstone and pebbles at base.
	Bullhead	Gething	75-1000	Fine- to coarse-grained, calcareous, carbonaceous sandstone, coal, shale, and conglomerate
		Dunlevy (3000-3200)	Cadomin (45-700)	Massive conglomerate and conglomeratic sandstone
				Sandstone, fine- to coarse-grained, quartzose; shale, marine to non-marine; massive quartzites; some carbonaceous sandstone and shale; conglomerate
			Monach (300-400)	
			Beattie Peaks (750-1200)	
Lower Cretaceous and ?Jurassic			Monteith (1000-1750)	

was completed recently by the author (Stott, 1960a, 1961a, 1961b, 1962).

BULLHEAD GROUP

A succession of sandstones, conglomerates, and coal-bearing beds lying between Triassic rocks and marine Lower Cretaceous beds were called the Bullhead Mountain Formation by McLearn (1918; see Figure 2). As later pointed out (McLearn and Kindle, 1950, p. 63), McLearn did not intend to include the Jurassic Fernie shales but only meant to apply the name to the overlying beds. The Bullhead Mountain Formation, when originally defined, was divided into upper and lower members and the former was later given the name Gething by McLearn (1923). The formation was raised to group status and the name was shortened to Bullhead by Wickenden and Shaw (1943).

The present status of beds below the Gething Formation is in a state of flux. Several different classifications have been proposed (Figure 2); each in a different area and each based on a limited area of study. Until such times as broader regional studies adequately determine facies variations and regional unconformities, it is unlikely that a satisfactory and widely applicable terminology can be defined.

The lower formation was first named Dunlevy by Beach and Spivak (1944) who drew its upper boundary at the top of massive conglomerates and below the coal-bearing beds of the Gething Formation. However, according to the Alberta Study Group (1954, p. 277), Beach and Spivak later considered that their lower Dunlevy Formation was largely equivalent to the Nikanassin Formation of the Alberta Foothills. The Study Group suggested that the Bullhead Group should embrace only the Gething Formation and conglomerates of the Cadomin Formation and that the underlying beds should be included in the Nikanassin Formation.

A different classification was proposed by Mathews (1947) who recognized two major divisions - Marine and Non-Marine Bullhead - in the Carbon Creek basin west of the type region of the Dunlevy and Gething Formations. His basal Marine Bullhead was divided into three new formations; Monteith, Beattie Peaks and Monach. The Non-Marine Bullhead, according to Mathews (1947, p. 12), included the Gething and the upper part of the Dunlevy Formation.

During recent studies near Peace River, the writer had the opportunity to briefly examine a well exposed and continuous section on Mount McAllister and other outcrops in the Carbon Creek region. The three formations of Mathews are readily recognized and mapped in that area. However, on Mount McAllister, the coarse quartzose sandstones of the Monach are overlain by a succession of thinly interbedded carbonaceous sandstones and shales. Those beds, having great resemblance to the older Beattie Peaks Formation, are overlain by massive beds of coarse-grained, conglomeratic sandstone (Cadomin) which in turn grade upwards into typical Gething sediments. It is evident that Mathews' Non-Marine Bullhead includes a carbonaceous unit between his Monach Formation and the Cadomin conglomerates.

In a discussion of the unconformity between the Nikanassin and Luscar

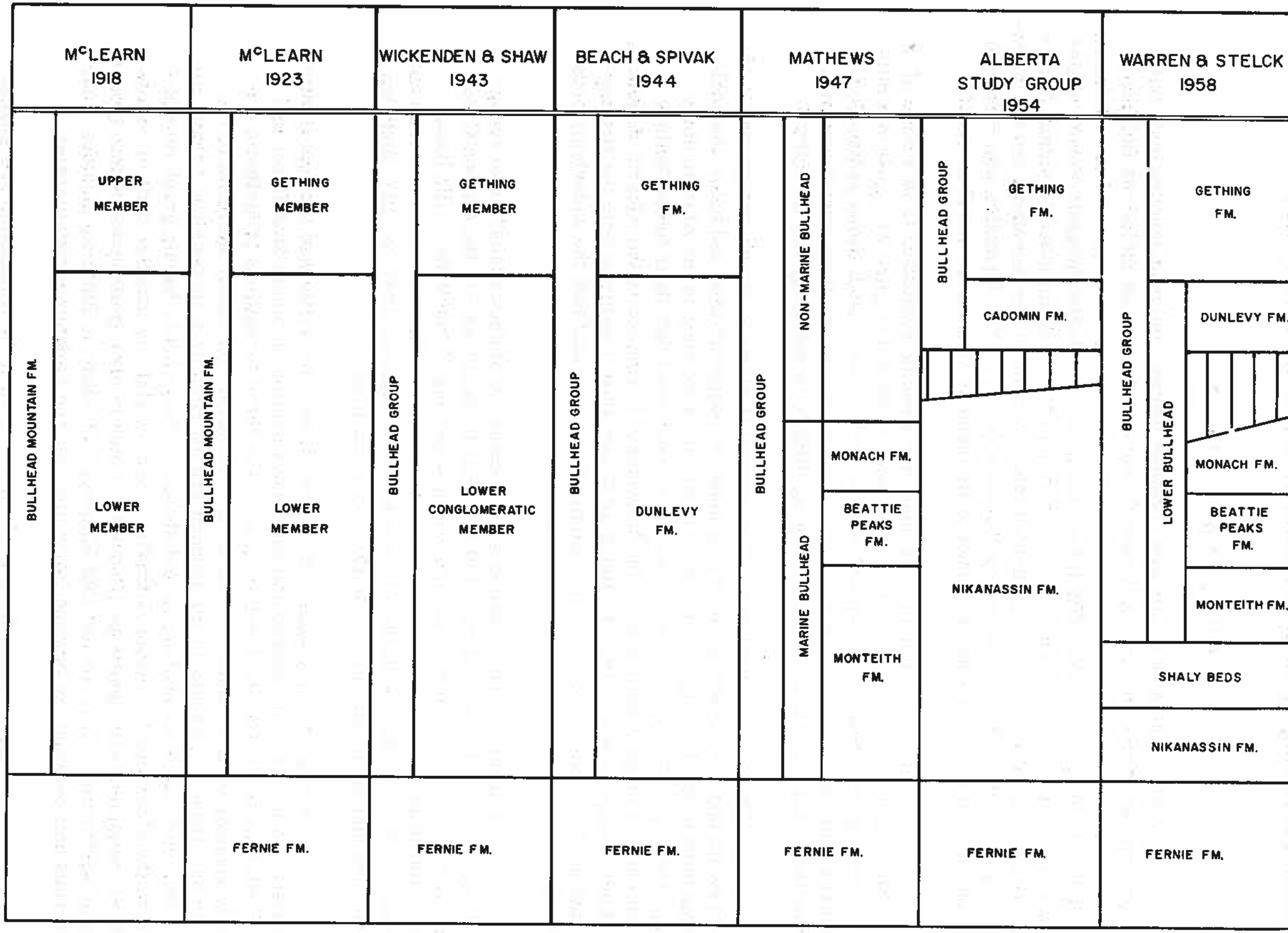

Figure 2. Comparison of nomenclature of Bullhead rocks.

Formations. Warren and Stelck (1958) briefly outlined another succession which was, in large part, a modification of the earlier studies (see Figure 2). They suggested that two additional units (Nikanassin and Shaly Beds) could be recognized below the Monteith Formation.

Muller (1961), in his recent studies of the Pine Pass map-area which included the Carbon Creek basin, used Mathews' terminology. He mapped the Monteith Formation as lying directly above Fernie shales, thereby disagreeing with the succession suggested by Warren and Stelck. Muller's "Gething" Formation is a misnomer as his map-unit includes a much greater succession than the type Gething and in many places probably contains no beds equivalent to that formation.

In an unpublished manuscript, Symons (1960) proposed additional subdivisions of the Bullhead Group between Peace River and Gathto Creek but his discussion of the stratigraphy is very brief and his correlations are somewhat inconclusive.

In another unpublished manuscript, Hughes (1961) attempted to erect two new groups with the major division being made at the top of Mathews' Monach Formation but Hughes' divisions are not entirely satisfactory nor well documented. It seems preferable to make the two-fold division at the major erosional unconformity, placing the earliest Cretaceous rocks of the Carbon Creek basin in one group and the coal-bearing beds of the Gething Formation and underlying conglomerates and coarse-grained sandstones in another.

South of Peace River, equivalent beds are not too well known. The relationship of the Minnes Formation (Ziegler and Pocock, 1960) and the type Nikanassin Formation to the Peace River succession is not well documented.

A brief summary of the Lower Bullhead formations follow. For the purposes of this account, Mathews' terminology is used although it may not be entirely adequate. However, these stratigraphic subdivisions are useful, even in those areas where the Dunlevy Formation has been mapped, for establishing stratigraphic relationships with the overlying beds.

MONTEITH FORMATION

The Monteith Formation was proposed by Mathews (1947, p. 10) for flaggy to massive sandstones and quartzites that he believed to lie above the Jurassic Fernie Formation. The type section is presumably on Mount Monteith but Mathews indicated the presence of good exposures on Beattie Peaks.

The formation extends around the Carbon Creek basin where the prominent quartzites (Plate I) form a high rim on the eastern side. Muller (1961) indicated that the formation extended southeastward across Pine River to Mount Le Hudette and Goodrich Peak. During studies south of there, the writer (Stott, 1960a, 1961a) did not see quartzites similar to those of the typical Monteith but that part of the stratigraphic column was not studied in detail. The Monteith quartzites were recognized north of Peace River towards Halfway River and eastward on Butler Ridge. The Monteith beds in the vicinity of the canyon have been included by most workers in the Dunlevy Formation.

Mathews reported that the Monteith Formation was 1,750 feet thick on Beattie Peaks and not over 1,000 feet at Indian Head. Muller (1961) stated that the formation reached a thickness of over 2,000 feet in the Pine Pass map-area.

According to Mathews (1947, p. 10):

> "The greater part of the Monteith formation is made up of dark grey arkosic sandstone, massive to flaggy, and in places showing cross-bedding and ripple marks. This sandstone occurs in beds usually from 10 to 30 feet thick, each separated by a few feet of shale or shaly sandstone. The uppermost 500 feet of the formation is made up of white quartzite, commonly stylolitic and locally vuggy."

The discussion of Warren and Stelck (1958) deals only briefly with the Bullhead succession and does not clearly indicate whether they consider that a previously unrecognized succession of sandstones lies between the Monteith and Fernie Formations or whether they are restricting Monteith to the upper quartzites.

Fossils identified and dated by Jeletzky[1] and reported by Muller (1961) from the Monteith Formation are of Berriasian to Lower Valanginian age.

BEATTIE PEAKS FORMATION

The Beattie Peaks Formation, named by Mathews (1947, p. 11) is typically developed on the western slopes of Beattie Peaks. It comprises interbedded shales and sandstones and is readily mapped as a recessive unit above the prominent Monteith quartzites.

The formation occurs within the Carbon Creek basin, being about 1,200 feet on Beattie Peaks, 750 feet at Indian Head, and 600 feet on Beaudette Creek (Mathews, 1947, p. 11). Muller (1961) considered that the formation attained a thickness of 1,500 feet and mapped it as far as Goodrich Peak south of Pine River. A thick unit, considered to be at least partly equivalent to Beattie Peaks strata occurs above the Monteith quartzites north of Gold Bar but disappears northeastwards towards Pink Mountain and eastward on Butler Ridge. The greater thickness of the formation in areas outside of Carbon Creek basin may possibly be due to the inclusion of beds equivalent to the type Monach and younger beds.

The Beattie Peaks Formation contains a succession of thinly interbedded, platy siltstones, sandstones, and shales. Some of the shale is black and appears very carbonaceous but no coal seams were noted. The sandstone occurs in 4-foot to 5-foot units, is thin-bedded to flaggy, dark grey to brownish-grey, very fine-grained and laminated. Ripple marks are common. The upper part of the formation becomes

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1 Palaeontologist, Geological Survey of Canada.

Stott, 6-4-61

Plate I. Massive quartzites of Monteith Formation, Mount McAllister, east flank of Carbon Creek basin.

Stott, 6-12-61

Plate II. Lower beds of Gething Formation, downstream from Peace River Mine at head of canyon.

sandier by an increase in sandstone units and is gradational into the sandstones of the Monach Formation.

Muller obtained fossils from the Beattie Peaks that were identified by Jeletzky as being of early Valanginian age.

MONACH FORMATION

Massive, medium- to coarse-grained quartzose sandstones lying above the Battie Peaks Formation were defined as the Monach Formation by Mathews (1947, p. 11). The type section is on The Monach but Mathews reported good exposures on Beattie Peaks. The formation is mapped within the Carbon Creek basin but no published report shows it to extend beyond there. Muller (1961) had difficulty in recognizing the formation as a mappable unit and included it, where present, with overlying beds. The apparent absence of the Monach south of Pine River and north of Peace River may be attributed to either facies changes or to an unconformable succession from which the Monach has been removed by erosion. Much of the Monach sandstone on Mount McAllister is similar to underlying and overlying beds and could grade laterally into beds that could not be separated lithologically from enclosing sediments.

Mathews considered that the Monach Formation was overlain by Non-Marine Bullhead strata but did not clearly establish the relationship of those bed to the Gething Formation. In an almost continuously exposed and very thick section on Mount McAllister, the Monach is separated from the Cadomin conglomerates and sandstones by a succession of interbedded fine-grained brown, laminated sandstone and silty shale. Some of those sandstones are typical of the more southerly Nikanassin Formation, being very finely laminated, black, and limonitic. Although the sediments appear carbonaceous (and were apparently included by Mathews in his Non-Marine Bullhead), large coal seams are not present and there is little or no evidence of minor coal although thin beds could be present.

Muller (1961) reported that fossils of Middle Valanginian age were collected from the Monach Formation.

DUNLEVY FORMATION

The name Dunlevy was applied by Beach and Spivak (1944) to the lower Bullhead sediments in the vicinity of Peace River Canyon. McLearn and Kindle (1950, p. 64) divided the Dunlevy into two parts; the lower part consisting of quartzitic sandstone with carbonaceous shales, and the upper part comprising "400 to 600 feet of massive, cross-bedded coarse-grained, grey to reddish weathering conglomeratic sandstones and grits". These latter beds are included by the writer in the Cadomin Formation.

Beach and Spivak (1944, p. 4) measured 2,440 feet of Dunlevy beds on Mount Gething and estimated that the total thickness ranged from about 3,000 to 3,200 feet. The Dunlevy Formation, mapped only in the immediate vicinity of the canyon, contains, according to Beach and Spivak, thick-bedded, fine-grained quartzitic sandstone and carbonaceous shale. In areas where the Dunlevy beds have been mapped, the lower part includes rocks similar to those of Mathews' formations. The quartzites exposed on Butler Ridge are typical of the Monteith Formation of the Carbon Creek basin. Quartzites exposed along the road between Gold Bar and Rainbow Rocks were also mapped as Dunlevy but are typical of the Monteith rocks. At the same locality, the overlying interbedded sandstones and shales are typical of the Beattie Peaks Formation. Although Hughes (1961) considered that the Monach Formation also outcropped at Rainbow Rocks, evidence of its presence was inconclusive. The Dunlevy beds that Beach and Spivak described on Mount Gething (presumably the type section) bear much similarity to the succession of Carbon Creek basin.

CADOMIN FORMATION

The Cadomin Formation (McKay, 1929, 1930) originally defined south of Athabasca River, was mapped between there and Peace River canyon (Lang, 1947a, 1947b; Eccles, 1957; Irish, 1947, 1951, 1954, 1957; Stott, 1960a, 1961a). Although the typical massive conglomerates disappear south of Pine River, pebbly coarse-grained sandstone occurring in a similar stratigraphic position in the Peace River Foothills is considered to be equivalent.

Those beds outcrop at the Head of the Canyon where over 300 feet were measured. More than 500 feet of those sandstones are present on Mount Gething and more than 660 feet on Butler Ridge. Similar beds are exposed in the Carbon Creek basin where they occur several hundred feet above the Monach Formation. North of Peace River, the coarse-grained sandstones grade into finer sediments.

As previously stated, the Cadomin sediments lie well above the Monach Formation in the Carbon Creek basin. Near Rainbow Rocks, they lie on the Beattie Peaks Formation and farther east on Butler Ridge, they lie either on or just above the Monteith Formation. A similar relationship was found in the area between Peace River and Sikanni Chief River. At the latter locality, equivalent beds appear to rest directly on the Jurassic Fernie Formation. A major erosional unconformity is postulated to explain the relationships.

The relationship of the coarse basal unit and the Gething Formation is not entirely clear. At the Head of the Canyon, the Gething Formation lies above the conglomeratic sandstones but it is readily seen that some of the higher and coarser sandstones grade laterally into interbedded coal, sandstone, and shale. There is, therefore, some possibility that in nearby areas, the coarser sediments are actually in part lateral equivalents of the Gething Formation rather than a distinctly older preceding unit. Such relationships were established between the two formations in the region south of Pine River (Figure 6).

The sandstones occur in massive 5-foot to 20-foot beds. Bedding is not always apparent but both planar and cross-bedded units are present. Pebbles, commonly well rounded and composed mainly of chert and quartzite, are embedded in a matrix of strongly cemented, coarse- to medium-grained sandstone.

The Cadomin and Gething Formations are part of one depositional sequence in part of northeastern British Columbia (Figure 6). The Cadomin conglomerates and sandstones are a piedmont facies which grades easterly and northeasterly from the western Foothills into floodplain deposits included in the Gething Formation.

The Cadomin Formation lies well above the Monach Formation in the Carbon Creek basin. As the youngest fauna reported from the latter is Middle Valanginian, the Cadomin Formation, of that region at least, must be somewhat younger.

GETHING FORMATION

The Gething Formation (McLearn, 1923, p. 4B) outcrops in the Peace River canyon (Plate II) and the exposures on Aylard Creek[1] and the North Shore are considered as type. McLearn (1923, Figure 2) showed, in a composite section, that the type formation was about 1,400 feet thick. A revised correlation by the writer (Figure 3) indicates that the thickness is nearer 1,000 feet.

The Gething Formation extends southward from Peace River to upper Smoky River where equivalent beds are included in the basal part of the Luscar Formation. Variation in thickness is significant only when both the Gething and Cadomin facies are considered together (Figure 6).

Sandstones of the Gething Formation are fine- to coarse-grained, generally carbonaceous, and laminated. Mudstones are commonly carbonaceous and silty. Coal development is at a maximum in the canyon but coal does occur within the formation in the region to the south.

North of Peace River, the coal-bearing beds grade laterally into thick-bedded, fairly clean, fine-grained sandstones separated by thin units of shale. In that region, only minor coal and conglomerates occur within the succession.

The Cadomin-Gething succession has already proven to be a reservoir of petroleum and natural gas in northeastern British Columbia. Petroleum is obtained from those beds in the Aitken Creek, Beatton River West, Buick Creek, and Charlie Lake fields. Natural gas is obtained from the succession in the Aitken Creek, Boundary Lake, Buick Creek West, Fort St. John, Fort St. John Airport, Fort St. John Southeast, and Montney fields. The success, to date, warrants anticipation of additional discoveries in those rocks.

Dinosaur footprints, occurring on sandstone surfaces within the Gething Formation, are exposed in the canyon. Six genera and eight species of dinosaurs were identified by Sternberg (1932). No reptilian bones have been reported from the formation.

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1 Aylard Creek, as used herein, is a small tributary flowing into the canyon between Gething and Moosebar Creeks. It should not be confused with Aylard Creek at Gold Bar.

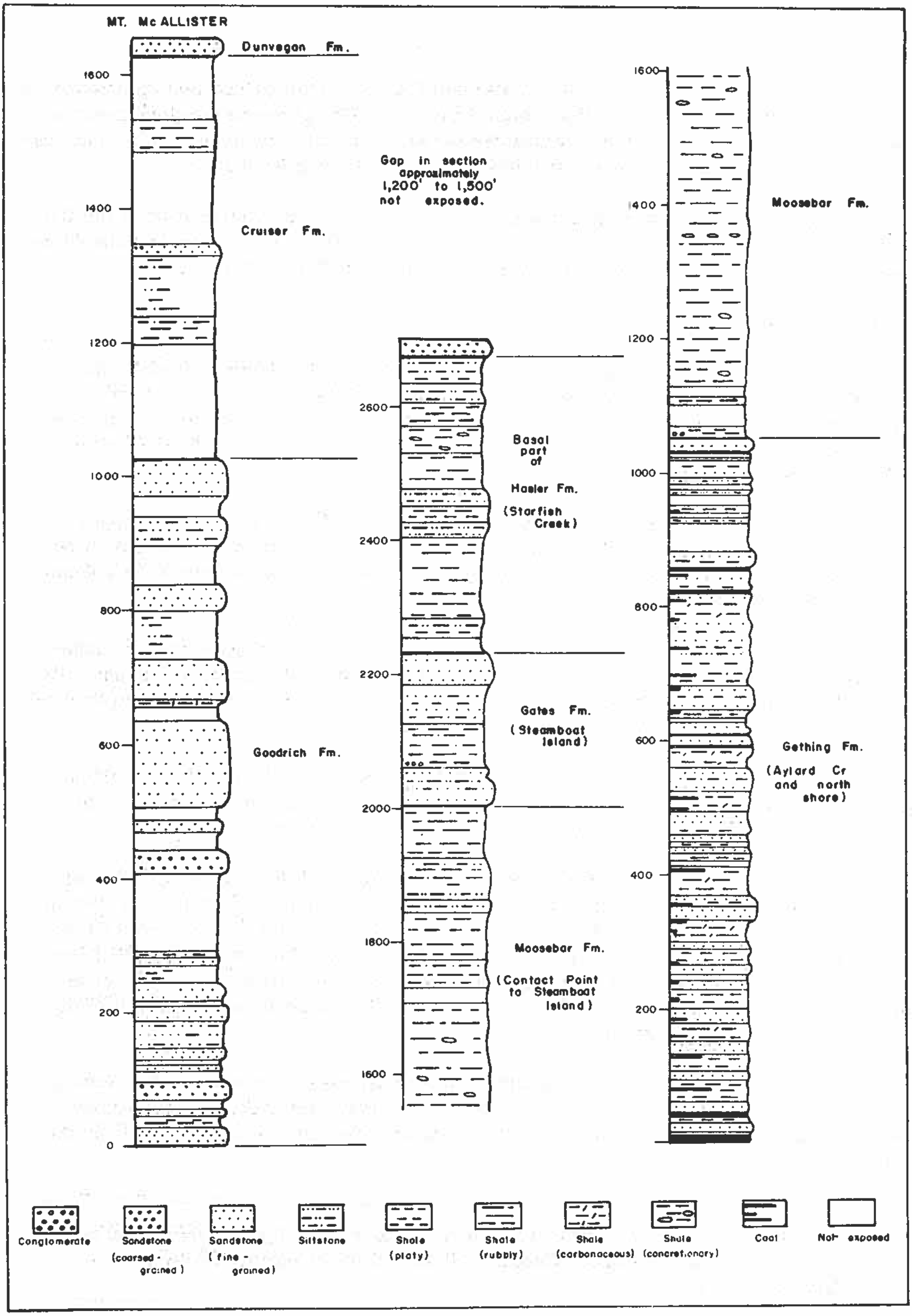

FIGURE 3. Composite columnar sections of Cretaceous formation in vicinity of Peace River Foothills, British Columbia.

Flora obtained from the Gething Formation is considered by Bell, McGregor, and Hueber[1] to be of the same age as the lower Blairmore flora that is generally considered to be Aptian (Bell, 1956). A similar flora, containing a much larger number of lower Blairmore species, was obtained from the Lower Member of the Commotion Formation south of Pine River. As the Commotion Formation contains marine fossils of Middle Albian age, it is apparent that the "Lower Blairmore-Luscar-Gething" flora extends upwards into rocks of Middle Albian age. Therefore, the dating of the Gething Formation on floral evidence becomes inconclusive. Beds of Middle Valanginian age lie much below the Gething Formation in Carbon Creek basin and Middle Albian Moosebar shales overlie it. The Gething Formation can, therefore, be dated only as Neocomian to Albian in age.

FORT ST. JOHN GROUP

Lower Cretaceous rocks of predominantly marine origin in the vicinity of Peace River were included in the Fort St. John Group (Dawson, 1881; see also McLearn, 1918, 1923, 1932; McLearn and Kindle, 1950). Farther south, those marine rocks intertongue with continental sediments and, as stated by McLearn and Kindle (1950, p. 73), "it is not possible to use one, uniform classification of the strata for all of northeastern British Columbia". In the Peace River canyon area, the group is divided, from the base upwards, into Moosebar, Gates, Hasler, Goodrich, and Cruiser Formations (Figures 3, 4). Farther south in the vicinity of Pine River, the succession becomes Moosebar, Commotion, Hasler, Goodrich, and Cruiser Formations. Other divisions are used in other parts of the Foothills and in the Plains (Figure 5). Although the terminology appears complex, the numerous names are useful for mapping purposes and emphasize the major variations in facies that occur in that region.

MOOSEBAR FORMATION

The type locality of the Moosebar Formation, as defined by McLearn (1923), is on the south side of Peace River below Contact Point (Plate III), although the upper beds are better exposed across the river. At that locality, the formation is about 950 feet thick (Figure 3). The Moosebar Formation consists of dark grey to black marine shales with some interbedded siltstone and sandstone.

The lower contact with the Gething Formation is exposed at Contact Point and also at the type Gething section on Aylard Creek. At Contact Point, one foot of gritty, argillaceous sandstone with disseminated pebbles rests abruptly on carbonaceous sandstone of the Gething Formation. The pebbly sandstone is overlain by typical silty marine mudstone. On Aylard Creek, pebbles are embedded in the surface of the upper sandstone of the Gething Formation and Moosebar shale lies immediately above. Farther east on Johnson Creek, a two-foot bed of pebbles in an argillaceous matrix marks the base of the Moosebar Formation. Similar relationships were noted farther south. Although the contact may be disconformable, no evidence of a regional erosional unconformity was found.

1 Palaeobotanists, Geological Survey of Canada.

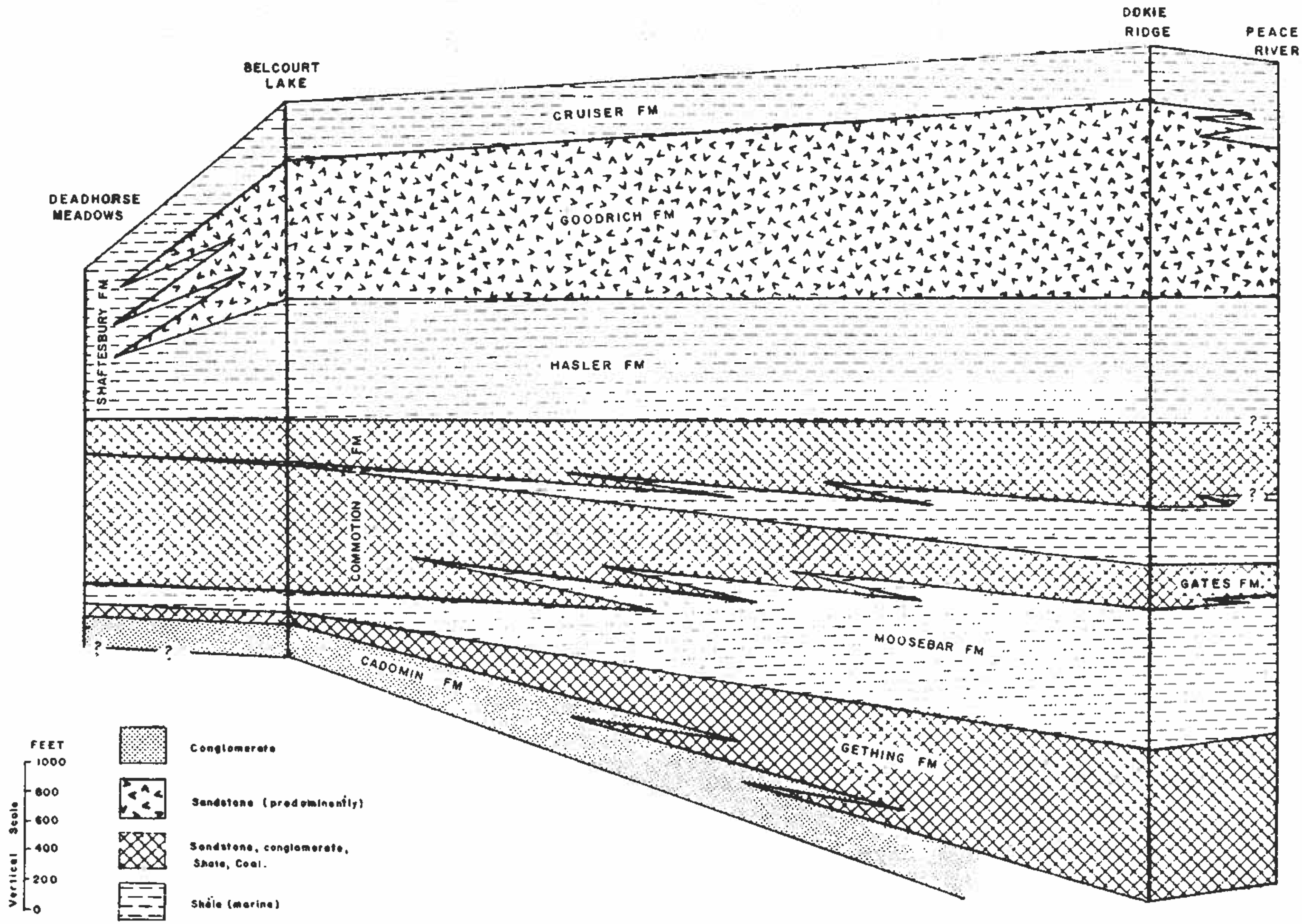

FIGURE 4 : SCHEMATIC DIAGRAM, BASED ON MEASURED OUTCROP SECTIONS, OF FORT ST. JOHN GROUP, GETHING & CADOMIN FORMATIONS, FOOTHILLS OF ALBERTA & BRITISH COLUMBIA.

The upper beds of the Moosebar Formation are gradational into the overlying Gates Formation (Plate V) and the contact is drawn at the base of thick-bedded sandstone.

The Moosebar Formation extends southeastward along the Foothills at least as far as Kakwa River (Figures 4, 6). It decreases from its maximum thickness in the vicinity of Peace River to a minimum of about 75 feet on Kakwa River. As marine beds in an equivalent stratigraphic position were reported from the Athabasca River by Mellon and Wall (1961), the formation may extend southward beyond upper Smoky River. Equivalent beds north of the canyon are included in the Buckinghorse Formation (Hage, 1944).

The basal shales of the Moosebar Formation are dark grey to black, rubbly to blocky, and contain ironstone concretions. The lower beds are commonly glauconitic. Highly glauconitic argillaceous sandstone and siltstone, occurring near the base of the formation on Bullmoose Mountain and Sikanni Chief River are probably equivalent to the Bluesky Formation of the Plains. The Moosebar shales grade upwards into silty mudstone and siltstone that are brown to green in colour.

Marine shales of the Moosebar Formation intertongue with nearshore and continental sediments included in the Gates and Commotion Formations (Figure 6). The dominance of marine sediments near Peace River indicates that the marine environment persisted longer there than farther south where deposits of the continental environment almost entirely replace the marine rocks.

The Moosebar Formation contains the Middle Albian Lemuroceras-Beudanticeras fauna. It is correlated with the Bluesky Formation and the Wilrich Member of the Spirit River Formation of the Plains, the Loon River and Clearwater Formations of eastern Alberta, the basal Buckinghorse and basal Garbutt shales of the more northerly part of British Columbia (Figure 5).

GATES FORMATION

The prominent sandstone at the Gates (Plate IV) on Peace River east of Hudson Hope was defined as the Gates Formation by McLearn (1923). At that locality, only about 60 feet are exposed but farther west at Steamboat Island, more than 225 feet are present (Figure 3). At the latter locality, the formation consists of two sandstones (Plate V) separated by a thick interval of interbedded shale and siltstone.

The lower beds of the Gates Formation are transitional into the underlying Moosebar sediments (Plate V). The upper contact is more abrupt. At the Gates, the uppermost fine-grained sandstone is overlain by 4 feet of massive argillaceous siltstone which in turn is overlain by silty mudstone.

The Gates sandstone was traced by helicopter from Steamboat Island southwestward along Moosecall Lake towards Mount McAllister. Immediately east of the latter locality the Gates is included as the lower member of the Commotion Formation (Figures 4, 6). The Gates Formation, therefore, occurs only in the immediate

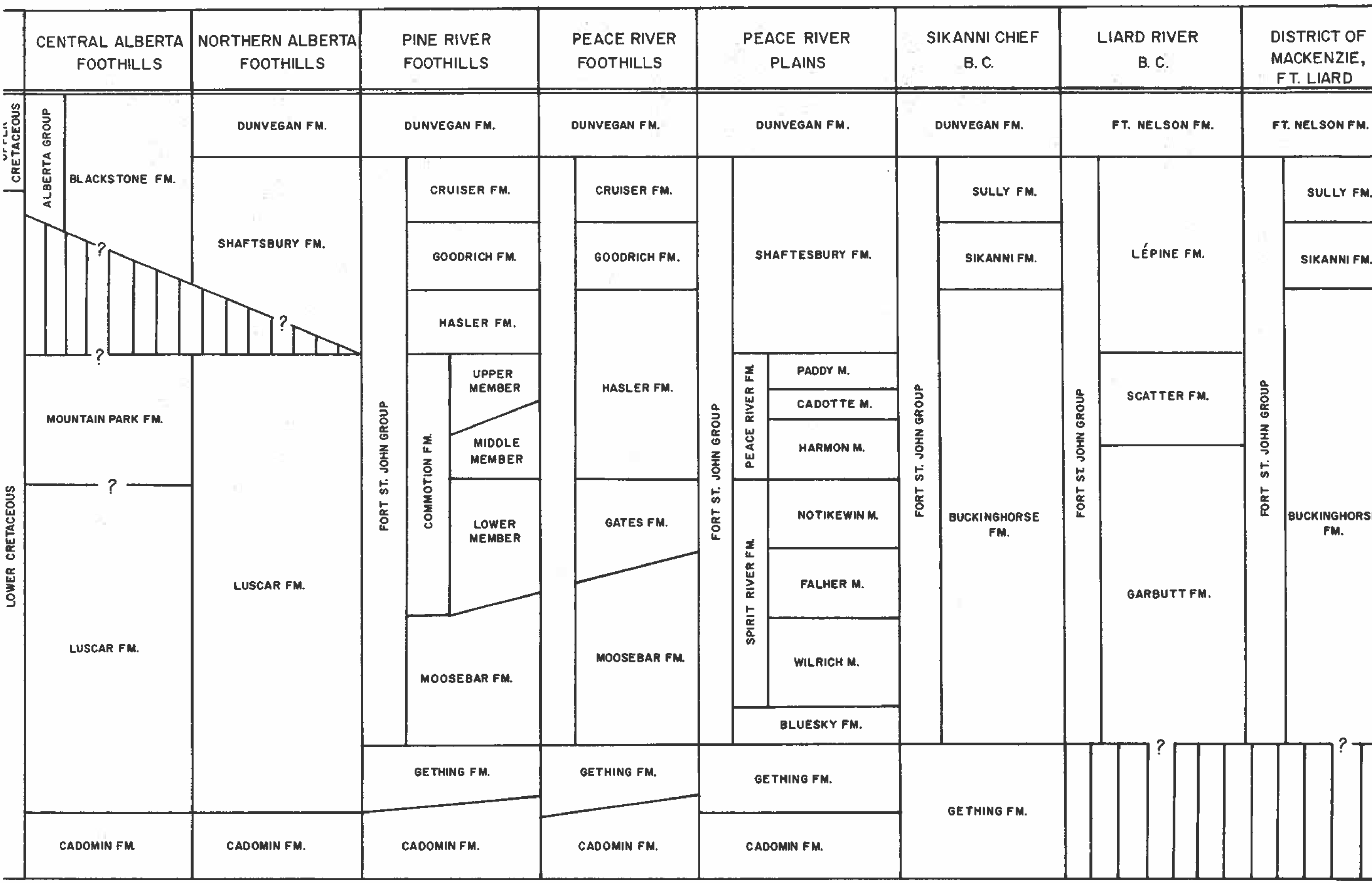

Figure 5. Correlation of Lower Cretaceous Fort St. John Group of Northern Foothills Region.

Stott, 4-3-61

Plate III. Moosebar Formation at type locality, Contact Point, south side of Peace River below canyon.

Stott, 7-2-61

Plate IV. Gates Formation, type locality at The Gates east of Hudson Hope.

Stott, 4-5-61

Plate V. Gates Formation at Steamboat Island, east end of canyon. Upper beds of Moosebar Formation in lower slope.

