No 7

By E. J. Fahey

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ABSTRACT

No 7

IMPERIAL OIL LTD., CANOL PROJECT

Assignment No. 26

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Date submitted: January 31, 1944.

Read and accepted by: Hugh R. Link

Date: 2/2/'44.

CONFIDENTIAL

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PHOTOGRAPHS

1. General view of most of Donnelly River basin.

2. Part of Donnelly River.

3. Bear Rock breccia on Gibson Creek.

4. Bear Rock breccia on Gibson Creek. Shows blocks lying at various attitudes.

5. Beavertail limestone at falls west of Mount Dellis.

6. Unconformity between Beavertail limestone and Cretaceous sandstone.

7. Looking southeast along fault scarp of Gibson Range.

8. Contorted Bear Rock formation near top of the Battleaxe fault scarp.

9. Looking northeast along fault scarps of Mount Dellis and the Gibson Range.

10. Mount Dellis from ridge near Bath Mills.

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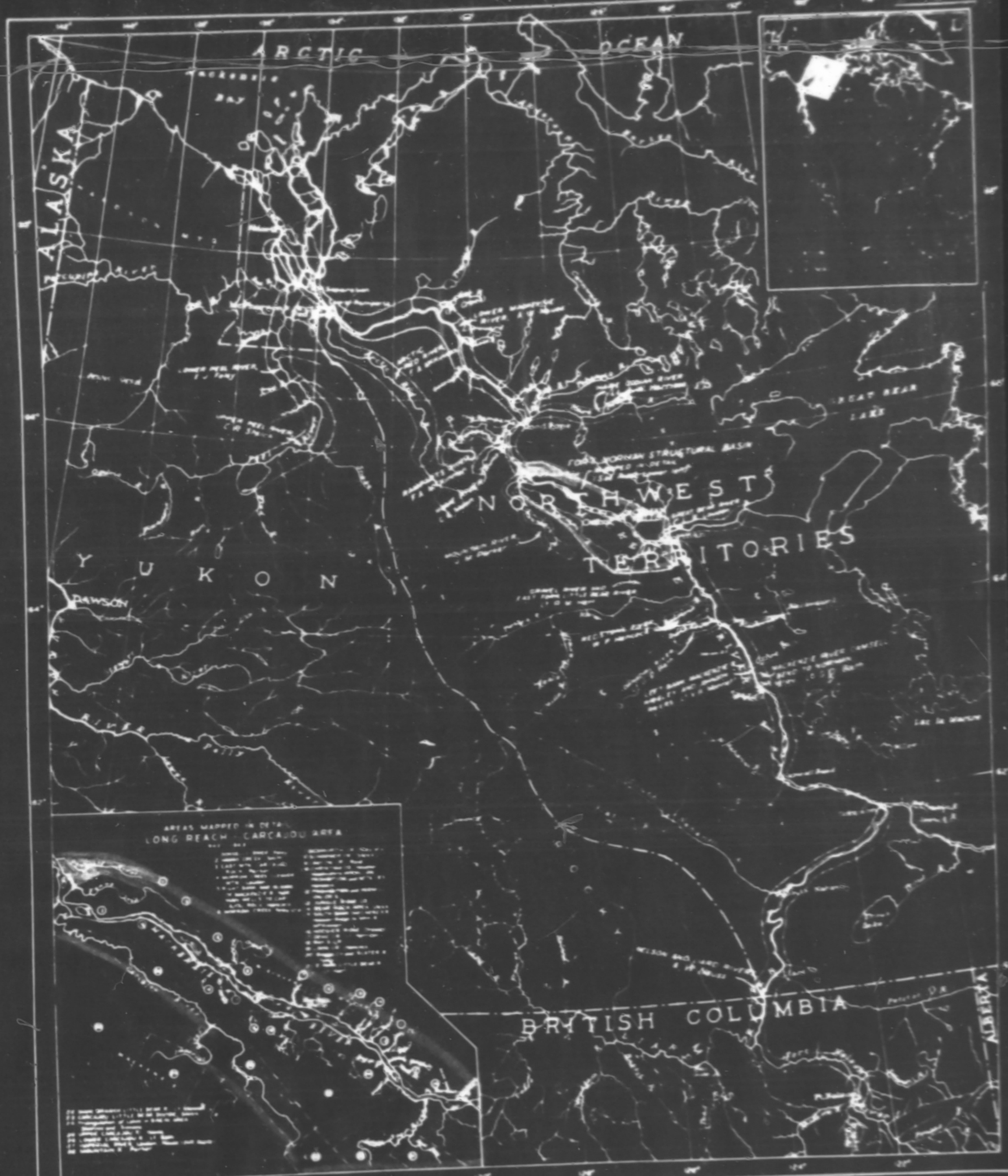
A B S T R A C T

In the Donnelly River area there are strata of Silurian, Devonian and Cretaceous age. The top of the Devonian Beavertail limestone is porous coral reef material, and the overlying basal Cretaceous sandstones are also very porous. The two contain fairly large amounts of asphalt and asphaltite, and would obviously furnish ideal reservoir conditions for oil, if located on a promising structural trap.

The mountains of the area are sharp asymmetric anticlines bounded on one side by high angle reverse faults. These faults are evidently minor accessory faults on a more profound displacement that affected all of this general region. No structures worthy of drilling for oil were found.

It is suggested that, because of the particularly excellent reservoir conditions offered here, geophysical investigations in nearby areas might be the means of discovering a good structural prospect.



INDEX MAP OF
NORTH WESTERN CANADA SHOWING
DONNELLY RIVER AREA

Chapter I.

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

The Donnelly River flows into the Mackenzie River between the Sans Sault Rapids and Beavertail Point and the area in general lies between 65° 45' and 66° 57' north Latitude and between 128° 00' and 128° 55' west Longitude. The river is named after C.B.C. Donnelly of the Dominion and Manitoba Land Surveys. The geological mapping of this area was done by Party 'F', consisting of Mr. Ross B. Pringle and the writer. Mr. Pringle's knowledge of this type of life and travel, and his general "all round" ability were a very great aid to the writer. The party was landed at Chick Lake by airplane on June 30th, 1943, and made its way by canoe to the Mackenzie where work was completed on August 1st.

Before going into the field, a rather thorough aerial reconnaissance was made. Dr. L. R. Laudon took a number of oblique aerial photographs during this flight, and these were of great service in working areas that were not covered by vertical photographs. In general, the vertical photographs were used in mapping and the 1 inch to 1 mile map prepared by Mr. Alex Frame was used as a base. Mr. Frame also rectified the above mentioned obliques to fill in the previously unphotographed portions of the area. In the field areas without good control were sketched in roughly, and these areas include Mt. [illegible], Mt. Crumble, Battleaxe, the [illegible] Virginia Hills, and Beavertail Mountain. The disconnected strips of verticals were connected by means of about 12 miles of plane table surveying along the Donnelly River. Surveys to check the [illegible] were made in the areas covered by [illegible] Photos [illegible] and [illegible]. [illegible] photographs of the area were

received after the work had been completed, but areas of questionable geological interpretation were found to be covered only by oblique photographs.

On two photographs, CPA 278 and 284, are shown the locations of flags which were set by the J. Gordon Turnbull and Sverdrup and Parcel Company. Their survey began at the astronomic pier at Fort Good Hope and ran through the Chick Lake area.

In 1919, Dr. T. A. Link of the Imperial Oil Ltd. (11) mapped that part of the area which lies along the Mackenzie River. Canadian Government geologists (1, 7, 9, 15) have also covered that same portion of the area. Mr. John M. Parker (18, 19) and Dr. H.T.U. Smith (20) have mapped areas adjacent to the Donnelly River and their results have been most helpful to the writer. However, in addition, the writer has had many profitable discussions with every geologist on the present project. Mr. C. R. Stelck, assisted by Mr. Keith Huff, made the final fossil determinations. The drawings presented herewith were done by Mr. H. A. Gibson.

These drawings are listed under "List of Plates" at the beginning of this Report. A preliminary report on this assignment No. 26, has already been submitted.

Chapter II.

T O P O G R A P H Y

The Mackenzie River flows along the west edge of the Donnelly River area, and large steamboats travel it between Fort Smith and the Arctic Ocean. There are many lakes that airplanes can land upon. The Donnelly River itself can be travelled only by canoe, and in its upper reaches, where the gradient is 16.8 feet per mile, there are many riffles that the canoe has to be dragged over. There is only one portage, at the waterfall near the west end of Mt. Dellis. In the middle and lower portions of the river the water is slow and deep, but as the Mackenzie is approached the gradient again increases and there are many shallows. Most of the rapids are due to the presence of large glacial boulders, and the one waterfall is at a place where the river cuts through the Beavertail limestone.

The nearest settlements are Norman Wells, 80 miles to the south east, and Fort Good Hope, 40 miles to the north east, measured along the Mackenzie from the mouth of the Donnelly.

Climate, flora and fauna need not be discussed here, as they are the same for all this section of the Mackenzie Basin.

