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FINAL

GEOLOGICAL REPORT

ON

THE UPPER PART OF THE LITTLE BEAR RIVER AREA

NORTHWEST TERRITORIES (CANADA)

IMPERIAL OIL LIMITED - CANOL PROJECT

Assignment No. 20

By: Lt. V. N. Monnett Party Chief

J.M. Nicholls Helper

E. Bauder Helper

Date submitted: January 14,1944.

Read and accepted by: Merritt Cook

Date: Jan. 20th. 1944.

Photo Enclosures

FEB 22 1944

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LIST OF ILLUSTRATIONS

A B S T R A C T

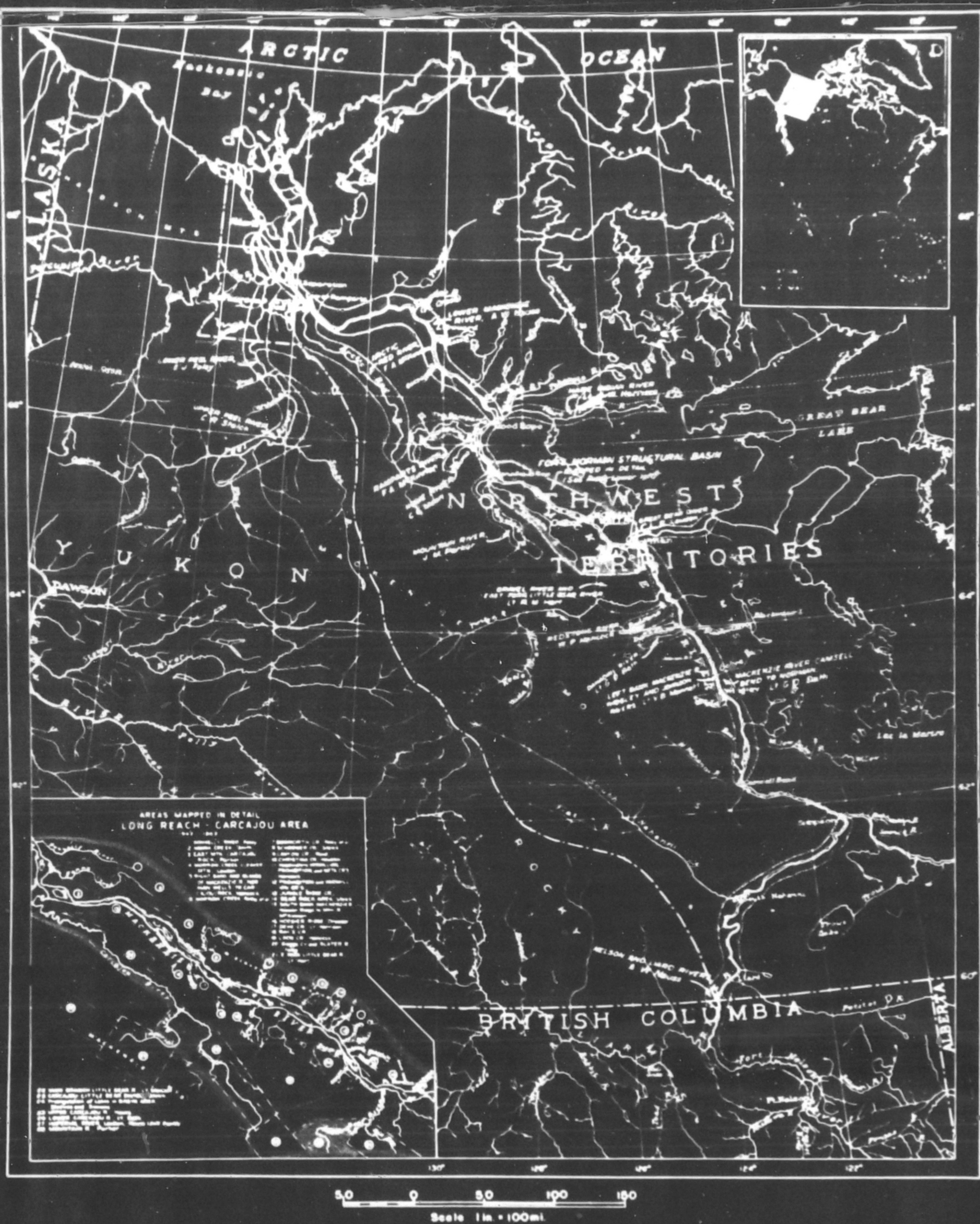
In the extreme upstream portion of the Little Bear River faulting has thrown up beds of Silurian and Middle Devonian to make the Gambill Mountains. The river flanks this uplift flowing in Upper Devonian beds.