Stott, 5-11-61

Plate VI. Shales above Gates Formation across river from Starfish Creek. Sandy beds at top are equivalent to Upper Commotion Member.

vicinity of Peace River canyon and extends eastward towards Fort St. John. It has not been recognized in outcrop north of Peace River.

Sandstones of the Gates Formation are fine-grained, well sorted, and massive to thick-bedded. Some interbedded siltstone and shale are included. Some of the sandstone contains abundant glauconite.

The Gates and Moosebar Formations contain the deposits of a major marine transgression and regression. The Moosebar Formation contains the offshore marine shales and the Gates includes the transitional, nearshore sandstones. . That depositional sequence grades vertically and laterally from marine shale into nearshore sandstone and, in the region south of Peace River, into sediments of the delta and floodplain environments that are included in the Commotion Formation (Figure 6). The initial transgression extended towards upper Smoky River but marine conditions persisted much longer near Peace River.

The Gates Formation contains fossils of the Middle Albian Lemuroceras-Beudanticeras zone and is overlain by beds of the Middle Albian Gastroplites zone. The formation is equivalent to the upper beds of the Spirit River Formation of the Plains and to middle beds of the Buckinghorse Formation in the more northerly Foothills (Figure 5). Equivalent beds farther south are included in the Commotion and Luscar Formations.

Suitable reservoir rock may exist at several horizons in the Fort St. John Group, including that of the Gates sandstone. Considerable drilling has been carried out east of the Foothills and three gas fields - Dawson Creek, Sunrise, and Pouce Coupe - produce from the Cadotte sandstone (upper Commotion equivalent of the Fort St. John Group). Such marine sandstones, similar to the Gates and Cadotte, occur at several widespread horizons and their well-sorted character are favorable to good porosity. The development of stratigraphic traps, formed by sandstones enclosed by shales, is favored by the type of intertonguing that is common throughout the group.

HASLER FORMATION

In its type region, the Hasler Formation comprises those marine shales between the Commotion and Goodrich Formations (Wickenden and Shaw, 1943, p. 6; see also Stott, 1961b, p. 15). On Peace River near Hudson Hope, beds equivalent to the upper two members of the Commotion Formation are predominantly marine shale and, for mapping purposes, have been included in the Hasler Formation (Plate VI).

No complete section of the Hasler Formation is known to outcrop in the vicinity of Peace River. The type section on Dokie Ridge south of the canyon is 868 feet thick (Stott, 1961b, p. 15). Its thickness near Peace River, due to the inclusion of older beds is probably in the order of 1,200 to 1,500 feet.

The Hasler Formation is a succession of marine shale with some siltstone and sandstone. The shales, similar to other Cretaceous marine shales, are

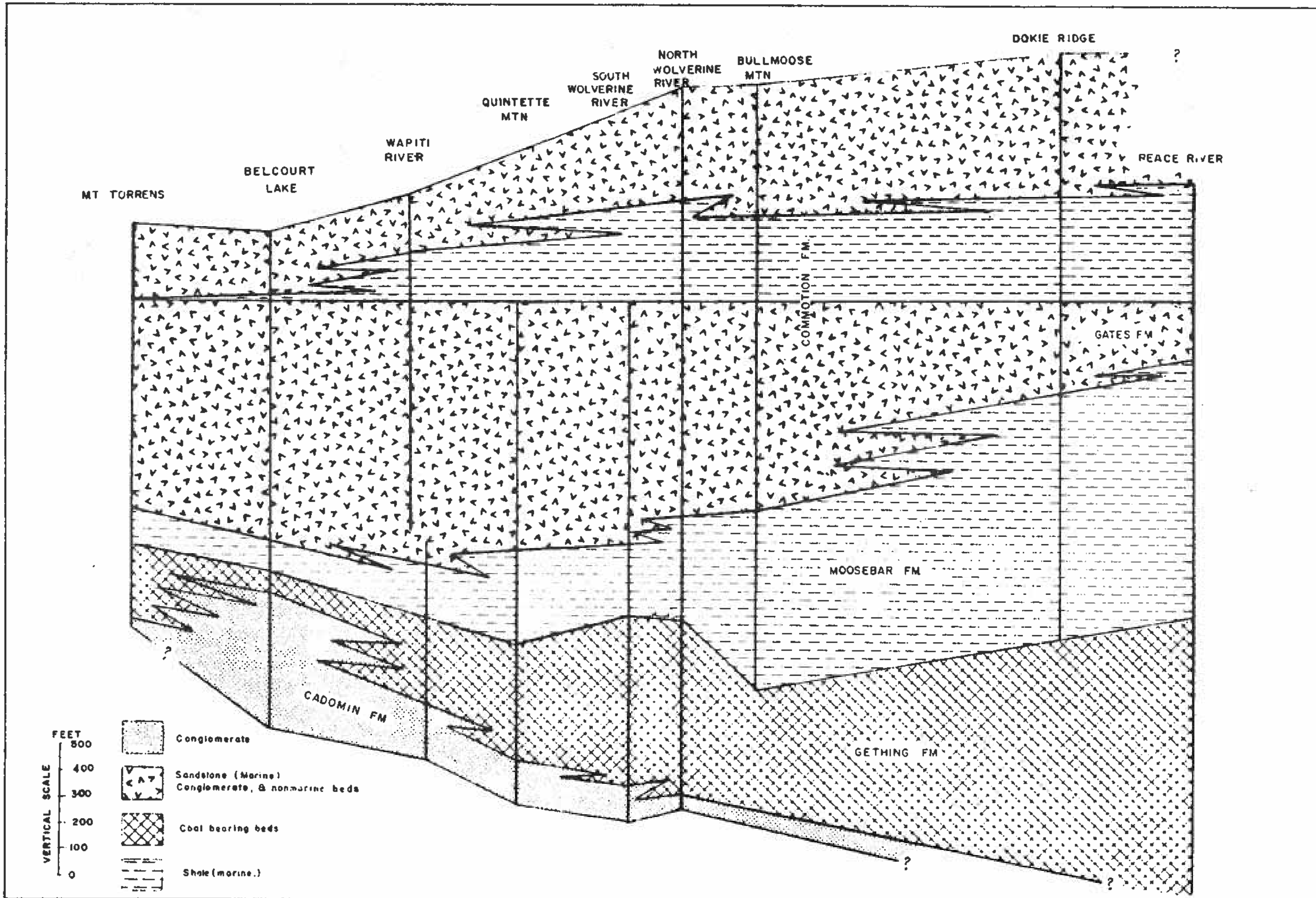

FIGURE 6 - SCHEMATIC DIAGRAM, BASED ON MEASURED OUTCROP SECTIONS, OF COMMOTION, GATES, MOOSEBAR, GETHING AND CADOMIN FORMATIONS, FOOTHILLS OF ALBERTA & BRITISH COLUMBIA.

dark grey to black, rubbly to blocky, weather rusty, and contain sideritic concretions.

A major transgression is recorded by the Hasler sediments, indicating widespread marine conditions throughout northeastern British Columbia during Middle to Late Albian time. That marine invasion extended far over the Commotion beds and brought to an end the deposition of continental sediments in the present Foothills region of British Columbia during late Lower Cretaceous time.

The type Hasler Formation lies above beds containing the Middle Albian Gastroplites fauna and below beds containing the late Albian Neogastroplites fauna. In the Peace River canyon region, the Hasler Formation includes older beds containing the Gastroplites fauna. A brief discussion of the nicrofauna from those beds and other members of the group is given by Stelck et al (1956). The Hasler Formation is correlated with the basal Shaftesbury shales of the Plains and with beds of the Upper Buckinghorse and basal Lépine Formations to the north (Figure 5).

GOODRICH FORMATION

The Goodrich sandstones, originally defined as a formation by Wickenden and Shaw (1943) extends northward from its type locality in the Pine valley towards Peace River. The formation is well exposed on Mount McAllister where more than 1,000 feet of beds were measured (Figure 3). The Goodrich sandstones grade eastward into shale and lose their identity as a mappable unit in the vicinity of Cameron Lakes south of Hudson Hope. Although they are not recognized in the Peace River valley, equivalent sandstones occurring farther north are included in the Sikanni Formation.

Both upper and lower boundaries of the Goodrich are more or less gradational. Neither appear to lie at any persistent stratigraphic position from one place to another, but more probably are drawn at different levels as successive sandstones grade laterally into shale.

On Mount McAllister, the Goodrich Formation consists of a succession of sandstones, 5 feet to 80 feet thick, separated by recessive, covered intervals that are presumed to be mainly shale or mudstone. The sandstones are fine-grained, laminated, brown, and brown weathering. Some minor coarse-grained sandstone and conglomerates do occur within the formation. Although carbonaceous mudstone and some angiosperm plant fossils are present in the upper part, the formation is probably mostly of marine origin.

The sandstones, the nearshore facies of the Hasler-Cruiser-Shaftesbury sea, attain their maximum development between Mount McAllister and Dokie Ridge. The depositional trend is approximately parallel to the Foothills of that region. The easternmost extension of the sandstone is an approximate line between Hudson Hope and the junction of Pine and Murray Rivers.

The Goodrich Formation contains the late Albian Neogastroplites fauna. It is correlated with the middle part of the Shaftesbury Formation of the Plains and with the Sikanni sandstones north of Peace River. Some part of it is probably equivalent to the "Fish Scale" sands used as a key horizon in subsurface correlations.

CRUISER FORMATION

The Cruiser Formation (Wickenden and Shaw, 1943; see also Stott, 1961b, p. 24), consisting of marine shale, outcrops in only a few localities and exposures are insufficient to determine in detail the facies variations along the Foothills. The shales apparently intertongue with Goodrich- and Dunvegan-type sandstones and both upper and lower boundaries change stratigraphic position within relatively short distances.

In the type section, 742 feet of shales outcrop but westward on Dokie Ridge, only 361 feet are included in the formation (Stott, 1961b). On Mount McAllister, just south of Peace River, 611 feet were considered to belong to the formation (Figure 3). The differences are attributed mainly to facies changes.

The Cruiser shales and mudstones are silty, dark grey, and rusty weathering. A few reddish brown weathering sideritic concretions occur. Siltstone and fine-grained sandstone, occurring in half-inch to three-inch beds, increase in abundance towards the top.

The marine transgression recorded in the Cruiser Formation did not extend as far as the Hasler invasion. The nearshore sands found in the sections on Mount McAllister and Dokie Ridge indicate that the shoreline was not far distant.

As fossils are rare in the Cruiser Formation, its age is inferred from the enclosing beds. The underlying Goodrich beds contain the late Albian Neogastroplites fauna and the overlying Dunvegan Formation contains a fauna that Jeletzky tentatively considers to be of early upper Cenomanian age. Thus, the Cruiser Formation can be dated as being of latest Albian to early Cenomanian age. It is correlated with the upper Shaftesbury shales of the Plains and the Sully Formation (Stott, 1960b) of the District of Mackenzie. It is probably equivalent to most of the shales between the Fish Scale marker-horizon and the Dunvegan Formation.

SHAFTESBURY FORMATION

The Shaftesbury Formation was originally defined by McLearn and Henderson (1944) as those marine shale beds lying between the Dunvegan and Peace River Formations. Although the formation is used mainly as a subsurface unit, it is applicable in some parts of the Foothills (Stott, 1960a, 1961a). In the Peace River region where the Goodrich sandstones disappear, marine shales apparently extend from the Dunvegan to the Gates Formation and therefore include beds equivalent to the type Shaftesbury as well as older beds. That succession contains the offshore, mid-basin shales equivalent to the Hasler-Goodrich-Cruiser succession.

Irish (1958) included all the shales between the Gates and Dunvegan Formations in his 'Upper Shales' and stated that they ranged between about 1,400 feet and 1,800 feet in thickness

DUNVEGAN FORMATION

The Dunvegan Formation, as defined by Dawson (1881) included a succession of sandstone and interbedded shale in the vicinity of Dunvegan on Peace River.

The Dunvegan Formation lies conformably on the Fort St. John Group. The upper beds are commonly gradational into the overlying Smoky Group and the contact is drawn above carbonaceous shale and massive sandstone.

Although the Dunvegan is widely distributed in northeastern British Columbia, few complete outcrop sections are known. The western outcrop limit of the formation north of Peace River is shown by Irish (1958) to lie between Halfway River and the Alaska Highway. South of Peace River, the western outcrop limit parallels Pine and Moberly Rivers and extends into the area immediately south of Hudson Hope. Part of the formation is well exposed above Bear Flat on Peace River west of Fort St. John.

According to Irish (1958), the Dunvegan Formation in the Charlie Lake map-area ranges between 500 feet and 600 feet in thickness. Over 900 feet of Dunvegan strata were measured by the writer on Mount McAllister, but the upper contact is not present there and a total thickness was not obtained.

The Dunvegan Formation of the Charlie Lake map-area was described by Irish (1958):

> "The lower 300 feet to 350 feet are characterized by three massive cross-bedded, cliff-forming beds up to 40 feet thick, which in places grade into and are replaced laterally by less massive beds. The upper part of the formation consists of a succession of thin-bedded sandstone and arenaceous shale strata that are transitional into the overlying Kaskapau Formation. Beds of very coarse sandstone and fine conglomerate occur in the formation only in the northwestern part of the area."

In general, the sandstones are fine- to coarse-grained, commonly cross-bedded, laminated, and weather brown. The interbedded mudstones are olive brown to green. Carbonaceous material occurs more commonly in the Foothills exposures and some thin coal seams are present. In the vicinity of Moberly Lake, the Dunvegan sandstones are predominantly fine-grained but some coarser sandstones with disseminated pebbles do occur. On Mount McAllister, the sandstones are medium-grained with some 10-foot to 15-foot conglomerate units.

The Dunvegan Formation contains sediments of the deltaic and nearshore environments. It records the most major advance of those environments into the present Plains region since the previous widespread continental deposition of Middle Albian time.

The Dunvegan Formation contains the <u>Inoceramus dunveganensis</u>, I.

rutherfordi, and Unio (Pleurobema) dowlingi fauna which Jeletzky tentatively considers to be contemporaneous with the Cenomanian Acanthoceras fauna.

SMOKY GROUP

Only the basal beds of the Smoky Group are exposed in the vicinity of Peace River and they are included in the Kaskapau Formation. Throughout most of the region, those beds are concealed by glacial sediments. Irish (1958) reported small exposures on Peace River at the provincial boundary and on Kiskatinaw River about 3 miles above its mouth. The beds are better exposed in the creeks flowing into Peace River east of the provincial boundary. The Smoky Group of the Foothills south of Pine River are described by Stott (1961c, 1962).

The basal Kaskapau beds include silty, dark grey, sideritic, rusty weathering shales and some thin interbeds of siltstone. To the south of Peace River and east of the Alaska Highway, several sandstone are recognized within the lower part of the Kaskapau Formation. These were named Doe Creek and Pouce Coupe sandstones (Warren and Stelck, 1940) and Howard Creek sandstone (Stelck and Wall, 1954). Those sandstones are fine-grained, well-sorted, brownish-grey, and brown weathering. They occur in thin- to thick-bedded units containing minor quantities of interbedded silty shales.

The sandstones of the Kaskapau Formation have some potential as reservoir rock. To date, one well in Pouce Coupe South Field is producing gas from the Doe Creek sandstone.

The basal Smoky shales contain the Dunveganoceras fauna of late Cenomanian age. It is possible that farther west in the Foothills, beds equivalent to those lower sediments may be included in the Dunvegan Formation.

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THE JURASSIC FERNIE GROUP IN NORTHEASTERN BRITISH COLUMBIA

By

W. N. Hamilton

INTRODUCTION

During the summer of 1958, the author was employed by The California Standard Company and was engaged in geological mapping in northeastern British Columbia. In the course of this work, eastward and northward thinning of the Jurassic Fernie group was noted, and study of the group was suggested as a thesis subject. A thesis, in partial fulfillment of requirements for the degree of Bachelor of Science, was submitted to the Faculty of Engineering at the University of Saskatchewan in April, 1959, and from it this paper has been prepared.

Acknowledgement is made to the California Standard Company for the material provided, to Dr. W. G. E. Caldwell of the University of Saskatchewan for helpful suggestions and criticisms, and to Dr. G. Westermann of McMaster University for the identification of fossil collections.

NOMENCLATURE

The name Fernie has come to be applied to a predominantly shaly sequence which includes most of the strata of Jurassic age in the Canadian Rocky Mountains. The name was first used by McEvoy and Leach (1902), and later was defined by Leach (1912), as a formational term applicable to the Jurassic shale sequence of the Fernie area. In subsequent writings, the Fernie has been referred to as a formation by some authors, but as a group by most. Frebold (1957) formally proposed group status for the Fernie, but, although he was able to make division into Upper, Middle and Lower units on faunal evidence, and recognized various "members" and "beds", he did not propose formational terms for the group.

In northeastern British Columbia, use of the term Fernie formation for the Jurassic shales was proposed by Hage (1944). McLearn and Kindle (1950) used the term Fernie group, and, in conformity with currently accepted usage elsewhere, the group status is followed in this paper.

Although group status for the Fernie has achieved wide acceptance, no formational names for its divisions have been forthcoming - all the more remarkable when it is considered that three major lithologic divisions of the group are recognizable in both surface and subsurface sections over a wide area. These three divisions are the Passage Beds at the top, the Nordegg "member" at the base, and the intervening unit, predominantly of shale, which includes equivalents of the "Paper shale" (otherwise known as the "Poker Chip shale"), the Rock Creek member, and the "Grey beds".

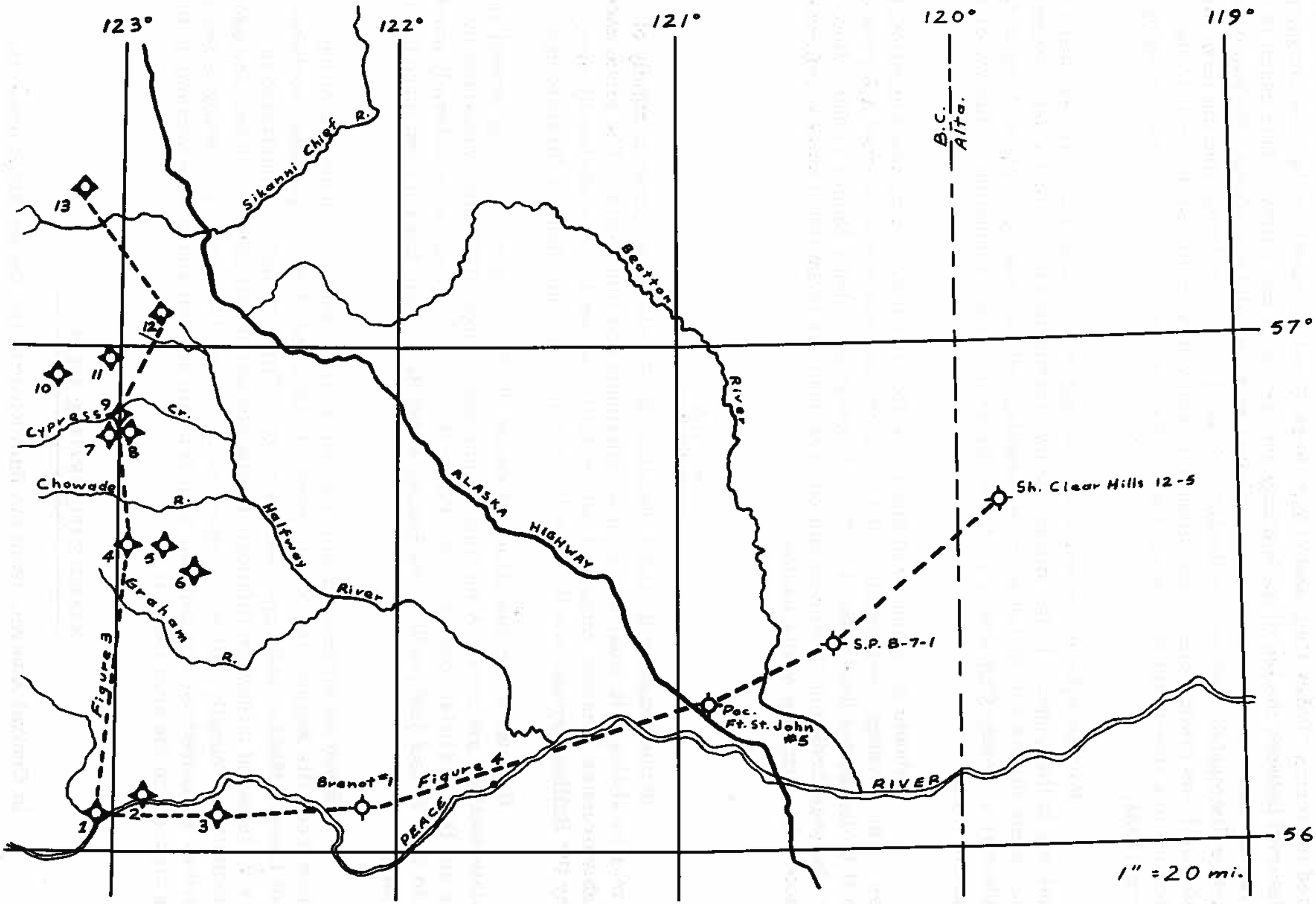

123°
122°
121°
120°
119°
57°
56°
B.C.
Alta.
Sikanni Chief R.
Beatton River
Cypress Cr.
Chowade R.
Halfway River
Graham R.
ALASKA HIGHWAY
PEACE RIVER
Figure 3
Figure 4
Brenot #1
Pac. Ft. St. John #5
S.P. B-7-1
Sh. Clear Hills 12-5
1
2
3
4
5
6
7
8
9
10
11
12
13
1" = 20 mi.

FIGURE 1

Describing subsurface occurrences in the Peace River area, Lackie (1958) applied the terms "Poker Chip shale" and "Rock Creek member" to the beds occupying the interval between the top of the Nordegg and the top of the Fernie. This usage is unfortunate since no correlation to the original surface units was shown, the two units cannot be distinguished where the Rock Creek sand is not developed, and the term Rock Creek itself was preoccupied three times in North American literature prior to its application to a five-to thirty-foot sand in the Fernie group of the Blairmore area by Warren (1934).

For the sake of convenience, Nordegg and Passage Beds are discussed as formations in this paper. In the absence of any appropriate name for the intervening strata, some liberty will be taken by pre-empting and contrasting an alias of one of the members (i.e. Poker Chip shale) to derive the term "Poker formation". Let the chip fall where it may!

It should be emphasized that the writer is not proposing new formational names. The Nordegg, long considered a member, can properly be termed a formation since it is designated thus in the A.S.P.G. Lexicon of Geologic Names (1960). However, Passage Beds and "Poker formation" are used, as formational names, informally, and solely for purposes of discussion.

GENERAL

In northeastern British Columbia, the Fernie group consists mainly of dark marine shales with some sandstones, siltstones and limestones. The group unconformably overlies Triassic rocks and, where fully developed, is gradationally overlain by the Bullhead group, which, basally, may include some beds of Jurassic age.

Because of the dominance of shales the Fernie group is easily eroded and complete sections are rare. A maximum thickness of about 1100 feet, measured by Beach and Spivak (1944), occurs on the Peace River. The group thins uniformly northward to only 16 feet just north of the Sikanni Chief River, and has not been found beyond that point.

Based on correlation with Frebold's (1957) generalized section of the Northern Foothills Region, the Fernie group, in the area of study, probably contains beds of Lower, Middle, and Upper Jurassic age. This correlation, illustrated in Figure 2, is based largely on lithologic similarity and stratigraphic position, and can be substantiated faunally only with respect to the Lower Jurassic. This study is based on thirteen measured outcrop sections together with several subsurface sections in the plains adjacent to the area (Fig. 1).

NORDEGG FORMATION

In Central Alberta, from the Ram River to the Smoky River area, the Nordegg formation is represented by dark, cherty, phosphatic limestones carrying a Sinemurian fauna. In the area of study, in surface exposures and in cores, equivalent

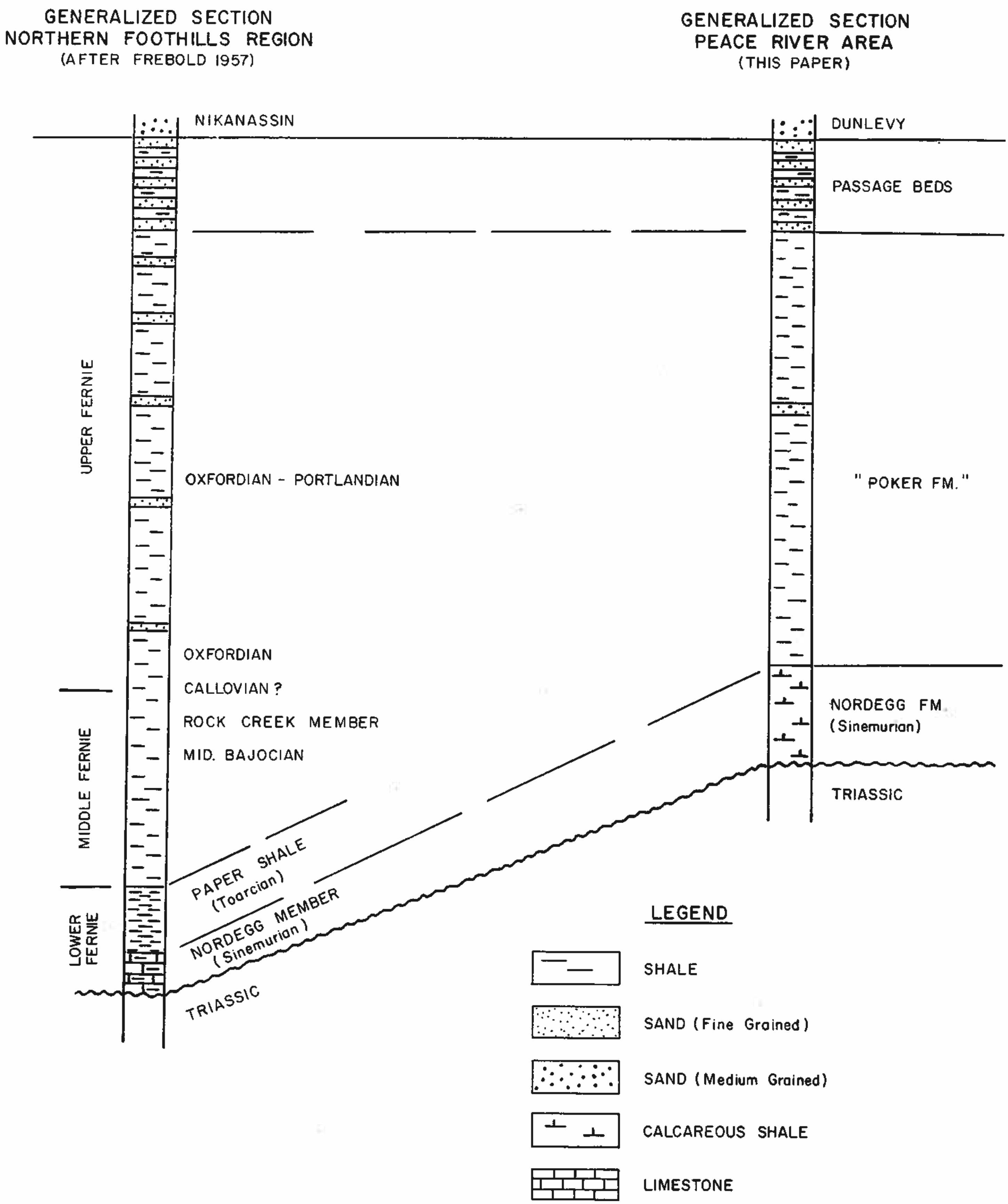

GENERALIZED SECTION
NORTHERN FOOTHILLS REGION
(AFTER FREBOLD 1957)
GENERALIZED SECTION
PEACE RIVER AREA
(THIS PAPER)
NIKANASSIN
DUNLEVY
PASSAGE BEDS
UPPER FERNIE
OXFORDIAN - PORTLANDIAN
"POKER FM."
OXFORDIAN
CALLOVIAN ?
ROCK CREEK MEMBER
MID. BAJOCIAN
MIDDLE FERNIE
NORDEGG FM.
(Sinemurian)
TRIASSIC
PAPER SHALE
(Toarcian)
NORDEGG MEMBER
(Sinemurian)
LOWER FERNIE
TRIASSIC
LEGEND
SHALE
SAND (Fine Grained)
SAND (Medium Grained)
CALCAREOUS SHALE
LIMESTONE

FIGURE 2

strata consist of dark-brown to black, bituminous, calcareous shales. These shales emit a strong petroliferous odor when broken and produce a light-brown streak when scratched. Thin platy beds of dark-brown to black limestone, commonly two to four inches thick and rarely up to two feet thick, are interbedded with the shales.

The Nordegg formation in thickness varies from zero at the erosional edge to a maximum of about 150 feet. It rests unconformably on Triassic rocks, and on progressively older beds to the north, south, and east of the Peace River area. In the immediate vicinity of the Peace River the formation rests on Monotis subcircularis beds of Triassic age, so that the erosional interval is limited to the Rhaetic and Hettangian stages. The lower contact of the Nordegg is seldom exposed, but where seen it is sharp, distinct, and no more than disconformable. On electric logs, the Nordegg formation is characterized by low self potential and high resistivity, and contacts generally are defined clearly by these characteristics.

Section 12, which was studied by the author, was first examined by Hage (1944). From a two foot argillaceous zone at the base Hage (op. cit., p. 6) collected:

> Gryphaea sp., Oxytoma cf. cygnipes Young and Bird, Pecten sp., and Rhynchonella sp. F. H. McLearn, who identified these fossils, assigned them tentatively a Lower Jurassic age. The ammonite Arnioceras, found in the overlying black shales, is a definitive Lower Jurassic index.

Fossils collected from the Nordegg formation by the author include:

Section 12: Entolium sp., (?) Chlamys sp, pectinids.

Section 7: (?) Epammonites sp., Cf. Attractites sp., Liostrea sp., Chlamys sp., ostreids, pectinids.

Section 8: Attractites sp., Pentracrinites cf. pustulatus (Quensted), Liostrea sp., Posidonia sp., Oxytoma aff. cygnipes Phillips, and Chlamys sp.

Dr. G. Westermann has identified these fossils and determined them to be of Lower Jurassic (Sinemurian) age.

"POKER FORMATION"

In the area of study, the "Poker formation" is mainly a black, noncalcareous shale, platy to papery, and rarely rusty weathering. Concretions and lenses of ironstone occur, and in Sections 3, 8, 9, and 10 the shales are arenaceous and contain rare stringers of sandstone or siltstone. There is no consistent lithologic variation within this shale sequence which would permit separation of the formation into members. In Section 9, however, a two-foot bed of sandstone is found 50 feet above the top of the Nordegg member, and the section above this consists of interbedded sandstones and shales. It is possible that the shales below this sandstone bed may correspond to the

Paper shale and the overlying sandier beds to the "Rock Creek member" of Lackie (1958). In the subsurface, the "Poker formation" is characterized by a subdued self potential curve, and generally by a highly irregular resistivity curve, these irregularities possibly reflecting ironstone and sandy beds. To the east of the area of study, Lackie (1958) has shown that a massive sandstone develops in the median part of the formation, and the upper part is generally much sandier than it is farther west.

Maximum observed thickness of the "Poker formation" in the area of study is about 900 feet and was measured in Section 1, the most westerly section on the Peace River. Northward and eastward thinning is apparent, much of which appears to be due to differential rates of sedimentation (Figs. 3, 4). Final elimination of the unit, however, is brought about by erosional truncation. The contact of the "Poker formation" with the Nordegg formation is, where seen, sharp but apparently conformable.

No fossils were found in the "Poker formation". It seems likely that the formation includes equivalents of the "Paper shale" member of probable Toarcian age (Frebold, 1957), since Frebold (op. cit., p. 10) has noted that:

"The Toarcian is distributed much more widely than the Sinemurian. It seems to be present wherever rocks of the Fernie occur, but owing to scarcity of fossils it is not always possible to decide which part of the Toarcian is represented for parts may be locally absent."

On the basis of the sandy beds in Section 9 and equivalent beds farther east (Lackie, 1958), it can probably be inferred also that the "Rock Creek member", and therefore the Bajocian stage, is represented. Whether the "Gray beds" equivalents of Callovian age are represented is a matter for speculation. The Oxfordian stage may also be represented in part within the formation.

PASSAGE BEDS

This formation is very characteristic of the Fernie group throughout the Rocky Mountains of Canada, and forms a transition zone between the Fernie and the overlying Kootenay, Nikanassin, or Dunlevy formations. In the area of study, the formation consists of dark arenaceous shales with thin sandstone intercalations and occasional nodules of orange-weathering ironstone. The sandstone beds, which become increasingly prominent toward the top of the formation, are dark grey, rusty weathering, argillaceous, and non-calcareous. The sand grains are predominantly quartz, and vary in size from silt to coarse sand with finer sand grades predominant. The beds, which are slabby to blocky, range in thickness from two inches to two feet, and are finely laminated and crossbedded.

The thickness of the Passage Beds in surface exposures ranges from 130 feet near the Peace River to zero in the most northerly sections. Recognition of the Passage Beds on electric logs is difficult, but where the beds overlying the Fernie are the quartzose sands of the Nikanassin rather than the cherty, conglomeratic sands of the Cadomin, a zone of interfingering sandstones and shales, presumably representing

Passage Beds, can generally be detected. In field exposures, the lower contact of the Passage Beds is placed at the lowermost sandstone, and the upper contact at the first massive sandstone, which generally has a thickness greater than 10 feet. Both contacts are gradational, and to a considerable degree arbitrary, and therefore vary from section to section.

No distinctive fossils have been found in the Passage Beds. Frebold, Mountjoy and Reed (1959) have shown that the Green beds, a sandy, glauconitic shale sequence occurring beneath the Passage Beds in the Central and Southern Foothills, carry an Oxfordian fauna, and that an Upper Oxfordian and Lower Kimmeridgian fauna is present in the lower part of the Passage Beds. The occurrence of Titanites occidentalis in the lower part of the Kootenay formation of the Fernie area (Frebold, 1957, p. 35) suggests a Portlandian age for the overlying beds. Based on lithologic correlation with the fossiliferous beds to the south, it is probable that the Passage Beds of the Peace River area are Oxfordian to Portlandian in age.

CORRELATIONS AND DEPOSITIONAL HISTORY

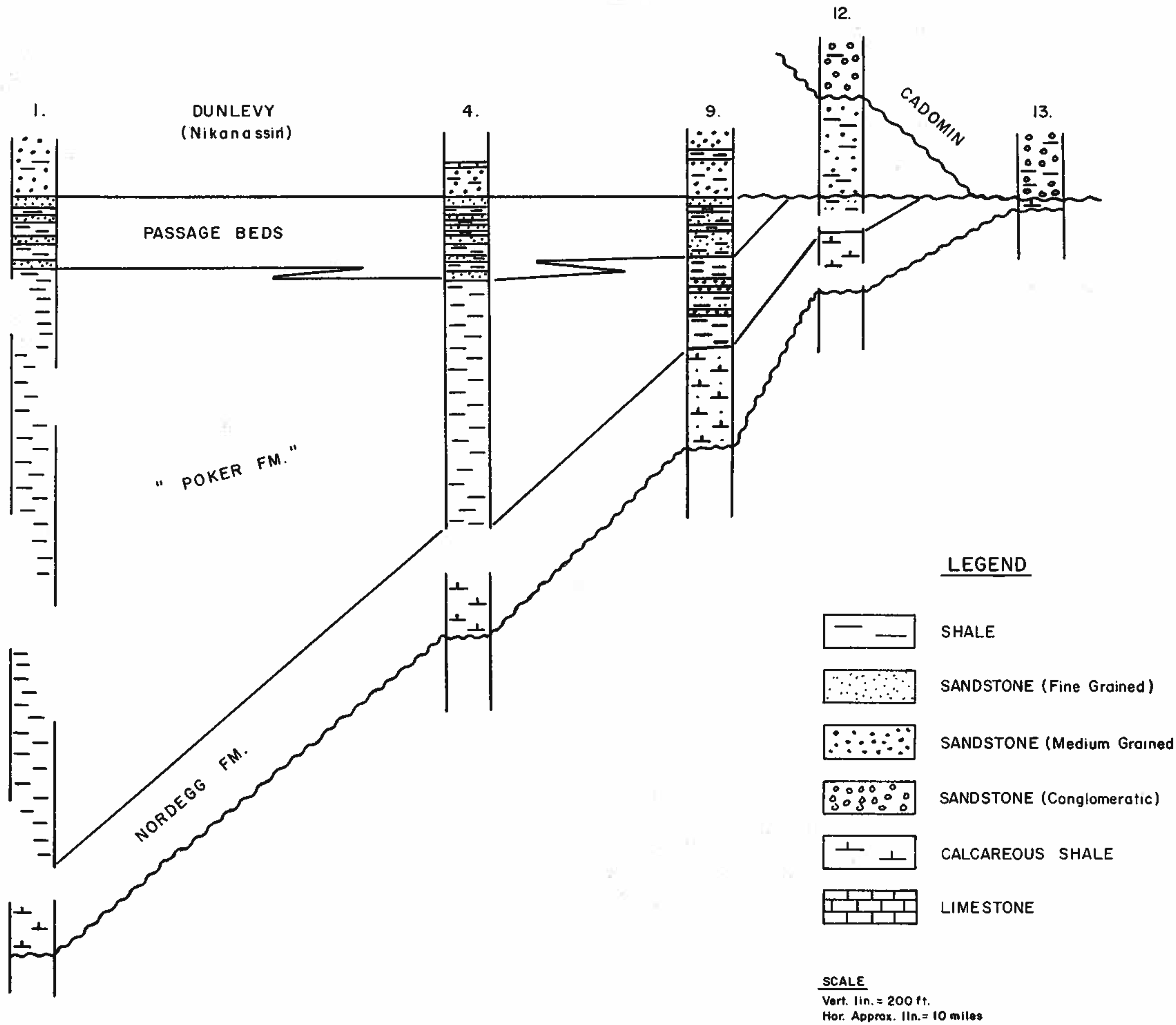
Correlations of the Fernie group to the north and to the east of the Peace River area are shown in Figures 3 and 4 respectively.