There are two main mountain ranges, the Mount Effie-Battleaxe-West Virginia Hills - Beavertail Mountain range, and the Gibson's Peak-Mount Dellis Range. Mount Effie is the highest in the area, and its top is approximately 3000 feet above the Mackenzie River. Gibson's Peak is about 2200 feet higher than the Mackenzie, and has about 1500 feet of relief above the lowland. It continues eastward to Brokenoff Mountain in the Hanna River Area. Mount Dellis has about 1200 feet

relief and Battleaxe nearly 1000 feet. Photo coverage is insufficient to determine these heights by means of difference in parallax. There are two separate smaller mountains, Mount Grumble and the Bath Hills, the latter rising to about 750 feet above the Mackenzie. The locations of Mount Effie, Battleaxe, the West Virginia Hills and Mount Grumble have only been outlined on the map by rough sketching.

There are two important topographical and structural basins in the area, the Chick Lake basin, and the lower Donnelly River basin. The two are separated by Mount Grumble. These lowlands contain many lakes and swamps with thick brush.

Lying in front of Battleaxe is a low ridge that probably owes its origin to material deposited by the glacier as a local moraine. Glacial grooving on a large scale is common on most of the mountains. On the ridge north of Lily Lake there are many curiously curved grooves, which probably have a glacial origin.

At the base of the cliff of Gibson's Peak there are great waves of talus and slumped rock that extend far out into the muskeg flat. Along the Donnelly River there are many large landslides and mud flows in the area of soft Cretaceous shales. Recent uplift has caused the river to be quite deeply entrenched in places.

The topographic features owe their form almost entirely to the geologic structure of the resistant limestones, and the topography has been modified only slightly by subsequent erosion effected by ice and water.

Chapter III.

S T R A T I G R A P H Y

Formations exposed in the Donnelly River area are as follows:

Pleistocene & Recent	Clays, silts, sands and gravels.	
Cretaceous (K)	Clay shales with bentonite; sandstone and conglomerate at the base	370' +/-
Devonian		
Fort Creek (Dfc)	Black shales; limestones at base.	51' +/-
Beavertail (Dbt)	Limestones and reef limestones.	172-220' +/-
Ramparts (Dr)	Limestones and shales	1171'
Bear Rock (Dbr)	Limestones, dolomitic limestones, and limestone breccias	720'
Silurian		
Mount Ronning (Smr)	Limestone, some beds of novaculite.	1000' +/-

The columnar section for Gibson's Creek was measured with the plane table. In that section there are wide areas with no outcrops and some of the thicknesses for those intervals may be in error, although most of them agree fairly well with neighboring map areas (see Plate 7). It should be kept in mind that the present stratigraphic grouping and nomenclature is subject to change in later regional interpretation. Many shale samples were taken throughout the area, but have not yet been examined for microfauna. A complete list of all specimens is attached hereto.

SILURIAN

Mount Ronning Formation (Smr)

The base of the Mount Ronning formation was not seen, and the exposed thickness was not measured, since it is found only on nearly vertical cliffs about 1000 feet high. The contact with the overlying Bear Rock formation was not seen in this area, but in other areas the contact is unconformable. It crops out in the Gibson Peak-Mount Dellis range, and also on Mount Effie, but the latter mountain was not visited. Only the upper few hundred feet of Mount Ronning was studied, and it was observed to be a light grey hard limestone that weathers light grey. The bedding planes are two to three feet apart. Numerous beds of white novaculite varying from three inches to two feet in thickness are scattered through the upper part of the formation. The total thickness of the formation was not measured, but it exceeds 1000 feet.

Fossils were found only within 20 feet of the top and included:

Halysites	Heliophyllum
Syringopora	Stromatoporoids
Favosites	Zaphrentis
Orthoceras	

The Mount Ronning forms the great scarps of the highest mountains.

This formation has no bearing on oil possibilities for this particular area.

DEVONIAN

Bear Rock Formation (Dbr)

This formation probably overlies the Silurian unconformably though the contact was not seen in this area. The upper contact was

not seen, but in most localities the Vamparts lies conformably on the Bear Rock. In the Donnelly River area the Bear Rock occurs in the Gibson Peak-Mount Dellis range, in the Bath Hills, in the West Virginia Hills, and in Battleaxe and on up to Mount Effie.

The lowest 585 feet of the Bear Rock is poorly exposed in the vicinity of Gibson Creek. There are only a very few outcrops of light grey limestone that weathers light grey. No evaporites were seen, but in the Hanna River (20), Morrow Creek (10), and Hare Indian River (4) areas evaporites are present, and it is suspected that soft, non-resistant anhydrite may be present on Gibson Creek. In the Hanna River area the gypsum is 500 to 800 feet thick.

Above the poorly exposed interval is 15 feet of hard grey limestone that weathers grey. It has 4-inch to 6-inch bedding. Overlying this is 100 feet of dark grey, hard, slightly dolomitic limestone that weathers grey. It has thinly spaced black laminae and sometimes has a sugary texture. These limestones grade laterally into brecciated zones. The breccia is composed of angular masses of the same limestone lying at haphazard attitudes and cemented by a matrix of light brown limestone that weathers yellow. (See Photos 3 & 4). When these haphazard dips are encountered in coring on a well, it must be remembered that they have no relation whatsoever to the true dip of the formation.

It is obvious that the bedded limestones grade laterally into the brecciated zones, and it is obvious that the angular limestone masses have not been transported. The cementing matrix is sometimes banded and has the appearance of travertine. It is believed that the limestones are of chemical origin and that practically all of the Bear Rock anhydrite and limestone was deposited from super-

saturated solutions. Dr. Link (13) has reported salt springs in the Bear Rock. The breccia probably originated in place as the result of stresses set up by volume changes due to solution. This alteration may have been initiated, or at least localized, in zones of structural deformation, or it is even possible that the deformation may be the more important of the two processes.

The upper 20 feet of the Bear Rock is a hard grey limestone that weathers grey and reddish brown. It has 2-inch to 6-inch bedding. This upper limestone very often has a petroliferous odor when freshly broken.

On Gibson Creek the Bear Rock formation is 720 feet thick. Dr. Smith (20) reports that on Paige Mountain, in the Hanna River area, there is no Bear Rock, or that it is very thin. However, it is not impossible that it was faulted out in that locality. Or possibly the varying thicknesses of the Bear Rock may have been deposited in partly separated basins or lagoons of different depth which owe their origin to structural relief or to major irregularities on the pre-Bear Rock erosion surface.

No fossils were found in the Bear Rock formation. In the Hanna River area, Dr. Smith (20) considers the evaporites to be Silurian in age, but general usage places it in the Devonian. What he considers to be upper Bear Rock is actually the lower part of the Ramparts, and his evaporite section has been re-interpreted and placed below the breccias, without any pronounced unconformity (See Plate 7). The Bear Rock breccias weather to characteristic hoodoo forms. Caves and sink holes are common. The upper twenty feet often has a petroliferous odor, though it is probably not porous enough to make a

productive oil reservoir. The cavities in the breccia zones might serve as oil reservoirs.

Ramparts Formation (Dr)

The Ramparts formation rests conformably upon the Bear Rock. It is overlain conformably by the Beavertail Limestone. The upper contact is placed at a wavy shale parting in the limestones which could conceivably represent a disconformity. The contact was placed at this horizon to conform with that of Mr. Parker in the Carcajou Rock area (18), since he was the only previous recent worker in this general area.

The Ramparts formation crops out on the downdip side of all of the fault mountains in the area, and is also found in the Bath Hills.

The lower portion of the Ramparts was never seen in the field. There are no exposures and it is assumed to be shale. On Gibson Creek this covered interval is 360 feet thick, and on Mt. Dellis it is only about 40 feet thick, but this latter may be due to squeezing in the tight fold.

Above this is 40 feet of hard, grey limestone. The lowest 10 feet is rubbly, with 3-inch bedding. The middle portion is massive, and the upper 10 feet has 6-inch bedding. In some localities it is quite fossiliferous, containing:

Odontocephalus	Favosites
Atrypa reticularis	Stromatoporoids
Atrypa spinosa	Cladopora
Heliophyllum	Pleurotomaria
Acervularia	

Overlying the limestone on Gibson Creek is another zone of no exposures, measuring 720 feet in thickness. It is also presumed to

be shale or very shaley limestone. This interval was seen, in part only, in the Bath Hills and on the hill northeast of there. It was a dark brown and grey platey hard limestone that weathers yellow. It had 2-inch bedding and there was some interbedded brown shale.

Above this interval are 40 feet of dark grey hard limestones in 2-inch to 1-foot beds, with interbedded brownish grey soft shale. This limestone contains many fossils:

Terebratula
Atrypa spinosa
Atrypa reticularis
Spirifer
Productella
Stringocephalus burtini
Newberria
Paracyclas
Pleurotomaria
Cystiphyllum
Prismatophyllum
Favosites
Cyathophyllum
Acervularia
Stromatoporoid
Cladopora
Odontocephalus
Crinoids

The top of the Ramparts formation is an 11-foot layer of grey hard limestone with 3-foot bedding. Possibly it would be as well to include this in the Beavertail, putting the contact at the top of the underlying interbedded thin limestones and shales. This 11-foot layer is quite fossiliferous and contains:

Cladopora
Stromatoporoids
Cystiphyllum
Cyathophyllum
Martinia
Paracyclas
Atrypa spinosa

The total thickness of the Ramparts formation on Gibson Creek is 111 feet, and in the Bighorn River area the same beds total

about 1063 feet, but they have all been called Bear Rock by Dr. Smith (20). The equivalent of the beds called Ramparts on Gibson Creek measures about 880 feet on the north side of East Mountain, according to Mr. Parker (18). (See Plate 7). He states that its total thickness on the Mountain River is 1245 feet.

