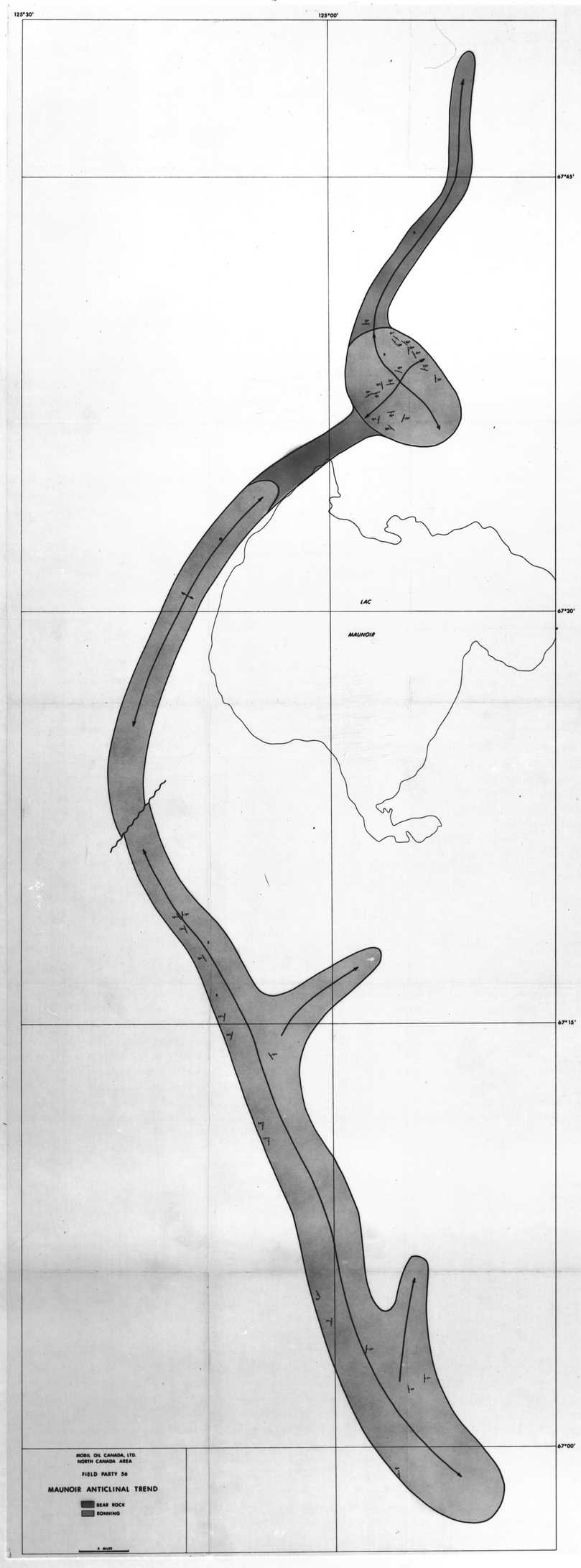

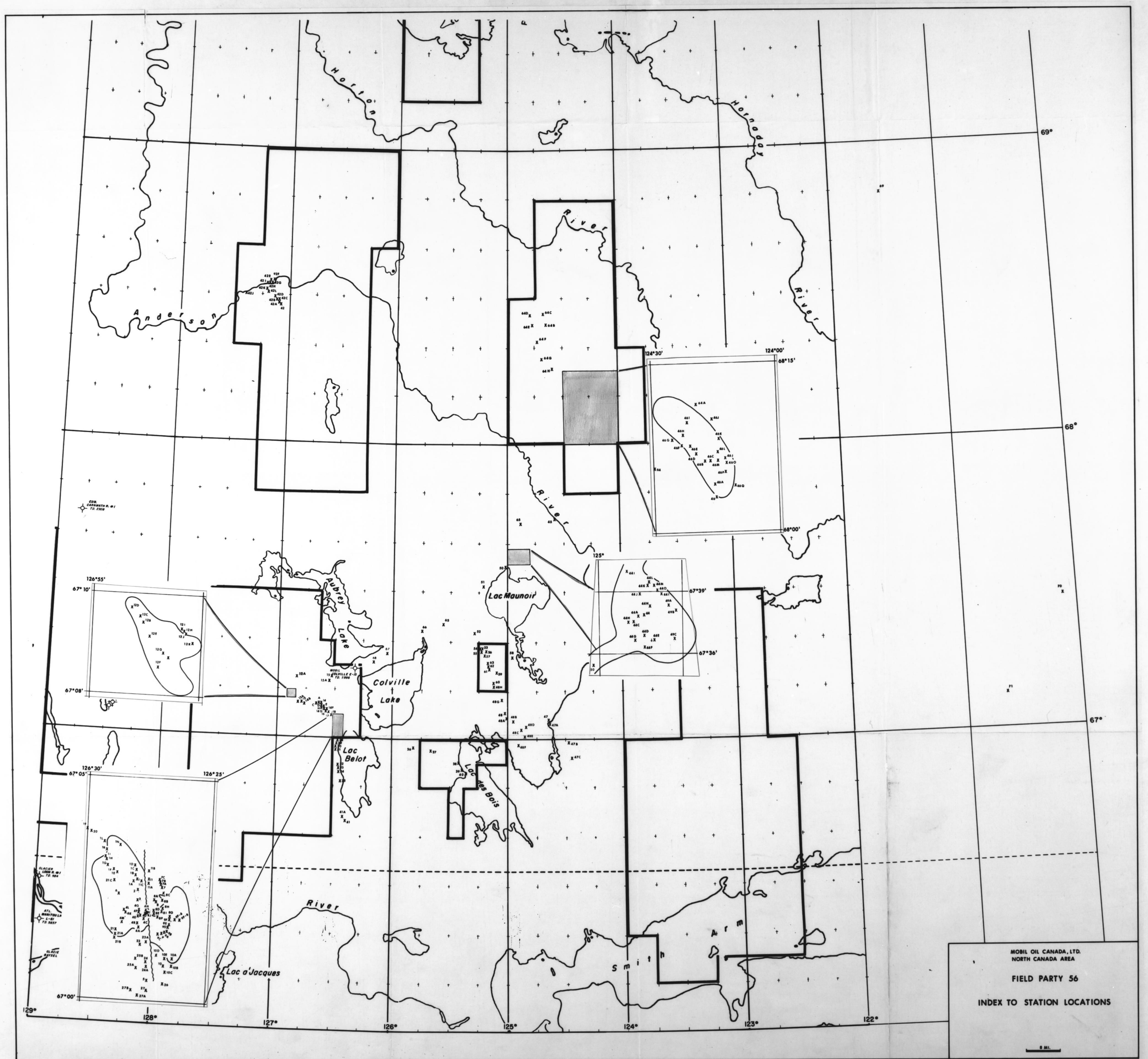

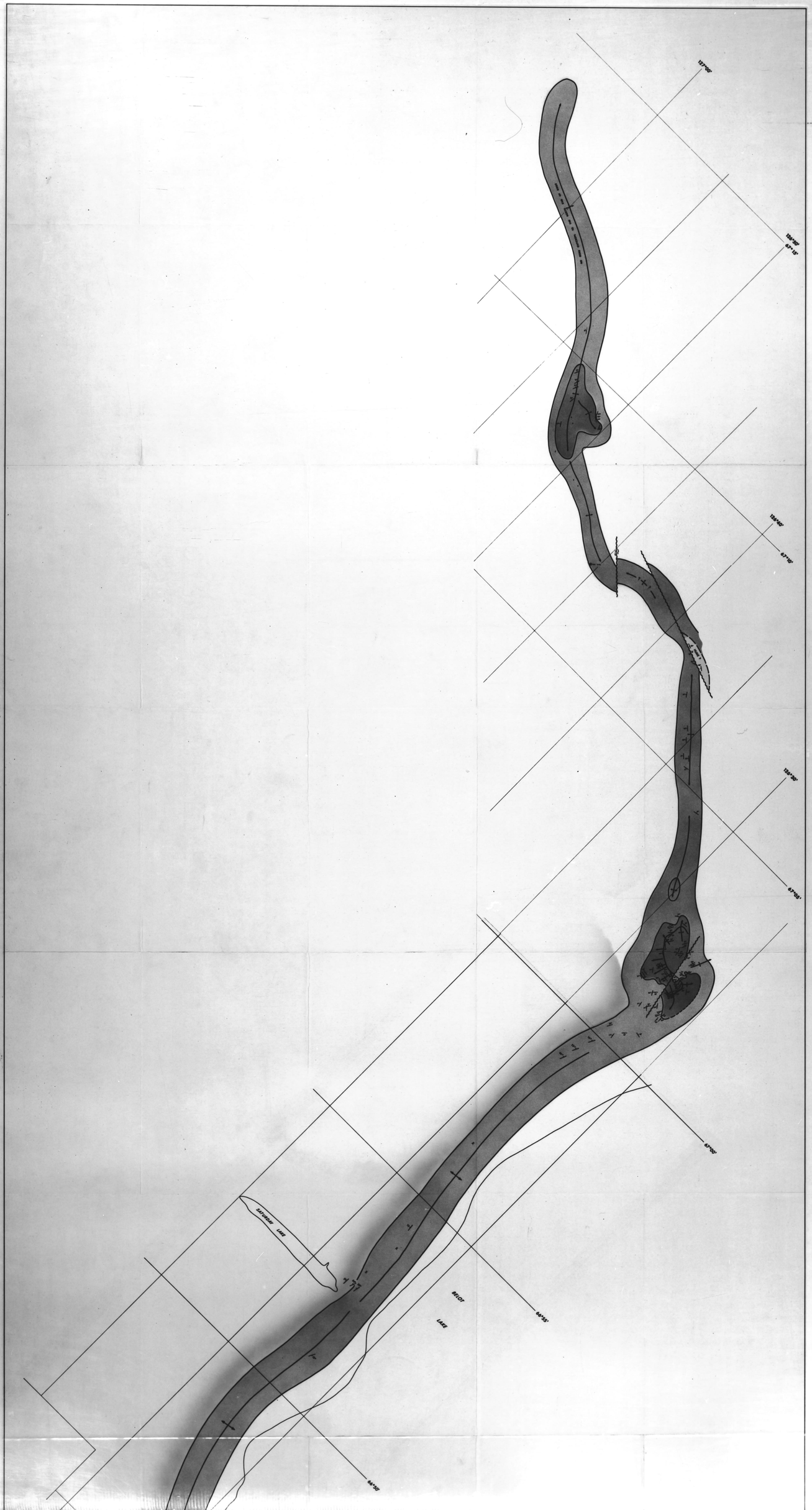

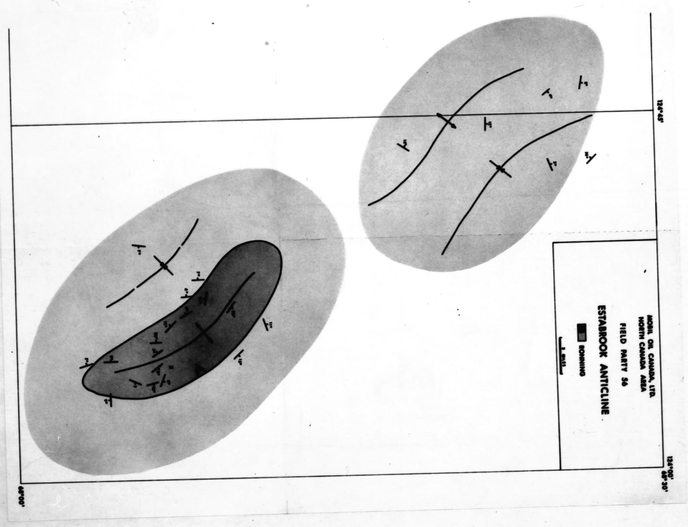

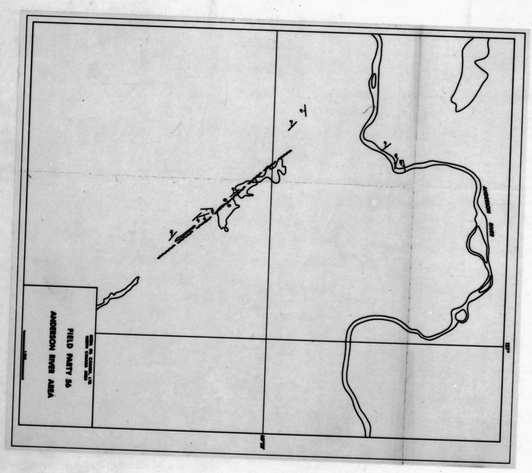

REPORT OF GEOLOGICAL FIELD PARTY #56 (1971)

ANDERSON PLAINS AREA

NORTHWEST TERRITORIES

Z.F. NIKIFORUK
January 1973

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REPORT OF GEOLOGICAL FIELD PARTY #56 (1971)
ANDERSON PLAINS AREA
NORTHWEST TERRITORIES

INTRODUCTION

This report is an account of the structural mapping project conducted by Field Party #56, during the period July 10 to August 3, 1971, in the general Colville Hills, Anderson Plains area of the Northwest Territories.

Personnel on Field Party #56 were as follows:

Z. F. Nikiforuk	Mobil Geologist
G.P. Brugeyroux	Mobil Geologist
H. L. Bullis	Mobil Beaver Pilot
C. C. Miller	Helicopter Pilot
L. C. Skidmore	Aircraft Engineer
C. Kirke	Cook

Field Party personnel, less the two pilots, along with all field equipment and supplies, left Calgary on the morning of July 10, 1971, in the Mobil DC-3 and arrived in Normal Wells the same day. The following day, all equipment and supplies were flown to the base camp location on Walkatwoway Lake ($66^{o}58'N$, $126^{o}35'W$) by a float equipped single Otter aircraft chartered from Northward Aviation. Initial fuel supply for the helicopter and the Beaver were also brought in on the same aircraft on an extra trip.

The Mobil float equipped Beaver aircraft arrived in camp on July 13, 1971 after having been delayed on its flight from Calgary

by inclement weather in Northern Alberta. The Beaver was used in hauling gasoline and other supplies from Norman Wells to augment the initial supply brought in by the single Otter. Other duties included caching gasoline in outlying areas far from base camp that was used for refueling the helicopter. Mobil's Beaver stayed with Field Party #56 until the beginning of the last week in July when it departed to meet a prior commitment with the Mobil Field Party in Northeastern British Columbia. With the departure of the Mobil Beaver float equipped, fixed wing aircraft were chartered from Northward Aviation, as needed, for restocking gasoline supplies and the camp move back to Norman Wells.

A Hiller 12-E helicopter was chartered from Klondike Helicopters of Calgary for use in transporting field personnel during mapping. It arrived in camp on July 15, 1971 some four days later than original plans called for. The helicopter generally performed up to expectations and had sufficient power to land and take off from cramped quarters. Only 2 or 3 spots of interest were missed due to the helicopter not being able to land within reasonable walking distance. Chuck Miller proved to be a very experienced and extremely competent helicopter pilot. His decision not to land at any particular spot never had to be questioned.

It was originally planned to do the mapping project from several base camps, moving camp when all work close at hand was completed.

It became apparent that the time wasted by camp moves would be all out of proportion to the extra flying time it would take to fly to remote parts of the project area. Therefore, the Beaver was used to good advantage to set out gasoline caches for the longer helicopter flights. The Tadenet Block, Maunoir Dome, and Estabrook Lake area, which ordinarily would have been out of helicopter range, were mapped quite easily from the one base camp in this manner.

SUMMARY OF FIELD OPERATIONS

Mapping procedure consisted of plotting field stations on enlarged photo-mosaic sheets. No great difficulty was experienced in identifying ground stations on the photo-mosaic sheets. Horizontal control consisted of the photo-mosaic sheets supplimented by topographic maps. Vertical control was taken care of by using a K & E Altimeter. Frequent checks were made to known elevations on the topographic maps and to stations established during the course of mapping.