Figure 3 shows the northward thinning of the formation, and indicates that this thinning may be due to several factors. Firstly, depositional thinning is evidenced by gradual reduction in thickness northward of the "Poker formation", and by the introduction of a sandier facies in the direction, possible reflecting approach to a source area. Secondly, the Passage Beds are missing in Section 12, yet the overlying beds bear more resemblance to the Dunlevy formation than to the Cadomin formation. This has been described by Hage (1944 p. 8) as follows:

"On Pink Mountain, just north of Halfway River, the base of the (Bullhead) group is marked by a coal seam over 5 feet thick, which is overlain by 140 feet of fine-grained dark grey sandstone interbedded with dark grey and carbonaceous shale. These beds resemble the Kootenay formation in the Foothills of southern Alberta, and are overlain by coarse grained, quartzitic sandstone beds with conglomerate and scattered pebbles of chert, quartzite, limestone, altered ironstone, and porphyry in the basal part."

If the immediately overlying beds are indeed Dunlevy, then it is possible that absence of Passage Beds may be attributable to a local disconformity between the Dunlevy formation and Fernie group. The third cause of northward thinning is, of course, final truncation of the Fernie beds by the pre-Cadomin unconformity.

The east-west cross-section of Figure 4 indicates a similar pattern to that of Figure 3. Nordegg formation, "Poker formation" and Passage Beds are all recognizable in F.P.C. Brenot Creek No. 1, and in Pacific Ft. St. John No. 5, so that the considerable condensation of the Fernie group can be attributed largely to depositional thinning. To the east, pre-Cadomin erosion becomes responsible for most of the



1.
4.
9.
12.
13.
DUNLEVY
(Nikanassin)
CADOMIN
PASSAGE BEDS
" POKER FM."
NORDEGG FM.
LEGEND
SHALE
SANDSTONE (Fine Grained)
SANDSTONE (Medium Grained)
SANDSTONE (Conglomeratic)
CALCAREOUS SHALE
LIMESTONE
SCALE
Vert. 1in. = 200 ft.
Hor. Approx. 1in. = 10 miles

FIGURE 3

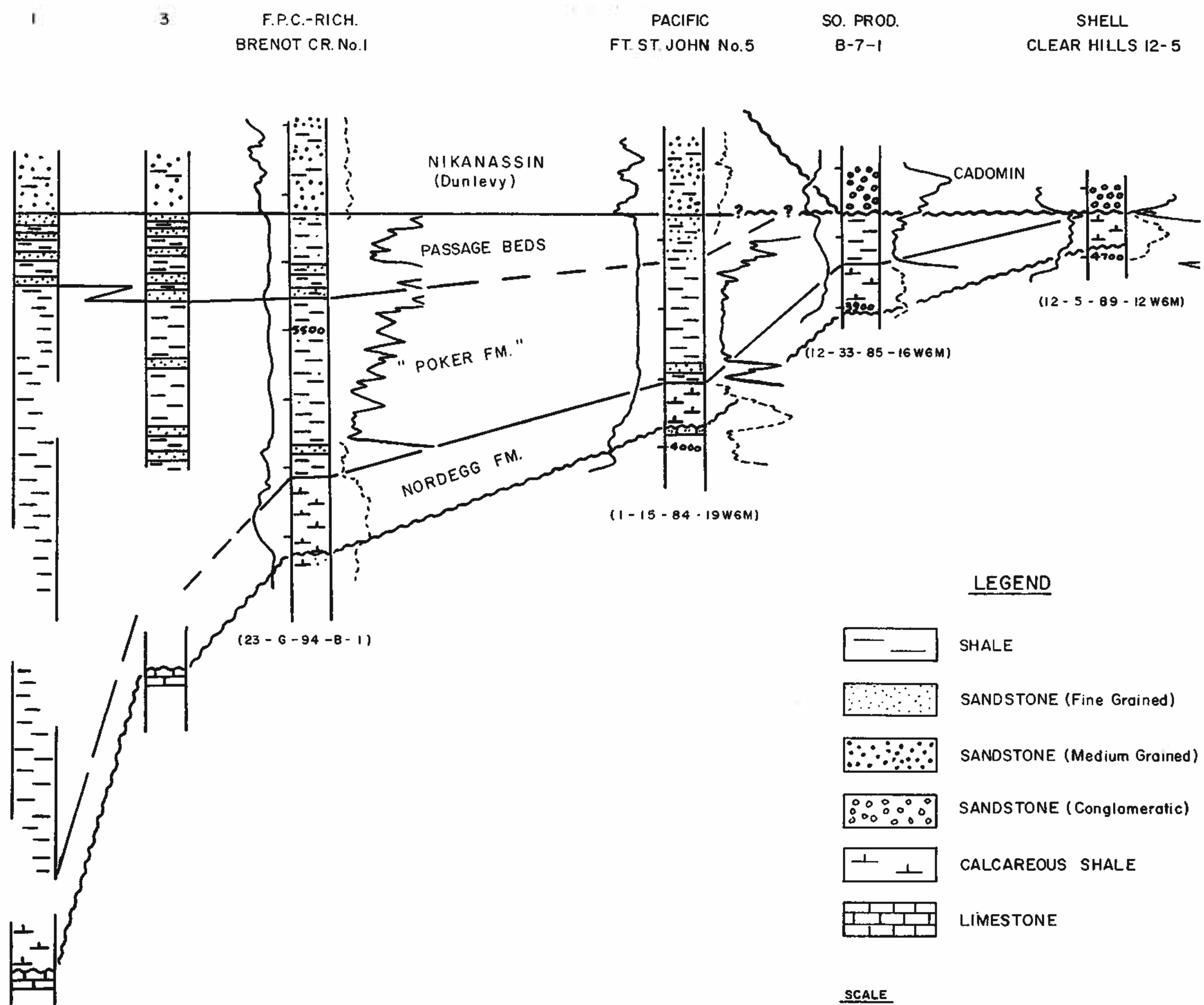

1
3
F.P.C.-RICH.
BRENOT CR. No.1
PACIFIC
FT. ST. JOHN No.5
SO. PROD.
B-7-1
SHELL
CLEAR HILLS 12-5
NIKANASSIN
(Dunlevy)
CADOMIN
PASSAGE BEDS
"POKER FM."
NORDEGG FM.
5500
4000
3900
4700
(23 - G - 94 - B - 1)
(1 - 15 - 84 - 19W6M)
(12 - 33 - 85 - 16W6M)
(12 - 5 - 89 - 12 W6M)
LEGEND
SHALE
SANDSTONE (Fine Grained)
SANDSTONE (Medium Grained)
SANDSTONE (Conglomeratic)
CALCAREOUS SHALE
LIMESTONE
SCALE
Vert. 1in. = 200'ft.
Hor. ARBITRARY

FIGURE 4

thinning. Control utilized in this study has not been sufficient to demonstrate any definite evidence of a pre-Dunlevy (Nikanassin) disconformity in this direction.

The depositional history of the Fernie group which emerges from the above correlations indicates a sudden marine incursion in Sinemurian time represented by deposition of the Nordegg formation over an extensive peneplaned surface. This incursion must have carried the Nordegg seas well beyond the present erosional limit of the formation since no evidence of near-shore conditions is present in most easterly or northerly sections. Marine conditions persisted during "Poker formation" deposition, with both the thickness patterns and facies indicating the possible existence of a shoreline to the north and east. The Passage Beds appear to reflect a shallowing and partial retreat of the Jurassic seas, with the possibility of local emergence (in the vicinity of Pink Mountain at least), in late Jurassic time. This depositional history is, generally speaking, one of marine offlap.

Frebold (1957, p. 42) is of the opinion that the Fernie group does not represent continuous deposition and that the Fernie sea did not persist throughout the time interval from Sinemurian to Portlandian. This opinion is based on the absence of guide fossils of the European standard and on the fact that the maximum thickness of the Fernie is much less than that of the European Jurassic section. The picture of sudden marine incursion, prolonged inundation, and partial withdrawal outlined above is not consistent with Frebold's views. The only marine withdrawal evidenced by the stratigraphy occurred toward the close of Fernie time. It seems to the author, therefore, that the absence of faunal zones may possibly be due to geographical or ecological conditions rather than to withdrawals of the Fernie sea. The thinness of the section is possibly due to the low relief of the peneplane on which the Fernie seas advanced, and consequent low relief of the bordering landmass.

This study has been limited both in scope and areal extent, and the conclusions regarding the depositional history of the Fernie group must therefore be considered as only tentative. However, the wealth of subsurface data available from the Plains area farther east should permit testing of the interpretation. If the group truly represents offlap marine deposition, then a disconformity should be detected between Nikanassin and Fernie in wells east of the Foothills. The disconformity may be marked by truncation or absence of Passage Beds prior to the removal of Nikanassin and consequent bevelling of the Fernie group by pre-Cadomin unconformity. But a final answer to the problem of depositional history may require micropaleontological or palynological studies.

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TRIASSIC STRATIGRAPHY IN THE VICINITY OF PEACE RIVER FOOTHILLS, BRITISH COLUMBIA [1]

By

D. J. Colquhoun

Columbia, South Carolina, U.S.A. [2]

INTRODUCTION

Studies of the Triassic in the Peace River surface area and vicinity have mostly resulted from the work of F. H. McLearn dating from 1917 and it is to him that much of the excellent state of knowledge concerning the fauna and stratigraphy of these sediments is due. McLearn (1940) outlined the physiography along Peace River, and his description has been reprinted (McLearn and Kindle, 1950).

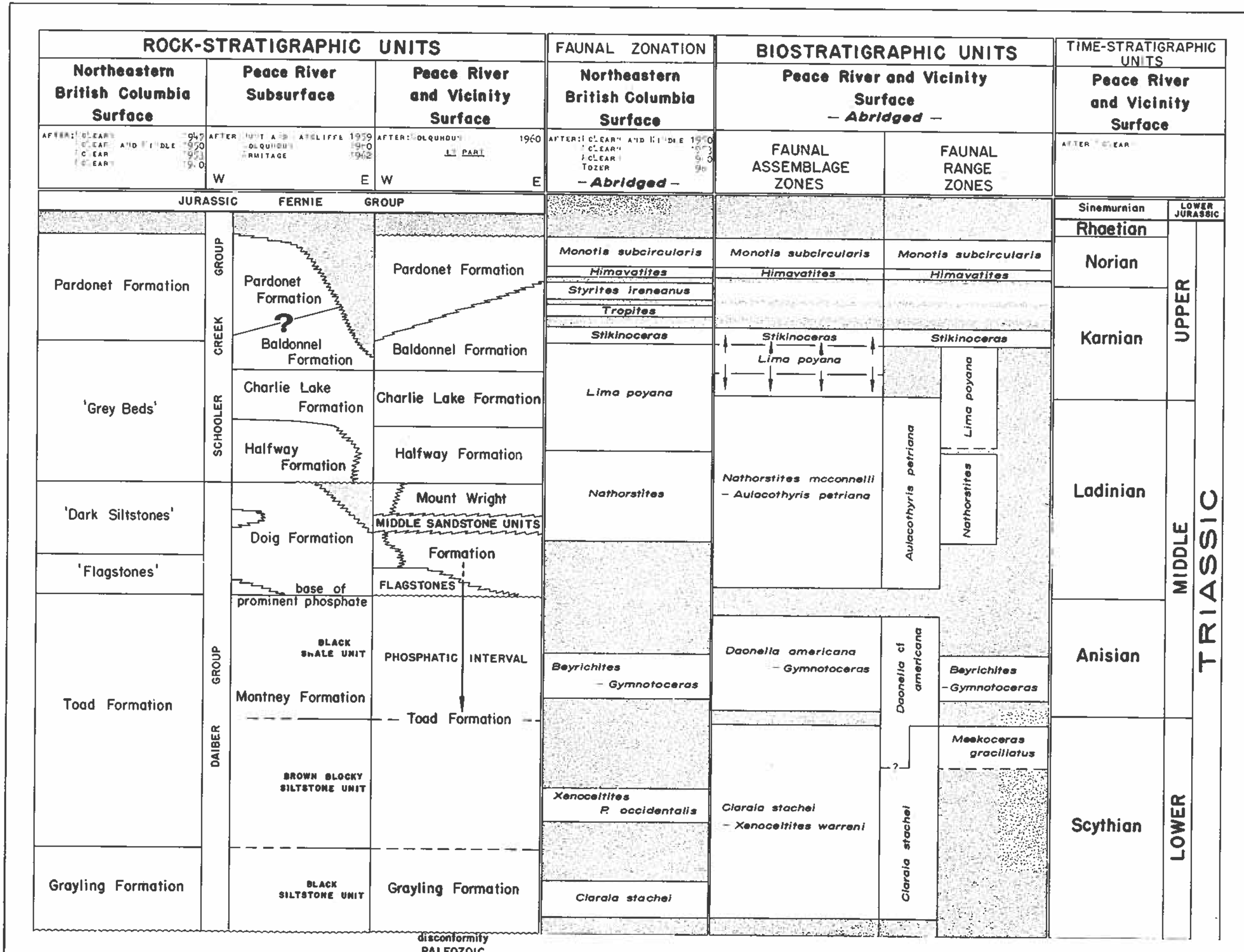
PREVIOUS WORK

McLearn's numerous articles (1918, 1921, 1930, 1937, 1939, 1940, 1941, 1943, 1947, 1953 and 1960, McLearn and Kindle, (1950) resulted in the rock stratigraphic terminology, fossil zonation, and time-stratigraphic subdivision illustrated in Figure 1. E. T. Tozer (1961) essentially followed McLearn's terminology carrying the term Toad, introduced by E. D. Kindle (1944), for strata in the Liard River area, at least in the Halfway River sections to near the base of the Triassic. In the subsurface A. D. Hunt and J. D. Ratcliffe in 1959 redefined McLearn's Schooler Creek Formation (1930, 1937) raising it to group status, and introduced three new formations

[1] The writer is indebted to the Imperial Oil Company Limited for permission to publish, and particularly to Dr. R. P. Glaister with whom the writer worked during the summer of 1958 on these strata, and who is largely responsible for the recognition of the Baldonnel limits in this portion of the surface and in part for the lithology. The author also acknowledges the aid of Mr. B. Gallant and other members of the Dawson Creek Geological Department of Imperial Oil Limited in interpretation of the lithology of the Clearwater Lake sections. The Halfway River composite section is compiled from data collected by F. L. Kidd in 1947 for Charlie Lake and Toad strata from a section near Mt. Wright, and from strata measured at Mt. Wright by Glaister and Colquhoun. Fossil identifications were field-checked by the author in 1958, and more thoroughly identified by Dr. C. H. Crickmay in 1958; with the exception of the Clearwater sections, which were identified by the writer during 1959, together with subsurface collections. The work is extracted in part from a Doctoral Dissertation at the University of Illinois, completed under Professor H. W. Scott, to whom the writer expresses thanks. The financial support of Imperial Oil during the summer of 1959, the University of Illinois during the academic years 1958-1959 and 1959-1960; and the University of South Carolina, through the Committee on Faculty Research, during the spring of 1962, is acknowledged.

[2] Assistant Professor of Geology, University of South Carolina.

Fig. I. Table of Triassic stratigraphic units.



COMPILED ... B. ... COLQUHOUN '92

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which are illustrated in Figure 1. J. A. Armitage in a paper before the A.A.P.G.-A.S.P.G. meeting in May of 1960 introduced the sub-Halfway terminology illustrated in Figure 1. Colquhoun (1960) informally introduced the rock-stratigraphic terminology illustrated in Figure 1 and mapped the major units of the surface and subsurface together reporting lithology and fossil collections. The terms in light of the code of stratigraphic nomenclature (1961) need amplification.

DAIBER GROUP

Lower Triassic exposures have not been noted along Peace River, and in order to complete the outcrop stratigraphic succession it is necessary to study strata lying to the north and south of this river (Figure 2). The term Daiber Group was formally introduced by Armitage (1962) for those Triassic strata underlying the Halfway Formation in the subsurface. The term results essentially from a redefinition of McLearn's Schooler Creek Formation by Hunt and Ratcliffe (1959) in that it includes strata equivalent to McLearn's provisional terms 'Dark Siltstones' and 'Flagstones'. Armitage formally introduced the subsurface terms Doig Formation for strata lying above a usually prominent subsurface phosphate bed, and Montney Formation for strata lying below. On the basis of Stelk's (Hunt and Ratcliffe, 1959) identification of Nathorstites together with the Anisian species Parapopanoceras, he correlated the former with the 'Flagstones' and 'Dark Siltstones', and the latter with the Toad. Colquhoun (1960) informally introduced the terms Mount Wright to include McLearn's 'Flagstones' and 'Dark Siltstone' beds, and Hart Pass for strata lying below, mapping them in the surface and subsurface. The latter term, not being a proper geographic name is invalid under the 1961 Code of Stratigraphic Nomenclature. The Toad lithology was recognized by McLearn at Mount Wright along Halfway River and at other localities (1946). Tozer (1961) in this area used the term Toad Formation to near the base of the Triassic, and in southern part of this area recognized a series of unnamed beds lying below the 'Grey Beds'.

GRAYLING TOAD FORMATIONS

The terms Grayling Formation and Toad Formation were introduced by Kindle (1944), for Triassic sediments in the Liard River area.

The following is an alternate surface section of the Toad Formation and the Grayling Formation:

Location: Along a ridge four miles northeast of Clearwater Lake.
Map Reference: Unit 93, Zone E, N.T.S. 93 - 0 - 10.
(abridged)

Interval	Lithology
	OVERLYING STRATA MOUNT WRIGHT FORMATION Top Toad Formation
0 - 150 (150')	Siltstone, medium to dark grey, medium grey-buff weathering, calcareous in part, dolomitic in part, slightly argillaceous, laminated in part, mostly thick bedded, platy fracturing. Daonella cf. americana, Smith.

150 - 180 (30')	Siltstone, dark grey, medium grey-buff weathering, argillaceous, calcareous, very slightly dolomitic, some minor shale.
180 - 230 (50')	Siltstone, medium grey and dark grey, calcareous, thin platy fracturing, thin-bedded; and shale, brown-grey, nearly fissile, slightly silty, calcareous.
230 - 350 (120')	Siltstone, medium grey, buff-grey weathering, calcareous, very slightly dolomitic, massive at top, thin platy toward base; some shale as above.
350 - 430 (80')	Siltstone, medium and dark grey, laminated, medium grey-buff weathering, calcareous, trace dolomite, argillaceous in part, thick bedded, platy fracturing; interbedded with thin dark fissile shale and siltstone as above but thin and platy.
430 - 600 (170')	Shale, dark grey to black, calcareous, pure to slightly silty, soft, fissile, topographically low weathering, 70%; Siltstone, dark grey and medium grey, medium grey-buff weathering, calcareous, laminated, thin, platy fracturing, in part massive. Daonella sp.
600 - 620 (20')	Siltstone, medium to dark grey, buff-grey weathering calcareous, argillaceous, some poorly preserved pelecypod and ammonite impressions, thin-bedded, platy fracturing. Daonella cf. americana, Smith, cf. Meekoceras sp.
620 - 690 (70')	Siltstone, medium grey, buff-grey weathering, calcareous, slightly dolomitic, massive to thick-bedded, becoming argillaceous and thin-bedded toward base.

Base Toad Formation - Top Grayling Formation

690 - 750 (60')	Interbedded siltstone, dark grey, argillaceous calcareous, very slightly dolomitic, 80%; and shale, dark grey-brown, fissile, calcareous, slightly silty to clean, ammonite impressions. Ammonite indet.
750 - 770 (20')	Shale, dark grey, earthy grey-brown weathering, calcareous very silty, very thin-bedded, platy; bedding planes show many poor pelecypod and ammonite imprints.
770 - 810 (40')	Siltstone, medium to dark grey, buff-grey weathering, calcareous, slabby and thin platy; and shale as above occurring as thin interbeds.
810 - 1010 (200')	Shale, dark grey, dark earthy brown weathering, very silty, thin platy; and minor siltstone as above. Daonella sp.
1010 - 1080 (70')	Shale, dark earthy to black, calcareous, very slightly silty to pure, and shale as above, very silty.

1080 - 1090 (10')	Siltstone, medium grey, slightly buff-grey weathering, calcareous, very slightly dolomitic, very argillaceous, platy weathering, some ammonite imprints; and shale, black, silty, calcareous, platy to fissile.
1090 - 1110 (20')	Shale, dark grey, calcareous, very silty, irregular platy fracture.
1110 - 1140 (30')	Siltstone, medium to dark grey, slightly buff grey weathering, calcareous, argillaceous, platy; shale as above.
1140 - 1230 (90')	Shale, dark grey to dark earthy brown-grey to black, dark grey slightly brown weathering, calcareous, silty to pure, thin platy to fissile; with minor medium grey siltstone as above.
1230 - 1240 (10')	Siltstone, medium grey, buff-grey weathering, calcareous, argillaceous, in part grading to shale, 80%; shale as above 20%.
1240 - 1260 (20')	Shale, dark grey, dark earthy brown weathering, slightly calcareous, very silty, thin platy to fissile.
1260 - 1310 (50')	Siltstone and shale as above; 80% siltstone at the top becoming 20% at base.
1310 - 1380 (70')	Shale, dark earthy brown, non-calcareous, silty, nearly fissile, with minor silt bands.
1380 - 1405 (25')	Siltstone and shale as above.
	FAULT, truncates a few of the Hart Pass beds.
Total thickness (1405')	Base Grayling Formation

Lithology

In the western foothills, the lower portion of the Triassic succession is slightly silty. Dark grey to black shale and minor fine-grained sandstone variably developed up to approximately 600 feet in thickness, which probably represents the lithology of the Grayling Formation, is irregularly present in both the surface and subsurface, over a wide area. It lies with regional unconformity and local disconformity on various Paleozoic formations. Locally, basal conglomerates have been observed. Colquhoun (1960) could not successfully map this lithology regionally in the subsurface, but the lithology has been noted south of this area at the surface and appears lithologically equivalent with Manko's 'black siltstone unit' of the Sulphur Mountain Formation (Manko, 1960, W. H. Ziegler and E. Manko unpublished data, 1958). Succeeding these strata and gradational with them occur up to approximately 1100 feet of dark and medium grey, frequently 'platy' weathering and thin-bedded dolomitic and calcareous siltstone, frequently bearing thin black argillaceous laminae, together with minor dark grey micritic limestone lenses. The upper portion of the Toad Formation occasionally is developed with very thin 'book-leaf' bedding, although this type of lithology can occur throughout the unit locally. The upper portion of the Toad Formation is phosphatic in the surface and subsurface (Colquhoun, 1960; Barss, 1961, personal communication) at many localities. At a section near the Graham River in the N.W. 1/4 of Zone F, N.T.S. 94 - B - 11, approximately six hundred feet below the Mount Wright-Toad contact, strata were observed bearing large limestone lenses carrying a lower Triassic fauna in a dolomitic dark grey shale. Immediately overlying, thin-bedded to very thin-bedded 'platy' to 'book-leaf' weathering, dark grey, argillaceous, calcareous siltstones were noted bearing abundant phosphate nodules up to one inch in diameter, concentrated along planes parallel to the bedding. It is thought these strata represent Anisian time, though fossils apart from poorly preserved Daonella cf. americana (Smith, 1914) and indeterminate ammonoids were not found. These beds are overlain by sandstones, siltstones and limestones of the Mount Wright Formation, although the latter correlation is not as yet definitive based on paleontology at this locality. Quantitative phosphate analyses were run in part on a number of sections, and the results are indicated in Figure 2 for the Clearwater Lake localities. The phosphate in these samples was for the most part aphanitic, and only samples containing a strongly positive reaction are reported. E. Manko (1960) (W.H. Ziegler and E. Manko unpublished data, 1959) observed phosphate in the 'black shale and upper siltstone' units of the Sulphur Mountain beds mostly near the base of the latter. It is thought that the former is lithologically and paleontologically correlative in part with these beds, and the latter lithologically equivalent and in part paleontologically correlative with the Mount Wright Formation.

Along Peace River, the beds outcropping along Long Ledge, at the foot of Beattie Hill, are thought to be Toad. They consist of argillaceous to very argillaceous, very thin and thin bedded siltstones, shales and rare sandstones. McLearn (1940) has noted Daonella sp. at this locality. With the exception of this exposure the writer knows of no other accessible Toad outcrop along Peace River.

Paleontology

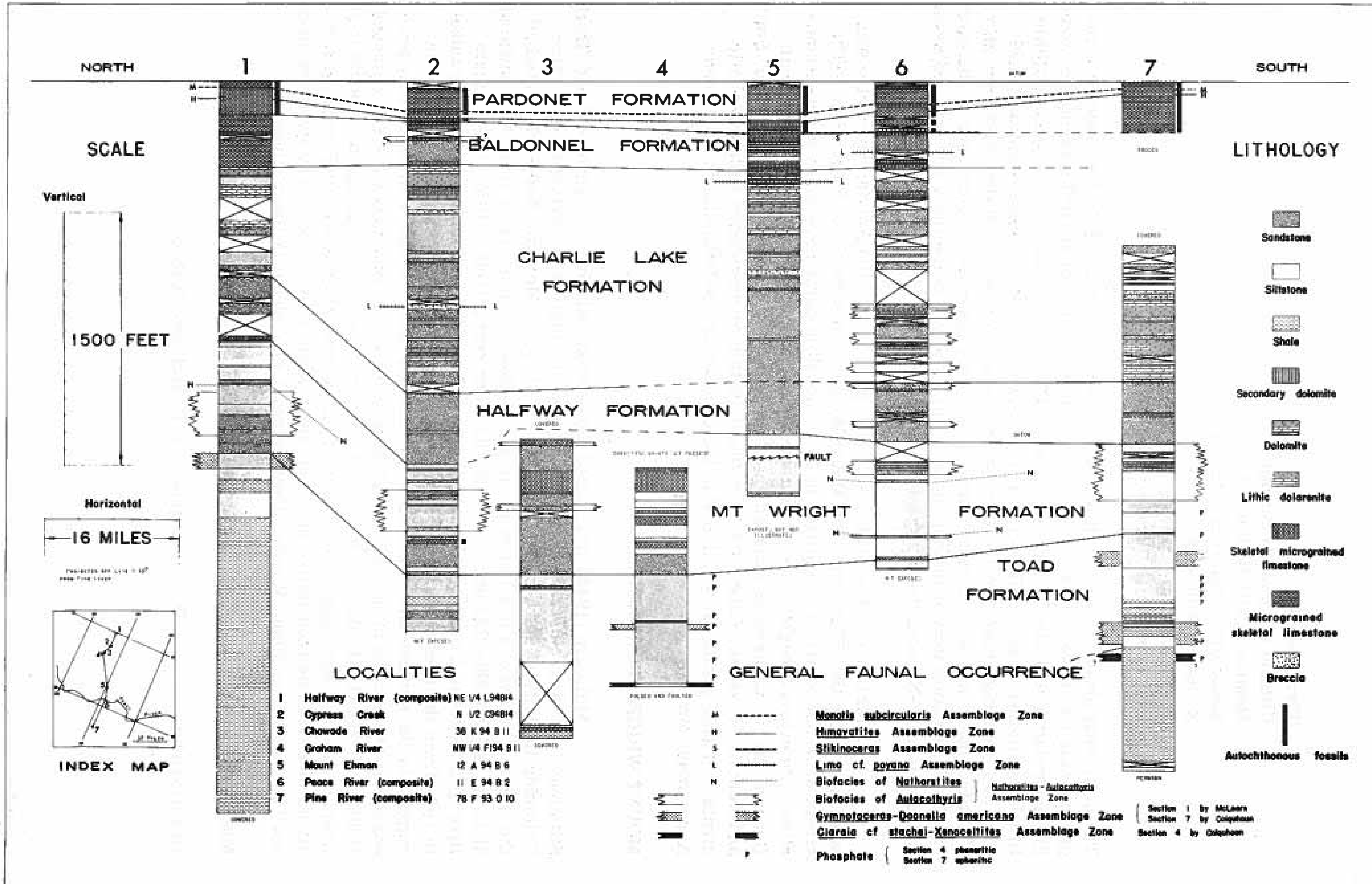
Within the Grayling and Toad Formations several faunas have been recognized from this area. At Mount Laurier (S.W. 1/4, Zone D, N.T.S. 94 - B - 14), 360 feet above the base of the Triassic the following were collected:

Claraia sp.
Xenoceltites sp.
Orthoceras sp.
Ussuria ? sp.
Columbites sp. ind.
Inyoites sp. ind.

The fauna is indicative of early Triassic Scythian age, and is found in a section consisting of dark grey, calcareous, topographically low weathering shales, siltstones and rare sandstones thought to represent the Grayling lithology. The section is not illustrated in Figure 2.

Immediately below the phosphatic beds near the Graham River the following fauna was found:

Fig. 2. Cross section from Halfway River to Pine River, British Columbia.



Compiled by D. J. Colquhoun 1962

Drafted by M. J. Green

Tirolites? sp.
Claraia cf. stachei Bittner
Monotis ovalis Whiteaves
Xenoceltites warreni, McLearn
X. hannai Mathews
Koninckites sp.
Meekoceras gracilitatis, White

The collection probably occurs about 700 feet above the base of the Triassic on a regional basis (the base of this section being faulted) and is of early Triassic age, possibly correlative with the Meekoceras Zone of Idaho and California. It occurs within a lithology similar to the published Toad descriptions. Badly preserved taxa of this zone are probably present at the Clearwater Lake sections within the Toad Formation. The Claraia cf. stachei, Bittner, Range Zone, thus appears to be broader in the stratigraphic succession than previously noted, and these two collections are grouped in the Claraia stachei-Xenoceltites warreni Assemblage Zone.

McLearn (1946, 1948) noted the presence of the Anisian Gymnotoceras zone underlying the 'Flagstones' on Mount Wright within the Toad Formation. The strata were not positively identified in 1958, possibly being covered by a small landslide. In strata thought to be correlative in time and equivalent in lithology near Graham River, Clearwater Lake and at other localities Daonella cf. americana, Smith and Donella cf. dubia, Gabb have been found, within or associated with phosphatic strata. These strata are combined in the Gymnotoceras-Daonella cf. americana Assemblage Zone.

MOUNT WRIGHT FORMATION

McLearn (1946) introduced the provisional terms 'Flagstones' and 'Dark Siltstones' for surface strata overlying the Toad formation in Northeastern British Columbia in Halfway and Sikanni Chief River valleys. McLearn had earlier studied the 'Dark Siltstones' along Peace River and included both the beds at Beattie Ledge and at Long Ledge within this unit. The strata were recognized in 1958 near Graham River, at Cypress Creek, and Mount Ehman and in 1959 for numerous samples taken in 1958 from the Clearwater Lake localities, (Pine Pass composite). They were mapped in the surface and subsurface. The term Mount Wright was informally proposed and the section at the Mount Wright locality was assigned as the type (Colquhoun, 1960). Tozer (1961) carried the terms 'Dark Siltstones' and 'Flagstones' south to the Graham River. Armitage (1962) formally introduced the term Doig Formation for strata thought to be correlative and equivalent in the subsurface. The following is the section exposed on Mount Wright along the north side of the Halfway River.

Map Coordinates: S.W. 1/4 of Zone C, N.T.S. 94 - G - 3.

Described by: D.J. Colquhoun, R.I. McPherson (1958)

Interval	Lithology
	OVERLYING STRATA HALFWAY FORMATION (Contact gradational)
	Top Mount Wright Formation
	Top of 'Dark Siltstones'
0 - 10 (10')	Siltstone, brown-grey, slightly dolomitic, slightly calcareous, some carbonaceous fragments, medium-bedded.
10 - 74 (64')	Siltstone, grey, calcareous, arenaceous, slightly argillaceous, carbonaceous shale partings, thin-bedded.
74 - 215 (141')	Siltstone, grey to dark grey, calcareous, slightly argillaceous to very argillaceous, thin-bedded to very thin.
215 - 225 (10')	Siltstone, grey, arenaceous, calcareous, thin-bedded.
	(Top of Middle Sandstone Units)
225 - 235 (10')	Sandstone, buff, very fine-grained, silty, calcareous, thin to medium-bedded.
235 - 245 (10')	Microgranular limestone, grey, composed of 30% poorly preserved brachiopod shells and fragments, 20% very fine quartz grains, 50% finely micrograined calcareous matrix, thin to medium-bedded.
245 - 265 (20')	Siltstone, grey, arenaceous to very arenaceous, slightly argillaceous, calcareous; scattered brachiopods, thin to medium-bedded Aulacothyris petriana, McLearn.
	(Base of Middle Sandstone Units)
265 - 289 (24')	Siltstone, grey to dark grey, slightly arenaceous, slightly argillaceous, calcareous, some carbonaceous shale partings, thin-bedded. Nathorstites mcconnelli, Whiteaves.
289 - 326 (37')	Siltstone, dark grey, argillaceous, slightly arenaceous, slightly calcareous thin-bedded. Pelecypod indet. Nathorstites mcconnelli, Whiteaves, N. mcconnelli var. lenticularis, Whiteaves, Nitanoceras selwyni, McLearn, Protrachyceras cf. zauwae, McLearn, Paratrachyceras cf. meginae, McLearn.
326 - 341 (15')	Siltstone, grey, calcareous, thin-bedded.
341 - 361 (20')	Siltstone, dark grey, argillaceous, calcareous, organic, thin-bedded.

361 - 399 (38')	Siltstone, grey, arenaceous, slightly argillaceous, slightly organic, calcareous, thin-bedded.
399 - 407 (8')	Shale, dark grey, silty, calcareous, thin-bedded.

Base of 'Dark Siltstones'
Top of 'Flagstones'

407 - 420 (13')	Microgranular limestone, grey, composed of 30% skeletal fragments up to 2mm in diameter, 15% quartz silt grains, 55% micrograined matrix. Aulacothyris petriana, McLearn, medium to thick-bedded.
420 - 488 (68')	Sandstone, grey, very fine-grained, slightly silty, calcareous, some carbonaceous plant fragments, thin-bedded. Aulacothyris petriana, McLearn, Pelecypod indet. Gastropod indet.
488 - 508 (20')	Sandstone, grey, very fine grained, silty, slightly argillaceous,. calcareous, with 15% medium grained skeletal material medium-bedded. Spiriferina sp. nov., Aulacothyris petriana, McLearn.
508 - 538 (30')	Sandstone, buff, fine grained, poorly sorted, calcareous, thin-bedded.
538 - 555 (17')	Sandstone, buff, fine grained, composed of 40% quartz grains, 10% chert grains, 2% lithic grains, 25% skeletal material up to 1 mm in diameter, cemented with calcite, thin to medium-bedded.
555 - 571 (16')	Sandstone, light grey, medium grained, slightly calcareous, poor intergranular porosity due to weak cementation, medium to thick-bedded.
571 - 591 (20')	Sandstone; similar to 538 - 555.
591 - 621 (30')	Sandstone, buff, fine grained, calcareous, thin to medium-bedded.
621 - 651 (30')	Sandstone, buff, very fine grained, silty, slightly argillaceous, slightly calcareous, thin-bedded.

Base of 'Flagstones' covered
Base of Mount Wright Formation

UNDERLYING STRATA TOAD FORMATION reported by McLearn.

Along Peace River, the best exposed section of these strata occurs along Beattie Ledge and on Beattie Hill. McLearn (1940) described these strata. Figure 2, Section 6 is taken from the following log below the Halfway Formation.

Described by: D. J. Colquhoun; R. McPherson.

