INTERIM GEOLOGICAL REPORT

THE "NIKANASSIN" PROBLEM

MONKMAN PASS PRP GRIZZLY c-36-A   NTS 93-I-15

REQUESTED

BY

McLAWS & COMPANY

FOR

NOBLE MINES AND OILS LTD.

PREPARED

BY

RUTH A. REED, P. GEOL.

CALGARY, ALBERTA

OCTOBER, 1976

This *Interim Geological Report* has been prepared by Ruth A. Reed, Professional Geologist, Registered with the Alberta Association of Professional Engineers, Geologists and Geophysicists, whose stamp of Registration appears over her signature here and at the end of the report.

The geological opinions and interpretations expressed in this *Interim Report* are to be considered as *preliminary* and may be altered in the light of new or additional data, at a later time. The opinions and interpretations are based upon the studies carried out during July, August and September of 1975. No new well data has been obtained as per Letter Agreement.

Consultations relating to the geological and engineering problems were held with Mr. G. I. Lewis, formerly Exploration Manager, Foothills District, Shell Canada Ltd., Dr. R. A. Brown, former Manager Northwest Territories District, Shell Canada Ltd. and Mr. K. Hindmarch, Engineer, Shell Canada Ltd., Dr. D.F. Stott, Director, Institute of Sedimentary and Petroleum Geology, Geological Survey of Canada, Calgary, Alberta and Dr. Hans Frebold, Jurassic Specialist, retired from and continuing to publish through the Geological Survey of Canada, Ottawa.

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RUTH A. REED, P. GEOL.

ENCLOSURES

4 Figures included in the body of the report:

INTRODUCTION

The Nikanassin Formation was originally defined to apply to a sequence of sedimentary rocks in the Central Foothills of Alberta. Later usage carried it beyond the standard definition of Formation. Dr. D. F. Stott of the Geological Survey of Canada in conjunction with Ziegler and Pocock of Imperial Oil Enterprises Ltd. arrived at a new Group name for this sedimentary sequence, the Minnes Group. The Minnes Group is defined as those sediments lying between the Cadomin Conglomerate and the Fernie Group north of the Smoky River in the Foothills of western Alberta and northeastern British Columbia.

The Nikanassin Formation of the central Foothills of Alberta, on Palaeontological evidence, correlates with the lower part of the Minnes Group. Most of the Minnes Group is younger than the Nikanassin.

The base of both the Nikanassin Formation and the Minnes Group is everywhere poorly defined. The first reliable stratigraphic marker, the Jurassic Oxfordian Green Beds, lies below the base of the Nikanassin Formation and the Minnes Group. This marker bed needs to be drilled and found, in either the ditch cuttings or the core, before it is known if the Nikanassin Formation has been drilled completely.

The Nikanassin Formation also known as the Nikanassin Facies and the Kootenay Facies, Kootenay Formation, and Minnes Group.

The above terms have been applied to the sedimentary sequence lying between the Lower Cretaceous, Cadomin Conglomerate, and the Jurassic, Fernie Group in the Foothills and Mountains of Alberta and British Columbia.

A review of the literature is warranted for a clear understanding of the terminology, as the acreage held by Noble Mines and Oils is located in the area where the majority of the terminology problems lie. Some subsurface geologists have attempted to carry the terminology of the Peace River Plains into the Foothills. Others have attempted to carry the terminology of the southern and central Foothills into northeastern British Columbia. Further complications are encountered in this geographic area as a result of facies changes in the sedimentary sequence and by the effects of the pre-Cadomin conglomerate unconformity. Some of the effects and implications of the erosion which occurred during the period is demonstrated Fig. 9 (Stott, 1968).

The definition of a stratigraphic formation used in this Interim Report, is that of the Geological Institute's Glossary of Geology, which follows:

<u>Formation</u> (stratigraphic):

A basic or fundamental rock-stratigraphic unit in the local classification of rocks.... generally characterized by some degree of internal.... distinctive lithologic features...; a convenient unit of considerable thickness and extent, used in mapping, describing, or interpreting the geology of a region, and the only formal unit that is used for completely dividing the whole geologic column all over the world into named units on the basis of lithology.... its age or time value may not necessarily be the same wherever it is recognized....

In the southern Foothills of Alberta and the Mountains of southern British Columbia, the sedimentary sequence lying between the Cadomin conglomerate and the Fernie group, (also known as <u>Fernie shales</u> and <u>Fernie formation</u>) is known as the Kootenay formation. The formation consists of a series of interbedded sandstones, carbonaceous shales, siltstones with varying amounts of carbonaceous material and coal. The sediments are considered to have been deposited under continental and/or brackish water conditions.

In the central Foothills of Alberta, the sequence lying between the Cadomin conglomerate and the Fernie group, consisting of sandstones, shales and siltstones is sufficiently different in character to have warranted a new formational name. MacKay, (1929) in the Brûlé map-area, east of Jasper National Park, established the name Nikanassin formation for this sequence of marine and/or brackish water deposits.

In the northern Foothills of Alberta and northeastern British Columbia, Stott, (1960, 1967a) traced the Nikanassin formation northward from the Smoky River to Bullmoose Creek and Bullmoose Mountain area. Later he changed the terminology from Nikanassin formation to Minnes group.

The lands owned by Noble Mines and Oils Ltd. are located approximately 30-40 miles southeast of Bullmoose Mountain and Bullmoose Creek area.

At about the same time that Stott, D.F. of the Geological Survey of Canada was working the area between the Smoky and Pine Rivers, Ziegler and Pocock, of Imperial Oil Enterprises Ltd. were working the area between the Athabasca and Narraway Rivers. Both Stott, and Ziegler and Popock published in 1960. Stott, carried the terminology <u>Nikanassin formation</u> as far northward as Bullmoose Creek area. Stott, (1960, p.8) states, "... the formation includes both marine and non-marine strata but has not been studied in detail... . The Nikanassin Formation, traced northward from Smoky River to

Bullmoose Creek, outcrops in a northwesterly trending belt lying immediately east of the main ranges of the Rocky Mountains. In many places it forms the exposed cores of large anticlinal structures and is commonly highly contorted.... The formation consists of fine-grained sandstone interbedded with dark carbonaceous shales... Thin coal beds occur throughout the upper part of the formation."

Ziegler and Pocock, (1960) state, "... the complex of strata between the Fernie Group (below) and the Cadomin Formation (above) was studied in detail. This group of strata is usually known as the Nikanassin Formation and is considered equivalent to the Kootenay Formation of the Southern Alberta Foothills .... the Kootenay Formation comprises a predominately continental coal-bearing shale-sand sequence ..... the Nikanassin sediments are of predominately marine origin; ..... .

