GEOLOGY OF THE
NORTH NAHANNI - ROOT RIVER AREA
ENCOMPASSING PERMITS
5504, 6918, 6919, 6922 and 6923

- by -

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ABSTRACT

This report covers the stratigraphic geology of an area that extends from the Nahanni Plateau to the Redstone River and follows the trend of the Rouge, Redstone, Dusky, Whittaker and Iverson Ranges. It also includes an account of the detailed structural geology of the Permits #5504, 6918, 6919, 6922 and 6923. The area was studied in the field from July to August, 1971.

The stratigraphic studies were directed to assess the reservoir and source potential of formations from Ordovician to Middle Devonian that lie within the permit areas. Significant reef trends of sucrosic dolomite were found in the Whittaker Formation and the Bear Rock Group. The relation of these trends to the permit areas was plotted and their potential assessed.

A photogeological study was made of each permit area. This was checked by aerial reconnaissance and on the ground. Detailed structural sections were made of three anticlines, one in each permit, to assess closure and their economic prospectiveness.

Recommendations for each permit area are appended.

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SUMMATION AND RECOMMENDATIONS

I. PERMIT #5504

Hollow Mountain Anticline - 50% Westcoast Petroleum, 50% Mesa Petroleum

The Hollow Mountain Anticline is a box fold that formed as a result of decollement folding in the Laramide Orogeny. It is thrust to the east. Continued compression from the west caused oversteepening of the western limb and a reverse thrusting to the west. The anticline is 12 miles long and has a maximum width of 1 1/2 miles. It has 1000+ feet of effective closure. The bituminous dolomites of the Bear Rock Group are the prospective target. A 600+ foot reefal step could mark the reef to off reef transition of these dolomites with basinal shales over the crest of the anticline. An estimated 1400 feet of impervious Funeral shales overly and cap the Bear Rock dolomites. The facies boundary from shale to dolomite should provide an excellent velocity contrast for seismic differentiation of a potential reef edge in the Bear Rock Group.

An alternate reservoir could exist in the Sombre Formation. The sharpness and angularity of the box folding must have placed great compressional stress on the competent dolomites of the Sombre Formation. Intense brecciation and good fracture porosity could be expected in the core of this anticline. Drilling depth to the Bear Rock Group would be 1400+ feet and 2000+ feet to the Sombre Formation.

Negative Features

The Bear Rock reef trend (Manetoe Formation) sweeps in an accurate line east of the permit area. A potential reef step was observed in front of

this major reef front in the North Nahanni Gorge.

Several alternate possibilities for a reef step in the crest of the anticline exist:

a) Any and all Bear Rock reef steps lie to the east of the permit area.

b) The main reef was localized throughout all Bear Rock time and the dolomites encountered at Texaco Ram Plateau N-44 and Texaco North Nahanni N-42 would remain basinal dolomites to the base of the formation.

Recommendation

It is recommended that Westcoast and Mesa run a seismic line from the syncline to the east across the crest of the anticline to delineate a possible reefal step in the Bear Rock Group. Just north of the crestal culmination a stream has breached the anticline and would provide ready access for this traverse line.

The eastern limb of the syncline dips sharply to a faulted axis. This limb should be included in the seismic coverage since it would provide a suitable trap for a porosity pinchout of reef to off reef.

II. PERMITS #6918 and 6919

North Root River Anticline - Westcoast 100%.

These permits are dominated by the North Root River Anticline. This anticline is over 17 miles long and 4 miles wide. The crest follows a sinuous course and dips gently to the south for almost sixteen miles. North of the crestal culmination, the northward nose of the anticline is thrust faulted and lacks effective closure.

A Whittaker reef trend of sucrosic dolomite is estimated to pass across the crestal culmination of the anticline. However, biostromal reef fingers could bleed off any potential reservoir to the northern thrust contact with the Dusky Anticline.

The possibility does exist for an updip pinchout of a Whittaker reef along the south plunging nose of the anticline. Delineation of such a reef seismically would be difficult for two reasons: 1) the crestal terrain of the south plunging nose is so rough that it would not be possible to move conventional seismic equipment along it; 2) the velocity contrast between reef and enclosing dolomites would be negligible.

Recommendation

It is recommended that Westcoast Petroleum drop these two permits upon the expiry of the current work bonus.

III. PERMITS #6922 and 6923

Marten Creek Block

All anticlines inspected in these two permit blocks were either breached, lacked effective closure or were surficial flexures.

Recommendations

It is recommended that Westcoast Petroleum terminate these two permits upon expiry of the current work bonus.

OPERATIONS

A geological field party was sent into the general North Nahanni River, Root River-Redstone River area (Fig. 1) by Westcoast Petroleum Ltd. from July 6 to August 6 to evaluate Permits #5504, 6918, 6919, 6922 and 6923. The field work was in two parts. It was intended to establish a base camp at Iverson Lake for the period July 6 to July 21 to evaluate Permit #5504 and then move to Slim Lake for the balance of the period to evaluate Permits 6918, 6919, 6922 and 6923. These arrangements were made in anticipation that the weather would remain fine and without recognition of the vicissitudes of Okanagan's Bell helicopter 47G3B-1. However, these two factors profoundly modified the plans of the party in the field.

A base camp was established at Iverson Lake July 6 and geological reconnaissance commenced July 7. Discovery of damage to the right side of the rear elevator of the helicopter July 8 necessitated repairs in Norman Wells. Further engine defects were found that kept this machine in Norman Wells until July 13. A replacement helicopter came in July 12 and broke down the same evening at the head of English Chief River. This machine was operative again July 12. Altogether seven and one half days were lost from down time on Okanagan's machine. Five full days and four half days were lost because of weather.

Continuous rainstorms from July 20 to July 23 delayed the camp move from Iverson Lake to Slim Lake until July 24. The northern part of the operation ran very smoothly until the helicopter again broke down August 2 and remained inoperative until the close of the field party August 6.

PERSONNEL

Westcoast Petroleum's field party consisted of the following personnel:

Peter McGill	Westcoast - Party Chief
Riaz Chaudhry	Westcoast - Geologist
Gabriele Foschi	Temporary - Geologist
Glenn Mossop	Temporary - Assistant
Jim Fisher	Cook - supplied by Canfield Services
Pat Rorison	Pilot - Okanagan Helicopters
Ken Knopp	Mechanic's Assistant July 6-24 - Okanagan Helicopters
Barry Stone	Licenced Mechanic July 24-August 6 - Okanagan Helicopters

The personnel were extremely pleasant and willing. They unquestionably contributed to the success of the party in the face of rather adverse conditions.

TRANSPORTATION

Okanagan supplied one Bell 47G3B-1 helicopter. As already detailed, the mechanical deficiencies of this machine (7 1/2 days of down time) restricted the scope of this survey despite the excellence and technical competence of the staff supplied.

Gas, personnel and supplies were hauled by various Otter aircraft and pilots from Northward Aviation. All arrangements with Northward worked smoothly.

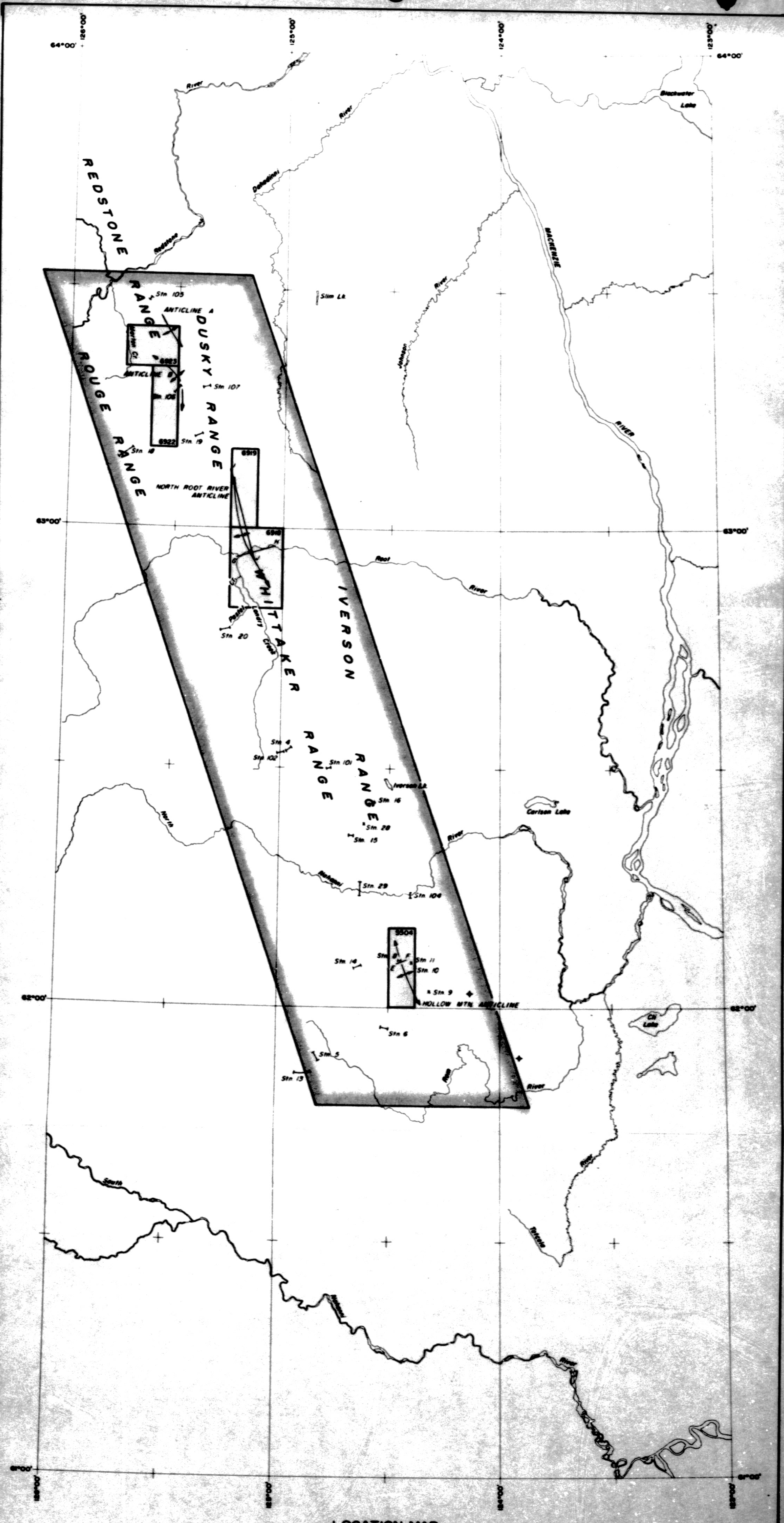
INTRODUCTION

The function of Westcoast Petroleum's field party was to explore the petroleum potential of three permit blocks in the general North Nahanni-Root River area (Fig. 1). Exploration was directed towards finding favorable combinations of structure and stratigraphy for entrapment of hydrocarbons. The area is characterized by sharply folded anticlines and broad synclines, a function of décollement folding and a reflection of the structural style of this portion of the Mackenzie Mountain Fold Belt. The prospective formations in these structures are entirely Paleozoic and range in age from Ordovician to Middle Devonian. Predominantly it is a carbonate sequence and within the interfingering tongues of carbonate there are lateral lithologic variations from back reef carbonates to reefal sucrosic dolomites and basinal shales and limestones.

The photogeology of each permit area was prepared by J. Bakhoven prior to the departure of the field party. From this work, the major structures were known. It remained for the field party to check the photogeologic interpretation, collect dips and strikes and assess the structural closure of each anticline. Stratigraphic sections were measured and lithologies studied with two things in mind. One, to assess the porosity potential of a given formation within a structure. Two, lithofacies were studied in order to delineate reef trends and assess their prospectiveness within the permit area.

Three Geological Survey of Canada papers by Douglas and Norris (1960 1961 and 1963) ably described the geology of the area. These papers were referred to constantly. The G.S.C. work in this area was reconnaissance geology. The lithofacies studies were entirely the product of Westcoast geologists.

In this report it is proposed to describe the lithology of successive formations from Ordovician to Middle Devonian. Following some discussion of the mechanics of décollement folding and the structural style of this part of the Mackenzie Mountain Fold Belt, significant anticlines in each permit area will be discussed separately. A summation and recommendations are given at the beginning of the report.



LOCATION MAP
SHOWING PERMIT AREAS
AND PRINCIPAL TOPOGRAPHIC FEATURES

Figure 1

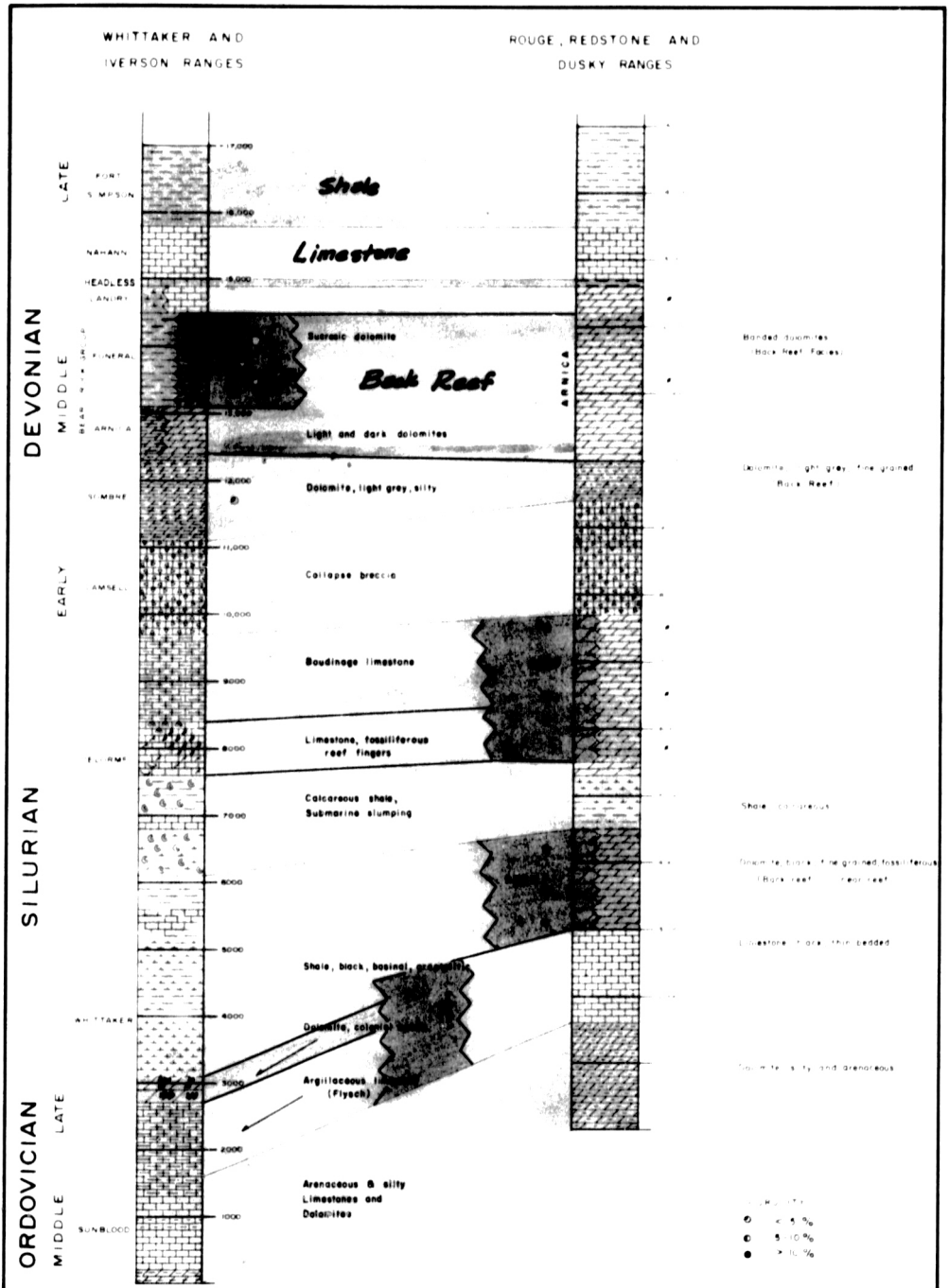


FIGURE 2

GENERALIZED STRATIGRAPHIC COLUMNS OF THE ORDOVICIAN TO DEVONIAN SEQUENCE FOR AREA STUDIED

STRATIGRAPHY

INTRODUCTION

The area covered by stratigraphic field work follows the strike of the Redstone, Rouge, Whittaker and Delorme Ranges (Fig. 1). From Ordovician until Middle Devonian time the hingline between the stable platform (craton) to the east and the basinal sediments to the west lay along the same trend except that north of the Root River it swings more to the northwest. Both in a vertical and a lateral sense the sediments in this area are highly variable in response to migrating positions of the hingeline.

Two generalized lithologic columns have been drawn to show the lithologic succession and the contrasting lithologies between the stable shelf to the north in the Rouge, Redstone and Dusky Ranges and the more basinal sediments to the south in the Whittaker and Iverson Ranges (Fig. 2). Altogether there are some 15,000+ feet of sediments from the Middle Ordovician to the top of the Middle Devonian.

The lowest sediments exposed in this area are green shales but they are not in stratigraphic contact with adjacent strata. They have been caught up in thrusts on the Delorme and Whittaker Range and have then acted diapirically. The green shale is believed to equate with the evaporitic sequence of the Saline River Formation of Cambrian age.

The lowest formation exposed in this area is the Sunblood. It is a variably silty to arenaeous dolomite. It is overlain by the Whittaker Formation. To the north in the Rouge, Redstone and Dusky Ranges this formation is either reef or near reef dolomites. In contrast to the south it consists of cyclic deposits of argillaceous limestone and shale and black graptolitic shales. The

overlying Delorme is a fine grained dolomite in the north but to the south it is either epigenetic slumped shales or boudinage limestones.

The Camsell Formation is remarkably uniform over the whole area. It consists of a limestone collapse breccia. It only loses its lithologic character to the south at Tundra Ridge Station 13 (Fig. 1).

The Sombre Formation thins to zero in the north at the Redstone River on the Redstone Range. To the south and west it thickens dramatically. The overlying Bear Rock Group has a diverse number of lithofacies that reflect the varying environment of deposition. The Arnica Formation is a back reef dolomite. The Manetoe is a reefal, sucrosic dolomite facies while the Funeral shales are the basinal equivalents of these same formations. The Landry Formation is a separate event with a reef trend distinct from the underlying Bear Rock Group.

Throughout the study area the Headless Formation is an interbedded shale and calcareous shale overlain by the Nahanni Formation. The shale out edge of this latter formation, a micritic-skeletal limestone, was observed in the Nahanni Plateau but generally lies to the west of the study area.

Some intergranular porosity was found in the sucrosic dolomites of the Whittaker and Bear Rock reefs. Normally poor, leached, vuggy porosity was found in the reef facies of the Delorme Formation and in the back reef facies of the Delorme and Arnica Formations.

SUNBLOOD FORMATION

In this study the Sunblood Formation was only examined at two localities, on the east flank of the Whittaker Range and at Pastel Creek. The formation is orange to rusty weathering. It is very distinctive in the field.

On the Whittaker Range 1,615 feet are exposed (Douglas and Norris, 1961). Sediments vary from argillaceous limestones to silty limestones and dolomites and dolomitic sandstones. At Pastel Creek (Station 20) sediments consisted of silty and sandy dolomites with some sandstones, fine to coarse grained and cross bedded. There is a fault contact on both sides of this section.

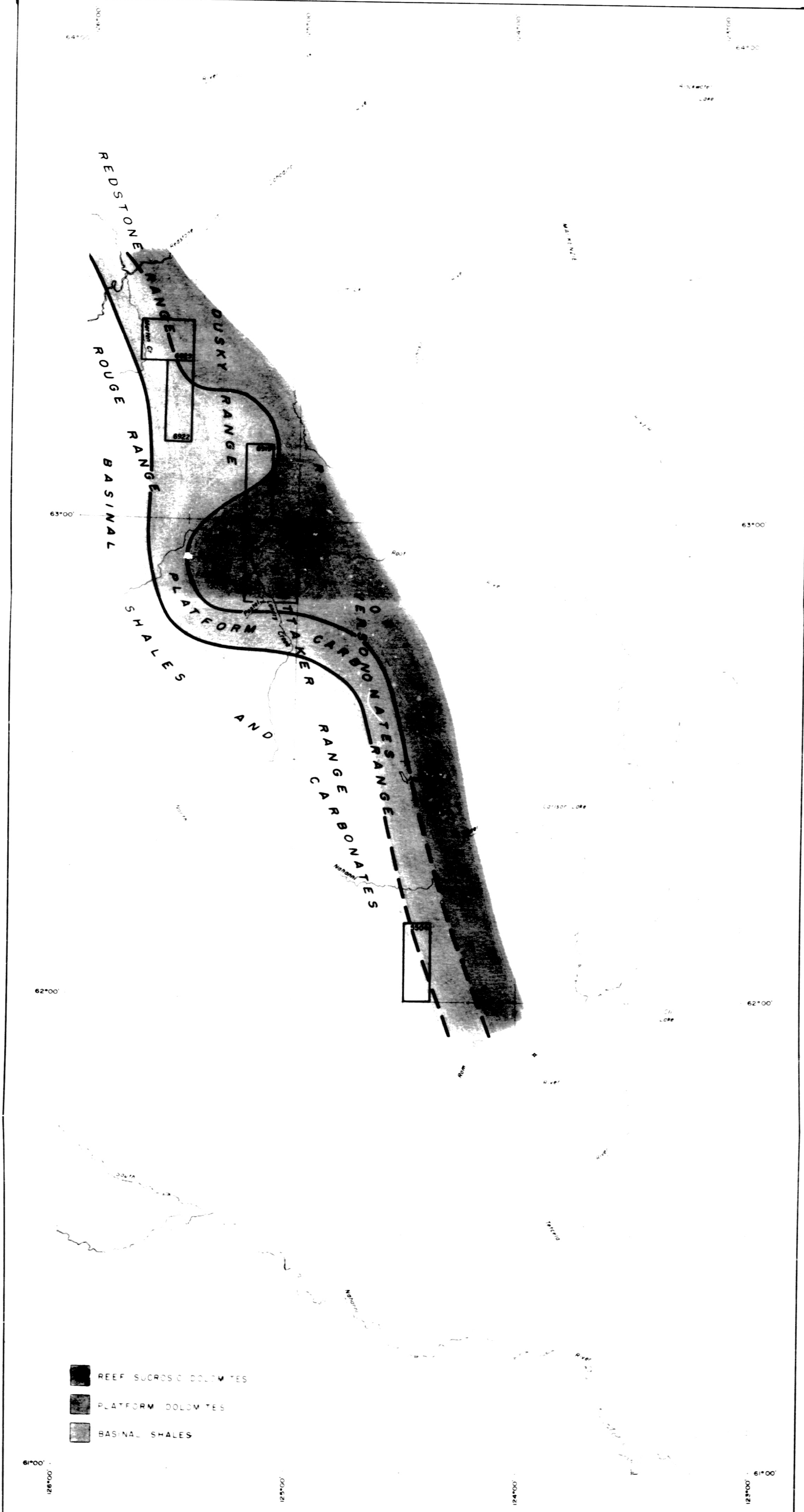
A detailed examination of the Sunblood Formation was not attempted due to lack of time and operational problems. A cursory field inspection showed the formation, tight, well lithified, at times silicified and generally unfavorable for reservoir development.

WHITTAKER FORMATION

Reef and off reef facies can be observed in the Whittaker Formation. The reef facies is a sucrosic dolomite. In the subsurface it would be a highly desirable prospect with good reservoir potential. The shelf or platform facies of the Whittaker Formation is highly bituminous and can be regarded as an excellent source rock.