Interval	Lithology
	Base of Halfway Formation Top of Dark Siltstones
0 - 108 (108')	Concealed
	Top Middle Sandstone Units
108 - 113 (5')	Sandstone, grey, very fine grained, calcareous, medium-bedded.
113 - 128 (20')	Siltstone, brownish grey, calcareous, slightly arenaceous in part thin-bedded. Mathorstites mcconnelli Whiteaves.
128 - 148 (20')	Sandstone, brownish-grey, very fine grained, silty, calcareous; some carbonaceous shale partings; scattered bands containing brachiopods medium-bedded. Aulacothyris petriana McLearn.
148 - 158 (10')	Siltstone, grey, argillaceous, calcareous; brachiopods common; Fossil fragments, thin-bedded.
158 - 188 (30')	Sandstone, brownish-grey, very fine grained, silty, calcareous, thin-bedded; some comminuted plant fragments.
	Base Middle Sandstone Units
188 - 193 (5')	Siltstone, brownish-grey, arenaceous, slightly argillaceous, calcareous, with 5% scattered fossil casts, thin-bedded.
193 - 198 (5')	Sandstone, grey, very fine grained, silty, calcareous with 15% medium to coarse grained skeletal material, thin-bedded.
198 - 218 (20')	Siltstone, brownish-grey, arenaceous, very slightly argillaceous, calcareous, thin-bedded.
218 - 238 (20')	Sandstone, brownish-grey, very fine grained, silty, calcareous; abundant organic partings, thin-bedded.
238 - 328 (90')	Siltstone, grey to dark grey, slightly argillaceous to argillaceous, calcareous, slightly organic, very thin-bedded. Pelecypod ind.
328 - 338 (10')	Siltstone, dark grey, argillaceous, very calcareous, thin-bedded.
338 - 398	Siltstone, dark grey, argillaceous, calcareous, thin-bedded.

398 - 418 (20') Siltstone, dark grey, argillaceous, very calcareous, laminated, thin-bedded.

418 - 458 (40') Siltstone, dark grey, argillaceous, calcareous, thin-bedded.

458 - 518 (60') Siltstone, dark grey, argillaceous, very calcareous, thin-bedded.

518 - 548 (30') Siltstone, dark grey, slightly argillaceous to argillaceous, calcareous, thin-bedded.

548 - 558 (10') Sandstone, greyish-buff, very fine grained, slightly silty, calcareous, thin-bedded.

558 - 578 (20') Siltstone, dark grey, argillaceous, calcareous; Daonella sp. ind. Daonella nitanae, McLearn. Pelecypod ind. Nathorstites mcconnelli, Whiteaves. N. mcconnelli var. lenticularis, Whiteaves. Protrachyceras sikanianum, McLearn.

578 - 638 Siltstone, brownish-grey, arenaceous, argillaceous, calcareous. Daonella nitanae, McLearn. Lobites pacianus, McLearn. Nitanoceras selwyni, McLearn. Nitanoceras sp. Parananites sp. n. Nathorstites mcconnelli, Whiteaves. Nathorstites mcconnelli var. lenticularis, Whiteaves. Protrachyceras sikanianum, McLearn. Sirenites meginae, Mc Learn. Halobia sp. ind.

638 - 668 (30') Siltstone, dark grey, very argillaceous, calcareous, thin-bedded.

668 - 678 (10') Siltstone, dark brownish-grey, argillaceous, calcareous, thin-bedded.

678 - 688 (10') Siltstone, brownish-grey, arenaceous, slightly argillaceous, calcareous, thin-bedded.

688 - 698 Sandstone, grey, very fine grained, silty, calcareous.

Base Mount Wright Formation
(Small interval concealed)
Top of Toad Formation

698 - 748 (50') Siltstone, grey, arenaceous slightly argillaceous, calcareous, carbonaceous, thin platy to book-leaf weathering.

748 - 758 Underlying strata concealed.

Lithology

Lithologically the Mount Wright Formation consists of a complex of two dominant lithofacies, a thin to medium-bedded platy weathering, dark to medium grey calcareous, argillaceous siltstone, and a thin to thick-bedded medium grey to light grey to buff, very fine grained to medium grained calcareous and dolomitic sandstone. In the northern and central part of this area the latter is the more strongly developed, while in the southern portion (along Peace River and at sections near Clearwater Lake) the former. The first significant occurrence of fine and medium sand is found at the base of the formation in McLearn's 'Flagstones' in the surface, and at a similar position stratigraphically in the subsurface at several localities. Sand is also developed more strongly in the central portion of the formation (see figure 2, sections 2, 6 and 7 and figure 3, section 5). It can be developed to the exclusion of nearly all of the siltstone lithology (figure 2, sections 3 and 4), in which case it probably is lithologically equivalent to Kindle's Liard Formation (1944) or it may be present as only a percentage increase in the arenaceous component (figure 2, sections 6 and 7), in which case it is lithologically equivalent to McLearn's 'Dark Siltstones' along Peace River. Within the sandstones, the quartz grains are subrounded to subangular, the roundness decreasing with size. Bioclastic debris is also present in some, pelecypod and brachiopod being most common. Pressure quartz has also been noted. Within the siltstones the quartz grains are generally subangular to angular and enclosed within a dark grey, dolomitic to calcareous argillaceous matrix. The latter ranges from about 10 to 90 percent, the higher values being more confined to the subsurface.

Rarely in the area between Graham and Halfway Rivers in the northerly and westerly parts of the surface exposures, there is developed as well a coquinoid rotten arenaceous allochthonous limestone lithofacies of variable thickness bearing abundant poorly preserved pelecypod fragments, in some cases lying directly upon and cutting into the Toad formation. The lithology has been noted in the subsurface at the base of the Doig Formation (Imperial Pacific Jedney 99J) associated with phosphatic pebbles and nodules up to 1/4" in diameter. The surface variations of these facies within the Mount Wright is illustrated in Figure 2. In view of this, it is thought that there is some definite evidence of erosion between the Mount Wright and the Toad formations. At the surface, in this area, the contact with the overlying Halfway Formation is transitional. At the Clearwater Lake localities, the lower contact appears transitional with the Toad Formation, the upper, abrupt.

Paleontology

The Mount Wright Formation contains the Nathorstites mcconnelli, - Aulacothyris petriana Assemblage Zone, whose range is illustrated on Figure 1, and may be interpreted on Figures 2 and 3, for the various sections. It is characterized by a large number of ammonites, pelecypods and brachiopods which have been figured and described by McLearn in numerous publications. The brachiopod genus Aulacothyris (Coenothyris) petriana McLearn, has been found extensively developed within the Mount Wright, Halfway and Charlie Lake Formations, and its noted occurrences are also illustrated. The species, together with other brachiopods is also present at the Imperial Calvin Doig River #1 well, immediately above the base of the Doig Formation at 4491 feet below K.B. Detailed study of this genus has not revealed any significant differences between those fossils occurring within the Nathorstites Range Zone, and those occurring below that zone within the northern 'Flagstones' nor the southern basal

Mount Wright. Below the Nathorstites mcconnelli-Aulacothyris petriana Assemblage Zone at the Clearwater Lake localities (figure 2, section 7) cf. Crania sp. was noted immediately above the Toad Formation, in sediments possibly indicating restricted conditions.

The Mount Wright Formation therefore is established lithologically as a genetic unit of two major distinct lithofacies characterized by the first major influx of medium and fine sand with the 'Flagstones' into a medium and dark grey calcareous siltstone sequence. These sands are related to latter influx within all overlying Triassic Formations. The source of many of these sandstones is thought to be mainly from the west in view of regional mapping studies (Hunt and Ratcliffe, 1959, figure 10: Armitage (1961) Colquhoun, 1960). Paleontologically, development of the Aulacothyris petriana-Nathorstites mcconnelli Assemblage Zone within these strata, the former appearing within the basal portion and not noted below indicates a similar age.

SCHOOLER CREEK GROUP

The term Schooler Creek was introduced by McLearn (1921) and subsequently defined to include all Triassic beds of the foothills along Peace River and in the vicinity including the 'Dark Siltstones' (McLearn, 1937). McLearn and Kindle (1950) suggested the term might be discarded and McLearn did so later (McLearn, 1953, 1960). Hunt and Ratcliffe (1959) redefined the term erecting the Schooler Creek Group for subsurface Triassic strata including and overlying the Halfway Formation. Since the base of the latter is usually readily apparent in the surface exposures in this area, a similar surface terminology is herein employed. McLearn (1921, 1930, 1940, 1946, and Mc Learn and Kindle, 1950) recognized two major stratigraphic divisions occurring within this redefined Schooler Creek Group, the lower which he originally termed the Grey member and the upper, the Pardonet member (1940), of the Schooler Creek formation (original definition). They were subsequently termed 'Grey beds' (1946) and 'Pardonet beds' (1947). In 1960 he raised the latter to formational status, assigning the section at Pardonet Hill along Peace River as the type section. This section was described by McLearn in 1947 and is illustrated on Figure 3.

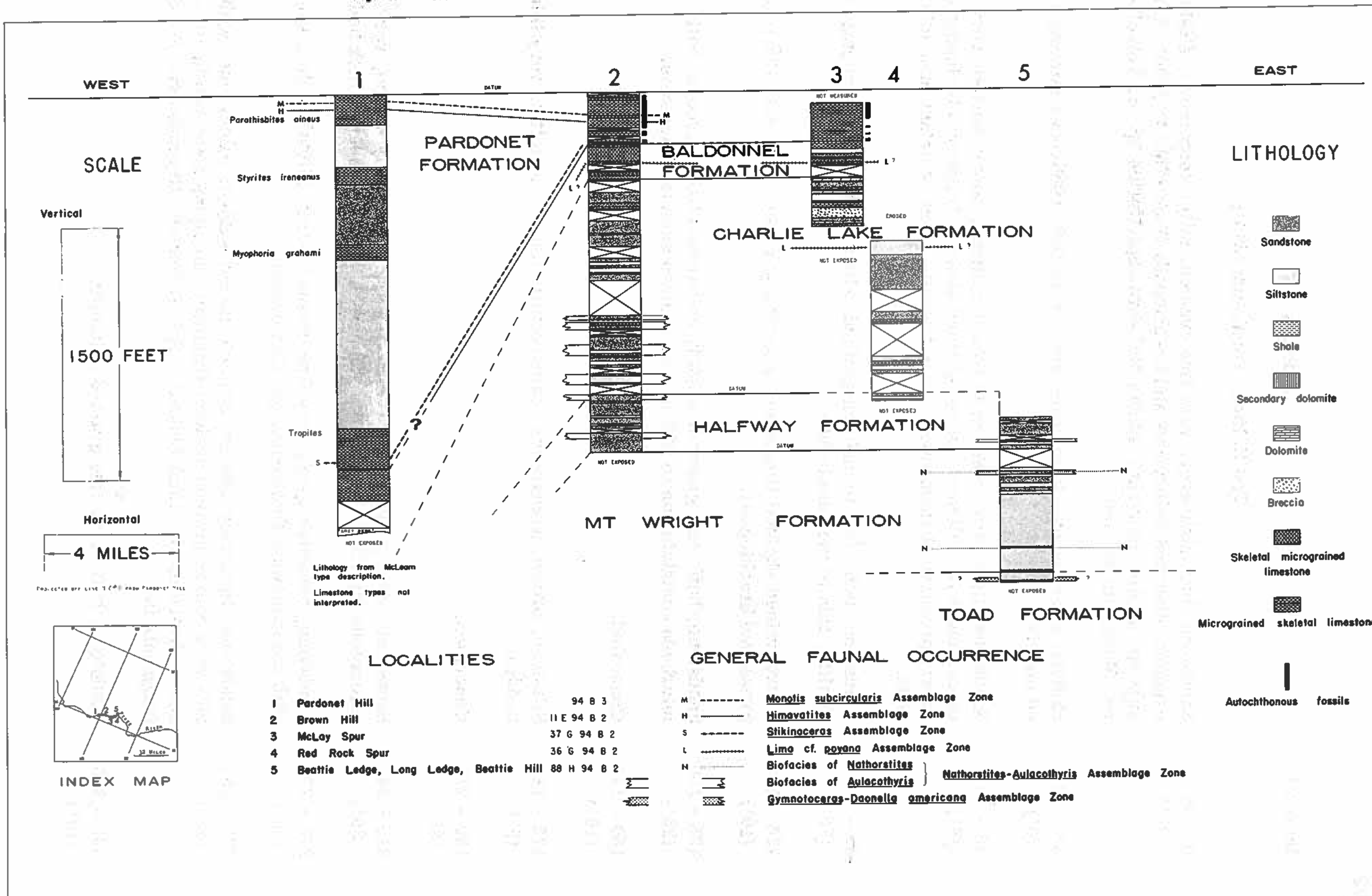
HALFWAY FORMATION

The Halfway Formation was defined by Hunt and Ratcliffe (1959) for widespread sandstone strata lying upon the undifferentiated Toad-Grayling Formations in the subsurface, disconformably toward the east and transitionally to the west. Armitage (1962) suggested the latter term be discarded in favor of the term Daiber Group. The type section of the Halfway Formation is taken from the Southern Production Well No. B-14-1 at LDS 1, Sec. 12, T. 84, R. 23 N 6th Mer. from 5000 to 5148 below K.B. (Hunt and Ratcliffe, 1959).

The following is an alternate surface section of the Halfway Formation:

Location:	Brown Hill on the north side of the Peace River
Map Reference:	11 - E/94 - B - 2
Described by:	R.P. Glaister, A.R. Yeske (1958)

Fig. 3. Cross section from Pardonet Hill to Beattie Ledge, Long Ledge, Beattie Hill, British Columbia.



Compiled by D. J. Colquhoun 1962

Drafted by M. J. Green

Interval	Lithology
	Top Halfway Formation (345')
0 - 38 (38')	Sandstone, brownish-grey, very fine grained, silty, calcareous, slightly organic; abundant pelecypods and brachiopods from 1790' to 1800'; Lingula sp. n. Aulacothyris petriana McLearn, Spiriferina sp. n. Volsella sp. Margarita sp. ind.
38 - 42 (4')	Skeletal micrograined limestone, grey, with 40% arenaceous micrograined matrix.
42 - 50 (8')	Sandstone, light grey, medium to coarse grained, poorly sorted, very calcareous with 30% very coarse grained skeletal fragments including some poorly preserved brachiopods; thick bedded; more resistant than adjacent beds.
50 - 125 (75')	Sandstone, buff, fine to medium grained, slightly calcareous, slightly dolomitic, thin to medium-bedded.
125 - 135 (10')	Micrograined skeletal limestone, grey to dark grey, silty with 10% poorly preserved brachiopods.
135 - 160 (25')	Sandstone, buff, fine grained, slightly calcareous to calcareous, with interbeds containing up to 20% coarse grained skeletal fragments.
160 - 175 (15')	Concealed.
175 - 180 (5')	Siltstone, brown, arenaceous, calcareous, slightly dolomitic, very thin-bedded.
180 - 215 (35')	Concealed.
215 - 245 (30')	Sandstone, light grey, medium to coarse grained, poorly sorted, very calcareous with 30% very coarse grained skeletal fragments, thick bedded.
245 - 275 (30')	Sandstone, brownish-grey, very fine grained, silty, slightly calcareous with carbonaceous shale partings, thin bedded.
275 - 335 (60')	Sandstone, light grey, coarse grained, poorly sorted, calcareous, with 20% very coarse grained skeletal fragments including some poorly preserved brachiopods, thick bedded. Spiriferina sp. Gryphaea sp. Fossil fragments ind.
335 - 345 (10')	Sandstone, buff, very fine grained dolomitic.

Underlying beds concealed.
Sharp topographic break, possibly covered Mt. Wright Formation.

Lithology

The difficulty in correlating the Halfway Formation from subsurface to surface lies not in the nature of the lower contact which is usually apparent at the surface but in the nature of the upper, because of an abrupt facies change in the overlying Charlie Lake Formation in the western subsurface and surface which is expressed in an almost exponential increase in sand content, toward the west and north (see figure 2). Determination of the contact between the two formations north of Peace River becomes extremely difficult based on lithologic appearance alone and it must be placed within a gradational zone. It is however, slightly coarser grained and forms more prominent cliffs than the Charlie Lake sandstone facies and it does not have present within it the extensive siltstones and dolomites characteristic of the overlying Charlie Lake Formation. South of Peace River the contact is readily apparent (see figure 2). The lower contact is transitional with the underlying Mount Wright within the area at one locality at least. At Mount Wright a zone of several feet of alternating dark grey siltstones and light grey sandstones was observed, the latter increasing at the expense of the former on ascending the section. The upper contact is taken either at the top of the sandstone in the southern sections, or at the appearance of dolomites or siltstones coupled with a decrease in thickness of the sand beds, and a suppression of slopes topographically.

Lithologically the Halfway Formation is composed of sandstone, ranging from orthoquartzite to lithic greywacke (Pettijohn 1957, p. 291) for the most part. The sand component ranges from very fine to medium grained, and from well rounded to subangular, varying as in the case of the Mount Wright Formation sands. Visually, sorting ranges from good to moderate. The sand component is made up almost entirely of quartz and pressure quartz has been noted. Lithic fragments are also present. Minor amounts of chert and feldspar have been seen in thin section. Comminuted skeletal material is frequently present, brachiopod and pelecypod debris predominating. Matrix is of several types, calcareous and dolomitic cement is most common but argillaceous and silty varieties have been noted. Minor occurrences of siltstone and skeletal limestone have been noted. The latter are generally not very thick and may be extremely rich in brachiopods of the Aulacothyris and Spiriferina type, which from statistical studies appear to have been washed and selectively sorted in part.

Paleontology

The Halfway Formation carries the Nathorstites-Aulacothyris Assemblage Zone within this area. Ammonites are in general rare, pelecypods somewhat more common and brachiopods most common. McLearn has described and figured numerous taxa of the Nathorstites zone occurring within the lower 'Grey Beds'. Some members of the general assemblage have been found much higher than the uppermost portion of the Halfway Formation itself. In addition to ammonite evidence, brachiopods noted in the underlying Mount Wright continue in almost identical development far up the section and well into the Charlie Lake Formation. The pelecypods, as McLearn has noted (1940), are very similar to the pelecypod fauna developed within the Mount Wright.

CHARLIE LAKE FORMATION

The Charlie Lake Formation was formally proposed by Hunt and Ratcliffe (1959) for subsurface Triassic strata lying below the Baldonnel Formation and above the Halfway Formation. The term was initially introduced by L.M. Clarke in 1954. Hunt and Ratcliffe indicate it correlates with the Mahaffy Cliffs fauna along Peace River, and occupies a central portion of McLearn's 'Grey Beds'. They have shown a number of major facies occurring within it, and particularly a western - sandstone facies. Hunt and Ratcliffe (1959) assigned the section present at the Pacific Fort St. John #16 well, located at LSD. 2, sec. 18, T. 84, R. 19 W. 6th Mer., from 4256 to 5168 feet below K.B. as the type.

The following alternate surface section along Peace River is assigned to the Charlie Lake Formation.

Location:	Brown Hill along the north side of Peace River.
Map reference:	11 - E/94 - B - 2
Described by:	R.P. Glaister, A.R. Yeske (1958)

Interval	Lithology
	Charlie Lake Formation (1285')
0 - 15 (15')	Sandstone, brownish-grey, very fine grained slightly dolomitic, slightly calcareous.
15 - 85 (70')	Sandstone, brownish-grey, very fine grained, dolomitic, very slightly calcareous; mainly concealed.
85 - 115 (30')	Sandstone, brownish-grey, very fine grained, dolomitic, thin-bedded.
115 - 145 (30')	Sandstone, grey, very fine grained, slightly dolomitic, slightly calcareous, slightly organic with dark grey carbonaceous partings, thin-bedded; 70% concealed. Coenothyris sp. Pelecypod ind.
145 - 149 (4')	Siltstone, buff, very dolomitic, thin-bedded.
149 - 155 (6')	Crypotograined limestone, buff, slightly silty.
155 - 160 (5')	Sandstone, grey, very fine grained, calcareous.
160 - 170 (10')	Skeletal micrograined limestone, dark grey, very fine grained with 40% arenaceous micrograined matrix, thin-bedded.

170 - 175 (5')	Sandstone, grey, very fine grained, silty, calcareous, medium-bedded.
175 - 180 (5')	Micrograined limestone, buff, arenaceous, medium-bedded.
180 - 185 (5')	Sandstone, light buff, medium grained, slightly dolomitic, slightly siliceous.
185 - 255 (70')	Mainly concealed; some fine to medium grained sandstone "float".
255 - 265	Sandstone, light buff, fine to medium grained, slightly dolomitic, streaked with iron oxide staining, medium-bedded.
265 - 325 (60')	Sandstone, red to buff, very fine to fine grained, dolomitic minute carbonaceous plant fragments in the lower part; partly concealed.
325 - 335 (10')	Siltstone, buff, arenaceous, very dolomitic.
335 - 405 (70')	Sandstone, grey to buff, very fine grained, dolomitic with threads of carbonaceous material, thin to medium-bedded.
405 - 475 (70')	Mainly concealed.
475 - 570 (95')	Sandstone, brownish-grey, very fine grained, dolomitic; interbedded with brownish-grey, slightly argillaceous dolomitic siltstone; some carbonaceous partings.
570 - 610 (40')	Sandstone, grey, medium grained, very calcareous with 35% - 40% coarse grained skeletal material, thin-bedded. Pelecypoda ind.
610 - 815 (205')	Mainly concealed.
815 - 840 (25')	Sandstone, brownish-grey, very fine grained, calcareous, with carbonaceous plant fragments, pelecypods and brachiopods; _Aulacothyris petriana_ McLearn. _Spiriferina_ cf. _borealis_ Whiteaves. _Margarita_ cf. _triassica_ Whiteaves. _Isculites schooleri_ McLearn. _Paratrachyceras_ (?) sp.
840 - 857 (17')	Mainly concealed.
857 - 872 (15')	Skeletal micrograined limestone, grey, very coarse grained (some entire poorly preserved pelecypods and brachiopods), with 30% arenaceous micrograined matrix.

872 - 877 (5')	Sandstone, buff, very fine grained, calcareous with 1/2 inch bands containing 20% - 30% very coarse grained skeletal fragments; a few poorly preserved pelecypods. Aulacothyris petriana, McLearn. Spiriferina sp. Gryphaea sp. Reptile bone.
877 - 885 (8')	Skeletal micrograined limestone, grey, very coarse grained (some entire pelecypods and brachiopods), with 30% arenaceous micrograined matrix. Aulacothyris sp. ind. Spiriferina cf. borealis. Whiteaves.
885 - 900 (15')	Sandstone, grey, medium grained, silty, dolomitic, medium-bedded.
900 - 935 (35')	Mainly concealed.
935 - 945 (10')	Dolomite buff, cryptocrystalline, silty.
945 - 970 (25')	Sandstone, buff, fine grained, slightly dolomitic, slightly calcareous, thick bedded; interbedded with sandstone, grey, very fine grained, silty, dolomitic.
970 - 980 (10')	Sandstone, grey, coarse grained, poorly sorted, calcareous with 20% skeletal fragments, 5% - 10% rock grains, poorly preserved gastropods and brachiopods? Aulacothyris sp. ind. Spiriferina sp. ind.
980 - 990 (10')	Sandstone, light grey, fine to medium grained, poorly sorted, calcareous, with 10% - 20% medium skeletal grains.
990 - 1015 (25')	Sandstone, buff, fine grained, calcareous, medium-bedded.
1015 - 1021 (6')	Sandstone, greyish-buff, medium grained, very calcareous with 30% coarse grained skeletal fragments. Aulacothyris petriana, McLearn. Gryphaea sp.
1021 - 1045 (24')	Siltstone, grey, slightly argillaceous, calcareous, abundant brachiopods (Coenothyris).
1045 - 1050 (5')	Sandstone, light grey, fine to medium grained, very calcareous with 25% coarse skeletal fragments and some entire brachiopods. Aulacothyris petriana McLearn.
1050 - 1065 (15')	Mainly concealed.
1065 - 1090 (25')	Sandstone, buff, medium grained, poorly sorted, very calcareous, with 20% - 40% medium to very coarse skeletal grains and some poorly preserved brachiopods.

1090 - 1110 (20')	Siltstone, brownish-grey, slightly arenaceous, calcareous; partly concealed.
1110 - 1125 (15')	Sandstone, buff, fine grained, calcareous; partly concealed.
1125 - 1165 (40')	Concealed.
1165 - 1175 (10')	Sandstone, buff, very fine grained, calcareous.
1175 - 1215 (40')	Siltstone, brownish-grey, slightly arenaceous, calcareous, very thin-bedded.
1215 - 1218 (3')	Sandstone, buff, very fine grained, calcareous with abundant brachiopods in the upper foot, thin-bedded. Aulacothyris petriana, McLearn, Spiriferina sp.
1218 - 1285 (67')	Concealed.

Base Charlie Lake Formation

The Halfway-Charlie Lake contact at the surface forms a gradational series of beds in several of the sections within this area, and because of widespread sandstone development, the contact must be placed in these within a zone. South of Peace River the contact is well-marked. The upper contact with the Baldonnel Formation is taken at the occurrence of well developed allochthonous skeletal micrograined limestone which frequently carry the Lima cf. poyana, Assemblage Zone. The western sandstone facies indicated by Hunt and Ratcliffe (1959) in the subsurface is apparent at the surface and is in general of decreasing lateral extent throughout Charlie Lake time, although several widespread 'pulses' have been noted. The sand content drops appreciably toward the east in the subsurface and toward the south as indicated in Figure 2, section 7. More than twenty sandstone beds have been noted in the western foothills, which are probably more normal marine in nature at least in the lower portion of some sections, and possibly deposited under more saline conditions higher in these sections.

Siltstones, dolomites and limestones become more common upwards in the Charlie Lake sections with decreasing sand influx toward the east and south.

Lithology

The number of distinctive rock types developed within the Charlie Lake Formation is larger than within any other Triassic formation in the area, largely through the introduction of widespread evaporitic conditions.

Among the clastic rocks, sandstones very similar to the underlying Halfway Formation are present. Very fine to rarely medium grained, thin to thick-bedded, moderately to well sorted sands persist, with a dolomitic to calcitic matrix. Dolomitic cement is common upwards in the sections, and may even be well developed in the lower part of the section as at Cypress Creek. The lower more normal marine sands are closely limited in the subsurface by evaporitic conditions. Comminuted skeletal debris is similarly developed as in the Halfway. Dolomitic siltstones are also present, some grading to argillaceous sandstones. Generally they are medium grey in the outcrop area, but buff and pink varieties noted in the subsurface are also present as at Red Rock Spur. In addition to these clastics, allochthonous skeletal micrograined limestone, dolomitized limestone, and cryptocrystalline dolomite beds may be noted, generally light grey and buff in color. Collapse breccias have been noted in most of the illustrated sections, and are thought to indicate the former presence of evaporitic strata.

Paleontology

In the Peace River Foothills McLearn originally noted the presence of four faunal zones occurring within the 'Grey Beds', three of which lie within strata now ascribed to the Charlie Lake Formation. These include the Nathorstites, Mahaffy Cliffs and Red Rock Spur Zones. Two of these, the Mahaffy Cliffs and Red Rock Spur faunas were latter grouped together (McLearn and Kindle, 1950). The Lima poyana Zone, which has been ascribed to subsurface Baldonnel strata (Hunt and Ratcliffe, 1959, from determination by Stelck) may also properly be included here though it is not well developed. The age of these faunas is late Ladinian and Karnian (McLearn 1937, 1940). Due to the stratigraphic range of the individual taxa, it is necessary to distinguish between Assemblage Zones and Range Zones. The limits of Nathorstites-Aulacothyris' Assemblage Zone have been placed somewhat higher than the Range Zone in other studies. At Brown Hill, in the Peace River Foothills, the following fauna was collected from a point 1320 feet below the top of the Triassic in that area, or at a point about one-half way through the Charlie Lake succession:

Aulacothyris (Coenothyris) petriana, McLearn
Spiriferina cf. borealis, Whiteaves
Margarita cf. triassica, Whiteaves
Ischulites schooleri, McLearn
Protachyceras (?) sp.

The brachiopods are almost identical with those occurring in the underlying Mount Wright and Halfway Formations in the vicinity, and the whole collection appears closely allied to the Nathorstites mcconnelli-Aulacothyris petriana Assemblage Zone noted in lower collections at Brown Hill, at McLay Spur, and at Beattie Ledge and Beattie Hill. Overlying these strata on Brown Hill occur about 650 feet of strata which did not yield good collections, and these beds are succeeded by strata carrying the Lima poyana Assemblage Zone, within the Baldonnel Formation. In addition to the brachiopods, pelecypods and ammonites which are rather more extensively developed in the lower portion of the Charlie Lake Formation than in the upper, there occur a number of other collections within these strata that may be more valuable as indices of more saline conditions than as actual correlation faunas. From Red Rock Spur the following fauna was collected associated with variegated siltstones which lay close to variegated shales and cryptocrystalline dolomites:

Aulacothyris petriana, McLearn
Pteria sp. nov.
Myophoria silentiana, Zeithen
Myophoria sp.
Lima cf. poyana, McLearn
Pecten cf. nihanianus, McLearn
Pelecypoda indet.

The Lima poyana Assemblage and Range Zone may be relatively broad in time, and may overlap the Nathorstites-Aulacothyris Assemblage Zone. McLearn in numerous papers has outlined additional collections and stratigraphic successions at all the above localities, as well as others. His 1940, 1941A and 1941C papers are particularly significant in the field of stratigraphy, paleontology and stage zonation within this area.

From the Cypress Creek section (figure 2) occurring in a collapse breccia about one-half way through the Charlie Lake succession the following were found:

Cassianella cf. beyrichi Bittner
Chalmys sp.
Lima sp.
Melania sp.

The fauna in outcrop was composed of about 80% pelecypod and 20% gastropod species but was too far altered to give good specimens. From a similar stratigraphic position at Mount Ehman the following were identified:

Myophoria sp. indet.
Omphaloptycha ? sp.

These latter collections, and others noted in various sections, all occurred in highly porous dolomitized, very light grey, arenaceous limestone, and the latter in each case formed either the overlying stratum to a collapse breccia, or was incorporated within it.

The upper portion of the Charlie Lake Formation has proven very sparcely fossiliferous and attempted collections are very meagre. Not until the Lima poyana Assemblage Zone was reached did good collecting become possible again. The latter fauna is included in a lithology that is assigned to the Baldonnel Formation.

BALDONNEL FORMATION

Clark (1954) introduced the term Baldonnel for a widely occurring dolomite at the top of the subsurface Triassic in the Fort St. John area. Hunt and Ratcliffe (1959) assigned a subsurface type section at LSD. 2, sec. 18, T. 84, R. 19 W. 6th Mer.

in the Pacific Fort St. John well number 16, from 4256 to 5168 feet, described the formation, and mapped it by isopachs. The position of the strata within McLearn's paleontological zonation has been outlined by Hunt and Ratcliffe by means of fossils identified by Stelck (1959), occurring within the Lima poyana Zone. They point out a resemblance with the upper 'Grey beds'.

The following is an alternate surface section of the Baldonnel Formation occurring at Brown Hill along Peace River.

Map reference: 11 - E/94 - B - 2
Described by: R.P. Glaister, A.R. Yeske (1958)

Interval	Lithology
	Baldonnel Formation (225')
0 - 15 (15')	Siltstone, greyish-buff, arenaceous alternating 1/8 inch thick, light grey, calcareous, and dark grey, siliceous bands.
15 - 30 (15')	Skeletal micrograined limestone, buff; composed of 60% skeletal (pelecypod) grains up to 2 mm across, 40% slightly silty, micrograined matrix; medium-bedded, rubbly weathering.
30 - 40 (10')	Sandstone, brownish-grey, very fine grained, very calcareous, with 15% fine grained skeletal material (crinoids), 5% interstitial organic residue; Anodontophora (?) sp.
40 - 70 (30')	Skeletal limestone, brownish-grey, fine grained, crinoidal, partly dolomitized with some leached fossil casts, slightly silty; fair leached vug and poor intercrystalline porosity; 5% organic residue.
70 - 120 (50')	Skeletal micrograined limestone, brownish-grey; composed of 50% skeletal grains up to 2 mm across including thin shelled pelecypod fragments, 30% micrograined matrix, 20% very fine quartz grains; medium-bedded; partly concealed. Pelecypoda ind.
120 - 130 (10')	Siltstone, brownish-grey, siliceous, with 20% dolomitized fine grained skeletal material; thin-bedded; scattered silicified Isocrinus on weathered surface. Isocrinus californicus, Clark.
130 - 135 (5')	Sandstone, brownish-grey, composed of 85% quartz grains, 10% chert grains, 5% organic clay matrix, cemented with silica.
135 - 180 (45')	Sandstone, buff, fine grained, very calcareous with 25% fine grained skeletal material; mainly concealed.
180 - 190 (10')	Siltstone, brownish-grey, slightly arenaceous, very calcareous with 25% fine grained skeletal (crinoidal ?) material.

190 - 197 (7')	Skeletal, micrograined limestone, grey, composed of small poorly preserved pelecypods in 40% arenaceous micrograined matrix. Lima sp. ind. Pelecypoda ind.
197 - 210 (13')	Siltstone, brownish-grey, arenaceous, calcareous with 10% - 30% fine grained skeletal material.
210 - 225 (15')	Skeletal limestone, greyish-buff, medium grained, with 30% silty micrograined to very fine grained matrix.

Base Baldonnel Formation

Widespread facies change is present between surface and subsurface units (Colquhoun, 1960). In the western outcrop belt of the Peace River Foothills, the Baldonnel Formation is developed as an allochthonous skeletal micrograined limestone to a micritic limestone with little to no secondary dolomitization. The lower contact is taken at the top of sandstones, siltstones, and cryptocrystalline dolomites of the Charlie Lake Formation and is usually abrupt and conformable. The upper contact with the autochthonous dark grey limestones of the Pardonet Formation is usually gradational and may take place within a rather wide interval. Good exposures of the formation have been noted in most sections illustrated in Figure 2, and may be seen at McLay Spur, and Brown Hill along the Peace River.

Lithology

Carbonate rocks of several types are the dominant constituents of the Baldonnel Formation. From thin-section studies their composition varies from skeletal micrograined limestone through micrograined skeletal limestone to micritic limestone. Skeletal micrograined limestones are the most common rock type, and many thin-sections have shown an allochthonous nature to the strata. The skeletal component consists for the most part of entire and comminuted pelecypod, brachiopod, and gastropod debris, more or less abraided. In many sections the fossils were oriented with their long axis parallel to the bedding. Several beds occurring within the foothills, usually within the Baldonnel-Pardonet transition beds, have an autochthonous aspect in which thinner shelled forms have survived their depositional environment and are neither very abraided nor broken; in the subsurface this is not as common as in the surface. The presence of isolated crinoid columnals and plates is noteworthy in addition to the other phyla. In color, the surface sediments vary from light to medium grey and more rarely dark grey. Also present within the lithology are several fine-grained lithic greywackes and protoquartzites which extend eastward from the foothills a short distance in the subsurface. Grey arenaceous siltstones have also been noted. Chert is present within these strata, but rarely in this area of the surface. Bituminous infillings have also been noted.

Paleontology

Along Peace River McLearn in numerous papers has figured and described fossils from the Lima poyana Zone, at Brown Hill, and McLay Spur as well as at other locations. The Assemblage Zone has been noted at Cypress Creek, Mount Ehman, and Mount Wright. The Baldonnel-Pardonet contact does not appear to be time constant, but appears to transgress at least the Stikinoceras Assemblage Zone in the surface (see figure 2). The environment, as indicated by the allochthonous nature of the strata, is probably not suited for ammonite preservation. It is thought, with reference to the mapped occurrences of the various faunal assemblage zones noted on Figure 2, that the Baldonnel Formation includes strata time equivalent to approximately the base of the Himavatites Assemblage Zone in the surface, and probably in the subsurface as well.

PARDONET FORMATION

McLearn 1960 raised the rank of the Pardonet Beds to Pardonet Formation assigning the exposures on Pardonet Hill along Peace River as type section (see figure 3). Typically the Pardonet is approximately 400 feet thick in the west and decreases to 0 feet a short distance east of the Foothills in the subsurface. The section at Pardonet Hill is of course much thicker.

The following is an alternate section of the Pardonet Formation exposed at Brown Hill along Peace River.