It is, therefore, proposed to re-define the entire sequence which lies between the Fernie and the Cadomin, as one formation which is composed of sediments of varying characters, i.e. of marine sediments and continental sediments ..... (a) continental or brackish and coal-bearing - the Kootenay facies, (b) marine to brackish -the Nikanassin facies. Strata of these two facies types would thus form a new formation - the

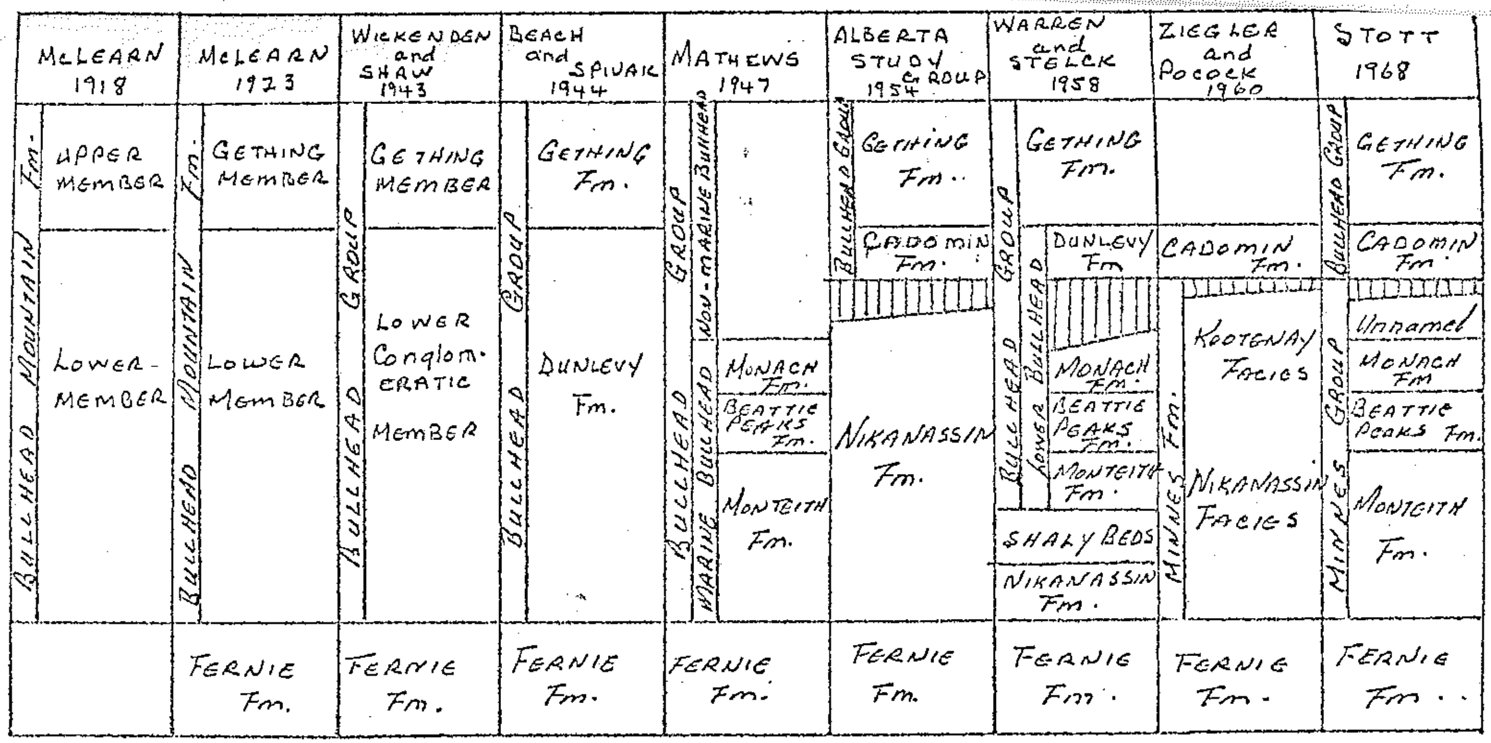

FIGURE I   NOMENCLATURE CHART after STOTT, 1968

Minnes formation, which is bounded at the base by the Fernie group and at the top by the Cadomin formation. As the type location of the new formation we propose Mt. Minnes, Long. 120° 04' - Lat. 54° 09' 45" (approximately). This mountain is situated just across the B.C. - Alberta boundary, to the northeast of Kakwa Lake ..."

The acreage held by Noble Mines and Oils Ltd. lies approximately 50 - 60 miles northeast of Mount Minnes.

The Alberta Study Group, (1954) defined the Nikanassin formation as follows: "... the formation rests on the Fernie formation (Jurassic) and is overlain by the Cadomin conglomerate (Lower Cretaceous). The lower contact with the Fernie is everywhere poorly defined and unsatisfactory. It appears to be equivalent to the Kootenay of the southern foothills and the Dunlevy of the Pine and Peace River Valleys..."

It is not considered pertinent to this <u>Interim Report</u>, to delve into the relationships of the Dunlevy formation, see Fig 1.

Dr. D. F. Stott's stratigraphic studies beginning in the latter part of the 1950's and continuing through to the early 1970's was a large-scale regional stratigraphic study extending approximately from the Smoky River to the Liard River. The Geological Survey of Canada attempts to keep the geological community informed of the progress of such a study through the publication of Preliminary Papers. When a portion or all of the larger study has been completed, the results are published in the form of Bulletins or Memoirs. It sometimes arises that geological opinions expressed in a Paper will be altered when seen in the context of the whole study. The changes will be published in a Bulletin or Memoir. This happened in the case of Dr. D. F. Stott. In his (1960) Paper, he carries the terminology,"Nikanassin" formation northward from the Smoky River to Bullmoose Creek - Bullmoose Mountain area. In his (1967) Paper (p. 21) he states: "... The writer does not like to extend the poorly defined and variously used term Nikanassin this far north. It is proposed that the better defined and dated Minnes Formation (Ziegler and Pocock (1960)) be raised to group rank to include beds occurring between the Fernie Shales and Cadomin Conglomerate, that is, the Monteith, Beattie Peaks, and Monach Formations and the overlying unnamed shaly beds of Carbon Creek Basin." In his Bulletin (p. 11, 1968) Stott has consolidated his geological interpretation of the beds lying between the Cadomin and the Fernie Shales, in the area between the Smoky and Peace Rivers, as follows: "... Beds between the Jurassic Fernie Formation and the base of the Cadomin Formation are herein included in the Minnes

Group (see Ziegler and Pocock, 1960; also Stott, 1967)."

The Minnes formation (Ziegler and Pocock) consists of the Nikanassin facies overlying the Fernie group and the Kootenay facies overlain by the Cadomin conglomerate.

The Nikanassin facies described by Ziegler and Pocock, (1960), mainly of marine origin, consist of silts and sandstones, and shales and mudstones. The silts and sandstones are usually very quartzose, sometimes feldspathic and often quite clean. Bedding and sorting improve eastward accompanied by a decrease in grain size. Siliceous cement increases eastward at the expense of calcareous cement.

The Kootenay facies as described by the above authors, is in most respects similar to the Nikanassin facies with the basic and decisive difference that the facies was deposited under continental or possibly brackish environmental conditions. They describe the sandstones as being usually quartzitic, feldspathic, coarse to fine grained, and show a decrease in grain size from west to east. They become better cemented and harder from west to east. The sands are often very carbonaceous; coaly plant hash is quite abundant in most sands. Silts and shales are usually extremely carbonaceous to coaly and contain abundant plant hash. Coal horizons may be up to three (3) feet or more. The sedimentation of the Kootenay facies is rhythmical. The rhythms develop from sandstone to siltstones, shales and coal. The coal is often overlain by a rhythm of the same character. The rhythms can change laterally very rapidly. Ziegler and Pocock found no similarity between two sections 1,000 feet apart.

They further observed in the area between the Athabasca River and the Narraway River that the occurrence of marine and non-marine facies developments of the sedimentary sequence between the Fernie and the Cadomin formations is extremely variable. Eastern foothills sections usually consist of a lower sequence of sediments, showing a marine character, whereas the upper sediments are of continental origin. Farther to the north and to the west it becomes more and more apparent that the two facies developments are strongly interfingering both laterally and vertically in the section.

The above factors account for some of the difficulties encountered when attempting to correlate sections penetrated in the wells in the Monkman Pass- Grizzly Valley area.

