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NOTES ON THE DEVONIAN SYSTEM OF THE NORTH-CENTRAL PLAINS OF ALBERTA

(REPORT AND FOUR FIGURES)

By
Helen R. Belyea

OTTAWA
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INTRODUCTION

The accompanying sections and maps of the Devonian strata were compiled from the results of detailed studies of the cores and cuttings from exploratory wells drilled in the north-central plains of Alberta. Most of the logs of these wells were compiled in 1951 and 1952, but some were prepared in previous years[1].

[1]Detailed logs of the Palaeozoic sections of wells in this area are available for study in the office of the Geological Survey at Calgary; mimeographed copies of most of these can be supplied upon request.

Cross-sections compiled from these well logs (Figures 2, 3, and 4) have been constructed to represent the facies changes in the area from township 60 north to township 88, and from the Alberta-Saskatchewan boundary to rge. 15, W. 5th mer., and relationships with the Lesser Slave Lake and Edmonton areas are shown by contour and isopach maps (Figure 1). Correlation with the Edmonton area is also shown by the inclusion in Figure 3 of Imperial Clyde No. 1 well in tp. 59, rge. 24, W. 4th mer., that is, within the area covered by the report of the Geological Staff, Imperial Oil Limited (2)[2].

[2]Numbers in parentheses are those of References on this page.

ACKNOWLEDGMENTS

Fossil identifications of assistance in the preparation of this report were made by D. J. McLaren of the Stratigraphic Palaeontology Division of the Geological Survey of Canada. The writer is grateful to Canadian Stratigraphic Services for making their material available and for their co-operation and readiness to discuss many problems; to Fortune Oil Corporation, Imperial Oil Limited, Pacific Petroleums Limited, and Seaboard Oil Company of Delaware for permission to examine their cores and for the courtesies shown during this work; and to the Alberta Petroleum and Natural Gas Conservation Board for supplying samples and facilities for examining cores.

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STRATIGRAPHY

GENERAL STATEMENT

The area covered in this report lies to the north of the Edmonton area in which the formations in the upper part of the Devonian System have been described by the Geological Staff, Imperial Oil Limited (2). The figures and text attempt to portray the facies changes that occur northward from the Edmonton area with which correlations have been attempted. As this work is of a preliminary nature and covers only a small part of the region underlain by Devonian sedimentary rocks in Alberta, as few new stratigraphic subdivisions as possible have been introduced.

The north-central plains of Alberta are underlain by sedimentary formations ranging in age from Cambrian to Upper Cretaceous. This report, however, is concerned chiefly with those of Devonian age, although some that may be in part older and in part younger are included.

The Devonian sequence of the north-central Plains is part of the large Devonian basin of deposition that covers much of the Interior Plains of Canada and the United States. In the region under discussion it lies between the Canadian Shield to the northeast and the Peace River arch to the west (7); the isopach map, Figure 1B, shows the distribution and thickness of these strata. The lowest beds studied are here defined as those of the Elk Point group, the lower part of which may be of pre-Devonian age. The beds of this group rest on Cambrian strata from about the latitude of the Imperial Grosmont well southward; to the northeast, they overlap the Precambrian rocks of the Canadian Shield; and to the west, over the Peace River arch, limestones probably of Middle Devonian age rest on basal Palaeozoic sandstones whose exact age is unknown. The limestones and some of the sandstones are probably equivalent to a part of the Elk Point group.

The beds of the Elk Point group form a predominantly evaporitic sequence. They consist of: (a) a lower, red bed and salt series; (b) a dense dolomite series; (c) a pronounced reef

facies of Middle Devonian age, probably overlying the dolomite series unconformably; and (d) an evaporitic sequence including salt and anhydrite. West of the Lesser Slave Lake area, over the Peace River arch, the Imperial Grouard well (Figure 4) did not encounter the typical Elk Point section. In this region beds presumably equivalent to the Beaverhill formation rest on a fossiliferous limestone, which, in turn, overlies the basal Palaeozoic sandstone beds.