At the north end of this uplift the river enters an entrenched, meandering valley cut in beds of Cretaceous age and from this point on down to the mouth of the river the valley walls expose Cretaceous beds only.

The dominant structural feature reflected in these Cretaceous beds is a large syncline. The axis of this syncline crosses the upstream portion of the river a few miles south of Blueberry Creek. It then trends roughly parallel to that part of the Little Bear River lying between the mouth of East Fork and the big bend of Little Bear River, and crosses the East Fork River near its mouth.

All Cretaceous beds in the upper part of the Little Bear River, above the mouth of East Fork, reveal dips directly associated with this syncline except on the big bend of the river. A structural nose is in evidence on this bend.

The presence of this nose makes the interstream area north of the river an interesting area and more work should be done there. Exploration in this area must be by geophysical methods however, as outcrops of bedrock are absent.



INDEX MAP OF
NORTH WESTERN CANADA SHOWING
UPPER PART OF LITTLE BEAR RIVER AREA

Chapter I.

I N T R O D U C T I O N

The area assigned to Party 'M' (Lt. V. B. Monnett, J. A. Simons, and J. H. Nicholls) for geological reconnaissance by Dr. T. A. Link in Assignment No. 36 is shown on the map (Encl. #1) accompanying this report.

For purposes of discussion, the region is divisible into three distinct parts. These are the Wrigley River area, the Johnson River area, and that part of the Mackenzie River area lying between the mouths of these two tributary streams.

Neither the Wrigley River nor the Johnson River were navigable by canoe. Although both streams carry a large volume of water, the stream beds are so strewn with large boulders that navigation of the stream by any kind of boat is impossible. This necessitated ascending these two rivers on foot, and carrying all of the necessary supplies and equipment.

Party 'M' was flown by a Norseman Pontoon Plane from Norman Wells to the settlement of Wrigley, a distance of about 200 miles. After ascending the Wrigley River on a six day pack trip, the party traversed the 35 miles from Wrigley down to Johnson River by canoe. The Johnson River was then surveyed. It was necessary to make a return trip to the Wrigley River in order to map a structure found on the north branch of this river.

Oblique photographs were obtained of the Wrigley River and part of the Mackenzie River, but these proved to be of little value as that part of the area which revealed outcrops was too far

flood stage of varying degrees during the entire time that Party 'M' was on it and even 'trekking' the canoe upstream was impossible. This necessitated covering all of the area above Blueberry Creek by back-packing food and equipment.

Aerial photos of the entire area were available and these were used as the base map on which the geology was plotted.

Chapter II.

T O P O G R A P H Y

In any discussion of the topography of this area, the physiographic history must be introduced to some extent. The Little Bear River itself affords an excellent illustration of a river, once meandering with large and numerous bends over an almost flat plain, rejuvenated so rapidly that the meanders became entrenched, resulting in the present condition of the stream. The river flows in a winding course through a narrow valley flanked by steep banks averaging about one hundred feet in height. It is in these cut banks that the bedrock is revealed.

In the area adjoining the stream, the former flat plains forming the valley flat on which the Little Bear River developed its meanders now remain as relatively flat, muskeg-covered areas which have been left high above the stream bed and which are in the very first stages of dissection by small tributary streams. Outcrops are very rare in these areas.

Blueberry Ridge, a low continuous line of hills immediately west of Lake Ann, rises above the surrounding muskeg area sufficiently to merit mentioning. This ridge is further discussed under the chapter on Structure.

The most striking relief feature in the entire area is the Gambill Mountains, a line of hills lying east of the uppermost part of the Little Bear River. These mountains rise about 1600 feet above the nearby stream and trend in almost a North-South direction in their northern part.

The Little Bear River has been unable to transport the large

volume of gravels brought down from the western slope of these mountains. The resulting river channel is divided into several smaller, interlacing channels and the stream maintains this braided appearance until it is well away from these mountains.

Chapter III.

STRATIGRAPHY

General

Only beds of Cretaceous age were found away from the immediate area of the Gambill Mountains. Within these mountains, rocks of Silurian and Devonian age are exposed. Thicknesses of these pre-Cretaceous rocks were estimated, as this part of the area was studied during a six day pack trip and carrying the necessary survey instruments for measuring section would not have proved worthwhile. However, with the aid of the aerial photographs and the measured dips, the formation thicknesses given in this report should be approximately correct. The following table is an abridged stratigraphic column:

	East Fork Shale
CRETACEOUS	Little Bear Series (700 feet)
	Slater River Shale (900 feet)
----------	unconformity----------
	Norman Series (700 ± feet)
UPPER DEVONIAN	
	Ft. Creek Shale (800 ± feet)
----------	----------
	Ramparts-Beavertail Formation (300 feet)
MIDDLE DEVONIAN--------	unconformity----------
	Bear Rock Formation (400 - 800 feet)
----------	unconformity----------
SILURIAN	Mt. Hensing Formation (1800 ± feet)

SILURIAN

Mt. Ronning

The Silurian beds composing the crest and the entire eastern flank of the Gambill Mountains consist of grey dolomites and limestones. In general these beds are hard and massive although there are interspersed zones of relatively thin bedded limestone. A medium grey color is dominant, although the beds frequently present buff, weathered faces. Fossils are rare but a few fragments of individual corals were found standing out on limestone due to differential weathering. One Stromatoporoid fragment was found. These few fossils partially weather out of the dolomite in which they are contained as brownish nodules and are easily discernible.