At the type section of the Minnes formation, Ziegler and Pocock (1960) report a measured thickness of 6,380 feet. Stott, (personal communication) is of the opinion the section contains some repetition due to faulting, and 3,000 to 4,000 feet may be a more realistic figure, although he has not measured a section in the vicinity.

In the vicinity of the Pine and Peace Rivers, several geologists have studied the outcrops of the sedimentary sequence lying between the Fernie group and the Cadomin conglomerate, (Mathews, 1947; Hughes, 1964, 1967; Stott, 1967, 1968, 1972). Stott, (1967, p. 21) raised the Minnes formation to Group rank to include beds occurring between the Fernie shales and the Cadomin conglomerate, that is, the Monteith, Beattie Peaks and Monach formations and the overlying unnamed shaly beds of the Carbon Creek Basin.

To briefly summarize, we are concerned with the sedimentary sequence lying between the Cadomin conglomerate above and the Fernie group below. In the southern Foothills where the sediments are essentially continental, the sequence is known as the Kootenay formation. In the central Foothills, the sequence is known as the Nikanassin formation, deposited in a marine to brackish environment. In the vicinity of the Smoky River, Bullmoose Creek and the Peace River the sequence has thickened from less than a thousand feet in the central foothills to several thousands of feet and contains both marine and continental deposits with great variability both vertically and laterally, and where it is known as the Minnes group.

gler and Pocock (1960)		Stott (1967, 1968)
asca River to Narraway		Smoky River to Peace River
Section Mt. Minnes		
ormation (Kootenay facies ((((((Nikanassin facies	Minnes Group	(Monach formation (plus unnamed shaly (beds ((((Beattie Peaks formation ((Monteith formation Unit II Unit I
held by Noble Mines and Oils ies approximately 50 to 60 northeast of Mt. Minnes.		Lands held by Noble Mines and Oils Ltd. are situated within and to the east of the upper part of the southern half of the map-area. (see Stott, 1968, fig. 2).

For a summary of the nomenclature see fig. 1.

Thickness - Nikanassin formation; Minnes group, "Nikanassin formation".

Thickness of Nikanassin formation southeast of and in the immediate vicinity of the Smoky River was determined by Irish in the Kvass Flats area as follows:

Kvass Flats (53^o 45' and 54^o00' Lat. and 119^o 15' and 119^o 30' Long.) Irish, (1954) "No complete section of the formation is exposed but enough information was obtained to suggest a great thickness of Nikanassin in this map-area. A total thickness of about 4,000 feet was obtained by scaling from structure sections ..." He goes on to say that it may be too thick due to thrust faulting, but places the thickness in the order of 3,500 to 4,000 feet. This figure is in approximate agreement with Thorsteinsson, (1952) who obtained about 4,000 feet in the southern part of the adjacent Grande Cache map area to the southeast.

The Minnes group, in outcrops, attains a thickness of between 3,000 and 4,000 feet in the area between the Smoky River and Bullmoose Creek - Bullmoose Mountain area, as indicated in an earlier discussion in this Interim Report, although Imperial Oil Enterprises Ltd. reports a thickness of 6,380 feet.

the Monteith formation, the lower formation of the Minnes group, and the formation which contains the majority of the sandstone, attains a thickness in the order of 2,000 feet, in the area extending from Mount Minnes to Carbon Creek, Stott, fig. 4. (1972). These figures represent, as nearly as possible, the true depositional thickness.

In the subsurface of Monkman Pass - Grizzly Valley area, which lies east of the strike of the outcrops discussed in this report, the data from the following wells, obtained from the British Columbia Government, Department of Mines and Petroleum Resources, Petroleum and Natural Gas Branch indicate a drilled thickness for the Minnes group (also called Nikanassin by the Oil Industry) as follows: (No attempt, on the part of the author, has been made at this stage in the study, to work out the possibility of repetition due to faulting).

WELL	LOCATION		THICKNESS
Columbian Monkman Pass	a-54-G	93-I-15	2,590 feet
Quasar Grizzly	a-74-G	93-I-15	3,034 feet
Richfield et al Grizzly Valley	d-63-G	93-I-15	ca 2,755 feet
KM AEG Quasar Grizzly	a-49-H	93-I-15	2,617 feet
Quasar N. Grizzly	a-85-G	93-I-15	2,205 feet
Quasar et al Grizzly	a-3-A	93-I-15	2,375 feet

The name Schoepfer appears on the Mechanical Logs as a Witness to the recording, on two different dates - March 9, 1968 and June 6, 1968. The implication of this is, that it might be the same Schoepfer who was the Wellsite Geologist for Monkman Pass PRP Grizzly c-36-A.

orrelation

he Oil Companies * who have drilled in the Monkman Pass-rizzly Valley region have used the terminology Nikanassin ormation when reporting to the British Columbia Government, epartment of Mines and Mineral Resources, Petroleum and atural Gas Branch. It appears from the reports that the terminology Nikanassin formation has been used in the sense of MacKay, (1929), which is the sedimentary sequence lying between the Cadomin conglomerate and the Fernie shale. What they have done without realizing it, in all probability, is equate the Nikanassin formation of MacKay with the Minnes Group. This would appear to be in error. The Nikanassin formation according to Stott, (1967, 1972) may be equivalent to the basal beds of the Monteith formation, based on field and palaeontological studies (Stott, 1967). Most of the Minnes group is younger than the Nikanassin formation (Stott, 1972).

* Due to the confidential nature of this geological study, no contact has been made by the writer with any of the Oil Companies who have drilled in the area, to determine their interpretation of the term Nikanassin formation.

The Fernie Group, (Fernie shale, Fernie formation)

Dr. Hans Frebold and the writer have examined the outcrops of the Fernie group from the United States Border to Snake Indian Valley north of Jasper. Prior to the research for this Interim Report, the writer had examined ditch cuttings and cores from wells in the Foothills and the Plains bordering the Foothills, from the United States Border to just south of the Peace River area. Stott's division of the Fernie group north of the Peace River into six (6) lithologic units (1967a) resembles the succession of the southern and central Alberta Foothills. Therefore, it may be presumed that there is little change in the Jurassic Fernie group succession between the Smoky and Peace Rivers with the exception of some eastward thinning. The Fernie group maintains a fairly constant thickness along strike, being 732 feet south of Halfway River, Stott, (1967a).

As pointed out by the Alberta Study Group, (1954), Ziegler and Pocock (1960), Stott (1967a), and by Dr. Hans Frebold, a renowned Jurassic specialist, the contact between the Fernie and the overlying beds is everwhere problematical. This applies to southern Alberta where the Fernie group is overlain by the Kootenay; to central Alberta, where it is overlain by the Nikanassin; to northeastern British Columbia where it is overlain by the Minnes group.

Stott, (1967a) states, "... The upper beds of the Fernie Formation are gradational into the overlying Monteith sandstones. A thick succession of interbedded fine-grained sandstone and silty shale is included in the Fernie Formation. The contact is drawn at the base of the first thick succession of sandstone. This contact ..... seems to occurr at progressively higher stratigraphic levels from southeast to northwest..."

Ziegler and Pocock, (1960) state that the position of the base of the Minnes Formation is highly problematic and is very arbitrarily chosen. Generally speaking, they continue, the base of the eastern Minnes sections is taken at the first appearance of massive sandstone beds on top of the Passage Beds of the Fernie Group (see fig.3). In the western sections the Passage Beds are of a lithology which is extremely similar to one of the Nikanassin facies. To date (1960), they have found no well developed marker horizon, which could serve as a consistent and easily correlatable base.