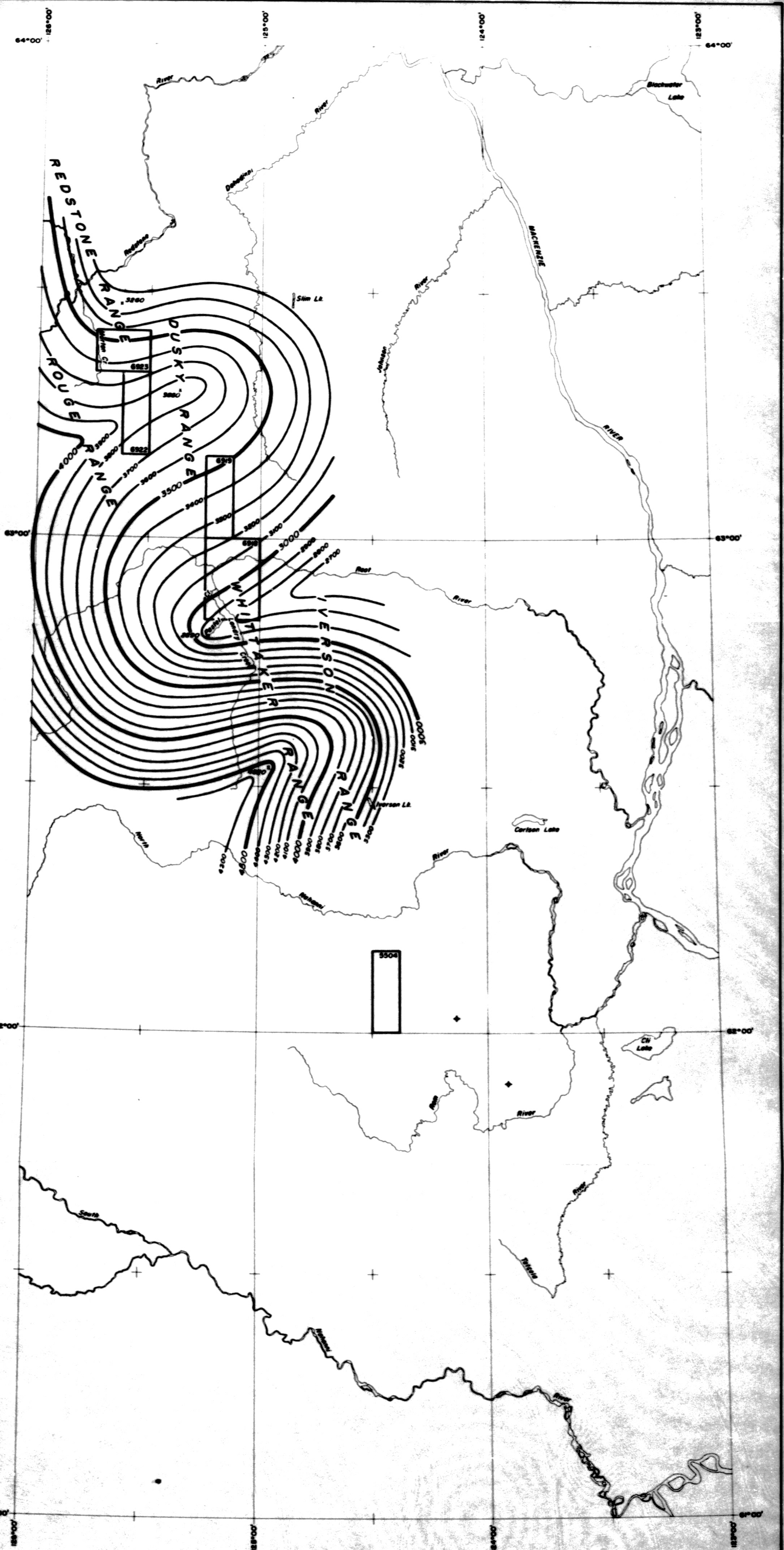
The Whittaker Formation has a wide range of lithologies associated with the transition of carbonate sediments from shelf to basinal facies. A line of section A-B (Fig. 3) has been drawn to show the facies variation in the Whittaker Formation from shelf margin to basinal sediments.

At Blue Lake, Station 105, a median unit of fine to medium grained dolomite has abundant relict remains of colonial corals, Halysites, Favosites, along with horn corals, Amphipora and finger Stromatopora. Immediately south from Blue Lake the upper part of this unit contains patch reefs of structureless light colored sucrosic dolomite. These reefs contrast with the enclosing black bedded dolomites of the platform. From this evidence it is thought that a barrier



REEF DEVELOPMENT
MIDDLE AND UPPER WHITTAKER FORMATION

Figure 4



ISOPACH
WHITTAKER FORMATION

Figure 5

reef probably exists to the west of Blue Lake.

A good exposure of reefal sucrosic dolomites is found in the middle part of the section at Station 107 (Plates 1 & 2) and its "shale out" can be followed some miles to the south of this station along the crest of the Dusky Range. A massive reef body was found in the upper part of the Whittaker Formation immediately to the north of Station 20 in the Delorme Range. From this station, the passage to the basinal sediments of Station 4 on the west flank of the Whittaker Anticline is really dramatic. At this latter station the basal 1400 feet consists of flysch type argillaceous limestones and shales. A median unit of platform type dolomites with some colonial corals, highly silicified is followed by some 2900 feet of black, calcareous, graptolitic shales.

The dominant facies distribution of the sediments is shown (Fig. 4). The reefs trend generally northwest but with a large lobe extending through the Root River permit block and crossing the crest of the Root River Anticline. The prospects here and in the Marten Creek permit block will be discussed under the structural section.

The isopach map (Fig. 5) shows basinal development to the west and southwest. The strong re-entrant to the north of the North Nahanni River and a more positive feature to the west of Pastel Creek continue to assert themselves up to the close of Bear Rock time.

The reefal facies of the Whittaker Formation is a medium grained sucrosic dolomite. In outcrop it has generally poor pinpoint and leached vuggy porosity. Some intergranular porosity is present. The platform facies are tight.

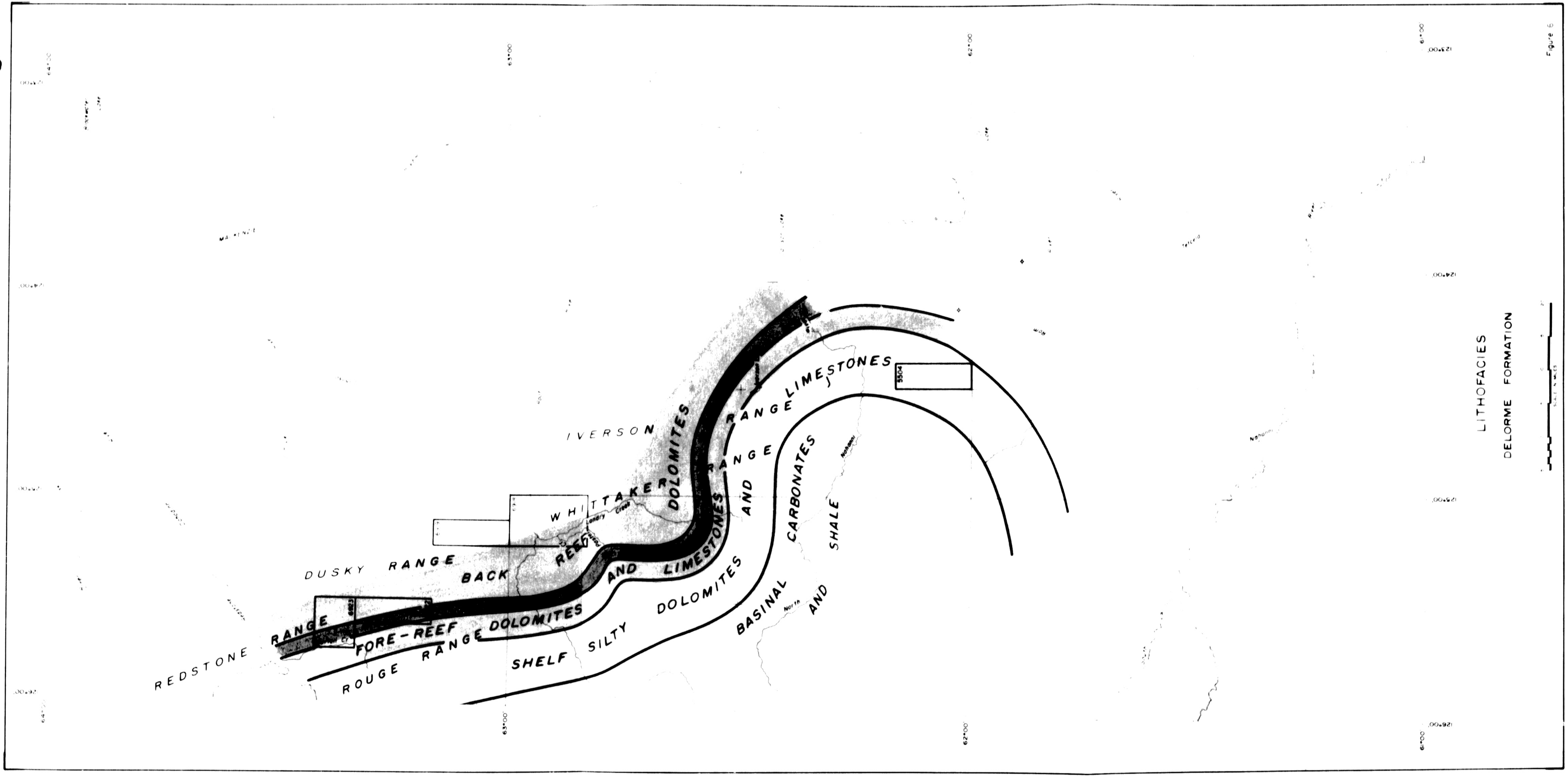
DELORME FORMATION

The shelf facies of the Delorme Formation is characteristically a light grey, fine grained dolomite, mostly tight, but with some scattered, leached, vuggy porosity. Disseminated pyrite crystals impart either a buff or reddish weathering color to the formation. This character makes it easy to recognize and follow in the field.

A reef facies was found two miles north of Station 102 at the headwaters of Landry River. Mechanical troubles with the helicopter forced postponement of a visit to this locality. In a forereef position at Station 102 (Fig. 4), at the headwaters of the English Chief River, the lower 1500 feet consists of submarine slumped, calcareous shales. This is overlain by 700 feet of interbedded skeletal micritic or micritic skeletal limestones with up to 80% Amphipora in certain beds. These reefoid fingers can be traced back to the main reef front at the head of Landry River. From this it is assumed that the Delorme was deposited in a very shallow sea and organic structures are biostromal rather than biohermal. At Station 102 the overlying 1400 feet consisted of boudinage limestones. The same interval at the head of the Landry River consisted of massive dolomites that appear reefal.

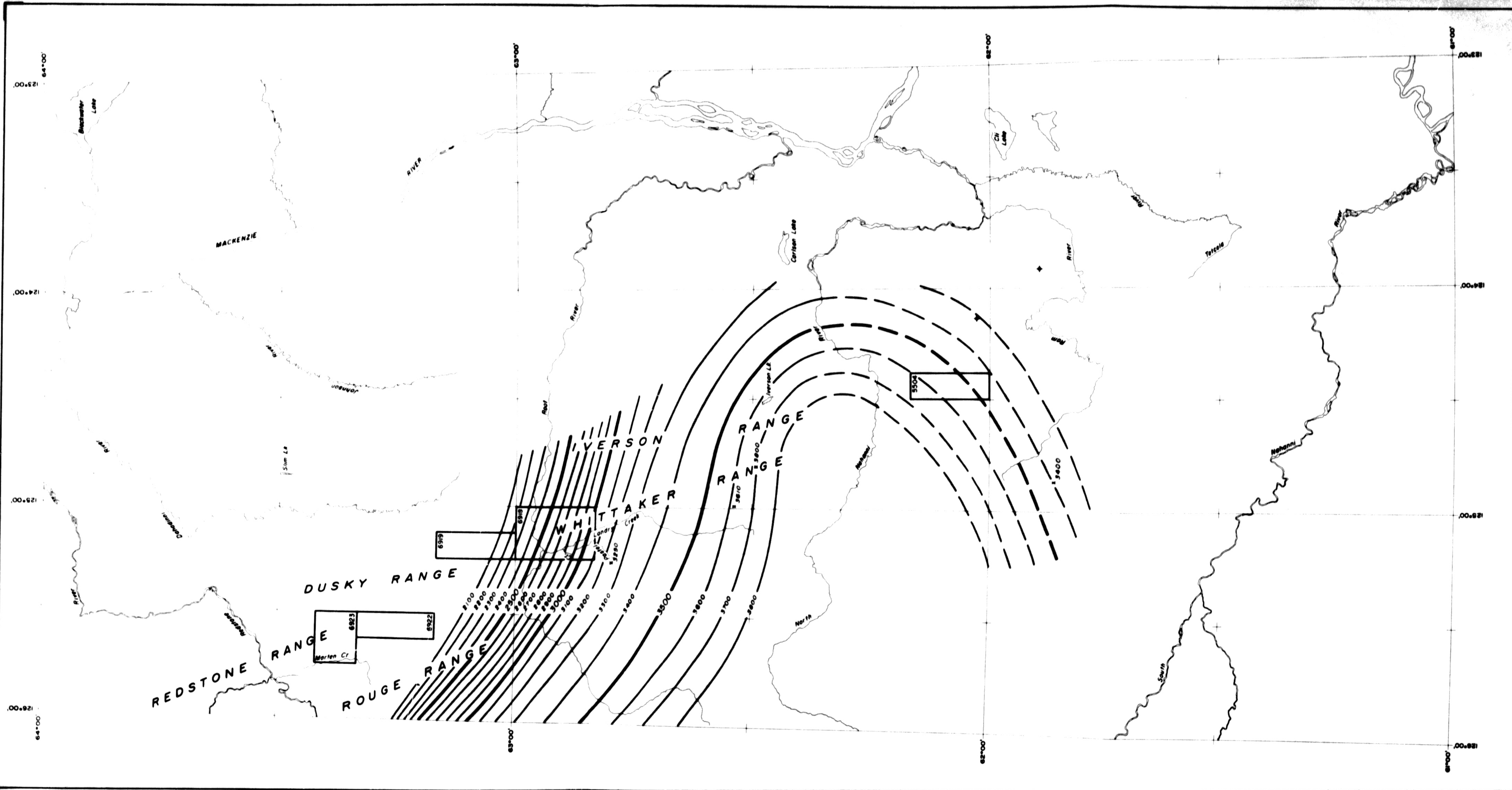
A very near reef or reefal section of the Delorme Formation was inspected at Station 21. Here the dolomite was massive, light grey, fine to coarse grained with poor intergranular and poor pinpoint and leached vuggy porosity. Relict structures at times suggested Stromatopora and corals. There were interbeds of dolomitized lime mud.

With two control points that show reefing (Station 21 and Station 22) and with aerial reconnaissance of basinal sediments to the south it is possible



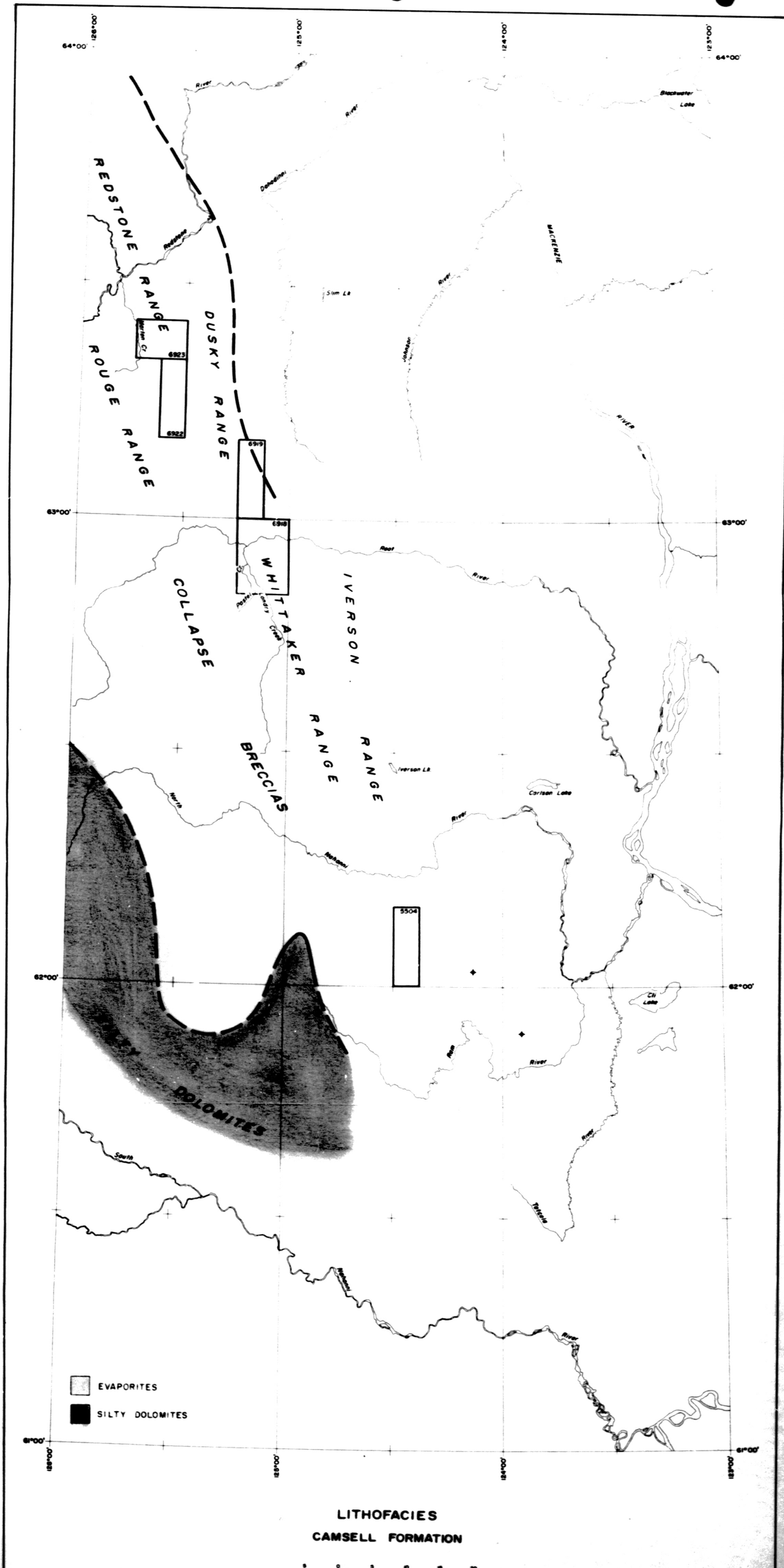
LITHOFACIES
DELORME FORMATION

Figure 6



ISOPACH
DELORME FORMATION

Figure 7



LITHOFACIES

CAMSELL FORMATION

Figure 8

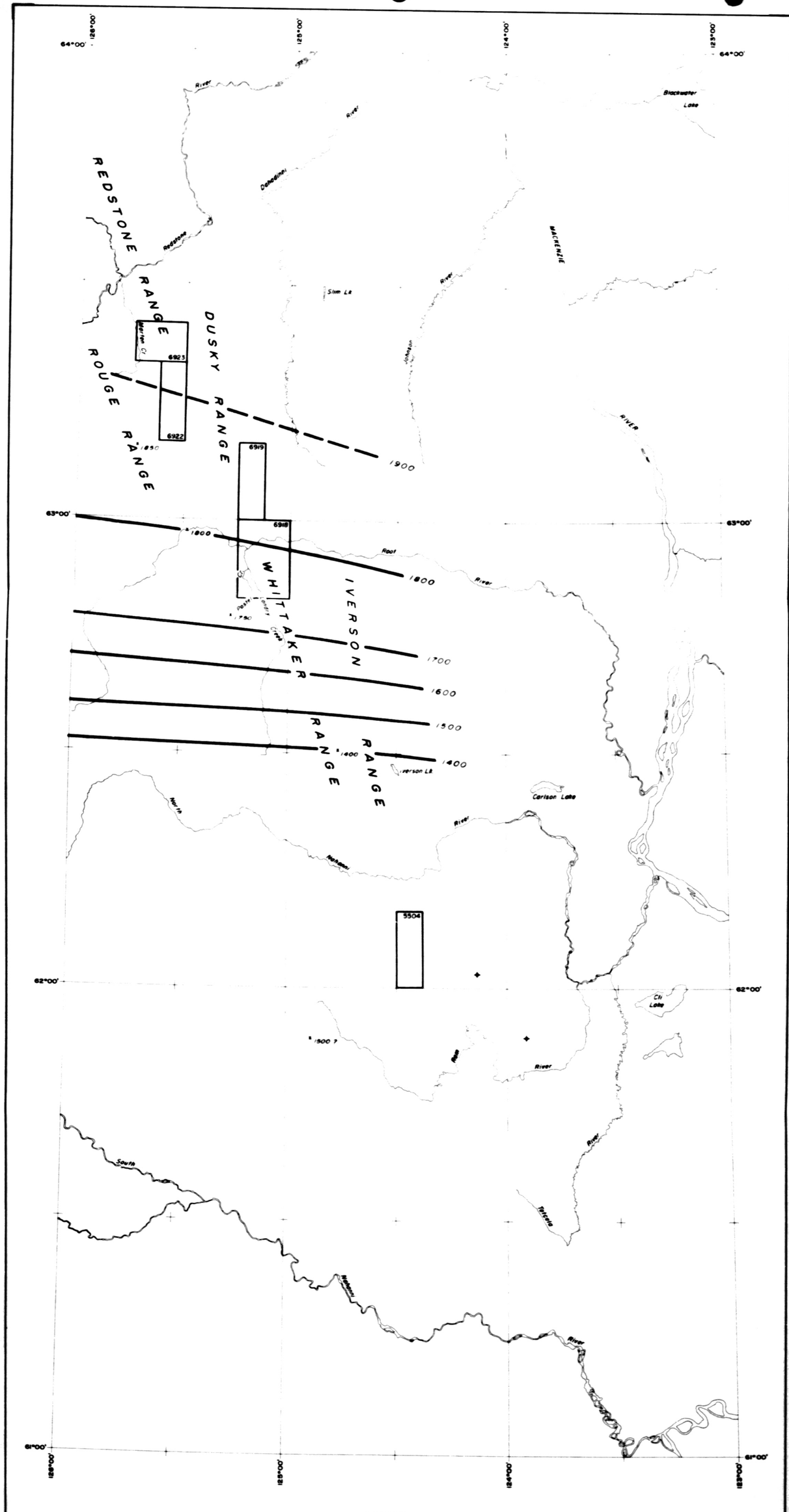
to draw a lithofacies map (Fig. 6). The reef margin can be traced from the north and it swings to the east around a basinal reentrant south of Root River.

The isopach map for the Delorme Formation (Fig. 7) shows a basin to the south and southwest of the Root River. Where the reef margin is controlled it seems to roughly follow the 3000 to 3600 foot contour lines. This suggests that the reef trend should be projected from Station 20 to the northwest. However at Station 18, the lower 1600 feet of dolomites are regarded as forereef platform facies. The uppermost 500 feet of limestones are boudinage in type. For this reason the reef trend is shown lying to the east of Station 18.

The reef facies with some intergranular and leached vuggy porosity is the only potential reservoir in this formation. The source potential of the formation appears poor in comparison with the Whittaker Formation.

CAMSELL FORMATION

Throughout the study area the Camsell Formation remains remarkably uniform in both lithology and thickness. The dominant lithologic character is a collapse breccia of light grey or cream, micritic limestone with red shale inclusions. The Camsell Formation was examined in detail at four localities. At three, Stations 18, 20 and 101 (see Appendix) both micro- and mega-brecciation was observed. The microbrecciation could have been caused by syngenetic solution of evaporites and brecciation of marginal carbonates in a sabkha environment. The mega- phase may have resulted from solution of the evaporites and massive collapse of the carbonates after burial following some epeirogenic event, say an unconformity at the top of the Camsell. In any



ISOPACH

CAMSELL FORMATION

Figure 9

event the carbonates are extremely well cemented and now form a tough, resistant formation.