Although the base of this formation was not seen, there are approximately 1800 feet of these beds exposed. They are regarded as being equivalent to the Mt. Ronning Formation of Silurian age.

DEVONIAN

Bear Rock

Unconformably overlying these hard dolomitic limestones is the Bear Rock formation. The lithology of this formation here is identical to that found in the Kay Mountains, Bear Rock, Oil Creek and elsewhere. It consists of angular, brecciated, dolomitic limestone fragments firmly held together by a calcium carbonate matrix. Bedding planes are seldom seen and accurate dip readings are difficult to obtain on this formation. Although the Bear Rock formation weathers to a dominantly buff color, a dark grey color is not unusual. Small caves and indentations are usually seen on steep cliffs in the Bear Rock formation. The thickness of this formation in the Gambill Mountains is between 400 and 500 feet.

Beavertail - Ramparts

A thin bedded series of buff and grey limestones and shales overlying the Bear Rock formation represents the Ramparts - Beavertail formation. There are no criteria here to separate these beds into two distinct formations.

At the base of this formation and resting unconformably on the older beds (a break that is very apparent here) lies a hundred feet of tan and grey interbedded limestones and shales. The weathered bedrock and the talus are tan in color, but the fresh surfaces are more grey. The limestones are fine grained and become shaly towards the top and bottom of each layer. The shales are dominantly medium grey, but tan shales are not unusual, and there appear to be a few thin beds of black shale very similar in appearance to the Ft. Creek shales. These black shale beds were not actually found in place, but the probability that they are contained within the lower hundred feet of Ramparts seems certain.

Above this hundred foot zone, three distinct limestone beds are found averaging twenty feet in thickness, and separated by fifty feet of interbedded limestone and shale. The twenty foot limestone beds form three minor ridges along the western flank of the mountains. Fossils were collected at the top of the middle limestone ledge (200 feet above the base of the Ramparts) which have been identified as a Beavertail fauna (4). The third and outer limestone ridge, forming the first rise from the river flat, consists of a hard, dark grey, fine crystalline limestone yielding occasional fossils. A fresh broken piece of this limestone gives a strong petroleum odor and has a very slight brownish oil stain which soon disappears.

There are approximately 300 feet of Ramparts- Beavertail exposed.

Fort Creek

The black, brittle, slaty shales of the Fort Creek Formation were found in a small stream running along the western flank of the Gambill Mountains just north of Ration Creek. As the stream was parallel to the strike, no appreciable section could be examined and no determination of thickness was made.

Norman Series

One outcrop of the Norman Series was found on the west bank of Little Bear River just opposite the mouth of Ration Creek. The outcrop consisted of reddish brown to greenish sandstone beds separated by greenish grey shale. The sandstone is very fine grained and several fossils were collected which serve to identify this series.

CRETACEOUS

General

From the single outcrop of Norman Sandstone described above on downstream to the mouth of Little Bear River, only beds of Cretaceous age are found. These beds present a complex problem in stratigraphy and even local correlation of individual beds is extremely difficult.

Basically, the Cretaceous of this area has been divided into three series by Dr. T. A. Link (1). The lower division consisting of a grey shale series referred to as Slater River Shale, the middle series consisting of shales, sandstones and coal known as the Little Bear Series; and an upper grey shale known as the East Fork series. With the exception of two exposures of Slater River Shale, all outcrops from the Gambill Mountains down to within a mile of the mouth of East Fork River consisted of beds within the Little Bear Series.

Slater River Shale

Two outcrops of this shale were found on the small tributary which enters Little Bear River about three miles downstream from Ration Creek. Both exposures reveal soft, dark grey shales containing an occasional thin bed of ironstone concretions. Outcrops of this shale are commonly covered by mud flows making strike and dip readings difficult to obtain.

As only the central part of this formation was seen, any thicknesses given are necessarily a rather rough estimate. Dr. Link (1) estimated 900 feet of this shale on the lower part of this river. This figure seems to be a good estimate for the upper part of the river as well.

Little Bear Series

This series of sandstone, shales, lignites and coal outcrop from the beginning of the unbraided, entrenched, meandering stream channel near the Gambill Mountains down to within a mile of the mouth of East Fork.