From personal experience, working in the field and with ditch cuttings and cores, the top of Passage Beds has not been too difficult to identify in southern Alberta. In the central Foothills, however, it is very difficult indeed, not only from ditch cuttings, but also from Mechanical Logs,

Series	Stages	1. N. Rocky Mtn Foothills, Alta	2. Pine River Foothills, B.C.	3. Peace River Foothills, B.C.	4. Peace River Plains, Alta
Upper Cretaceous	Cenomanian	Smoky Group: Kaskapau Fm.	Smoky Group: Kaskapau Fm.	Smoky Group: Kaskapau Fm.	Kaskapau Fm.
Upper Cretaceous	Cenomanian	Dunvegan Fm.	Dunvegan Fm.	Dunvegan Fm.	Dunvegan Fm.
Lower Cretaceous	Albian		Fort Saint John Group: Cruiser Fm.	Fort Saint John Group: Cruiser Fm.	Fort Saint John Group: Shaftesbury Fm.
Lower Cretaceous	Albian		Goodrich Fm.	Goodrich Fm.	Shaftesbury Fm.
Lower Cretaceous	Albian		Hasler Fm.	Hasler Fm.	Shaftesbury Fm.
Lower Cretaceous	Albian	Luscar Formation	Commotion Formation: Boulder Crk Member	Hasler Fm.	Peace Rv. Fm.: Paddy Mbr., Cadotte Mbr.
Lower Cretaceous	Albian	Luscar Formation	Commotion Formation: Hulcross Member	Hasler Fm.	Peace Rv. Fm.: Harmon Mbr.
Lower Cretaceous	Albian	Luscar Formation	Commotion Formation: Gates Member	Gates Fm.	Spirit Rv. Fm.: Notikewin Mbr.
Lower Cretaceous	Albian	Luscar Formation	Moosebar Fm	Moosebar Fm.	Spirit Rv. Fm.: Falher Mbr., Wilrich Mbr.
Lower Cretaceous	Albian	Luscar Formation	Bullhead Group: Gething Fm.	Bullhead Group: Gething Fm.	Bluesky Fm. / Bullhead Grp.: Gething Fm.
Lower Cretaceous	?	Cadomin Formation	Cadomin Formation	Cadomin Formation	Cadomin Formation

1. after Bell, 1956; Stott, 1968.
2. " " " ; " " .
3. " " " ; " " .
4. After Alberta Study Group, 1954

Fig. 2 Correlation of Lower Cretaceous Formations to determine when one had passed from the Nikanassin formation into the Fernie group, due to the transitional nature of the sediments. In the subsurface, the first good marker horizon in the Fernie group is the Oxfordian Green Beds, Frebold, Hans, Mountjoy E. Reed, Ruth (1959), Stott, Fig. 3, (1967).

The contact between the Fernie group and the overlying beds has been treated here in some detail. The purpose being, to show that there seems to be no way, one knows with certainty, in either outcrops or wells, the location of the contact between the Fernie group and the overlying beds. The implications for the lawsuit may be significant, in that it is difficult to understand how a formation could be properly tested if it has not been completely drilled. To be certain that the Minnes Group has been completely drilled, and more especially in a structurally complex region, the Green Beds of the Fernie group would have to be encountered in the ditch cuttings.

The sequence between the Cadomin conglomerate and the base of the Fernie group is notorious throughout the Foothills and Mountains for its major structural complications due to major thrust faults, folds and general contortion of the beds, including overturned strata. This fact makes it almost imperative to reach a marker bed, below the Minnes group, if the group is to be completely drilled and adequately tested for hydrocarbons. This becomes even more significant, in a structurally complex area, in the light of the general lithologic similarities between the Unit 1. of the Monteith formation, and the Beattie Peaks formation, which immediately overlies the Monteith.

The Cadomin conglomerate overlying the Kootenay and Nikanassin formations, and the Minnes group has proved to be easily recognizable both in outcrop and ditch cuttings.

Monkman Pass PRP Grizzly c-36-A 93-I-15

A considerable amount of time has been spent on the ditch cuttings of the above well. The samples examined are stored with the Institute of Sedimentary and Petroleum Geology, Geological Survey of Canada, Calgary, Alberta. Most of the ditch cuttings over the critical intervals were highly contaminated with crude oil and diesel fuel, used in place of drilling mud. The contamination of the cuttings was so high that it was impossible to determine the rock types. The writer washed the ditch cuttings with detergent in a 100 mesh sieve (screen) to prevent the loss of any of the finer particles.

NORTH OF PEACE RIVER

TABLE OF FORMATIONS

CENTRAL AND NORTHERN CANADIAN ROCKY MOUNTAINS AND FOOTHILLS

Age	Group	Formation	Unit	Lithology	Central and Northern Canadian Rocky Mountains and Foothills	
		STRATIGRAPHIC UNITS		LITHOLOGY		
EROSIONAL UNCONFORMITY.						
LOWER CRETACEOUS	MINNES GROUP	Beattie Peaks and ?younger beds				
		MONTEITH Fm.		MASSIVE SS.; some Congl.		
				ALTERNATING UNITS OF THICK BEDDED SS. and SILTY MUDSTONES; few BEDS CONGL. SS.	LOWER PART OF NIKANASSIN Fm.	
JURASSIC		FERNIE Fm.	UNIT 6, 68-240'	Thinly interbedded, SS, siltstone, and mudstone	PASSAGE BEDS	JURASSIC After FREBOLD, MOUNTJOY and REED 1959
			UNIT 5 60'-99'	Dark marine sideritic shales.		
			UNIT 4	GLAUCONITIC SILTSTONES and mudstones; some sideritic concretions	GREEN BEDS	
			UNIT 3 65'-273'	Dark grey - black sideritic shales.	GREY BEDS and ?ROCK CRK MBR	
			UNIT 2 23'-68'	BLACK CALCAREOUS FISSILE SHALES	PAPER SH.	
			NORDEGG MBR.		NORDEGG MBR	
EROSIONAL UNCONFORMITY					EROSIONAL UNCONFORMITY	

MODIFIED AFTER STOTT, 1967

The ditch cuttings were examined from 1,000 feet to total depth. It is essential, in a faulted area, to get a feel of the well and the caving patterns. This feel of the well helps increase one's sensitivity to those subtle changes which herald thrust faulting, and clues are picked up, which help in putting together the geological picture.

The Gething and Moosebar formations have been studied in some detail, as well as the "Nikanassin" (used here in the sense of the B.C. Govt. reports). The Commotion formation has not been studied to the same degree. See fig. 2 for correlation of the Lower Cretaceous formations.

The interval in c-36-A from ± 4,065 feet to ± 5,030 feet, called "Nikanassin" (in the sense of B.C. Govt. reports) and by P.H. Schoepfer, P. Geol. does not appear to have diagnostic lithologic characteristics, in common with the "Nikanassin", in the lower portion of the c-36-A well or with the "Nikanassin" of Gray Oil Grizzly PRP NW c-25-A, or the "Nikanassin" of Quasar et al Grizzly a-3-A. However, the sediments of this interval do have lithologic characteristics in common with the Gething formation, and possibly the Commotion formation.

Some of the sandstones in c-36-A between 4,130 and 4,220 feet and the shale from 4,500 to 4,510 feet contain a fairly high percentage of a green mineral which has the appearance of glauconite, although some of it could be chlorite.

In c-36-A, near the top of the Gething formation (3603') there are sandstones and siltstones containing a fairly high percentage of glauconite-like grains. In the remainder of this Interim Report these glauconite-like grains will be referred to as glauconite. No glauconite was observed in the Moosebar. If I recall correctly, glauconite was present in the sediments near the top of the Gething formation in c-25-A and a-3-A. On recall, the Commotion formation, studied to date, contains minor amounts of glauconite in sandstones near the top of the formation. This needs to be further researched. (It was at this point of checking and comparing, the ditch cuttings from possibly equivalent formations in the same well and nearby wells, that the study was terminated by Noble Mines and Oils. The request, to write this report followed approximately a year later).