At Station 13 (see Appendix) Tundra Ridge, the interval is represented by a very fine grained dolomite, alternately light and dark colored. The light bands are algal mat. The dark bands have a relict, micritic skeletal texture. The dolomites are interbedded with 10-15% siltstone and sandstone, fine grained, subangular and tight. An arbitrary division has to be made between the Camsell and the underlying Delorme Formation from which it is indistinguishable lithologically at this station.

Figure 8 shows the gross lithologies. Reefing, if it does exist, lies to the west and south of the present area of study. The isopach map (Fig. 9) shows very gradual thickening of the Camsell Formation to the north. This is in the opposite sense to the normal direction of basin thickening to the south and west in the Lower and Middle Paleozoic. It could be a function of pre-Sombre erosion or it may be caused by a very slight collapse of a positive feature north of the Root River. The real cause is unknown.

SOMBRE FORMATION

Throughout the area examined the Sombre Formation is dominantly a light or dark grey dolomite, crypto- or very fine grained. There is some scattered leached, vuggy porosity, but its reservoir potential is minor. It is not regarded as prospective in any of Westcoast's permit areas.

The relict texture of these very fine grained dolomites is frequently either algal mat or mud mounds. The mud mounds are quite often particularly well preserved. This type of evidence certainly suggests a very shallow water

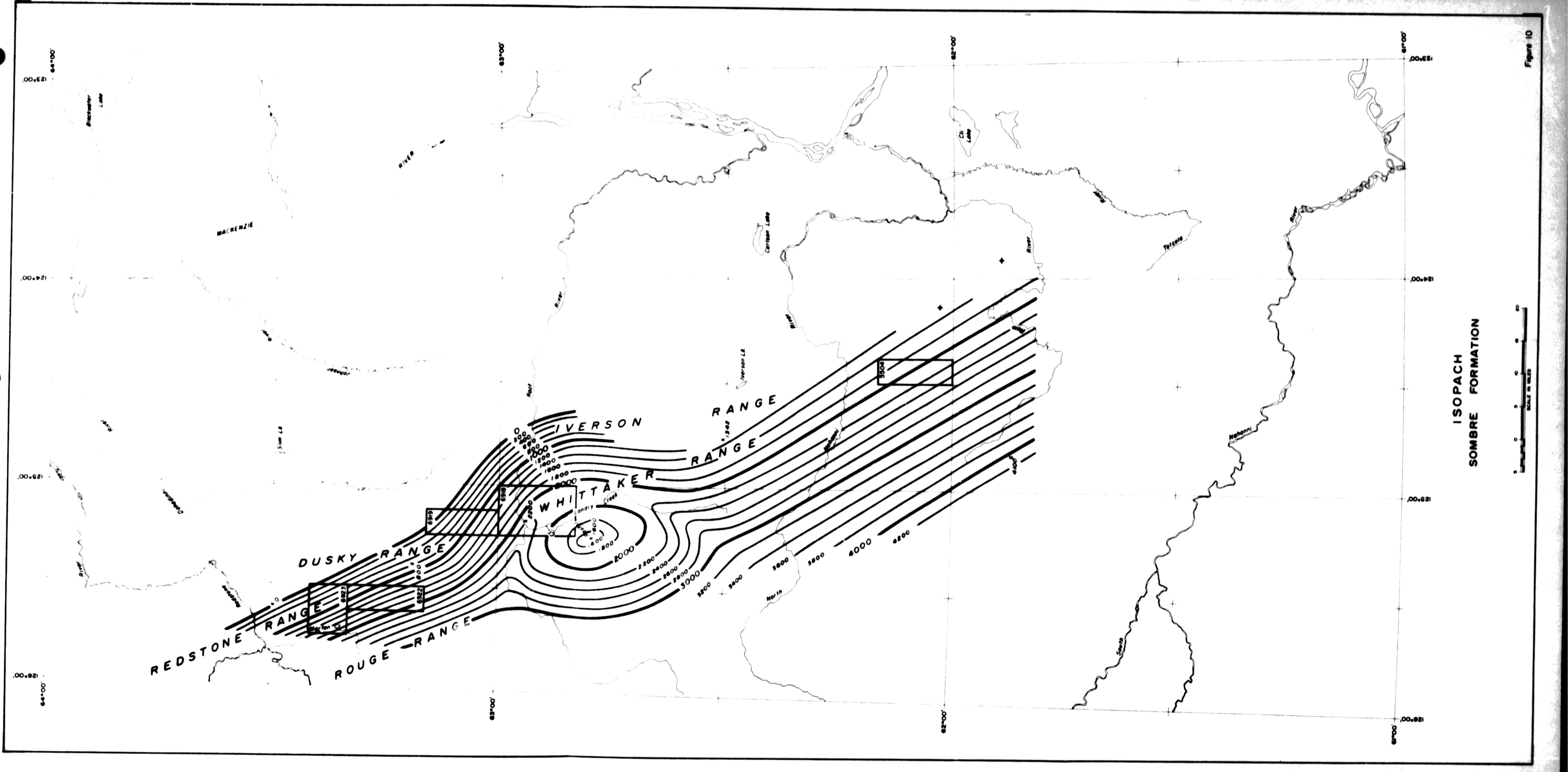


Figure 10

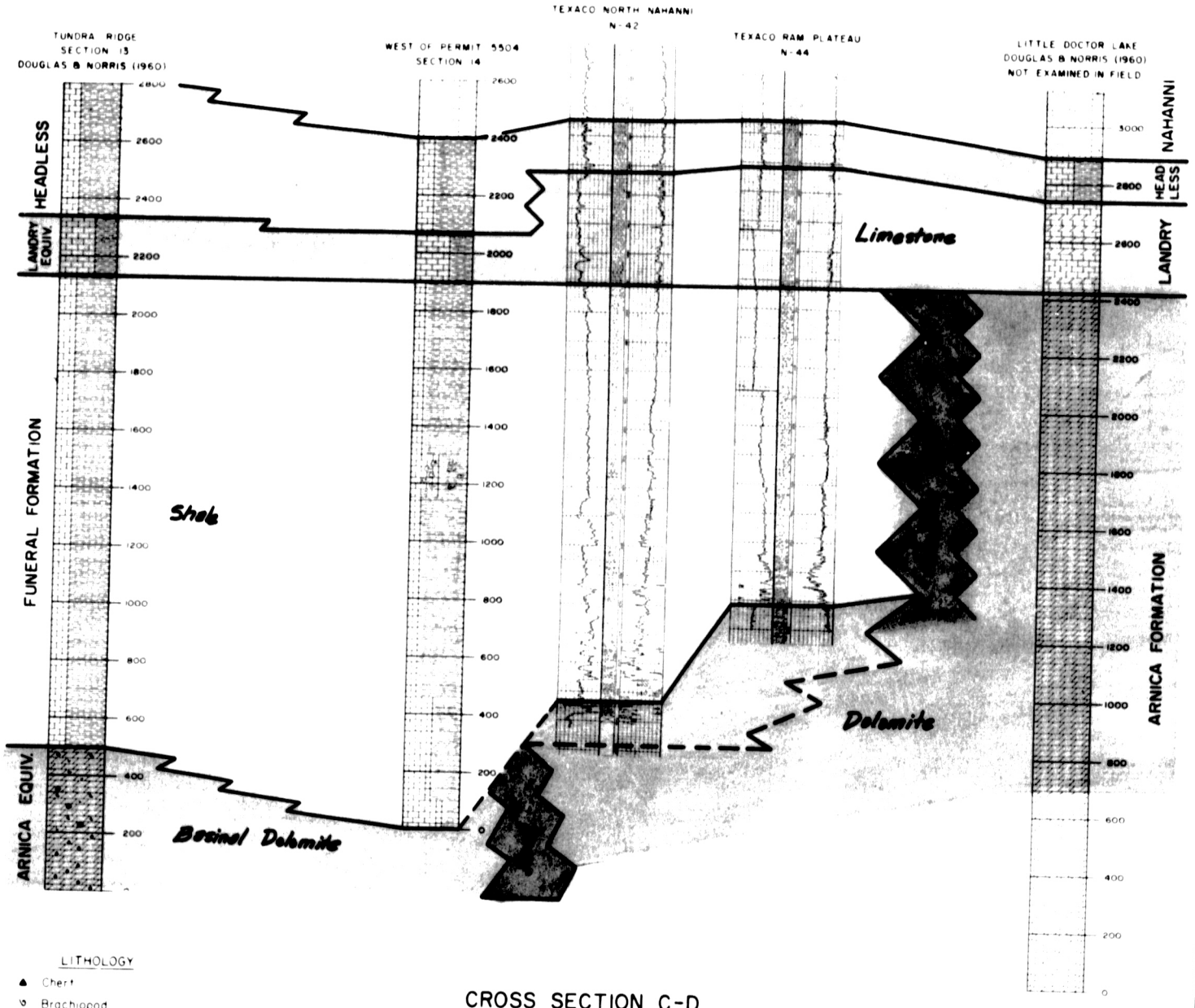
ISOPACH
SOMBRE FORMATION

near shore deposition. Ebanks (private communication) has described mud mounds on the Florida coast in a back reef, near shore location. This interpretation is supported by the presence of a short interval (300') of collapse breccia near the middle of the Sombre Formation at Station 18. At this locality for a short period a sabkha type environment prevailed.

The isopach map (Fig. 10) shows a very profound thickening of the Sombre Formation from zero in the Redstone Range south of the Redstone River to a maximum of 4100 feet at Station 13 on Tundra Ridge. An anomalous thin at Station 20 interrupts the otherwise uniform thickening of the Sombre Formation to the southwest. The truncation to the east, may be a function of pre-Arnica erosion (Douglas and Norris 1961, 1962). However, there is no field evidence of a pronounced unconformity and certainly the facies are back reef-nearshore and rarely sabkha. It could be that this rapid thickening to the west is merely a function of deposition. The anomalous thinning at Station 20 is most likely the result of diapiric action of the Saline River evaporites initiated in Sombre time. Penecontemporaneous erosion thinned the formation at this station. Further evidence of diapiric action of Cambrian evaporites is cited in the Arnica Formation (Plate 6) and the Funeral shales (Plates 7 and 8).

BEAR ROCK GROUP

The Bear Rock reef facies (Manetoe Formation) has the best reservoir characteristics of any sediments examined in the Paleozoic sequence. Unfortunately coincidence with favorable structures and depth of burial are the limiting factors in the prospectiveness of this formation. At its best the reef is a coarse sucrosic dolomite with good intergranular porosity. Two



CROSS SECTION C-D
LITHOFACIES OF BEAR ROCK

Figure 11

growth situations exist. One, the reef formed a barrier up to a 1000 feet high. Such reefs are found at Stations 15 and 28 (Plate 3 and Appendix for Station 15). In contrast, a series of reefal steps could delineate the transgressive onlap of the Bear Rock sea onto the stable shelf. In the North Nahanni gorge at Station 29 (Plate 4) a step about 200 feet high was observed in the Arnica Formation of the Bear Rock Group. There was a corresponding thinning of the Funeral shale facies over this step.

The back reef to fore reef facies relationships of the Bear Rock Group are shown on a line of cross section C-D (Fig. 11). There is a back reef dolomite facies, the Arnica Formation, a reef front of sucrosic dolomite, the Manetoe Formation, inferred in this cross section and fore reef basinal shales of the Funeral Formation. These shales thicken rapidly to the west from 1090 feet at Texaco Ram Plateau N-44 to 2300 feet at Tundra Ridge Station 13.

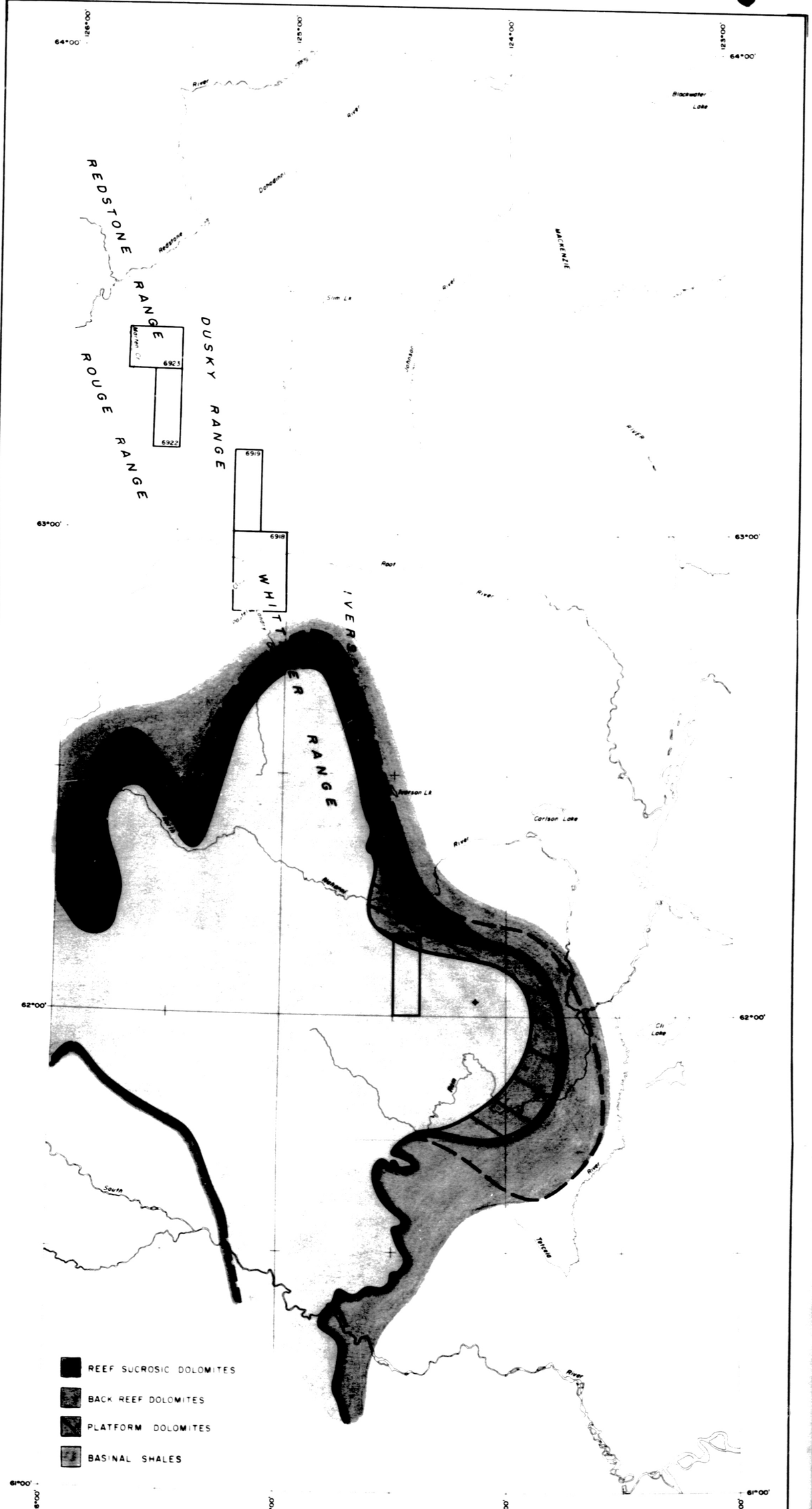
The Arnica Formation was examined at Stations 107, 18, and 19. At Station 107, North Nahanni Gorge (Plate 5) the upper half of the Arnica Formation was found to consist of interbedded light and dark grey, fine grained dolomite. The dark bands are fossiliferous with occasionally up to 30% Amphipora and some leached vuggy porosity. The light bands were non fossiliferous and tight. A similar back reef type of environment could be ascribed to the Arnica at Station 18. Here the dark grey dolomites, very fine to fine grained, were bituminous and the relict texture micritic-skeletal with Amphipora sp., finger Stromatopora and crinoid ossicles. In these beds there was periodically up to 20% plugged, leached, vuggy porosity. The Arnica is not a simple formation or a single event. At Station 18 a pronounced unconformity (Plate 6) was found midway through the formation (see Appendix for lithology).

In the time available it was not possible to follow this unconformable surface further. It was noted, however, at both Stations 18 and 19 that there was a band of leached vuggy porosity now plugged by white dolomite about midway through the Arnica Formation. An unconformity was also noted at the top of the Funeral Formation east of Station 13 in the Nahanni Plateau area (Plate 7 and 8). This suggests that during periods of mild orogeny in the Middle Devonian, the Saline River evaporites were mobilized and doming of the overlying sediments took place.

The Manetoe reef facies of the Bear Rock Group was examined at Station 16 immediately west of Iverson Lake . At this locality the reef was massive and structureless and along the line of section at Station 16 was found to consist mostly of a coarse white replacement dolomite. Only the uppermost 75 feet had leached vuggy porosity and good intergranular porosity. Less than a 1/4 mile to the north, good intergranular porosity was observed down from the top of the formation for several hundred feet. In fact it was so friable that it could be readily kicked apart like coarse sand.

At Station 15 it was estimated that there were 1000± feet of Funeral shales two miles from the time equivalent the Manetoe reef facies (Plate 3) at Station 28. At this latter locality an estimate of a 1000± feet for the height of the reef would be reasonable. The off reef equivalent of the Manetoe and Arnica Formations, the Funeral Formation consists mostly of fissile, black, calcareous shales.

The Funeral Formation is overlain by the Landry Formation (Fig. 11). With the shale out of the Landry, the Funeral Formation merges with the overlying Headless Formation. In the western part of the Nahanni Plateau it becomes very difficult to pick the top of the Funeral Formation from the



LITHOFACIES

BEAR ROCK GROUP

Figure 12

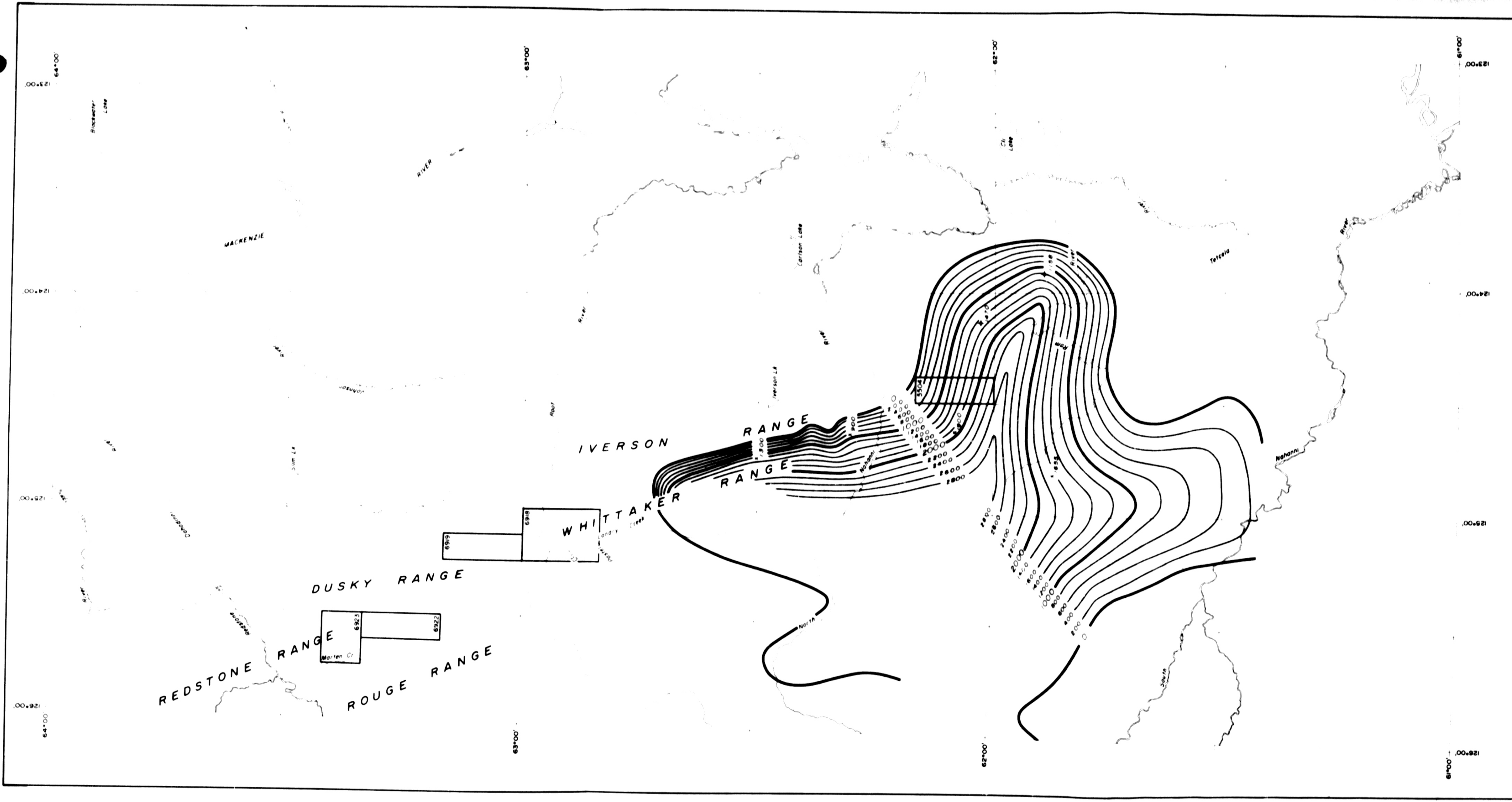
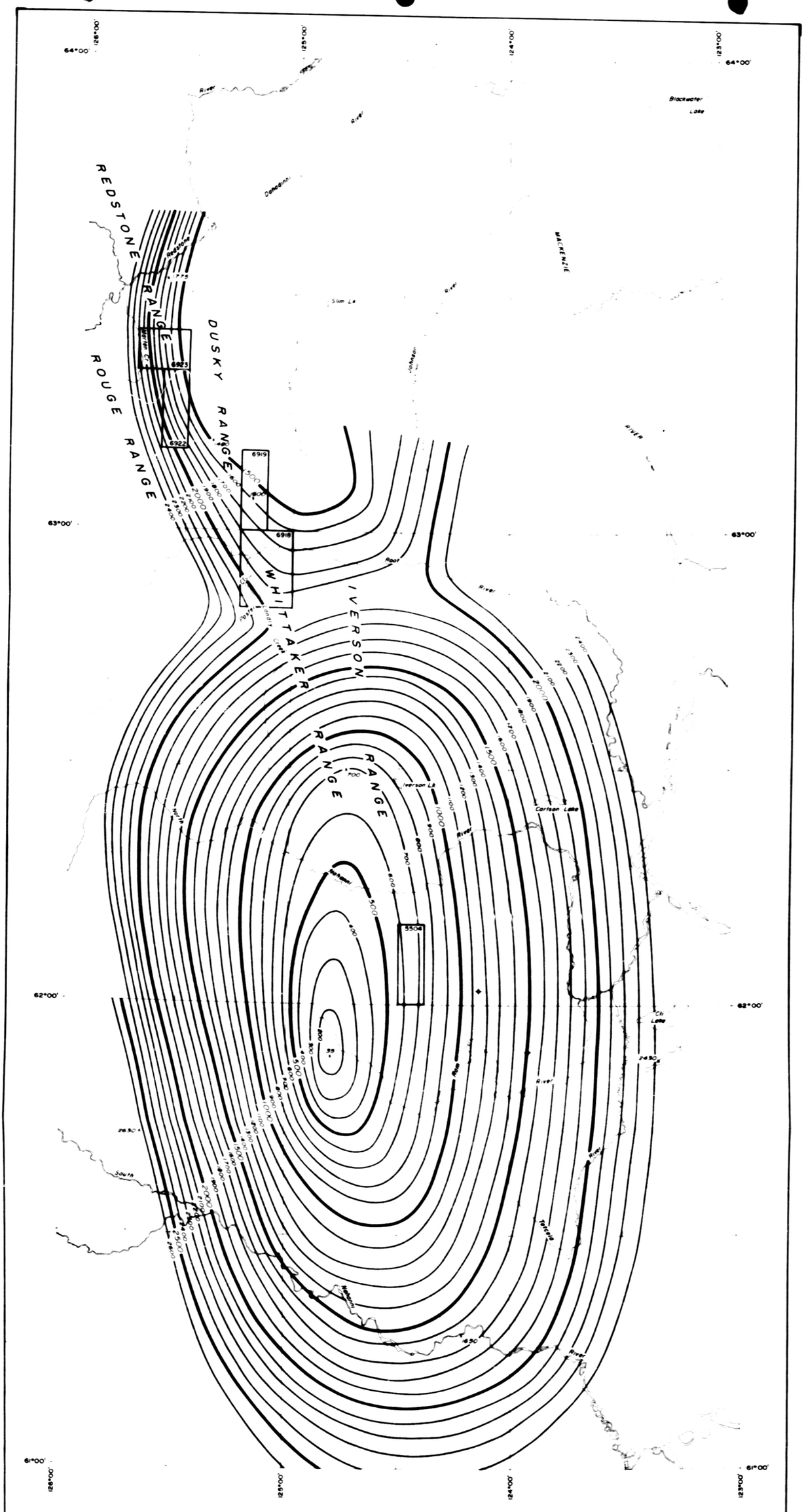


Figure 13

ISOPACH
FUNERAL FORMATION



ISOPACH
ARNICA FORMATION AND PLATFORM EQUIVALENTS

Figure 14

overlying Headless Formation.