An excellent section of this series was obtained on the south limb of the large syncline (see encl.#2). Outcrops were numerous and dips were low enough to permit the construction of an almost complete stratigraphic column of the Little Bear Series. In spite of this fact, it was found that correlation of beds within this series over a distance of a few miles was impossible. Sandstones, 20 feet or more in thickness, grade laterally into shale within a very short distance. A shale zone may form soft mud flows at one outcrop, whereas less than a mile away the shale stands out as a vertical wall due to a local sandy and highly ferruginous content.

Although a detailed section describing each sandstone and shale bed appears to be valueless in this area, important generalities can be made. The columnar section (see encl. #2) accompanying this report, represents the entire Cretaceous section exposed down to the East Fork River. The Little Bear Series can be divided into three zones for descriptive purposes.

Zone 'A' The lower part of the Little Bear Series consists of 200' of sandstone and shale. The shale is grey but contains brown ironstone and weathers brown in places. The sandstone may be fine to coarse grained, and is tan to greenish grey in color.

Zone 'B' 350 feet of sandstone and shale. The shale is grey mottled with brown, but the sandstone has a "salt and pepper" appearance with conglomeratic streaks. A few thin lignite beds are associated with this medium to coarse grained "salt and pepper" sandstone.

Zone 'C' 100 feet plus of sandstone and shale with coal and lignite seams. The coal varies in thickness from a few inches to several feet in thickness. The shale is highly carbonaceous in places but elsewhere is more grey and iron stained.

The stratigraphic section several miles to the north coincides with this section in general. The coal beds are better developed to the north, however, and first appear somewhat lower in the section.

Dr. Link estimated 780 feet of Little Bear Series on the lower part of the river. As more than 650 feet have been described in this report, neither the top nor bottom of this series was actually seen, a total thickness of about 780 feet is possible, although 700 feet seems to be a more correct figure for this area.

Fossil zones in that part of the Cretaceous involved in this area are not common.

East Fork Shale

Overlying the Little Bear Series is a series of soft, medium grey shales very similar in appearance to the Slater River Shale.

As this shale is first encountered near the mouth of East Fork and outcrops along the lower part of the East Fork River, Dr. Link (1) designated this shale as the East Fork Shale. This shale was not found in the upper part of the Little Bear River.

Chapter IV.

S T R U C T U R E

Gambill Mountains

The only topographical and structural feature of note along the Little Bear River is the line of high hills lying east and southeast of the braided channel part of the River.

The trend of this ridge is N 15° East coinciding with the strike of the formations exposed. This relationship between the strike of the beds and the trend of the ridge is maintained even upstream towards the headwaters of Little Bear River, where the ridge makes a sudden turn of almost 45° to the west.

The cross section (Encl. #3) accompanying this report intersects these mountains at their northern end. A section through the mountains four miles south would be identical. The cross section reveals a steep dipping homocline striking N 15° E and dipping westward 40 to 45 degrees. The beds involved in this homocline come to an abrupt end on the east side of the mountains with no indication of any reversal in dip in the northern part of the mountains at least. This gives a high steep eastern face to these mountains and the conclusion immediately drawn is that the range is bounded on the east by a strike fault. The valley and much lower lying hills east of this fault will probably show that the Gambill Mountains are only a faulted limb of a large anticline, but this lowland was not included in the field work. This area is interpreted by Lt. Hart as being a graben area. For a discussion of this region, the reader is referred to Hart's Report, (2).

The fault is interpreted as a rather low overthrust on the cross section. Evidence that such a condition exists here was not

observed, but as this type of faulting is dominant in this part of the Mackenzie River basin, it is shown as such on the cross section.

The dominant structural feature reflected in the Cretaceous beds from the Gambill Mountains downstream to the mouth of East Fork is a large asymmetrical syncline trending roughly northeast- southwest in the immediate vicinity of Little Bear River. The southeastern limb of this syncline rises rather rapidly against the Gambill Mountain uplift with the dips increasing progressively toward the uplift. An almost continuous section of the Cretaceous Little Bear Series is exposed on this flank of the syncline.

North of the synclinal axis the beds dip gently and more or less evenly southward over a distance of about 7 miles to the big bend of the river.

Extension of the synclinal axis on eastward must be done with general information only, as no outcrops are found in this interstream area. Since the Gambill Mountain uplift decreases in magnitude to the north and finally merges into the low muskeg hills about 5 miles north of Ration Creek, it appears probable that this syncline may be extended around the north end of this uplift and continue eastward to the syncline mapped by Lt. Hart on the East Fork Branch. The prolongation of this synclinal axis is not entirely an assumption as the dips recorded on the Little Bear River below its big bend are to the south, that is, toward the uplift.