Most of the Ramparts formation is soft and non-resistant. The lower limestone forms a separate scarp, and the upper limestone forms the foot of the Beavertail scarp.

The Ramparts shales might act as source beds. A small amount of asphalt was found in the thin bedded limestones near the top of the Ramparts (Specimen 20089).

Beavertail Limestone (Dbt)

This formation takes its name from the outcrop at Beavertail Point, though the limestone there is the lensing reef on top and is not in any way typical of the true Beavertail Limestone.

The Beavertail overlies the Ramparts limestone conformably although there may be a slight possibility of a disconformity. The contact with the overlying Fort Creek shale showed no discordance, but in other areas it is unconformable. In most of the Donnelly River Area, however, the Beavertail is overlain by the Cretaceous, with a great unconformity between. The Beavertail crops out in the same localities as does the Ramparts formation. The base of the Beavertail was taken to be the ½-inch wavy bed of black clay shale, that lies 11 feet above the topmost interbedded limestone and shale of the Ramparts. Over the wavy shale stringer was 8 feet of hard, rubbly, grey and light brown limestone. It weathers yellow. Fossils found were:

Cladopora

Cystiphyllum

Atrypa spinosa

One single specimen of Stringocephalus burtini was found in this horizon.

Overlying is 16 feet of hard light grey limestone that weathers yellow. The beds are 6 inches to 3 feet thick. It contains:

Atrypa	Stromatoporoids
Cystiphyllum	Crinoids
Cyathophyllum	

Above this limestone there is usually a thick development of reef limestone. There are only two localities; on Gibson Creek and at a point about 3 miles north of Lily Lake, where the reef is not present. However, the reef is present quite close by in both localities. The reef is a light grey hard limestone, that is often made up almost entirely of Stromatoporoids and Cladopora, the latter sometimes giving what has been called a "rice pudding" appearance. The top of it is often fractured in 1 to 6-inch pieces. It usually has a typical massive appearance, though in the vicinity of the Bath Hills, where it is thicker than usual, it is very well bedded. This top reef limestone varies in thickness from nothing to nearly 200 feet. At Beavertail Point there is about 50 feet of this reef limestone exposed, and at that particular locality it is a hard, dark brown to black limestone that weathers light grey. It has 2-inch to 3-foot bedding and contains a great many Stromatoporoids and Cladopora, with typical "rice pudding" appearance. The limestone here is very often stained black by asphalt. This reef material is

shown in Specimen No. 20095.

The Beavertail Limestone as a whole, varies in thickness from about 14 feet where no reef is present, to 220 feet in the Bath Hills and nearby. In the Hanna River Area (20) the thickness is 220 feet, though a few feet of the uppermost Ramparts is included. At the Ramparts of the Mackenzie River the Beavertail is 195 feet thick (19)(See Plate 7).

The coral reefs at the top of the Beavertail in this area are similar, lithologically to the reefs at Norman Wells, but they might be at a lower stratigraphic horizon. In the Hanna River (20) area and Morrow Creek area (10) it appears to the writer, from the data presented, that the reef is continuous with the Beavertail limestone and that there is no higher separate reef (Kee Scarp) in the Fort Creek Shales. The reef lies on the Beavertail in the northeast part of Carcajou Ridge, though farther west on the ridge there is shale between the Beavertail and the reef (18). In the entire region around Norman Wells, it seems to the writer that there may be several separate reefs of similar character, ranging in position from the top of the Beavertail to the base of the Bosworth, but not all of them of exactly the same stratigraphic horizon. However, because of the unconformity at the base of the Fort Creek, it is also possible that there may be but the one reef with varying amounts of shale, or no shale at all, between it and the true Beavertail limestone. The Beavertail limestones usually crop out as scarps, sometimes about 200 feet high.

The top part of the Beavertail reef limestone sometimes has a petroliferous odor when freshly broken. More often than not, the fractures and coral interstices contain films and blebs of asphalt

and asphaltite. It should prove an excellent reservoir for oil if found under the proper structural conditions to form a trap.

Many sulphur springs are found in areas where the Beavertail limestone crops out, or where it is not far beneath the ground surface.

Fort Creek Formation (Dfc)

In the Donnelly River area the Fort Creek formation is found only at a locality three miles north of Lily Lake. It appears to overlie the Beavertail conformably and there is no Beavertail reef at this locality. To the north of Good Hope, however, Dr. Nauss (17) reports that the Fort Creek rests unconformably on the Ramparts (Hare Indian) shales. The Fort Creek north of Lily Lake is probably overlain unconformably by Cretaceous, although the contact was not seen. The section is given below:

Top

3 feet +-	Shale, black, weathers light grey.	Tentaculites	20070
		Discina	
40 feet	Limestone, light grey, weathers light grey, soft, with interbedded shale, brown, weathers brown, soft.	Lingula	20073
			20072
		Cyrtina	
		Martinia	
8 feet	Limestone, light grey weathers light grey, hard, rubbly. Weathers to "hoodoos".	Hypothyridina	20071
		Atrypa	
		Stromatoporoids	

Bottom - Beavertail Limestone

In the Hanna River area (20) the basal Fort Creek is calcareous, and in the Morrow Creek area (10) it is a "marly" zone with a Lower Fort Creek fauna. Though these have been reported as above the "Kee Scarp" limestone, it is more reasonable that their Kee Scarp is

actually Beavertail limestone or reef limestone.

In other areas, where it is well exposed, the Fort Creek appears to be a particularly good source bed. It would also make good cover rock over the Beavertail reef reservoir.

CRETACEOUS (K)

The great unconformity between the Beavertail and Cretaceous has been seen in a number of places. (See Photo no.6). There is never any angular discordance in dip, but the eroded irregularities in the top of the Beavertail sometimes have a relief of 8 feet in one exposure. In one locality Cretaceous sandstones were seen in open joints 20 feet below the top of the Beavertail. As previously stated, the Fort Creek was seen in only one locality. The Haswerth was not seen anywhere in the area. North of Good Hope the Cretaceous lies unconformably on the Hamparts (Shre Indian) shales.

Cretaceous beds were seen on Gibson Creek, all along the Donnelly River and just north of the Bath Hills, and their presence north of Beavertail Point is indicated by float.

The basal Cretaceous beds of this area are shown in detail on the accompanying sections (See Plate 6). There is a basal medium grained sandstone that sometimes has a conglomeratic phase. In one locality there was a small lens of black carbonaceous shale and sandy shale immediately overlying the Beavertail limestone. Above the basal sandstones are sandy shales and shaley sandstones. The entire basal section varies considerably from place to place. It is overlain by at least 300 feet of dark grey shale with some bentonite and many concretions. The shale specimens have not yet been studied microscopically.

The lower sands carry petrified wood and worm-like fucoids

In the upper thick shales are a few similar fucoids and also ammonites, including Hoplites and Beudanticeras. The Cretaceous occurs only in the lowland and its beds are so soft that they have no influence on the topography. The basal sandstones and conglomerates very often contain asphalt and asphaltite and are ideal as reservoir beds. The thick shale above would act as impermeable cover.

PLEISTOCENE AND RECENT

In the Donnelly River there are many huge glacial boulders of limestone and igneous material, some of them 8 feet in diameter. In the lower Donnelly area there are a few exposures of soft river clay, which might be fluvio-glacial material. Overlying this is 20 fee. of sand.

There are the usual stream deposits in the Donnelly valley, and on the banks of the Mackenzie are thick deposits of silt and sand.

Chapter IV.

S T R U C T U R A L G E O L O G Y

General Structure

Though other unconformities are undoubtedly present, the only one that is actually exposed in this area is that between the Devonian Beavertail limestone and the Cretaceous sandstones and conglomerates. There is no angular discordance.

The Chick Lake basin is synclinal. The lower Donnelly River basin, southwest of Battleaxe, is a structural low bounded on the north by a large fault.

There are three main uplifts in the Donnelly River area, Mount Effie, the Battleaxe-West Virginia Hills-Beavertail Mountain range and the Gibson Peak-Mount Dellis range. These are asymmetric anticlines which are cut off on the steeper side by high angle reverse faults. Mount Grumble and the Bath Hills are smaller features. There are only a few normal faults in the entire area. There are a few tear faults. Most of the large faults die out en echelon, that is, pass into separate faults of smaller displacement. This type of structure has also been noticed from the air on the east end of the Imperial Range.