Douglas and Norris (1960, 1961) have placed the black argillaceous limestones at the base of the Funeral Formation in the Arnica Formation. These limestones are basinal and lithologically distinct from the back reef Arnica dolomites. In this report they are included in the Funeral Formation.

The lithofacies map of the Bear Rock Group (Fig. 12) shows a lobate subbasin enclosed by a fringing reef. The information for this reef trend was derived from Douglas and Norris (1960, 1961) and field observation in the study area. The isopach map for the Funeral Formation (Fig. 13) delineates the area of maximum fill and the form of the basin. The isopach map for the Arnica Formation (Fig. 14) is the complement of the Funeral Formation. It shows thick shelf sediments thinning to the basin centre.

LANDRY FORMATION

No formal study of the Landry Formation was undertaken. It can be seen from cross section C-D (Fig. 11) that it thins westward and is progressively replaced by the Headless shales. In a shelf position it is primarily a lime mud (for example at Stations 18, 19 and 106). At the shale out edge, Station 14, it was a very argillaceous, bioclastic limestone with abundant brachiopods. At Tundra Ridge, Station 13, it has been completely replaced by the Headless shales.

HEADLESS FORMATION

The Headless Formation was not studied in this area. Where it overlies shelf sediments of the Landry Formation and underlies similar sediments of Nahanni Formation it is normally 200-300 feet thick. It thickens to the west (Fig. 11) at the expense of the Landry and Nahanni Formations as these

formations shale out. On the shelf it is interbedded, very argillaceous limestone and very calcareous shale. With the shale out of the Landry and Nahanni Formations it becomes progressively more argillaceous.

NAHANNI FORMATION

The Nahanni Formation was measured only to assist in the construction of structural cross sections. Its exposure on the flanks of the three suitable anticlines ruled it out as a potential prospect.

At Stations 8 and 106 it is an interbedded micritic and micritic-skeletal limestone. The skeletal portion includes brachiopods, solitary corals and some crinoids. The Nahanni Formation shales out fairly abruptly on the western edge of the Nahanni Plateau area (Plate 9). This lateral change to Headless shales has been plotted by Douglas and Norris (1960).

STRUCTURE

INTRODUCTION

STRUCTURAL STYLE MACKENZIE MOUNTAIN FOLD BELT

The structural style of the Mackenzie Mountain Fold Belt is significantly different from the southern Rocky Mountains. There is little duplication of plates in the Mackenzie Mountain Fold Belt unlike the multiple plates of the southern Rocky Mountains.

Décollement folding is dominant in the Dahadinni and Root River areas. Several observations support this proposition. First, steeply folded anticlines are separated by broad synclines. Mechanically this sequence would be unlikely in an intensely thrust stystem. The sequence is also unlikely to be draped on thrust basement blocks. Second, green shale masses have been found thrusting diapirically along the more westerly thrust planes examined.

Diapirs were found north of Station 20 on the Delorme Thrust and on the west flank of the Dusky Range. Their emplacement is accompanied by massive brecciation of the country rock. As noted already, the green shale has to be older than Middle Ordovician. Lithologically it is similar to the green shales of the Middle Cambrian Mt. Cap and Saline River Formations. The green shale and the now leached evaporites form a breccia. In the subsurface it would form the plane of gliding for décollement folding.

Décollement folding dates back to Buxtorf (1910) who observed that the Mesozoic folds of the Jura were folded independently of the crystalline basement and glided on the very incompetent layers of Triassic anhydrite. The principles of decollement folding are well summarized by de Sitter (1956).

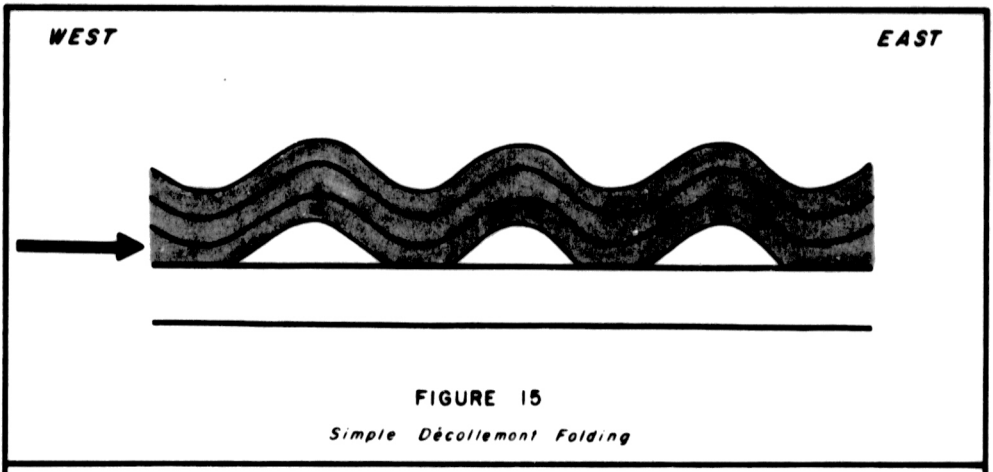


FIGURE 15

Simple Décollement Folding

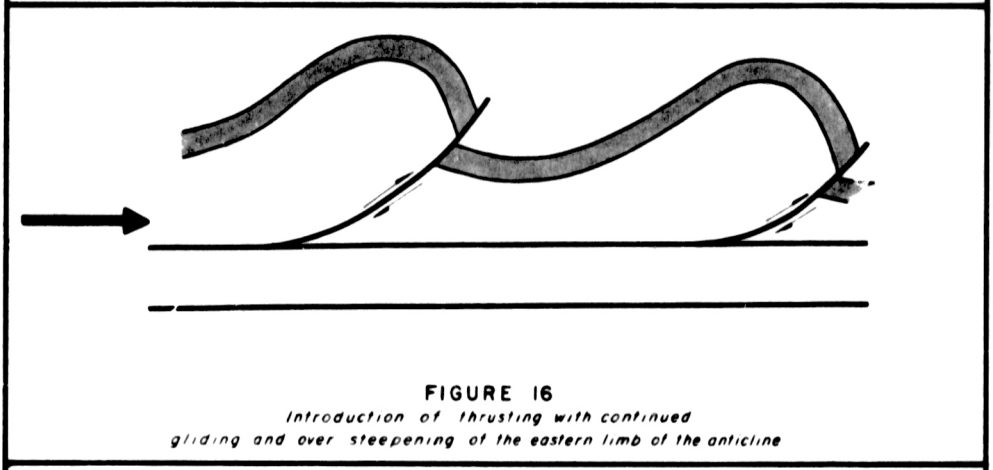


FIGURE 16

Introduction of thrusting with continued gliding and over steepening of the eastern limb of the anticline

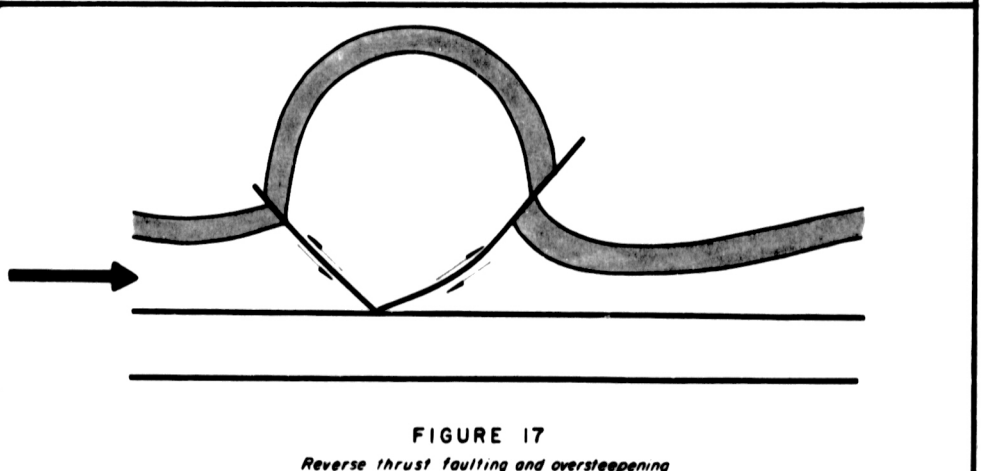


FIGURE 17

Reverse thrust faulting and oversteepening of the western limb of the anticline

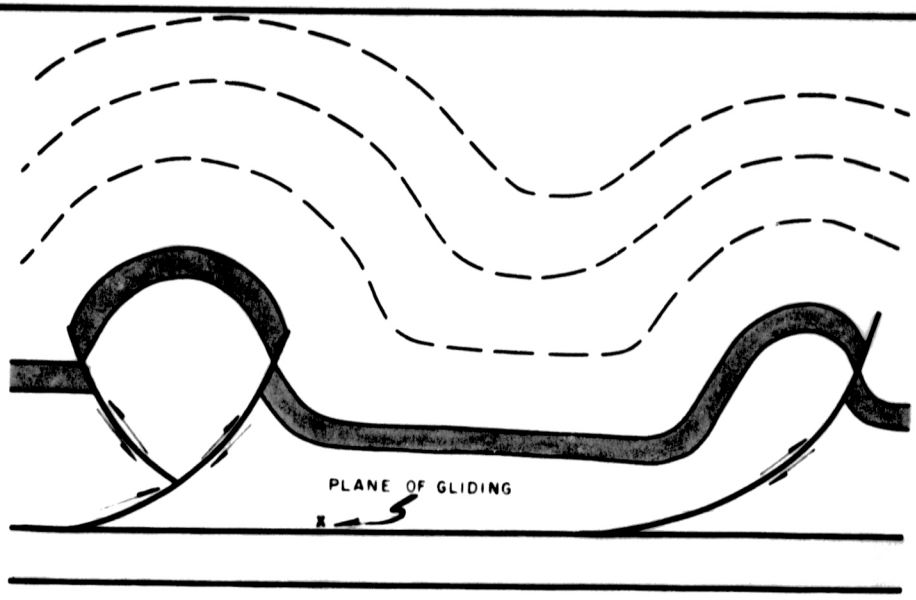


FIGURE 18

Continued erosion will result in broad synclines and narrow, sharply folded anticlines

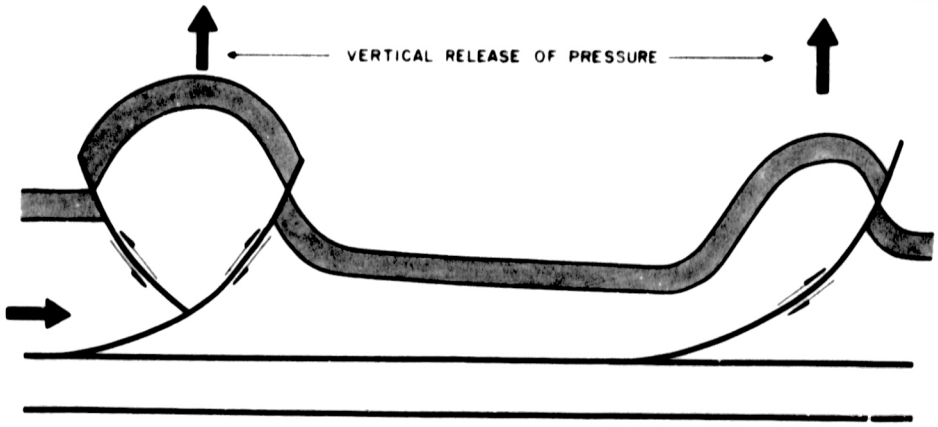


FIGURE 19

Relatively flat synclines and narrow, sharply folded anticlines are a function of a space problem in the syncline. The rocks of the syncline cannot bend down into the plane of gliding. By contrast pressure and shortening can be easily relieved by anticlinal folding.

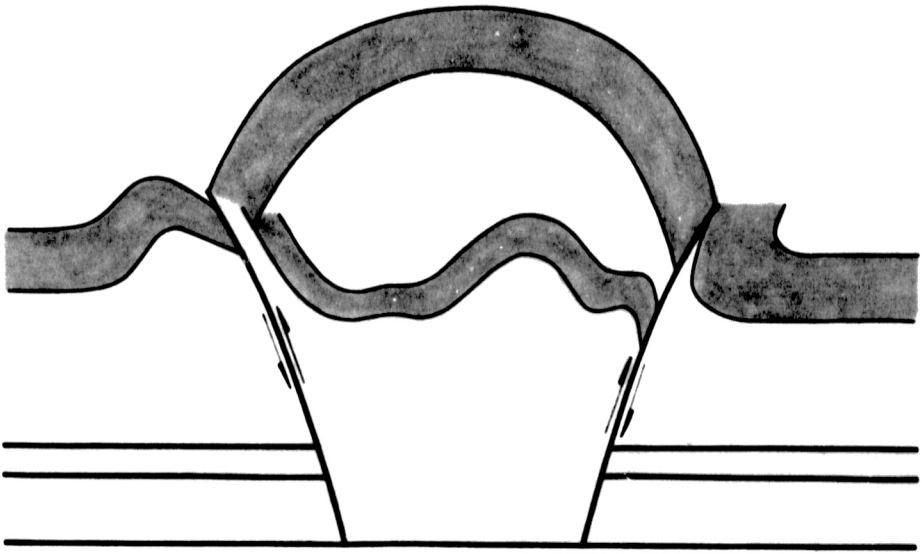


FIGURE 20

More intense pressure from gliding, probably with some basement thrusting results in a piston action with the décollement layer pushed up into the core of the anticline. This has apparently happened in the core of the Root River anticline. (After de Sitter - 1956)

The sequence of development of steeply folded anticlines, thrust to the east and reverse thrust to the west, along with broad synclines is outlined (Fig. 15-19). The initial stage is simple décollement folding (Fig. 15) with gliding from west to east. Oversteeping of the easterr limb (Fig.16) and continued gliding brings relief of pressure by overthrusting of the anticline over the syncline. Further pressure from the plate sliding behind the anticline will steepen the west limb and lead to reverse thrusting (Fig. 17), to form a typical box shaped anticline.

De Sitter (1956, p. 177-79) points out whether there are broad anticlines or broad synclines is a function of the depth of erosion (Fig. 18). With deep erosion the synclines are broad and flat and the anticline narrow and sharply folded. The synclines are flat because the folded sediments cannot be depressed into the plane of gliding.

In the Root River area on the Delorme thrust and on the western flank of the Dusky Range, the pressures involved in décollement folding have become more intense. It is just possible that thrust basement blocks may have become involved. Any case with more intense pressure, the décollement layer is mobilized and acts as a diapiric piston thrusting up through the overlying rock (Fig. 20). The latter type of anticline is usually a much broader structure than those described above as box folds.

There are regional trends for the different types of décollement folds. The simple asymmetrically thrust folds are located along the Camsell and Nahanni Ranges. The box folds occur in the next set of ranges to the west, the Iverson and Dahadinni Ranges. The Dusky and Delorme Ranges are more typical of the diapiric extrusion form of anticline.

IMPORTANT POINTS IN STRUCTURE ASSESSMENT

1. The displacement or foreshortening by décollement folding and thrusting is not great quantitatively.

2. It follows that in this type of folding multiple plates will not develop. Although not specifically developed in the foregoing, the following are also pertinent.

3. In the Mackenzie Mountains in the zone of more intense diapiric action, the folds are either thrust across the crest or are now very deeply eroded so are no longer favorable structural prospects.

4. Organic reefs in the Ordovician, Silurian and Devonian sediments are only viable prospects where they occur in zones of asymmetrical folds or box folds.

PHOTOGEOLOGY

The photogeology for the permit areas of this report (Fig. 1) was very ably undertaken by J. Bakhoven. The photomosaics (Figs. 21, 24 and 28) are included in the structural discussion of each permit area.

PERMIT #5504 HOLLOW MOUNTAIN ANTICLINE

STRUCTURE

The photogeology shows that the permit area (Fig. 21) is dominated by the Hollow Mountain Anticline.

The Hollow Mountain Anticline lies en echelon with the Iverson Anticline to the north and is flanked on the southwest by a gently dipping northern extension of the Nahanni Plateau. In its present morphological form the Fort Simpson shales have been stripped from the crest of the anticline and Nahanni carbonates exposed. Topographically the crest is over 4,000 feet high. Stream erosion has breached the anticline north of the crestal culmination and exposed the top of the Funeral Formation. This anticline is one and one half miles wide and over twelve miles long. It plunges gently to the northwest and southeast. It has over 1000+ feet of closure and is free of crestal faults.

The Hollow Mountain Anticline is a box fold (Plate 10) (Fig. 22) thrust to the east and reverse thrust to the west. On the eastern flank at Station 10, Nahanni limestones are thrust over Fort Simpson shales. Oversteepening of the eastern limb (Fig. 23) was followed by thrusting. Further pressure from the west oversteepened the western limb and reverse thrust the anticline over the western synclinal plate (Fig. 23). Field evidence of this thrust was observed in the stream eroding down dip on the western flank where Nahanni limestones rest on Fort Simpson shales. The eastern and western flanks of this box fold are tightly folded. Maximum dips of 50° to 55° were measured on both flanks.

STRATIGRAPHY

The carbonates of Bear Rock Group could be prospective in this anticline. As shown in a lithofacies map of the Bear Rock Formation (Fig.12) the Manetoe reef front passes in an arcuate sweep to the east of the permit area. At this locality Bear Rock carbonates would be overlain by approximately 1400 feet of Funeral shales. Immediately to the west of Station 14 (Fig. 1) 1900 feet of Funeral shales were measured in an incomplete section without a base. The possibility exists of a 600 foot reefal step in the Bear Rock Group. It would be possible to run a seismic line across the crest following the line of the transverse stream erosion. The shale to carbonate would provide a good velocity contrast that could prove or disprove this hypothesis. The risk of this prospect is the possible lack of an adequate cover. The Sombre does have poor leached vuggy porosity at Station 20 to the southwest but it is not considered a desirab target in this prospect. The core of the antirline is very tightly folded. It is quite possible that the competent Sombre Formation could have been extensively brecciated by this extremely tight flexuring. Fracture porosity would provide an adequate reservoir in this case.

STRUCTURAL SECTION ACROSS THE HOLLOW MOUNTAIN ANTICLINE

PERMIT 5504

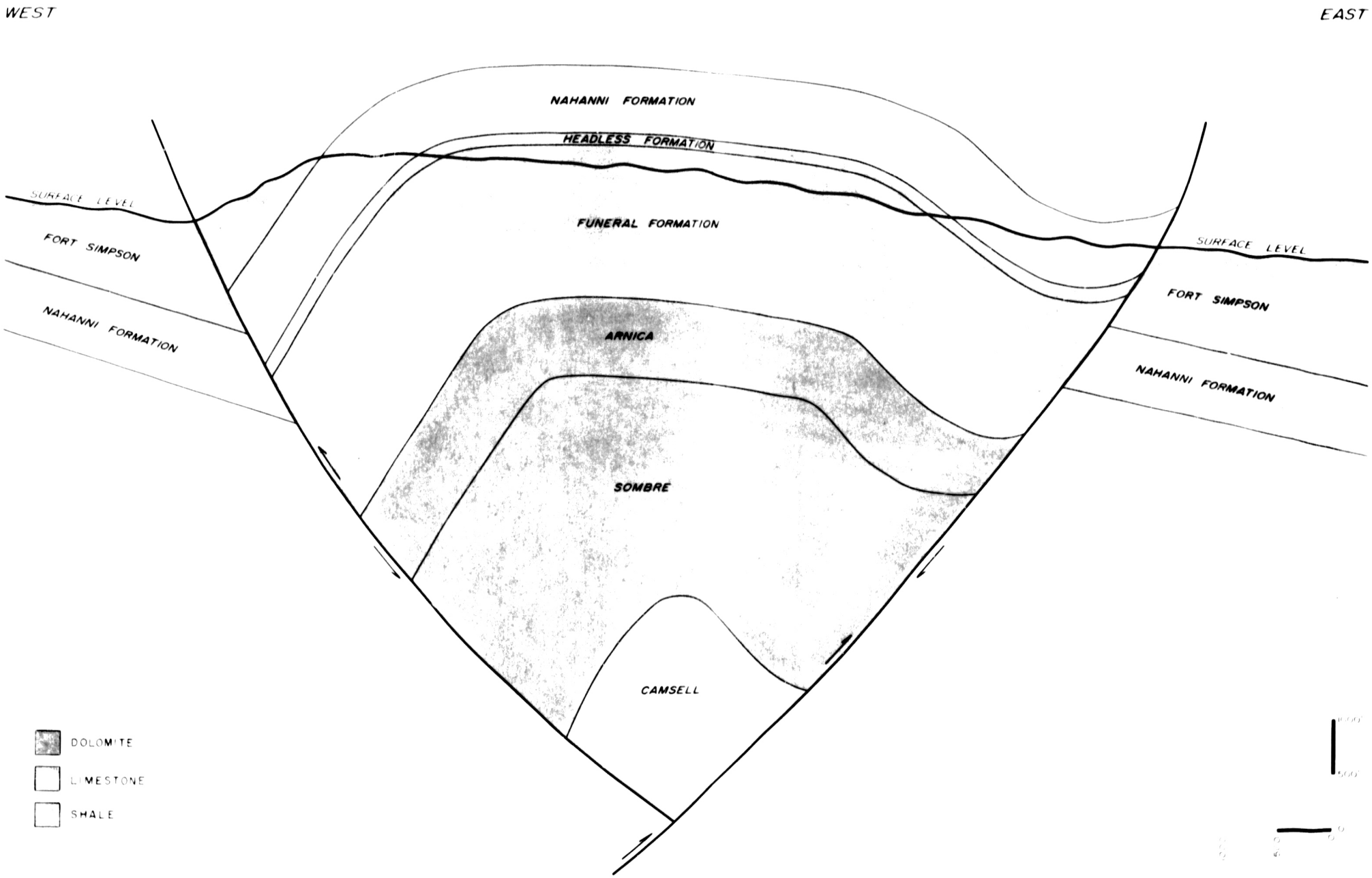


Figure 22

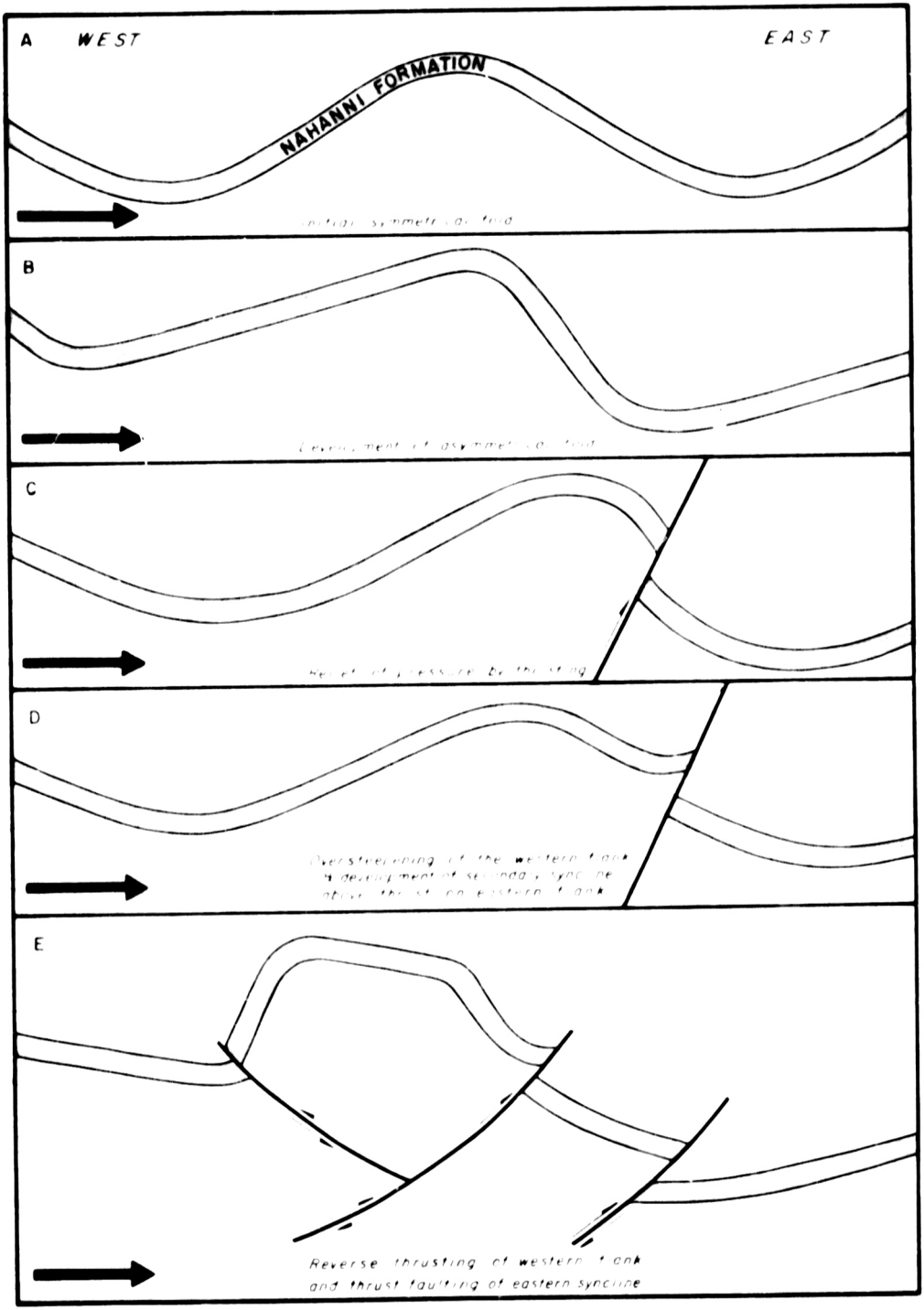

A
WEST
EAST
NAHANNI FORMATION
initial symmetrical fold
B
development of asymmetrical fold
C
relief of pressure by thrusting
D
Overturning of the western flank
& development of secondary syncline
above the eastern flank
E
Reverse thrusting of western flank
and thrust faulting of eastern syncline