At all outcrops visited the following were noted:

(a) Position on photo-mosaic

(b) Structure and dip

(c) Elevation

(d) Joints and their attitude

(e) Lithology

(f) Any other features such as slickensides, etc.

(g) Samples collected

SHEET

On all the structures mapped every outcrop that was seen from the air was visited. Sometimes a walk of a mile or more was necessary, but at most times it was possible to find a landing spot within a hundred yards.

The main stumbling blocks to detailed structural mapping on all the structures that were mapped are as follows:

(1) General lack of outcrop: On all the structural trends that were mapped there is a paucity of good outcrop. Exposures that are present are generally small and expose only a small stratigraphic section. Often what appeared to be good outcrop from the air proved to be, on landing, a rubble heap or talus slope with no rock in place.

(2) Frost heaved outcrops: Very often a good looking outcrop proved to be badly frosted heaved. Such an outcrop would have the joints expanded so drastically that they would be up to four feet wide. Dips from frost heaved outcrops, are unusable except for the general dip direction. Strike, however, can generally be estimated and be usable. The main field problem here is on very small outcrops where a decision has to be made whether or not to use the measured attitudes. For the most part reliable attitudes on larger outcrops, that were definitely in place, were recorded.

(3) Lack of stratigraphic markers: No markers are present in the Ronning and Bear Rock-Gossage carbonates on the structural trends that were mapped.

(4) Small scale structures superimposed on the major structure: These small flexures are very common especially on Maunoir Ridge, but were also noted on the Estabrook anticline. Here if the outcrop is small, it may be possible that erroneous dips could be recorded, if it happened that only the flank of one of the small structures was exposed in a particular outcrop. Again, extra care had to be taken on small outcrops to insure that they were part of a large structure and not a flank of one of the minor flexures.

Field identification of the Ronning, Bear Rock, or Gossage carbonate is straight forward. Their individual lithologies are sufficiently distinct in outcrop that they present no problem in their identification.

REGIONAL GEOLOGY

STRUCTURE

The Coppermine Arch cuts across the eastern end of the map area and exposes Proterozoic sediments along most of its length. Paleozoic sedimentary strata unconformably flank both sides of the arch and cross the arch at its southern end. Westward from the Coppermine Arch the Paleozoic rocks dip gently under the Horton and Anderson Plains.

Generally flat lying or gently dipping strata of the Horton and Anderson Plains have been tectonically disturbed to form the

Colville Uplift in the Colville Lake area. The Colville Hills are formed by a number of low to medium relief, generally anticlinal ridges, which as a group display a variety of trends and opposing asymmetries.

Tunago Ridge, a west dipping homocline of Ronning Group strata, trends north-northeast past the west end of Tunago Lake. The south end of the ridge merges with the Jacques Range of the Northern Franklin Mountains.

Belot Ridge occurs en echelon to the west of Tunago Ridge and extends northerly along the west side of Lac Belot. Immediately to the north of Lac Belot, Belot Ridge bifurcates with the longer northwest branch extending some 30 miles before plunging out. The shorter north branch extends just a short distance from the point of bifurcation before it too plunges out. Two high structural and topographic domes, that expose Ronning strata, characterize Belot Ridge. One dome is located at the point of bifurcation at the north end of Lac Belot, and the second some 15 miles to the northwest along the ridge.

Colville Ridge, between Aubrey and Colville Lakes, trends east northeast away from Belot Ridge towards Maunoir Ridge. The exact relationship between Colville Ridge and the other two ridges is not known. Low swampy ground with no outcrops obscures the projected points of junction so that the structural relationship between the ridges cannot be mapped by surface methods.

Maunoir Ridge is a broad asymmetric anticlinal ridge that trends north-northwest. South of the west end of Lac Maunoir, at the projected point of junction with Colville Ridge, Maunoir Ridge swings sharply to the northeast and continues for some 30 miles before plunging out. Maunoir Dome, a high topographic and structural feature, occurs about mid-way on the northeasterly trending portion of Maunoir Ridge. Maunoir Dome, like its counterpart domes on Belot Ridge, exposes Ronning carbonates in its core that are flanked by Bear Rock carbonates.

In the Estabrook Lake area, Estabrook anticline forms a prominent northwesterly trending broad hill. The south end of the anticline falls on the northeast projection of the northeast end of Maunoir Ridge. The two structures are not connected but the northwesterly trend of the Estabrook anticline is characteristic of the Belot and Maunoir Ridge trend directions. Immediately northwest of the Estabrook anticline there is a second anticlinal structure. This structure is poorly exposed. Its configuration and exact relationship to Estabrook anticline are presently obscure.

On the Tadenet Block the G.S.C. has mapped a small, faulted, doubly plunging anticline. Field work indicates that the structure as mapped by the G.S.C. does not exist. Details of this feature and anticlinal ridges mentioned previously will be discussed in a latter portion of this report.

STRATIGRAPHY

Sediments of Cambrian, Siluro-Ordovician, Devonian and Cretaceous ages outcrop in the project area or are developed in the subsurface. Paleozoic rocks unconformably overlie a Proterozoic sedimentary sequence in outcrop on the flanks of the Coppermine Arch and in the subsurface. All Paleozoic sedimentary sequences thin in an eastward direction toward the Canadian Shield due both to erosional and depositional thinning. North of the project area in the Darnley Bay region, Cretaceous sediments overstep the Paleozoics to lie directly on the Proterozoic. Four regional unconformities are present in the sedimentary sequence in the project area; these are at:

(1) Base of the Cambrian
(2) Base of the Mt. Kindle formation in the Ronning Group
(3) Base of the Bear Rock or Gossage
(4) Base of the Cretaceous

Major unconformities are known within the Proterozoic sedimentary sequence and have been documented in the shield area to the east of the project area. These unconformities are observed on seismic sections from the Rond Lake Block, however no work has been done on them and ties to outcrop would be exceedingly difficult to make.

Cambrian

The Cambrian sedimentary sequence is divided into three formations: Old Fort Island (Mt. Clark), Mt. Cap and Saline River. The

attempts to carry the markers any distance to the west or north of the Mackenzie River have not been successful. Once adequate well

Pelletoid, fetid, fine to medium grained, dark coloured lime-

of the north end of Lac Belot, the ridge bifurcates with the longer northwest branch continuing some 30 miles before plunging out.

most part of the Bear Rock. Reliable structure attitudes can be measured on these flanking beds. However, great care had to be taken, at times, to separate true bedding planes from an extremely

and are separated by a small covered interval from the sand.

Old Fort Island formation is a basal sandstone that unconformably overlies a Proterozoic sedimentary sequence while the contact of the Saline River formation with carbonates of the overlying Ronning Group is gradational. According to age dating by the G.S.C. the basal portion of the Ronning is Upper Cambrian. However, this contact is impossible to pick on mechanical logs or samples so that in the subsurface, and most places in outcrop, the base of the Ronning carbonate is considered to be the Cambrian-Ordovician boundary.

In the Anderson-Horton Plains area, an accurate composite thickness of the Cambrian is difficult to arrive at, in that outcrops are small and widely spaced. Subsurface control is limited to the section penetrated in the Mobil Colville E-15 Precambrian abandonment. This well can be considered as having a representative Cambrian section in the project area. In the E-15 well the total Cambrian is 1,258 feet thick and consists of 108 feet sandstone and shale assigned to the Old Fort Island formation; 405 feet of mixe shales, silt, limestone and dolomite assigned to the Mt. Cap formation; and 745 feet of shale, silts, anhydrite and halite of the Saline River formation. The basal 360 feet of the Saline River formation is composed of halite of the Saline River salt member.

Old Fort Island Formation

The Old Fort Island formation is a sequence of light grey,

buff and pink, medium to fine grained quartz sandstones, that occasionally have lenses of coarse quartz granules and pebbles. These friable porous sandstones are in the order of 200 feet thick in the outcrop belt, on the west flank of the Coppermine Arch where they unconformably overlie sediments of Proterozoic age. A minimum of 200 feet of relief on the unconformity is shown by inlying knobs of resistant Proterozoic sediments. Except where the erosional knobs are present, the basal sands form a continuous sheet. However, in the Leith Peninsula area, on the south shore of Great Bear Lake, a resistant ridge stood as a topographic high with 1100 feet of relief during deposition of the Old Fort Island sandstones. Ridges, of the type present on Leith Peninsula, may be present in the subsurface of the Anderson-Horton Plains area and could have caused the formation of hydrocarbon traps under suitable conditions.

Source area for the Old Fort Island sandstones evidently was the shield area to the east of the present day outcrop belt. The present day outcrop belt follows a general north-northwesterly trending line that follows the west edge of the shield from the north arm of Great Slave Lake to the west flank of the Coppermine Arch. Depositional strike of the Old Fort Island sands probably parallels the trend of the present day outcrop belt.

In the Anderson-Horton Plains area the subsurface distribution of these sands is not precisely known due to the lack of adequate well control. A sandstone-siltstone sequence 108 feet thick is

present in the Mobil Colville E-15 Proterozoic abandonment, with a mechanical log calculated gross porous interval of 22 feet. It is not developed in the Mobil et al Ontadek Lake N-39 nor in the Mobil et al Iroquois D-40 abandonments, respectively, 90 miles to the southwest and 100 miles north-northwest of the Colville E-15 well. The Elf Horton River G-02 abandonment, 200 miles north of Colville E-15, appears, on mechanical log examination only, to have bottomed in Ronning-Cambrian carbonates. No evidence that the Old Fort Island sand horizon is developed in the Horton River G-02 well can be found on the mechanical logs.

Available subsurface evidence indicates that the westward depositional edge of the Old Fort Island sand probably trends north-south through roughly the middle of the Rond Lake permit block. Northward from the Rond Lake block the westward edge of the sand swings to the northeast to cut the Tadenet Permit block diagonally from the southwest corner to the northeast corner, then continues or northeastward to cross the southeast portion of the Franklin Bay Permit Block.

Mt. Cap Formation

Conformably overlying the sandstones of the Old Fort Island formation are grey, green and red shales with intercalated glauconitic sandstones and siltstones, and grey, black and brown dolomites of the Mt. Cap formation. Oolitic texture is occasionally exhibited by some of the Mt. Cap formation dolomites. Complete

outcrop sections are not exposed in the Anderson-Horton Plains area; according to the G.S.C., the composite thickness is in the order of 200 to 300 feet. In the Colville E-15 well, a section of shales, silts, dolomite, with traces of anhydrite, 405 feet thick, is assigned to the Mt. Cap formation. Porosity has not been logged in any of the Mt. Cap formation glauconitic sands in outcrop or in the subsurface.

Saline River Formation

The Saline River formation conformably overlies the Mt. Cap formation and is conformably and gradationally overlain by the Ronning group carbonates. In the small scattered outcrops on the west flank of the Coppermine Arch the formation consists of recessive green and red shales with interbeds of thinly bedded siltstone and silty dolomite. Rarely exposed intervals of white and pink gypsum form part of the exposures. Depositional features such as mud cracks, ripple marks and salt crystal casts are common.

Within the subsurface the lithology is basically identical to the outcrop lithology with the main difference being the development of a thick basal salt member. The salt member attains its greatest known thickness in the western Anderson Plains area in the Mobil et al Ontadek Lake N-49 abandonment where 860 feet was entombed. Ninety miles to the northwest in the Mobil et al Iroquois D-30 abandonment the salt has thinned to 230 feet; and 85 miles to the

northeast in the Mobil Colville E-15 abandonment the salt thickness is 360 feet.

Precise northern and eastern limits of the salt are presently unknown. Extensive seismic in the Grandview area puts the western limit of the seismically mappable salt event along a NW-SE trend, just west of the Mackenzie River. On Sigma vibroseis sections the salt event fades out some 25 miles east of Maunoir Dome and on another Sigma section it fades out some 10 miles south of the southeast corner of the Tadenet Permit Block. The Cambrian salt event is not present on the seismic sections from Smith Arm, Great Bear Lake, nor the vibroseis sections in the Mahoney Lake area.

As indicated on the index map, the subsurface eastern and northern limits of the salt form a broad north-easterly trending V-shaped lobe. The southeastern side of the lobe trends northeastward from Tunago Lake to just east of Maunoir Dome. There the edge swings sharply westward to trend between the Tadenet and Rond Lake Permit Blocks, from there the edge probably swings northwestward between the Tadenet Block and the Nomac acreage.

The salt is important from an exploration point in that it forms a top seal for Mt. Cap fracture porosity and Old Fort Island sandstone porosity in the Belot Hills and Maunoir Ridge anticlinal trends. Its presence beneath the Estabrook Permit block is, at present, debatable. However, anhydrite and salt casts are present

in the outcrop to the east and could lend support to the postulation of a thin evaporite member in the Saline River beneath the Estabrook Block.

Ronning Group

Ronning group carbonates conformably and gradationally overlie the shales and siltstones of the Saline River formation. Thickness of the Ronning group carbonates ranges from an erosional feather edge on the west flank of the Coppermine Arch to a maximum drilled thickness of 4,800 feet in the Ontaratue Basin. On the whole, the thick carbonates of the Ronning group do not lend themselves to easy subdivision, neither in outcrop nor in the subsurface.

In their surface mapping projects in the general Anderson Plains-Colville Hills area, the G.S.C. recognizes 4 units within the Ronning. These units from base upwards are as follows:

Unit 1 or Cyclic Unit - dolomite and rare limestone, with cyclic repetitions of tight laminated dolomite beds, oolite beds, conglomerate beds, stromatolitic beds, and thin dolomitic shale beds. The presence of cyclically recurring thin beds and partings of green dolomitic shale distinguishes this unit from the overlying unit. Relative to the underlying Saline River it is a resistant unit and weathers in a pale yellow color.

Unit 2A or Laminated Unit - dolomite, pale brownish grey, fine to coarse crystalline, interbedded with dolomite, greyish

orange, very fine crystalline, partly laminated and is also cyclic but lacks the shale beds and partings of the underlying unit. Vuggy porosity is common in the coarse crystalline dolomites.

Unit 2B - Dolomite, pale yellow brown to pale grey, mainly medium crystalline, few thin dolomitic green shale beds, and characterized by an abundance of white and yellowish-grey bedded chert, stromatolites and oolites replaced by chert, and vugs lined with drusy quartz crystals.

Unit 4 or Mt. Kindle Formation - Dolomite, brownish grey to medium grey, fine to medium crystalline, thick bedded, with abundant light grey or white chert in thin beds or as scattered nodules. Vuggy porosity is common. An abundant fauna of silicified halysitid, favositid and horn corals and orthocone cepholopods characterize this unit.

Dolomite belonging to the Mt. Kindle form the surface outcrop on the two domal features on the Belot Hills anticlinal trend. The Maunoir Ridge, Maunoir Dome and Estabrook anticlines have exposures that consist of Unit 2B dolomites.

In the subsurface a workable breakdown of the carbonate sequence has not yet been established. The surface units cannot be identified with any degree of confidence. In wells drilled along the Mackenzie River, north west of Norman Wells, it is possible to correlate mechanical log markers from well to well. However,

attempts to carry the markers any distance to the west or north of the Mackenzie River have not been successful. Once adequate well density has been attained the Ronning carbonate sequence in the subsurface will probably be broken down into mappable units.

Bear Rock - Gossage Formations

Early Middle Devonian carbonates assigned to the Bear Rock and Gossage formations overlie the Ronning carbonates with sharp regional unconformity. Relief on the Ronning erosional surface is reported, by V. Zay Smith, to be in the order of several hundred feet in exposures on the Hornaday River.