The Upper Devonian Beaverhill formation, which succeeds the Elk Point, reflects marine invasion overlapping the Elk Point and, to the west, progressing over the elevated Precambrian surface of the Peace River arch. During the deposition of the Beaverhill, stromatoporoid-coral-algal growth commenced wherever conditions were favourable, commonly forming widespread biostromal deposits and, rarely, developing into reefs. Alternating shale and limestone units represent cyclical changes in the depositional environment. A definite tendency towards the development of reefs within the succeeding Woodbend formation indicates changes in the configuration of this part of the basin at the beginning of Woodbend deposition. Over much of the north-central Alberta plains, the Cooking Lake member at the base of the Woodbend forms a thin or tabular shelf deposit composed largely of dense, and pelletoid, shallow-water limestones, with sporadic reefs. Larger reef complexes developed under favourable conditions, particularly towards the edge of the shelf, some continuing to develop into the major reef complexes of the Woodbend. A green shale, off-reef facies was deposited to the west of the Cooking Lake reef area, the approximate trend of its boundary with the reef facies being shown in Figure 1B. Unstable conditions and alternating deposition of limestones, muds, and silts, accompanied by shallowing of the water to the base level of deposition, seems to have been common throughout the period during which Woodbend sediments were accumulating. These limestones, muds, and silts are referred to the Ireton member of the Woodbend. The contact between the Woodbend formation and the overlying Winterburn formation in places shows evidence of a break in sedimentation. The Winterburn formation is characterized by interbedding and interfingering of silt, fine sand, dense limestone, and organic carbonates, suggesting shallow water deposition. Reef growth as developed in places within the Nisku member was terminated locally by sands of the Calmar and Graminia members. Gradual decrease in the volume of sand and silt permitted fine-grained limestones to accumulate; these are referred to the Wabamun formation.

Over most of the north-central plains of Alberta as illustrated in Figure 1A, the upper part of the Wabamun and overlying beds were removed by erosion in pre-Cretaceous time. In the Lesser Slave Lake area, in the western part of the north-central Plains, a black shale known as the Exshaw formation, and generally believed to be correlative with the Exshaw shale of the Rocky Mountains, overlies the Wabamun formation. This black shale is overlain in turn by strata of known Mississippian age, but whether it is of Devonian or Mississippian

age or whether it is everywhere correlative with the Exshaw beds of the type area is still uncertain[1]. No new information

[1]Since this report was written, C. H. Crickmay (Discrimination of Late Upper Devonian, Jour. of Pal., July 1952, pp. 585-610) has presented his opinion that the Exshaw black shales of the Alberta plains are Mississippian in age, and that in places limestones of Mississippian age rest on dolomites of the Wabamun formation. In the sections illustrated in this report the limestones referred to the Mississippian by Crickmay may be represented in the Imperial Dapp No. 1 well between depths of 3,091 and 3,150 feet; in the Imperial Grouard well between 4,290 and 4,330 feet; and in the Socony Utikuma well between 2,783 and 2,830 feet.

regarding the Exshaw has been obtained from the north-central Plains; therefore, the present study has been restricted to the beds below the Wabamun-Exshaw contact, which marks a sharp change in depositional environment.

TABLE OF FORMATIONS

Edmonton area, 1950[1]			North-central Plains of Alberta	
Epoch	Formation	Member	Formation or group	Member and facies
Upper Devonian	Wabamun		Wabamun	
	Winterburn	Graminia Calmar Nisku	Winterburn	Graminia Calmar Nisku
	Woodbend	Ireton Leduc Duvernay	Woodbend	Ireton Grosmont and other reef complexes Hondo Duvernay Green shale facies Cooking Lake
	Beaverhill		Beaverhill	
Middle Devonian and probably older	Elk Point		Elk Point	

[1] Geological Staff, Imperial Oil Limited, Western Division, 1950.