Map reference: 11 - E/94 - B - 2
Described by: R.P. Glaister, A.R. Yeske (1958)

Interval	Lithology
	Overlying beds of Fernie group concealed.
	Pardonet Formation (295')
0 - 15 (15')	Concealed
15 - 20 (5')	Micrograined skeletal limestone, dark grey; composed of 20% - 40% pelecypods in a silty, organic, micrograined matrix, very thin-bedded, feted. Brachiopoda ind. Monotis subcircularis, Gabb. Pelecypoda ind.
20 - 40 (20')	Skeletal micrograined limestone, dark grey; composed of compressed pelecypod shells in 10% - 25% organic, silty, micrograined matrix; very thin wavy bedding; feted. Monotis subcircularis, Gabb. Lima sp. ind.
40 - 83 (43')	Micrograined skeletal limestone, dark grey, composed of 20% - 30% well preserved pelecypods in a silty organic micrograined matrix, very thin-bedded, feted. Monotis subcircularis, Gabb. Anomia sp. Sphaera sp.; Monotis subcircularis, Gabb.
83 - 130 (47')	Micrograined skeletal limestone, dark grey, composed of 10% - 20% well preserved pelecypods in a very silty, slightly argillaceous, organic, micrograined matrix, very thin-bedded, feted. Monotis subcircularis,

	Gabb. Plagiostoma sp. Gryphaea sp.; Monotis subcircularis, Gabb. Plagiostoma sp.; Halobia cf. pacalis, McLearn. Pelecypoda ind. Himavatites cf. columbianus, McLearn. Ammonoidea ind.; Fossil ind. Himavatites cf. columbianus, McLearn.
130 - 150 (20')	Skeletal micrograined limestone, dark grey, composed of 50% - 70% immature pelecypods in a slightly argillaceous, silty, organic, micrograined matrix; feted. Halobia cf. pacalis, McLearn.
150 - 160 (10')	Micrograined skeletal limestone, dark grey, composed of 20% - 30% well preserved pelecypods in a slightly argillaceous, very silty, organic, micrograined matrix; feted. Halobia cf. pacalis, McLearn.
160 - 170 (10')	Skeletal micrograined limestone, dark grey, composed of 50% - 70% compressed pelecypod shells in a silty, organic, micrograined matrix; feted. Halobia non pacalis. Gryphaea sp.
170 - 230 (60')	Micrograined skeletal limestone, dark grey, composed of 10% - 20% poorly preserved pelecypods in a slightly argillaceous, silty, organic, micrograined matrix; feted; concealed from 205' to 220'. Halobia sp. Lima sp. Gryphaea sp.; Pelecypoda ind.
230 - 275 (45')	Skeletal micrograined limestone, dark grey, composed of 50% - 70% pelecypod shells in a slightly argillaceous, slightly silty, organic, micrograined matrix; feted; mainly concealed from 255' to 275'; Halobia.
275 - 280 (5')	Micrograined skeletal limestone, dark grey, composed of 20% - 40% pelecypods in a slightly argillaceous, very silty, organic, micrograined matrix; Stikinoceras aff. kerri, McLearn. S. sp. n. Parathisbites (?) sp.

Lithology

The Pardonet Formation is usually expressed as a series of thin and medium-bedded, dark grey, silty autochthonous limestones of skeletal micrograined to micrograined composition. The strata are termed autochthonous because of the very-fine grained nature of the rocks, and the excellent state of preservation of the faunas. Even extremely thin, finely ornamented pelecypods of various genera occur highly packed, and little abraided. The skeletal components mark the chief parameters used in mapping the carbonate strata in the field. Those limestones containing over 50% skeletal material are termed skeletal micritic or skeletal micrograined, and those containing less micritic skeletal or micrograined skeletal. In nearly all cases, thin-section study has revealed a very fine-grained, silty, argillaceous, organic, calcareous matrix. Relatively more minor in occurrence are fine-grained sandstones (lithic greywackes), and siltstones. The upper contact is abrupt and disconformable with the Jurassic shales of the Fernie Group within this area. The lower contact with the Baldonnel Formation taken at the base of the autochthonous facies is gradational.

Paleontology

The fauna of the Pardonet was thoroughly described by McLearn (1960) as well as in numerous other papers. The diversity of the fauna, its abundance, and the outstanding state of its preservation coupled with the ease of separation of the material, makes the Pardonet one of the most outstanding collection zones of the Triassic succession within this area. The ammonite and pelecypod faunas are well developed and relatively common, and in particular the Monotis subcircularis, and Himavatites bearing beds can be noted in the central outcrop area in most sections. The lower contact of the Pardonet has been observed to transgress the Stikinoceras Assemblage Zone, as well as others not illustrated. (See Figure 2). McLearn (1941) has noted a rarety of ammonites at McLay Spur in comparison with the Brown Hill and Pardonet Hill localities. Colquhoun (1960) thought that the transition from autochthonous to allochthonous limestones was responsible, and thought affinities with the Halobia Zone (McLearn 1937, 1940) could be seen in the Baldonnel subsurface fauna. From this evidence it is apparent that the Baldonnel-Pardonet contact is not time constant, but possibly is younger in the east than in the west, similar lines of evidence were shown by Armitage (1962) on the basis of lithology. Tozer (1961, p. 14) has suggested somewhat the same process in western exposures.

SUMMARY

Examination of Triassic surface strata in the Peace River Foothills and vicinity has revealed little apparent stratigraphic difference between these beds and those encountered in drilling toward the east. The major units may be mapped together, to produce regionally significant results. Facies changes within the major surface subdivisions can be traced into the subsurface.

The subdivision of the Toad and Grayling Formations remains a problem. The three-fold unit division noted by Manko in the Rock Lake area (Manko, 1960; Ziegler and Manko, unpublished data 1958); Scythian 'lower black siltstones' and 'blocky brown siltstone', and Anisian 'black shale' units may be correlated toward the north from this area at least as far as Wapiti Lake, and can be noted over a vast area in the eastern subsurface. Northward from Wapiti Lake and westward in the subsurface toward the Peace River Foothills, increase in finer clastics obscures the division between the latter two units lithologically. At the surface, with the possible exception of the section near Graham River (Figure 2, section 4), no lithological break in this interval has been noted that can be regionally correlated.

A second major problem lies in adequate demonstration of phosphate. The 'black shale' and 'upper siltstone' units have been visually observed to be phosphatic, (Manko, 1960, Ziegler and Manko unpublished data 1958), and a majority of occurrences lie at the base of the latter. These units can be traced into the subsurface on the basis of lithology. In Peace River Foothills and vicinity phosphate has been visually observed in the upper portion of the Toad Formation at one locality and chemically deduced in a number of other sections. By chemical analyses it has been observed to occur within the lower portion of the Mount Wright as well, but analyses have been insufficient to demonstrate its presence over a broad range within the latter. Lithological correlations from the surface Mount Wright to the subsurface Doig Formation have been based on general appearance of strata coupled with recognized marker beds, and enhanced with the recognition of Nathorstites mcconnelli, Whiteaves by Stelck. In addition to this species Aulacothyris petriana, McLearn and Spiriferina cf. onestae McLearn, have also been noted; at a similar stratigraphic position. The identification of Parapopanoceras sp. associated with these taxa is at variance with surface range observations to date. Both the Doig Formation and 'black shale' unit of the Montney Formation being phosphatic, correlation would be further enhanced if phosphate could be shown to occur more widely within the Mount Wright. General lithologic similarity of some of the untested Mount Wright silts and shales to samples which gave a high phosphatic analyses in lower portions of the sections is all that can be noted to date.

The Mount Wright Formation is thought to be correlative lithologically with Manko's 'upper siltstone' unit and has been mapped as such (Colquhoun, 1960). It represents a complex of relatively rapid facies changes within this area, ranging from the 'Liard' type sandstones, to the 'Dark Siltstones'.

The Halfway Formation at the surface can usually be noted and can be correlated at the surface over a large area. Sandstone, at the base of the Whitehorse Formation as noted by Manko (1960) has been observed irregularly as far south as Kananaskis Lakes Alberta.

The Charlie Lake Formation in this area can also be traced over a broad area in the surface and subsurface and it is thought to be equivalent and in part correlative with the Whitehorse Formation as noted by Manko (1960). It too has been noted as far south as Kaninaskis Lakes.

The Baldonnel Formation is thought to be present at least as far south as Wapiti Lake, and the Pardonet Formation to have approximately the same geographic range.

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PERMO-CARBONIFEROUS STRATIGRAPHY OF THE ROCKY MOUNTAINS NORTH OF PEACE RIVER

By

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ABSTRACT

The Permo-Carboniferous of the Peace River area of the Rocky Mountains and foothills is represented by rocks ranging in age from lowermost Mississippian to Permian.

The lowermost Mississippian is represented by the upper part of a thick shale unit for which the term Besa River formation is proposed by Kidd (this volume).

Osage, Meramec and possibly lowermost Chester are represented by a cherty limestone sequence to which Sutherland (1958) has given the name Prophet formation.

Most of the Chester, plus the Pennsylvanian and Permian are represented by a predominantly clastic sequence for which the term Chowade Group is proposed.

INTRODUCTION AND ACKNOWLEDGEMENTS

Geological mapping in the Rocky Mountains of northeastern British Columbia during the summer of 1958 led to the recognition of two major map units within the Permo-Carboniferous.

The Prophet formation (Sutherland, 1958) is a chert and cherty limestone sequence which carries Osagean, Meramecian and possibly lowermost Chesterian fauna. The formation is gradational into the underlying Besa River formation (Kidd - this volume) and it is therefore probable that the Kinderhook, and in places perhaps part of the Osage may be represented within the Besa River.

The Prophet is overlain by a sequence of shales, sandstones and silty and argillaceous limestones which carries a fauna indicative of Chesterian and problematical Upper Pennsylvanian or Lower Permian age. While this sequence is clearly equivalent to the Belloy and Taylor Flat formations and the Floral Group of the subsurface to the east, these subdivisions do not have practical application to most surface exposures. Therefore the term Chowade Group is proposed for application to surface exposures of this sequence.

The release of the information contained herein is by permission of The California Standard Company. All faunal identifications have been made by Dr. S. J. Nelson, and his helpful criticism of the text is acknowledged. The writer is also indebted to C.N. Chernoff, with whom he was closely associated in this mapping project, and to several of his associates in California Standard for suggestions and criticisms.

PROPHET FORMATION

Sutherland (1958) has proposed the name Prophet formation for the cliff-forming cherty limestone of Mississippian age in this area. The type section proposed by him is on "Bull" Creek, a tributary of the Muskwa River, at approximately 57° 47' N Latitude and 123° 47' W Longitude. At this location the Prophet formation is unconformably overlain by Triassic, the Chowade Group and an indeterminate amount of the upper Prophet having been removed by northward erosional bevelling.

Since the type section proposed by Sutherland is incomplete, it is proposed that Section No. 4 of this report, located 8 miles east-south-east of Redfern Lake at 57° 17' N, 123° 38' W, may be considered as an alternate type section. Essential faunal and lithologic identity plus continuous field mapping between the two localities seem sufficient to render this a valid substitution.

The Prophet formation consists of interbedded chert, cherty limestone and limestone in varying proportions. The upper half to two-thirds is slabby to massive while the lower part is more thinly bedded and contains interbeds of siliceous shale and siltstone. The outstanding lithologic characteristic of the formation is the high chert content, which in places appears to range up to 70 percent. Colors are predominantly grey to black.

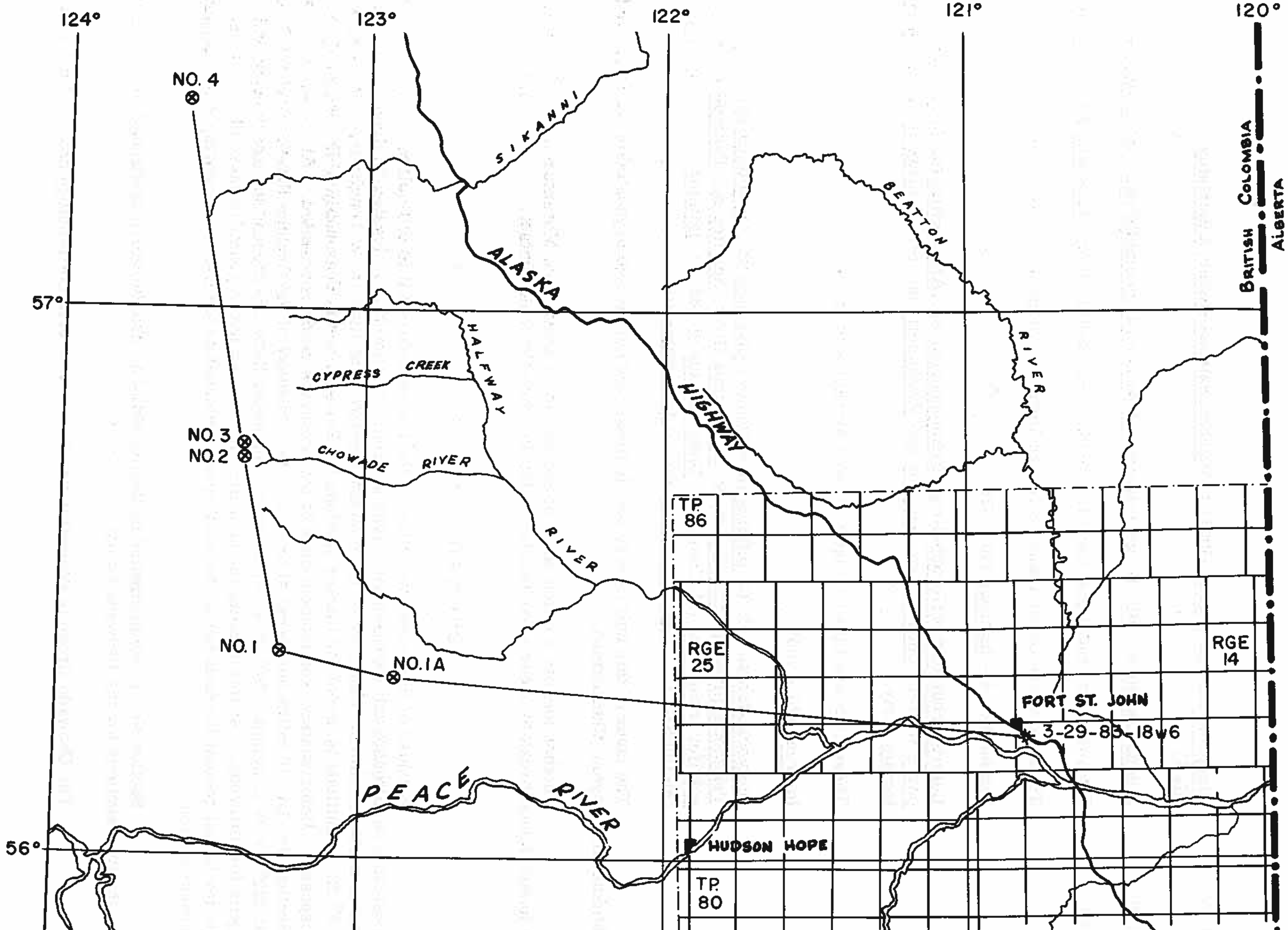
Thickness of the Prophet within the area under discussion varies from 600 feet to 1,500 feet. This wide variation is undoubtedly in part due to tectonic influences, but it is suspected that diachronism of the lower contact may also contribute, i.e. the formation may include a longer time span in areas of maximum thickness.

The lower contact of the Prophet is decidely gradational into what Sutherland termed the "Basal Shale Unit", for which the term Besa River formation is now proposed (Kidd - this volume). The contact has been placed at the lowermost resistant beds in the gradational interval, and may as previously inferred, be diachronic. The underlying Besa River formation is characterized by grey to black shales with minor argillaceous limestones, and is seldom if ever fully exposed.

Fossils collected from the Prophet include:

Section No. 1 (See Figure 1 for localities)

555' (talus) Cliothyridina sp. ? Orthotetes sp. nr. O. kaskaskiensis (McChesney), Spirifer sp. Chonetes sp.



LOCATION MAP

1 INCH TO 16 MI.

FIGURE 1

645' Linoproductus altonensis (Hall) (?) Echinoconchus sp. nr. biseriatus (Hall)

790' Echinoconchus sp. nr. E. genevienvensis Weller Rhipidomella sp.

850' Dictyoclostid brachiopod (not identifiable), Productid spines, Chonetes sp.

These beds are Upper Osage to Lower Meramec in age.

Section No. 4 - Interval 240 - 535'

Leiorhynchus carboniferum Girty, Echinoconchus sp., Ambocoelia cf. A. parva Weller, Chonetes sp., Spirifer sp., Productella sp. cf. P. hirsutiformis Girty.

These beds are Upper Osage to Lower Meramec in age.

Interval 720 - 765'

Dictyoclostus sp. cf. D. inflatus (McChesney), Chonetes sp., Orthotetes sp., Trioplophyllites sp., Spirifer cf. S. arkansanus Girty, Spirifer sp., Punctospirifer transversa (McChesney), Dictyoclostus sp. cf. D. inflatus (McChesney)?, Gigantoproductus sp., or Orthotetes sp.

The fauna of this unit is very poorly preserved but the age suggested is Middle Etherington (Chesterian).

Another locality 5 miles south of Section No. 1 showed the Meramec-Chester faunal break to occur a few feet below the Prophet-Chowade contact.

CHOWADE GROUP

Because of the recessive nature of the Chowade Group it is difficult to designate an adequate and representative type section. Section No. 1, located thirteen miles north-northwest, along strike from Mount Brewster, at 123° 15' W Longitude, 56° 22' N Latitude is one of the thicker sections in the area, and is reasonably well exposed. Unfortunately, the topmost beds of the section are not represented. At Section No. 1A, 16 miles northwest of Goldbar, on a tributary of the Graham River, at 122° 53' W Longitude, 56° 18.5' N. Latitude, the upper beds are present and are quite fossiliferous. At this locality the beds are repeated by faulting, and because of better faunal content the beds below the fault have been selected for the accompanying cross-section.

Section No. 1, supplemented by section No. 1A, are therefore designated as the type sections for the Chowade Group.

The Chowade Group is generally divisible, on the basis of lithology and topographic expression, into three units. These units and their approximate correlation are shown in Figure 2 and will be discussed in ascending order.

Unit A consists of about 300 feet of dark grey fissile shale containing ironstone nodules and a few limestone stringers. Both lithology and thickness are relatively constant throughout the area. Topographic expression is, as might be expected, recessive.

The contact of this unit with the underlying Prophet formation is sharp and appears conformable.

No diagnostic fossils have been found in Unit A, but the presence of a Chester fauna in the topmost beds of the Prophet at Section No. 4 and of species suggestive of a Mississippian age in overlying beds strongly infer that the unit is of Chester age.

Unit B has a thickness of 430 feet at the type section, and this thickness is near the maximum for the area, with gradual northward thinning being evident. The unit is predominantly fine grained quartzose sandstone with occasional black chert grains and pebbles. The sandstone is commonly calcareous, and thin limestone stringers occur quite frequently. Interbeds of siltstone are present throughout. The unit is erosionally more resistant than either Unit A or Unit C and generally forms a gentle ridge.

The lower contact of Unit B is seldom well exposed and is most often picked at the change in topographic expression. Those exposures of the contact which have been seen suggest that it is gradational in nature.

Fossils are rare in Unit B and those having been found are:

Section No. 1 - 1580 feet:	*Spirifer* sp.
Section No. 4 - 1210 feet:	*Ambocoelia* sp. cf. *A. parva* Weller, *Leiorhynchus* sp.

This limited fauna is by no means diagnostic, but does suggest a Mississipian rather than a Permo-Pennsylvanian age. If the fauna is Mississippian then the stratigraphic position would necessitate a Chesterian age.

Unit C has, in the vicinity of the type section and the supplementary type section, a thickness of about 600 feet. The unit is characterized by a greater predominance of calcareous strata than in Unit B. Argillaceous and silty limestones, which weather in a platy and flaggy fashion, are interbedded with shales and occasional calcareous sandstones. The sequence is capped by a massive dark grey to black chert bed 50 to 150 feet in thickness. In the most northerly parts of the area (e.g. Section No. 4) the unit becomes quite sandy and no satisfactory separation from Unit B is evident.

Exposure of the lower contact of Unit C is everywhere poor, but no evidence of unconformable or disconformable relationships has been seen to substantiate the indicated faunal break. The upper contact, between the massive chert and the Lower Triassic shales, is sharp and in view of the truncation of Chowade group to the north of the subject area, must be assumed to be unconformable. Evidence of unconformity within the area is, however, limited to variability in thickness of the chert unit.

Although Unit C is generally unfossiliferous, Section No. 1A has yielded the following:

? Pterospirifer altus (Schlotheim)
Spiriferella keilhavie (von Buch)
Brachythyrina sokolovi (Tschernyschew)
Cliothyridina sp., Ambocoelia - like brachiopods
Dilasma timanicum Tschernyschew (?)

About 42 miles farther south the formation yielded:

Muirwoodia transversa Cooper
Waagenoconcha sp., Neospirifer sp.
? Pterospirifer altus (Schlotheim)

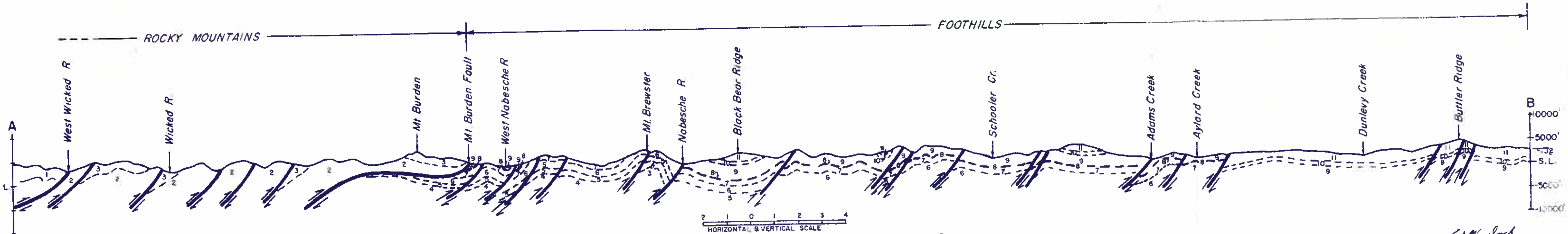
This fauna is allied to that of the Upper Carboniferous and Permian of Russia, and is widely dispersed in the Yukon Territory. Fusulinid evidence from the latter area indicates that it is either Upper Pennsylvanian or Lower Permian (Sakmarian or Artinskian), probably the latter.

CORRELATION TO SUBSURFACE

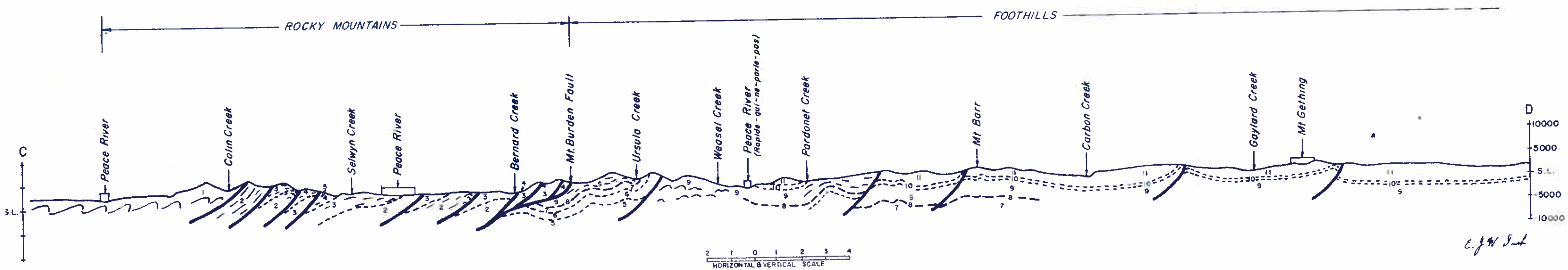
Figure No. 2 shows the suggested correlation of the Chowade group to the plains well Pacific Fort St. John No. 23. The formations and names proposed by Halbertsma (1959) for that well are indicated. Faunal identifications tend to verify the correlation suggested by the lithologic sequence.

The top of the Prophet formation lies close to the Meramec-Chester faunal break, as does top of the Debolt of the plains. The age of the Golata formation, based on plant spore determinations by Dr. Staplin (Halbersma, 1959) is Chesterian. Megafauna indicate a similar age for Unit A, and W. Bamber of the Geological Survey of Canada (personal communication) advises that Golata spores have been found in samples taken from Unit A in Section No. 1.

Halbertsma and Staplin (1960) report that the Kiskatinaw carries Grandispora and other spores of definite Chester age. Since Unit B carries a megafauna of probable Mississippian age overlying the known Chester spores of Unit A, and since the lithology is very similar, equation with the Kiskatinaw seems likely.



DIAGRAMMATIC STRUCTURE SECTION ALONG A-B
NORTH SIDE OF PEACE RIVER



DIAGRAMMATIC STRUCTURE SECTION ALONG C-D
SOUTH SIDE OF PEACE RIVER

LEGEND

CRETACEOUS
LOWER CRETACEOUS

12 — FORT ST. JOHN GROUP: SHALE, MINOR SANDSTONE (Marine)

CRETACEOUS AND JURASSIC
LOWER CRETACEOUS AND UPPER JURASSIC

11 — BULLHEAD GROUP: QUARTZITIC SANDSTONE, SILTSTONE, SHALE, COAL (Marine and Non-Marine) THICKNESS 3,500 — 4,500 FEET

JURASSIC

10 — FERNIE GROUP? (Assumed From Stratigraphic Position) SHALE, SILTY SHALE, MINOR SANDSTONE (Marine) THICKNESS 300 — 500 FEET

TRIASSIC

9 — TOAD-GRAYLING, LIARD AND PARDONET DIVISIONS: SHALE CALCAREOUS SILTSTONE, CALCAREOUS SANDSTONE, LIMESTONE, DOLOMITE (Marine) THICKNESS 3,000 — 3,500 FEET

PERMIAN?

8 — CHERT (Marine) THICKNESS 20-60 FEET

PENNSYLVANIAN AND MISSISSIPPIAN

7 — QUARTZITIC SANDSTONE, SILTSTONE, SHALE, LIMESTONE (Marine) THICKNESS 100 — 600 FEET

MISSISSIPPIAN

6 — PROPHET FORMATION: LIMESTONE, CHERTY LIMESTONE, CHERT, MINOR SHALE AND SILTSTONE (Marine) THICKNESS 500 FEET

DEVONIAN
UPPER DEVONIAN

5 — SHALE, MINOR LIMESTONE (Marine) THICKNESS 800 - 1,000 FEET

MIDDLE DEVONIAN

4 — LIMESTONE, ARGILLACEOUS LIMESTONE, CALCAREOUS SHALE (Marine) THICKNESS 800 — 1,100 FEET

SILURIAN AND ORDOVICIAN

3 — DOLOMITE, SILTY DOLOMITE, MINOR QUARTZITIC SANDSTONE AND LIMESTONE (Marine) THICKNESS 2,200 FEET

LOWER PALAEOZOIC
LOWER ORDOVICIAN AND CAMBRIAN?

2 — LIMESTONE, SILTSTONE, SHALE, DOLOMITE (Marine) THICKNESS 2,000+ FEET

PRECAMBRIAN AND/OR LOWER PALAEOZOIC

1 — MISINCHINKA GROUP: SCHISTS, SCHISTOSE SANDSTONE; MINOR LIMESTONE AND WHITE QUARTZ (Metamorphosed Sediments) THICKNESS 4,000± FEET

No very precise dating of the Taylor Flat and Belloy formations has been published. Halbertsma and Staplin (1960) refer to a species of Florinites in the Taylor Flat "which correspond in age roughly to that of the fusulinids of the Lower Norquay formation". Halbertsma (1959) assigns the Belloy formation a Permian age on the basis of the occurrence of Neospirifer cf. ameratus Morton and Juresania cf. ovalis Dunbar and Condra in the type section. Unit C, of problematical Pennsylvanian or Permian age, would appear to be an approximate equivalent of the Belloy and Taylor Flat, but separation of the unit into these two formations is not possible and indeed poses difficulties in many of the subsurface sections.

In conclusion then, it would appear that the top of the Debolt and the top of the Prophet are correlative or very nearly so. The Golata equates with Unit A of the Chowade, the Kiskatinaw with Unit B, and the Belloy and Taylor Flat are the lateral and approximate age equivalents of Unit C. Despite the demonstrated age equivalence, the subsurface terminology, with the possible exception of the Golata, does not describe practical or well defined field mapping subdivisions. It is proposed that the term Chowade group be used for surface exposures of the Chester-Pennsylvanian-Permian sequence in the area.

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THE BESA RIVER FORMATION *

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ABSTRACT

The name Besa River formation is suggested by the author for the thick black shale sequence which is present in the northeast British Columbia foothills and mountains, lying between Mississippian cherty limestones and Middle Devonian carbonates. This shale has a thickness of about 3000 feet and constitutes a single mappable rock unit. Although the faunal content in this seemingly euxenic environment is sparse, evidence is presented which demonstrates that the Besa River shale includes Kinderhook and Upper Devonian, with an even wider time range a distinct possibility.

INTRODUCTION

The summer of 1946 was spent by the writer in the foothills and mountains of northeastern British Columbia, examining Mesozoic and Paleozoic stratigraphy along minor and major waterways, the latter including the Sikanni Chief, Prophet and Muskwa Rivers.

As work progressed it became evident that the familiar massive carbonate units of the southern Rockies, the Palliser and Fairholme, were not present, and that a thick (3000 ft.±) black shale sequence occupied the entire interval between Middle Devonian carbonates and the Rundle equivalents to which the term Prophet formation has since been applied. West of the frontal ranges of the Paleozoic mountain belt the presence of this shale unit could be readily predicted by the subdued topography of the areas in which it outcropped.

The upper reaches of the Besa River valley (See Figure 1) is carved out of these shales. Heading in Redfern Lake, the stream flows east for some six miles and then turns due north joining Keilly Creek about eight miles from the bend. Most of this distance the valley is cut in the shale formation, and at the sharp northward bend the contact with the underlying Middle Devonian carbonates is exposed in a rather small outcrop. Although the shales along the river are reasonably well exposed, folding and faulting create complications which do not permit the designation of a type section in this vicinity. In view of the abundant presence of the shales in this stream valley, however, the term Besa River formation was adopted.

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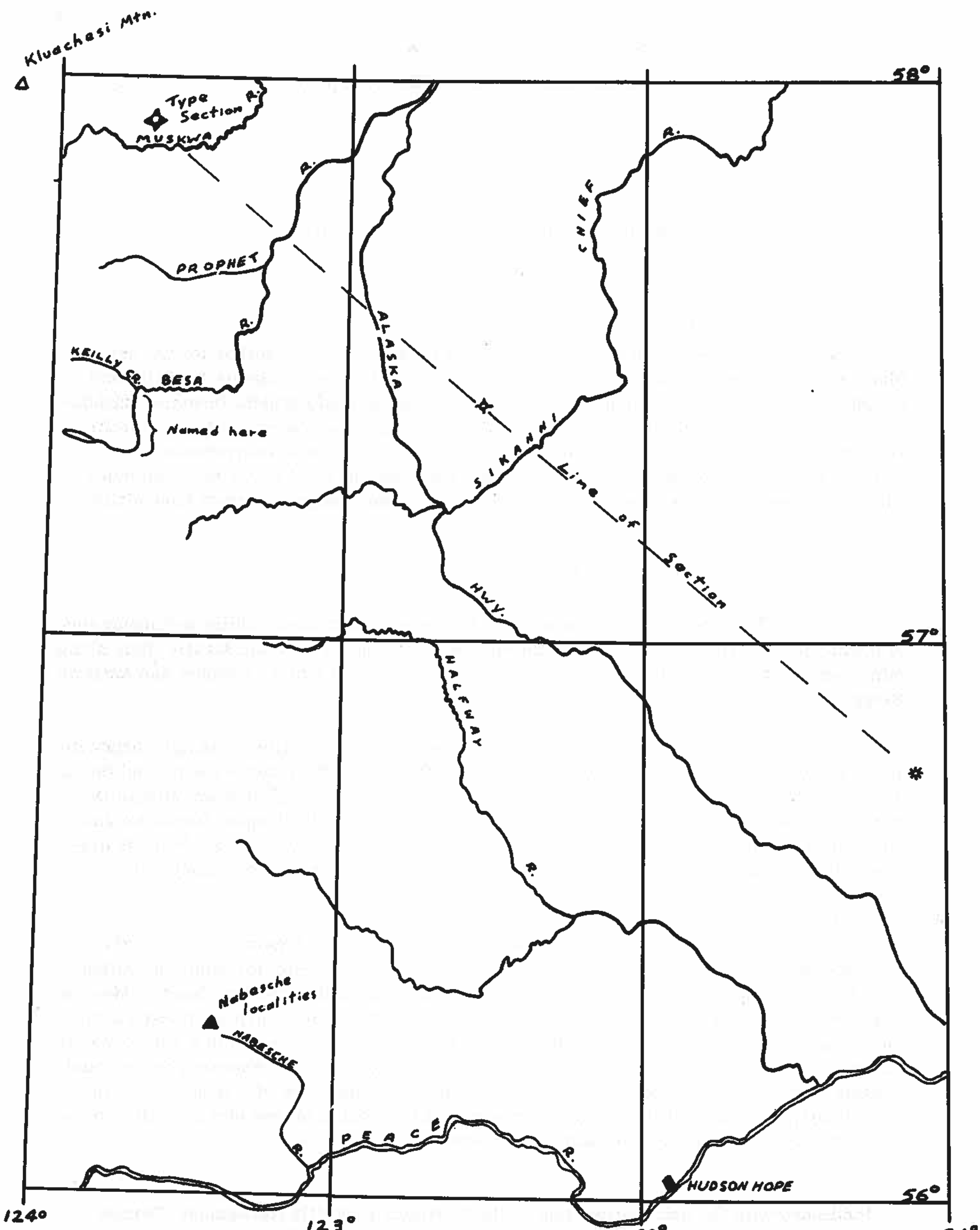


Figure 1

Locality Index

1" = 16 mi.

The discovery of oil at Leduc and Redwater in 1947 and 1948 respectively made the Upper Devonian of Western Canada world famous, and those simple and lovable terms D1, D2 and D3 became widely known. As exploration proceeded a more dignified terminology, Wabamun, Winterburn and Woodbend was proposed and was carried north and west with the advancing tide of exploration. As this tide advanced into northeast British Columbia it soon became evident that the hitherto ubiquitous Wabamun and Winterburn carbonates were undergoing a facies change to shale. As they did so the separation of Upper Devonian from basal Mississippian became increasingly more difficult. It is now clear that west of a line from about where the Peace River leaves the Paleozoic mountain front thence through Fort Nelson and on into the Territories the basal Mississippian and the Upper Devonian are represented largely if not wholly by a thick shale unit, as illustrated in Figure 2. It is for this shale unit, which in field exposures as well as in several of the more westerly wells constitutes a single mappable unit, that the term Besa River formation is suggested.

TYPE LOCALITY

The proposed type locality lies about four miles north of the Muskwa River, at a point about eight miles east of the pack trail crossing of that river. The approximate location of this section is 57° 56' 30" N., 123° 43' 00" W. At this locality the lower contact is not exposed, but the contact with the overlying Prophet is.

LITHOLOGY

The Besa River formation consists almost entirely of shales, dark grey to black, thin bedded to fissile, varying from slightly calcareous to non-calcareous. Black chert and pyrite are present at intervals throughout the section; siltstone and thin limestones are in places evident near the top. Fossil content is meagre, and this plus the lithologic characteristics suggest a euxenic environment of deposition.

UPPER CONTACT

The top of the Besa River formation has been taken at the base of the first massive limestone of the overlying Prophet formation. This contact is decidedly gradational, with black chert, siltstone and thin limestone stringers often evident below the contact and shales and silty shales sometimes present above. Since the contact is gradational it may well be diachronic from one section to another.

LOWER CONTACT

The lower contact is not exposed at the type locality, but can be observed at a small outcrop in the Besa River as mentioned previously. Although the areal extent of the outcrop is small it appears that the contact with the underlying dark grey carbonate is sharp and perhaps disconformable (?).