Without getting into the correlation problems of the Gething and Bluesky formations, fig. 2. Stott (1968), reports strongly glauconitic units near the base of the Moosebar formation and in the upper part of the Gething formation. A high percentage of the Bluesky sediments is the constituent glauconite. In the Gething outcrops, the glauconite occurs in well sorted, fine-grained sandstones. In c-36-A, the glauconite occurs in sandstones and siltstones, and in one thin bed of shale, all near the top of the Gething formation.

By comparison; in outcrops, the massive sandstone unit (unit 2) of the Monteith formation contains "traces of glauconite, occurring as small pellets, were found in a few sandstones", Stott, (p. 30, 1967). Stott, does not mention glauconite as a constituent of the Beattie Peaks and younger beds of the Minnes group.

Therefore, the presence of a fairly high percentage of glauconite in the sandstones, siltstones and shales in the upper part of the interval from ± 4065' to ± 5030', suggests a fairly strong similarity with the upper part of Gething formation beginning at 3603'.

By comparison; with the "Nikanassin" formation in the lower part of c-36-A, the "Nikanassin" of c-25-A and a-3-A, there appears to be little similarity between the sandstones.

The interval from ± 4,065- ± 5,030 in c-36-A contains thin coaly beds and beds of shaly coal over approximately a 450 500 foot gross interval. The presence of these thin beds, is supported not only by sample examination but by the Borehole Compensated Sonic Log.

By comparison; Ziegler and Pocock, (1960) reported that minor coal may be present in the upper part of their Minnes formation, located southwest of the c-36-A, but it is not common.

Only traces of coaly material were observed in the "Nikanassin" of c-25-A, and a-3-A wells.

Coal is an integral part of both the Commotion and Gething formations; these formations are the main contributors to the major coal producing region south of the Monkman Pass - Grizzly Valley area.

In c-36-A the sandstones in the lower part of the interval from ± 4,065 - ± 5,050 feet, contain a fairly high percentage of detrital carbonate. The carbonate occurs both as cementing material and as detrital grains. Stott, (p. 30, 1968) in his discussion of the lithologies of the Gething formation, makes the following comment, -

> "Carbonate grains are common in the wackes ...... The carbonate occurs primarily as detrital grains ... but in a few sandstones, also as patches of cement. Sandstone cemented wholly by carbonate is rare in the Gething Formation ..."

By comparison; the Minnes group does contain detrital carbonate, however its position in the sedimentary sequence of the Minnes group may be signigicant not only for comparison of the two intervals in c-36-A, but also for the problem of having 'adequately tested the Nikanassin formation.'

Stott, (p. 29 & 30 1967a) notes that the Monteith sandstones in outcrop can be divided into two main types, one by abundant lithic grains and the other, by a dominance of quartz. The first group is characteristic of sandstones interbedded with shales. The second type is typical of the massive sandstones and conglomerates of the upper Monteith. He continues that the lithic sandstones of the lower unit of the Monteith contains three main constituents: quartz, detrital carbonate, and lithic fragments. The detrital carbonate may form as much as 40% of the rock. The carbonate occurs as rounded grains generally surrounded by limonite, and as cement.

It would appear that the detrital carbonate of the Minnes group is found in Stott's unit one of the Monteith formation. That is the unit that is transitional between the Fernie group and the Minnes group. This evidence tends to support the interpretation that c-36-A did not penetrate this unit as only very minor amounts of carbonate were observed in the ditch cuttings of the "Nikanassin" formation. The sandstones in the section beginning at 7,756 feet were conspicuous by their lack of any appreciable amounts of carbonate. The sandstones contained a fairly high content of dark rock fragments and siliceous cement, as I recall.

By comparison; the Gething, and possibly the Commotion formations contain carbonate both in the form of detrital grains and as cementing material in c-36-A. Stott describes carbonate in both forms as constituents of the outcrops of both the Gething and Commotion formations.

In c-36-A the interval from ± 4,065 - ± 5,030 feet contains highly slickensided shale, and highly fractured sandstones with associated calcite infilling, both of which are usually associated with structural features such as - folding, general contortion of the beds and thrust faulting. These features have been frequently observed prior to and in association with a major thrust fault.

The intervals discussed and compared in c-36-A well were examined and compared prior to a study of the literature of the area. This was done by design, in order that the lithologies in the well could speak for themselves, rather than trying to make them fit a preconceived idea.

The weight of the evidence tends to support and perhaps even quite strongly, that the interval from ± 4,065 ± 5,030 feet more closely resembles the Gething formation or possibly the Commotion formation, than any part of the Minnes group.

From experience, the interval does not compare at all favourably with sediments below the Cadomin conglomerate which appear in ditch cuttings as lithic and quartzose sandstones, fine, grading to coarse grained, hard, siliceous, dark grey-brown and dark brown-grey, greasy appearing. Generally, very little, if any carbonate unless fractured with some calcite smears or infill. The sediments above the Cadomin conglomerate, on the other hand, are usually more variable as to grain size and colour; lighter in colour often with light brown to buff tones and generally quite calcareous.

The Commotion sandstones, contain a fairly high percentage of detrital carbonate, coal and a heavy mineral assemblage characterized by a green chlorite mineral, Stott, (p. 75 1968). It is possible to confuse green chlorite and glauconite under a binocular microscope. However, it is doubtful, if all of the green grains would be misidentified. There is something about glauconite which is generally speaking, quite distinctive.

Although my impression is that the interval from ± 4,065' to ± 5,030 in c-36-A tends to be more closely related to the Gething formation, than the Commotion formation, the possible correlation with the Commotion has not been researched as thoroughly as it should be, for a valid comparison, and for that reason both formations appear on the Strike Cross-section.

The bottom part of Monkman Pass PRP Grizzly c-36-A from ca. 8,700 feet to Total Depth on Borehole Compensated Sonic Log shows a very different character from above. It is not typical of any known "Nikanassin" formation sediments, to my knowledge.

The Log has been checked by Mr. K. Hindmarch, Shell Canada Ltd. for proper functioning of the logging tool. In his opinion, the tool is functioning properly over the depth in question, from ca. 8,700 feet to ca. 8,975 feet.

The hole deviation may be indicative of structural complications. It is noted, in the report by Laurie O. Alho, Petroleum Engineer - Consultant for Monkman Pass Petroleums Ltd., Vancouver, that the Directional Survey showed the following degrees of deviation from 7,820'- 8,936':

Depth	Degrees of Deviation
7,820	7^{o}
8,052	7^{o}
8,810	11^{o}
8,263	$7\ 7/8^{o}$
8,380	8^{o}
8,626	14^{o}
8,797	12^{o}
8,868	$11\ 1/8^{o}$
8,936	10^{o}

The interval from ca. 8,780 feet for approximately 150 feet, from ditch cuttings is characterized by poor samples, highly fractured material with varying degrees of calcite infill.

The rather sudden increase in hole deviation, poor samples, highly fractured zone, Log characteristics not similar to known "Nikanassin", all suggest faulting. The samples are poor but contain shale with some characteristics of the Moosebar. Personally, I suspect the well has faulted. However, I also have some reservations - the poor samples do not help, and as well the short interval below the questionable fault zone to total depth. It was a questionable place to abandon a well, from a geological view point.