SOME LIMESTONE TYPES IN THE UPPER DEVONIAN SERIES OF THE NORTH-CENTRAL PLAINS

The limestones of the Upper Devonian Series in Alberta have certain distinctive characteristics that may prove useful in stratigraphic correlations and in the interpretation of facies changes. They occur in units of varying thickness interbedded with greenish grey, finely silty, calcareous shales. The basal member of these limestone units is usually a thin, fine-grained limestone, containing abundant crinoid fragments and interbedded with thin, brown, shaly laminae that are generally irregular and wavy as though accumulated on a shallow bottom subject to wave or current action. Above this member lies the main body of the limestone unit, commonly composed of a wealth of organisms, such as stromatoporoids, corals, algae, and symbiotic forms, which, under favourable conditions, may develop into local, thick accumulations or reefs. The matrix is composed of coarse-grained organic debris and fine lime muds. Except for the stromatoporoid-coral-algal zones, limestones composed of accumulated benthonic organisms are rare. In the normal sequence, where deposition was continuous, each stromatoporoid-coral-algal zone is succeeded by beds that show a gradual change to limy muds, which commonly contain abundant organic debris, and in places to algal and pelletoid[1] limestones of various types. These types warrant a

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[1]The term "pelletoid" is used to describe any limestones composed of small to large discrete grains or pellets of very fine-grained limestones either in a fine-grained matrix or cemented by crystalline calcite. In most cases the origin of the pellets cannot be readily proved. Pellets ranging from 0.05 to 1.5 or 2 mm. in diameter are common.

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brief description and some speculation as to the conditions under which they may have formed. Some of the very fine lime muds are cryptocrystalline and characterless; more commonly, however, they contain very small, usually broken, fragments of fossils such as very thin brachiopod fragments, small, thin-shelled gastropods, ostracods, crinoid fragments, etc., and in some places display indistinct structures suggestive of organic origin, possibly algal. Much of the limestone of this type may have been precipitated from sea water by the action of algae or bacteria. In many places where accumulation of broken fragments of crinoids, brachiopods, and other fossils in lime muds or in argillaceous muds are extremely abundant, the rocks may be effectively described as 'fossiliferous-fragmental'. Although much of the limestone may have been wholly or in part precipitated by chemical action from sea water, as already mentioned, much limestone of this type seems to have been transported over the sea floor or deposited from suspension, and can with some justification be classified as calcilutite or, if coarse grained, as calcarenite. Coarser pelletoid limestones of various types are closely associated with the fine-grained limestones, the individual pellets being composed of limestone of this same type. Many of the pelletoid limestones of the Devonian of Alberta may be concretionary aggregates formed by precipitation of calcium carbonate in agitated water or about a nucleus such as air bubbles or the fine silt that occurs in small

amounts in limestone of this type; others, very abundant in the 'reef' areas, and overlying them, show cellular structure and appear to have been precipitated by the action of algae; algal crusts are common in such limestone; some are probably faecal pellets; some, especially the more irregular, angular grains, may be truly clastic, mechanically transported lime-sand grains; some indistinctly separated grains suggest only slight movement by wave or current action. True oolites are comparatively rare, although some zones have been identified, and scattered oolites are common in beds composed predominantly of other types of pellets. In most cases the pellets have formed as discrete grains cemented later by clear crystalline calcite. Most of the limestones in the region under discussion show little porosity except where dolomitized. All, however, of whatever origin, whether chemically precipitated, or precipitated by the direct action of algae, or whether formed by current or wave action, point to a similar shallow-water origin under conditions of light, air, and movement of water by wave or current action, which permit optimum growth of organisms. As such conditions are also most favourable for the destruction of organic debris, they would explain the paucity of organic remains and the fact that only thin, small pieces of clear calcite remain of the shells of such animals as brachiopods and gastropods.

ELK POINT GROUP

The 'Elk Point' sequence was defined by J. R. McGehee (5) as a formation; but as it consists of several lithological units and may even include rocks of more than one period, it is here given group status. However, the writer has not made sufficiently extensive studies to define new subdivisions for the Elk Point strata.