The possibility of the Gambill Mountain fault dying out to the north and becoming a fold which swings eastward to parallel the syncline has been suggested by Lt. Hart. This seems to be an acceptable idea as Hart reports an anticlinal ridge immediately south of the syncline on East Fork River. Lt. Hart's report (2) presents a

regional picture of the area and contains discussion of this idea.

The only indication of a possible structure favorable as an oil reservoir occurs on the big bend of Little Bear River. This consists of a nose-like structure probably plunging to the southwest. Evidence of this nose is as follows:

(1) The strikes and dips found on the main part of the big river bend are nearly at right angles to those measured both above and below the bend. This is true, not for merely one or two of the readings taken on the bend, but for all of them. These irregularities in dip seem best explained on the assumption that a structural nose lies in this area.

(2) A southwest dip is definitely established on the upstream portion of the bend. Blueberry Ridge, lying 2 to 3 miles southwest of the large river bend, may be a topographic expression of the northwest strike in this area.

(3) A section of Cretaceous East Fork shale was found by Dr. T. A. Link (1) overlying the coal beds of the Little Bear Series up Coal Creek. The youngest beds observed above the big bend of the river were the thin coal beds of the Little Bear Series found near the center of the syncline. The presence of East Fork shale on Coal Creek means that these beds must lie upstream from Coal Creek. This calls for a change in the strike to a more northerly direction in the interstream area between the mouth of Blueberry Creek and Coal Creek. The corresponding dip would thus become more eastward in direction.

With a southeast and a southwest dip thus established, a west to northwest dip is needed to make an ideal structural nose. Such a dip was not seen. It will be noted, however, that the dips appear to be swinging to the west as the outside part of the big bend is approached. (Encl. # 1)

Chapter V.

OIL AND GAS MANIFESTATIONS AND MINERAL DEPOSITS

No oil or gas seepages were observed. The only indication of petroliferous beds was the distinct petroleum odor obtained from a freshly broken piece of the hard, fine crystalline limestone of the uppermost part of the Ramparts - Beavertail formation.

Although this particular limestone appears too dense to act as a reservoir bed, it is possible that the softer and more porous fossiliferous limestones within the Ramparts - Beavertail formation may also have contained oil or gas but that it has escaped at the outcrops.

Coal beds are fairly abundant along the Little Bear River from the Branch of East Fork upstream to the beginning of the big bend. Dr. Link described these coals in detail in his report (1).

Chapter VI.

CONCLUSIONS AND RECOMMENDATIONS

No structures favorable for drilling were found in this area.

The structural nose in the vicinity of the big bend of Little Bear River is recommended as being worthy of further investigation.

Additional exploration on this nose must be by geophysical methods almost entirely as reconnaissance trips by plane over this area reveal very few outcrops.

Although no reef condition was seen or even suggested in the Devonian beds, the presence of a strong petroleum odor in the upper part of the Ramparts - Beavertail formation suggests that a closed structure in this area would offer an excellent drilling location. Therefore, if the character of the structural nose could be determined to the north, it might be found to develop into an anticline which would offer an excellent drilling site.