Within the Anderson Plains - Colville Hills outcrop belt, two facies of the Early Middle Devonian outcrop. These are the Bear Rock limestone and dolomite breccia, and the Gossage bedded limestones and dolomites. Lithologically, the Bear Rock is composed of a massive, chaotic breccia of limestone and dolomite blocks. Breccia fragments range in size from tiny angular pieces to blocks well over 50 feet long. Most of the breccia blocks exhibit finely laminated bedding planes, however, the attitude of individual fragments rarely gives the true formational attitude, due to their chaotic arrangement. Anhydrite outcrops in the Franklin Mountains, and is present in the subsurface; no anhydrite was seen during the course of field work. The presence of anhydrite in the Bear Rock is suspected as the numerous sink holes on the southeastern portion of the Rond Lake Permit Block are probably due to the solution of anhydrite.

Pelletoid, fetid, fine to medium grained, dark coloured limestones and bedded dolomites, without evaporites, are the dominant lithologies in the Gossage formation. Thin interbeds of grey to dark grey calcareous shales are present in most outcrops of the Gossage limestones. These shaly intervals break the monotonous limestone outcrops into beds that vary between several inches to several feet thick.

Cretaceous

Cretaceous sands and shales although relatively widespread in the project area, rarely form good outcrops. Within the project area the Cretaceous forms a thin unconformable veneer over the Paleozoic carbonates, and is itself masked by extensive muskey cover and glacial drift. Only three outcrops of Cretaceous were located during the field season; two consisted of the Basal Cretaceous sands and one of Basal sand with some overlying shales. The basal sands form many low rounded hills in the northwestern portion of the Rond Lake Block and in the central and southern portions of the Tadenet Block. The hills do not expose true outcrop but are covered by loose sand similar to the basal sands and are unlike glacial sands.

DETAILED STRUCTURE

Belot Hills Anticlinal Trend

The southern portion of the Belot Hills anticlinal trend parallels the west shore of Lac Belot. Immediately to the northwest

of the north end of Lac Belot, the ridge bifurcates with the longer northwest branch continuing some 30 miles before plunging out. The shorter north branch continues for some 6 miles before it, too, plunges out. Mapping has indicated that the prominent topographic feature at the point of bifurcation is a structural dome. For ease of reference this dome will be called Belot Dome. Some 15 miles, along the northwesterly trending branch, from Belot Dome a similar prominent topographic feature was found to be a structural dome as well. For ease of reference, this dome will be called Aubrey Dome.

South of Belot Dome, Belot Ridge is relatively low, but in contrast to the rolling plains area to the west and Lac Belot to the east, it stands out very markedly. The portion of the ridge south of Belot Dome to just south of the south end of Lac Belot, exposes outcrops of Basal Cretaceous sandstone on the west flank.

The crest of this portion of the ridge exposes the massive chaotic Bear Rock breccia where true structural attitude is impossible to obtain due to the jumbled arrangement of even the largest breccia blocks. Trench-like lineaments are characteristic of the crestal portion of the ridge. These features are of uncertain origin, possible explanations for them are: faulting, joint enlargement by solution, or collapse due to solution of underlying gypsum beds. The west flank of the ridge is formed by undisturbed fine to medium and in some cases massive bedded limestone of the upper-

most part of the Bear Rock. Reliable structure attitudes can be measured on these flanking beds. However, great care had to be taken, at times, to separate true bedding planes from an extremely well developed joint system. At first glance the joint system appears identical to bedding; shaly partings and fine bedding laminations on the weathered surface were used to differentiate between bedding and joints.

Dips on the west flank of Belot Ridge are steep, varying between 30 and 56 degrees W., strike being north-south parallel to the ridge. The steep dips on the west flank flatten out sharply on approaching the top of the ridge, dips here fall in the range of 10 to 20 degrees W.

Basal Cretaceous bituminous sandstones outcrop at the east end of Saturday Lake, 66°53'N., about midway on the south portion of Belot Ridge. Here, massively crossbedded sandstones at the foot of the ridge have a slight westward dip. A dip of 2 to 3 degrees was estimated from the air as the massive crossbedded nature of the sandstone precludes measuring a regional dip on the outcrop. A short distance up the flank of the hill and directly above the crossbedded sandstone, another outcrop of sandstone is present. This sand is lithologically similar but is non-bituminous and fine bedded. A covered and overgrown interval separates the two sandstone outcrops. Attitude of the fine bedded sands is, dip 56° W strike 180°. Bedded Bear Rock limestones outcrop just up the slope

and are separated by a small covered interval from the sand. Attitude of the limestones is identical to the fine bedded sands.

Exact field relationship between the two sandstone outcrops could not be established. The fine bedded sand is stratigraphically lower than the cross bedded sandstone, because it overlies the Bear Rock with only a small covered interval. At the extreme east end of the cross bedded sand the beds were observed to bend sharply upwards. This indicates that the cross bedded sands, before erosion, extended up the flank of the ridge to lie directly on the fine bedded sand.

No evidence was encountered in the field that indicates faulting is present along the west side of this portion of Belot Ridge. The structure of the west flank of the ridge being such that the gently west dipping Cretaceous sands and Bear Rock limestones are bent up sharply to form the west flank. On approaching the top of the ridge, the flanking beds flatten out so that, in effect, we have the west half of a box anticline. Outcrops are not present on the extreme east flank of Belot Ridge, so that it is not known if the east half of the box anticline exists or if the east side of the ridge is formed by a thrust fault.

Belot Dome is located at the bifurcation point of Belot Ridge immediately to the northwest of the north end of Lac Belot. Surface exposures in the core of the dome are of cherty fossiliferous,

in part porous, dolomite of the Mt. Kindle formation. Flanking beds are the Bear Rock breccia to the south and the Gossage bedded limestones to the north.

Good outcrop is not plentiful on the Belot Dome, but sufficient exposure was located to define the basic structure. The dome is roughly elliptical in outline and is broken by a north-south trending, right lateral, tear fault. Horizontal displacement along the fault is in the order of 1 mile. A vertical component is also present as the Ronning outcrops to the east of the fault are at a lower elevation. Faults other than the tear fault were not apparent. A gully exposure of a series of Ronning outcrops on the southwest flank of the main part of the dome showed consistent southwest dips down to plains level with no sign of disruption by a west trending fault. Another similar series of Ronning outcrops are present in another gully on the east flank of the part of the dome east of the tear fault. Here again the Ronning was followed down to plains level with no evidence of faulting.

Precise structural closure on the dome is difficult or impossible to calculate. Main problem being the lack of stratigraphic markers. In most cases the bedding plane dips and the topographic slope angle vary only by the matter of a few degrees, with the topographic slope angle being steeper as a rule. From the close correspondence of the values for slope angle and bedding

plane dips it is apparent that structural closure is very close to topographic closure, with the structural closure being smaller. An estimated vertical closure of 800 to 900 feet appears in order for Belot Dome.

Exposures on the portion of Belot Ridge between Belot and Aubrey Domes consist of scattered pelletoid, fetid, dark colored Gossage limestones. From the northeastward and southwestward dips it is apparent that this portion of the ridge is anticlinal. At the midpoint of this portion of the ridge a tear fault that crosses the ridge at a sharp angle is suspected. Movement is apparently right lateral but the few scattered small outcrops of the Gossage at this point do not allow any further detail on the suspected fault to be mapped. At this same point one outcrop of fossiliferous limestone was located. This limestone is suspected to be part of the Hume formation. Hume outcropping at this location is not extremely anomalous as this portion of the ridge is the structural saddle between the Belot and Aubrey dome culminations.

Aubrey Dome is an area of Ronning dolomite outcrop on a structural culmination about 15 miles northwest along Belot Ridge from Belot Dome. It is separated from Belot Dome by a low structural saddle that exposes beds that may belong to the Hume formation. Outcrop control on Aubrey Dome is very scanty, but sufficient

outcrop is present to indicate that it is a structural dome much like Belot Dome. A northwesterly trending right lateral tear fault is suspected to be present in that a shallow valley separates two areas of Ronning outcrop and breaks the topographic feature into two as well. Dips on the flanks of Aubrey Dome vary between 15^{o} and 30^{o} much like the dips on the flanks of Belot Dome. Closure is estimated as being between 800 and 900 feet on the basis of topographic relief. On Aubrey Dome, as on Belot Dome, there is a close correspondence between topographic slope and bedding plane dips.

Belot Ridge continues for some 15 miles to the northwest of Aubrey Dome before plunging out. Only one outcrop of Gossage limestone was located on this portion of the ridge. It is considered that this part of the ridge is anticlinal like the rest of the Belot structural trend.

Colville Anticlinal Trend

The Colville anticlinal trend is an east-northeast trending topographic ridge located between Aubry and Colville Lakes. It is approximately 40 miles long and merges imperceptively with Belot and Maunoir ridges at its southwest and northeast ends respectively. Bedrock exposures are poor, and few in number, along the ridge, at the points of junction with Belot and Maunoir ridges there are no outcrops whatsoever, so that the exact structural relationships of the ridges that join each other at almost right angles cannot be learned from surface mapping.

Bedrock exposures along the Colville ridge are of the Bear Rock breccia, so that the structural altitude of the outcrops cannot be measured. However, one outcrop at Station 15, some 6 miles southwest of the Colville E-15 abandonment, exposes Basal Cretaceous sandstone that overlies bedded Bear Rock linestones. Contact between the sandstone and the limestone is hidden by a short covered interval. Both the sandstone and the limestone dip s teeply westward, $15^{o}/88^{o}$ W and $10^{o}/72^{o}$ N respectively. Sufficient outcrop is not present in the general area of Station 15 to establish if the steeply dipping sandstone and limestone form the west limb of an anticline or a portion of a steeply west dipping fault block.

Lack of sufficient good exposures and the fact that the outcrops that are present are of the Bear Rock breccia precludes detailed structural mapping of Colville ridge. Colville ridge is considered to be anticlinal in that (a) the ridge is similar to the Belot Hills and Maunoir structural trends that are known to be

anticlines (b) seismic data from lines shot along and across the ridge indicate that it is an anticline, (c) photo-geological interpretation shows the structure to be an anticline.

Maunoir Anticlinal Trend

Maunoir Ridge is a broad, poorly exposed anticline, the southern portion of which trends north-northwest between Lac Des Bois and Lac Maunoir. Immediately to the west of the west end of Lac Maunoir, at the point of junction with Colville Ridge, Maunoir Ridge swings sharply northeastward. The ridge continues some 40 miles in that direction before plunging out just short of the Anderson River. At roughly the mid way point of the northeasterly trending section, Maunoir Dome, a high structural and topographic feature, stands out very markedly.

Ronning dolomites form the outcrops in the core of Maunoir Dome and on the portion of Maunoir Ridge south of the junction with Colville Ridge. Bear Rock breccia and some bedded limestones form the outcrops low on the flanks of Maunoir Dome and on Maunoir Ridge northeast of the junction with Colville Ridge. Bear Rock carbonates also, form the ridge that extends northeastward from Maunoir dome. On the latter ridge, however, there are no true outcrops, only frost shattered and heaved Bear Rock debris being present. The debris provided lithology but no structural data could be obtained.

The north-northwest trending southern portion of Maunoir Ridge is a broad, closed, assymetric anticline with the west limb being the more steeply dipping one. For ease of reference this anticline will be called Maunoir Anticline. Outcrops are few in number on the east limb, however, a glacial drainage channel that cuts obliquely through the structure at 67°05'N gives a good picture of the

assymetric nature of Maunoir Anticline. Dips on the west limb fall in the range of 10^{o} to 25^{o}W and on the east limb range between 5^{o} and 15^{o}E.

Many small scale anticlinal and synclinal ripples are superimposed on the main anticlinal structure. Trend of the small scale structures parallels that of the main trend. On some small outcrops where only a small portion of a small scale outcrop is exposed, anomalous dips are present. For the main part the anomalous dips were east dip or extremely steep west dip on the west limb and vice versa for the east limb. Dips that were obviously anomalous and due to being on the flanks of small scale structures were disregarded and not recorded during field mapping.

Closure on the south end of the Maunoir Anticline is easily demonstrated as sufficient outcrop is present to establish the south plunge of the anticlinal axis. West and east dips are also easily demonstrated from outcrop control, although outcrops are not as plentiful on the east limb as they are on the west one. Northerly plunge of the axis is not easily shown by surface mapping due to lack of sufficient outcrop, but can be shown to exist from Bear Rock carbonate - Ronning dolomite field relationships. Bear Rock carbonates are present in outcrop in the topographically low portion of Maunoir Ridge between Maunoir Dome and Maunoir Anticline. The Bear Rock carbonates here, are structurally lower than the Ronning dolomites that form the crest of Maunoir Anticline. Therefore north plunge must exist on the north end of Maunoir Anticline , to carry the crestal Ronning dolomites below the structurally low Bear Rock carbonates.

Precise structural closure is difficult to arrive at using surface mapping techniques, in that no stratigraphic markers are present in the Ronning sequence. Dips on the limbs of the anticline and topographic slope have a close relationship, with the structural dips being generally slightly steeper than topographic slope on the limbs. From this relationship structural closure approximates topographic closure and would be in the order of 700 or 800 feet.

Maunoir Dome is situated immediately north of Lac Maunoir at roughly the midway point of the northeasterly trending portion of Maunoir Ridge. It is a roughly circular structural dome that forms a high topographic feature that stands out very markedly above the surrounding lake covered plains area. For the most part Ronning dolomite forms all the outcrop on the dome, with the few Bear Rock outcrops being found low on the north and southwest flanks at the point of junction with Maunoir Ridge. Dip on the flanks of the Maunoir Dome vary between 10^{o} and 46^{o}, being steepest low on the flanks. Dips,on approaching the top of the Dome, flatten out and are on the average 10^{o}. Closure again is difficult to ascertain from surface mapping in that there is a lack of stratigraphic markers. Here, as on Maunoir Anticline, there is a close relationship between flank dips and topographic slope, with the structural dips being slightly steeped than the topographic slope. Again a close approximation between topographic and structural closure exists, and on this basis a structural closure of 1200 feet is assumed.

No true outcrop exists on the portion of Maunoir Ridge that extends northeasterly towards the Anderson River from Maunoir Dome. Here only frost shattered and heaved debris from the Bear Rock breccia and bedded limestones is present at a few scattered localities. No structural data could be obtained from the debris, however, this

portion of the ridge is assumed to be anticlinal from its general similarity in topographic form to the rest of Maunoir Ridge.

Estabrook Anticline

Estabrook anticline is located some 35 miles northeast of Maunoir Dome and is on strike with the northeasterly trending part of Maunoir Ridge, however, no direct structural connection exists between the two. Dolomites and cherts of the Ronning formation form all the outcrops on Estabrook anticline and the surrounding rolling hill area. Outcrop is very plentiful on the anticline itself with dips ranging between 3^{o} and 36^{o}. Many small sharp anticlinal and synclinal ripples are present in localized areas on the Estabrook anticline. These, however, did not present a mapping problem as there was sufficient outcrop available to sort out these minor complications.

Estabrook anticline trends northwesterly and is approximately 11 miles long and 3 miles wide. Closure is readily mappable by surface methods. In as much as there are no stratigraphic markers in the Ronning formation no precise structural closure could be mapped. Taking into account its topographic relief and dips, the closure on Estabrook anticline is in the order of 400 to 500 feet.

Another, but ill defined, anticline is present, on trend, immediately to the northwest of Estabrook anticline. Sufficient outcrop is not present on this anticline to delineate it by surface means. From the sparse outcrops that are present, and its topographic form, it appears to be similar in size and shape to the Estabrook anticline.

Anderson River Structure on Tadenet Block

On the Tadenet Block immediately south of the Anderson River, at 127°05'W, G.S.C. mapping shows a small doubly plunging anticline. Field mapping indicates that the anticline as such does not exist. Instead a tilted, west dipping fault block of gossage bedded limestones is present at the location. The fault scarp has a relief of about 150 feet and merges imperceptably along strike, to the northwest and southeast, into muskeg covered rolling hill country, so as to give the appearance of NW and SE plunge.