Although they may have a displacement of more than 2000 feet, the large reverse faults are rather small when compared to the large thrusts in the Rocky Mountains. These small faults are considered to be only accessory faults to a far greater movement deep in the crust. The Donnelly River Area is situated within a huge lobe that appears to have been pushed out in front of the main Mackenzie Mountain mass. The main movement took place deep in the earth's crust, and this main move-

west may have been expressed as a deep almost flat lying fault zone, or as a deep sheet-like zone of flowage. However, much of the movement was taken up in folds and on relatively minor high angle reverse faults. These dip either toward or away from the direction of the major movement, and may strike either parallel to the edges of the lobe, or at a large angle to its edge, that is, the latter can be considered as tear faults. Sometimes, instead of cutting across, these tears curve into the parallel trends. The two main trends are northwest-southeast, and east-west, and are of relatively the same age.

Local Structure

The Gibson Peak range (See Photo no. 7) has fairly steep dips on the north side and a sheer fault scarp on the south. The fault is of the high angle reverse type with over 2000 feet of displacement. Minor overturning can be observed in the rocks of the cliff near the top. The base of this cliff was not examined, but the rocks there are probably Cretaceous.

On the north side of the mountain there is some small faulting in the top of the Bear Rock formation, in fact it almost seems that wherever the upper Bear Rock is exposed there is minor faulting. This may be due to the yielding character of the underlying breccia. On the west end of the range the Silurian rocks lose elevation and come down almost to the level of the lowland. The displacement of the main fault decreases rapidly, but before the fault dies out completely the movement is taken up by another fault which has its displacement increasing to the west.

The small slices of successive formations that are shown

between these en echelon faults in various parts of the map were seen in some cases, though not in all cases.

Four Thirty Creek, at the east end of Chick Lake, was traversed because of a slight topographic swell in that locality, but no outcrops were found.

The Chick Lake syncline is bounded on the west by Victory Ridge and Mount Grumble. Victory Ridge is a curiously situated anticlinal nose between separate portions of the Gibson Peak-Mount Dellis range. It plunges northwestward and dies out under the Donnelly River. The uplift begins again beyond the river, but here it is expressed as the Mount Grumble fault.

The area northwest of Mount Grumble was not covered by aerial photographs, nor by a base map. The geology is complex and may possibly not be correctly interpreted because the correct space relationships were not available. However, the Mt. Grumble fault is believed to extend northwestward, acting as a tear fault between the north dipping Battleaxe fault block and the south dipping Mount Effie fault block. Victory Ridge then, is also believed to be an incipient tear between the two fault blocks concerned, that is, between different sections of the Gibson Peak-Mount Dellis range.

The western end of the Mount Effie ridge was traversed in the overturned zone which passes eastward into the fault, but Mount Effie itself was not traversed and the topography and geology were estimated from afar. The Battleaxe fault has a displacement of about 1000 feet. High on its scarp the Bear Rock formation shows complex contorting, overturning and minor faulting (Photo No.8). There are no outcrops at the foot of the scarp.

North of Mount Dellis, the Donnelly River passes through a fault gap in the Beavertail scarp. This dip fault is but a small one, causing a horizontal separation of about 40 feet.

Mount Dellis, (Photos 9 and 10) on the west end, is a very tight almost isoclinal fold, but as one goes eastward the south limb passes into a fault. This fault also is of the high angle reverse type. The displacement is over 1500 feet. The material at the base of the cliff is assumed to be Cretaceous, though that is not definitely known. The tear fault at the west end of Mount Dellis is poorly exposed.

The Bath Hills are formed by two anticlines, modified by three small normal faults, each with a displacement of about 50 feet. The northernmost anticline is the more important of the two and is almost isoclinal. There might be some faulting associated with the almost vertical dips in the Bear Rock formation. There are few outcrops northeast of the Bath Hills and the mapped interpretation of the structure is based on but very little evidence. Northwest of the Bath Hills, the Beavertail limestone undulates gently and then dips beneath the Cretaceous.

Beavertail Mountain is a gently rounded anticlinal nose that plunges westward. On its south side is a steep flexure which passes eastward into a fault. This fault continues northeastwardly, dying out and appearing again, en echelon, until it reaches the Mount Grumble tear fault, beyond Battleaxe.

The main portion of the West Virginia Hills was not visited and the topography and geology is only sketched in. No structural petroleum prospects were found.

Chapter V.

H I S T O R I C A L G E O L O G Y

The geologic history of the Donnelly River area does not differ appreciably from that of the general vicinity, and need not be discussed separately here.

Chapter VI.

OIL AND GAS MANIFESTATIONS AND MINERAL DEPOSITS

Asphalt and asphaltite were found in nearly every exposure of the unconformity between the porous Beavertail coral reef limestone and the porous basal sands of the Cretaceous. These can be seen in Specimens 20057, 20060, 20061, 20075, 20076, 20077, 20077A, and 20095. Their exact locations are given in the attached list. This situation is ideal from the standpoint of reservoir rocks, in that there is a really good porous section just above, and also just below the unconformity.

One very slight oil film was seen on a pool of water in the lower part of the Beavertail limestone outcrop at the waterfalls west of Mount Dellis. The rocks from the top of the Beavertail sometimes give a petroliferous odor when freshly broken, and the limestones at the top of the Bear Rock do the same. A small amount of asphalt was found in the limestone near the top of the Ramparts formation in the Bath Hills. (Specimen 20095).

Near the east end of Black Lake, bubbles can be seen coming to the water surface. These could be natural gas, or might be swamp gas. In a small [illegible] see [illegible]

bubbles very likely were not natural gas. They may have been from air that was trapped in mud cracks by rising water due to the heavy rains at that time.

There are many sulphur springs in the area, and practically all of them can be seen to issue from the Beavertail limestone. Others occur in the basal Cretaceous, obviously near the Beavertail limestone. It is suspected that most of the sulphur springs in the Fort Creek Shale of nearby areas are really emanating from the Beavertail limestone. At the sulphur spring on the Donnelly River, two and a half miles southwest of the end of Victory Ridge, a few bubbles of gas can be seen coming to the surface of the river. They may be composed of hydrogen sulphide.

The best source beds in the area are the Fort Creek shales, but these were seen at only one locality. However, they might be present in the structural lows beneath the Cretaceous. The Ramparts shales should also serve as good source beds.

The Bear Rock breccia might make a good reservoir rock. But the basal Cretaceous sands offer a practically perfect reservoir rock, and they usually overlie the porous coral reef limestones at the top of the Beavertail. As previously stated they often contain asphalt and asphaltite which has probably migrated along the unconformity from buried Fort Creek shales. The overlying Cretaceous shales would make good impermeable cover rocks.

No structures were found that are worthy of drilling for oil.

Chapter VII.

CONCLUSIONS AND RECOMMENDATIONS

Ideal reservoir rocks with positive evidence of oil were found in the Donnelly River area. However, there are no suitable structural conditions and drilling cannot be recommended anywhere in this area.

The Chick Lake Cretaceous basin is only about three to five miles wide, and the lower Donnelly River Cretaceous basin is only four to six miles wide, so perhaps it would not be wise to make a search for structures therein with geophysical equipment. However, the size of these basins may not be detrimental.

Because of the excellent reservoir conditions available, it might prove profitable to do geophysical work west of the Mackenzie River in this general area, and also north of the Beavertail Mountain-Battleaxe Range. There might be closures on the western extension of that trend.