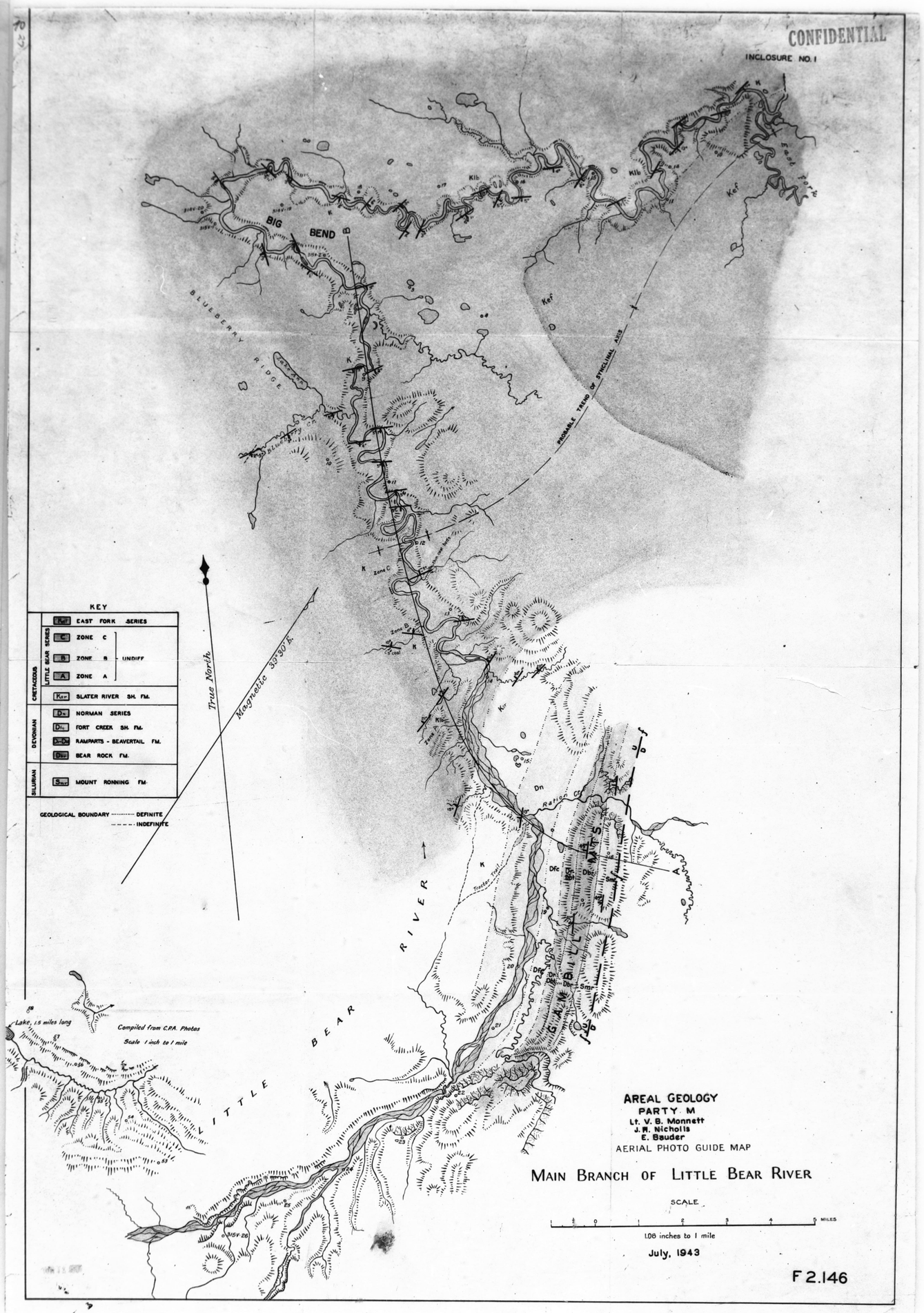
B I B L I O G R A P H Y

1. T. A. Link - Geological Report on Ft. Norman Area, 1921.

2. R. M. Hart - "The Gravel River and East Fork of Little Bear River and Kay Mountains", Assignment Nos. 2-2a, 30 and 37, 1944.

3. C.R. Stelck - "Carcajou River - Little Bear Divide Area", Assignment No. 28, Report No. 34, 1943.

4. C. R. Stelck - Personal Communication.



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INCLOSURE NO. 2

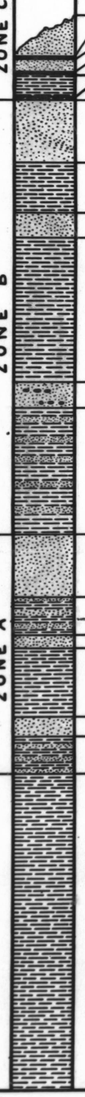
COLUMNAR SECTION
OF CRETACEOUS ROCKS EXPOSED ALONG
LITTLE BEAR RIVER

SCALE: 1"=100 FEET

PARTY M

Lt. V. B. Monnett
John Nichols
Ed Bauder

July, 1943



Age	Fm.		Thickness	Description
CRETACEOUS	LITTLE BEAR SERIES	ZONE C	?	Sandstone.
			2'-3'	Coal
			10'	Sandstone, medium to coarse-grained.
			2'-3'	Coal
			20'	Shale, dark grey, carbonaceous.
			2'-3'	Lignite, first seen.
		ZONE B	50'	Sandstone, medium to coarse grained, cross-bedded, very soft.
			40'	Shale, grey, with brown iron splotches.
			20'	Sandstone, medium to coarse, salt and pepper.
			115'	Shale, medium-grey, but differs from basal grey shale in that it contains numerous brown iron splotches. Also several ironstone beds
			20'	Sandstone, medium to coarse-grained, salt and pepper appearance. Some small conglomerate streaks, cross-bedded, carbonaceous in places.
			110'	Sandstone and shale. Sandstone is medium-grained, with salt and pepper appearance. Some ledges are greenish-gray, but generally tan. Shale is the dark grey shale, mottled brown, and, in places, weathering brown.
		ZONE A	50'	Sandstone, tan, fine to medium-grained. Weathers grayish white. First appearance of "salt and pepper" sandstone at top.
			30'	Sandstone and shale, dark grey to brown.
			10'	Sandstone, fine-grained, light brown, weathers grayish-white to tan.
			50'	Shale, grey, but in many places mottled brown. Weathers brown in many places. This distinguishes this middle shale from lower ones.
			15'	Sandstone, yellowish-tan, very fine-grained. Contains small iron concretions.
			30'	Sandstone and shale, interbedded, grey to tan, medium to fine-grained.
	SLATER RIVER SHALE		250+	Grey, soft shale. Usually forms banks of mud flows and slumps.