Outcrop is present only along the top of the east facing fault scarp where it has been subjected to heavy frost action. The joints in the Gossage limestone have opened up to several feet wide or more in some cases. The effect ofthe joint widening is to rotate the joint blocks to the northeast, which in turn gives an apparent north east dip. If the apparent northeast dip is mistaken for true dip the fault block would be interpreted as an anticline. From all appearances that is what happened during the G.S.C. mapping and subsequent structural interpretation.

To complicate matters further there are many small anticlinal and synclinal ripples in exposures, north of the fault block, on the Anderson River. Some of these small structures are also present on the fault block and if care is not taken erroneous east dips may be mapped as being part of a large structure whereas they may only be on the flank of one of the small scale features. The exact origin of the small scale structures is unclear but they may be related to buried erosional topography on the top of the underlying Ronning. These features are much to small to warrant their consideration as possible hydrocarbon prospects.

Structure West of Lac Des Bois

In the area west of the prominent east trending peninsula on the west shore of Lac Des Bois there is an area of scattered Ronning outcrop. Outcrop is to sparse to get an exact picture of the structure, but the Ronning is structurally high as Bear Rock breccia outcrops to the west on the east shore of Lac Belot and is present in a thrust fault on the west shore of Lac Des Bois. The above noted thrust fault suggests that the structurally high Ronning may be related to folding associated with thrusting. Lack of sufficient outcrop precludes detailing the area to gain an idea of the nature of the structural high.

At lake level on the west shore of Lac Des Bois just to the north of the eastward projecting peninsula the Bear Rock breccia was observed to be thrust over a Basal? Cretaceous tar sand. Trace of the fault plane in the exposure is N20^{o} and dip 55^{o} NW. The tar sand is badly crumpled beneath the fault and tar has impregnated the Bear Rock breccia for 2 or 3 feet above the fault plane.

Age of the Structures

Geological evidence gathered during the 1971 field session shows that the structures in the Colville Hills - Anderson Plains area are of Laranide age and that they formed, at the same time that the Franklin Mountains were built. The most convincing evidence is that the Cretaceous is tectonicallyinvolved in the structures. At Saturday Lake on the west flank of the Belot Hills 66^{o}43'N the Cretaceous basal sands dip at an angle of 56^{o} west, at plains level near the base of the Belot Hills the dip is very slight to the west. This locality shows that the Cretaceous is definitely involved in the Belot Hills structure and that the basically flat lying sandstones

at plain level do not abutt against a pre-existing structure. At a locality 6 miles southwest of the Mobil Colville E-15 abandonment exposures of steeply dipping Cretaceous sandstones, dip 88°W, overlie, with contact covered, equally steeply dipping Bear Rock limestones. Here again the Cretaceous was involved in tectonic movements.

On the west shore of Lac Des Bois Basal? Cretaceous tar sands are overridden by Bear Rock breccia along a steeply dipping thrust fault. Again the Cretaceous is shown to be tectonically involved.

Tunago Ridge which trends northeasterly past the west side of Tunago Lake towards Lac Des Bois, merges with the north eastermost range of the Franklin Mountains. Tunago Ridge is similar to the other ridges in the Colville-Anderson area and like them is an anticlinal structure that forms a sinuous topographic feature. Since Tunago Ridge merges with the Franklin Mountains it must have originated at the same time and therefore supports the Laramide age for the rest of the Colville-Anderson anticlinal ridges.

All evidence points to a Laramide origin for the Colville-Anderson structures, but the exact mechanism of their formation and their diversity of trends cannot be solved with the data available.

Hydrocarbon Shows

Two new localities with hydrocarbon shows were found during the mapping project. The first one was the discovery of oil stained fractured Ronning dolomite on Belot dome at Station 41. Here the dolomite is brecciated with angular clasts up to 5" across. The breccia is stained with dark brown weathered oil and some tar.

A Basal? Cretaceous tar sand was discovered on the west shore of Lac Des Bois at station 39 and 40. Only several feet of tar sand is exposed with base below lake level. The sand is thoroughly saturated

with tar that flows when heated by the direct rays of the sun.

Conclusions and Recommendations

Structural mapping by Field Party # 56 showed that the topographic ridges in the Anderson Plains area are anticlinal in nature and that closure exists on these anticlinal trends. Two closures, Belot Dome and Aubry Dome are located on the Belot Hills trend. On the Maunoir trend two closures are likewise present, Maunoir anticline and Maunoir Dome.

In the Estabrook Lake area, Estabrook anticline is indicated to be a closed structural feature. Another ill-defined anticline is present to the northwest of Estabrook anticline.

On the Tadenet Block the doubly plunging anticline as mapped by the G.S.C. was found to be non-existent.

Five potential drilling locations were thus mapped by Party # 56; they being Aubry Dome, Belot Dome, Maunoir Anticline, Maunoir Dome and Estabrook Anticline.

At the end of the mapping project recommendation was made for acquiring the acreage over the Estabrook anticline. The Estabrook permit block that was acquired covers both the Estabrook anticline and the poorly defined anticline to the northwest of it.

A proposal to drill a wild cat well on the Belot Dome was made at the same time. This proposal resulted in the drilling of the Mobil Belot Hills M-65 wild cat well, which was abandoned after finding the target Basal Cambrian sands water laden. However, hydrocarbon indications were found in the drill cuttings.

Recommendation is here given that on the basis of the Basal Cambrian sand thickness in the Belot Hills M-65 well that Mobil not

in part porous, dolomite of the Mt. Kindle formation. Flanking beds are the Bear Rock breccia to the south and the Gossage bedded limestones to the north.

Good outcrop is not plentiful on the Belot Dome, but sufficient exposure was located to define the basic structure. The dome is roughly elliptical in outline and is broken by a north-south trending, right lateral, tear fault. Horizontal displacement along the fault is in the order of 1 mile. A vertical component is also present as the Ronning outcrops to the east of the fault are at a lower elevation. Faults other than the tear fault were not apparent. A gully exposure of a series of Ronning outcrops on the southwest flank of the main part of the dome showed consistent southwest dips down to plains level with no sign of disruption by a west trending fault. Another similar series of Ronning outcrops are present in another gully on the east flank of the part of the dome east of the tear fault. Here again the Ronning was followed down to plains level with no evidence of faulting.

Precise structural closure on the dome is difficult or impossible to calculate. Main problem being the lack of stratigraphic markers. In most cases the bedding plane dips and the topographic slope angle vary only by the matter of a few degrees, with the topographic slope angle being steeper as a rule. From the close correspondence of the values for slope angle and bedding

plane dips it is apparent that structural closure is very close to topographic closure, with the structural closure being smaller. An estimated vertical closure of 800 to 900 feet appears in order for Belot Dome.

Exposures on the portion of Belot Ridge between Belot and Aubrey Domes consist of scattered pelletoid, fetid, dark colored Gossage limestones. From the northeastward and southwestward dips it is apparent that this portion of the ridge is anticlinal. At the midpoint of this portion of the ridge a tear fault that crosses the ridge at a sharp angle is suspected. Movement is apparently right lateral but the few scattered small outcrops of the Gossage at this point do not allow any further detail on the suspected fault to be mapped. At this same point one outcrop of fossiliferous limestone was located. This limestone is suspected to be part of the Hume formation. Hume outcropping at this location is not extremely anomalous as this portion of the ridge is the structural saddle between the Belot and Aubrey dome culminations.

Aubrey Dome is an area of Ronning dolomite outcrop on a structural culmination about 15 miles northwest along Belot Ridge from Belot Dome. It is separated from Belot Dome by a low structural saddle that exposes beds that may belong to the Hume formation. Outcrop control on Aubrey Dome is very scanty, but sufficient

drill on the Aubry Dome. The sand at that locality may be near the depositinal edge and consequently poorly developed.

Basal cambrian sands would be the prime objective of wells drilled on the Maunoir Anticline, Maunoir Dome and Estabrook Anticline. The first two of these three large closed features can be expected to have a good section of Saline River salt to act as a seal, at the Estabrook anticline the salt would probably be very thin as this locality is near the eastern feather edge of the salt. Sand thickness in the range of 200 feet can be expected at all three locations.

Further refinement of the structures is not possible by surface geologic means so that seismic may have to be employed for further structural studies. However, seismic has shown limited success in defining precise structure over the Belot Hills trend so that refinements in the seismic techniques would have to be made.

Another method of further detailing of the structures would be by a structure drill program. This method would be expensive in that dip meter logs would have to be run or oriented cores cut.

APPENDIX

Description of individual stations

APPENDIX

Station #1 Elevation 3040

Ronning outcrop
Dolomite medium grey medium crystalline, siliceous and cherty, poor vuggy and intercrystalline porosity

Strike: 40° Dip: 14°NW
Joints: 50°/86°NW
325°/77°S
Sample # 1-1

Station #1A Elevation 2970

Ronning outcrop
Lithology as in Station #1

Strike: 180° Dip 21°W
Joints: 65°/77°NW
345°/75°E
Sample #1A-1

Station #1B Elevation 2955

Ronning outcrop
Dolomite medium grey, fine to medium crystalline, no porosity.

Strike: 340° Dip 21°NW
Joints: 340°/90°
50°/82°SE
Sample # 1B-1

Station #1C Elevation 2905

Ronning outcrop
Dolomite grey, fine crystalline, stromatolitic, cherty, no porosity.

Strike: 30° Dip 14°NW
Joints: 340°/80°E
75°/78°N
Sample # 1C

Station 1D — Elevation 2850

Ronning outcrop
Dolomite light grey to white, fine crystalline, medium bedded, no porosity

Strike: 35° Dip 14°NW
Joints: 330°/85°W
90°/80°S
Sample # 1D

Station 1E — Elevation 2880

Ronning Outcrop
Dolomite medium grey, cherty and siliceous, fine crystalline, tight

Strike: 35°/16°NW
Joints: 33°/75°NW
Sample #1E

Station 1F — Elevation 2800

Ronning outcrop
Dolomite light grey-brown, fine crystalline, with some grey mottling, trace intercrystalline porosity.

Strike: 60° Dip 12°W
Joints: 330°/73°NE
55°/74°SE
Sample #1F

Station 1G — Elevation 2755

Ronning outcrop
Dolomite medium grey, medium crystalline, silicified chain corals, stromatoporoids and few brachiopods, no porosity.

Strike: 40° Dip 12°NW
Joints: 330°/85°SW
60°/68°SE
Sample #1G

Station 1H — Elevation 2685

Ronning outcrop
Dolomite medium to coarse grained, grey, thick bedded, no porosity.

Strike 30° Dip 15°NW
Joints: 70°/80°N
340°/90°
Sample #1H

Station 1I — Elevation 2680

Ronning outcrop
Dolomite grey to light brown, coarse crystalline, good intercrystalline porosity.

Strike: 25° Dip 7°NW
Joints: 55°/90°
310°/74°W
Sample #1I

Station 1J — Elevation 2610

Ronning outcrop
Dolomite, grey to light grey, medium crystalline, tight

Strike: 15° Dip 12°W
Joints: 345°/86°E
85°/76°S
Sample #1J

Station 1K — Elevation 2545

Bear Rock outcrop
Limestone dark grey-brown, fine crystalline, fetid odour, tight

No strike dip or joints as outcrop is badly frosted heaved and shattered
Sample # 1K

Station 1L — Elevation 2515

Bear Rock outcrop
Lithology as in Station 1K

Strike: 65° Dip 21°NW
Joints: not apparent
Sample # 1L

Station 1M — Elevation 2500

Ronning outcrop
Dolomite medium grey, with light grey mottling, fine to medium crystalline, siliceous, some scattered vugs up to 1" across with quartz crystal lining.

No apparent bedding
Joints: 45°/76°SE
310°/48°SW
Sample # 1M

Station 1N — Elevation 2590

Ronning outcrop
Dolomite medium grey, fine crystalline, siliceous, no porosity.

Strike: 85° Dip 16°N
Joints: 340°/86°E
50°/76°SE
Sample # 1N-1 1N-2

Station #3 Elevation 2905

This station was used as an elevation check station for checking the altimeter readings during the mapping of the immediate area

Station #4 Elevation 2815

Elevation check station

Station #4A Elevation 2600

Ronning outcrop

Dolomite medium grey brown to light brown micro to fine crystalline beds 1 to 2 feet thick, vuggy porosity with vugs varying in size from pin point to ¼" across. Some vugs are enlarged up to 4" across due to surface leaching.

Strike: 295^{o} Dip 29^{o}S
Joints: $180^{o}/86^{o}$E
$90^{o}/77^{o}$N
$310^{o}/70^{o}$NE
Sample # 4A-1 4A-2

Station #4B Elevation 2650

Ronning outcrop

Dolomite light grey, medium crystalline, fossiliferous with few silicified chain and colonial corals, no porosity.

No visible bedding planes
Sample # 4B

Anderson River Structure on Tadenet Block

On the Tadenet Block immediately south of the Anderson River, at 127°05'W, G.S.C. mapping shows a small doubly plunging anticline. Field mapping indicates that the anticline as such does not exist. Instead a tilted, west dipping fault block of gossage bedded limestones is present at the location. The fault scarp has a relief of about 150 feet and merges imperceptably along strike, to the northwest and southeast, into muskeg covered rolling hill country, so as to give the appearance of NW and SE plunge.

Outcrop is present only along the top of the east facing fault scarp where it has been subjected to heavy frost action. The joints in the Gossage limestone have opened up to several feet wide or more in some cases. The effect ofthe joint widening is to rotate the joint blocks to the northeast, which in turn gives an apparent north east dip. If the apparent northeast dip is mistaken for true dip the fault block would be interpreted as an anticline. From all appearances that is what happened during the G.S.C. mapping and subsequent structural interpretation.

To complicate matters further there are many small anticlinal and synclinal ripples in exposures, north of the fault block, on the Anderson River. Some of these small structures are also present on the fault block and if care is not taken erroneous east dips may be mapped as being part of a large structure whereas they may only be on the flank of one of the small scale features. The exact origin of the small scale structures is unclear but they may be related to buried erosional topography on the top of the underlying Ronning. These features are much to small to warrant their consideration as possible hydrocarbon prospects.

Structure West of Lac Des Bois

In the area west of the prominent east trending peninsula on the west shore of Lac Des Bois there is an area of scattered Ronning outcrop. Outcrop is to sparse to get an exact picture of the structure, but the Ronning is structurally high as Bear Rock breccia outcrops to the west on the east shore of Lac Belot and is present in a thrust fault on the west shore of Lac Des Bois. The above noted thrust fault suggests that the structurally high Ronning may be related to folding associated with thrusting. Lack of sufficient outcrop precludes detailing the area to gain an idea of the nature of the structural high.

At lake level on the west shore of Lac Des Bois just to the north of the eastward projecting peninsula the Bear Rock breccia was observed to be thrust over a Basal? Cretaceous tar sand. Trace of the fault plane in the exposure is N20^{o} and dip 55^{o} NW. The tar sand is badly crumpled beneath the fault and tar has impregnated the Bear Rock breccia for 2 or 3 feet above the fault plane.

Age of the Structures

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Recommendation is here given that on the basis of the Basal Cambrian sand thickness in the Belot Hills M-65 well that Mobil not

Station #4C Elevation 2720

Ronning outcrop

Dolomite light grey-brown on weathered surface, grey brown on fresh, mottled on weathered surface, fossiliferous with silicified horn and colonial corals and few straight cone cephalopods, scattered small vugs less ¼" across but enlarged on surface.

Strike: 280° Dip 20°S
Joints: 225°/77°N
330°/70°E
195°/87°W
Samples 4C-1
4C-2
4C-3
Fossils 4C (2 bags)

Station #4D Elevation 2790

Ronning outcrop

Dolomite as in station 4C but bedding planes not identifiable. Outcrop is traversed by breccia b nds that weave across the outcrop and have no apparent relationship to the joint system, breccia bands are up to 2 feet wide, pinch and swell, breccia fragments are up to 2" across and have a green shaly matrix in part, these breccia zones appear identical to the breccia zones in the Colville E-15 well.