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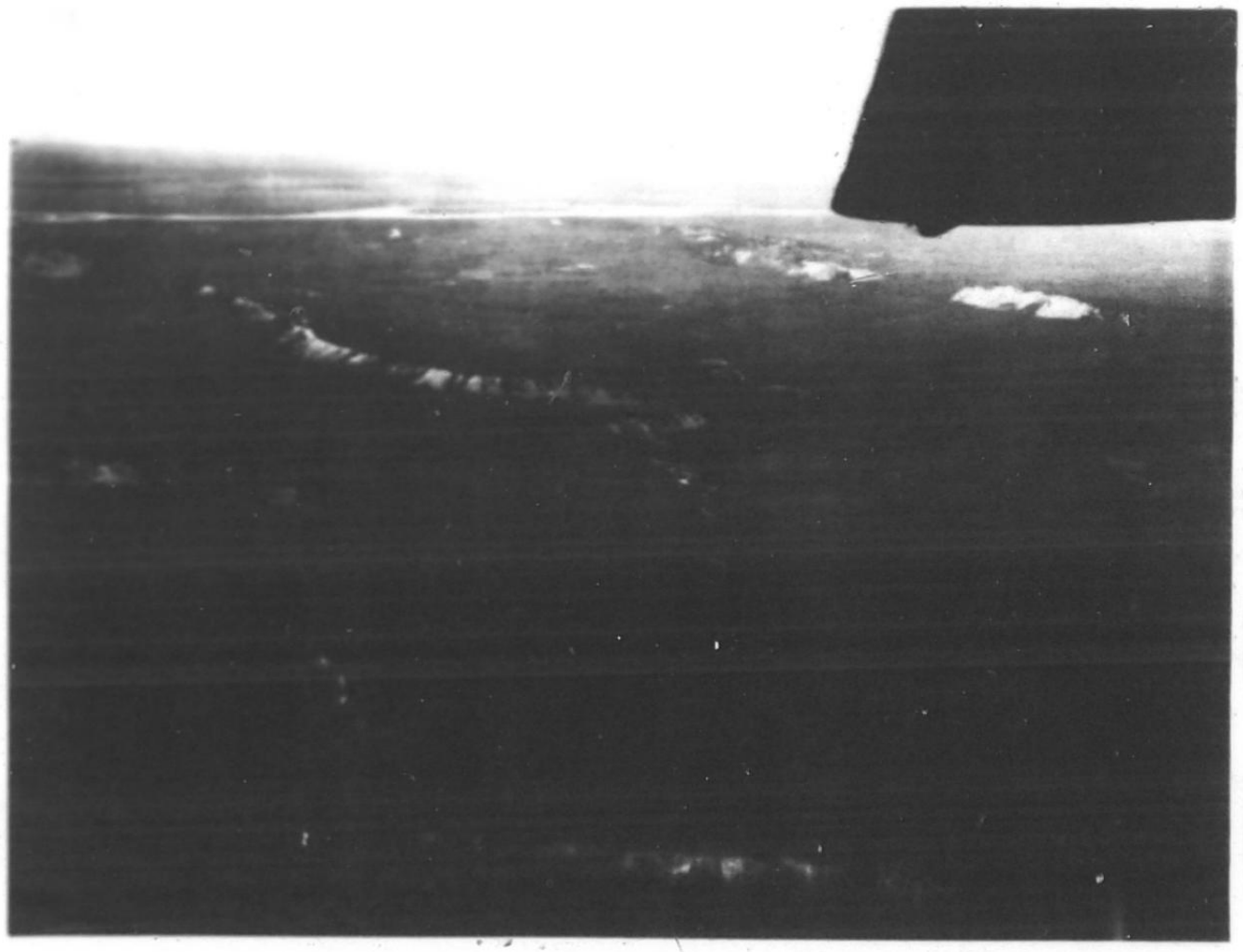

PHOTO I

General view of most of Donnelly River basin. Part of Chick Lake in lower right corner. Victory Ridge in center. Battleaxe, West Virginia Hills and Beavertail Mountain on right.

PHOTO II

Part of Donnelly River, Battleaxe
in background.

PHOTO III

Bear Rock breccia on Gibson Creek. Chick Lake and Mount Effie in background.

PHOTO IV

Bear Rock breccia in Gibson Creek. Shows blocks lying at various attitudes.

PHOTO V

Beavertail limestone at
falls west of Mount Dellis.
Mount Dellis in background.

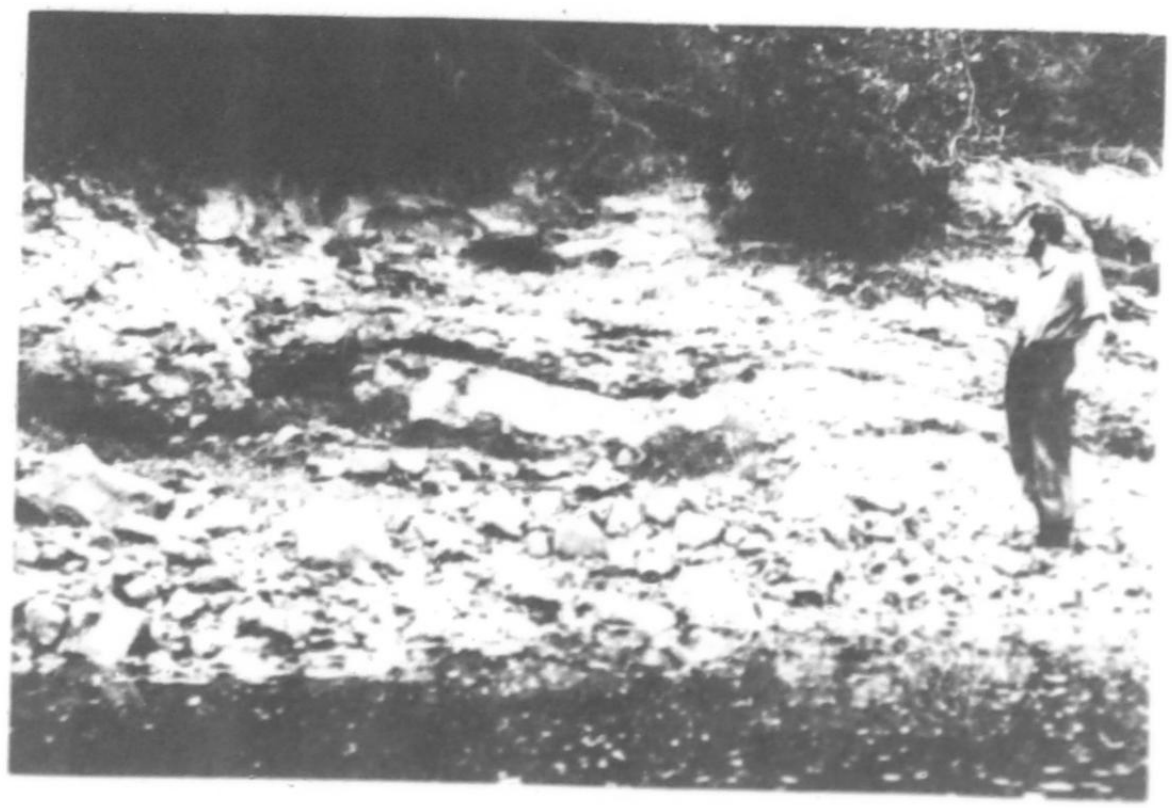

PHOTO VI

Unconformity between Beavertail
limestone and Cretaceous sandstone,
at rapids north of Mount Dellis.

PHOTO VII

Looking southeast along
fault scarp of Gibson Range.

PHOTO VIII

Contorted bedrock formation
near top of the Battlemore
fault scarp.

PHOTO IX

Looking northeast along fault scarps of Mount Dellis and the Gibson Range.

PHOTO X

Mount Dellis from ridge near Bath Hills. Gibson Range in background.

APPENDIX

January 14,1944

MEMORANDUM

TO: Dr. T. A. Link.

RE: Fossil Identification

Attached is a tentative identification of fossils collected by Mr. E. J. Foley on Assignment No. 26 - - Donnelly River and adjoining Areas.

C.R.Stelck.

Kh/cm

FOSSIL IDENTIFICATION - DONNELLY RIVER & ADJOINING AREAS -- E. J. Foley.

Suite No.	Location	Fossil	Accession No.	Age
20034-37	---------	---------	------	--------
(none)				
20038	F115 Gibson Creek	Shale sample	-------	Cretaceous
20038a	Gibson Creek section	Small Cladopora	42346	Beavertail
"	"	Stromatoporoids	42347	"
20039	Gibson Creek section	Atrypa	42348	Beavertail
"	"	Stromatoporoids	42349	"
20040	Gibson Creek section	Paracyclas	42350	Beavertail ?
"	"	Stringocephalus burtini (rare)	42351	"
"	"	Atrypa spinosa	42352	"
"	"	Small Cladopora	42353	"
"	"	Cystiphyllum	42354	"
20041	Gibson Creek section	Cystiphyllum	42355	Ramparts
"	"	Cyathophyllum	42356	"
"	"	Atrypa spinosa	42357	"
"	"	Paracyclas	42358	"
"	"	Small Cladopora	42359	"
"	"	Stromatoporoids	42360	"
"	"	Coral ?	42361	"
20042	Gibson Creek section	Stringocephalus burtini	42362	Ramparts
"	"	Paracyclas	42363	"
"	"	Atrypa spinosa	42364	"
"	"	Atrypa reticularis	42365	"
"	"	Cystiphyllum	42366	"
"	"	Cladopora	42367	"
"	"	Chonetes	42368	"
"	"	Pleurotomaria	42369	"
"	"	Productella	42370	"
"	"	Newberria	42371	"
"	"	Prismatophyllum	42372	"
"	"	Alveolites	42373	"
"	"	Terebratula	42374	"
20043	Gibson Creek section	Shale sample	-----	--------
20044	Gibson Creek section	Atrypa reticularis	42257	Ramparts
"	"	Pleurotomaria	42258	"
"	"	Cladopora	42259	"
"	"	Stromatoporoids	42260	"
"	"	Odontocephalus	42261	"
"	"	Atrypa spinosa	42262	"
20044a	Gibson Creek section	Cladopora	42263	Ramparts
"	"	Favosites	42264	"
"	"	Heliophyllum	42265	"
"	"	Acervularia	42266	"
"	"	Atrypa reticularis	42267	"
"	"	Pleurotomaria	42268	"
20045 (Out)	----------	Stromatoporoid	42269	"
		----------	-----	------