The accompanying cross-section, Figure 2, shows the stratigraphic succession, lithological changes, and probable correlative horizons in the Elk Point group from the Imperial Dapp No. 1 well northeast roughly across the strike of the Devonian in this area to the Bear Biltmore No. 1 well. Detailed studies were made of the samples and cores of the wells shown in the figure and the log of the Elk Point in the Imperial Grosmont No. 1 well is given in the Appendix to this report. The datum line for this cross-section is taken as the base of a persistent biostromal unit characterized by abundant stromatoporoids.

Lowest Red-bed and Salt Unit

The oldest or lowest rocks of the Elk Point basin in this area are penetrated by the Imperial Grosmont No. 1 and Bear Parkford No. 1[1] wells. Southwest from the Imperial Grosmont well

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[1]Not shown on Figure 2.

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progressive transgression of the Elk Point strata over the underlying Cambrian is shown in the Imperial Clyde and Imperial Dapp

wells. A similar transgression occurs to the northeast where, in the Bear Biltmore well, some 700 feet of beds of the lower part of the Elk Point encountered in the Imperial Grosmont and Bear Parkford wells are missing, and what appear to be higher beds of the Elk Point rest on Precambrian rocks.

In the Imperial Grosmont, Imperial Clyde, and Imperial Dapp wells the Elk Point group rests on strata of Cambrian age. The basal beds of the Elk Point in both the Clyde and Dapp wells seem to consist of reworked Cambrian strata, and it is difficult to determine the exact position of the contact between Elk Point and the known Cambrian strata.

The lowest beds of the Elk Point consist of brick-red sandy shales and shaly sandstones some of which contain scattered grains of glauconite. They are overlain, in the Grosmont well, by a salt member, the "third salt" of the Elk Point area. To the southwest, deposition of Elk Point strata has overlapped the Cambrian and the lowest beds of the Elk Point occurring in the Grosmont well are missing in the Clyde well, and the "third salt" is represented by a shoreward facies of interbedded shales and dense, shaly, finely silty dolomites. Above the "third salt" in the Grosmont well and extending southwest through the area represented by the Clyde well are deposits of a second evaporitic cycle, which occurred contemporaneously with the extension of the basin to the area represented by the Dapp well as shown in Figure 2. The samples from the rotary drill-cuttings of beds representing this cycle are too poor to define the exact sequence of the cycle. In general, red and green shales, anhydrite, and some siltstones and sandstones appear to be represented in the lowest 100 feet, with some limestones and dolomites occurring with anhydrite and shale in the succeeding 30 feet, followed by red and green shales to the "second salt" member. In the vicinity of the Dapp well, the equivalent shoreward facies of brick-red sandstone, siltstones, and shales becomes more shaly upwards and shows the extension of a thin stringer of the salt member into this area. Following deposition of the salt, the closing phases of the evaporitic cycle continued, with anhydrites and dense dolomites and shales succeeded by interbedded dolomites and red shales. A dolomite and anhydrite overlying the basal beds of the Bear Biltmore well may be correlative with some part of this upper sequence.

The above-described "red-bed" or evaporitic-type strata seem to form a single lithological unit separated sharply from the overlying beds. Gradual transgression appears to have occurred during their deposition southwestward over the Cambrian beds towards the Imperial Dapp well and northeastward over Cambrian and Precambrian rocks towards the Bear Biltmore well and beyond the limits of Figure 2 to the Bear Rodeo No. 1 well in the McMurray area.