No strike or Dip
Joints: 320°/77°NE
40°/90°
Samples: 4D - breccia sample
4D-1
4D-2
4D-3

Station #4E Elevation 2785

Ronning outcrop

Dolomite grey brown, mottled on weathered surface, few silicified corals, few scattered small vugs no distinct bedding planes

Joints: 50°/78°NW
320°/82°SW
Sample # 4E-1

Station # 4F Elevation 2780

Ronning outcrop stratigraphically below Station 4E
Dolomite grey brown weathering, mottled massive bedded, many silicified stromatoporoids, solitary and colonial (Halysites and Favosites) corals, occasional straight cone cephalopod

Strike: 285° Dip 27°S
Joints: 310°/71°NE
55°/80°NW
305°/50°NE
Sample # 4F-1
Fossils 4F

Station # 4G Elevation 2790

Ronning outcrop stratigraphically below 4F
Dolomite grey brown with mottled weathered surface fine crystalline, beds 10" to 18" thick, narrow linear bands of vuggy porosity with vugs up to ½" across that are enlarged on the weathered surface

Strike 285° Dip 27°S
Joints: 50°/78°NW
290°/47°N
351°/70°NE
Samples: 4G-1
4G-2

Station #4H Elevation 2745

Ronning outcrop
Chert, grey and milky white with bluish tint, finely banded in part and appears to replace stromatolitic carbonate, strongly brecciated in part.

Strike 295° Dip 29°S
Sample 4H-1

Station # 4I Elevation 2680

Ronning outcrop

Dolomite grey brown, fine crystalline, good vuggy porosity with elongated vugs up to 1½" long concentrated in narrow bands that parallel bedding porosity up to 12 - 15%, vugs have a druzzy quartz crystal lining.

Approximately 50 feet of section exposed, at base there is a 15 foot section of milky and grey bedded chert. Chert and overlying dolomite is badly fractured much like in the Colville E-15 well. The chert is finely laminated with contorted stromatolitic layers being very common. Immediately above the chert and at the base of the dolomite there is an irregular brecciated dolomite band, fragments are angular and vary in size from tiny particles to 4" or 5" across. This breccia is oil stained with dark brown weathered oil and some tar.

Strike: 295° Dip 24°S
Joints: 10°/65°W
325°/77°NE
65°/71°N
Samples: 4I-1
4I-2
4I-3 (oil stained)
4I-4

Station # 4J Elevation 2640

Ronning Outcrop

Station 4J is 100 yards south of Station 4I and on same stratigraphic level as chert in Station 4I.
Exposed at Station 4J there is a massive dolomite conglomerate with finely banded brecciated chert overlying it. The contact is not exposed so that the exact stratigraphic relationship between the chert and conglomerate could not be determined. Conglomerate consists of carbonate cobbles up to 4" across. Cobbles are rounded although some are angular and consist of various brown and grey shades of dolomite. This conglomerate could mark a minor unconformity within the Ronning or could be an interformational conglomerate.
Above the conglomerate the beds are finely bedded stromatolitic chert, few well developed stromotolites are 2 feet across and 1 foot high. In coring if a side of a stromatolite was cut erroneous high dips in some cases over 45° would be inferred.

Joints: $10^{\circ}/87^{\circ}E$
$20^{\circ}/55^{\circ}NW$
$5^{\circ}/83^{\circ}E$

Sample 4J-1

Station 4K Elevation 2540

Ronning outcrop
Dolomite, grey brown weathering, light grey on fresh surface, fine to micro-crystalline, massive bedded with fine lamination on weathered surface, fair intercrystalline and fine vuggy porosity.

Strike: 275° Dip $17^{\circ}S$
Joints: $25^{\circ}/85^{\circ}SE$
$315^{\circ}/83^{\circ}S$
Sample: 4K-1

Station 4L Elevation 2485

Ronning Outcrop
Dolomite grey weathering, massive bedded with fine laminations on weathered surface few narrow bands of small elongated vugs. Intercalated with the massive dolomite is grey weathering thin bedded platy dolomite with fine specks of bitumen? in fine pin point vugs.

Strike: 340° Dip 13° unreliable as joints have to be opened by frost action up to 2 feet wide.

Joints: $310^{\circ}/81^{\circ}N$
$40^{\circ}/76^{\circ}NW$
Samples: 4L-2 (massive dol)
4L-1 (thin bedded)

Station 4M Elevation 2605

Ronning outcrop
Dolomite light grey to brown weathering, micro to fine crystalline, few small elongated vugs and minor pin point porosity. Outcrop is slumped in that joint planes have opened up to over a foot wide.

Strike: 325° Dip $14^{\circ}SW$ (not reliable)
Joints: $38^{\circ}/83^{\circ}NW$
$315^{\circ}/90^{\circ}$
Sample: 4M-1

Station #5 & #6 — Elevation check points - no geologic data.

Station 7 — Elevation 2605

Elevation check point

Station 7A — Elevation 2555

Bear Rock Outcrop

Limestone grey weathering medium to dark brown on fresh surface, thin bedded, pelletoid, fetid odour, some intercalated massive breccia, few fine calcite veins in the breccia no porosity.

Strike: 45° Dip 25°NW
Joints: 30°/72°SE
330°/71°SW
Sample: 7A-1 (breccia)
7A-2 (bedded)

Station 7B — Elevation 2550

Bear Rock outcrop 100 feet north of Station 7A

Lithology as in Station 7A

Strike 40° Dip 32°NW
Sample 7B-1

Station 7C — Elevation 2540

Bear Rock Outcrop 150 feet north of Station 7B

Limestone grey weathering, medium to dark brown on fresh surface, pelletoid, fine laminations on weathered surface, no porosity.

Strike 20° Dip 30°NW
Joints 340°/64°NE
Sample 7C-1

APPENDIX

Description of individual stations

Station 8 — Elevation 2640

Elevation check station

Station 8A — Elevation 2635

Bear Rock outcrop 100' north of Station 8
Limestone dark brown on fresh surface, grey weathering, pelletoid, fine bedded, no porosity.

Strike: 85° Dip 11°N
Joints: 340°/84°E
Sample: 8A-1

Station 8B — Elevation 2560

Bear Rock outcrop
Limestone, massive, pelletoid, grey weathering, dark brown on fresh surface, finely laminated on weathered surface, fetid odour, no porosity.

Strike: 42° Dip 18°NW
Joints: 320°/84°NE
10°/84°N
320°/65°SW
Samples: 8B-1
8B-2

Station 8C — Elevation 2355

Ronning outcrop in creek gully
Dolomite grey weathering, light grey on fresh surface, cherty, druzzy quartz crystal lined vugs, vugs are elongated up to ½" long and are aligned in narrow widely spaced bands. Much interbedded white fine bedded stromatolitic chert.

Strike: 180° Dip 26°E
Dip steepens to 35°E at east end of 50 yard long outcrop
Joints: 330°/65°SW
70°/63°NW
Samples: 8C-1
8C-2
8C-3
8C-4
8C-5

Station 8D Elevation 2610

Bear Rock breccia outcrop
Limestone grey weathering, medium dark brown on fresh surface no bedding planes apparent, strongly brecciated, many fine and few large calcite veins, some porosity in the breccia due to openings between breccia fragments.

Joints: 335°/72°W
90°/35°S
35°/72°SE
Samples: 8D-1
8D-2

Station 8E Elevation 2600

Bear Rock outcrop
Limestone grey weathering, dark brown on fresh surface, pelletoid, fetid odor, strike and dip may be anomalous due to drag folding, no porosity.

Strike: 335° Dip 30°SW
Joints: 38°/73°SE
315°/65°NE
Samples: 8E-1
8E-2

Station 8F Elevation 2550

Ronning outcrop
Dolomite, grey weathering, medium grey on fresh surface, fine to medium crystalline, few narrow bands of vuggy porosity, thin irregular strings of white and grey chert and minor stromatolitic chert.

Strike: 50° Dip 30°NW
Joints: 50°/86°SE
310°/75°SW
Samples: 8F-1
8F-2
8F-3

Station 8G Elevation 2530

Ronning outcrop
Dolomite grey weathering, light grey on fresh surface, fine to medium crystalline, poor vuggy porosity vugs less than ½" long but enlarged on surface, few stringers of finely banded stromatolitic chert.

Strike: 15° Dip 35°E
Joints: 350°/83°W
70°/84°SE
Samples: 8G-1
8G-2

Station 8H Elevation 2490

Ronning dolomite outcrop

Strike: 285°?? Dip 29°NE??
Very questionable reading as outcrop is small and appears to have been moved by frost heaving

Sample: 8H-1

Station 8-I Elevation 2585

Ronning outcrop
Dolomite light grey, fine to medium crystalline, with high percentage of milky white chert, no porosity.

Strike: 355° Dip 24°E
Joints: 55°/68°NW
290°/83°S
Sample: 8I-1

Station 9 Elevation 2580

Ronning outcrop
Dolomite, grey weathering, light brown on fresh surface, finely laminated on weathered surface, fine to medium crystalline, fossiliferous with silicified Favosites and Halysites, horn corals and cephalopods, fair small vug, pin point and intercrystalline porosity.

Strike: 83° Dip 16°S
Joints: 70°/77°NW
300°/82°N
Samples: 9-1
9-2
9-3
9 - Fossils

Station 9A Elevation 2555

Ronning outcrop
Dolomite, mottled grey weathering with strongly pitted surface, grey-brown on fresh surface, fossiliferous with poorly preserved silicified colonial corals and few cephalopods fair small vug and pin point porosity.

Strike: 30° Dip 23°SE
Joints: 305°/82°S
35°/68°NW
Samples: 9A-1
9A-2

Station 9B Elevation 2540

Ronning outcrop
Dolomite, grey weathering, light brown on fresh surface, fine crystalline, few scattered vugs and widely spaced narrow bands of elongated vugs.

Strike: 60° Dip 26°SE
Joints: 30°/70°W
285°/76°S
Samples: 9B-1
9B-2

Station 9C — Elevation 2565

Ronning outcrop 150 feet west of Station 9
Dolomite as in Station 9

Strike: 305° Dip 19°SW
Joints: 285°/78°N
20°/90°
Sample: 9C-1

Station 9D — Elevation 2515

Ronning outcrop
Dolomite grey weathering, brown on fresh surface, brecciated with pieces mainly under 2" (much like breccia zones in Colville E-15) few scattered vugs.

Strike: 10° Dip 20°E
Joints: 330°/60°SW
70°/78°N
Sample: 9D-1

Station 9E — Elevation 2490

Ronning outcrop
Dolomite mottled grey-brown weathering, light brown on fresh surface, fine crystalline, few silicified Favosites and straight cone cephalopods, few narrow bands of small vug and pin point porosity.

Strike: 10° Dip 16°E
Joints: 60°/77°NW
335°/79°SW
Samples: 9E-1
9E-2
9E-3

Station 9F Elevation 2415

Ronning outcrop in creek bed
Dolomite grey weathering, brown on fresh surface, chert stringers and nodules, fossiliferous with few silicified colonial corals and cephalopods.

Strike: 15° Dip 24°E
Joints: 35°/68°NW
Samples: 9F-1
9F-2
9F-3

Stations 9F-2 to 9F-7 are spaced at approximately 20 yard intervals and proceed up section on east flank of Belot Dome.

At Station 9F-4 Elevation 2350

Strike: 20° Dip 50°E
Joints: 285°/49°S
Sample: 9F-4

At Station 9F-7 Elevation 2305

Strike: 45° Dip 19°SE
Joints: 290°/81°S
35°/68°NW
Sample: 9F-7

Station 9F-8 Elevation 2280

Ronning outcrop
Dolomite, brown, in beds 6" to 18" thick, medium crystalline, scattered vugs, minor trace of oil stain, strong oil odour, some solid bitumen in the vugs.

Strike: 330° Dip 19°NE
Sample: 9F-8

Station 10 Elevation 2625

Bear Rock outcrop
Limestone grey weathering, dark brown on fresh surface, pelletoid, fetid odour, fine laminations on weathered surface, no porosity.

Strike: 40° Dip 9° SE
Joints: 320°/70°S
90°/74°N
Sample: 10-1

Station 10A Elevation 2455

Ronning outcrop immediately stratigraphically below Bear Rock in Station 10, however contact is not exposed as it is covered by scree.
Dolomite, grey weathering, light brown on fresh surface, fine to medium crystalline, trace intercrystalline and small vug porosity.

Strike: 25° Dip 14°E
Joints: 320°/90°
275°/81°N
Sample: 10A-1

Station 10B Elevation

Bear Rock outcrop
Limestone, grey weathering, dark brown on fresh surface, pelletoid, finely laminated on weathered surface, fine crystalline, no porosity.

Strike: 180° Dip 34°E
Joints: 40°/69°NW
290°/80°S
Sample: 10B-1

Station 10C Elevation 2510

Bear Rock Outcrop
Limestone, grey weathering, dark brown on fresh surface, fetid, pelletoid, finely laminated on weathered surface, no porosity.

Strike: 180° Dip 19°E
Joints: 50°/71°NW
325°/73°SW
Sample: 10C-1

Station 10D Elevation 2490

Bear Rock outcrop
Limestone, grey weathering, brown on fresh surface, thin bedded, pelletoid no porosity, between Station 10D and 10 there is some Bear Rock breccia exposed.

Strike: 330° Dip 25°SW
Sample: 10D-1

At 10D-2 100 feet north of 10D outcrop of Bear Rock limestone

Strike 340° Dip 29°SW
Sample 10D-2

Station 10E Elevation 2560

Bear Rock outcrop
Limestone breccia, mottled grey-brown weathering, brown on fresh surface, fetid odour, outcrop consists of chaotically arranged large and small finely laminated limestone and dolomite blocks, poor irregular vuggy porosity. At base of breccia there are thin bedded brown pelletoid limestones on which the attitude was taken.

Strike: 35° Dip 14°SE
Joints: 320°/90°
60°/76°NW
Samples: 10E-1
10E-2

Station 10F Elevation 2670

Ronning Outcrop
Dolomite, grey weathering, light brown on fresh surface, cherty and siliceous bands and stringers, medium crystalline, good vuggy and intercrystalline porosity, few narrow bands of excellent vuggy porosity.

Strike: 280° Dip $9^{\circ}S$
Joints: $355^{\circ}/90^{\circ}$
$60^{\circ}/90^{\circ}$
Samples: 10F-1
10F-2
10F-3
10F-4

Station 11 Elevation 2585

Bear Rock outcrop
Limestone grey weathering, in beds 3" to 12" thick, dark brown on fresh surface, fetid, pelletoid, partly brecciated with calcite veins healing fractures, no porosity.

Strike: 10° Dip $45^{\circ}E$
Joints: $275^{\circ}/60^{\circ}S$
$5^{\circ}/85^{\circ}E$
Sample: 11-1

Immediately south of station 11 a breccia zone outcrops which consists of chert that looks like reworked Ronning chert. The outcrop is badly chopped up and has the appearance of a tectonic breccia but was interpreted as being a basal Bear Rock deposit that consists of reworked Ronning. Contact with the Ronning nor the Ronning were exposed.

Sample: 11-1A

Station 11B Elevation 2535

Basal Bear Rock conglomerate outcrop.
Conglomerate consisting of clasts of Ronning dolomite and chert, size range of clasts varies from sand size grains to boulders over 2 feet across, average size range is in the order of 2" to 4", most clasts are angular but some are definitely rounded, matrix is a coarse grained dolomite or limestone. A few large cavities have been infilled by

coarse crystalline calcite so that porosity is lacking. The conglomerate is poorly sorted, poorly defined vague bedding gives a strike of 310° and dip 10°NE.