Suite No.	Location	Fossil	Accession No.	Age
20046	Gibson Creek section	Favosites	42271	Silurian
"	"	Halysites	42272	"
"	"	Syringopora	42273	"
"	"	Zaphrentis	42274	"
"	"	Heliolites	42275	"
"	"	Stromatoporoid	42276	"
		Corals	42277	"
20047	Gibson Creek section	Favosites	42278	Silurian
20048	F116 Ridge NW Chick Lake	Cystiphyllum	42279	Beavertail
"	"	Cladopora	42280	"
"	"	Stromatoporoids	42281	"
		Cyathophyllum	42282	"
20049	F118 Upper Donnelly Rvr.	Shale sample	-----	Cretaceous
20050	F119 Upper Donnelly Rvr.	Shale sample	-----	Cretaceous
20051	F120 Upper Donnelly Rvr.	Shale sample	------	Cretaceous
20052	F120 Upper Donnelly Rvr.	Hoplites	42283	Cretaceous
"	"	Beudanticeras	42284	"
		Petrified wood	42285	"
20053	F122 Upper Donnelly Rvr.	Beudanticeras	42286	Cretaceous
20054	F123 Upper Donnelly Rvr.	Petrified wood	42287	Cretaceous
20055	F124 Upper Donnelly Rvr.	Shale sample	-----	Cretaceous
20056	F125 Upper Donnelly Rvr. at mouth Slimey Crk.	Shale sample	-----	Cretaceous
20057	F133 Donnelly Rvr. at Victory Ridge	Asphaltite in sandstone. Just above Beavertail.	-----	Base of Cretaceous
20058	F134 West end of Gibson Range	Halysites	42288	Silurian
"	"	Favosites	42289	"
"	"	Zaphrentis	42290	"
		Syringopora	42291	"
20059	F135a Donnelly Rvr. along N.side Victory Ridge.	Shale sample	-----	Cretaceous
20060	F136 Donnelly Rvr.along N.side Victory Ridge	Cladopora	42292	Beavertail
"	"	Stromatoporoid (Dried oil stain in Cladopora Limestone. Just below Cretaceous)	42293	"
20061	F136 Donnelly Rvr.along N.side Victory Ridge	Asphalt and Asphaltite. Just above Beavertail.	-----	Cretaceous
20062	F137 Donnelly Rvr.along N.side Victory Ridge	Beaudanticeras	42294	Cretaceous
"	"	Hoplites	42295	"
20063	F140 NW and Mt.Grumble	Stromatoporoids	42296	Beavertail
20064	F142 Approx. ½ mi.N.W. Lily Lake.	Favosites	42297	Ramparts
"	"	Atrypa	42298	"
"	"	Pleuretomaria	42299	"
"	"	Odontocephalus	42300	"
"	"	Crinoids	42301	"
"	"	Spirifer	42303	"
"	"	Stromatoporoid	42304	"
"	"	Cyathophyllum	42305	"
"	"	Cladopora	42306	"

Suite No.	Location	Fossil	Accession No.	Age
20065 &	F142 Approx. ½ mi.N.W. of Lily Lake	Atrypa	42307	Ramparts
20066	"	Cystiphyllum	42308	"
"	"	Cladopora	42309	"
"	"	Pleuretomaria	42310	"
"	"	Favosites	42311	"
"	"	Acervularia	42312	"
20067	F146 1½ mi.approx. NE of Lily Lake	Cystiphyllum	42313	Beavertail
"	"	Cladopora	42314	"
"	"	Stromatoporoid	42315	"
20068 (OUT)	----------	--------	----	--------
20069	F149 Approx. 3 mi.NE of Lily Lake	Bitumin, migrated up overturned zone	----	In Bear Rock
20070	F152 Approx. 3 mi.N Lily Lake	Discina	42319	Basal Ft.Creek
"	"	Tentaculites	42320	"
20071	F153 Approx. 3 mi. N. Lily Lake, & just W of Small Creek	Atrypa	42321	Basal Ft.Creek
"	"	Hypothyridina	42322	"
"	"	Stromatoporoid	42323	"
20072	F153 3 mi. approx. N. Lily Lake & just W of Small Creek	Martinia	42324	Basal Ft.Creek
"	"	Cyrtina (From "Marl")	42325	"
20073	F155 Approx. 3 mi. N. Lily Lake & just W.of Small Creek	Lingula, From Shale inter-bedded with "marl"	42326	Basal Ft. Creek
20074	F166 Middle Donnelly Rvr.	Shale sample	-----	Cretaceous
20075	F169 Middle Donnelly Rvr. Approx. 3 mi. W Victory Ridge	Carbonaceous shale and sandy shale. A little asphaltite. Lying on Beavertail.	-----	Cretaceous
20076	F189 Middle Donnelly Rvr. Approx. 3 mi.W Victory Ridge	Asphalt. In conglomerate	------	Cretaceous
20077	F204 Middle Donnelly Rvr.	Shale. A little asphalt	-----	Cretaceous
20077a	F222 East below Donnelly Rvr. Waterfall.	Sandstone with laminae of asphalt. Asphalt sometimes has fibrous structure due to having filled spaces in soft pulpy reeds?	------	Cretaceous
20078	F222 Just below Donnelly River Waterfall.	Shaley sandstone. Much carbonaceous material.	------	Cretaceous
20079	F219 Top of Mt. Dellis	Photograph of Orthoceras	42327	Silurian
20080	F224 Donnelly Rvr.below Mt. Dellis	Shale sample	423--	Cretaceous
20081	F227 Donnelly Rvr. below Mt. Dellis.	Shale sample	------	Cretaceous
20082	F238 Donnelly Rvr. below Mt. Dellis.	Fucoids	42328	Cretaceous
20083 (OUT)	----------	----------	-----	--------

Suite No.	Location	Fossil	Accession No.	Age.
20084	F244 Donnelly Rvr. below Mt. Dellis	Shale sample	------	Cretaceous
20085	F246 Donnelly Rvr. below Mt. Dellis	Fucoid	42329	Cretaceous
20086	F247 Donnelly Rvr. below Mt. Dellis	Shale sample	4-----	Cretaceous
20087	F259 Bath Hills (Cliff above Sink Hole)	Atrypa	42330	Beavertail
"	"	Cladopora	42331	"
"	"	Stromatoporoid	42332	"
20088	F260 Bath Hills (Base Soth Scarp. From 6" zone 8' below top of thin bedded rubbly ls. Atrypa from below this zone)	Cyathophyllum	42333	Top of Ramparts
"	"	Atrypa	42334	"
"	"	Cladopora	42335	"
"	"	Stringocephalus burtini	42336	"
"	"	Acervularia	42337	"
"	"	Stromatoporoid	42338	"
20089	F260 Bath Hills (Base South Scarp)	Asphalt in above	-----	Top of Ramparts
20090	F261 Bath Hills	Favosites	42339	Lower Ramparts?
20091	F265 Cliff. Approx. 2 mi. NW of PM 05.	Crinoids	42340	Beavertail
"	"	Stromatoporoid	42341	"
20092	F265 Cliff Approx. 2 mi. NW of PM 05	Shale sample	-----	Cretaceous
20093	F265 Cliff Approx. 2 mi. NW of PM 05	Shale sample	-----	Cretaceous
20094	F266 Approx. ½ mi. E of Beavertail Point, from upper 5' of Beavertail	Stromatoporoids	42342	Top of Beavertail
"	"	Cladopora	42343	"
20095	F272 Beavertail Point. Cladopora limestone with dried oil staining	Cladopora	42344	Top of Beavertail
"	"	Stromatoporoid	42345	"