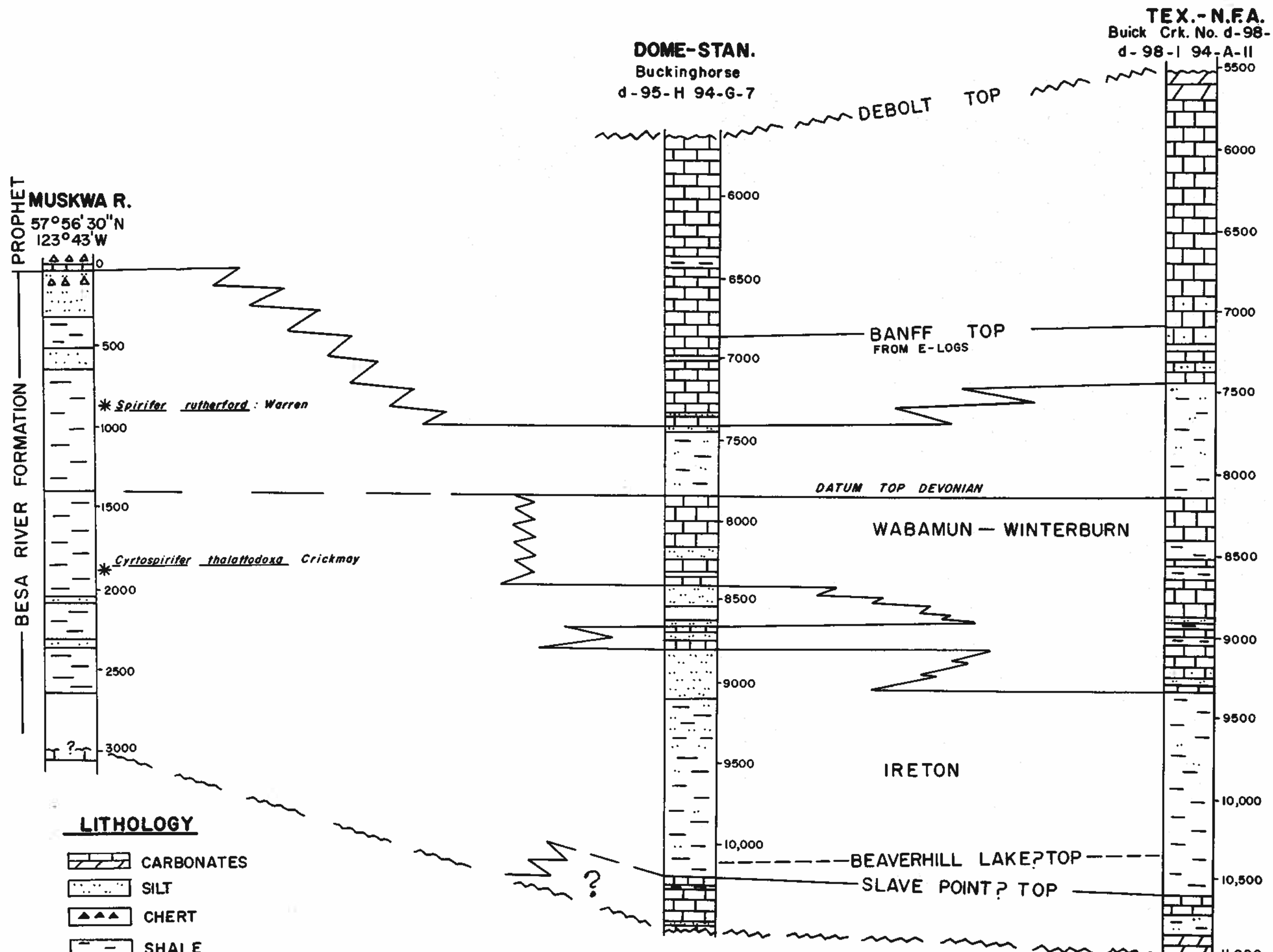

MUSKWA R.
57°56'30"N
123°43'W
PROPHET
BESA RIVER FORMATION
0
500
1000
1500
2000
2500
3000
* Spirifer rutherford : Warren
* Cyrtospirifer thalattodoxa Crickmay
DOME-STAN.
Buckinghorse
d-95-H 94-G-7
6000
6500
7000
7500
8000
8500
9000
9500
10,000
TEX.-N.F.A.
Buick Crk. No. d-98-1
d-98-1 94-A-11
5500
6000
6500
7000
7500
8000
8500
9000
9500
10,000
10,500
11,000
DEBOLT TOP
BANFF TOP
FROM E-LOGS
DATUM TOP DEVONIAN
WABAMUN — WINTERBURN
IRETON
BEAVERHILL LAKE? TOP
SLAVE POINT? TOP
?
LITHOLOGY
CARBONATES
SILT
CHERT
SHALE

FIGURE 2

Possibly the closest exposure of the lower contact to the proposed type section is at Kluachesi Mountain (approximately 57° 59' 30" N., 124° 06' 30" W.). Here too, the contact with the underlying Middle Devonian carbonate is abrupt.

AGE

Fossils are very sparse in the Besa River formation. At the proposed type locality two species were found, and through a most unusual freak of fate both are rather diagnostic. *Spirifer rutherfordi* Warren (*Platyrachella rutherfordi* (Warren)) occurred some 800 feet below the upper contact, indicating a Kinderhook (Lower Banff) age. *Cyrtospirifer thalattodoxa* (Crickmay) was found 2000 feet below the upper contact, indicating a Frasnian (Upper Hay River) age.

The most southerly good exposures of the Besa River formation known to the writer are near Nabesche Creek, north of the Peace River, at approximately 56° 19' N., 123° 25' W. and at 56° 18' N., 123° 32' W. At these localities, at about 1500 feet above the base of the formation, *Eleutherokomma* cf. *leducensis*, *Devonoproductus vulgaris* and *Leiorhynchus* cf. *athabaskensis*, of Upper Devonian age, were collected.

The overlying Prophet formation is much more fossiliferous. Among others, *Paryphorhynchus obscurum* Shimer, which occurs high in the Rundle formation at Lake Minnewanka, and *Spirifer* cf. *centronatus minnewankensis* Shimer, suggesting a fauna usually found near the base of the Rundle in the Alberta Rockies, suggest close equivalence of the Prophet and the Rundle.

At the exposure of the basal contact at Kluachesi Mountain, the underlying carbonates contain near their top *Leiorhynchus castanea* Meek and *Warrenella* sp. cf. *franklini* Meek, of Middle Devonian age. At the Nabesche Creek exposures, *Productella belanskii*, *Warrennella* aff. *kirki* and *Cyrtina panda*, indicating a Middle Devonian age, were found near the top of the underlying carbonates.

CONCLUSION

In summary then, a mappable lithologic unit consisting predominantly of shale, and representing an age range from Upper Devonian and possibly older to Kinderhook and probably younger, 3,000 feet thick more or less, is present in the mountains and northwestern plains of northeast British Columbia. It is proposed that the name Besa River formation be adopted for these beds.

BRIEF NOTES ON THE LOWER PALAEOZOIC ROCKS OF THE ROCKY MOUNTAINS ALONG THE PEACE RIVER, B. C.

By

B. T. Gallant

Imperial Oil Ltd., Dawson Creek, B. C.

GENERAL

A traverse of the Rocky Mountains and Foothills along the Peace River is unique in that the geologist can see a nearly complete record of geological events from Precambrian to Recent. However, the Lowe r Palaeozoic rocks of this area contain rapid facies and thickness changes, in combination with complex structure, making correlations and detailed stratigraphic studies most difficult. The Lower Palaeozoics and Precambrian consist of 15,000 - 20,000 feet of marine sediments. The upper part is predominantly carbonate and the lower part predominantly low grade metamorphosed clastics. Figure 1 is a generalized stratigraphic column of the rocks exposed in the Peace River Mountains. The Middle Devonian to Ordovician rocks are easily mapped as they contain adequate fossils. However, the thick sequence of Cambrian and older rocks was not examined in detail by the author and therefore the stratigraphic breakdown presented is taken from the Geological Survey of Canada Map No. 11 (93-0) by J. E. Muller (1961), see Figure 1.

CAMBRIAN - PRECAMBRIAN

Cambrian - Precambrian sediments range from 8,000 - 14,000 feet. The basal beds (Muller, 1961) called the Misinchinka Group can be subdivided into three units as follows:

	Upper	- Black slate, slaty greywacke; minor quartzite and conglomerate.
Misinchinka Group	Middle	- Limestone, calcareous schist, minor slate and chlorite schist.
	Lower	- Chlorite and sericite schist, phyllite, schistose grit and quartz-pebble conglomerate.

The thickness of the Group, obscured by close folding, is estimated to be between 5,000 and 10,000 feet. The upper unit of dark slates grades without apparent unconformity into Lower (?) Cambrian orthoquartzite.

The Misinchinka Group is overlain by 2,000 feet of white, cream and red,

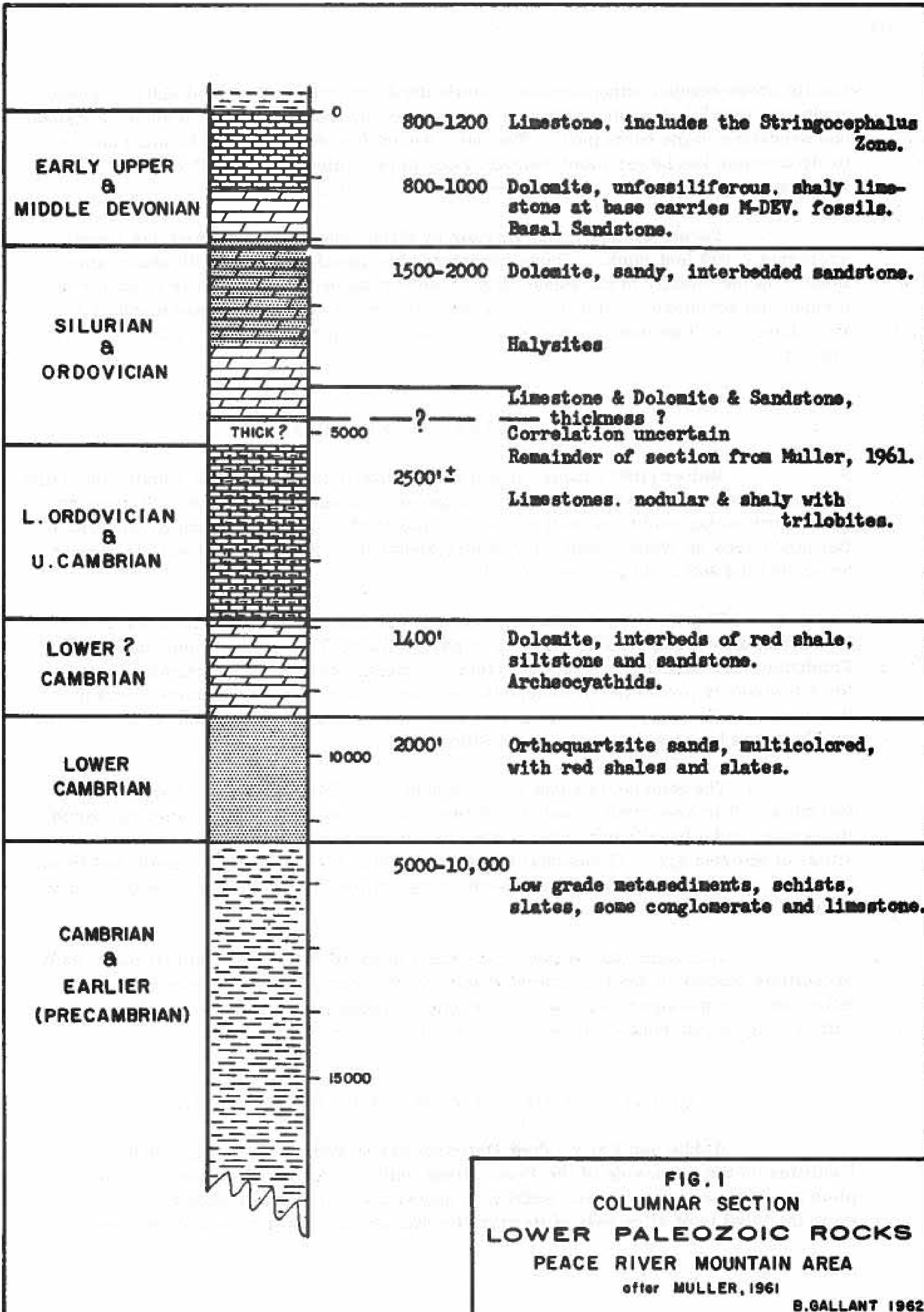


FIG. 1
COLUMNAR SECTION
LOWER PALEOZOIC ROCKS
PEACE RIVER MOUNTAIN AREA
after MULLER, 1961

B. GALLANT 1962

locally cross-bedded orthoquartzite, interbedded with minor shale and slate. These rocks are overlain by some 1400 feet of dolomite, interbedded with red shale, siltstone, and sandstone in the basal part. The unit, except for shale, is cliff forming and probably contains the Lower Cambrian Archeocyathids collected by the Provincial Mines Department on Highway 97, 17.1 miles from the Parsnip River.

These dolomites are overlain by Cambrian - Lower Ordovician limestones averaging 2,500 feet thick. These limestones are usually nodular with shale laminations. In the vicinity of the Peace River, Muller states that this unit is intensely deformed and schistose. Muller has collected trilobites at the Pine Pass north of Azouzetta Lake from this unit which he dates a probable Upper Cambrian - Lower Ordovician age.

ORDOVICIAN - SILURIAN

Muller (1961) maps the Silurian - Ordovician as one unit comprising more than 2,000 feet of dolomite, quartzitic sandstone with minor limestone. Silurian and Upper Ordovician rocks are well exposed on the north side of the Peace River west of Bernard Creek on Wedge Peak and Advance Mountain. Here, these two systems can be subdivided and could be over 5,000 feet thick.

The Ordovician refers to a section of carbonates and sandstones of unknown thickness and probably includes in part Muller's Lower Ordovician and Upper Cambrian limestone unit. The Ordovician is unfossiliferous where examined except for a few poorly preserved brachiopods, and consists of massive dolomites, sandy dolomites, with mostly sandstone in the lower part. This thick (?) unit is overlain by the Halysites bearing dolomites of the Silurian.

The Silurian is about 2,500 to 3,000 feet thick and can be subdivided into two units. The lower unit, about 1,500 feet thick, consists of silty dolomites, some limestones and a basal sandy zone. This unit carries silicified corals (mainly Halysites) of Silurian age. Occasional Upper Ordovician fossils have been collected from the basal sand. The dolomites are medium crystalline, silty throughout with thick to massive bedding.

The upper unit is about 1,200 feet thick and consists of interbedded finely crystalline dolomites and fine grained sandstones. Some limestones and clean dolomites occur in the upper 200 feet. This unit is unfossiliferous and is overlain by the buff to rusty weathering basal Devonian sandstone.

MIDDLE AND EARLY UPPER DEVONIAN

Middle and Early Upper Devonian carbonates are well exposed at three localities on the north side of the Peace River valley. All three sections are incomplete and therefore a composite section is necessary. The upper beds can be examined in the third fault slice east of Bernard Creek, and the lower beds can be measured

FIG. 2
CORRELATION SECTION
MIDDLE DEVONIAN – SILURIAN
PEACE RIVER AREA

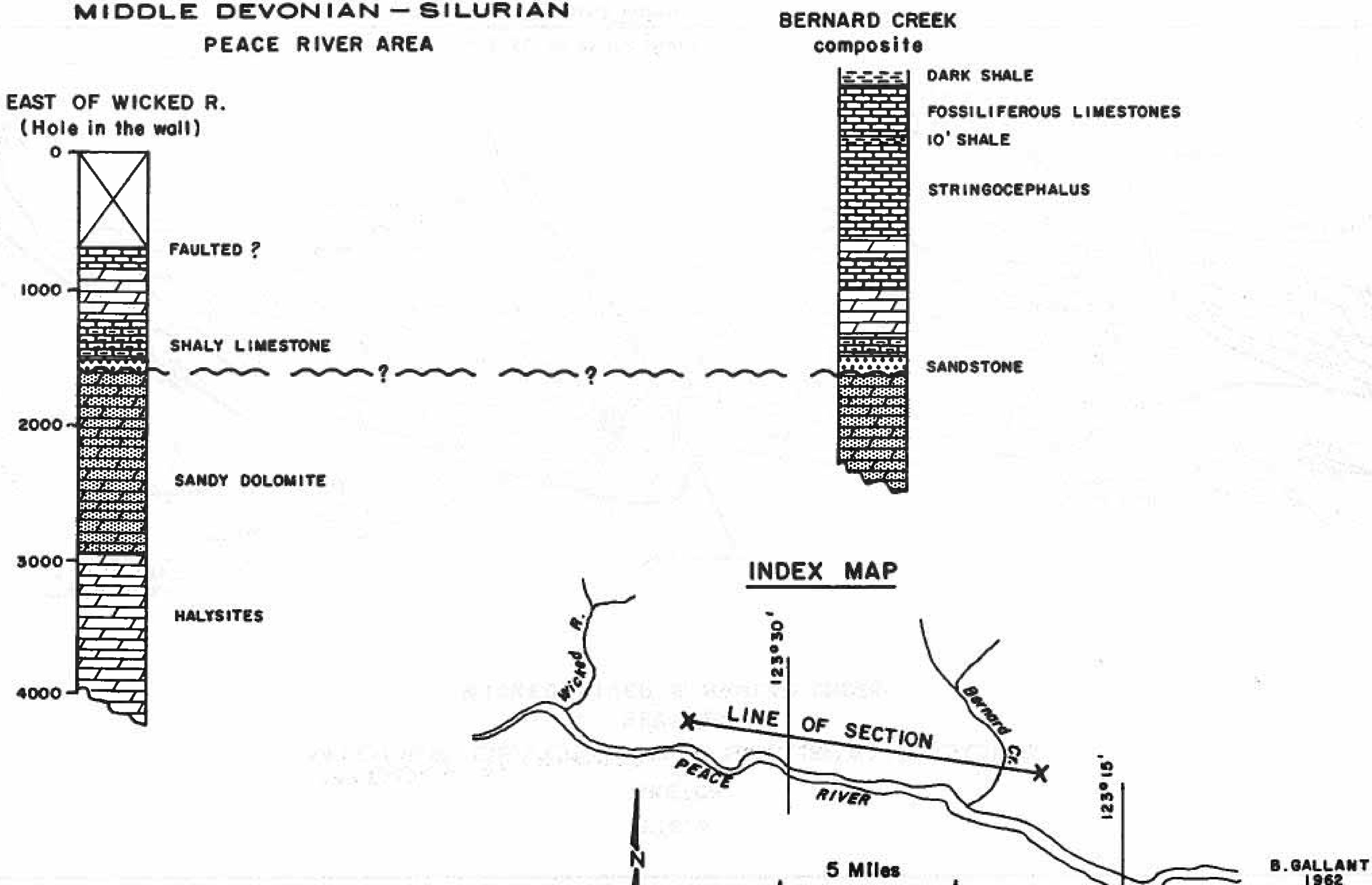


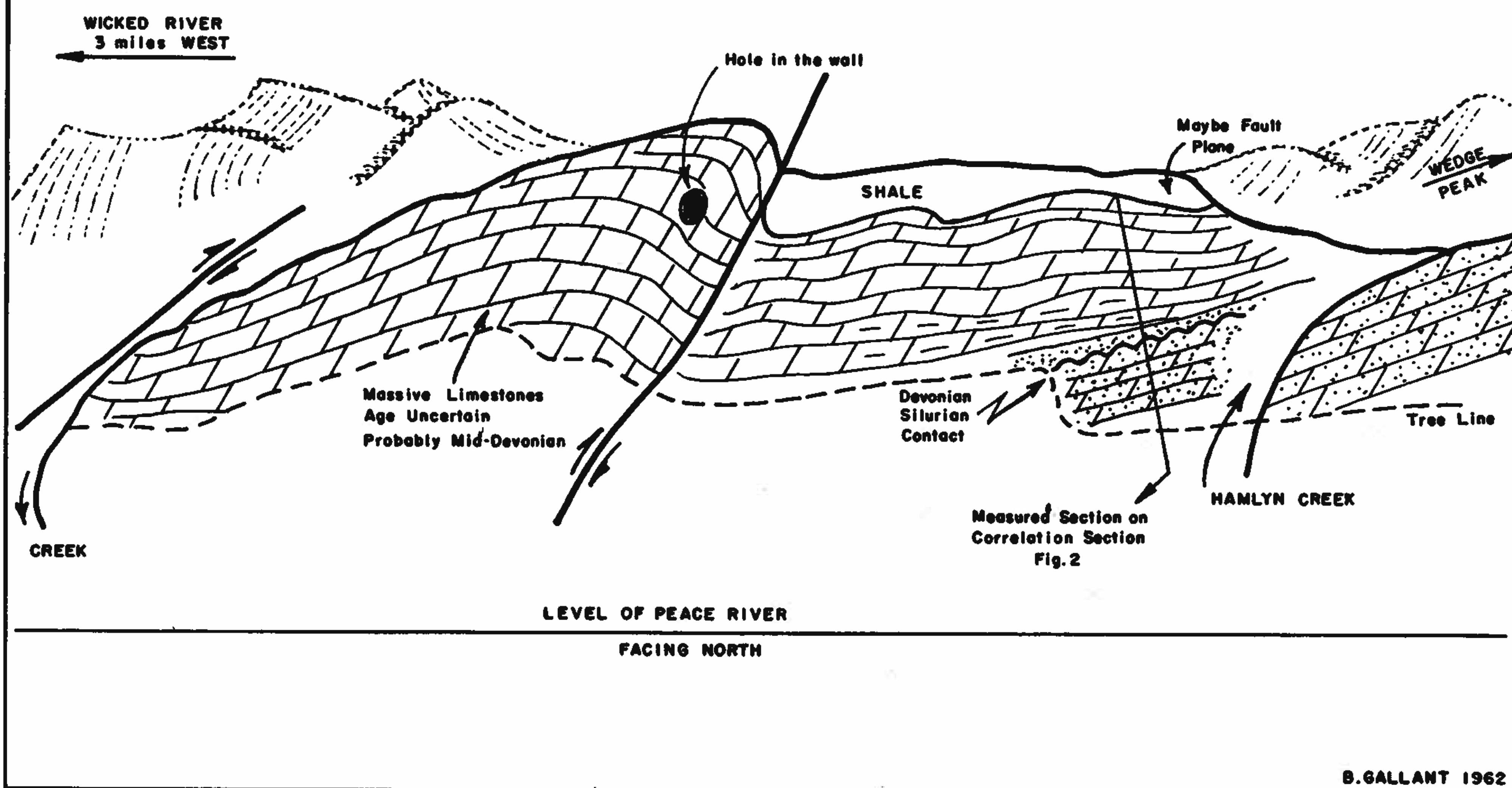
FIG. 3

SKETCH

MIDDLE DEVONIAN & SILURIAN ROCKS

BETWEEN

WICKED RIVER & HAMLYN CREEK



in a tight syncline east of Bernard Creek and at a second locality west of Hamlyn Creek.

Middle and Early Upper Devonian rocks are about 2,000 feet thick and consist of fossiliferous limestones and dolomites. The base of the Devonian is marked by a buff to rusty weathering basal sand. The basal sand overlies the dolomites and sandstones of the Silurian with disconformity, and the upper limestones are conformably overlain by the dark shales of the Upper Devonian - Mississippian Besa River formation.

Following is a more detailed breakdown of the lithologies. Note that the description below is a composite section.

	Overlain by Besa River Formation, dark shale.
90'	Limestone, medium grey, argillaceous to shaly, very fossiliferous. Early Upper Devonian.
60'	Limestone, massive bed, organic with dark matrix, stromatoporoids.
450'	Limestone, dark grey, abundant Amphipora in fine dark matrix.
10'	Shale, dark grey.
460'	Limestone, dark grey, some pellet limestones, occasional limestone bed grades laterally to porous dolomite, occasional skeletal limestone bed. Stringocephalus at 160 feet from top. Some dolomite breccias.
400 - 600'	Dolomite, medium grey to brownish grey, finely crystalline, only trace of poorly preserved fossils.
100 - 300'	Limestone, dark grey, very fossiliferous and carries a good Middle Devonian fauna of brachiopods and corals.
20 - 100'	Sandstone, and sandy limestone, distinctive buff to rusty weathering, medium grained quartzose sand. Basal sand of Devonian and overlies with disconformity Silurian sandstones and dolomites.
2070' ±	

Muller (1961) states that Middle Devonian rocks are but 1,000 feet thick and consist of limestone with minor shale. The author has examined a partial section south of the Peace River and noted the section to be limestone with a thick basal sand. The unfossiliferous dolomites in the lower part of the section at Bernard Creek are missing and the Stringocephalus zone is only 200 feet above the basal sand. At the outcrop examined, the upper beds are faulted out and an accurate correlation is difficult, however, it appears that a facies change does occur.

At this point some readers might disagree as to the position of the Devonian - Silurian contact and the apparent absence of any Lower Devonian (?) rocks.

Others who have examined the same outcrops may prefer to place the contact within or at the base of the unfossiliferous dolomite and sandstone unit of the Silurian. However, a disconformity is apparent below the basal sandstone and Middle Devonian fossils were collected above this same sand, therefore, the disconformity observed probably represents a break in sedimentation between Silurian and Middle Devonian strata.

REFERENCE

Muller, J. E., G. S. C. Map 11-1961 Sheet 93-0

DIAGRAMMATIC STRUCTURE CROSS-SECTIONS ALONG THE NORTH AND SOUTH SIDES OF PEACE RIVER VALLEY, B.C. *

By

E.J.W. Irish

Geologist, Geological Survey of Canada

The structure cross-sections (A-B) and (C-D) are drawn along east-west lines (see map) between 122 degrees 10 minutes and 124 degrees west longitude, a distance of about 71 miles across most of the Rocky Mountains and Foothills at this latitude. Section (A-B) is along the north side and section (C-D) mainly along the south side of Peace River valley and both are at an angle of about 120 degrees to the regional strike (North 30 degrees West) of the strata. The surface geology for the structure sections is taken from the Geological Survey of Canada preliminary map No. 37, 1961 (E.J.W. Irish, 1962). The sections are quite general and, since no subsurface control is available, the presence of some rock units in the more easterly parts of each cross-section is assumed.

The division between Rocky Mountains and Foothills is placed, arbitrarily, in both sections, at the Mt. Burden fault. West of this thrust the exposed strata are mainly of lower and middle Paleozoic ages while east of the fault, Mesozoic rocks predominate. Also, west of the fault the topography is much more rugged and the average elevation above sea-level is a little higher than the region east of the fault.

Numerous small faults and folds occur that have not been shown on the structure sections.

ROCKY MOUNTAINS

That part of the Rocky Mountains between the Rocky Mountain Trench and West Wicked River (Section A-B) and as far east as Collin Creek (Section C-D) is underlain by folded and faulted metamorphosed rocks of the Misinchinka group. The main part of the Mountains, between West Wicked River and the Mt. Burden fault (Section A-B) and between Collin Creek and the Mt. Burden fault (Section C-D), consists of a series of thrust slices that have repeated carbonate strata of Ordovician, Silurian and Devonian ages. Stratigraphic displacement on these faults probably ranges from a few hundreds to several thousands of feet. Folding is of minor importance in the mountains along and close to Peace River Valley. Thrusting of the massive carbonates relatively to the northeast has resulted in sheer northeast-facing slopes and, in general, more gentle southwest slopes. This faulting, combined with subsequent erosion, has produced ruggea and precipitous ridges that trend across the strike of the formations and which are separated by deeply incised stream valleys. The altitude of the ridges above sea-level is between 6,500 feet and 8,000 feet. Average relief is about 3,000 feet but is as much as 4,000 feet along the valley of Peace River.

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The Mt. Burden fault, the only fault named in this region, has brought Paleozoic rocks up over formations of Mesozoic age and is, therefore, considered to be the principal thrust in the area crossed by the structure sections. It is interpreted as being folded over a southeast-plunging anticline in the vicinity of Mt. Burden.

FOOTHILLS

The Foothills extend from the Mt. Burden thrust on the west to Butler Ridge on the east and are underlain, mainly, by Mesozoic strata of Triassic and Lower Cretaceous ages (Sections A-B and C-D). The exception to this is the area between the Mt. Burden fault and Mt. Brewster. This region is transitional stratigraphically between the Lower Paleozoic Mountains and the Mesozoic Foothills since it exposes mainly Mississippian strata. Mt. Brewster itself appears to be a faulted and tightly folded anticlinorium exposing Mississippian formations.

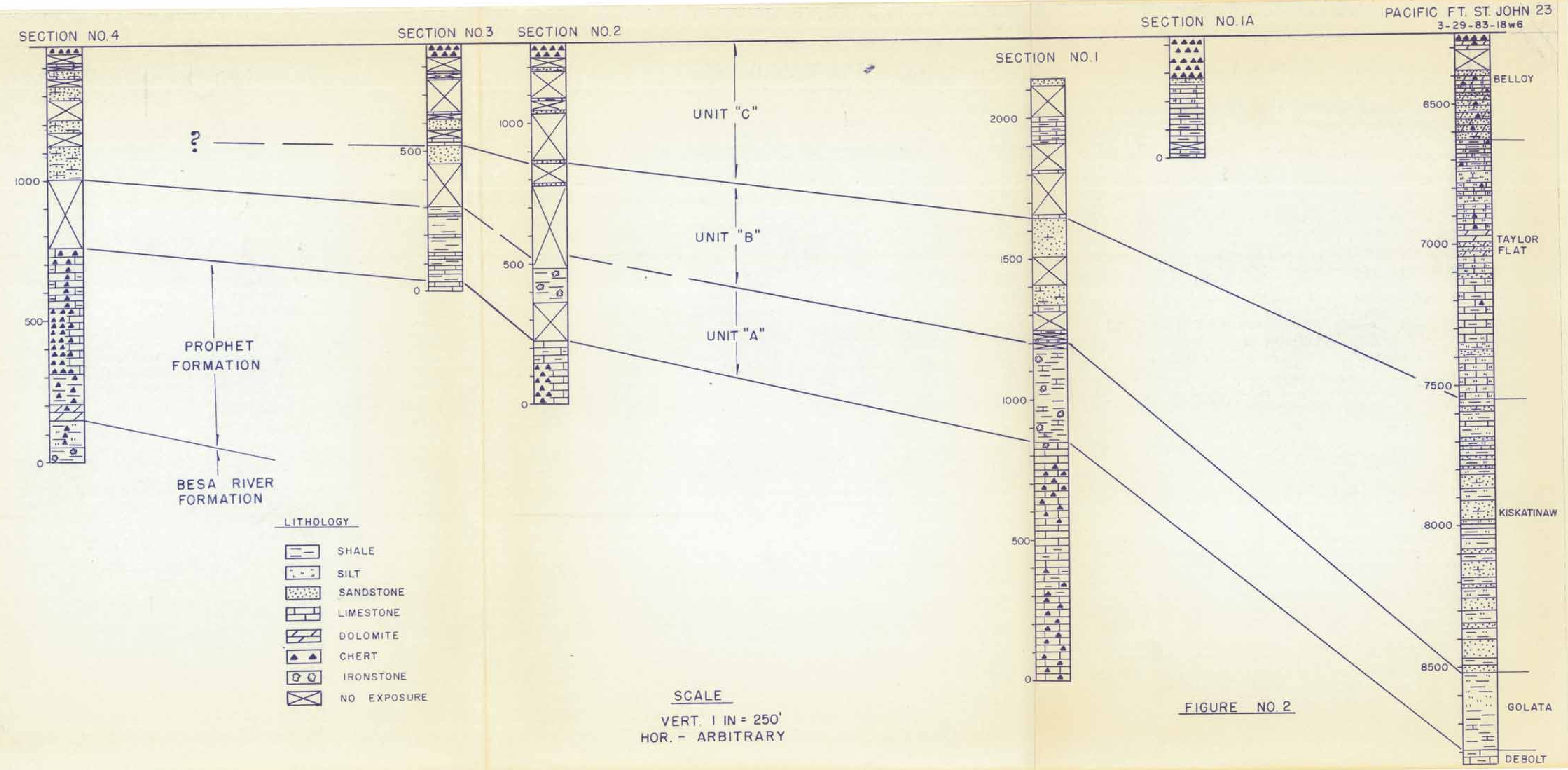
Within the Foothills, the average altitude of the ridges is between 5,500 and 6,500 feet or about 1,000 to 1,500 feet lower than the average in the Mountains. The ridges are more rounded and the slopes of the intervening valleys are more gentle.

Triassic strata are exposed at the surface from Nabesche River eastward to a point just east of Aylard Creek (Section A-B). From this point eastward to Butler Ridge the underlying rocks belong to the Lower Cretaceous Bullhead group. East of Butler Ridge the Bullhead group is in turn overlain by the Fort St. John group.

In contrast to the Mountains, folding is probably more important than faulting in the Foothills region. Many southwest-dipping thrust faults occur but stratigraphic displacement on any single fault is normally measured only in tens or hundreds of feet. The folds consist of a succession of narrow, compressed anticlines separated by broad synclines having gently dipping limbs as is shown on both Section (A-B) and Section (C-D). In many cases the tightly folded anticlines are faulted near their axes. Several anticlines along Peace River valley have their southwest flanks steeply inclined while the northeast flank is inclined at a very small angle which tends to give to the fold a flat-topped appearance. This type is not well illustrated on the structure sections but the anticline immediately east of Adams Creek (Section A-B) and that on the east side of Pardonet Creek (Section C-D) are of this type.

In general, both anticlines and synclines plunge southeasterly with the result that larger areas of younger formations occur at the surface on the south side of Peace River than are present north of the valley.

Note: To simplify the sections the term Bullhead group has been used here to include all Upper Jurassic and Lower Cretaceous formations overlying the Jurassic Fernie group and overlain by the Lower Cretaceous Fort St. John group. In the Carbon Creek basin the group includes the Marine and Non-marine Bullhead divisions of Mathews (1947). In the Dunlevy Creek-Butler Ridge area it includes the Dunlevy formation (Beech, H.H. and Spivak, J., 1944) and the Gething formation (McLearn, F.H., 1923).


SECTION NO. 4
SECTION NO. 3
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PACIFIC FT. ST. JOHN 23
3-29-83-18w6
UNIT "C"
UNIT "B"
UNIT "A"
?
PROPHET FORMATION
BESA RIVER FORMATION
BELLOY
TAYLOR FLAT
KISKATINAW
GOLATA
DEBOLT
6500
7000
7500
8000
8500
2000
1500
1000
500
0
LITHOLOGY
SHALE
SILT
SANDSTONE
LIMESTONE
DOLOMITE
CHERT
IRONSTONE
NO EXPOSURE
SCALE
VERT. 1 IN = 250'
HOR. - ARBITRARY

FIGURE NO. 2

Editor's Note: Section A-B is drawn along Latitude 56° 10', from approximately 123° 55' W. to 122° 10' W. This section falls, therefore, along the north Boundary of the regional map in pocket.

Section C-D is drawn along a line approximately 1-1/2 miles north of Latitude 56° 00' N., from 123° 52' W. to 122° 15' W.

Both sections are applicable to, and are drawn on the same scale as G.S.C. preliminary Map No. 37, 1961.

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McLearn F.H., 1923: Peace River Coal Area, B.C., Geological Survey of Canada, Sum. Rept., 1922, pt. B, pp. 1-46.

McLearn, F.H. and Kindle, E.D., 1950: Geology of Northeastern British Columbia; Geological Survey of Canada, Memoir 259.

Mathews, W.H., 1947: Geology and Coal Resources of the Carbon Creek-Mount Bickford Map-Area, 1946; British Columbia Department of Mines, Bull. No. 24.

COMPILATION MAP, PEACE RIVER AREA

This compilation (see pocket) by the editors of your Guide Book attempts to portray the geology in the vicinity of our field trip. Many sources, both published and unpublished, have been drawn on freely, and in order to avoid omission of necessary credits or revelation of confidential sources, we wish only to acknowledge our indebtedness to all published work on the area.

Where conflicts between this map and published data exist no claim for infallibility can be or is made on behalf of the compilation map. Conflicts in our information did arise; where these conflicts could be resolved by reference to a third source this was done; where no third source was available the mapping shown on the available interpretation having the most detailed scale was taken.

The map units used require some amplification. The Dunlevy-Gething contact has been taken at the top of the Cadomin-type lithology. In the most westerly outcrops of these units the position of this contact is often questionable, and it may not lie at the same stratigraphic position everywhere.

To the east of Pardonet Hill, the Triassic has been divided into an upper resistant unit (TR p-l) and a lower recessive unit (TR l). This contact lies at the approximate position of the base of the Doig Formation (Mt. Wright of Colquhoun, base of Liard of the Shell detailed maps). As such, the contact corresponds approximately to the base of the Nathorstites zone; it should be appreciated, however, that the contact is lithologic and not necessarily stratigraphic. To the west of Pardonet Hill exposure does not appear to permit ready division of the Triassic, and areas mapped as Triassic may well contain local exposures of Chowade Group or Fernie Group.

Du-m map division represents carbonates and shales containing Stringocephalus and younger fauna. This unit is variable in lithology and thickness within the area.

The Dm map unit represents 1,000 feet or more of sandy dolomite which is unfossiliferous and lies with apparent conformity beneath the Du-m unit. Unit Dm may include Lower Devonian equivalents. The unit thins markedly in a southward direction.

Unit S includes the Halysites-bearing dolomites of the area; over 1,000 feet of the upper part of this unit is unfossiliferous, and post-Silurian strata may be included. The basal sand of unit S carries, in places, an Upper Ordovician fauna.

Unit O represents limestones believed to be largely of Ordovician age but possibly including some Lower Cambrian.

Unit C, the "Misinchinka Group" is generally considered to represent Cambrian and older rock units. The Misinchinka is, however, highly metamorphosed and it is considered possible by some workers in the area that higher Paleozoic equivalents may in places be represented.