Sample 11B-1

Station 11C — Elevation 2940

Ronning outcrop
Dolomite, grey on weathered surface, light brown on fresh surface, milky white chert interbeds and stringers chert has a few large fine druzzy quartz crystal lined irregular vugs.

Strike: 5° Dip 15°W
Joints: 30°/87°E
305°/71°SW
Samples: 11C-1
11C-2

Station 12 — Elevation 2920

Elevation control point

Station 12A — Elevation 2260

Bear Rock outcrop
Limestone grey weathering, dark brown on fresh surface, pelletoid, beds 3" to 18" thick, fetid odour, no porosity.

Strike: 140° Dip 14°W
Joints: 40°/74°NW
315°/86°NE
Samples: 12A-1
12A-2

Station 12B — Elevation 2630

Ronning outcrop
Dolomite, grey weathering, light grey on fresh surface, fine to medium crystalline, thin bedded and nodular milky chert forms small portion of section, fair intercrystalline porosity, few druzzy quartz crystal lined vugs.

Strike: 25° Dip 16°NW
Joints: 35°/83°W
65°/87°S
Sample: 12B-1

Station 12C Elevation 2580

Ronning outcrop
Dolomite, grey weathering, grey to light brown on fresh surface, few small elongated vugs, dolomite is underlain by milky white fine banded stromatolitic chert. Stromatolites are up to 2 feet across and 1 foot high with the side layers curving downward at angles up to 60°.

Strike: 15° Dip 10°W
Joints: 25°/79°W
95°/81°N
Samples: 12C-1
12C-2

Station 12D Elevation 2530

Ronning outcrop
Dolomite, grey weathering, light grey-brown on fresh surface, medium to coarse crystalline, few scattered irregular vugs.

Strike: 20° Dip 12°NW
Joints: 180°/90°
295°/79°E
Samples: 12D-1
12D-2

Station 12E Elevation 2640

Ronning outcrop
Dolomite grey and light brown on weathered surface, light brown on fresh surface fine to medium crystalline, poor intercrystalline porosity and fair vuggy porosity.

Strike 5° Dip 36°W
Joints: 275°/66°N
350°/41°E
Sample: 12E-1

Station 12F Elevation 2630

Ronning outcrop
Chert milky white, fine banded, stromatolitic.

Strike: 330° Dip 47°SW
Joints: 50°/85°NW
335°/57°NE
Sample: 12F-1

Station 12G Elevation 2895

Ronning rubble no rock in place

Station 12H Elevation 2550

Bear Rock outcrop
Limestone, medium grey brown on weathered surface, dark brown on fresh surface, fetid odour, pelletoid, no porosity.

Strike: 310° Dip 22°N
Joints: 15°/76°NW
340°/74°W
Samples: 12H-1
12H-2

Station 12I Elevation 2620

Bear Rock outcrop
Limestone, grey weathering, dark brown on fresh surface, fetid, pelletoid, no porosity.

Strike: 335° Dip 27°N
Joints: 275°/59°S
10°/74°W
Sample: 12I-1

Station 12J — Elevation 2660

Ronning outcrop
Dolomite grey brown weathering, light brown on fresh surface, fine to medium crystalline, few scattered vugs and trace intercrystalline porosity.

Strike: 300° Dip 44°N
Joints: 40°/86°NW
90°/45°S
Sample: 12J-1

Station 12K — Elevation 2630

Ronning outcrop
Chert, milky white and grey, finely banded, stromatolitic, fractured.

Strike: 335° Dip 30°NE
Joints: 275°/64°S
330°/50°SE
Sample: 12K-1

Station 13 — Elevation 2375

Bear Rock outcrop
Limestone, dark brown, thin bedded pelletoid, no porosity, outcrop is too badly frost heaved to get a useful attitude on the bedding.

Sample 13-1

Station 13A — Elevation 2525

Bear Rock outcrop
Limestone rubble no bedding planes apparent as outcrop is very badly slumped and frost heaved.

Sample 13A-1

Station 14 Elevation 2190

Bear Rock outcrop
Limestone, grey-brown weathering, dark brown on fresh surface, pelletoid, rare poorly preserved brachiopods, no porosity.

Strike: 305° Dip 48°NW
Samples: 14I-1
14 Fossils

Station 14A Elevation 2130

Bear Rock outcrop
Limestone, grey-brown weathering, dark brown on fresh surface, thin bedded, few poorly preserved brachiopods and gastropods that were impossible to collect, no porosity.

Strike: 260° Dip 36°N
Joints: 20°/84°E
270°/55°S
Sample: 14A-1

Outcrop at Station 14 and 14A could possibly be Hume limestones as the limestone is slightly different and fossiliferous as compared to Bear Rock limestones, also not fetid at Stations 14 & 14A

Station 14B Elevation 2160

Bear Rock outcrop
Limestone thin to medium bedded, grey brown weathering, dark brown on fresh surface, pelletoid overlies a massive breccia with chaotically arranged clasts up to 2 feet across Breccia and bedded limestone each 10 feet thick, much coarse crystalline calcite infill destroys all porosity in the breccia.

Flat lying
Joints: 250°/75°W
100°/90°
Slickensides: 330°/72°SW
310°/64°SW
Samples: 14B-2
14B-1

Station 14G Elevation 2075

Bear Rock outcrop
Limestone, grey weathering, dark grey to black on fresh surface, thin bedded, finely laminated on weathered surface, no porosity, slightly up section stratigraphically from 14E

Strike: 310° Dip 5°SW
Joints: 290°/84°S
65°/81°NW
Sample: 14G-1

Station 14H Elevation 2055

Bear Rock outcrop
Limestone, grey weathering, dark brown on fresh surface, outcrop consists of interbedded thin bedded limestone and breccia, thin bedded limestone is pelletoid and fetid, no porosity.

Strike: 310° Dip 53°SW
Joints: 27°/90°
Sample: 14H-1

Station 15 Elevation 1790

Outcrop of Cretaceous sandstone and Bear Rock limestone and Breccia
Limestone, grey weathering, dark brown on fresh surface, fine grained, pelletoid, fetid, with interbedded massive chaotic breccia with blocks several feet across, no porosity.

Strike: 190° Dip 72°W (of Bear Rock)
Joints: 305°/88°SW
Slickensides: 325°/48°NE
Samples: 15-1
15-2
15-3

Cretaceous outcrop consists of sandstone, grey and light brown, medium grained with few coarse grains, fair sorting, weakly cemented, good porosity.

Strike: 15° Dip 88°W (Cret. ss)
Sample: 15-4

The Cretaceous sand outcrop is to the west of the Bear Rock outcrop. A covered interval of 50 feet, separates the two outcrops so that the contact is not exposed.

Station 15A — Elevation 1930

Bear Rock outcrop
Limestone, grey weathering, dark brown on fresh surface, fine grained, pelletoid, thin to medium bedded, no porosity.

Strike: 252° 52° NW
Joints: 210°/53° N
305°/89° S
Sample: 15A-1

Down slope to the west of the Bear Rock outcrop, but not in contact with the limestone due to a covered interval are Cretaceous sandstones.
Sandstone is brown, medium-coarse grained, porous, no apparent bedding is present due to small extent of outcrop. Dip appears to be steep to the NW much like the Bear Rock limestone higher up slope.

Sample 15A-2

Station 16 — Elevation 2055

Bear Rock outcrop
Limestone, grey weathering, brown on fresh surface, fetid odour, fine grained, pelletoid, no porosity.

Strike: 260° Dip 11° SW
Joints: 40°/80° SE
350°/87° SW
Sample: 16-1

Station 17 Elevation 2190

Bear Rock outcrop
Limestone, medium brown, fine, pelletoid, thin to medium bedded, fine laminations on weathered surface, tight, outcro to badly slumped to get reliable strike and dip.

Joints: 297°/90°
32°/81°W
Sample: 17-1

Station 18 Elevation 2290

Bear Rock outcrop
Limestone, brown on fresh surface, fetid odour, fine grained, thin to medium bedded, fine laminations on weathered surface, no porosity.

Strike: 80° Dip 8°N
Joints: 45°/86°SE
120°/83°N
Sample: 18-1

Station 19 Elevation 2300

Ronning outcrop
Dolomite, grey weathering, light brown on fresh surface, fine crystalline, rare silicified straight cone cephalopods, poor small vug porosity.

Strike: 190° Dip 26°W
Joints: 306°/72°SW
80°/66°S
50°/70°SE
Sample: 19-1

Station 20 Elevation 2340

Ronning outcrop
Dolomite, grey weathering, light brown on fresh surface, fine to medium crystalline, good vuggy porosity that occurs in narrow widely spaced bands, minor intercrystalline porosity.

Strike: 30° Dip 21°NW
Joints: 50°/69°SE
320°/86°NE
Samples: 20-1
20-2

Station 21 Elevation 2350

Ronning outcrop
Dolomite, grey brown weathering, grey on fresh surface, fine crystalline, few thin calcite veins (¼" or less thick) trace of small vuggy porosity.

Strike: 280° Dip 24°S
Joints: 300°/69°NE
25°/90°
Sample: 21-1

Station 21A Elevation 2310

Ronning outcrop
Dolomite, grey brown weathering, grey on fresh surface, fine crystalline, few narrow bands of small aligned vugs, trace pin point porosity.

Strike: 285° Dip 24°S
Joints: 40°/85°SE
310°/64°NE
Sample: 21A-1

Station 21B — Elevation 2250

Bear Rock outcrop
Limestone, grey brown weathering, brown on fresh surface, fine grained, fetid odour, thin to medium bedded, few beds of breccia with small angular fragments, trace poor pin point porosity.

Strike: 302° Dip 41°SW
Joints: 300°/63°NE
Sample: 21B-1

Station 22 — Elevation 2710

Ronning outcrop
Dolomite, grey and brown mottled weathering, brown on fresh surface, fine to medium crystalline, good vuggy and fair intercrystalline porosity.

Strike: 315° Dip 10°SW
Joints: 320°/83°SW
40°/85°NW
Samples: 22-1
22-2

Station 23 — Elevation 2360

Bear Rock outcrop
Massive Bear Rock breccia outcrops, few good bedding planes but attitude as measured is reliable as measured on some continuous thin bedded limestones.

Strike: 330° Dip 26°SW
Samples: 23-1
23-2

Station 23A — Elevation 2350

Outcrop of Bear Rock
Outcrop of mainly massive Bear Rock breccia but thin bedded, pelletoid, fine grained, fetid limestones are present at the top of the outcrop, no porosity except in breccia where some vugs are present due to incomplete infill of interclasts spaces.

Strike: 225° Dip 18°SW
Joints: 10°/85°W
325°/67°NE
Samples: 23A-1

Station 24 — Elevation 2450

Bear Rock outcrop
Limestone interbedded thin bedded and massive limestones, brown, fetid, massive beds are partly a breccia.

Strike: 35° Dip 10°NW
Joints: 215°/49°NW
330°/57°NE
Sample: 24-1

Station 24A — Elevation 2470

Bear Rock outcrop
Limestone as in Station 24

Strike: 330° Dip 4°SW
Sample: 24A-1

Station 25 — Elevation 2520

Bear Rock outcrop
Breccia outcrop, no apparent bedding planes, outcrop is strongly jointed and slumped.

Joints: 180°/90°
253°/83°S
Sample: 25-1

Station 25A Elevation 2400

Bear Rock outcrop
Limestone, grey-light brown weathering, dark brown on fresh surface, fine grained, pelletoid, fetid odour, fine laminations on weathered surface, no porosity.

Strike: 355° Dip 9°SW
Joints: 55°/68°SE
310°/80°NE
Samples: 25A-1

Station 25B Elevation 2410

Bear Rock outcrop
Limestone massive, grey weathering, pelletoid fine laminations on weathered surface, no porosity, strongly jointed.

Strike: 15° Dip 31°W at break in slope on west flank, going down slope to west near base of outcrop the dip steepens to 60°W

Joints: 75°/88°NW
340°/74°NE
Sample: 25B-1

Station 26 Elevation 2140

Bear Rock outcrop
Limestone, thin to massively bedded, grey weathering, brown on fresh surface, some massive breccia at base of outcrop no porosity.

Strike: 285° Dip 18°N
Joints: 295°/80°SW
10°/77°E
Samples: 26-1
26-2

Station 27 Elevation 2100

Bear Rock outcrop
Limestone, grey on weathered surface, brown on fresh surface, pelletoid, fetid, thin to medium bedded, no porosity.

Strike: 55° Dip 15°SE
Joints: 15°/90°
320°/86°NE
Sample: 27-1

Station 27A Elevation 1990

Bear Rock outcrop
Breccia and limestone, grey on weathered surface, dark brown on fresh surface, thin to medium bedded, fetid odour, no porosity.

Strike: 180° Dip 17°W
Joints: 55°/86°SE
310°/77°NE
Samples: 27A-1
27A-2

Station 27B Elevation 1900

Bear Rock outcrop
Limestone, dark brown on fresh surface, pelletoid, fetid odour, thin to medium bedded, few massive beds that are partly brecciated, no porosity.

Strike: 30° Dip 40°NW
Joints: 35°/68° SE
330°/65°W
Samples: 27B-1
27B-2
27B-3

Station 28 Elevation 2075

Bear Rock outcrop
Massive Bear Rock breccia with some thin to medium bedded finely laminated limestone, grey on weathered surface, brown on fresh surface, strong fetid odour no porosity.

Strike: 20° Dip 14°NW
Joints: 50°/84°NW
143°/53°SW
Sample: 28-1

Station 29 Elevation 2180

Bear Rock outcrop
Massive breccia with clasts up to 8 feet long, clasts chaotically arranged and consist of fine laminated to thick bedded limestone and dolomite. No true bedding planes are present.

Joints: 290°/68°N
320°/41°SW
Sample: 29-1

Station 30 Elevation 2230

Bear Rock outcrop
Limestone, dark brown, fine grained, thin bedded tight, overlying massive chaotic breccia.

Strike: 195° Dip 23°W
Joints: 290°/86°S
30°/56°SE
Breccia consists of blocks of finely laminated limestone and dolomite, blocks are up to 10 to 15 feet across, chaotically arranged with no apparent bedding and no porosity.

Sample: 30-2 (thin bedded ls)

Station 30A — Elevation 2100

Bear Rock outcrop
Station is on west flank of Belot structure and is on westernmost outcrop at this point. Beds are thin bedded limestone similar to Station 30 and also overlie chaotic massive breccia.

Strike: 15° Dip 66°W
Joints: 355°/90°
85°/65°S
Sample: 30A-1

Station 31 — Elevation 2025

Bear Rock Outcrop
Massive breccia with large angular blocks. Apparent bedding is expressed by some narrow bands of thin bedded limestones

Strike: 315° Dip 17°SW
Joints: 180°/63°E
280°/83°N
Sample: 31-1

Station 32 — Elevation 1940

Bear Rock outcrop
Massive chaotic breccia, with extremely large jumbled limestone and dolomite blocks, few large white calcite infilled vugs and crevices, few apparent true bedding planes formed by narrow bands of thin bedded dark brown limestone.

Apparent Strike: 190° Dip 12°W
Joints: 248°/59°N
15°/82°W
Sample: 32-1

Station 33 Elevation 2170

Bear Rock outcrop
Massive chaotic breccia composed of large dolomite and limestone clasts at various angles of repose, no bedding planes apparent but from a distance from helicopter appears to strike north and dip west.

Joints: $330^{\circ}/85^{\circ}$SW
$55^{\circ}/83^{\circ}$SE
Sample: 33-1

Station 34 Elevation 2100

Bear Rock outcrop
Massive chaotic breccia of large angular dolomite and limestone clasts, no apparent bedding planes.