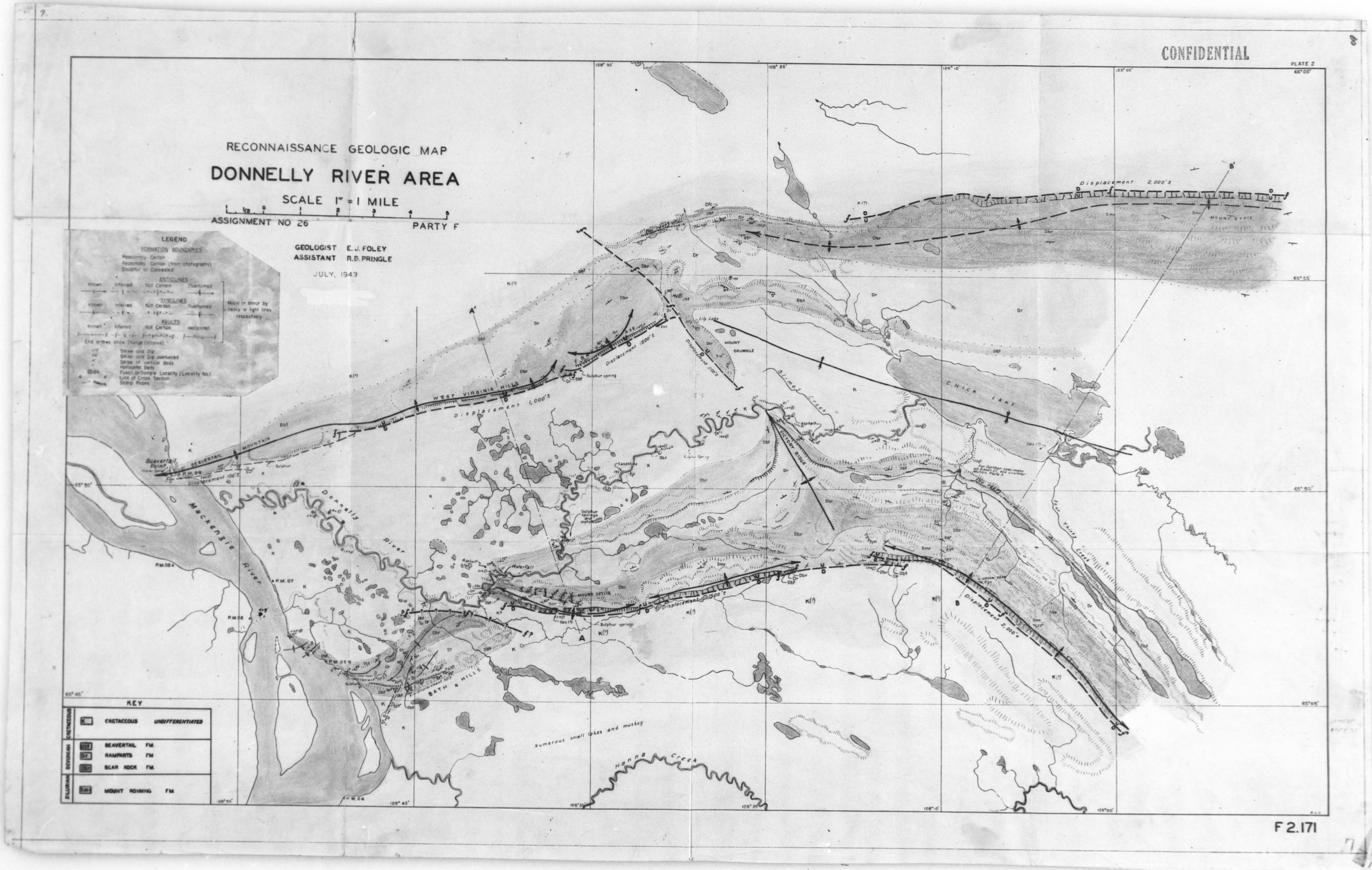

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PLATE III

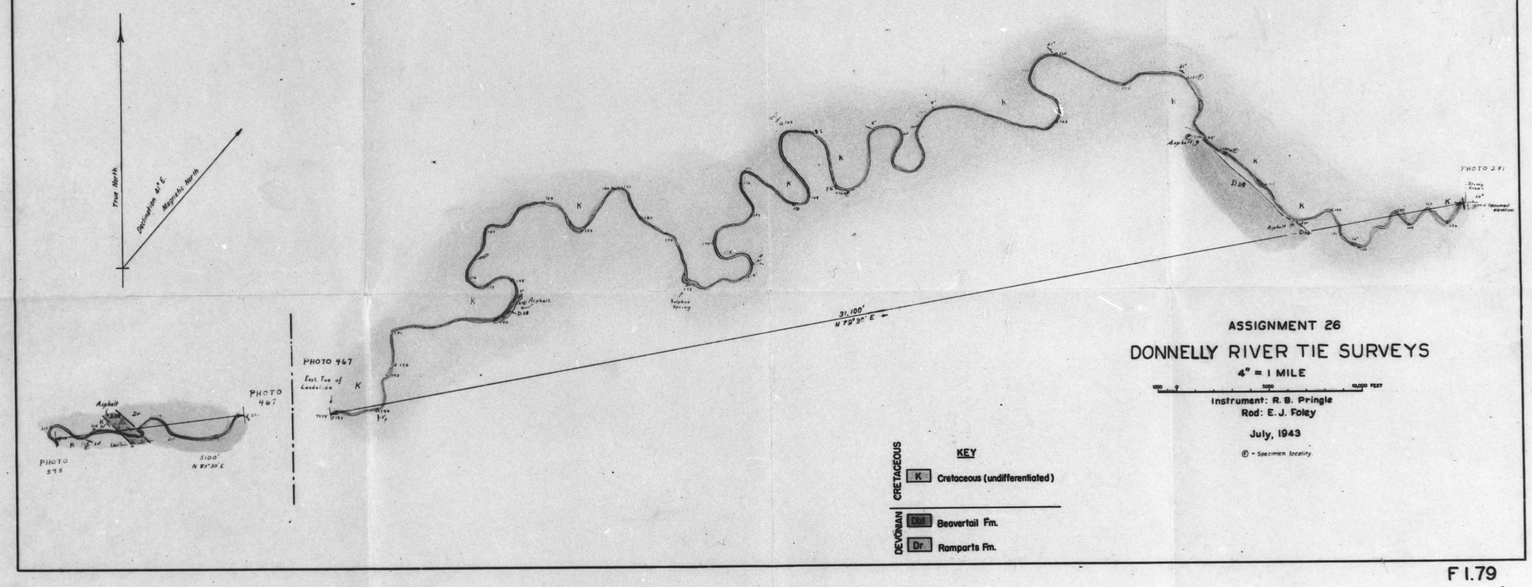

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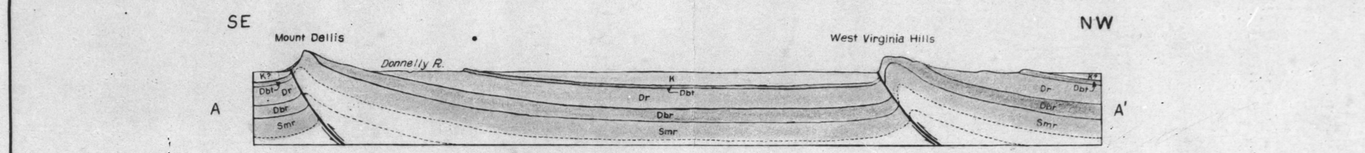
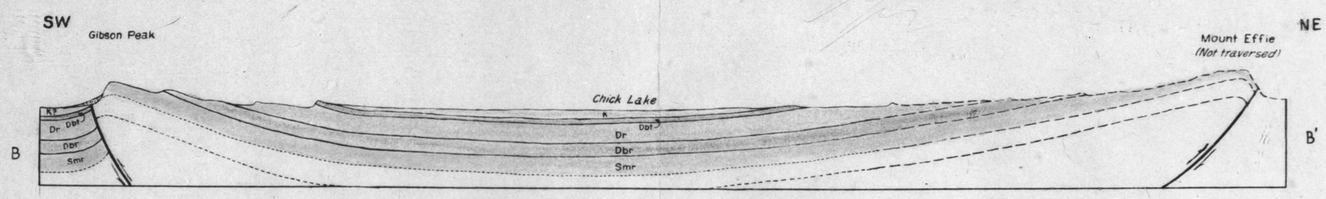
PLATE 4





KEY

CRETACEOUS	K	CRETACEOUS (UNDIFFERENTIATED)
DEVONIAN	DBT	BEAVERTAIL FM.
	DR	RAMPARTS FM.
	DBR	BEAR ROCK FM
SILURIAN	SMR	MOUNT RONNING FM.

STRUCTURE SECTIONS
IN THE
DONNELLY RIVER AREA

VERTICAL AND HORIZONTAL SCALE:
1" = 1 MILE
Elevations estimated
ASSIGNMENT 26 PARTY F
E. J. Foley
R.B. Pringle

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PLATE 5

COLUMNAR SECTION
(GIBSON CREEK)

DONNELLY RIVER AREA, N.W.T.

SCALE 1 IN. TO 100 FT.

ASSIGNMENT NO. 26.