FIGURE 23

STRUCTURAL SECTION OF NORTH ROOT RIVER ANTICLINE

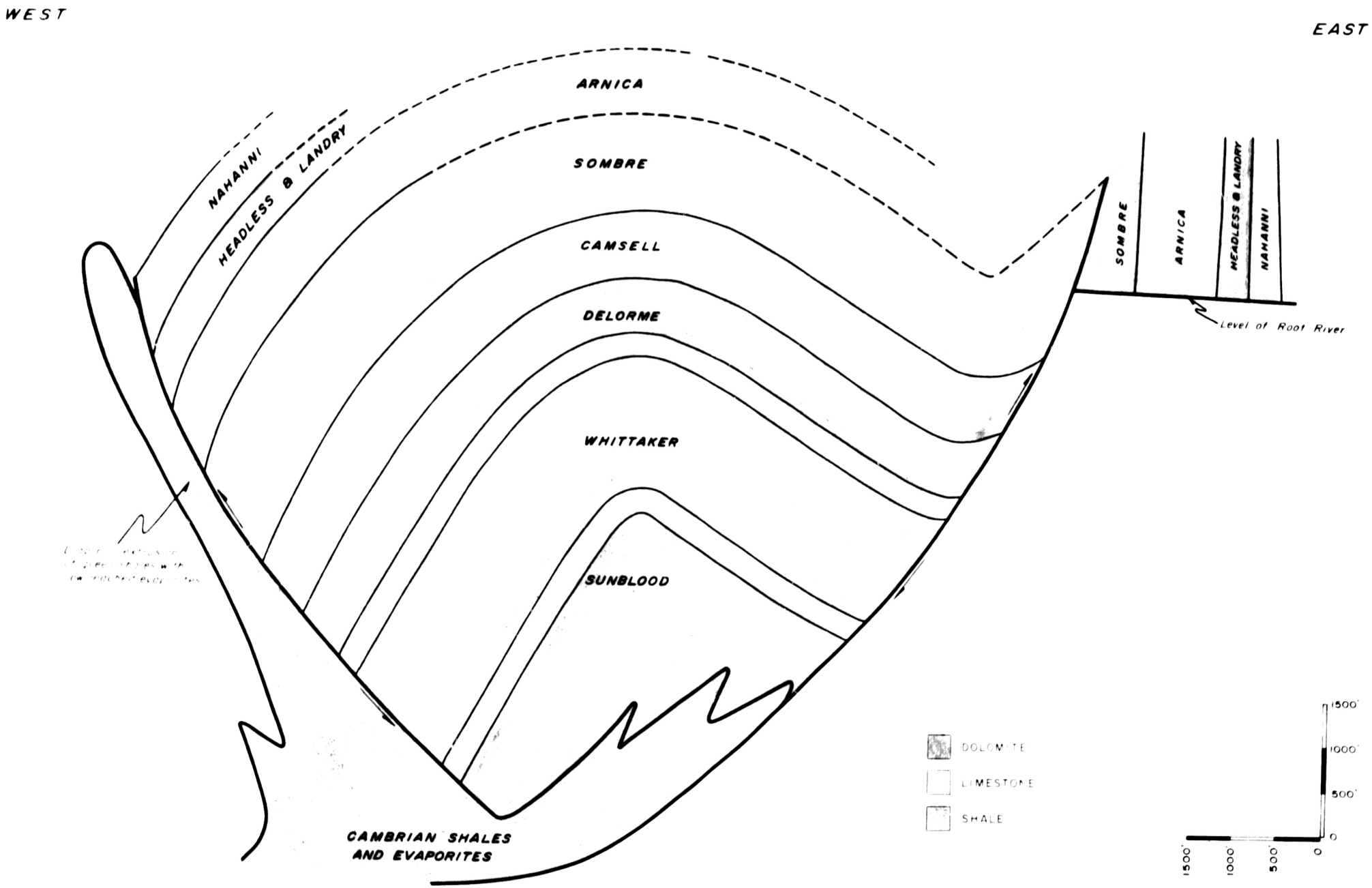


Figure 25

PERMITS 6918 AND 6919 NORTH ROOT RIVER ANTICLINE

The photogeology of permits 6918 and 6919 (Fig. 24) shows a structurally complex area dominated by the North Root River Anticline. This anticline is over 17 miles long and 4 miles wide. It lies en echelon and on the same structural trend as the Dusky Anticline to the north (Plate 11). It has been subject to multiple thrusts on the eastern flank and to reverse thrusting on the west with diapiric penetration along this thrust. From its crestal culmination near its northern end, the anticline plunges gently to the southeast along a sinuous course for nearly 16 miles. To the north it plunges from 0° to 5° for 1 1/2 miles. The northern termination is in the thrust contact with the more northerly Dusky Anticline. The North Root River Anticline does not appear to have effective closure.

An east-west section (Fig. 25) shows 2000+ feet of closure with the Whittaker Formation as the prime exploration target. However this closure is illusionary. A north-south structural section (Fig. 26) demonstrates that there is virtually no closure to the north. The slight closure visible on the surface would quickly be eliminated at depth by the southeast dipping thrust.

STRATIGRAPHIC PROSPECTS

The lithofacies map for the Whittaker Formation (Fig. 4) shows that a middle to upper Whittaker reef trend could cross the crestal culmination of the North Root River Anticline. With the absence of effective closure to the north, a prospect could still exist at the updip pinchout of the Whittaker sucrosic dolomite reef facies. The Whittaker was most likely biostromal rather than biohermal. A fingering has been observed south of Station 107 to

NORTHWEST - SOUTHEAST SECTION ALONG CREST OF NORTH ROOT RIVER ANTICLINE

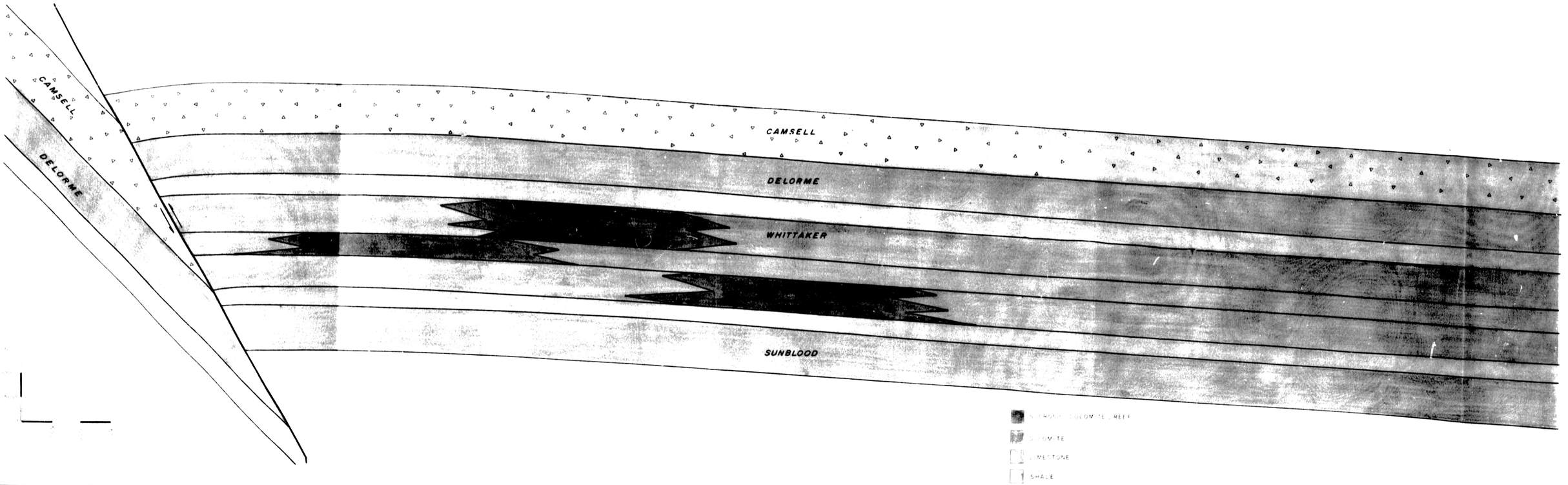


Figure 26

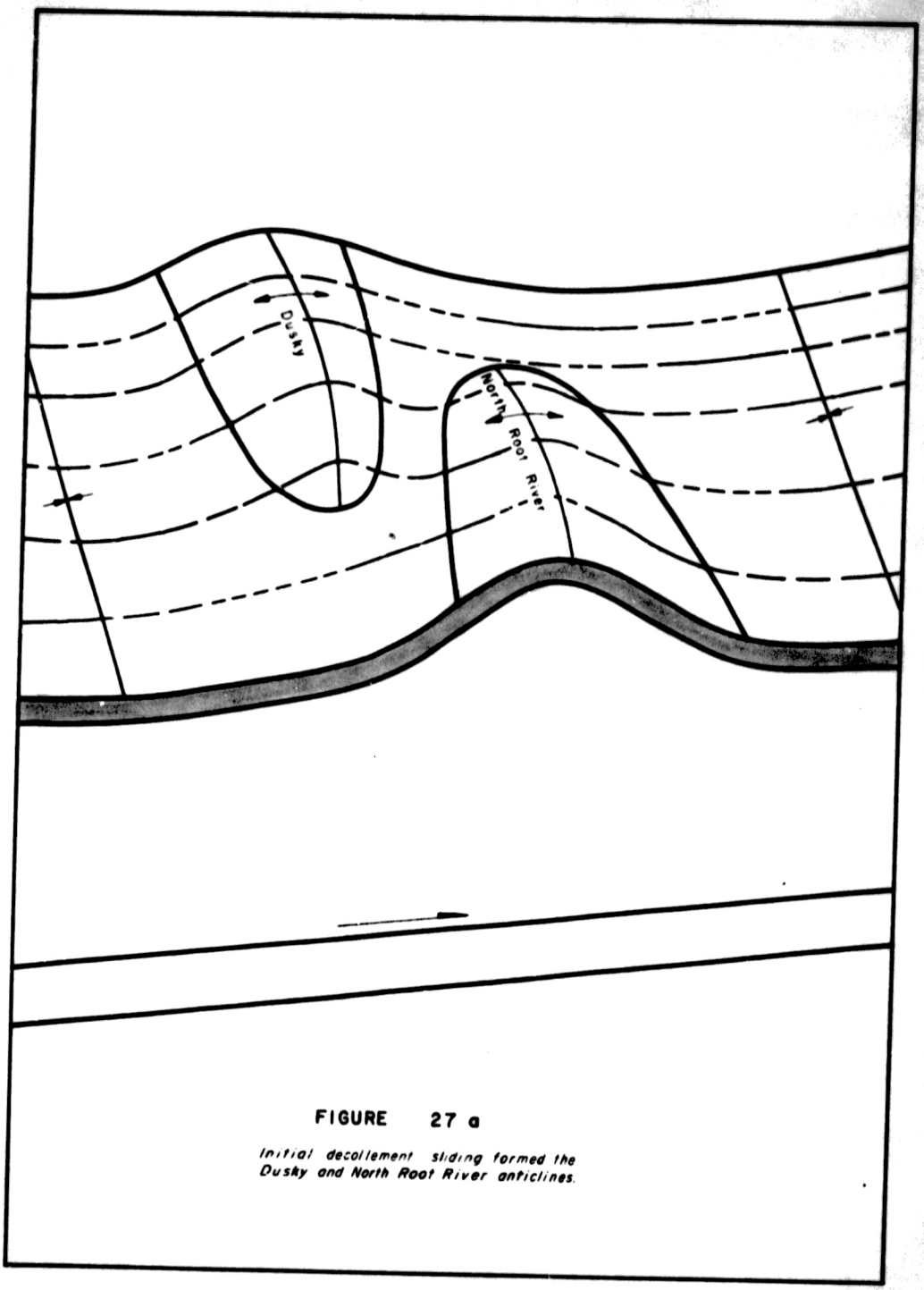


FIGURE 27 a

Initial decollement sliding formed the Dusky and North Root River anticlines.

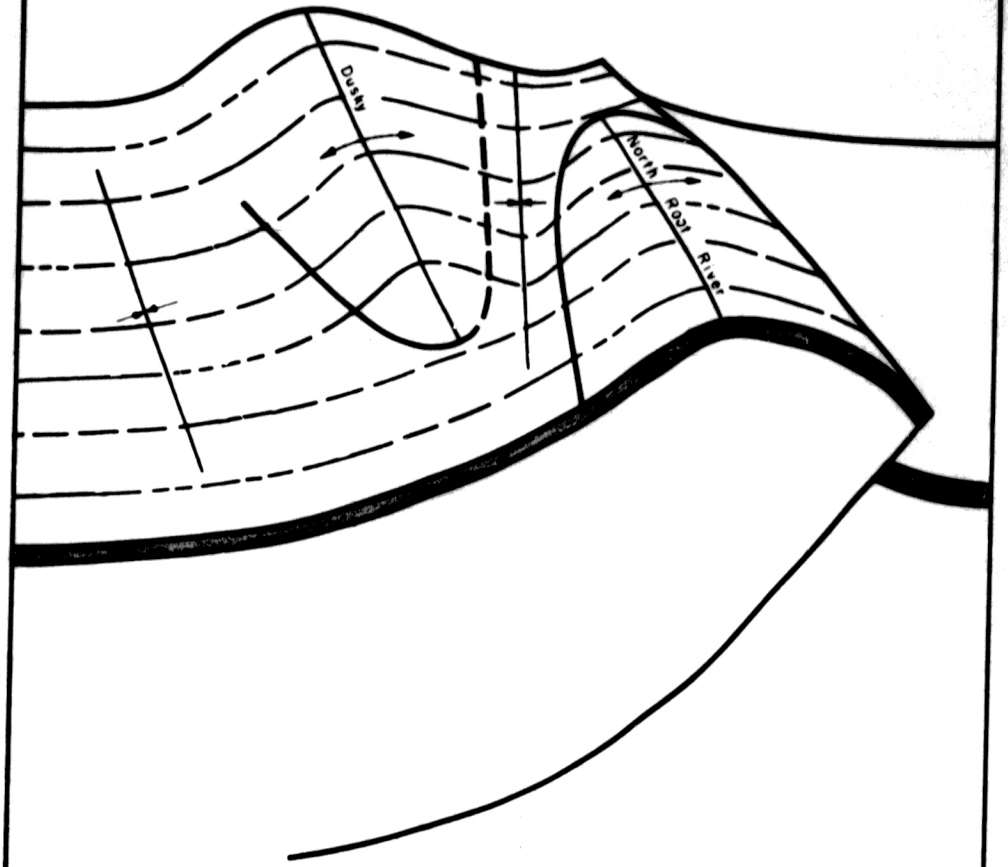


FIGURE 27 b

Additional sliding caused oversteepening of the eastern limb, and thrust faulting.

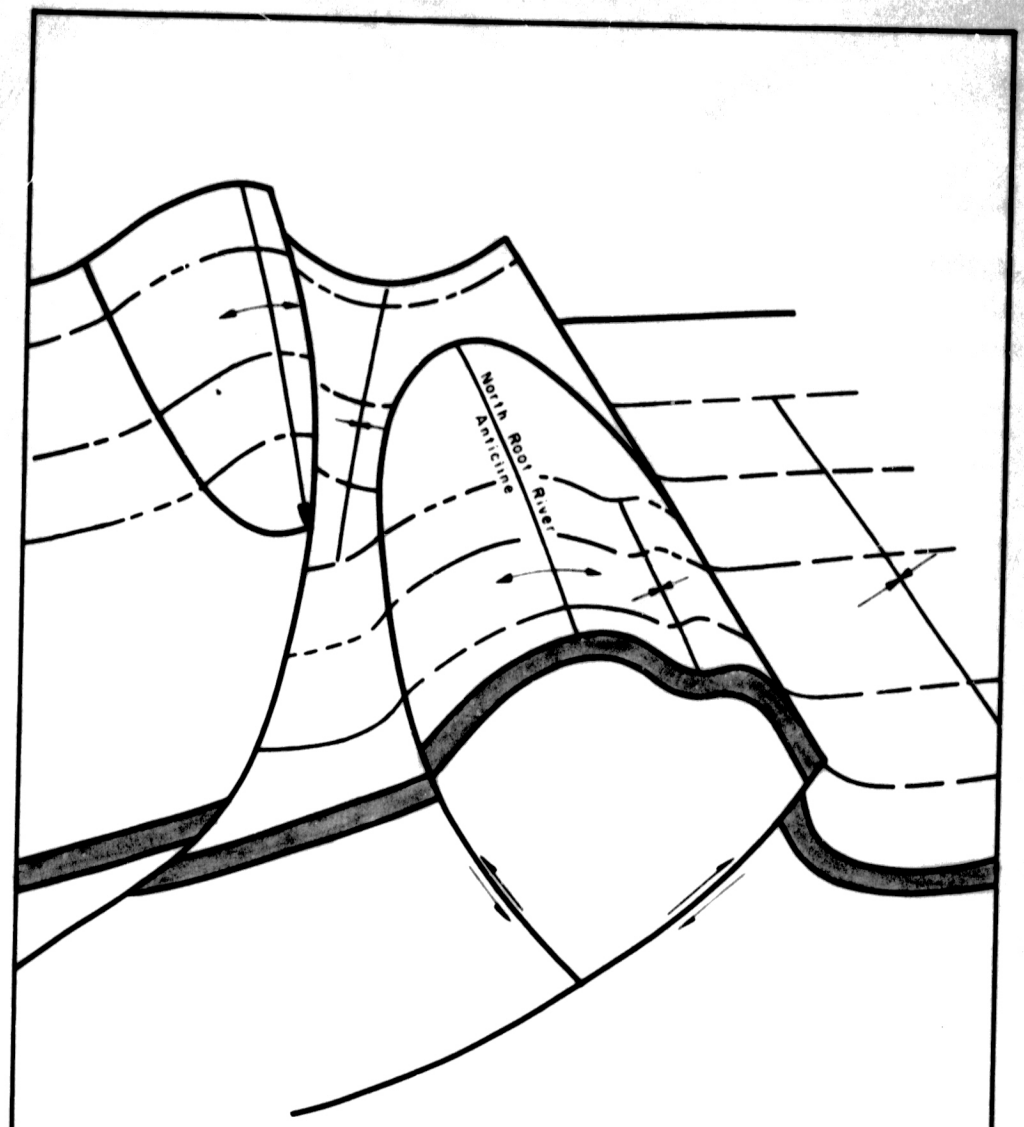


FIGURE 27c

Thrusting of the western limb of the North Root River anticline followed along with compressional flexing of the eastern limb. The Dusky anticline was also thrust faulted.

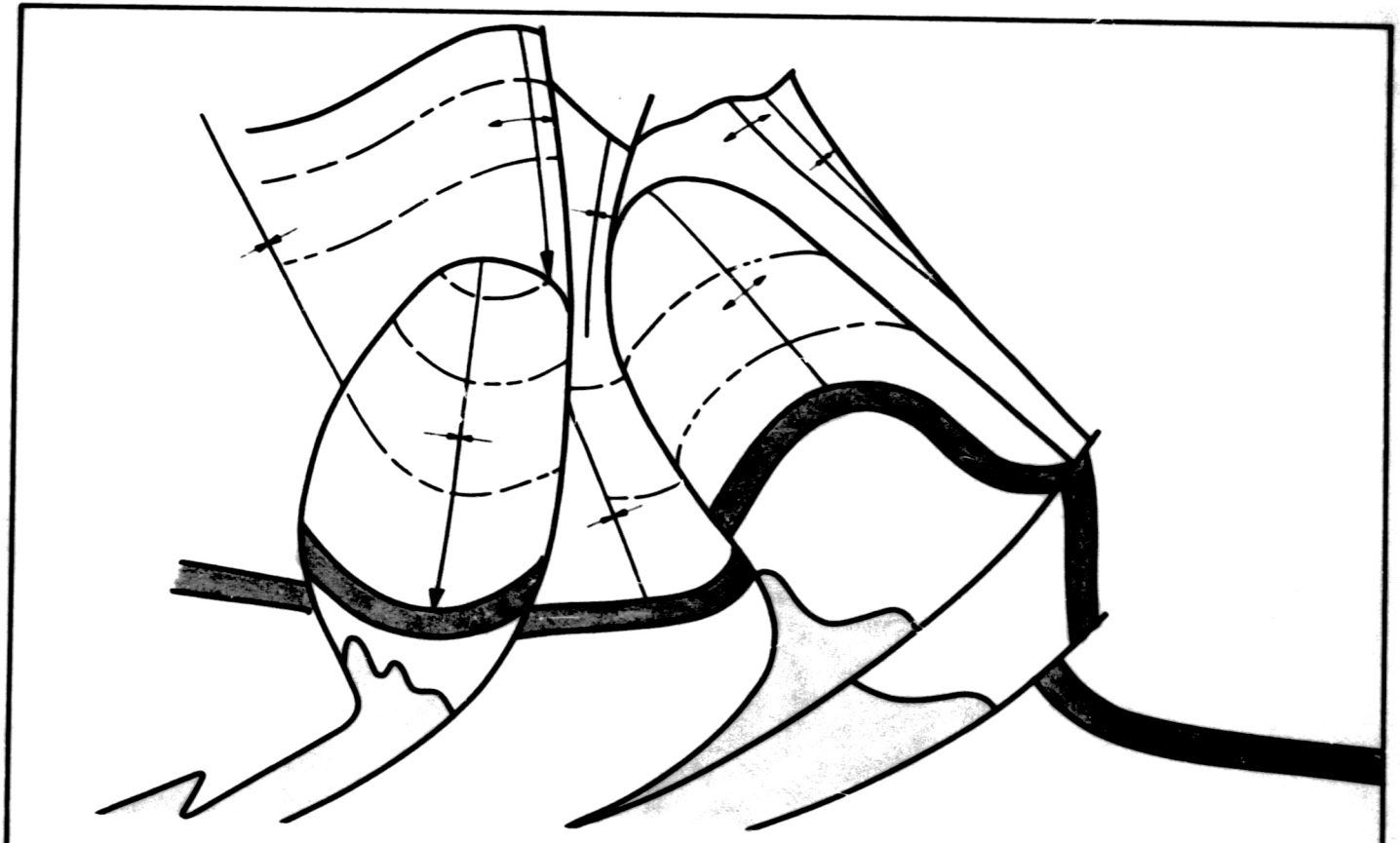


FIGURE 27d

The eastern limb of the North Root River anticline is thrust faulted for a second time. A syncline is thrust onto the Dusky anticline. Cambrian shales & evaporites are mobilized.