Dense Dolomite Unit

Resting on the red-bed sequence, in the Imperial Grosmont, Imperial Clyde, and Imperial Dapp wells, is a series of crypto-crystalline dolomites ranging through shades of cream, pale grey, green, pink, and light red. The lower beds are very sandy,

containing abundant, small to large, rounded, frosted quartz grains, which in places become sufficiently abundant to form dolomitic sandstones. Sand grains appear again in the upper beds in the Imperial Clyde well. In the Imperial Dapp well, the entire sequence is very sandy, and granule- to pebble-size grains occur in some beds. This variation suggests that the source of the clastic material is to the west. Overlying this series of non-argillaceous or 'clean' dolomites are 30 to 60 feet of pinkish grey to red argillaceous dolomites, with interbedded red and green shales, topped by a red shale; some intercalated beds of dolomitic sandstone, with granules of red dolomite in a light grey matrix, are similar in general appearance to the dolomites below, and should probably be grouped with them as beds transitional towards an environment favourable for the deposition of red beds. This unit may represent a marine cycle of transgression and regression as expressed in a shallow-water, near-shore environment followed by a period of red-bed deposition, the entire sequence showing a strong resemblance in lithology to beds identified as of Silurian age in Saskatchewan. Between these argillaceous red dolomites and shales and the overlying stromatoporoid zone in the Dapp, Clyde, Grosmont, and Maxgeorge wells are some 40 to 70 feet of soft, shaly dolomites, shales, and siltstones; some nodular dolomites carrying worn fossil fragments; quartz sandstones; and sandstones composed of dolomite grains. This sequence suggests a change in depositional conditions and, perhaps, periods of non-deposition.

The lower part of the Elk Point group encountered in the Bear Biltmore well requires specific comment. In it the beds underlying the dolomite zone, used as a reference for Figure 2, and resting on the Precambrian basement consist of a basal, arkosic, shaly sandstone overlain by a thin dolomite and anhydrite. On these rest a series of massive, red and green anhydritic mudstones, with interbedded anhydrite and dolomitic siltstone and dolomite towards the top. Just how these beds correlate with the section in the Imperial Grosmont well cannot be determined; possibly they represent the entire period of deposition already noted in the Grosmont well; or they may represent the shoreward facies of the cryptocrystalline sandy dolomites described from the other wells of the cross-section.

Marine, Fossiliferous Limestone and Dolomite Unit

Overlying the anhydritic beds in the Bear Biltmore well is a finely crystalline to sugary dolomite containing scattered crinoids and thin, brown, argillaceous laminae. A siliceous to cherty zone, with a somewhat weathered appearance and containing minute plant(?) spores similar to those found in what is believed to be the Elm Point formation in various wells in southern Saskatchewan, separates this finely crystalline dolomite from the coarser, stromatoporoid-coral-algal zone overlying it. This finely crystalline dolomite may be the equivalent of some part of the stromatoporoid-coral-algal zone in the wells to the west, but more probably it is represented there by a few feet of finely crystalline dolomite under the stromatoporoid-coral-algal zone in the Bear Maxgeorge and Imperial Dapp wells; that is, this zone

may pinch out to the west and in part represent the apparent interval of non-deposition, already mentioned, below the stromatoporoid-coral-algal zone. Or, alternately, the fine-grained dolomite may be represented in the wells to the west by the pale, cryptocrystalline, sandy dolomites deposited prior to the apparent period of non-deposition. Regardless of its correlation with the other wells, this dolomite with the crinoids and small plant spores seems to mark the beginning of a period during which conditions were favourable for the growth of abundant marine life and that culminated in the succeeding stromatoporoid-coral-algal zone.

The stromatoporoid-coral-algal zone consists of abundant organic remains in a coarse-grained matrix composed largely of organic debris and irregular pellets or grains of fine limestone. It has a loose, porous texture that was conducive to dolomitization, although not to such an extent that the original fossiliferous and pelletoid structures were completely destroyed, and in some wells, such as in the Dapp and Clyde wells, a large part of the zone has remained limestone. The unit varies in thickness from some 40 feet in the Imperial Dapp well to about 100 feet in the Bear Biltmore well, apparently showing a longer period of stromatoporoid-coral-algal development shoreward towards the positive area of the Canadian Shield.