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PLATE II

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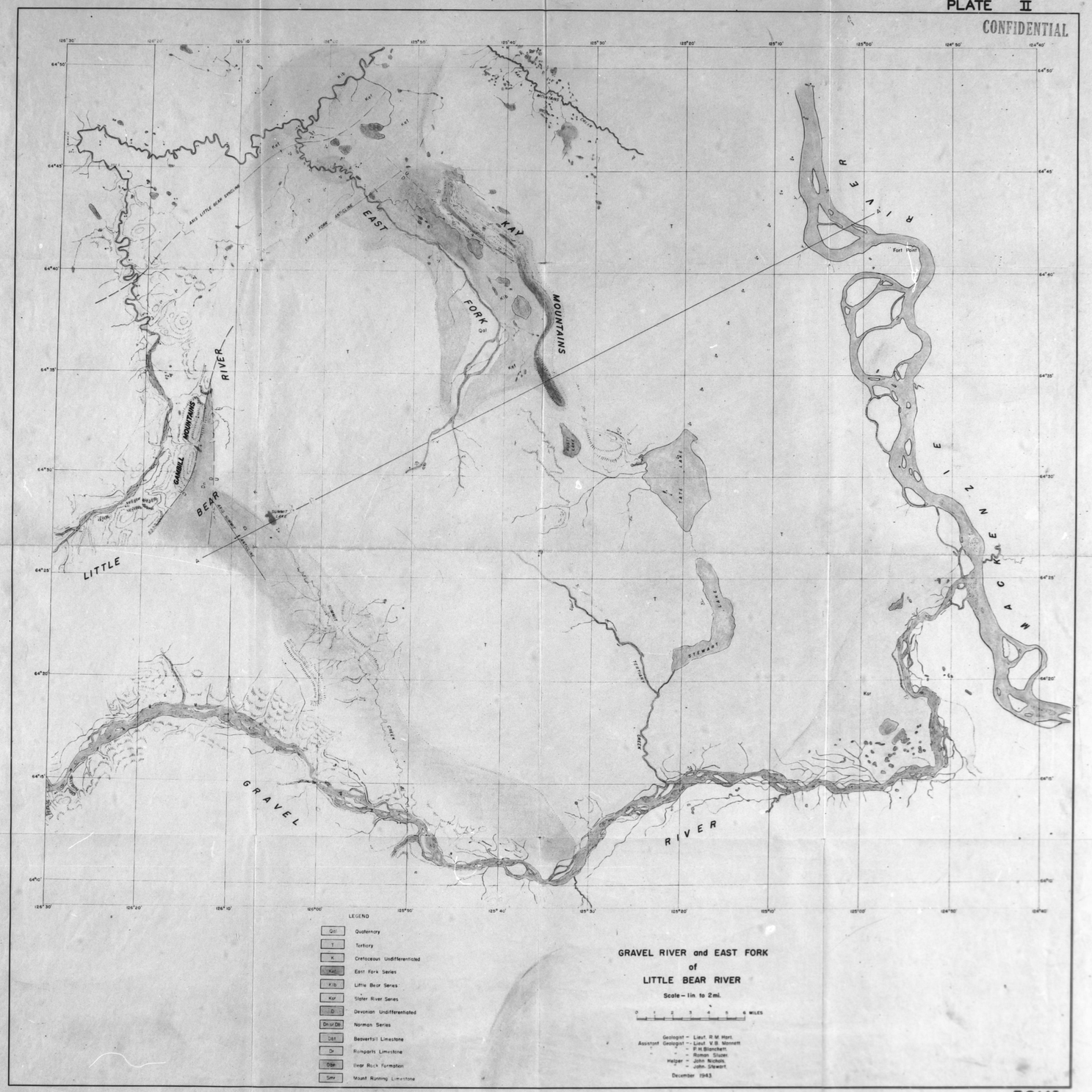

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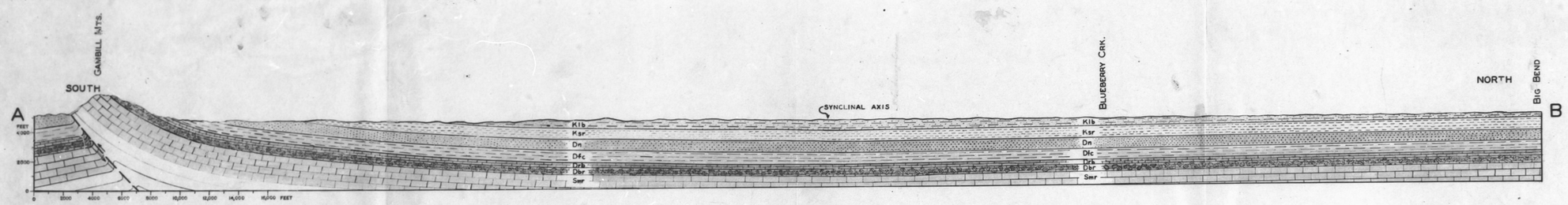
INCLOSURE NO. 3