ROAD LOG

Note: Road log mileage is set up for trip Fort St. John to Rainbow Rocks and return. Figures in brackets are cumulative mileage. Driving instructions have been simplifed to 'turn right, proceed straight ahead' et cetera for the trip in only. Instructions for observing rock exposures are preceded by 'look to right or look to left' et cetera, followed by compass direction in brackets. Again this is for trip in only, therefore, directions must be reversed on trip out to Fort St. John.

Miles Out	Miles In	
-	0.0	Fort St. John Hotel - Fort St. John, proceed straight west to junction with Alaska Highway.
1.7 (87.5)	1.1 (1.1)	Junction Alaska Highway - turn right onto highway and proceed ahead. Route underlain by Fort St. John Group undivided. Road runs sub-parallel to Stoddart Creek which drains south end of Charlie Lake.
5.1 (85.8)	1.7 (2.8)	Look to right (N.); series of low cliff forming exposures Dunvegan sandstone/shale sequence 1/2-mile north highway just east of Charlie Lake.
5.3 (80.7)	5.1 (7.9)	Junction Alaska Highway - Hudson Hope Road turn left onto Hudson Hope Road, proceed remaining on H.H. Road to junction with Gold Bar Road. H.H. Road underlain by mantled Dunvegan.
1.7 (75.4)	5.3 (13.2)	Bridge over Deep Creek (Creek shown as Wilder Creek on National Topographic Series Sheet 94A Charlie Lake Map). At this point H.H. Road underlain by Fort St. John Group undivided.
2.1 (73.7)	1.7 (14.9)	Look to right (N.); exposure of Dunvegan sandstone. H.H. Road underlain by partially mantled Dunvegan formation.
2.0 (71.6)	2.1 (17.0)	View Point - view of Peace River Valley, foothills and Rocky Mountains.
0.3 (69.6)	2.0 (19.0)	Hair pin turn - road cut exposes Recent river deposits.
0.2 (69.3)	0.3 (19.3)	Road cut exposes contact between Recent river deposits and underlying Dunvegan formation.
0.5 (69.1)	0.2 (19.5)	Road cut exposes Shaftesbury formation - shales with clay ironstone concretions.

Miles Out	Miles In	
1.7 (68.6)	0.5 (20.0)	Look to right (S.SE.); Burnt bituminous pyritic Shaftesbury shale. H.H. Road descending onto a lower Peace River terrace, Bear Flat straight ahead.
5.3 (66.9)	1.7 (21.7)	Bridge over Cache Creek look to right (N.E.) excellent exposure of Shaftesbury.
4.7 (61.6)	5.3 (27.0)	View Point - excellent view of the Peace River Valley can be had from this vantage point - especially good on trip out to Fort St. John. Good exposure of Shaftesbury in the river cut. H.H. Road at this point is underlain by mantled Fort St. John Group.
15.5 (56.9)	4.7 (31.7)	Attachie School-Halfway River crossing; excellent exposure of Shaftesbury in the river cut at both ends of the bridge.
1.4 (41.4)	15.5 (47.2)	Farrel Creek - look to left (S.) across Peace River, exposure of gently east dipping Shaftesbury shale. H.H. Road is underlain by Quaternary deposits. From this point to beyond Hudson Hope townsite the present road follows the old Peace River Portage trail.
1.7 (40.0)	1.4 (48.6)	Look to left (S.) across Peace River at exposures in river cut - note unconformity between Pleistocene glacial drift and gently east dipping Shaftesbury shales. Unconformity contact is typically knife sharp.
0.6 (38.3)	1.7 (50.3)	Look to left (S.); gully with between 500 feet and 600 feet of Shaftesbury exposed.
0.2 (37.7)	0.6 (50.9)	Look to left (S.) across Peace River; this is first exposure of the Gates sandstone which underlies the Shaftesbury.
1.7 (37.5)	0.2 (51.1)	Stampede Grounds (Stop) look to left (S.) just off the road good exposure of Gates sandstone. Note - excellent exposure of Gates across Peace River in the cut bank.
1.6 (35.8)	1.7 (52.8)	Look to left (S.); directly across Peace River, single 'Hoodoo'.
3.5 (34.2)	1.6 (54.4)	Lynx Creek bridge, look to right; exposure of Pleistocene sands, silts and gravels.

Miles Out	Miles In	
0.3 (30.7)	3.5 (57.9)	From this point look to left (S. SW.); you are looking down at Hudson Hope townsite.
1.9 (30.4)	0.3 (58.2)	Hudson Hope.
7.5 (28.5)	1.9 (60.1)	View Point - excellent view of the Peace River Valley especially good on trip out to Fort St. John. Gates formation is resistant sandstone at waters edge in the river cut. The Gates also forms the steep wall like cliffs of the small islands in the river. The Gates is overlain by the Shaftesbury formation. Note - monoclinal fold exposed in south bank of Peace River to the left (S.) just downstream.
0.8 (21.0)	7.5 (67.6)	At this point the road traverses the saddle between Bullhead Mountain to the right (N.) and Portage Mountain to the left (S.), directly ahead (W.) you can see Mount Gething (5,979 feet) which lies on the south side of the Peace River between Gaylard and Stott Creeks.
1.0 (20.2)	0.8 (68.4)	Look to right (N.); from this point you are looking into the axis of the Bullhead Mountain anticline which exposes upper Dunlevy.
2.0 (19.2)	1.0 (69.4)	Look to right (N.NE.); from this point you can look back at Bullhead Mountain anticline (Upper Dunlevy) and to the left (W.) the Bullhead Mountain syncline with poorly exposed Gething.
5.7 (17.2)	2.0 (71.4)	Turn right off the main road onto the Gold Bar trail and proceed straight ahead. The main road leads down to the Peace River damsite, 1.6 miles down main road is barrier across road at entrance to Peace River Dam Project.
0.6 (11.5)	5.7 (77.1)	Look to right (N.NE.); Gething formation forms the skyline ridge, Dunlevy is exposed below.
1.6 (10.9)	0.6 (77.7)	Bridge over Johnston Creek (Creek shown as Danish Creek on National Topographic Series Sheet 94B Halfway River map).
4.9 (9.3)	1.6 (79.3)	Bridge over Cust Creek.

Miles Out	Miles In	
0.2 (4.4)	4.9 (84.2)	Look to right (NE.); Gething formation forms skyline ridge. Cadomin equivalent is prominent massive cliff forming sandstone sequence below. Lowest exposures are Dunlevy formation.
0.1 (4.2)	0.2 (84.4)	Turn right to Ford across Dunlevy Creek.
3.3 (4.1)	0.1 (84.5)	Ford across Dunlevy Creek.
0.3 (0.8)	3.3 (87.8)	Look to right (NE.); Dunlevy formation exposed at roadside.
0.5 (0.5)	0.3 (88.1)	Look to right (N.NE.); Dunlevy formation sandstones form the ridge directly overhead.
(0.0)	0.5 (88.6)	Rainbow Rocks; Kyllo Brothers Landing.

RIVER LOG

This log contains a brief running commentary on points of major interest that will be encountered during the two-day boat traverse. Somewhat expanded notes have been included for each of the stops. The log is designed to be used in conjunction with the "Field Trip" maps and will be supplemented by the remarks of the individual boat guides and the contributing authors.

First Day on Peace River we will travel from Rainbow Rocks (Kyllo Brothers Landing) to mouth of Point Creek. Throughout this traverse there will be seven stops including the overnight stop at Point Creek.

Leave Rainbow Rocks and proceed up river to -

STOP NO. 1

Beattie Ledge - good section of "Dark siltstones" (Doig Formation), calcareous siltstones, sandstones and dark grey limestones, exposed near east end Beattie Ledge between Adams and Aylard Creeks, north bank P.R. According to Colquhoun, some Toad Formation may be exposed near river level. Contains Nathorstites and Daonella. Conformably overlain by "Grey Beds". Resistant unit at top of Beattie Hill is the Halfway Formation.

Continuing up river on the right is Branham Ridge - "Grey Beds" at river level essentially covered, overlain by Upper Triassic Pardonet, in turn overlain by Jurassic Fernie group (recessive weathering, numerous land slides), overlain by Lower Cretaceous Dunlevy formation of the Bullhead group. Note placer gold dredging equipment on the river bank. Just west of Branham Island is zone with two faults - faulting "Grey Beds" on Dunlevy.

STOP NO. 2

Black Rock Whirlpool - "Grey Beds" (fine-grained calcareous sandstones, limestones and calcareous siltstones). Section not complete as lowest part containing the Nathorstites fauna is below river level. Higher in the section Lingula and the Lima? poyana fauna can be found. Pelecypod fragments common. Red Rock Spur exposes roughly 1,300 feet of "Grey Beds" (Charlie Lake and Halfway equivalents). To the west on Bell Spur and McLay Spur the overlying Upper Triassic Pardonet (calcareous siltstones and dark grey carbonaceous limestones), are well exposed. The most common fossil in the Pardonet is Monotis subcircularis. Note small cave in Pardonet near top of ridge.

Proceeding up river just west of McLay Spur is Childerhose Coulee which is separated from Jewitt Spur by a small fault. Jewitt Spur exposes the higher part of the "Grey Beds" at river level capped by Pardonet. The Pardonet beds form the prominent ridge of Jewitt Spur and Schooler Hill and farther to the north Stelck Ridge.

Continuing up river, Schooler Creek will be seen to the north; the creek bed cuts into the "Grey Beds". Immediately north of the mouth of Schooler Creek is Kerr Spur which affords an excellent exposure of the upper part of the "Grey Beds" on the south face of the spur.

Directly north of Boat Race Island are the Mahaffy Cliffs which are again composed of "Grey Beds". The lowest exposed strata of the "Grey Beds" can be seen in Mahaffy Creek, a small stream that crosses the low flat between the base of Mahaffy Cliffs and the north bank of the Peace.

Immediately west of Mahaffy Cliffs is Folded Hill, which is composed of "Grey Beds" folded into two anticlinal and three synclinal folds. On the west side of Folded Hill in the core of the westernmost anticline is a poor exposure of Doig Formation, and possibly some Toad Formation. Folded Hill Creek flows down the core of the anticline.

Proceeding up river on the north bank of the Peace just west of Folded Hill is the Brown Hill-Teepee Rocks complex. On Brown Hill the "Grey Beds" are again well exposed. On the East Spur of Brown Hill the Halfway equivalents are near vertical and on the West Spur steeply dipping Pardonet and Baldonnel are exposed. The intervening Charlie Lake Formation is largely covered.

STOP NO. 3

Teepee Rocks Spur - directly east of the Spur is Teepee Rocks Coulee which is composed of recessive weathering shales of the Jurassic Fernie group. The Fernie shales are not exposed.

Teepee Rocks Spur exposes Lower Cretaceous Dunlevy formation of the Bullhead group. A short traverse will be made up Teepee Rocks Spur over the Dunlevy, then east across Teepee Rocks Coulee to the Pardonet and Baldonnel beds of the West Spur of Brown Hill; time permitting the traverse will continue to the Halfway on East Spur and return to Teepee Rocks for lunch.

After lunch continue up river; on the south side of the Peace is Pardonet Hill, an anticlinal fold exposing about 2,000 feet of Pardonet and "Grey Beds". The Pardonet Beds comprise dark calcareous shales and siltstones with lesser interbeds of dark limestone and rare fine-grained calcareous sandstones. The Pardonet Beds contain *Monotis subcircularis*, *Monotis alaskana*, the *Halobia* bearing *Himavatites* fauna, Tropites and the Halobia bearing *Stikinoceras* fauna (partial list only).

On the north side of the valley opposite Pardonet Hill is Black Bear Ridge, a synclinal fold exposing Dunlevy. The Dunlevy in its lower part is a partly marine (?) massive sandstone sequence with some shale, the upper part is a sequence of non-marine conglomerate, sandstone, and shale with thin coal seams. The formation has a thickness of 3,000 feet or more in this area.

To the west is Black Bear Valley, underlain by covered Fernie and Triassic, with beds of Permo-Pennsylvanian age in fault contact high on the west side of the valley.

STOP NO. 4

Mouth of Nabesche Creek - Exposure of Pardonet dark calcareous siltstones containing the fossil remains of the marine reptile Ichthyosaurus. The Pardonet Beds are exposed on the east limb of a small anticlinal fold surrounded by Fernie.

STOP NO. 5

Papide-qui-ne-parle-pas-

Here the highest Pardonet Beds (calcareous siltstones and impure limestones) with an abundance of the fossil Monotis subcircularis are exposed. The "ne-parle-pas" rapids are formed by the near vertical Pardonet Beds.

Proceed up river about four miles above the rapids to next stop.

STOP NO. 6

Fossil Point - Mississippian (Prophet formation) limestones exposed on the north bank of the Peace, containing brachiopods, corals and crinoid debris. Overlying rocks of Chowade Group (Permo-Carb.) are present high up on the west side of small creek valley, but are very poorly exposed.

Continuing up river, on the outer border of the Rocky Mountains to the south is Clearwater Creek. Exposed in the Clearwater valley are folded Triassic Pardonet Beds containing Monotis subcircularis.

Just beyond Clearwater Creek, again on the south, is the mouth of Point Creek.

STOP NO. 7

Point Creek - Overnight stop. Just west of the mouth of Point Creek on the north bank of the Peace are folded dark calcareous siltstones and limestones containing Discotropites indicating an early Upper Triassic age.

Second Day on Peace River we will travel from Point Creek to mouth of Wicked River, making six stops, and return to Rainbow Rocks.

About three miles up river west of Point Creek is "Fossil Island".

STOP NO. 8

Fossil Island - small rocky island in the channel of the Peace composed of dark grey to black limestones, containing numerous fossils. Forms found include corals, brachiopods, bryozoans and gastropods of late Middle Devonian age.

Proceeding up river from Fossil Island on the north bank of the Peace just east of the mouth of Bernard Creek an excellent example of chevron folding can be seen on an unnamed shoulder of the Mount Greene complex. The folded strata are of Devonian age.

To the south the prominent peak is Mount Crysdale rising to a height of 7,950 feet.

At the mouth of Bernard Creek look north to a large anticlinal fold exposing Silurian rocks in the core. The Silurian is overlain by Devonian dolomites. This fold forms the east shoulder of Advance Mountain.

Advance Mountain is an impressive sequence of cliff forming carbonate rocks, exposing Ordovician and Silurian. The Ordovician carbonates form the low dark grey shoulder. The fossiliferous Silurian dark grey carbonates overlie the Ordovician.

The yellow and light grey weathering dolomites which form the summit of the mountain are unfossiliferous, but have been included in the Silurian on your regional map.

To the southwest across the Peace River the high mountain is Mount Selwyn which rises to a height of 7,510 feet.

STOP NO. 9

Ordovician strata exposed at river level - limestone, dark grey, microgranular, argillaceous, rubbly, thin-bedded. Note the strong jointing and fracture system which is developed at right angles to the bedding.

Proceeding up river towards Wedge Peak, the massive yellow and light grey weathering Middle Devonian dolomites cap the top of the mountains on both sides of the Peace.

On Wedge Peak mountain carbonates of Ordovician, Silurian and Devonian age are exposed in that order from east to west.

STOP NO. 10

South bank of Peace; exposure of Middle Devonian dolomites opposite Wedge Peak. Dolomite, medium grey, fine to medium crystalline with sugary appearance.

Proceed to Stop No. 11.

STOP NO. 11

South bank of Peace opposite "Cave of the Winds" (Hole-in-the-wall); exposure of dolomite and dolomitic limestone, medium grey, fine-grained, cherty and apparently unfossiliferous - age probably Middle Devonian.

Continue up river past exposures of Devonian, Silurian and Ordovician rocks, crossing two major faults.

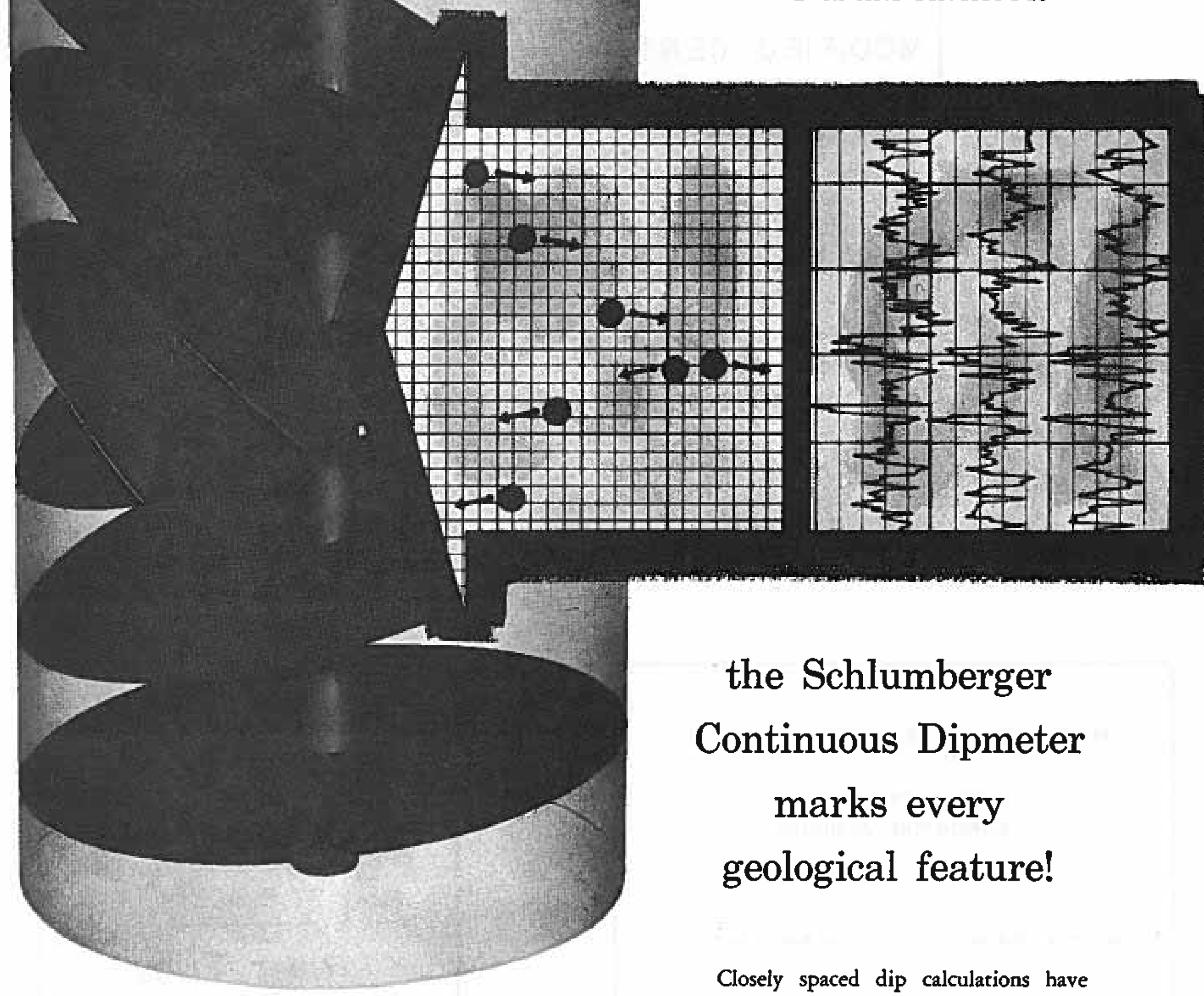
STOP NO. 12

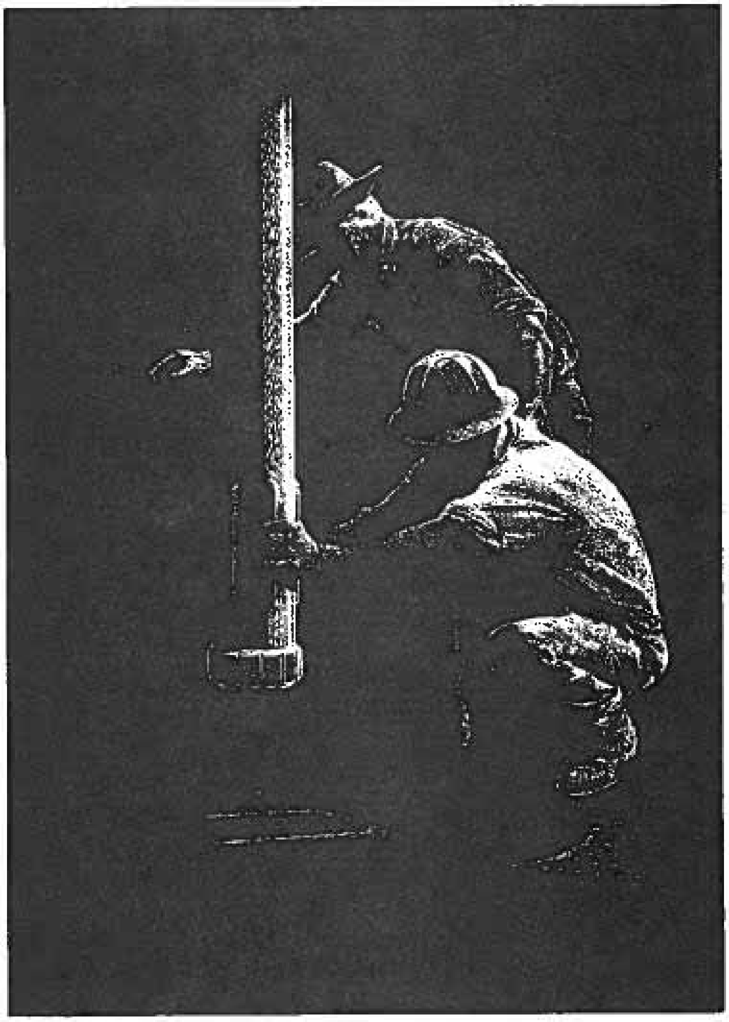
South bank of Peace River on so called "Quartz Mountain"; remains of old gold mining mill originally owned by Peace River Mining and Milling Company (1922-1923) and latter Gold Mountain Mines Syndicate (1933). Host rock quartzite, limestone and some schists. Quartzite contains small quartz stringers and veinlets that contain traces of gold.

STOP NO. 13

Exposure on south bank of Peace opposite Wicked River cabin just west of the mouth of Wicked River. Exposure of "Missinchinka" (?) dolomites and limestones. Carbonates are in part highly argillaceous, with numerous quartz and calcite veins, veinlets and irregular masses. The rocks are highly contorted with tight small scale folding.

End of boat traverse; return to Rainbow Rocks.





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NOTES


PEACE RIVER
RIVER
HUDSON HOPE
LEGEND
DUNVEGAN
CRUISER
GOODRICH
HASLER
COMMOTION
MOOSEBAR
BUCKINGHORSE
GETHING
DUNLEVY
BULLHEAD
FERNIE
TRIASSIC resistant (PARDONET - LIARD)
TRIASSIC recessive (TOAD - GRAYLING)
CHOWADE
PROPHET
BESA RIVER
UPPER & MIDDLE DEVONIAN
MIDDLE DEVONIAN ?
SILURIAN
ORDOVICIAN
MISINCHINKA GROUP
0 1/2 1 2 3
SCALE IN MILES
N.E.B.C.
PEACE RIVER AREA

GEOLOGICAL MAP OF THE PEACE RIVER BETWEEN FT. ST. JOHN AND FINLAY FORKS

SCALE 1" = 4000'

MAPPED BY

H.B. LYALL, R.S. MAHANNAH, P.A. ZIEGLER - SHELL OIL
H.H. BEACH & J. SPIVAK, E.D.W. IRISH, F.H. McLEARN — G.S.C.
W.H. MATHEWS — B.C. GOVERNMENT

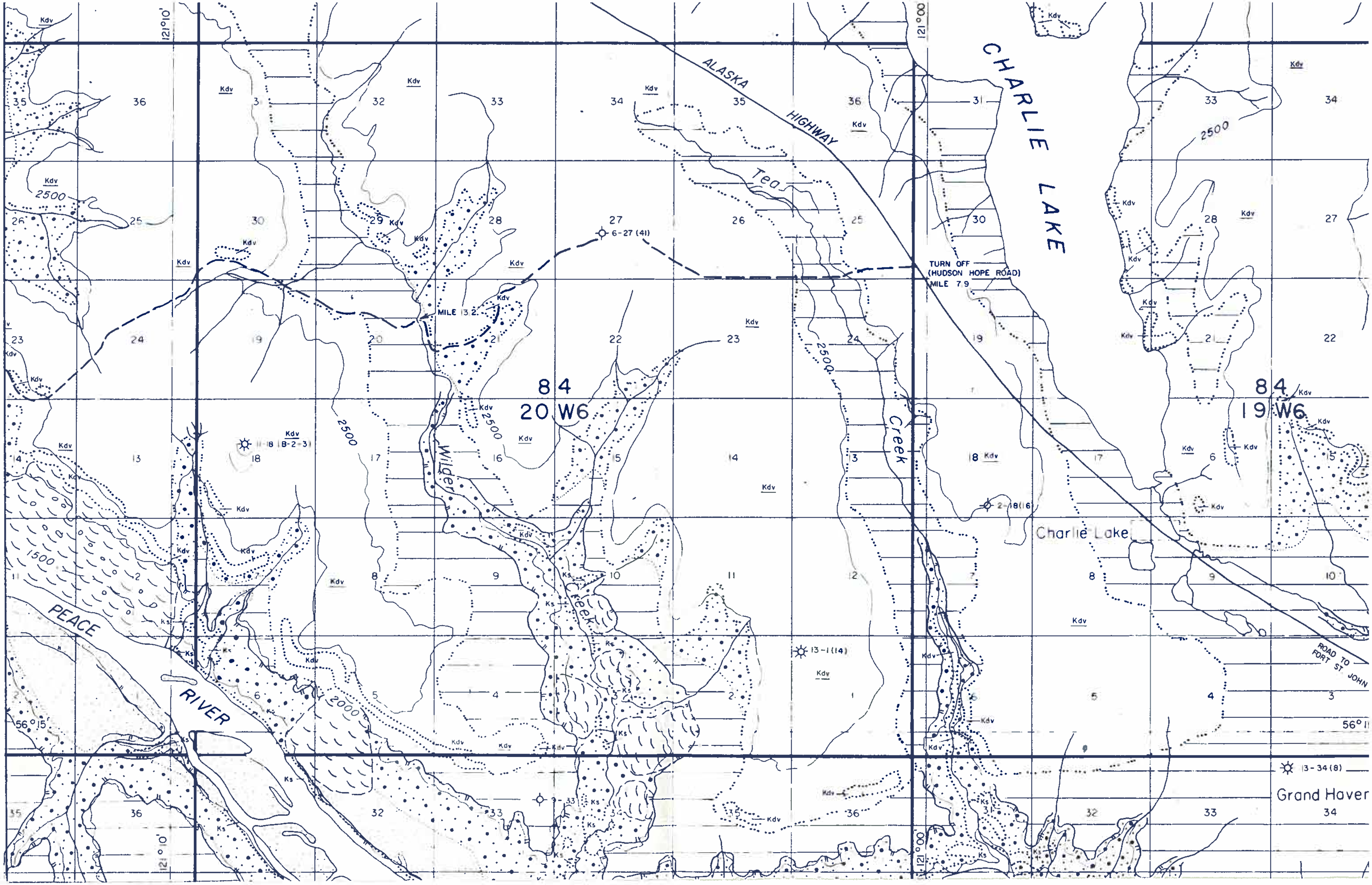
COMPILED BY

P.A. ZIEGLER — SHELL OIL CO. OF CANADA, LTD.

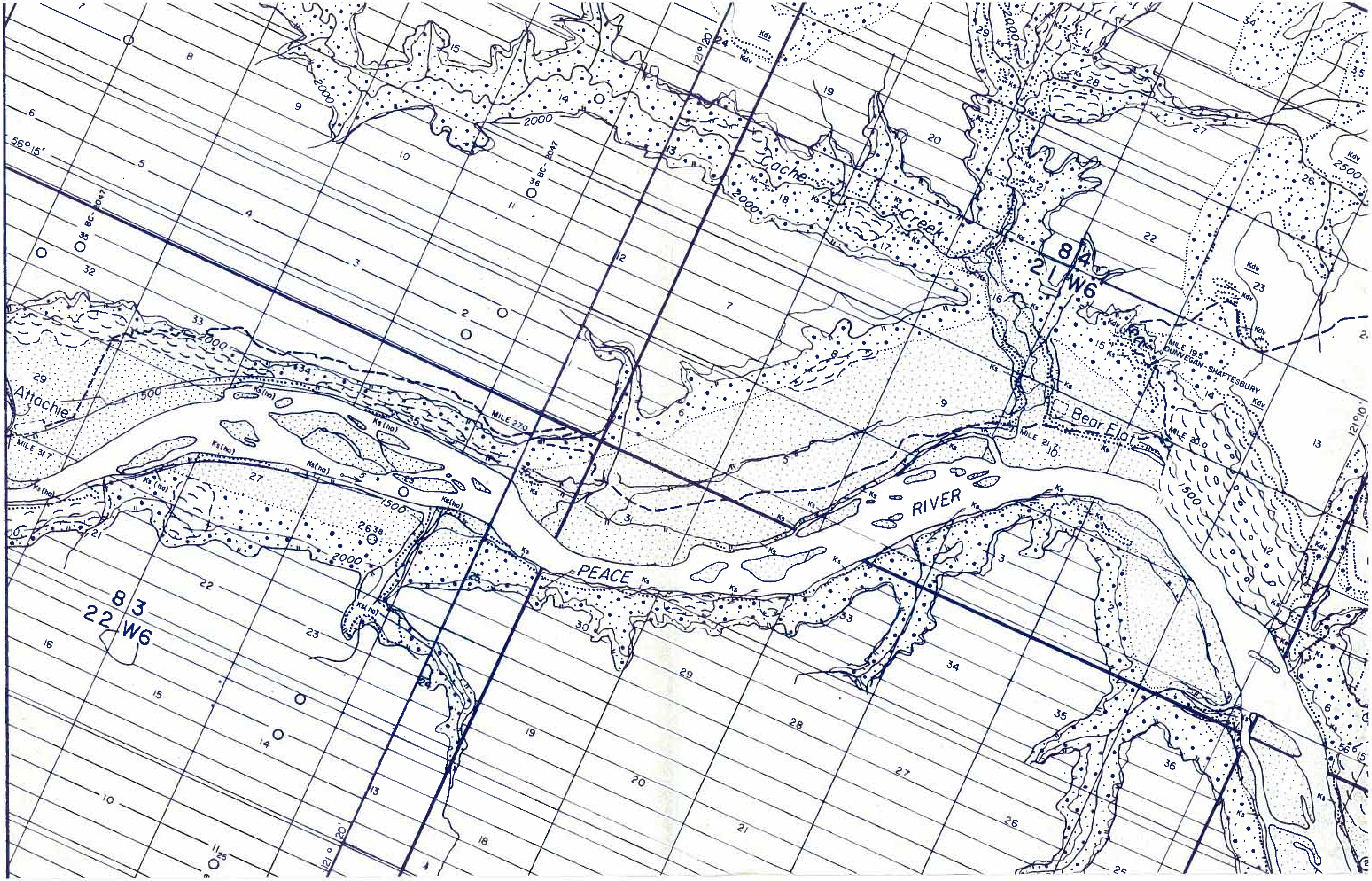
LEGEND

- EROSIONAL TERRACE
- ACCUMULATION TERRACE
- GROUND MORAINS
- KNOB & KETTLE MORAINE
- FLUVIO GLACIAL DEPOSITS (OLD RIVER TERRACES)
- ALLUVIAL
- ALLUVIAL FANS (ACTIVE)
- ALLUVIAL FANS (DRY)
- SLUMP
- SCREE
- DIP SLOPES (PHOTOGEOLOGICAL)
- DIPS (VERTICAL)
- DIP COMPONENT (STRIKE UNCERTAIN)
- DEFINITE OUTCROP
- INFERRED OUTCROP
- K-Jni AGE CERTAIN
- K-Jni AGE UNCERTAIN
- FORMATION BOUNDARY
- INFERRED FORMATION BOUNDARY
- THRUST FAULT, STEEP REVERSE FAULT
- NORMAL FAULT
- 7 STOPS AS LISTED IN GUIDEBOOK

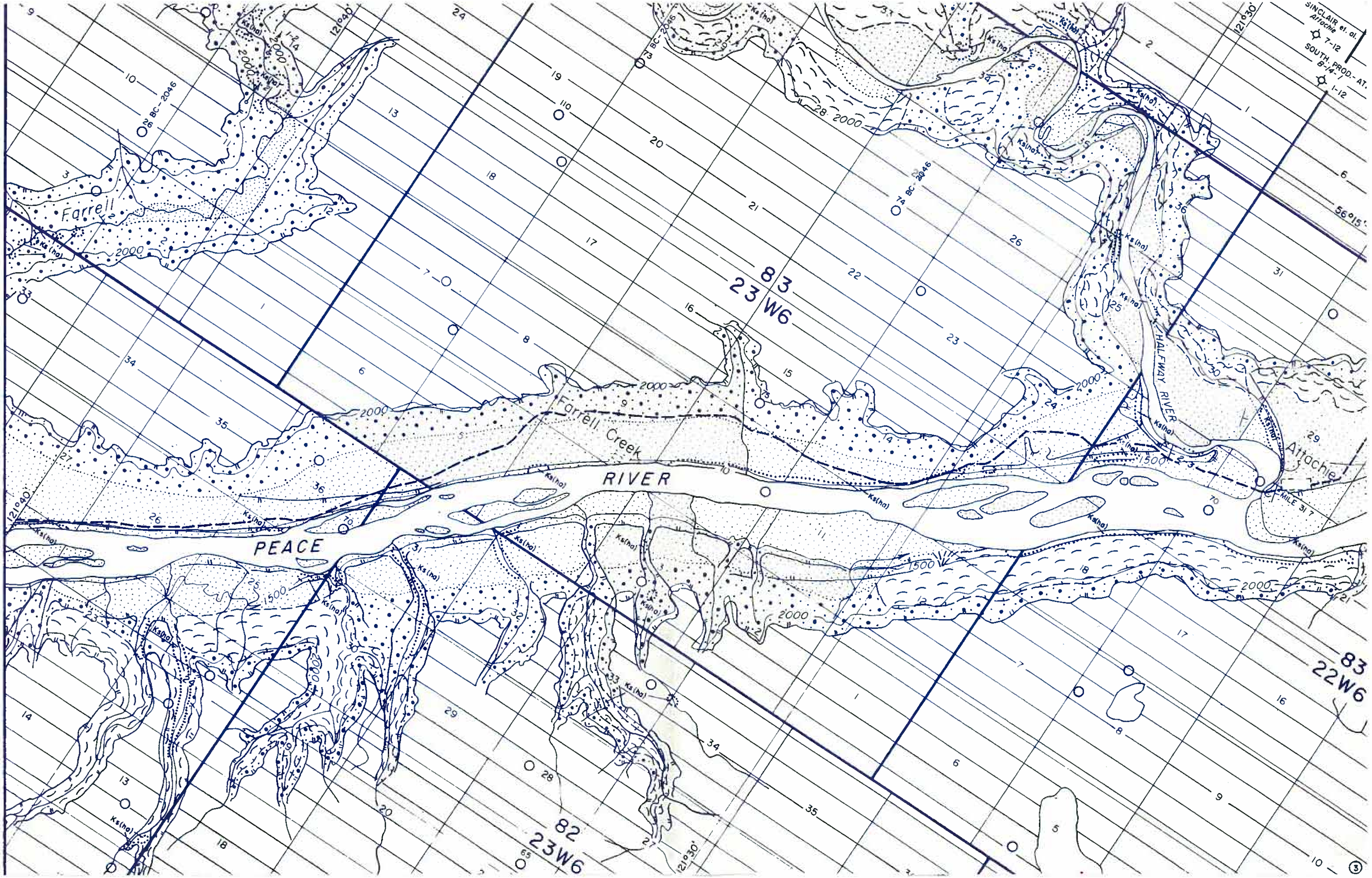
Kdv	DUNVEGAN SANDSTONE & CONGLOMERATE	UPPER CRETACEOUS
Ks / Ksi-sh	SIKANNI SHALE (SHAFTESBURY)	LOWER CRETACEOUS
Ks / Ksi-ss	SIKANNI SANDSTONE (SHAFTESBURY)	LOWER CRETACEOUS
Kha	HASLER SHALE (SHAFTESBURY / BUCKINGHORSE SHALE)	LOWER CRETACEOUS
Kcm / Kbk	COMMOTION SANDSTONE (BUCKINGHORSE SHALE)	LOWER CRETACEOUS
Kmb	MOOSEBAR SHALE (BUCKINGHORSE SHALE)	LOWER CRETACEOUS
Kbh	BULLHEAD SANDSTONE & QUARTZITE	LOWER CRETACEOUS
K-Jni	NIKANASSIN SANDSTONE & SHALE	JURASSIC
Jf	FERNIE SHALE	JURASSIC
Rp3	PARDONET 3 PLATY LIMESTONE & SHALE	TRIASSIC
Rp2	PARDONET 2 MAINLY CRINOIDAL LIMESTONE ≅ BALDONEL	TRIASSIC
Rp1	PARDONET 1 EVAPORITIC SEQUENCE ≅ CHARLIE LAKE	TRIASSIC
Rl 2	LIARD 2 MAINLY SANDSTONE ≅ HALFWAY SS.	TRIASSIC
Rl1	LIARD 1 SILTSTONE & SHALE ≅ DOIG FM.	TRIASSIC
Rtg	TOAD-GRAYLING SILTSTONE & SHALE	TRIASSIC
P-M	PERMIAN & STODDART, CHERT, SANDSTONE & SHALE	P, PP, M
Mr	RUNDLE, CRINOIDAL LIMESTONE & CHERT	MISSISSIPPIAN
M-Dbe	BESA RIVER SHALE INCLUDING SOME LIGHT GRAY LIME- STONE NEAR BASE (DU-DM)	DEVONIAN
DU-DM		DEVONIAN
DM	MIDDLE DEVONIAN LIMESTONE & DOLOMITE	DEVONIAN
DL	LOWER DEVONIAN DOLOMITE & SANDSTONE	DEVONIAN
S	SILURIAN DOLOMITE CONTAINING SILICEOUS CORAL FAUNA	SILURIAN
S-O	SILURO-ORDOVICIAN (SILSTONE, SHALE, DOLOMITE): SILTSTONE & SHALE	ORDOVICIAN
Oqtz	SILURO-ORDOVICIAN: QUARTZITE	ORDOVICIAN
Osh	SILURO-ORDOVICIAN: SILTSTONE & SHALE	ORDOVICIAN
Ocorb / O	ORDOVICIAN DOLOMITE (GASTROPODS, ALGAL BALLS, ORTHOCERIDS)	ORDOVICIAN
O-Є	CAMBRO ORDOVICIAN SHALY LIMESTONE	LOWER ORD. & UPPER CAMBRIAN