Evaporite - "First Salt" Unit

While the thick stromatoporoid-coral-algal zone was accumulating to the northeast in the region of the Bear Biltmore well and wells near McMurray, dense evaporitic-type carbonate beds, muds, and anhydrite were being deposited towards the centre of the basin. No cessation of deposition seems to have occurred between the stromatoporoid-coral-algal zone and these beds in the central part of the basin, but rather a gradual transition upwards from open-sea conditions favourable to organic growth to those of a basin with restricted circulation. The proximity of another shoreline on the southwest side of the basin is suggested by silty and sandy beds in the Dapp well. The basin appears to have become isolated from the open sea, resulting in the deposition of thick deposits of salt, with minor variations to anhydrite, dense dolomite, and mud. Whether the isolation of this basin was caused by a general withdrawal of the sea or by the effect of local restrictive barriers could not be determined from the limited area under study. In the area of the cross-section (Figure 2) the "first salt" member ranges in thickness from 100 feet in the Clyde well to more than 600 feet in the Biltmore well. Anhydrites, shales, and shaly dolomites to the southwest, in the Imperial Dapp well, appear to represent a nearer shore facies equivalent to the salt. A similar sequence of interbedded shales and dense dolomites in the Clyde well may represent the latter part of the period of salt deposition. The section from the top of the stromatoporoid-coral dolomite to the red beds overlying the salt thins northeastward from 750 feet in the Biltmore well to about 220 feet in the Bear Rodeo No. 1 well[1] in the town of McMurray.

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[1] Dr. R. deWit, personal communication.

The thickening of the salt unit in the area of the Bear Biltmore well raises problems in the interpretation of the history of the basin of deposition in this general area. During deposition of the eldest or lowest part of the Elk Point group, the thickest deposits were formed in the Grosmont-Parkford area whereas the area represented by the Bear Biltmore and Bear Vampire[1] wells was part of the bordering positive area of the Canadian Shield. Following the invasion and retreat of the sea in which the stromatoporoid-coral-algal zone grew, the area of the maximum downward movement of the basin appears to have migrated to the northeast, that is, to the area in which the salt unit penetrated by the Biltmore and Vampire No. 1 wells has thickened to more than 600 feet. Eastward, near the town of McMurray, there is more anhydrite with the salt, and the unit has thinned to about 200 feet. This represents a thinning of the salt unit at the rate of about 20 feet to the mile. Possibly the thick salt unit of the Biltmore-Vampire area may be entirely the result of the migration of the area of maximum subsidence of the basin to the area of the Biltmore and Vampire No. 1 wells, or, the thickening may, in part, be due to flowage of salt into this area as a result of movements in late Devonian or in post-Devonian time. Doming of the overlying strata might be expected in this case, but too few wells have been drilled to furnish positive evidence. The closure of the contours on the eroded Devonian surface in this area, as shown in Figure 1A, suggest at least some doming. Possibly both subsidence contemporaneous with deposition and later flowage of the salt have contributed to the present distribution and thickness of the salt unit.

[1]The Bear Vampire well is not included in the cross-section (Figure 2) but is about 25 miles east of the Bear Biltmore well. The cores of this well were studied by Dr. deWit who made the data for this well, as well as the data on the Bear Rodeo No. 1 and Bear Westmont No. 2 wells, available to the writer.

In all wells studied that penetrate the Elk Point, the salt or equivalent beds are covered by a succession, about 30 feet thick, of dense limestone, dolomite, and anhydrite topped by a red and green mottled shale, which seems to form a good horizon marker in this area and beyond it. This section is, in turn, overlain by another sequence, about 40 to 60 feet thick, of dolomites, siltstones, shales, and anhydrites, near the base of which is a zone with abundant Charaphyta, including what have been tentatively identified as Trochiliscus and Sarcella. This unit is similar to the Elk Point in lithology and, although above the red beds indicated by McGehee (5, Figure 2) as the "datum" for the Elk Point, is included with that group. It is differentiated sharply in this area from the fossiliferous limestones that overlie it and that form the base of the Beaverhill formation as described in the type section; thus this unit seems to lie between the defined limits of the Beaverhill formation and beds of the Elk Point group. Studies over a wider area may show whether these beds are more closely related to the Beaverhill or to the Elk Point. A description of these beds in the Bear Biltmore well is given in the Appendix.