The core in this well has not been examined. Drill stem test No. 1. 8,184' - 8,496' recovered GTS in 5 min. and

1,860' drilling fluid above the tool. This DST covered the cored interval.

The second DST from 8,515' - 8,868' covers in ascending order the possible fault zone, the highly fractured interval and what appears to be "Nikanassin" sandstones and shales.

The second DST got GTS in 4 min. with a flow rate during the latter part of the test of 7,340 cu. feet per day. How much of this is from the "Nikanassin" is very questionable.

The significance of presenting in some detail, the work of Stott, and others in this report was to place the well c-36-A in a broader perspective and to bring to bear any relevant data upon the interpretation of the "Nikanassin" problem pertinent to the well and the lawsuit.

From this, two rather significant geological issues are brought to the fore:

1. The Nikanassin of MacKay, (1929) carried into the area of the Smoky River by Thorsteinsson, (1952) and Irish, (1954) is according to Stott, (1967, 1972) equivalent to the transition beds between the Fernie group and the Minnes group. The " Nikanassin "used by the Oil Industry in

reporting to the British Columbia Government, Department of Mines and Natural Resources in the wells drilled in the Monkman Pass-Grizzly Valley area, is in the technical sense, probably equivalent to the basal part of the Minnes group or in other words roughly equivalent to Stott's unit 1 of the Monteith formation. The remainder of the Minnes group is younger. However, in general usage, the Oil Companies have equated it with the Minnes group.

2. The need to reach a marker horizon within the upper part of the Jurassic, Fernie group is critical if one is to be certain the Minnes group has been penetrated. This is even more critical in highly faulted and folded region.

A very cursory examination of some of the Mechanical Logs of the wells which have penetrated a complete section of the Minnes group in the Monkman Pass-Grizzly Valley area suggest a correlation within the group may be possible. Such an exercise may determine what part of the Minnes group has been penetrated in c-36-A and what may be expected in a complete section of the Minnes group.

Structure

To date, very little more than a generalized structural picture is known of the Monkman Pass - Grizzly Valley area.

Some of the wells on the Strike Cross-section are known to be faulted from sample and Mechanical Log studies. The other wells have faulting reported to the British Columbia Government. The validity of the data, not verified by sample study is highly questionable.

An attempt was made to draw a Structure section. There is not sufficient verified well information to make the effort feasible. The following wells would require verification by sample examination before a Structure section could be attempted. They are:

Trans-Era Wilrich et al Stony Lake	c-92-B	93-I-15
Quasar et al Grizzly CIA	d-30-H	93-I-15
KM AEG Quasar Grizzly	a-49-H	93-I-15
Quasar Grizzly	a-74-G	93-I-15
Richfield et al Grizzly Valley	d-63-G	93-I-15

The faults shown in the wells, on the Strike Cross-section have for the most part been left uninterpretated due to lack of information, accompanied by the <u>risk of miscorrelating thrust fault blocks</u>. There are several major thrust faults in the area. The location of those in relation to the Strike Cross-section is unknown. Further sample study is needed, and some reliable seismic data may be most helpful.

The possibility of obtaining seismic data from the British Columbia Government, Victoria was explored with no success. The seismic reports and/or maps filed with the British Columbia Government by the various Oil Companies are too general to be useful.

One of the well sections requiring further sample study, and comparison with the Moosebar section in other wells is the lower portion of c-36-A well. If, as suggested, the well has faulted to Moosebar at ca.8750 feet another complete Minnes group or "Nikanassin" (in the sense of MacKay, 1929) lies below the Total Depth of c-36-A, at 9007 feet.

If structural interpretations relative to the Strike Cross-section are to be attempted it is imperative the sediments in the lower part of the following wells be examined:

Trans-Era Wilrich Stony Lake	c-92-B	93-I-15
Gray Oil Grizzly Valley	d-59-A	93-I-15
Columbian Monkman Pass	a-54-G	93-I-15

This preliminary report is respectfully submitted with the caution that it is Interim. More data is available in the Monkman Pass-Grizzly Valley area for further study. The opinions and suggested geological interpretations are not to be considered final.

The Research required as an Expert Witness in the Vagn-Anderson-High Ridge lawsuit was suspended at the point of attempting to resolve the possibility of faulting into questionable Moosebar at ca 8750 ' in c-36-A, by Noble Mines and Oils Ltd., September 1975, The request for this Interim Report came approximately one year later. The time differential created a loss of geological knowledge. The writer accepts no responsibility for any loss of geological data and/or the interpretations, resulting from the suspension which occured approximately midway in the research followed by the lapse of approximately one (1) year from the date of suspension, until Noble Mines and Oils requested this Interim Report, which is based on the data at hand, at the time of the suspension.