PARTY F
E. J. Foley
R. B. Pringle

July, 1943

Age	Fm.	Column	Thickness	Description	Fossils – suite number and list.
MIDDLE DEVONIAN	BEAVERTAIL 172'		148'	Limestone, light brownish-grey, weathers grey; hard, rubbly. Beds 3' thick, a few massive layers. One 1" layer "rice pudding." (Exposed 1 mile west of Gibson Creek)	20038-A. Small *Cladapora*, Stromatoporoids.
			16'	Limestone, light grey, weathers yellow. Hard, contains some bitumen. Bedding 6" to 3' thick.	20039 *Atrypa*, *Cladapora*, Stromatoporoids.
			8'	Limestone, grey and light brown, weathers yellow. Hard, rubbly.	20040 Small *Cladapora*, *Stringocephalus burtini* (rare), *Atrypa spinosa*, *Paracyclas*, *Cystiphyllum*.
			½"	Clay shale, black, weathers black. Layer is wavy, could represent disconformity.	
	RAMPARTS 1171'		11'	Limestone, grey, weathers grey. Hard; 3' bedding.	20041 Stromatoporoids, *Cystiphyllum*, *Atrypa spinosa*, small Cladapora, Cup corals, *Cyathophyllum*, *Martinia*, *Paracyclas*
			40'+	Limestone, dark grey, weathers grey; hard; 2" to 1' bedding, with interbedded shale, brownish-grey, weathers grey, soft.	20042 *Cystiphyllum*, *Terebratula*, *Proetus*, *Chonetes*, *Cladapora*, *Atrypa spinosa*, *Atrypa reticularis*, *Productella*, *Stringocephalus burtini*, *Alveolites*, *Newberria*, *Paracyclas*, *Pleurotomaria*, *Prismatophyllum* 20043 (Shale)
		?	720'	No exposures, probably shale.	
			10'	Limestone, grey, weathers light grey; hard, 6" bedding.	20044 *Cladapora*, *Atrypa reticularis*, *Pleurotomaria*, *Odontocephalus*, *Atrypa spinosa*, Stromatoporoids
			30'+	Limestone, light grey, weathers light grey; massive; lowest 10' of exposure is rubbly, with 3" bedding.	20044-A *Acervularia*, *Cladapora*, *Atrypa reticularis*, *Favosites*, *Pleurotomaria*, Stromatoporoids.
		?	360'	No exposures, probably shale.	
	BEAR ROCK 720'?		20'	Limestone, grey, weathers grey and reddish-brown. Hard; 2" to 6" beds.	
			100'	Limestone, dark grey, weathers grey; hard; sometimes has black laminae; sometimes sugary. These grade laterally into breccia composed of "boulders" of same limestone as above in matrix of limstone, light brown, weathers yellow. Some minor faulting.	
			15+	Limestone, grey, weathers grey; hard; 4" to 6" beds.	
			585'?	Limestone, light grey, weathers light grey; very few outcrops. Anhydrite possibly present in covered portion?	
SILURIAN	MT. RONNING 1000'+		1000'+	Limestone, light grey, weathers light grey; hard; 2' to 3' bedding; a few layers of white novaculite, varying from 3" to 2' thick.	20046 (top): *Halysites*, *Heliolites*, *Syringopora*, *Favosites*, *Zaphrentis*, Stromatoporoids. 20047 (20 ft. below top) *Favosites*.

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PLATE 6

COLUMNAR SECTIONS
CRETACEOUS
DONNELLY RIVER AREA

SCALE: 1" = 100'

ASSIGNMENT NO. 26.
E.J. FOLEY, R.B. PRINGLE

AUGUST, 1943.

UPPER DONNELLY RIVER

AGE	COLUMN	THICKNESS	DESCRIPTION	FOSSIL SUITE No's
CRETACEOUS 370'+		250'	Shale, dark gray, weathers same, very slightly very fine sandy. Some concretions of shaly limestone, dark gray, weathers rusty brown, hard. Some to 10" x 5'. A few bentonitic layers, ½".	20062. Beaudenticeras, Hoplites. 20074, 20051, 20050, 20049, 20038. 20054 Petrified wood 20053 Beaudenticeras. 20052
		30'+	Shale, dark gray, weathers same. Slightly gritty.	
		30'±	Shale, dark gray, weathers same, soft, several layers of shaley, very fine sandstone, gray, weathers gray-brown, soft.	20059, 20056, 20055.
		30'	Sandstone, light gray to gray, weathers same, fine grained, soft, ripple-marked, ¼" to ½" bedding. Sometimes shaly with wavy black laminae.	20054. Petrified wood.
		25'	Sandstone, light gray and yellowish-brown, weathers same, medium to coarse-grained. Ripple marked. Base varies to 2' to 5' conglomerate, brown and grey, weathers same, pebbles to 2" of quartz, limestone, and igneous rock. Some is carbonaceous shale, black, hard, weathers gray, asphaltite.	20077, 20076, 20075
		5'	Sandstone, brown and black, weathers light gray, soft, medium grained, much asphaltite.	20061, 20057
DEVONIAN			BEAVERTAIL LIMESTONE.	

WEST END OF MT. DELLIS

AGE	COLUMN	THICKNESS	DESCRIPTION	FOSSIL SUITE No's
CRETACEOUS 353'+		310'+	Shale, dark gray, weathers same. Many ironstone concretions. Base not exposed.	20086, 20084, 20080, 20085 Ammonites, fucoid.
		4'+	Very shaly sandstone, gray, weathers dark gray, soft, very fine-grained. Much carbonaceous matter. Top not exposed.	20082, 20081. Petrified wood
		9'	Sandstone, light brown, weathers light-gray, soft, 3" bedding. Some asphalt.	
		3'	Shaly sandstone, light brown, weathers same; much carbonaceous material.	20078
		27'	Sandstone, light brown, weathers same, Soft, medium-grained, 2-in. bedding in lower 2 ft. Top is massive. Some asphalt.	20077a
DEVONIAN			BEAVERTAIL LIMESTONE.	

2 MI. NORTHWEST OF BATH HILLS

AGE	COLUMN	THICKNESS	DESCRIPTION	FOSSIL SUITE No's
CRETACEOUS 148'+		60'+	Shale, gray, weathers gray. Some 5" ironstone concretionary layers. Some shale is slightly gritty.	20093
		10'	Shaly sandstone, gray, weathers yellowish-gray. Hard, Wavy, black stringers. A 6" concretionary ironstone layer 3' below top.	
		4'	Sandstone, gray, weathers gray and yellow. Hard, medium-grained, 2-in. to 4-in. bedding. A few pebbles to ¼".	
		4'	Shaly sandstone, gray, weathers yellowish-gray, hard, wavy black laminae, ½" bedding	
		0.5'	Sandstone, yellow and gray, weathers same. Pebbly at base.	
		20'	Shale, dark gray, weathers same, some 6-in. to 1-ft. sandstone beds.	20092
		40'	Shaly sandstone, gray, weathers gray and yellow. ½-in. to 2-in. wavy bedding. Many carbonized plant remains.	
		8'	Sandstone, yellow, weathers same. Soft.	
		2'	Conglomerate, yellow, weathers same. Pebbles to 2". A little asphalt.	
DEVONIAN			BEAVERTAIL LIMESTONE	

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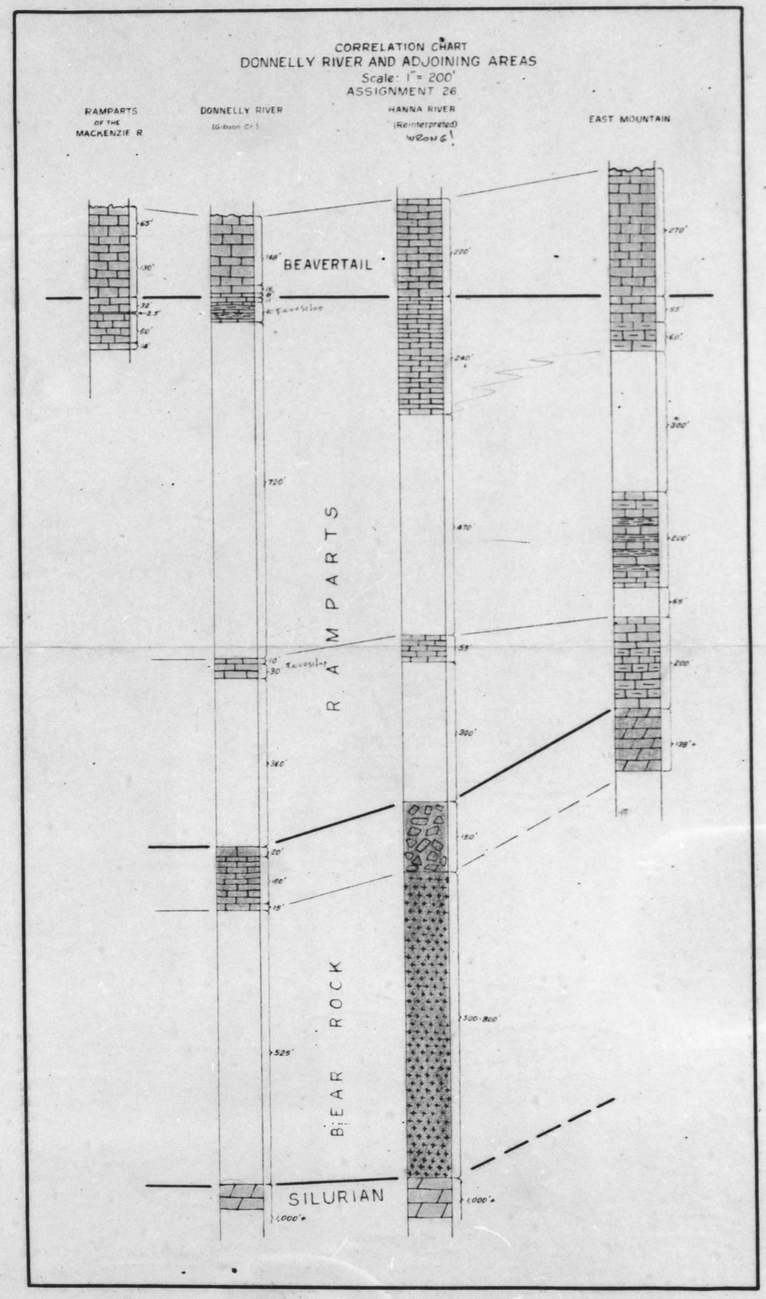
PLATE 7

CORRELATION CHART
DONNELLY RIVER AND ADJOINING AREAS
Scale: 1" = 200'
ASSIGNMENT 26



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