BEAVERHILL FORMATION

The following comments on the Beaverhill formation should be studied in connection with Figures 3 and 4. The reader is referred to the log of the Bear Biltmore No. 1 well, in the Appendix to this report, between depths of approximately 980 and 1,688 feet, for a detailed description of this formation representative of its character in the north-central plains of Alberta.

The Beaverhill formation in the north-central Plains, as in the type section (2, pp. 1,823-1,825) from the Anglo-Canadian Beaverhill Lake No. 2 well in l.s. 11, sec. 11, tp. 50, rge. 17, W.4th mer., consist of a cyclical repetition of calcareous shales and limestones. The cyclic nature of the deposition, readily seen in the major units shown in Figure 3, is repeated in minor cycles of thin-bedded shales and limestone.

In general, argillaceous or shaly beds are more abundant in the Beaverhill in the northeasterly parts of the north-central Plains, whereas more lime and less shale occur towards the centre as represented by the Imperial Grosmont, Imperial Clyde, Imperial Dapp, and Barnsdall Honolulu Seaboard Pelican Lake No. 1 wells. To the west, more argillaceous limestones and shales occur, as in the Barnsdall West Wabiskaw, Socony Utikuma, and other wells in the Lesser Slave Lake area, where the Beaverhill formation approaches the shoreline formed by the elevated surface of the Precambrian known as the Peace River arch. In the Lesser Slave Lake area, beds apparently equivalent to part of the Beaverhill consist of dense limestones and shales, and form a continuous sequence with similar beds equivalent to the succeeding Woodbend formation. As a result the two formations cannot be differentiated with certainty.

Lithology

The basal lithological unit of the Beaverhill formation is a thin, highly fossiliferous, light brown limestone, which varies in thickness from 8 feet, in the Bear Biltmore No. 1 well, and 6 feet in the type section, to approximately 25 feet in the Imperial Dapp No. 1 well. The basal Beaverhill limestone unit overlying the Elk Point in the Socony Utikuma well and overlying the basal Palaeozoic sandstones in the Imperial Grouard well may be this same unit, thickening to the north and west. This unit is sharply separated both from the underlying Elk Point beds and the overlying chocolate-brown shales and shaly limestone. The latter unit varies only slightly in composition from calcareous shales to dense, smooth-textured, muddy limestones, and its top is characterized by a decisively high resistivity curve on the electric log. The unit is about 15 to 20 feet thick in most wells in this area, but in the Bear Biltmore No. 1 well it is a brownish black shale only 1 foot thick.

Above the chocolate-brown shale and shaly limestone the Beaverhill strata in this area consist of an alternating sequence of greenish grey shales and carbonates showing a gradual increase upwards of the carbonate content as compared with the clastic mud-silt content. The major subdivisions of the Beaverhill consist, in brief, of a greenish grey shale, a limestone, a thin

shale unit, and a thick limestone followed by a shale, which forms the top of the formation. The succeeding Cooking Lake limestone member of the Woodbend formation completes the cycle. The shales of the Beaverhill are very similar to most of the shales throughout the overlying Devonian strata. They vary laterally and vertically within fairly narrow limits: at one end are the greenish grey, calcareous shales, with a high percentage of clay-size quartz and grains of a white mica, which in places gives them the characteristics of argillaceous siltstones rather than shales; at the other end are highly calcareous, light grey, blocky shales and dense, argillaceous limestones. Interbeds of more calcareous and less calcareous layers are common.