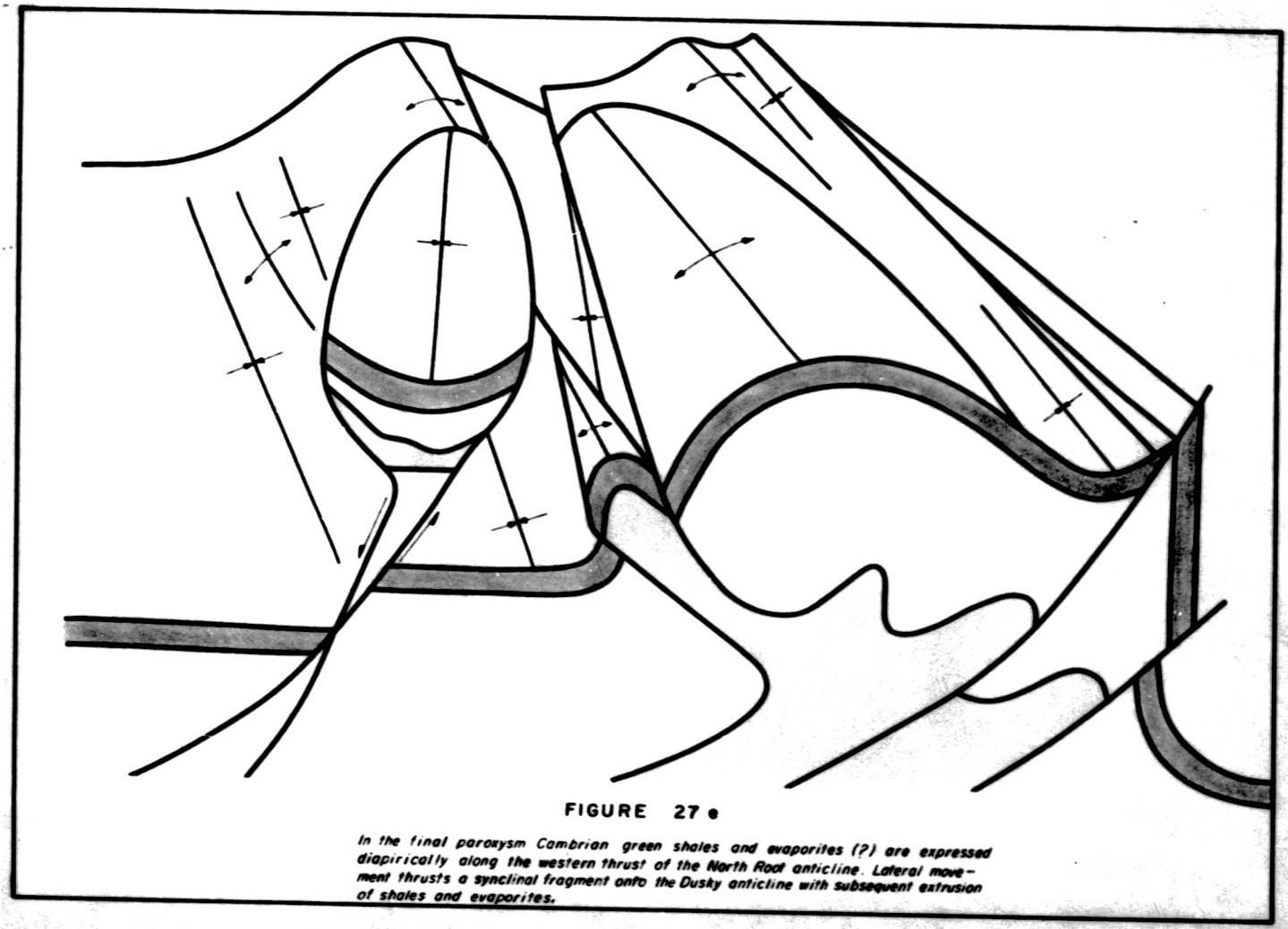


FIGURE 27 •

In the final paroxysm Cambrian green shales and evaporites (?) are expressed diapirically along the western thrust of the North Root anticline. Lateral movement thrusts a synclinal fragment onto the Dusky anticline with subsequent extrusion of shales and evaporites.

extend for over a mile. Any reef within the Whittaker Formation and near the crestal culmination could be bled off by these reef fingers extending updip from the main reef body.

There are several problems seismically in delineating such a reef body. First, the terrain is extremely broken and would not be accessible for normal tracked vehicles. Second, it is doubtful if the reef body could be delineated in the enclosing carbonates. It is extremely unlikely that there would be a sufficient velocity contrast to identify the reef body.

STRUCTURAL EVOLUTION OF THE NORTH ROOT RIVER ANTICLINE

The structural evolution of the North Root River Anticline is given to assist any further evaluation of this anticline and its complex history. All structural complications are a function of sliding in the Laramide orogeny.

Initial sliding generated the Dusky and North Root River Anticlines en echelon (Fig. 27a). Further sliding led to oversteepening of the eastern limb and thrust faulting of this limb (Fig. 27b). Oversteepening and reversed thrust faulting of the western limb followed along with superficial flexuring of the eastern limb (Fig. 27c). As synclinal flexuring of the eastern limb (Fig. 27d) became more pronounced it thrust faulted this syncline and pushed the remnant limb of the anticline into a vertical position. At the same time (Fig. 27e) green shales were expressed diapirically along the western reverse thrust and caused an anticline and syncline at the base of the western limb. Late phase transverse faulting carried a section of the Delorme syncline and thrust it along with diapiric green shales across the plunging nose of the Dusky Anticline.

PERMITS 6922 AND 6923 MARTEN CREEK BLOCK

The permits 6922 and 6923 straddle the Marten Creek Syncline. They are flanked to the east by the Redstone and Dusky Ranges and to the west by the structurally complex Rouge Range.

The two principal anticlines in this permit area are identified as Anticline A and Anticline B (Fig. 28). The area encompassing the northeast corner of the permit is structurally complex as the Redstone Range interacts with the Dusky Range.

Anticline A plunges to the southeast and is thrust faulted at its updip edge onto the Redstone Range. All beds from Whittaker up to Nahanni are exposed at this fault contact and have now weathered back, exposing the core of the anticline. This anticline is not a drilling prospect. Some small synclines and anticlines in the northeastern corner of the permit are surficial and not of economic structural importance.

Anticline B is an asymmetrical, tightly folded anticline, 1 1/2 miles wide and 7 miles long. It plunges rapidly to the southeast, but only slightly (1° to 3°) to the northwest. Its northern prolongation eventually dies out as a minor fold on the flank of Anticline A. Effective closure to the north is one of the problems associated with the prospectiveness of this anticline. The southeastern plunge of the anticline steps laterally sideways to the southwest as the southern end of the anticline interacts with the western flank of the Dusky Anticline. This lateral shift of the crest in no way impairs the closure at this end.

A cross section of Anticline B (Fig. 29) has been drawn transverse to the crestal axis, following a stream crossing (Fig. 28) within the southern

STRUCTURAL CROSS SECTION

WEST ANTICLINE B EAST

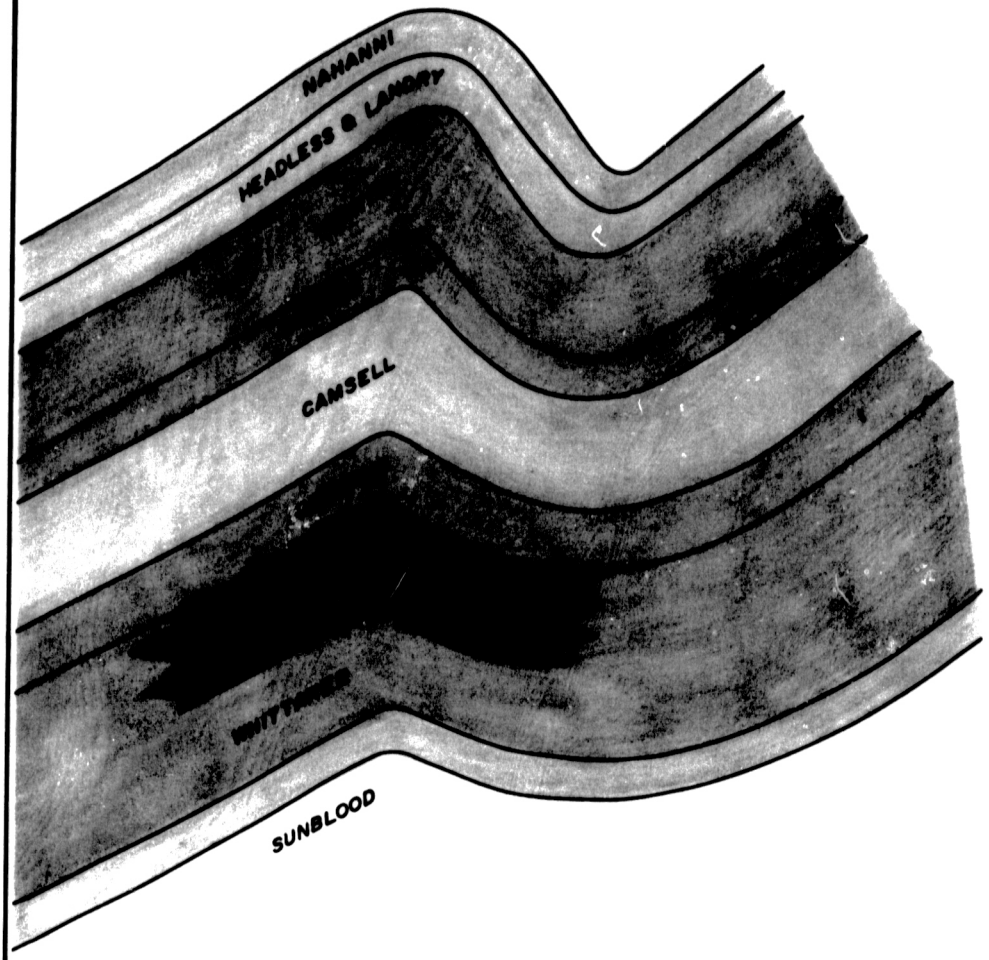


Figure 29

half of the anticline. This section shows that the anticline is progressively eliminated with depth. At 9000 feet the anticline would be approximately 3000 feet wide with 800+ feet of closure.

The stratigraphic objective would be the sucrosic dolomite of a Whittaker reef. It would be difficult to seismically identify such a reef because of the absence of a velocity contrast between the reef and the enclosing dolomites.

Further features that detract from the prospectiveness of this anticline are:

1. All formations are exposed in the Dusky Range at higher elevation to the east. The hydraulic head of fresh water could be sufficient to flush all formations in the anticline.

2. The northern plunge is inadequate for effective closure.

This is not a suitable drilling prospect.

BIBLIOGRAPHY

Buxtorf, A. (1910): "Geologische Beschreibung des Weissenstein-tunnels and seiner Umgebung," Mater. crt. geol. Suisse 21 (not seen by author).

de Sitter, L.U. (1956): "Structural Geology," McGraw-Hill Book Company, pp. 1-551.

Douglas, R.J.W. and D.K. Norris (1960): "Virginia Falls and Sibbeston Lake Map Areas, Northwest Territories 95F and 95G," G.S.C. Paper 60-19, pp. 1-26.

Douglas, R.J.W. and D.K. Norris (1961): "Camsell Bend and Root River Map Areas, District of Mackenzie, Northwest Territories 95J and 95K," G.S.C. Paper 61-13, pp. 1-36.

Douglas, R.J.W. and D.K. Norris (1963): "Dahadinni and Wrigley Map Areas, District of Mackenzie, Northwest Territories 95N and 95O," G.S.C. Paper 62-33, pp. 1-34.

PLATES

PLATE 1. Main reef body of sucrosic dolomites, Whittaker Formation, Station 107.

PLATE 2. Reef mounds extending in front of the main reef body, Station 107.

PLATE 3. Bear Rock reef front, Manetoe Formation. Looking south--1000+ feet of off reef shales lie to the right hand side and west two miles from this station.

PLATE 4. Station 29, North Nahanni Gorge, showing an Arnica step overlain by Funeral shales.

PLATE 5. Station 104, North Nahanni Gorge. Back reef Arnica dolomites overlain by Manetoe reef facies of the Bear Rock Group.

PLATE 6. Unconformity within back reef facies of the Arnica Formation, Bear Rock Group, Station 18.

PLATE 7. Unconformity at the top of Funeral Formation, east of Station 13, northern Nahanni Plateau area.

PLATE 8. Unconformity at the top of the Funeral Formation; further view along same range as in Plate 7.

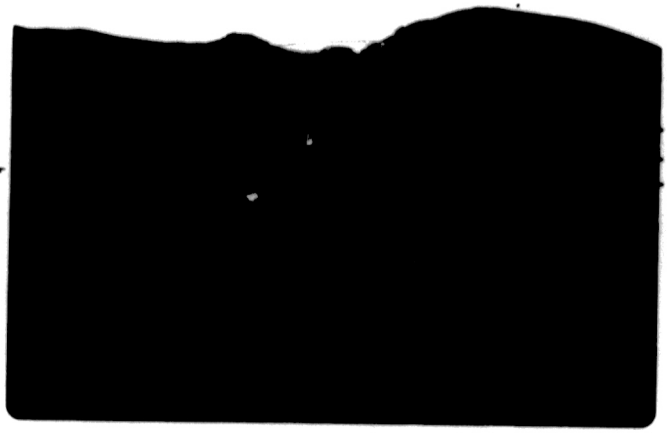


PLATE 9. Shale out of Nahanni Formation Corridor Creek, northern Nahanni Plateau area.

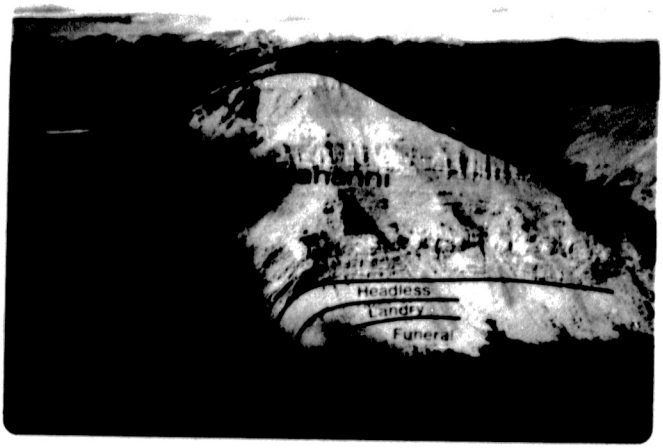


PLATE 10. View looking north of the western flank and crest of the Hollow Mountain anticline. Nahanni limestones overly Headless shales, vestigial Landry and subjacent Funeral shales.

PLATE 11. View north from north of the Root River of the crest of the North Root River Anticline. The light buff limestone are the Camsell Formation. In the middle distance the crest interacts with the east flank of the Dusky Anticline. A syncline is overthrust over the Dusky Anticline in the top left hand corner.

WESTCOAST PETROLEUM LTD

STRATIGRAPHIC SECTION

NTS:

LOCATION	TOP	BASE
LAT.	63° 17'	63° 18'
LONG.	125° 23'	125° 21'

OUTCROP SECTION
STATION Nº 107
DUSKY RANGE

FIELD DESCRIPTION BY: R. CHAUDHRY

PALEONTOLOGY BY:

TOTAL THICKNESS: 4000'

DATE: AUGUST 1, 1971

NOTE: Measured by tape and brunton along minor ridge to the crest of the range

SUMMARY

FORMATION	THICKNESS	TOP
Whittaker	3900'	
Ordovician	100'	

LEGEND

SHALE
SILTSTONE
SANDSTONE
CONGLOMERATE OR GRAVEL
LIMESTONE
DOLOMITE
CALCAREOUS
DOLOMITIC
ARGILLACEOUS
SANDY
QUARTZITIC
GYPSUM OR ANHYDRITE
CHERT
METAMORPHICS
SHALE
COAL OR LIGNITE
PYRITIC MATERIALS
PHOSPHATE
BENTONITE
SKELETAL MATERIAL
BRECCIATED
COVERED
STROMATOPORA
AMPHIPORA
HORN CORALS
COLONIAL CORALS
LIMESTONE FLOATSTONE BRECCIA
SUBMARINE SLUMPING
CROSS BEDDING
ANGULAR UNCONFORMITY
LIMESTONE PEBBLES

WHITTAKER

ORDOVICIAN

Dolomite, light and dark grey bands, fine grained.

Dolomite, medium grey, fine grained massive.
Fossils, Favosites and Halysites, finger stroms and horn corals.

Dolomite, medium and dark grey, fine grained.

10% blind vuggy porosity.

5% blind vuggy porosity.

Dolomite, light grey to medium grey.
Relict texture in part skeletal-micritic.

pinpoint vuggy porosity.

5% blind vuggy porosity,
2% crystalline porosity.

Dolomite, medium grey, fine grained, up to 30% chert.
Fossils, Favosites and Halysites.

Dolomite, dark grey, fine grained. Chert nodules.

Dolomite, dark grey, up to 20% Amphipora, finger stroms and horn corals.

Limestone, dark grey, micritic, occasional corals.

Limestone, dark grey, micritic and micritic-skeletal.
Skeletal includes Amphipora and brachiopods.

Dolomite, medium grey, cryptograined, argillaceous.

WESTCOAST PETROLEUM LTD.

STRATIGRAPHIC SECTION

NTS:

LOCATION	TOP	BASE
LAT.	63° 18'	63° 17'
LONG.	125° 29'	125° 30'

OUTCROP SECTION
STATION Nº 106
ANTICLINE B

FIELD DESCRIPTION BY: R. CHAUDHRY

PALEONTOLOGY BY:

TOTAL THICKNESS: 2440'

DATE: JULY 27, 1971

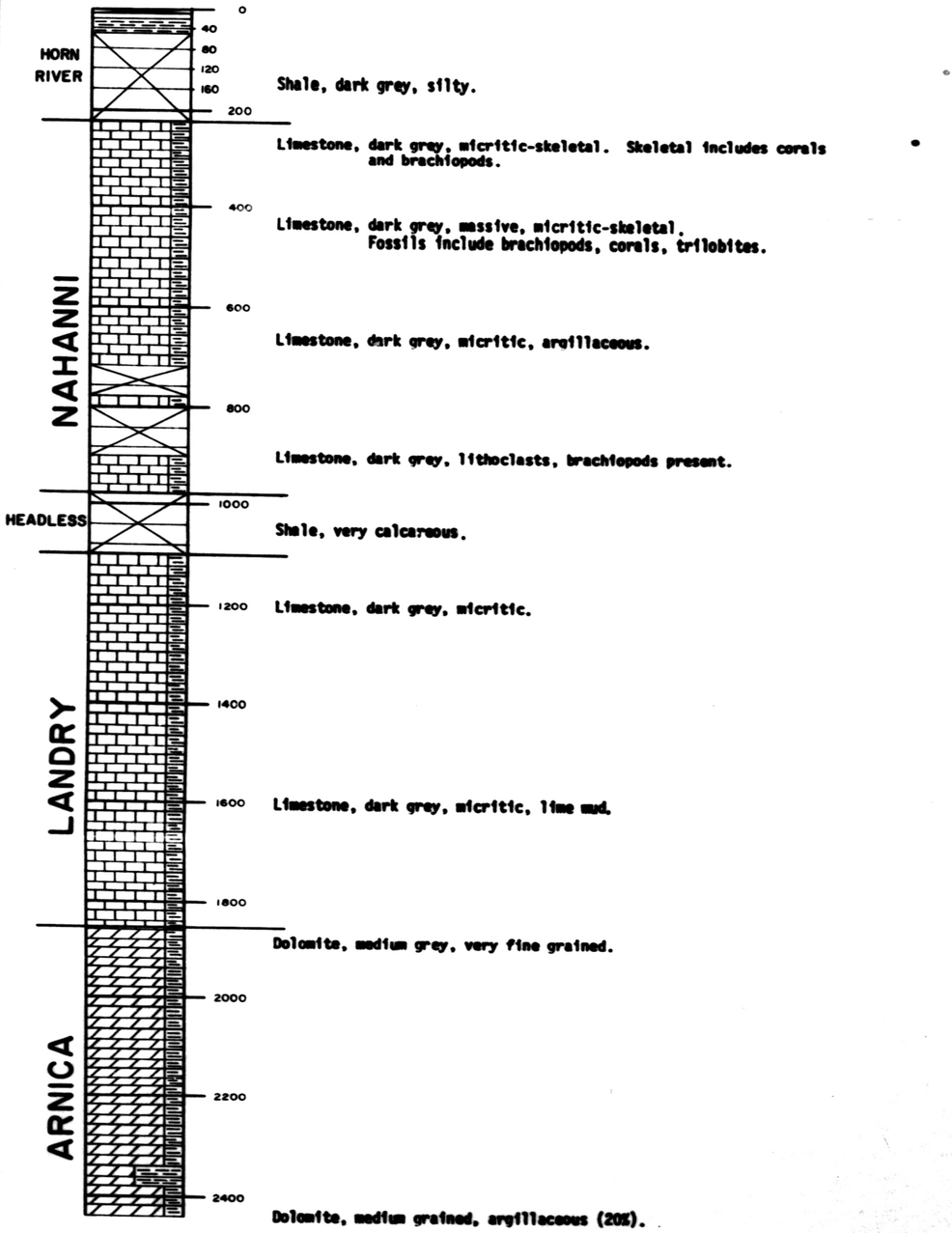
NOTE: Measured by tape and brunton along stream bed on west flank of anticline B.

SUMMARY

FORMATION	THICKNESS	LITHOLOGY
Horn River	220'	
Nahanni	760'	
Headless	130'	
Landry	740'	
Arnica	590'	

LEGEND

- SHALE
- SILTSTONE
- SANDSTONE
- CONGLOMERATE OR GRAVEL
- LIMESTONE
- DOLOMITE
- CALCAREOUS
- DOLOMITIC
- ARGILLACEOUS (ls, dol)
- SANDY (ls, dol)
- QUARTZITIC
- GYPSUM OR ANHYDRITE
- CHERT
- METASEDIMENTS
- IGNACEOUS
- COAL OR LIGNITE
- SILICEOUS
- PYRITIC, MICACEOUS
- IRONSTONE
- Be BENTINITE
- S SKELETAL MATERIAL
- Gl GLAUCONITIC
- BRECCIATED
- COVERED
- STROMATOPORA
- AMPHIPORA
- HORN CORALS
- COLONIAL CORALS
- LIMESTONE, COLLAPSE BRECCIA
- SUBMARINE SLUMPING
- CROSS BEDDING
- ANGULAR UNCONFORMITY
- DISCONFORMITY
- f — f FAULT



WESTCOAST PRODUCTION CO. LTD.