NORTH-SOUTH CROSS SECTION

UPPER PART OF LITTLE BEAR RIVER

SCALE 2" = 1 MILE (V.&H.)

ASSIGNMENT NO.20

PARTY 'M'

LEGEND

Klb	LITTLE BEAR SERIES
Ksr	SLATER RIVER SHALE
Dn	NORMAN SERIES
Dfc	FT. CREEK SHALE
Drk	RAMPARTS-BEAVERTAIL (UNDIFFERENTIATED)
Dbr	BEAR ROCK FORMATION
Smr	MT. RONNING

F-2.155

30x

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PLATE V

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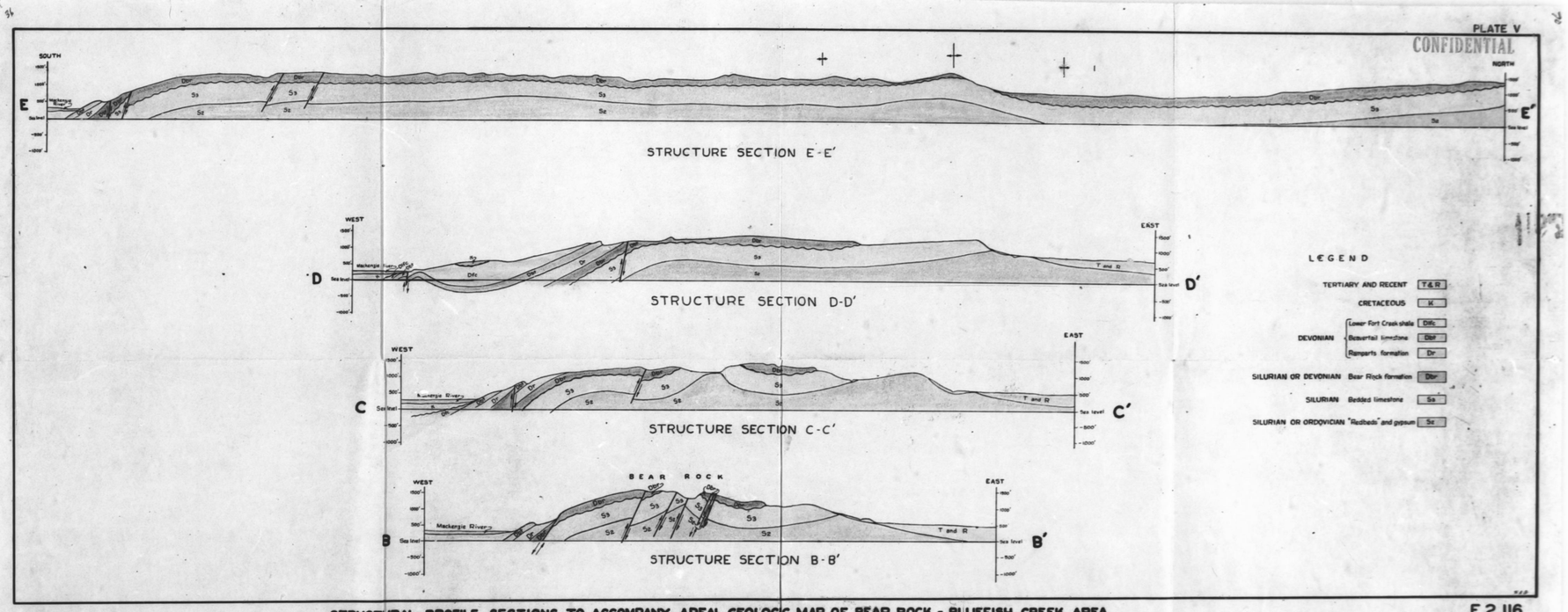

STRUCTURAL PROFILE SECTIONS TO ACCOMPANY AREAL GEOLOGIC MAP OF BEAR ROCK - BLUEFISH CREEK AREA

ASSIGNMENT NO. 1
SCALE (VERTICAL AND HORIZONTAL): 1" = 1 MILE
DATUM LEVEL: MACKENZIE RIVER = 500 FEET
PARTY B: Shrich, Six, and Carr
June, 1953

F 2.116

96-18

30x

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