Joints: $345^{\circ}/85^{\circ}$SW
Sample: 34-1

Station 34A Elevation 1600

Saturday Lake tar sand outcrop
Strongly crossbedded sandstone that is completely tar impregnated outcrops at the foot of the west flank of the Belot Hills at this station. Dip is to the west but is impossible to measure due to the strong crossbedded nature of the outcrop. From the air the dip appears to be in the order of 2° to 3° west with strike being N-S.
Above the basically flat lying sandstone described above, there is a sandstone outcrop part way up the west flank and separated from the tar sand by a covered interval. The sand there is not tar impregnated and is thin bedded with no cross beds. This thin bedded sand lies immediately above the Bear Rock carbonates but the contact is not exposed. From field relationships the thin bedded sand is stratigraphically lower than the tar sand. The exact structural picture is not exposed but at the east end of the tar sand outcrop the beds are bent sharply upward. As no evidence of faulting is present the west flank of the Belot Hills must represent a sharp flexure where the relatively flat lying beds of the plains area to the west are bent sharply upwards to form the west, steep dipping, flank of the Belot structure.

A good attitude was measured on the thin bedded sandstone.

Strike: 15° Dip 56°W

Contact with underlying Bear Rock limestone is not exposed but Bear Rock attitude is.

Strike 10° Dip 35°W
Samples: 34A-1
34A-2
34A-3
34A-4

Station 35 Elevation 2205

Bear Rock outcrop
Massive breccia composed of large angular block, no porosity, vague suggestion of bedding.

Apparent strike: 30° Dip 13°E
Joints: 30°/77°NW
326°/82°SW
Sample: 35-1

Station 36 Elevation 2080

Ronning outcrop
Dolomite, grey brown, mottled on weathered surface, light brown on fresh surface, fine to medium crystalline, beds 3 to 5 feet thick, no porosity.

Strike: 180° Dip - flat lying
Joints: 30°/88°NW
285°/89°NE
Sample: 36-1

Station 37 Elevation

Ronning outcrop
Dolomite, grey-brown mottled weathering surface, which is very rough and pitted, fine to medium, beds mainly 3 to 5 feet thick with few thin interbeds, good vuggy porosity in massive beds with large elongated vugs that are aligned parallel to bedding, minor bitumen in the vugs.

Strike: 300° Dip 4°NE
Joints: 77°/90°
343°/88°NE
Samples: 37-1
37-2

Station 38 Elevation 975

West shore of Lac des Bois north of prominent east trending peninsula.
Section starts in massive Bear Rock chaotic breccia and works down section to the north.
Breccia, dark brown, massive, no apparent bedding, consists of clasts of fine laminated dolomite and limestones in chaotic arrangements no porosity.

Samples 38-1
38-2
38-3
Covered for 150 feet north then small outcrop of breccia.
Sample 38-4
Covered interval for 150 feet then outcrop of Ronning.
Top of Ronning trend is
Strike: 180° Dip 26°E
Approximately 120 feet of Ronning is exposed.
The Ronning consists of dolomite and crumbly green shales that are thin bedded for the most part. The Ronning appears to be exposed in a core of an incompletely exposed small anticline with the Bear Rock being exposed in flank of the anticline.
Trend at north end of Ronning outcrop is:
Strike: 340° Dip 19°SW
Samples: 38-5 to 38-17

Station 39 Elevation 975

South of Station 38 here beds higher in the Bear Rock breccia are exposed at lake level.
About 300 - 400 feet of Bear Rock is present between Stations 38 and 39 these could not be measured or samples taken as the exposures are cliffs that form the shoreline of the lake.
At Station 39 the Bear Rock breccia is thrust over Basal Cretaceous tar sands. The fault plane is exposed and trends $20^{\circ}/55^{\circ}N$
The tar sands are badly crumpled beneath the fault and are exposed for about 150 feet to the south. The sand is highly impregnated and flows under direct heat from the sun.
The Bear Rock immediately above the fault is impregnated with heavy tarry oil from the sand.

Samples: 39-1 Bear Rock
39-2
39-3)
39-4) Tar Sand
39-5)

Station 40 Elevation 975

Cretaceous outcrop along east end of peninsula that extends eastward into Lac des Bois.
Tar Sand is exposed at lake level at north end of outcrop, here only a few feet of highly tar impregnated sand is present with base of sand not exposed. Overlying the tar sand are shales black and grey, thin bedded and platy, few thin (3" or less) bentonite layers, many rounded large concretions that are up to five feet in diameter. Fish scales, bones and Inoceramus shells are found in some of the concretions, shales have a sulphurous odour and some parts of the outcrop has a sulphur dust coating, beds dip very slightly to the south west (probably under 2°)

Samples: 40-1 (tar sand)
40-2)
40-3) shales
40-4)

Station 41 Elevation 1965

Bear Rock outcrop
Massive breccia with large jumbled angular blocks some over 10 feet long no apparent bedding and no porosity.

Joints: $8^{\circ}/72^{\circ}W$
$310^{\circ}/85^{\circ}NE$
Sample: 41-1

Station 41A Elevation 1975

Bear Rock outcrop
Massive chaotic unsorted breccia composed of blocks of various sized fine banded limestone and dolomite, no porosity, no apparent bedding.

Joints: $20^{\circ}/80^{\circ}NW$
Sample: 41A-1

Station 42 Elevation 1580

Bear Rock outcrop
Limestone, grey weathering, medium to dark brown on fresh surface, thin to medium bedded, pelletoid, fetid, outcrop is badly frost shattered and heaved, attitude is difficult to measure in that the outcrop joints are greatly frost expanded, even well back from scarp face the outcrop has been moved resulting in down slope rotation of joint blocks with consequent movement of bedding.

Strike: 305° Dip $12^{\circ}W$
Joints: $295^{\circ}/86^{\circ}NE$ $55^{\circ}/87^{\circ}SE$
Sample: 42-1

Station 42A Elevation 1620

Bear Rock outcrop on east facing scarp; scarp is about 100 feet high with outcrop restricted mainly to the top of the scarp.
Limestone, grey weathering, medium to dark brown on fresh surface, pelletoid, fetid, outcrop is badly frost heaved and shattered, with joints planes opened quite wide.

Strike: 315° Dip 5°NE
Joints: 295°/90°
340°/88°SE
Sample: 42A-1

From the air it appears that the beds forming the top of the east facing scarp plunge very gently to the south, however on the ground it is impossible to measure this apparent plunge.

Station 42B Elevation 1560

Bear Rock outcrop
Limestone, medium brown on fresh surface, fetid, pelletoid, badly frost heaved, attitude is questionable due to movement of outcrop.

Strike: 175° Dip 51°SE
Joints: 170°/47°NW
Sample: 42B-1

Station 42C Elevation 1590

Bear Rock outcrop
Limestone, grey weathering, brown on fresh surface, thin to medium bedded, fetid, pelletoid, no porosity.

Strike: 336° Dip 8°NE
Joints: 27°/81°NW
205°/83°NE
Sample: 42C-1

Station 42G Elevation 1250

Bear Rock outcrop
Limestone, grey weathering, brown on fresh surface, fetid , tight.

Strike: 280° Dip 14°S
Joints: 310°/86°S
270°/38°N
Sample: 42G-1
Attitude taken on flank of small sharp anticline.

Station 42H Elevation 1250

Bear Rock outcrop
Limestone, brown on fresh surface, thin bedded, fetid, tight.

Strike: 318° Dip 4°SW
Joints: 260°/90°
180°/87°E
Attitude measured on flank of small sharp anticline.

Station 42I Elevation 1260

Bear Rock outcrop
Limestone, grey weathering, brown on fresh surface, fetid tight, attitude measured on crest of small anticline that strike N-S and has dips of 11° on the limbs.

Joints: 300°/81°NE
40°/90°
Sample: 42I-1

Station 42J Elevation 1240

Hare Indian Shale outcrop
Shale, grey green crumbly and badly weathered, samples taken for source Rock analysis.

Samples: 42J-1
42J-2

Station 42K Elevation 1620

Bear Rock outcrop
Limestone, grey weathering, brown on fresh surface, pelletoid,tight,fetid.

Strike: 85° Dip 6°S
Joints: 300°/83°N
15°/90°
Sample: 42K-1

Station 42L Elevation 1660

Bear Rock outcrop
Limestone, grey weathering, brown on fresh surface, pelletoid, fetid, tight.

Strike: 310° Dip 2°SW
Joints: 60°/81°SW
230°/90°
Sample: 42L-1

Station 42M Elevation 1670

Bear Rock outcrop
Limestone, grey weathering, brown on fresh surface, fine grained, fetid,pelletoid, tight.

Flat lying
Joints: 315°/90°
35°/88°NW
Sample: 42M-1

Station 43

No station 43
Samples in collection that are labelled 43C to 43M should be 42C to 42M as error in numbering was made.

Station 44 Elevation 2810

Top of Maunoir Dome at Geoditic Survey Cairn

Ronning outcrop
Dolomite, grey-brown mottled weathering, brown on fresh surface, minor vuggy porosity, fine crystalline, outcrop badly disturbed by frost heaving so that no attitude could be measured.

Joints: $80^{o}/90^{o}$
$340^{o}/85^{o}SW$
Sample: 44-1

Station 44A Elevation 2750

Ronning outcrop
Dolomite, grey and brown weathering, grey on fresh surface, medium to coarse crystalline, no porosity except for widely spaced small vugs.

Strike: 347^{o} Dip $10^{o}W$
Joints: $180^{o}/90^{o}$
$75^{o}/80^{o}SE$
Sample: 44A-1

Station 44B Elevation 2760

Ronning outcrop
Dolomite, grey weathering, grey on fresh surface, fine crystalline, poor vuggy porosity that occurs as narrow bands of vugs that are elongated parallel to bedding, siliceous

Strike: 270^{o} Dip $12^{o}N$
Joints: $70^{o}/90^{o}$
$330^{o}/90^{o}$
Sample: 44B-1

Station 44C Elevation 4690

Ronning outcrop
Dolomite, grey-brown weathering, grey on fresh surface, medium crystalline, thin bedded with beds less than 6" thick tight.

Strike: 270° Dip 12°S
Joints: 75°/72°N
355°/90°
Sample: 44C-1

Station 44D Elevation 2670

Ronning outcrop
Dolomite, grey weathering, very cherty and siliceous grading to banded milky chert, fine crystalline, good vuggy porosity in the dolomite and some vugs in the cherty beds, vugs up to 3" across but mainly under 1" are elongated parallel to bedding, with druzzy quartz crystal lining.

Strike: 282° Dip 22°S
Joints: 70°/69°NW
335°/70°E
Samples: 44D-1
44D-2

Station 44E Elevation 2460

Ronning outcrop
Dolomite grey-brown weathering, light brown on fresh surface, cherty with much bonded milky chert as blebs and interbeds, fine crystalline, poor to fair vuggy porosity with vugs up to 1" elongated parallel to bedding and lined with druzzy quartz crystals.

Strike: 215° Dip 21°SE
Joints: 60°/78°NW 280°/85°N
Samples: 44E-1 44E-2

Station 44F Elevation 2340

Ronning outcrop
Dolomite, light grey-brown, medium crystalline, good vuggy porosity, elongated vugs that give outcrop a banded appearance, some of the vugs have a druzzy quartz crystal lining.

Strike: 330° Dip 30°SW
Joints: 345°/66°NE
85°/90°
Sample: 44F-1

Station 44G Elevation 2360

Ronning outcrop
Dolomite, grey weathering, cherty fine to medium crystalline, good vuggy porosity, overlies chert, white, finely banded, partly stromatolitic.

Strike: 25° Dip 12°NW
Joints: 35°/90°
350°/75°NE
Samples: 44F-1
44F-2

Station 44H Elevation 2710

Ronning outcrop
Dolomite, grey-brown mottled weathering, light brown on fresh surface, fine to medium crystalline, poor to fair scattered vuggy porosity, outcrop is badly slumped attitude measurement questionable.

Strike: 63° Dip 19°NW
Joints: 60°/62°SE
335°/80°NE
Sample: 44H-1

Station 44I Elevation 2325

Bear Rock outcrop
Limestone, dark brown, thin bedded, fine, fetid, overlying breccia composed of angular, jumbled, unsorted carbonate clasts up to 1 foot across, no porosity.

Strike: 273° Dip 15°N
Joints: 335°/70°SW
65°/90°
Samples: 44I-1
44I-2

Station 44J Elevation 2665

Ronning outcrop
Chert, grey and milky white, fine banded, stromatolitic with some stromatolites being 2 feet across and one foot high, no porosity.

Flat lying
Joints: 325°/90°
75°/90°
Sample: 44J-1

Station 44K Elevation 2290

Ronning outcrop
Dolomite, grey-brown weathering, grey on fresh surface, fine, much interbedded milky grey chert and chert nodules and stringers, good vuggy porosity in the least cherty intervals, vugs up to 1½" long and elongated parallel to bedding.

Strike: 310° Dip 29° NE
Joints: 50°/84°SE
340°/90°
Samples: 44K-1
44K-2

Station 44-0 Elevation 2390

Ronning outcrop
Dolomite brown and grey mottled weathering, brown on fresh surface, fine to medium crystalline, few poorly preserved straight cone cephalopods and colonial corals, few scattered vugs.

Strike: 340° Dip 35°N
Joints: 35°/56°NW
330°/69°NE
Sample: 44-0-1

Station 45 Elevation 1570

Ronning outcrop
Dolomite grey weathering light grey-brown on fresh surface, thin knobby weathering bedding, fine crystalline, no porosity.

Strike: 55° Dip 3°NW
Joints: 295°/88°E
40°/85°SE
Sample: 45-1

Station 46 Elevation 2340

Ronning outcrop
Dolomite, grey brown weathering, grey on fresh surface, fine to medium crystalline few scattered small vugs, underlain by chert, milky white, banded, stromatolitic.

Strike: 170° Dip 2°W
Joints: 315°/87°SW
75°/88°S
Samples: 46-1
46-2

Station 46A Elevation 2390

Ronning outcrop
Dolomite, grey weathering, light grey-brown on fresh surface, fine crystalline, few druzzy dolomite crystal lined vugs otherwise tight.

Strike: 180° Dip 9°W
Joints: 68°/90°
330°/53°SW
Sample: 46A-1

Station 46B Elevation 2250

Ronning outcrop
Dolomite, grey-brown weathering, light grey on fresh surface, fine crystalline, blebs and small stringers of white milky chert, few druzzy quartz crystal lined vugs.

Strike: 355° Dip 36°W
Joints: 320°/77°E
55°/47°SE
Samples: 46B-1
46B-2

Station 46C Elevation 2250

Ronning outcrop
Dolomite, grey-light brown weathering, light grey on fresh surface, fine to medium crystalline, widely separated bands of good vuggy porosity, vugs up to 3" long and elongated parallel to bedding.

Strike: 145° Dip 7°W
Joints: 65°/64°SE
325°/88°SW
Samples: 46C-1
46C-2

Station 46D Elevation 2190

Ronning outcrop
Dolomite grey weathering, grey on fresh surface, medium crystalline, small blebs and knobby stringers of grey chert, minor vuggy porosity with narrow bands of small vugs aligned parallel to bedding.

Strike: 140° Dip 11°W
Joints: 350°/80°E
90°/63°N
Samples: 46D-1
46D-2

Station 46E Elevation 2250

Ronning outcrop
Dolomite, grey and brown mottled weathering light brown on fresh surface, fine to medium crystalline, cherty and siliceous, with poorly preserved siliceous colonial corals, good small vuggy porosity.

Strike: 145° Dip 9°SE
Joints: 75°/90°
340°/87°E
Sample: 46E-1

Station 46F Elevation 2000

Ronning outcrop
Dolomite, grey weathering, grey on fresh surface, medium crystalline, poor to fair vuggy porosity with vugs up to 1" long and elongated parallel to bedding.

Strike: 345° Dip 4°NW
Joints: 55°/87°SE
345°/83°NE
Samples: 46F-1
46F-2

Station 46G Elevation 1960

Ronning outcrop
Dolomite, grey weathering, grey-brown on fresh surface, medium crystalline, poor to fair scattered and banded vuggy porosity, vugs are elongated parallel to bedding and up to 1½" long.