PROFESSIONAL GEOLOGIST ALBERTA
MS. RUTH A. REED

P. Geol.

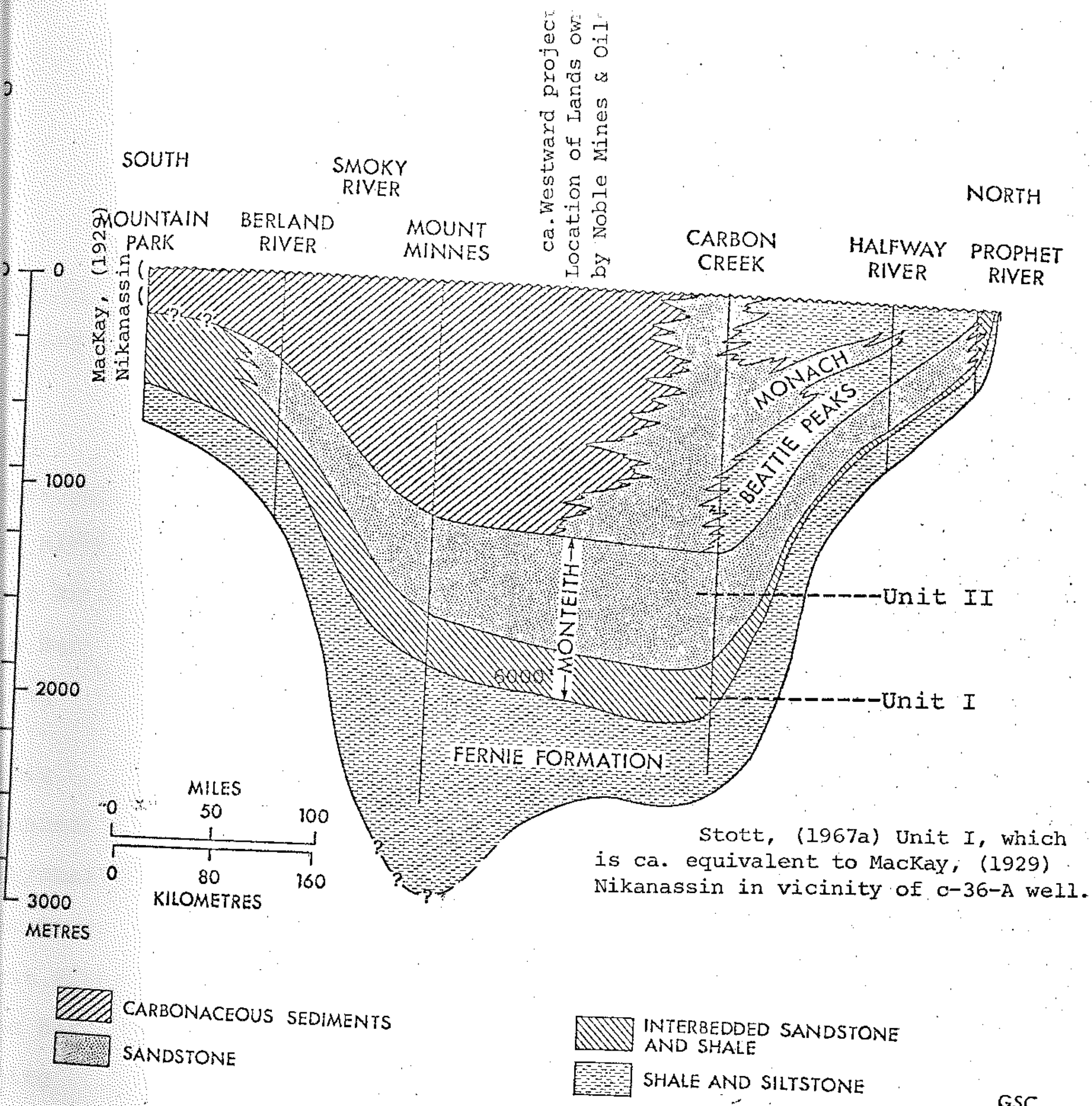

Fig.4 *Fernie - Minnes succession along the Foothills between Mountain Park and Prophet River.*

From Stott, (1972)

The pre-Cadomin erosion has removed ca. 3,000 feet in the Grizzly Valley-Monkman Pass area which lies east of the line of section shown above.

ADDENDUM

MONKMAN PASS PRP GRIZZLY c-36-A 93-I-15

OGICAL MARKERS

. Schoepfer, P. Geol.)

ER	DEPTH
tesbury	samples start
e River	1830
rit River	2090
se Bar	3150
hing	3603
omin	3977
anassin	4058
lt/Shaftsbury	5050
ce River	5436
rit River	5681
se Bar	6918
hing	7340
lomin	7697
anassin	7756
AL DEPTH	9007

 Fig. 2 for correlations.

FORMATION TOPS AND FAULTING

(this report)

FORMATION/FAULT	DEPTH (feet)
Commotion	1820
Moosebar	3218
Gething	3603
Cadomin	3979
Fault into Gething or Commotion	± 4065
Fault into Shaftsbury	± 5030
Commotion	5438
Moosebar	6918
Gething	7340
Cadomin	7690
Nikanassin	7756
?Fault into ?Moosebar	±8750
TOTAL DEPTH	9007

British Columbia Department of Mines and Petroleum Resources, Petroleum and Natural Gas Branch, WELL COMPLETION REPORT for the following wells:

Richfield Oil Corp. Grizzly Valley No. 1 (d-63-G, 93-I-15)

Quasar HB Phillips Wolverine c-32-K 93-I-15

Stanolind Lingrell No. 1 b-61-F 93-I-16

Quasar Grizzly a-74-G 93-I-15

Husky Alcon IOE Quintette a-70-C 93-I-15

Monkman Pass PRP Brizzly c-36-A 93-I-15

Gray Oil PRP NW Grizzly d-59-A 93-I-15

James PRP et al Grizzly d-2-A 93-I-15

Gray Oil PRP NW Grizzly c-25-A 93-I-15

Columbian Monkman Pass a-54-G 93-I-15

Quasar Grizzly a-85-G 93-I-15

KM AEG Quasar Grizzly a-49-H 93-I-15

Quasar et al Grizzly a-3-A 93-I-15

Trans-Era Wilrich Central Del rio Stony Lake No. 1, c-92-B 93-I-15

Quasar et al Grizzly CIA d-30-H 93-I-15

Quasar et al Grizzly b-62-G 93-I-15

Quasar Amoco Lapp d-62-D 94-H-10

Triad Prairie Creek a-24-H (1A) 93-I-10

From experience, the formation tops reported to the Government may be accurate but cannot be relied upon.

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pies of these Reports are either on file with McLaws & Company or have en ordered for filing.

Thrust in red
NOTE: c 36-A would look like the transparent overlay

Note - data based on 1. surface geology 2. Seismic 3. Well Control

STONY LAKE CROSS SECTION

SCALE: Horizontal & Vertical: 1" = 1 mile
Geol: H.R. Hovdebo 1976

UPPER CRETACEOUS	Kw	Wapiabi	
	Kc	Cardium	
	Kk	Kaskapau	
	Kd	Dunvegan	
LOWER CRETACEOUS	Ksh	Upper Shaftesbury	Cr Cruiser; Gd Goodrich; Ha Hasler
	Ksh	Lower Shaftesbury	Kco Commotion; Kga Gates; Kmo Moosebar
	Kbh	Bullhead	Kg Gething or Ks Crassier; Kcd Cadomin; Km Minnes (Monach, Beattie Peaks, Monteith); (Kd Dunlevy)
JURASSIC	Jf	Fernie	
TRIASSIC	Tr-pb	Pardonet (Trp) - Baldonnel (Trb)	
	Tr	Charlie Lake Toad, Grayling	
PERMIAN	Pb	Belloy	Pch Chowade
PENNSYLVANIAN	Ps	Stoddard	Pch Chowade
MISSISSIPPIAN	Mr	Rundle - Prophet	
	Mb	Banff	
MISSISSIPPIAN - DEV	MDbr	Besa River	
UPPER DEVONIAN	Dp	Palliser	
	Df	Fairholme	
MID - DEVONIAN	MD		
PRE - DEVONIAN	PD		

SECTION 15

od-89-K
c-32-K
K.B. 3415'
T.D. 9156'
a-83-G
93 1/14
93 1/15
93 1/16
93 1/11
93 1/10
93 1/9
K.B. 3639'
T.O. 17,250'
a-85-G
K.B. 3636'
T.D. 12,861'
a-74-G
d-63-G
K.B. 3587'
T.O. 12,631'
b-62-G
K.B. 3705'
T.O. 9297'
COLUMBIAN
Monkman Pass a-54-G
K.B. 3609'
T.D. 14,588'
a-49-H
K.B. 3723'
T.O. 13,322'
d-30-H
K.B. 3771'
T.D. 14,028'
PHILLIPS
Lone Mtn., a-65-E(1)
K.B. 3200'
T.D. 9121'
c-44-E(2)
STANOLIND
Lingrell, b-61-F(1)
K.B. 3583'
T.D. 12,512'
B.C. OIL & GAS et al
Red Willow, (1)27-G
K.B. 3407'
T.D. 2970'
TRANS-ERA WILRICH et al
Stony Lake, c-92-B(1)
A
K.B. 3587'
T.D. 5832'
a-74-B
G.L. 3491'
T.D. 42'
b-77-A
ALCON I.O.E
Quintette a-70-C
K.B. 3184'
T.D. 9717'
d-39-A
K.B. 4040'
T.D. 8556'
K.B. 4240'
T.O. 9007'
c-36-A
c-25-A
K.B. 4199'
T.O. 8752'
A'
d-2-A
K.B. 3853'
T.O. 8566'
a-3-A
K.B. 3785'
T.D. 11,845'
Murray
River
Wapiti
River
QUASAR ONION c-69-H
TRIAD
Prairie Crk., a-24-H
K.B. 3407'
T.D. 11,322'
c-88-F
A-A' = STRIKE X-SECTION
LEGEND
Gas Well (B.C. Reports)
Dry and Abandoned.
K.B. Kelly Bushing
T.D. Total depth.
o Location; No other data on hand
SCALE 1" = 8000'
INFORMALLY DRAFTED AND
PREPARED BY Ruth A. Reed, P. Geol. SEPT 1976.
for
NOBLE MINES and OILS LTD.
REQUESTED BY
McLAWS and COMPANY
TO ACCOMPANY
INTERIM GEOLOGICAL REPORT
INDEX MAP
SHOWING WELL LOCATIONS
AND
LINE OF SECTION
ENCL. # 2