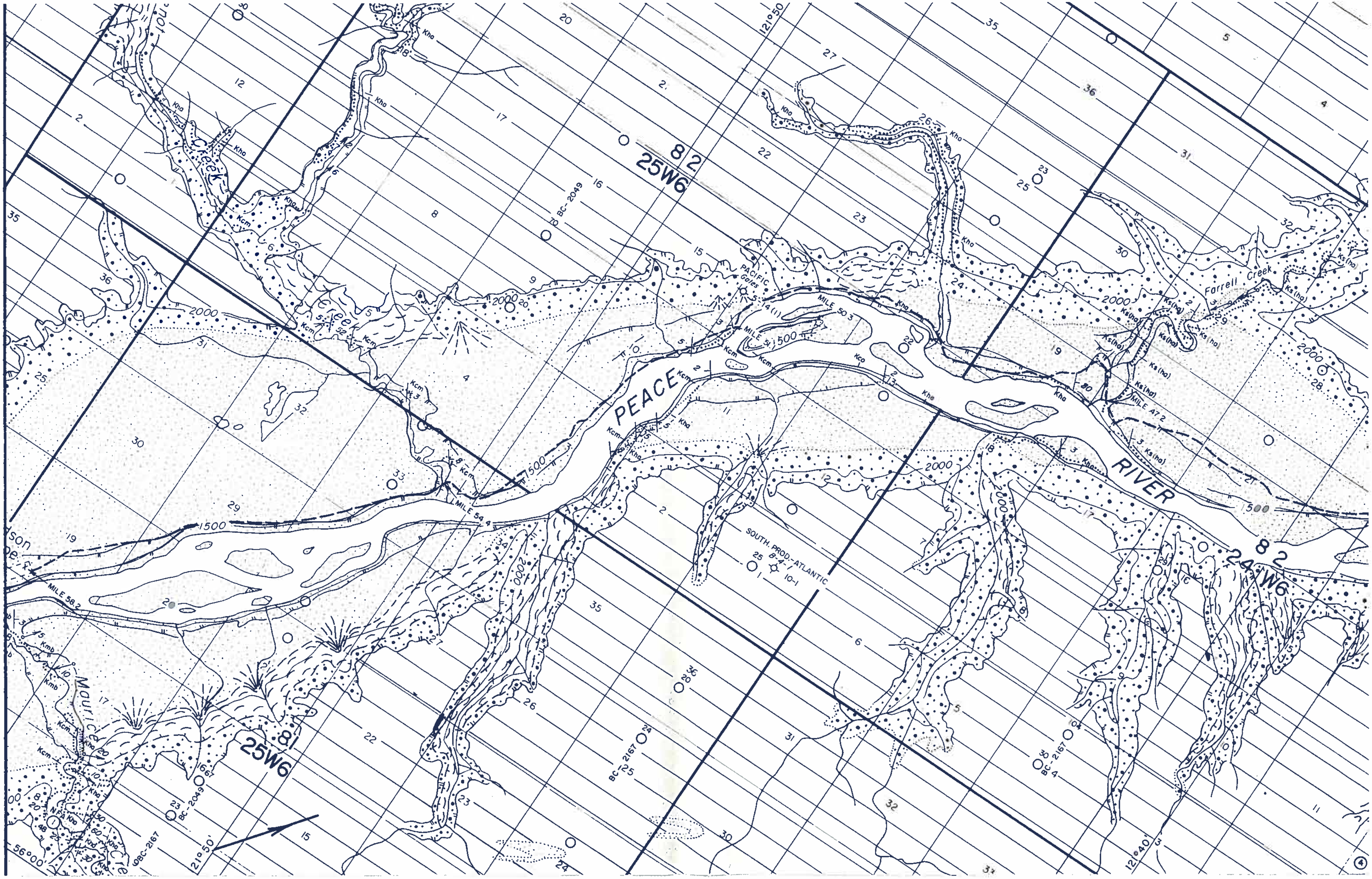
CHARLIE LAKE
ALASKA HIGHWAY
Tea Creek
Wilder Creek
PEACE RIVER
84
20 W6
84
19 W6
TURN OFF
(HUDSON HOPE ROAD)
MILE 7.9
MILE 13.2
Charlie Lake
Grand Haven
ROAD TO FORT ST JOHN
121°10'
121°00'
56°15'
6-27 (41)
11-18 (B-2-3)
13-1 (14)
2-18 (16)
13-34 (8)
2500
2000
1500
Kdv
Ks

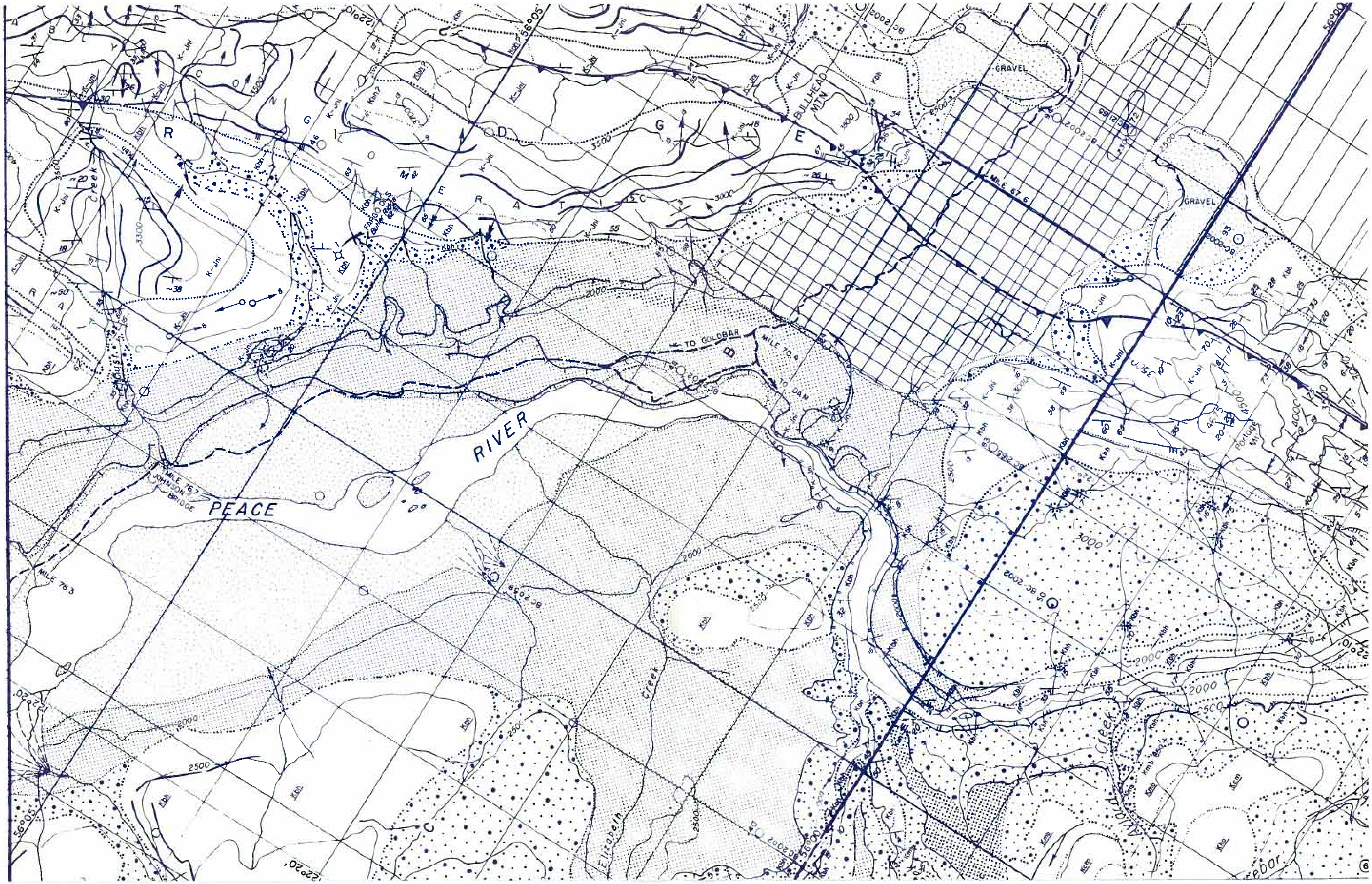


56° 15'
121° 20'
121° 10'
Cache Creek
PEACE RIVER
Attachie
Bear Flat
MILE 317
MILE 270
MILE 21.7
MILE 19.5
MILE 20.0
DUNVEGAN-SHAFTESBURY
8 4
21 W6
8 3
22 W6
BC-2047
Kdv
Ks
Ks(ho)
2000
1500
2500

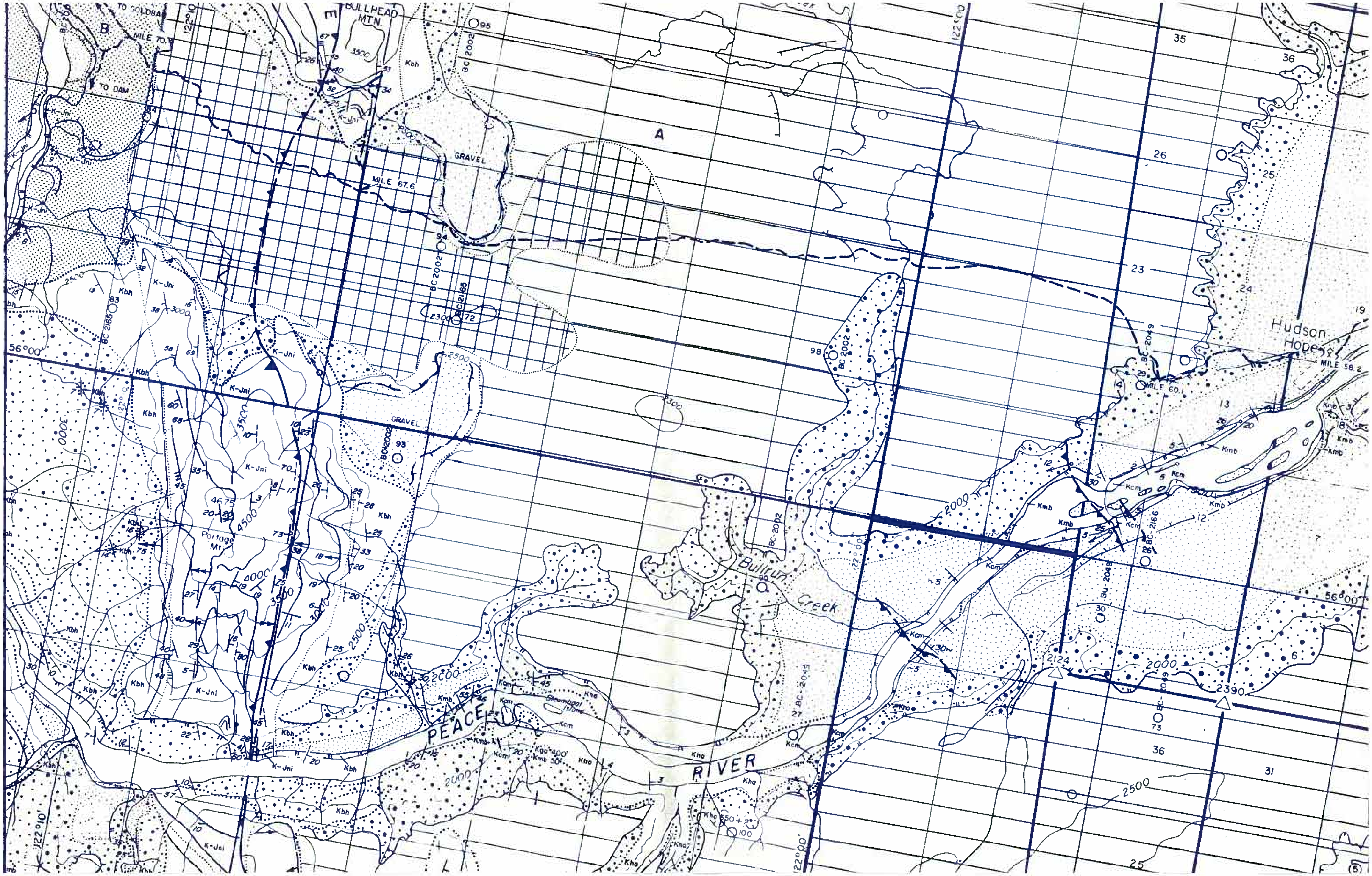


PEACE
RIVER
Farrell Creek
Farrell
HALFWAY RIVER
Attachie
83
23 W6
83
22W6
82
23W6
56°15'
121°40'
121°30'
SINCLAIR et. al. Attachie 7-12
SOUTH PROD.-AT. B-14-1 1-12
MILE 31.7
73 BC-2046
74 BC-2046
26 BC-2046
Ks(ha)
2000
1500
3


PEACE
RIVER
Farrell Creek
Creek
Maurice
82
25W6
81
25W6
82
24W6
MILE 50.3
MILE 51
MILE 54.4
MILE 58.2
MILE 47.2
PACIFIC
Gates
SOUTH. PROD.-ATLANTIC
BC-2049
BC-2167
2000
1500
121°50'
121°40'
56°00'
21°50'
Kha
Kcm
Kmb
Ks(ha)

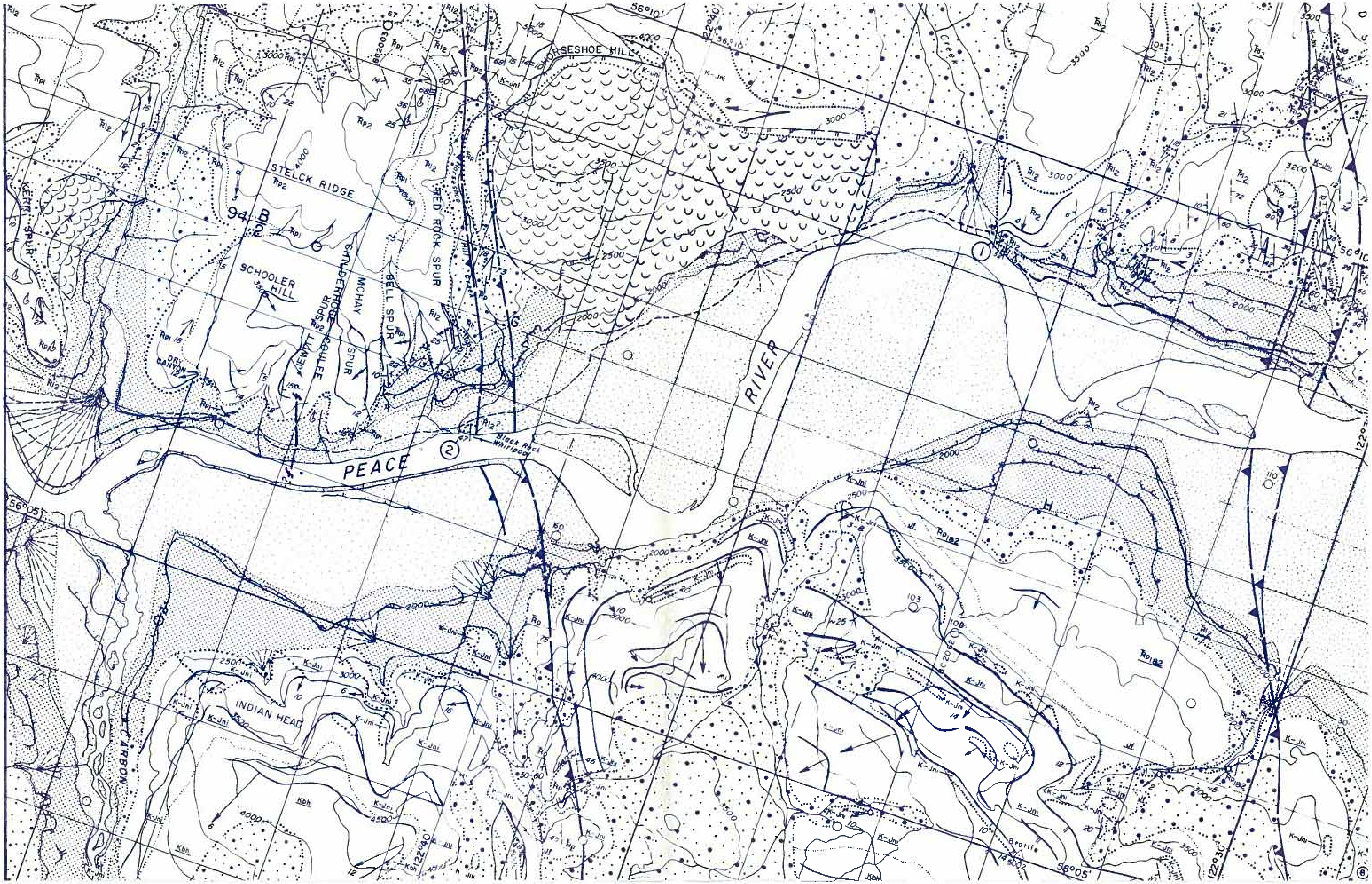


PEACE
RIVER
BULLHEAD MTN
GRAVEL
GRAVEL
MILE 67.6
MILE 70.4
MILE 76.7
JOHNSON BRIDGE
MILE 78.3
TO GOLDBAR
TO DAM
Elizabeth
Creek
Creek
56°05'
56°00'
122°10'
122°20'
BC 2002
K-Jni
Kbh

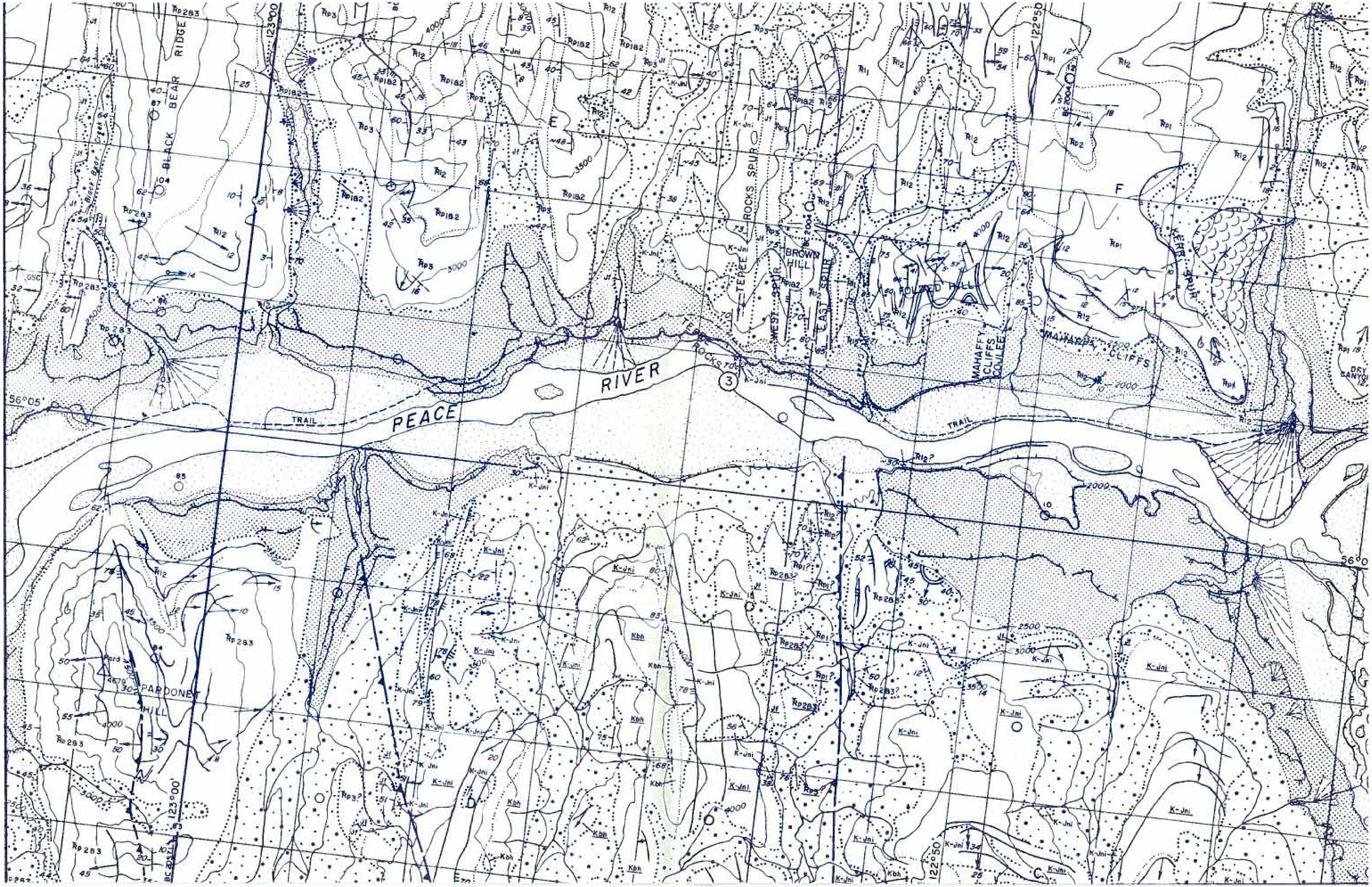


TO GOLDBAR
MILE 70.3
TO DAM
BULLHEAD MTN
3500
Kbh
BC 2002
GRAVEL
MILE 67.6
A
B
E
35
36
26
25
23
24
Hudson Hope
MILE 58.2
MILE 60.1
BC 2049
BC 2165
BC 2166
BC 2002
BC 2124
K-Jni
Kbh
Kmb
Kcm
Kha
Portage Mt
Bullrun Creek
PEACE RIVER
Steamboat Island
2124
2390
2000
2500
3000
4000
4500
4675
56°00'
122°00'
122°10'

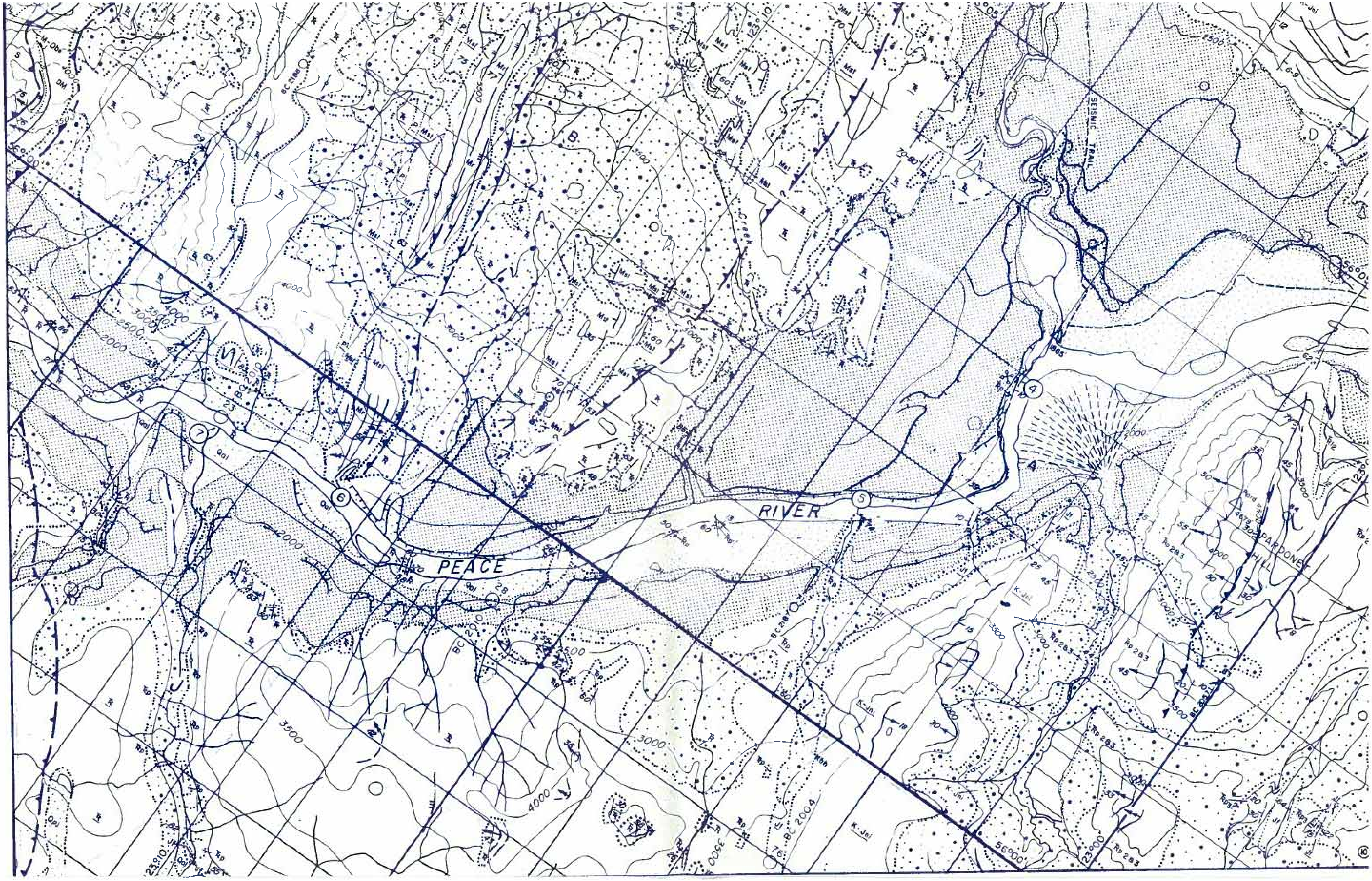
PEACE
RIVER
Dunlevy Lake
Dunlevy
RAINBOW ROCKS
KYLLO BROS. DOCK
MILE 87.6
MILE 87.1
MILE 86.8
MILE 83.5
MILE 78.3
MILE 76.7
JOHNSON RIDGE
S A N D S T O N E
Gravel
Hill
Table
Creek
COAL
94B
56°10'
56°05'
122°20'
122°30'
Kbh
K-Jni



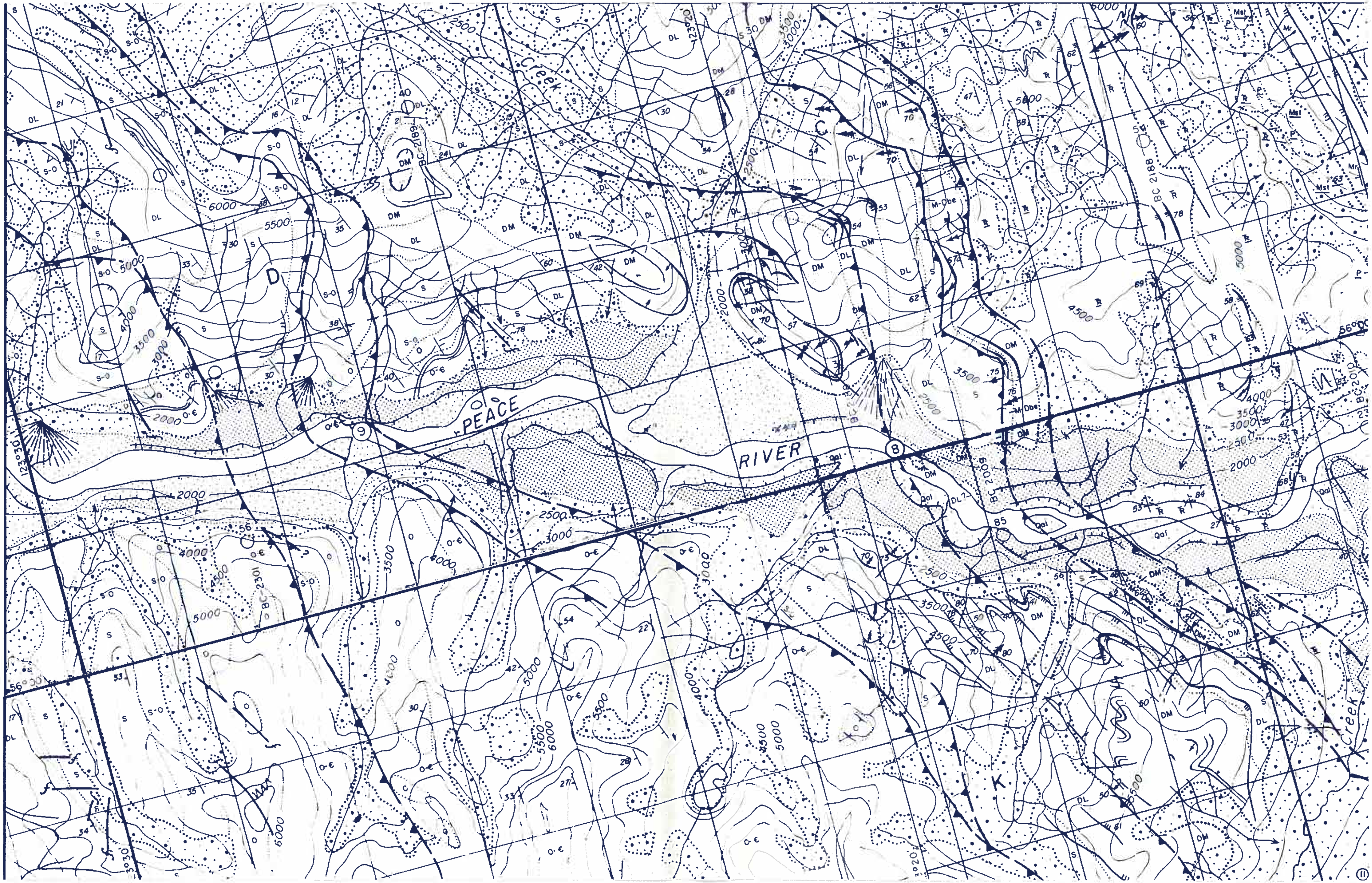
HORSESHOE HILL
STELCK RIDGE
KERR SPUR
SCHOOLER HILL
94 B
RED ROCK SPUR
BELL SPUR
MCHAY SPUR
JEWITT SPUR
DRY CANYON
PEACE
RIVER
Creek
Black Rock Whirlpool
INDIAN HEAD
CARBON
Beattie
56°10'
56°05'
122°40'
122°30'



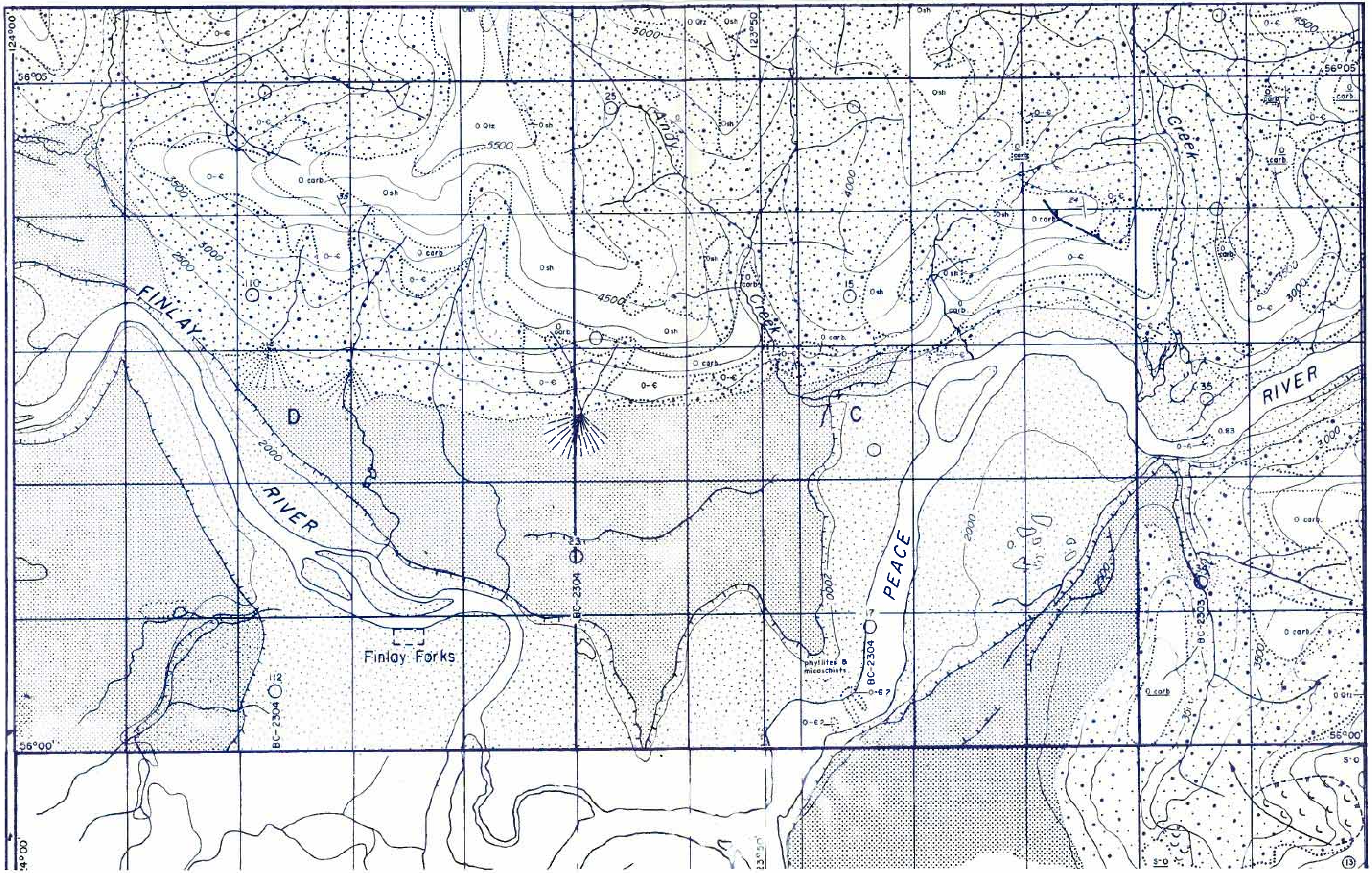
BLACK BEAR RIDGE
123°00'
122°50'
56°05'
E
F
D
C
ROCKS SPUR
TEPEE
BROWN HILL
WEST SPUR
EAST SPUR
MAHAFFY CLIFFS COULEE
MAHAFFY CLIFFS
KERR SPUR
DRY CANYON
PEACE
RIVER
TRAIL
TRAIL
PARDONET HILL



PEACE
RIVER
SEISMIC TRAIL
Creek
HILL
56°00'
BC 2004


PEACE
RIVER
Creek
Creek
123°30'
123°20'
56°00'
56°30'
BC-2189
BC 2188
BC-2301
BC 2009
BC 2010
D
C
K


PEACE
RIVER
Colin Creek
Selwyn Creek
Hamlyn Creek
Creek
DYKE
BC-2301
BC-2302
BC-2303
56°05'
56°00'
123°30'
123°40'
6850



124°00'
56°05'
123°50'
FINLAY
RIVER
FINLAY RIVER
PEACE
RIVER
Andy
Creek
Creek
D
C
Finlay Forks
phyllites & micaschists
BC-2304
BC-2303
O Qtz
O sh
O carb
O-€
5500
5000
4500
4000
3500
3000
2500
2000
56°00'
S-O
13