STRATIGRAPHIC SECTION

NTS:

LOCATION	TOP	BASE
LAT.	63° 28'	63° 28'
LONG.	125° 42'	125° 40'

OUTCROP SECTION
STATION Nº 105
BLUE LAKE

FIELD DESCRIPTION BY: R. CHAUDHRY

PALEONTOLOGY BY:

TOTAL THICKNESS: 3460'

DATE: JULY 26, 1971

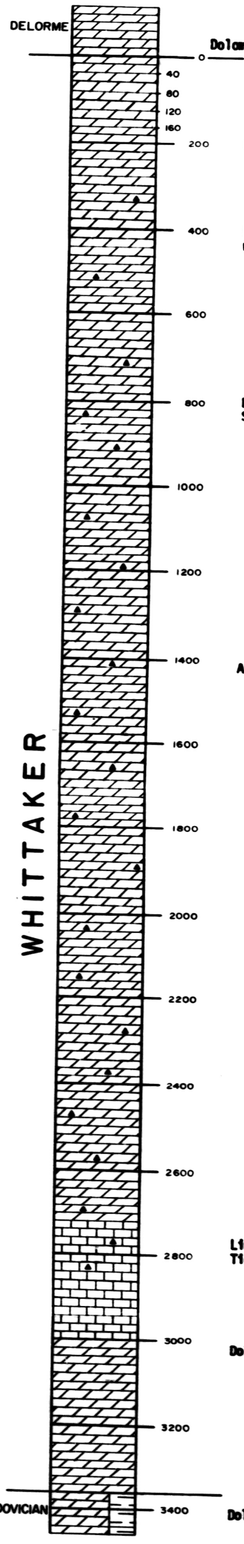
NOTE: Measured along south shore of Blue Lake and combined with section by Douglas and Norris (1963)

SUMMARY

FORMATION	THICKNESS	LITHOLOGY
Whittaker	3360'	
Ordovician	100'	

LEGEND

- SHALE
- SILTSTONE
- SANDSTONE
- CONGLOMERATE OR GRAVEL
- LIMESTONE
- DOLOMITE
- CALCAREOUS
- DOLOMITIC
- ARGILLACEOUS (ls, dol)
- SANDY (ls, dol)
- QUARTZITIC
- GYPSUM OR ANHYDRITE
- CHERT
- METASEDIMENTS
- IGNACEOUS
- COAL OR LIGNITE
- SILICEOUS
- PYRITIC, MICACEOUS
- IRONSTONE
- Be BENTINITE
- S SKELETAL MATERIAL
- Gl GLAUCONITIC
- BRECCIATED
- COVERED
- STROMATOPORA
- AMPHIPORA
- HORN CORALS
- COLONIAL CORALS
- LIMESTONE, COLLAPSE BRECCIA
- SUBMARINE SLUMPING
- CROSS BEDDING
- ANGULAR UNCONFORMITY
- DISCONFORMITY
- f FAULT



Dolomite, light grey, crypto- to fine grained, thin bedded, recessive.

Dolomite, grey to dark grey, fine grained, thin bedded.

Dolomite, dark grey, fine to medium grained, thick bedded to massive, some chert present.

Dolomite, medium grey, fine to medium grained, massive bedding, some chert. Some blind vugs present.

Amphipora, Halysites, fingerstroms and some corals present at this level.

Limestone, dark grey, thin to medium bedded, fine grained, chert present. Tight.

Dolomite, medium grey, fine grained, thin bedded, very slightly silty.

Dolomite, medium grey, fine grained, argillaceous.

Note: Thicknesses taken from G.S.C. Paper 62-33.

WESTCOAST PETROLEUM LTD.

STRATIGRAPHIC SECTION

NTS:

		TOP	BASE
LOCATION	LAT.	62° 13'	62° 14'
	LONG.	124° 24'	124° 24'

OUTCROP SECTION
STATION № 104
NORTH NAHANNI GORGE

FIELD DESCRIPTION BY: R. CHAUDHRY

PALEONTOLOGY BY:

TOTAL THICKNESS: 1200'

DATE: JULY 18, 1971

NOTE: Measured by tape and brunton on south bank of the North Nahanni gorge.

SUMMARY

FORMATION	THICKNESS	LITHOLOGY
Manetoe Form.	150'	
Arnica Form.	1050'	

LEGEND

- SHALE
- SILTSTONE
- SANDSTONE
- CONGLOMERATE OR GRAVEL
- LIMESTONE
- DOLOMITE
- CALCAREOUS
- DOLOMITIC
- ARGILLACEOUS (ls, dol)
- SANDY (ls, dol)
- QUARTZITIC
- GYPSUM OR ANHYDRITE
- CHERT
- METASEDIMENTS
- IGNACEOUS
- COAL OR LIGNITE
- SILICEOUS
- PYRITIC, MICACEOUS
- IRONSTONE
- Be BENTINITE
- S SKELETAL MATERIAL
- Gl GLAUCONITIC
- BRECCIATED
- COVERED
- STROMATOPORA
- AMPHIPORA
- HORN CORALS
- COLONIAL CORALS
- LIMESTONE, COLLAPSE BRECCIA
- SUBMARINE SLUMPING
- CROSS BEDDING
- ANGULAR UNCONFORMITY
- DISCONFORMITY
- f——f FAULT

0 – 160: Dolomite, dark grey, medium to coarse grained, calcite veining.

vuggy porosity >5%

200 – 600: Interbedded light and dark grey bands of dolomite

Dolomite, light grey, fine to medium grained, relict texture lime mud.

vuggy porosity >5%

Dolomite, dark grey, crypto- to fine grained, relict texture micritic-skeletal. Occasional beds with up to 30% Amphipora.

800 – 1200: poor vuggy porosity <5%

Base not exposed.

WESTCOAST PETROLEUM LTD.

STRATIGRAPHIC SECTION

NTS:

LOCATION	TOP	BASE
LAT.	62° 32'	62° 32'
LONG.	125° 01'	124° 58'

OUTCROP SECTION
STATION Nº 102
ENGLISH CHIEF RIVER

FIELD DESCRIPTION BY: R. CHAUDHRY

PALEONTOLOGY BY:

TOTAL THICKNESS: 3660'

DATE: JULY 12, 1971

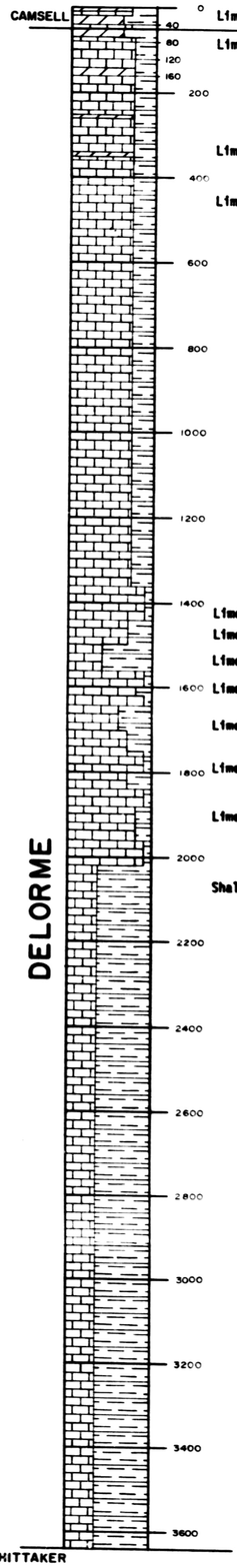
NOTE: Measured by tape and brunton along stream bed, headwaters of English Chief River.

SUMMARY

FORMATION	THICKNESS	LITHOLOGY
Camsell	50'	
Delorme	3610'	

LEGEND

- SHALE
- SILTSTONE
- SANDSTONE
- CONGLOMERATE OR GRAVEL
- LIMESTONE
- DOLOMITE
- CALCAREOUS
- DOLOMITIC
- ARGILLACEOUS (ls, dol)
- SANDY (ls, dol)
- QUARTZITIC
- GYPSUM OR ANHYDRITE
- CHERT
- METASEDIMENTS
- IGNACEOUS
- COAL OR LIGNITE
- SILICEOUS
- PYRITIC, MICACEOUS
- IRONSTONE
- Be BENTINITE
- S SKELETAL MATERIAL
- Gl GLAUCONITIC
- BRECCIATED
- COVERED
- STROMATOPORA
- AMPHIPORA
- HORN CORALS
- COLONIAL CORALS
- LIMESTONE, COLLAPSE BRECCIA
- SUBMARINE SLUMPING
- CROSS BEDDING
- ANGULAR UNCONFORMITY
- DISCONFORMITY
- f—f FAULT



WESTCOAST PETROLEUM LTD.

STRATIGRAPHIC SECTION

NTS:

LOCATION	TOP	BASE
LAT.	62° 30'	62° 30'
LONG.	124° 45'	124° 47'

OUTCROP SECTION
STATION Nº 101
TRENCH CR.

FIELD DESCRIPTION BY: R. CHAUDHRY

PALEONTOLOGY BY:

TOTAL THICKNESS: 2840'

DATE: JULY 8, 1971

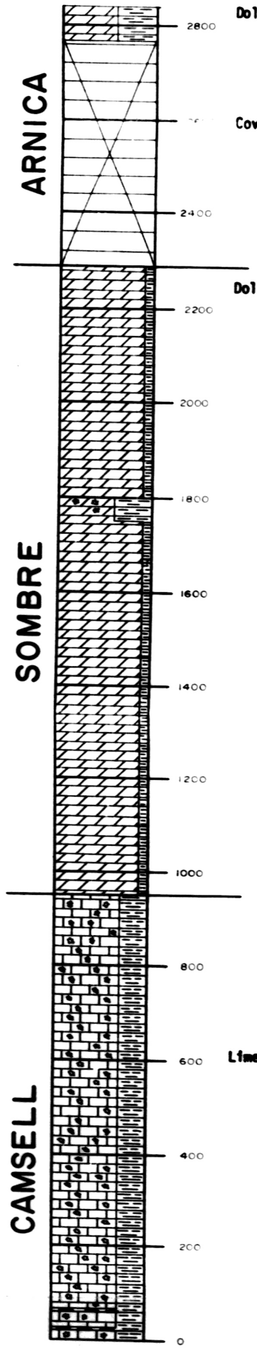
NOTE: Measured by tape and brunton on south side of Trench Creek.

SUMMARY

FORMATION	THICKNESS	LITHOLOGY
Camsell	950'	
Sombre	1340'	
Arnica	550'	

LEGEND

- SHALE
- SILTSTONE
- SANDSTONE
- CONGLOMERATE OR GRAVEL
- LIMESTONE
- DOLOMITE
- CALCAREOUS
- DOLOMITIC
- ARGILLACEOUS (ls, dol)
- SANDY (ls, dol)
- QUARTZITIC
- GYPSUM OR ANHYDRITE
- CHERT
- METASEDIMENTS
- IGNACEOUS
- COAL OR LIGNITE
- SILICEOUS
- PYRITIC, MICACEOUS
- IRONSTONE
- Be BENTINITE
- S SKELETAL MATERIAL
- Gl GLAUCONITIC
- BRECCIATED
- COVERED
- STROMATOPORA
- AMPHIPORA
- HORN CORALS
- COLONIAL CORALS
- LIMESTONE, COLLAPSE BRECCIA
- SUBMARINE SLUMPING
- CROSS BEDDING
- ANGULAR UNCONFORMITY
- DISCONFORMITY
- FAULT



Dolomite, dark grey, cryptograined, bituminous.

Covered, shale with some thin limestone interbeds.

Dolomite, dark grey, cryptograined to fine grained.

Limestone, medium grey, micritic, collapse breccia.

WESTCOAST PETROLEUM LTD.

STRATIGRAPHIC SECTION

NTS:

		TOP	BASE
LOCATION	LAT.	62° 48'	62° 48'
	LONG.	125° 14'	125° 17'

OUTCROP SECTION
STATION № 20
PASTEL CREEK

FIELD DESCRIPTION BY: P. McGILL

PALEONTOLOGY BY:

TOTAL THICKNESS: 9600'

DATE: JULY 29, 1971

NOTE: Interval thickness from Douglas and Norris (1961)

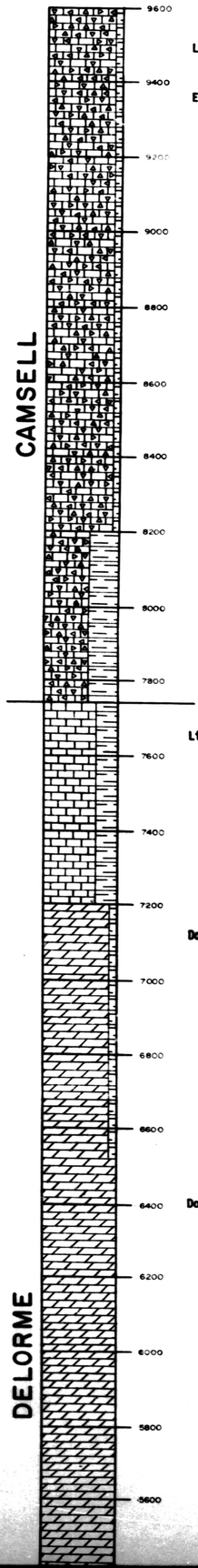
Described along ridge on north side of Pastel Creek.

SUMMARY

FORMATION	THICKNESS	LITHOLOGY
Camsell	1750'	
Delorme	3260'	
Whittaker	2890'	
Sunblood	1600'	

LEGEND

- SHALE
- SILTSTONE
- SANDSTONE
- CONGLOMERATE OR GRAVEL
- LIMESTONE
- DOLOMITE
- CALCAREOUS
- DOLOMITIC
- ARGILLACEOUS (ls, dol)
- SANDY (ls, dol)
- QUARTZITIC
- GYPSUM OR ANHYDRITE
- CHERT
- METASEDIMENTS
- IGNACEOUS
- COAL OR LIGNITE
- SILICEOUS
- PYRITIC, MICACEOUS
- IRONSTONE
- BENTINITE
- SKELETAL MATERIAL
- GLAUCONITIC
- BRECCIATED
- COVERED
- STROMATOPORA
- AMPHIPORA
- HORN CORALS
- COLONIAL CORALS
- LIMESTONE, COLLAPSE BRECCIA
- SUBMARINE SLUMPING
- CROSS BEDDING
- ANGULAR UNCONFORMITY
- DISCONFORMITY
- FAULT



Limestone, light grey, cream, collapse breccia with red shale inclusions. Tight.

Environment: Sabhka.

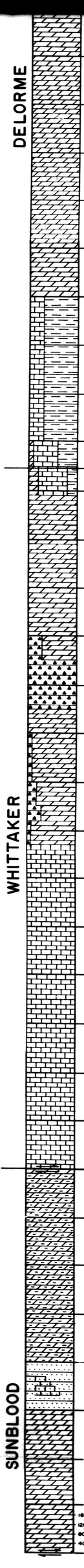
Limestone, dark grey, black, argillaceous in part micritic skeletal

Boudinage, shelf facies.

Dolomite, cream - light grey, laminated to thinly bedded, tight.

Dolomite light grey, fine grained.
Occasional scattered small vuggy porosity, permeability nil.

Probably back reef facies.



Occasional scattered small vuggy porosity, permeability unit.

Probably back reef facies.

Shale, black, very calcareous

Limestone, black, micritic skeletal, argillaceous, skeletal, mostly crinoids

Dolomite, dark grey to black, micritic-skeletal relict texture, 20% stroms, finger corals, crinoids, brachiopods. Platform facies.

Dolomite, dark grey, very fine grained, laminated basinal facies or platform margin.

Some submarine slumping near base of unit.

Chert, silicified thin bedded sediments. Tight.

Dolomite, dark grey, fine grained, relict texture, micritic skeletal 20% crinoid ossicles.

Platform facies

Up to 10% fracture porosity.

Dolomite, dark, fine grained, beds with 5% leached vuggy porosity, mostly tight.

In part relict skeletal, 15% brachiopods, gastropods, crinoids, occasional Stromatoporoides and colonial corals.

Limestone, dark grey - black, thin bedded recessive weathering.

(This unit faulted out on Pastal Creek South, but visible on next range west).

Dolomite, grey, fine grained, silty to very silty, tight.

Sandstone, cream, quartzitic, coarse grained dolomitic and cross bedded, tight.

Dolomite, grey, fine grained, silty to very silty to arenaceous.

Note: The sand interval was not measured. Its position in the section was estimated.

WESTCOAST PETROLEUM LTD.

STRATIGRAPHIC SECTION

NTS:

LOCATION	TOP	BASE
LAT.	63° 11'	63° 12'
LONG.	125° 25'	125° 23'

OUTCROP SECTION
STATION Nº 19
EAST OF ANTICLINE B

FIELD DESCRIPTION BY: P. McGILL

PALEONTOLOGY BY:

TOTAL THICKNESS: 3000'

DATE: JULY 27, 1971

NOTE: Interval thickness from Douglas and Norris (1963)

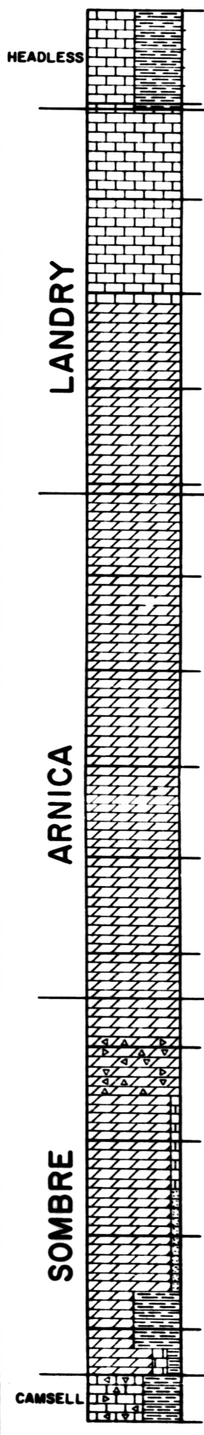
Described along stream bed.

SUMMARY

FORMATION	THICKNESS	LITHOLOGY
Camsell	100'	
Sombre	800'	
Arnica	1480'	
Landry	410'	
Headless	210'	

LEGEND

- SHALE
- SILTSTONE
- SANDSTONE
- CONGLOMERATE OR GRAVEL
- LIMESTONE
- DOLOMITE
- CALCAREOUS
- DOLOMITIC
- ARGILLACEOUS (ls, dol)
- SANDY (ls, dol)
- QUARTZITIC
- GYPSUM OR ANHYDRITE
- CHERT
- METASEDIMENTS
- IGNACEOUS
- COAL OR LIGNITE
- SILICEOUS
- PYRITIC, MICACEOUS
- IRONSTONE
- Be BENTINITE
- S SKELETAL MATERIAL
- Gl GLAUCONITIC
- BRECCIATED
- COVERED
- STROMATOPORA
- AMPHIPORA
- HORN CORALS
- COLONIAL CORALS
- LIMESTONE, COLLAPSE BRECCIA
- SUBMARINE SLUMPING
- CROSS BEDDING
- ANGULAR UNCONFORMITY
- DISCONFORMITY
- t—t FAULT



Limestone, grey-brown, very argillaceous, micritic

Shale, dark grey, very calcareous

Limestone, grey-brown to grey, lime mud.
Birdseye with clear calcite cement.

Dolomite, dominantly dark grey-black, micritic dolomitized lime mud, occasional coarse grained beds, poor intergranular porosity.

Dolomite, dark grey-black, very bituminous, bioclastic in part with finger stroms, amphipora crinoid ossicles, very fine to fine grained. Beds with 20% plugged leached vuggy porosity, some poor pinpoint porosity, less than 1%.

Dolomite, light grey, micritic, dolomitized lime mud.
(30% of the total)

Dolomite interbanded light grey and dark grey in equal proportions:
Light grey, dolomitized lime mud, cryptograined.
Dark grey, bituminous, fetid odor, bioclastic, fine grained in part , amphipora or crinoids up to 20% plugged leached vuggy porosity

Dolomite mostly light grey, cryptocrystalline weathers light grey - buff.

Lower part with some siltstone interbeds and 5% silt content in dolomite.

Some collapse breccia higher in section. Tight.

Environment: Mostly dolomitized back reef lime mud.

Dolomite, black, argillaceous, calcareous, bioclastic some beds amphipora, Tight.

Limestone, grey green to buff, very argillaceous, collapse breccia

Environment: Restricted, landward sabkha.

WESTCOAST PETROLEUM LTD.

STRATIGRAPHIC SECTION

NTS:

		TOP	BASE
LOCATION	LAT.	63°10'	63° 09'
	LONG.	125° 42'	125°46'

FIELD DESCRIPTION BY: P. McGILL

PALEONTOLOGY BY:

OUTCROP SECTION
STATION Nº 18
REDSTONE RANGE

TOTAL THICKNESS: 10,260

DATE: JULY 28, 1971

NOTE: Interval thickness from Douglas and Norris (1963)

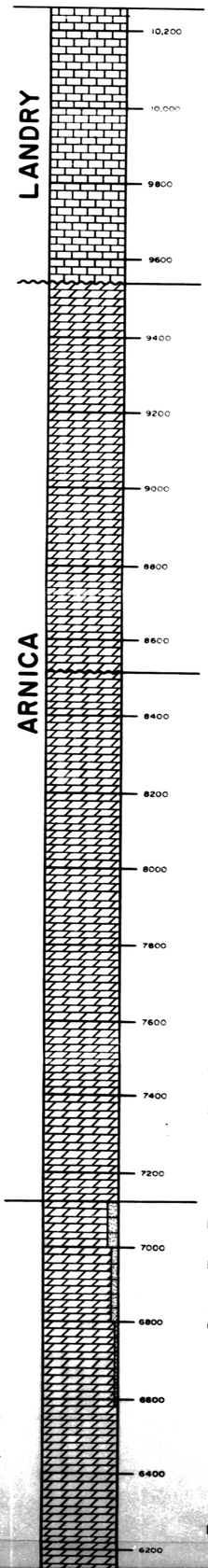
Section described along stream bed.

SUMMARY

FORMATION	THICKNESS	LITHOLOGY
Landry	720'	
Arnica	2420'	
Sombre	2870'	
Camsell	1850'	
Delorme	2100'	
Whittaker	300'	

LEGEND

- SHALE
- SILTSTONE
- SANDSTONE
- CONGLOMERATE OR GRAVEL
- LIMESTONE
- DOLOMITE
- CALCAREOUS
- DOLOMITIC
- ARGILLACEOUS (ls, dol)
- SANDY (ls, dol)
- QUARTZITIC
- GYPSUM OR ANHYDRITE
- CHERT
- METASEDIMENTS
- IGNACEOUS
- COAL OR LIGNITE
- SILICEOUS
- PYRITIC, MICACEOUS
- IRONSTONE
- BENTINITE
- SKELETAL MATERIAL
- GLAUCONITIC
- BRECCIATED
- COVERED
- STROMATOPORA
- AMPHIPORA
- HORN CORALS
- COLONIAL CORALS
- LIMESTONE, COLLAPSE BRECCIA
- SUBMARINE SLUMPING
- CROSS BEDDING
- ANGULAR UNCONFORMITY
- DISCONFORMITY
- FAULT



Limestone, grey-brown, lime mud, tight.

Dolomite, dark grey and white, fine to very coarse grained.
Extreme leaching, zebra stone and leached breccias.
All vugs now plugged with replacement dolomite.

Dolomite, dark grey, crypto- to very fine grained. Relict structure micritic skeletal.
Fine shelled brachiopods leached then plugged.
Some beds with 10% plugged leached vuggy porosity.

Dolomite, dark grey, cryptograined.
Relict structure, algal mat and mud mounds.
Tight.

(Unit thickness estimated)

Dolomite, mostly dark grey - black, very fine to medium grained, fetid odor.
Interbeds with relict micritic-skeletal with amphipora, brachiopods and crinoid ossicles.
Some interbeds of algal mat and algal mounds.
Up to 30% plugged leached vuggy porosity.
Overall about 10% plugged leached vuggy porosity.