GEOLOGICAL SURVEY OF CANADA
DEPARTMENT OF ENERGY, MINES AND RESOURCES

Figure 2

Geology of region between Smoky and Peace Rivers, central Rocky Mountain Foothills, Alberta and British Columbia

Scale 1:253,440
1 inch to 4 miles

Miles 4 0 4 8 12 Miles
Kilometres 6 0 6 12 18 Kilometres

LEGEND

CENOZOIC

QUATERNARY

PLEISTOCENE AND RECENT

- 23 — *Gravel, sand, silt, alluvium*

MESOZOIC

CRETACEOUS

UPPER CRETACEOUS

- 22 — *PUSKWASKAU FORMATION (lower part): dark shale*
- 21 — *BAD HEART FORMATION: fine-grained marine sandstone; carbonaceous sandstone and shale*
- 20 — *MUSKIKI FORMATION: Dark grey marine shale*
- 19 — *CARDIUM FORMATION: fine grained sandstone; shale*
- 18 — *KASKAPAU FORMATION: dark marine shale, siltstone and sandstone*
- 17 — *DUNVEGAN FORMATION: marine and non-marine sandstone and shale*

LOWER CRETACEOUS

FORT ST. JOHN GROUP

- 15 — *CRUISER FORMATION: marine shale*
- 16 — *HASLER AND CRUISER FORMATIONS (undivided): marine shale*
- 12 — *SHAFTESBURY FORMATION: marine shale*
- 14 — *GOODRICH FORMATION: fine-grained sandstone*
- 13 — *HASLER FORMATION: dark marine shale*
- 11 — *COMMOTION FORMATION: Boulder Creek Member: conglomerate; coarse-to-fine-grained sandstone; shale; coal*
- 10 — *COMMOTION FORMATION, Hullcross Member: dark marine shale*
- 8 — *COMMOTION FORMATION: conglomerate; carbonaceous sandstone and shale; coal*
- 9 — *COMMOTION FORMATION, Gates Member: carbonaceous sandstone; shale; coal*
- 7 — *MOOSEBAR FORMATION: dark marine shale*

BULLHEAD GROUP

- 6 — *GETHING FORMATION: conglomerate, carbonaceous sandstone and shale, coal*
- 5 — *CADOMIN FORMATION: massive conglomerate*

JURASSIC AND CRETACEOUS

LOWER CRETACEOUS AND EARLIER

MINNES GROUP

- 4 — *Fine-grained sandstone and carbonaceous shale*

JURASSIC

- 3 — *FERNIE FORMATION: dark marine shale*

TRIASSIC

- 2 — *Undivided: limestone; dolomite; sandstone; shale*

PALAEOZOIC AND MESOZOIC

- 1 — *Undivided: limestone; dolomite; sandstone; shale*

Rock outcrop
Geological boundary (approximate, arbitrary)
Bedding (inclined)
Thrust fault (approximate, assumed)
Anticline (approximate, assumed)
Syncline (approximate, assumed)
Well (location, oil, gas, abandoned)

Geology by R. T. D. Wickenden and G. Shaw, 1942; D. F. Stott, 1958, 1959, 1960

Compiled by D. F. Stott, 1963

To accompany Bulletin 152, by D. F. Stott

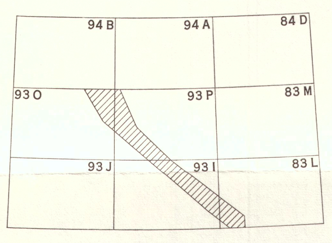
Road all weather
Other roads
Cart track or trail
Horizontal control point
Provincial boundary
Township boundary (surveyed, unsurveyed)
Intermittent stream
Marsh
Contours (interval 500 feet)
Height in feet above mean sea-level 3425

Cartography by the Geological Survey of Canada, 1966

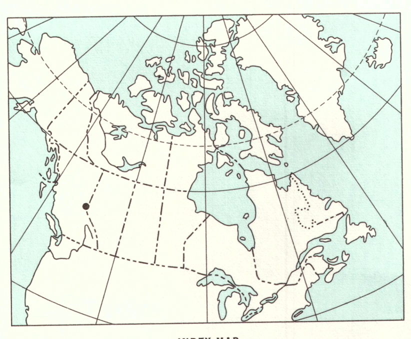
Base-map prepared by the Army Survey Establishment R.C.E. Dept. of National Defence, 1949-1955 and from advance information supplied by the Surveys and Mapping Branch, British Columbia Department of Lands and Forests

Approximate magnetic declination 24° 43′ East decreasing 3.7′ annually

This map is incidental to the stratigraphic study and represents only a preliminary reconnaissance. It is based on widely spaced ground traverses supplemented by the interpretation of air photographs in the intervening regions. Many places require more detailed study to solve the structural complexities



N.T.S. REFERENCE



INDEX MAP

Printed by the Surveys and Mapping Branch

Published 1967, the Centennial of Canadian Confederation
1867 | 1967


MONKMAN PASS-GRIZZLY VALLEY AREA
STRATIGRAPHIC STRIKE CROSS SECTION
TO ACCOMPANY INTERIM GEOLOGICAL REPORT
REQUESTED BY - McLAWS + CO. FOR - NOBLE MINES + OILS LTD.
SEPTEMBER 1976
ENCL. # I
TRANS-EMP WILRICH CENTRAL DEL RIO STONY LAKE No. 1 c-92-B NTS 93-I-15
K.B. 3587'
T.D. 5832'
SAMPLES HAVE NOT BEEN EXAMINED
GAS/OIL PRP NW GRIZZLY d-59-A NTS 93-I-15
K.B. 4040'
T.D. 8556'
MONKMAN PASS PRP GRIZZLY c-36-A NTS 93-I-15
K.B. 4240'
T.D. 9007
SAMPLES EXAMINED
CORE HAS NOT BEEN EXAMINED
GAS/OIL PRP NW GRIZZLY c-25-A NTS 93-I-15
K.B. 4199'
T.D. 8752'
SAMPLES CHECKED OVER PERTINENT INTERVALS
(AS OF SEPT. 1975)
JAMES PRP ET AL GRIZZLY d-2-A NTS 93-I-15
K.B. 3853'
T.D. 8566'
SAMPLES HAVE NOT BEEN EXAMINED
JURASSIC
CRETACEOUS (LOWER and UPPER)
FERNIE SHALES
"NIKANASSIN" FM.
GETHING FM.
MOOSEBAR FM.
COMMOTION FM.
SHAFTESBURY FM.
DUNVEGAN FM.
DIAGRAMMATIC
SHAFTESBURY FORMATION
COMMOTION FORMATION
MOOSEBAR FORMATION
GETHING FORMATION
"NIKANASSIN" FORMATION
DATUM SEA LEVEL
INTO GETHING OR ? COMMOTION
CAUTION -
SHOULD NOT BE CONSIDERED MORE THAN A POSTULATED HYPOTHESIS UNTIL THE DITCH-CUTTINGS HAVE BEEN EXAMINED
INFORMALLY DRAFTED
* THE "NIKANASSIN" OF c-36-A MAYBE ON A DIFFERENT THRUST BLOCK THAN d-2-A
B.C. GOVT. RECORDS
NO DST'S REPORTED
MAJOR THRUST FAULT(S)
SIZE OF FAULT(S) UNKNOWN
CORES AND PRODUCTION DATA (OR TEST DATA) FROM B.C. GOVT. RECORDS