Strike: 180° Dip 7°W
Joints: 55°/69°SE
330°/90°
Sample: 46G-1
46G-2

Station 46H Elevation 2120

Ronning outcrop
Dolomite grey weathering, light brown on fresh surface, medium to coarse crystalline, many rounded blebs and thin stringers of grey chert, fair intercrystalline and poor vuggy porosity.

Strike: 280° Dip 11°S
Joints: 330°/69°NE
60°/90°
Sample: 46H-1

Station 46I Elevation 2190

Ronning outcrop
Dolomite grey weathering, light brown on fresh surface, siliceous, with silicified fossil debris, few grey chert blebs and stringers, poor vuggy porosity.

Strike: 305° Dip 26°NE
Joints: 70°/79°SE
355°/86°W
Sample: 46I-1

Station 46J Elevation 2240

Ronning outcrop
Dolomite grey weathering, light grey-brown on fresh surface, medium to coarse crystalline, beds 2 to 5 feet thick, good vuggy porosity with vugs elongated parallel to bedding and up to 1½" long.

Strike: 315° Dip 15°NE
Joints: 65°/90°
335°/88°NE
Sample: 46J-1

Station 46K Elevation 2290

Ronning outcrop
Dolomite, grey weathering, light grey-brown on fresh surface, medium crystalline, few scattered druzzy quartz crystal lined vugs.

Strike: 35° Dip 19°SE
Joints: 320°/90°
65°/74°NW
Sample: 46K-1

Station 46L Elevation 2230

Ronning outcrop
Dolomite, grey brown weathering, grey on fresh surface, thin bedded, fine to medium crystalline, minor chert stringers, dolomite crystal infilled vugs, tight.

Flat lying
Joints: 180°/90°
80°/84°S
Sample: 46L-1

Station 46M Elevation 2320

Ronning outcrop
Dolomite, grey weathering, light grey brown on fresh surface, fine to medium crystalline, few narrow bands of small elongated vugs.

Strike: 330° Dip 3°E
Joints: 335°/90°
50°/90°
Sample: 46M-1

Station 46N Elevation 2440

Ronning outcrop
Dolomite, grey weathering, light grey brown on fresh surface, coarse crystalline, good vuggy porosity with vug bands several inches to several feet thick, vugs are elongated parallel to bedding.

Strike: 295° Dip 9°E
Joints: 335°/81°S
60°/76°SE
Samples: 46N-1
46N-2
46N-3

Station 46-0 Elevation 2190

Ronning outcrop
Dolomite, grey weathering, light grey-brown on fresh surface, fine to medium crystalline, few scattered small vugs.

Strike: 345° Dip 18°NE
Joints: 340°/87°SW
40°/75°NW
Sample: 46-0-1

Station 46P Elevation 2360

Ronning outcrop
Dolomite grey weathering, tan on fresh surface, medium to coarse crystalline, poor vuggy and intercrystalline porosity. Exposure here is good but there are many small anticlines and synclines so that a true strike and dip is impossible to arrive at. General impression is that the beds strike generally north and dip east.

Joints: $47^{\circ}/75^{\circ}$ NW
$315^{\circ}/87^{\circ}$ NE
Sample: 46P-1

Station 46Q Elevation 2260

Ronning outcrop
Dolomite, grey weathering, tan on fresh surface, fine to medium crystalline, good vuggy porosity with fine druzzy quartz crystal lined vugs.

Strike: 85° Dip 9°S
Joints: $180^{\circ}/90^{\circ}$
$80^{\circ}/88^{\circ}$ S
Sample: 46Q-1

Station 47 Elevation 1950

Ronning outcrop
Dolomite grey weathering, tan-light brown on fresh surface, thin to medium bedded, medium to coarse crystalline, few narrow bands of druzzy quartz crystal lined elongated vugs.

Strike: 300° Dip 10°SW
Joints: $340^{\circ}/90^{\circ}$
$80^{\circ}/84^{\circ}$S
Sample: 47-1

Station 47A Elevation 1950

Ronning outcrop
Dolomite, grey weathering, tan to light brown on fresh surface, massive bedded, few thin beds of cherty dolomite, medium crystalline, fair vuggy porosity, with vugs up to 1½" long and elongated parallel to bedding.

Strike: 300° Dip 14°SW
Joints: 60°/84°SE
330°/74°SW
Sample: 47A-1

Station 47B Elevation 2290

Ronning outcrop
Dolomite, grey brown weathering, grey on fresh surface, fine to medium crystalline, thin bedded beds 1" to 6" thick, no porosity.

Strike: 180° Dip 3°W
Joints: 75°/90°
343°/86°E
Sample: 47B-1

Station 47C Elevation 2550

Ronning outcrop
Dolomite, grey and light brown weathering, tan on fresh surface, medium to coarse crystalline, few large grey chert nodules, poor vuggy porosity with elongated vugs in narrow bands parallel to bedding, druzzy quartz crystals line most vugs.

Strike: 15° Dip 9°W
Joints: 65°/90°
345°/80°NE
Sample: 47C-1

Station 48C Elevation 2430

Ronning outcrop
Dolomite, grey and light brown weathering, tan on fresh surface, fine to medium crystalline, few grey chert nodules and thin stringers, good vuggy porosity with vugs elongated parallel to bedding.

Strike: 350° Dip 8°E
Joints: 320°/86°SW
85°/90°
Sample: 48C-1

Station 48D Elevation 2500

Ronning outcrop
Dolomite grey and light brown weathering, grey or tan on fresh surface, fine wavy laminations on weathered surface, fine crystalline, beds 2 to 3 feet thick, very few scattered small vugs.

Strike: 355° Dip 7°E
Joints: 75°/81°N
335°/90°
Sample: 48D-1

Station 48E Elevation 2550

Ronning outcrop
Dolomite, grey weathering, grey to tan on fresh surface, fine to medium crystalline, beds 18" to 4 feet thick, no porosity.

Flat lying
Joints: 300°/90°
15°/90°
Sample: 48E-1

Station 48F Elevation 2430

Ronning outcrop
Dolomite, grey weathering, tan on fresh surface, fine to medium crystalline, few large silicified colonial corals, no porosity.

Strike: 345° Dip 10°W
Joints: 280°/90°
10°/85°E
Sample: 48F-1

Station 48G Elevation 2600

Outcrop of red and dark brown conglomerate, ill sorted clasts of chert and dolomite that originally came from the Ronning formation, clasts vary in size up to a foot across, most are angular but some beds are composed of mainly rounded to subrounded clasts, cement is a hematite rich medium to coarse sandstone matrix, this outcrop of conglomerate is basically flat lying although it is strongly cross bedded. The Ronning is present on the slope immediately above the conglomerate outcrop, however there is no Ronning dolomite in place, just a scree slope. Therefore, the exact structure relationship between the conglomerate and the Ronning could not be determined.

Sample: 48G-1

Station 48H Elevation 2760

Ronning outcrop
Dolomite grey weathering, brown on fresh surface, fine crystalline, fine laminations on weathered surface, several narrow bands of vuggy porosity with the vugs elongated parallel to bedding.

Strike: 170° Dip 17°W
Joints: 75°/88°N
320°/ 90°
Sample: 48H-1

some vugs have druzzy quartz crystal lining.

Flat lying
Joints: $350^{o}/85^{o}E$
$350^{o}/56^{o}E$
$80^{o}/90^{o}$
Samples: 49C-1
49C-2

Station 50 Elevation 1760

Bear Rock outcrop
Bear Rock scree - not good enough to measure attitudes or joints, Limestone, grey weathering, grey-brown on fresh surface, strong fetid odour, no porosity.

Sample 50-1

Station 51 Elevation 1720

Ronning outcrop
Dolomite, grey weathering, brown on fresh surface, fine to medium crystalline, beds thickness varies between 1" and 2 feet, fine laminations on weathered surface, thicker beds have scattered elongated vugs.

Flat lying
Joints: $85^{o}/90^{o}$
$320^{o}/90^{o}$
Sample: 51-1

Station 52 Elevation 2200

Ronning outcrop
Ronning dolomite breccia that appears to be a fault breccia, outcrop is badly weathered and slumped trend of small canyon with the breccia outcrop is 50^{o}, this trend is probably the trend of the fault.

Sample 52-1

Station 53 Elevation 2390
Ronning outcrop

Dolomite, grey and light brown weathering grey on fresh surface, beds 2" to 2 feet thick, few laminations on weathered surface, much white and grey stromatolitic and irregular knobby bedded grey chert, good vuggy porosity.
This outcrop is on a crenulation or small anticlinal ripple on the west dipping limb of main fold therefore strike and dip are anomalous.

Strike: 350° Dip 13°E
Joints: 40°/90°
335°/85°SW
Sample: 53-1

Station 54 Elevation 2350

Just to west of Station 53
Ronning outcrop
Dolomite grey and light brown weathering, brown on fresh surface, fine crystalline, extremely cherty with a very high percentage of milky, fine banded, stromatolitic chert, good vuggy porosity in the dolomite and chert with some elongated druzzy quartz crystal lined vugs up to 6" across.

Strike: 310° Dip 18°W
Joints: 310°/86°NE
30°/87°SE
Sample: 54-1

Station 55 Elevation 2450

Ronning outcrop
Dolomite grey weathering, highly siliceous and cherty, medium crystalline, few scattered vugs:

Strike: 340° Dip 11°W
Joints: 330°/90°
70°/90°
Sample: 55-1

Station 56 Elevation 2620

Ronning outcrop
Dolomite, grey weathering, grey on fresh surface, fine to medium crystalline, fine laminations on weathered surface, no porosity.
Outcrop here is a series of small anticlinal and synclinal folds that trend 275° with limbs dipping up to 20°. These structures are superimposed on the main west dipping limb of the main fold.

Sample: 56-1

Station 57 Elevation 2550

Ronning outcrop
Dolomite grey weathering, grey on fresh surface, fine crystalline, highly siliceous and cherty, few small scattered vugs.

Strike: 320° Dip 16°W
Joints: 65°/80°SE
330°/70°NE
Sample: 57-1

Station 58 Elevation 2030

Ronning outcrop
Dolomite, grey weathering, light brown on fresh surface, fine crystalline, few poorly preserved brachiopods, few scattered vugs.

Flat lying
Joints: 55°/77°NW
340°/86°W
Sample: 58-1

Station 59 Elevation 2400

Ronning outcrop
Dolomite grey weathering, grey on fresh surface, fine to medium crystalline, few narrow bands of elongated vugs that are aligned parallel to bedding.

Strike: 315° Dip 17°NE
Joints: 330°/83°SW
55°/90°
Sample: 59-1

Station 60 Elevation 2600

Ronning outcrop
Dolomite grey weathering, grey on fresh surface, fine crystalline, very cherty and siliceous, chert and siliceous content give outcrop a banded appearance, poor vuggy porosity.

Strike: 10° Dip 24°W
Joints: 45°/90°
305°/57°NE
Sample: 60-1

Station 61 Elevation 2130

Ronning outcrop
Dolomite, grey weathering, grey-light brown on fresh surface, fine crystalline, poor vuggy and intercrystalline porosity.

Strike: 10° Dip 16°W
Joints: 50°/85°SE
325°/65°NE
Sample: 61-1

Station 64B Elevation 1990

Ronning outcrop
Dolomite grey weathering, brown on fresh surface, fine laminations on weathered surface, fine crystalline, no porosity.

Strike: 70° Dip 5°N
Joints: 290°/90°
10°/82°E
Sample: 64B-1

Station 64C Elevation 1935

Ronning outcrop
Dolomite, grey weathering, grey on fresh surface, fine to medium crystalline, fine laminations on weathered surface, thin bedded, no porosity.

Strike: 320° Dip 3°SW
Joints: 327°/90°
65°/90°
Sample: 64C-1

Station 64D Elevation 1840

Ronning outcrop
Dolomite, grey weathering, brown on fresh surface, fine laminations on weathered surface, fine crystalline, thin bedded, no porosity.

Strike: 290° Dip 8°N
Joints: 310°/85°NE
55°/71°SE
Sample: 64D-1

Station 64E Elevation 1970

Ronning outcrop
Dolomite, grey weathering, brown on fresh surface, fine crystalline, thin to medium bedded, no porosity.

Strike: 325° Dip 4° SW
Joints: 65°/86° NW
335°/90°
Sample: 64E-1

Station 64F Elevation 1980

Ronning outcrop
Dolomite, grey and brown weathering, grey on fresh surface, fine to medium crystalline, fine laminations on weathered surface, few small flattened vugs are only sign of porosity.

Strike: 280° Dip 12° N
Joints: 5°/90°
290°/80° S
Sample: 64F-1

Station 64G Elevation 2270

Ronning outcrop
Dolomite grey weathering, grey on fresh surface, cherty bands, medium crystalline, few narrow bands of elongated vugs otherwise tight.

Strike: 35° Dip 14° NW
Joints: 30°/90°
295°/77° S
Sample: 64G-1

Station 64H — Elevation 2250

Ronning outcrop
Dolomite grey weathering, grey on fresh surface, fine crystalline, no porosity, outcrop is too badly frost heaved to measure attitude.

Joints: $350^{\circ}/78^{\circ}E$
$85^{\circ}/90^{\circ}$
Sample: 64H-1

Station 65 — Elevation 2200

Bear Rock outcrop
Massive Bear Rock breccia, clasts are angular and up to 1 foot across, unsorted and in chaotic arrangement, no porosity, no apparent bedding.

Joints: $30^{\circ}/90^{\circ}$
Sample: 65-1

Station 66 — Elevation 910

Bear Rock outcrop
Rubble from Bear Rock breccia no rock in place

Sample: 66-1

Station 67 — Elevation 990

Bear Rock outcrop
Massive breccia of angular clasts up to several feet across, chaotic arrangement of clasts, no apparent bedding.

Joints: $295^{\circ}/75^{\circ}SW$
$50^{\circ}/78^{\circ}SE$
Sample: 67-1

Station 68 Elevation 980

Bear Rock Outcrop
Limestone, brown on fresh surface, grey weathering, fine crystalline, fetid, no obvious bedding planes but not brecciated, no porosity.

Joints: $280^{o}/90^{o}$
$180^{o}/90^{o}$
Sample: 68-1

Station 69

Basal Cambrian Sand Outcrop
Approximately 200 feet of sandstone exposed, neither top nor bottom contacts are exposed at this locality. Outcrop is badly frost heaved and joints widely expanded. Sandstone, grey and brown, medium to coarse grained, few thin conglomerate stringers with rounded pebbles under 1" in diameter, sorting is fair to good, outcrop is strongly crossbedded with low angle cross beds that indicate that the sand source was to the east, porosity is good to excellent with some of the sand beds being soft and friable.

Samples: 69-1
69-2
69-3
69-4

Station 70

Basal Cambrian Sandstone Outcrop
Outcrop is badly frost shattered and heaved. Section exposed here is only about 25 feet.
Sandstone, grey, medium to coarse, generally well sorted, few stringers and lenses of conglomerate that consists of pea size granules, cross bedding is well developed and of massive low angle type. Outcrop has a surface case hardening which destroys porosity on surface, knocking off the surface case hardened layer exposes sandstone that has poor to fair porosity, undoubtedly by digging well down into the outcrop the porosity should increase.

Samples: 70-1
70-2

Station 71

Basal Cambrian Sandstone Outcrop
Approximately 30 feet of sand exposed at this station, there are many scattered small outcrops exposing 30 feet or less of section, it is estimated that over 200 feet of sand is present in the area of the station but a composite section would have taken several days to make, even if a helicopter rather than the Beaver was being used.
Sandstone is grey and brown, medium to coarse, good sorting, case hardened on surface in a layer several inches thick, but poor porosity was found by digging down into the outcrop so that the tight sand is only a surface feature.

Samples: 71-1
71-2