Dolomite, medium grey, cryptocrystalline, dolomitized lime mud.

Dolomite, dark grey, very fine grained, dolomitized algal mat and mud mounds.

Dolomite, medium grey, cryptocrystalline, dolomitized lime mud interbedded with

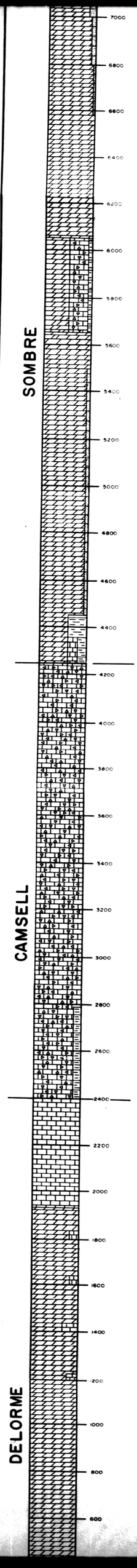
Dolomite, dark grey, very fine grained, dolomitized algal mat and mud mounds

Increasing number of interbeds of silty dolomite towards the top of the unit.

Tight.

Dolomite, dark grey, very fine grained.

Tight.



interbedded with

Dolomite, dark grey, very fine grained, dolomitized algal mat and mud mounds

Increasing number of interbeds of silty dolomite towards the top of the unit.

Tight.

Dolomite, dark grey, very fine grained.

Tight.

Dolomite, medium grey, very fine grained.

Limestone, cream, micritic, collapse breccia with red shale inclusions

Tight.

Environment: Sabkha

Interval thickness estimated.

Dolomite, light grey and dark grey, cryptograined to very fine grained, occasionally silty.

Mostly light grey, dolomitized lime mud.
Dark grey, dolomitized mud mounds

Occasional interbeds of dolomitic siltstone and red argillaceous dolomite.

Environment: Relict lime mud, back reef
Mud mounds shoreward from reef
Red mud flushed from shore margin.

Dolomite, black, fine grained.

Limestone, light grey - cream, micritic collapse breccia.
Upper part very resistant.

Tight.

Middle part with some interbeds of faecal pellets.

Environment: Sabhka.

Limestone, grey, micritic, argillaceous, red clay in collapse breccia.

Landward edge of Sabkha environment.

Tight.

Limestone, medium grey laminated beds with 10% detrital skeletal-micritic to interbeds.
faecal pellets also present
mostly boudinage limestone, occasional mud mounds.

Environment: Forereef shelf, platform.

Tight.

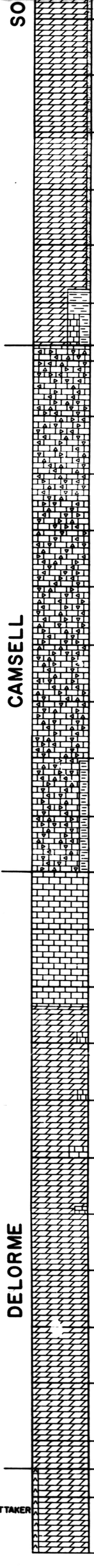
Dolomite, light grey to medium grey, very fine to fine grained, very finely laminated. 1 to 2% pyrite present as disseminated crystals, in parts buff to orange weathering color.

Interbedded with--

Dolomite, dark grey, very fine grained, very calcareous intensely burrowed. Burrows all dolomitized.

Tight.

Environment: Shelf, platform or back reef.



Dolomite, light grey and dark grey, cryptograined to very fine grained, occasionally silty.

Mostly light grey, dolomitized lime mud.
Dark grey, dolomitized mud mounds

Occasional interbeds of dolomitic siltstone and red argillaceous dolomite.

Environment: Relict lime mud, back reef
Mud mounds shoreward from reef
Red mud flushed from shore margin.

Dolomite, black, fine grained.

Limestone, light grey - cream, micritic collapse breccia.
Upper part very resistant.

Tight.

Middle part with some interbeds of faecal pellets.

Environment: Sabhka.

Limestone, grey, micritic, argillaceous, red clay in collapse breccia.

Landward edge of Sabhka environment.

Tight.

Limestone, medium grey laminated beds with 10% detrital skeletal-micritic to interbeds.
faecal pellets also present
mostly boudinage limestone, occasional mud mounds.

Environment: Forereef shelf, platform.

Tight.

Dolomite, light grey to medium grey, very fine to fine grained, very finely laminated. 1 to 2% pyrite present as disseminated crystals, in parts buff to orange weathering color,

Interbedded with--

Dolomite, dark grey, very fine grained, very calcareous intensely burrowed. Burrows all dolomitized.

Tight.

Environment: Shelf, platform or back reef.

Dolomite, black, fine to medium grained, 20% silicified finger Stromatoporoidea, and stroms.

Some leached porosity, up to 10%.
Total porosity 2% or less.

Environment: Immediate back reef-

WESTCOAST PETROLEUM LTD.

STRATIGRAPHIC SECTION

NTS:

LOCATION	TOP	BASE
LAT.	62° 26'	62° 26'
LONG.	124° 24'	124° 24'

OUTCROP SECTION
STATION Nº 16
IVERSON RANGE

FIELD DESCRIPTION BY: P. McGILL

PALEONTOLOGY BY:

TOTAL THICKNESS: 1070'

DATE: JULY 18, 1971

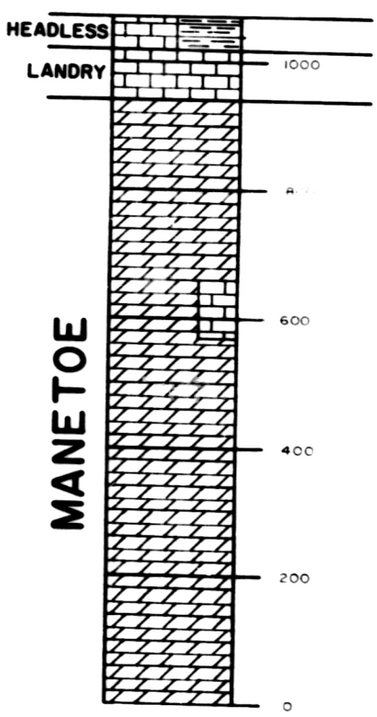
NOTE: Measured with pogo stick up a prominent ridge.

SUMMARY

FORMATION	THICKNESS	LITHOLOGY
Headless	50'	
Landry	80'	
Manetoe	940'	

LEGEND

- SHALE
- SILTSTONE
- SANDSTONE
- CONGLOMERATE OR GRAVEL
- LIMESTONE
- DOLOMITE
- CALCAREOUS
- DOLOMITIC
- ARGILLACEOUS (ls, dol)
- SANDY (ls, dol)
- QUARTZITIC
- GYPSUM OR ANHYDRITE
- CHERT
- METASEDIMENTS
- IGNACEOUS
- COAL OR LIGNITE
- SILICEOUS
- PYRITIC, MICACEOUS
- IRONSTONE
- Be BENTINITE
- S SKELETAL MATERIAL
- Gl GLAUCONITIC
- BRECCIATED
- COVERED
- STROMATOPORA
- AMPHIPORA
- HORN CORALS
- COLONIAL CORALS
- LIMESTONE, COLLAPSE BRECCIA
- SUBMARINE SLUMPING
- CROSS BEDDING
- ANGULAR UNCONFORMITY
- DISCONFORMITY
- f — f FAULT



Shale, dark grey, very argillaceous.

Limestone, light brown, micritic-skeletal.

Dolomite, 20% leached vuggy porosity, good intergranular porosity.
Dolomite, white, coarse grained, mostly replacement dolomite, up to 10% intergranular porosity 865-895 feet.
Lower some poor pinpoint porosity.

Dolomite, white, medium to coarse grained, replacement 70%.
Limestone, grey, lime mud 30% Tight.
Dolomite, white, medium to coarse grained 90% white replacement dolomite, plugged, leached, vuggy porosity.

Dolomite, dark grey, fine grained 50%, tight.
50% replacement dolomite, white medium to coarse grained, tight.

Dolomite, grey, fine to coarse grained, relict texture, skeletal micritic 50-80% shell hash.

BASE NOT EXPOSED

WESTCOAST PETROLEUM LTD.

STRATIGRAPHIC SECTION

NTS:

LOCATION	TOP	BASE
LAT.	62° 06'	62° 06'
LONG.	124° 27'	124° 26'

OUTCROP SECTION
STATION Nº 14
FUNERAL SECTION

FIELD DESCRIPTION BY: P. McGILL

PALEONTOLOGY BY:

TOTAL THICKNESS: 2600'

DATE: JULY 19, 1971

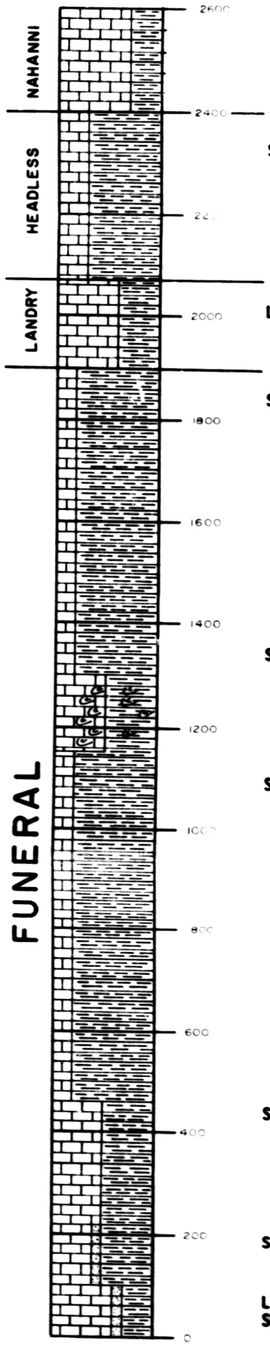
NOTE: Measured by tape and brunton along stream bed and then up side ridge.

SUMMARY

FORMATION	THICKNESS	LITHOLOGY
Nahanni	200'	
Headless	330'	
Landry	170'	
Funeral	1900'	

LEGEND

- SHALE
- SILTSTONE
- SANDSTONE
- CONGLOMERATE OR GRAVEL
- LIMESTONE
- DOLOMITE
- CALCAREOUS
- DOLOMITIC
- ARGILLACEOUS (ls, dol)
- SANDY (ls, dol)
- QUARTZITIC
- GYPSUM OR ANHYDRITE
- CHERT
- METASEDIMENTS
- IGNACEOUS
- COAL OR LIGNITE
- SILICEOUS
- PYRITIC, MICACEOUS
- IRONSTONE
- Be BENTINITE
- S SKELETAL MATERIAL
- Gl GLAUCONITIC
- BRECCIATED
- COVERED
- STROMATOPORA
- AMPHIPORA
- HORN CORALS
- COLONIAL CORALS
- LIMESTONE, COLLAPSE BRECCIA
- SUBMARINE SLUMPING
- CROSS BEDDING
- ANGULAR UNCONFORMITY
- DISCONFORMITY
- f—f FAULT



Shale, black, fissile to laminated, buff weathering.

Limestone, black, fissile to laminated, basinal facies at base grading to interbedded bioclastic limestones (Brachiopods) at top.

Shale, black, fissile and laminated, buff weathering. Basinal facies.

Shale, black, submarine slumping, buff weathering.

Shale, black, calcareous, buff weathering. Basinal facies.

Shale, black, very calcareous, fissile.

Shale, black, very calcareous, laminated.
Tentaculitids present.
Basinal facies.

Limestone, black, micritic, very argillaceous,
Shale, black, very calcareous. Basinal facies.

BASE OF FUNERAL NOT EXPOSED

Structure suggests this is close to a full section of Funeral.

WESTCOAST PETROLEUM LTD.

STRATIGRAPHIC SECTION

NTS:

		TOP	BASE
LOCATION	LAT.	124° 58'	124° 56'
	LONG.	62° 32'	62° 33'

OUTCROP SECTION

STATION Nº 4

HEADWATERS ENGLISH CHIEF RIVER

FIELD DESCRIPTION BY: P. McGILL

PALEONTOLOGY BY:

TOTAL THICKNESS: 4520'

DATE: JULY 13, 1971

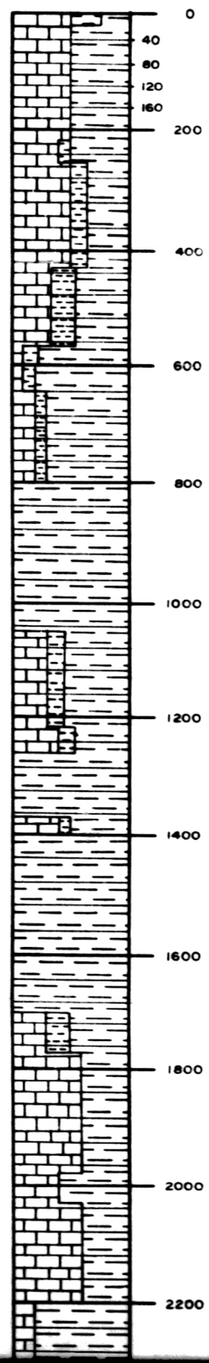
NOTE: Measured by tape and brunton down stream bed.

SUMMARY

FORMATION	THICKNESS	LITHOLOGY
Whittaker Form.	4520'	

LEGEND

- SHALE
- SILTSTONE
- SANDSTONE
- CONGLOMERATE OR GRAVEL
- LIMESTONE
- DOLOMITE
- CALCAREOUS
- DOLOMITIC
- ARGILLACEOUS (ls, dol)
- SANDY (ls, dol)
- QUARTZITIC
- GYPSUM OR ANHYDRITE
- CHERT
- METASEDIMENTS
- IGNACEOUS
- COAL OR LIGNITE
- SILICEOUS
- PYRITIC, MICACEOUS
- IRONSTONE
- Be BENTINITE
- S SKELETAL MATERIAL
- Gl GLAUCONITIC
- BRECCIATED
- COVERED
- STROMATOPORA
- AMPHIPORA
- HORN CORALS
- COLONIAL CORALS
- LIMESTONE, COLLAPSE BRECCIA
- SUBMARINE SLUMPING
- CROSS BEDDING
- ANGULAR UNCONFORMITY
- DISCONFORMITY
- f—f FAULT



FORMATION

Limestone, black.
Shale interbeds.
Flysch type deposit. Some submarine slumping at top of section.

Limestone (black) interbedded with shale from 330 feet to 430 feet, typical flysch deposits.

Shale, black, laminated and fissile, basinal.

Shale, black, fissile. At 600 feet Graptolite locality.

Shale, black, calcareous, laminated.

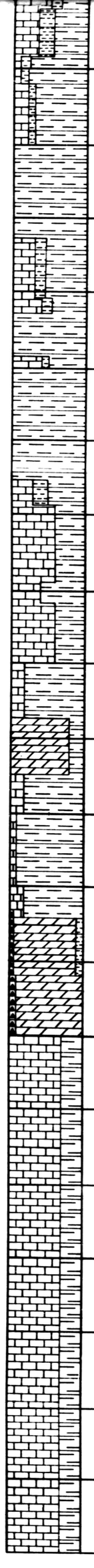
Shale, black, calcareous with some 1' limestone interbeds. Basinal facies.

Shale, black.

Shale, black, fissile.

Limestone, black, argillaceous, trace pyrite.

WHITTAKER FORMATION



Shale, black, laminated and fissile, basinal.

Shale, black, fissile. At 600 feet Graptolite locality.

Shale, black, calcareous, laminated.

Shale, black, calcareous with some 1' limestone interbeds.
Basinal facies.

Shale, black.

Shale, black, fissile.

Limestone, black, argillaceous, trace pyrite.

Dolomite, dark grey, micrograined.
Dolomitized lime mud, argillaceous
- frequent chert nodules
- quartz veining throughout Tight.

Shale, black, fissile.

Shale, black, fissile, recessive.

Dolomite, light grey, cryptograined, wavy, irregular bedding.

Dolomite, grey, very fine grained, massive fossiliferous %
Halysites and Favosites. Tight.

Interbedded
Limestone, black, micritic, very argillaceous, thin bedded.
Shale, black, calcareous.

Quartz veining throughout.

Basinal, flysch deposits.

WESTCOAST PETROLEUM LTD.

STRATIGRAPHIC SECTION

NTS:

LOCATION	TOP	BASE
LAT.	62° 06'	62°06'
LONG.	124° 27'	124° 26'

OUTCROP SECTION
STATION № 8
HOLLOW MOUNTAIN ANTICLINE

FIELD DESCRIPTION BY: P. McGILL

PALEONTOLOGY BY:

TOTAL THICKNESS: 1050'

DATE: JULY 16, 1971

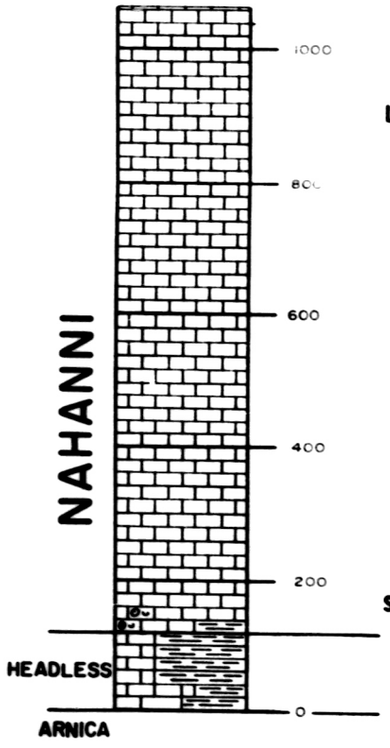
NOTE: Measured by tape and brunton on western flank of Hollow Mountain Anticline.

SUMMARY

FORMATION	THICKNESS	LITHOLOGY
Nahanni	940'	
Headless	110'	

LEGEND

- SHALE
- SILTSTONE
- SANDSTONE
- CONGLOMERATE OR GRAVEL
- LIMESTONE
- DOLOMITE
- CALCAREOUS
- DOLOMITIC
- ARGILLACEOUS (ls, dol)
- SANDY (ls, dol)
- QUARTZITIC
- GYPSUM OR ANHYDRITE
- CHERT
- METASEDIMENTS
- IGNACEOUS
- COAL OR LIGNITE
- SILICEOUS
- PYRITIC, MICACEOUS
- IRONSTONE
- Be BENTINITE
- S SKELETAL MATERIAL
- Gl GLAUCONITIC
- BRECCIATED
- COVERED
- STROMATOPORA
- AMPHIPORA
- HORN CORALS
- COLONIAL CORALS
- LIMESTONE, COLLAPSE BRECCIA
- SUBMARINE SLUMPING
- CROSS BEDDING
- ANGULAR UNCONFORMITY
- DISCONFORMITY
- FAULT



Limestone, dark grey to black, micritic to micritic skeletal.

Skeletal includes brachiopods, solitary corals and crinoids.

Shale, dark grey, very calcareous, with brachiopods and crinoids.

WESTCOAST PETROLEUM LTD.

STRATIGRAPHIC SECTION

NTS:

LOCATION	TOP	BASE
LAT.	124° 50'	124° 54'
LONG.	61° 52'	61° 52'

OUTCROP SECTION
STATION No. 13
TUNDRA RIDGE

FIELD DESCRIPTION BY: P. McGILL

PALEONTOLOGY BY:

TOTAL THICKNESS: 9500'

DATE: JULY 18, 1971

NOTE:

Interval thickness from Douglas and Norris (1960)

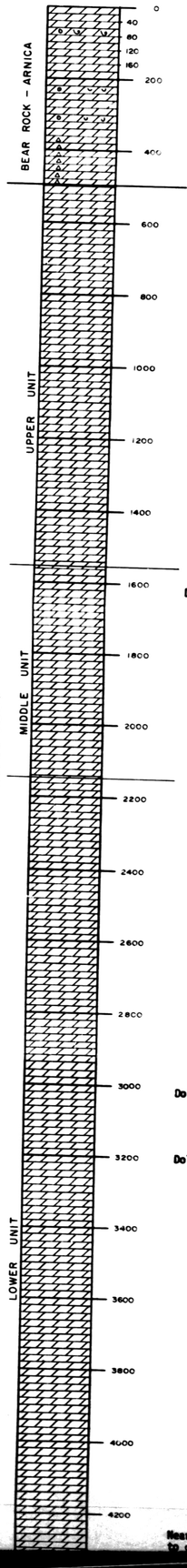
Described along crest of ridge.

SUMMARY

FORMATION	THICKNESS	LITHOLOGY
Bear Rock - Arnica	490'	
Sombre - Upper	1060'	
Middle	590'	
Lower	2440'	
Delorme & Camsell	4920'	

LEGEND

- SHALE
- SILTSTONE
- SANDSTONE
- CONGLOMERATE OR GRAVEL
- LIMESTONE
- DOLOMITE
- CALCAREOUS
- DOLOMITIC
- ARGILLACEOUS (ls, dol)
- SANDY (ls, dol)
- QUARTZITIC
- GYPSUM OR ANHYDRITE
- CHERT
- METASEDIMENTS
- IGNACEOUS
- COAL OR LIGNITE
- SILICEOUS
- PYRITIC, MICACEOUS
- IRONSTONE
- BENTINITE
- SKELETAL MATERIAL
- GLAUCONITIC
- BRECCIATED
- COVERED
- STROMATOPORA
- AMPHIPORA
- HORN CORALS
- COLONIAL CORALS
- LIMESTONE, COLLAPSE BRECCIA
- SUBMARINE SLUMPING
- CROSS BEDDING
- ANGULAR UNCONFORMITY
- DISCONFORMITY
- FAULT



Dolomite, dark grey, fine to medium grained, with some bioclastic beds. Some vuggy leached porosity less than 5%.

Dolomite, black, cryptograined, massive.

Dolomite, dark grey-black, fine to medium grained, some rare bioclastic layers.

Scattered poor leached vuggy porosity.

Dolomite, light grey, very fine to fine grained, algal laminate, tight.

Environment dolomitized back reef muds and algal laminates.

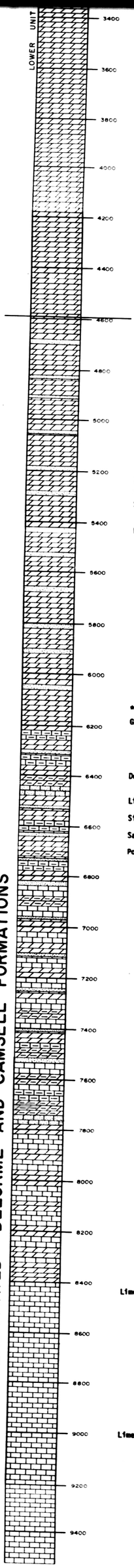
Dolomite, dark grey, fine to medium grained. Some leached vuggy porosity, less than 5%, mostly tight.

Dolomite, cream, very fine grained, algal mat, tight.

Dolomite, dark grey, fine grained, dolomitized lime mud or algal mat.

Environment: Back reef algal mat.

Near base of Sombre total 20' fine sucrosic dolomite with poor to good intercrystalline porosity.



UNDIFFERENTIATED DELORME AND CAMSELL FORMATIONS

Near base of Sombre total 20' fine sucrosic dolomite with poor to good intergranular porosity.

Dolomite, cream, very fine grained, algal mat.

alternating with

Dolomite, dark grey to black, fine grained, relict texture micritic-skeletal, mostly micritic.

Brachiopods present, rarely colonial corals.

Has bands of poor leached vuggy porosity ±5% with poor permeability.

Interbedded with 10-15% siltstone and sandstone.

Siltstone, cream, fine cross bedding.

Sandstone, cream, subangular, tight.

Environment: Very shallow water, lagoonal.

* Section not examined in detail below this level.

Gross units observed on opposite side of Tundra Creek.

Dolomite, in part light-grey to dark grey, very fine grained, algal laminate.

Limestone, light brown, micritic, faecal pellet.

Siltstone, cream, dolomitic,cut and fill structures.

Sandstone, cream, dolomitic, very fine grained, tight.

Porosity: scattered vuggy porosity usually in dark grey dolomite beds.

Limestone, black, very argillaceous or silty, thin bedded.

Limestone, black, micritic, massive or thickly bedded.