In the Beaverhill formation, the lowest greenish grey shale unit is 100 to 200 feet thick, and near the top contains what appears to be a widespread zone characterized by forms of Charaphyta tentatively identified as Trochiliscus and Sarcella. It is succeeded by a widespread limestone unit about 70 to 100 feet thick. This is generally a buff, very fine-grained limestone, abundantly fossiliferous, with pelletoid structures and rare stromatoporoid-coral-algal growths. It seems to have been a calcareous mudstone in which numerous organic remains were preserved. The limestone is transitional upwards to a thin unit of interbedded shale and dense, shaly limestone, which completes a limestone-shale cycle. This cycle is followed in turn by another, larger, limestone-shale cycle, which is represented by the upper member of the Beaverhill formation.

The upper limestone unit shows considerable variation in character, and it is the first well-developed occurrence of an association of limestone types common in the Upper Devonian Series of this basin. Considered as a whole in the area represented by the cross-section (Figure 3), this unit appears to be biostromal, but the distribution of stromatoporoid-coral-algal growth suggests that reefs may have accumulated in places. The thin bands of stromatoporoid-coral-algal growth in this unit, in the Bear Biltmore well, are represented by thicker bands in the Bear Beaumont to Imperial Grosmont wells. In the Imperial Clyde well, which represents the area in which reef development reached a maximum during succeeding Woodbend time, practically the whole upper limestone unit of the Beaverhill appears to be stromatoporoid-coral-algal growth, biohermal in nature, suggesting that conditions favourable for reef-building organisms began in Beaverhill time. West from the Clyde well reef-area, as shown by the Imperial Dapp well, no stromatoporoid or coral material was found in this upper limestone of the Beaverhill, although coarsely clastic fossil debris limestone and fine-grained calcarenites and calcilutites, such as are associated with reefs, replace the stromatoporoid-coral zone and suggest the presence of a near-reef facies. Similarly, in the Barnsdall West Wabiskaw No. 1 well (See Figure 4) dense limestones and muddy limestones replace others of the stromatoporoid-coral-algal type.

Following the maximum stromatoporoid-coral growth, argillaceous material and fine silt began sporadically to enter this area of deposition, and, as a result, the upper part of the Beaverhill limestone is interbedded with finely silty shales.

The volume of fine silt and argillaceous material gradually increased to form the dense limestone-shale unit at the top of the Beaverhill. Following the deposition of this unit there ensued a gradual return to conditions favourable to limestone deposition, marking the beginning of a new cycle. The limestone of this new cycle has been separated from the Beaverhill and placed in the Woodbend formation by Imperial Oil Limited (2, pp. 1,823-1,825), and as this formation boundary is commonly accepted it is followed in this report.

Delimitation and Thickness

The lower contact of the Beaverhill formation is placed at a lithological break at the base of a coarse-grained fossiliferous limestone that rests on greenish grey, argillaceous siltstone or on buff anhydrite and anhydritic dolomite and shale of Elk Point type. This contact appears to be at about the horizon of the highest siltstone (at 5,047 feet) in the type section described from the Anglo-Canadian Beaverhill Lake No. 2 well, which has been defined (2, p. 1,824) as the base of the Beaverhill formation. The change to this distinctive limestone marks a fairly constant horizon in the area under discussion, although the siltstone recognized just below the limestone in the type Anglo-Canadian Beaverhill Lake No. 2 well section is not always present. Thus, in the Bear Biltmore No. 1 well, the highest siltstone is about 40 feet below the fossiliferous limestone. Considering the shallow-water, lensing nature of the Elk Point sediments it is extremely doubtful that the same siltstone would extend from the Beaverhill Lake No. 2 to the Biltmore No. 1 well. As discussed under the Elk Point formation, these beds below the Beaverhill and above the red beds of the Elk Point form a unit in this area that is placed tentatively in the Elk Point group.

The top of the Beaverhill formation in this area is marked, as in the Edmonton area, by a gradual transition to the Cooking Lake limestone member of the Woodbend formation, and is placed at the highest calcareous shale and shaly limestone overlain by the Cooking Lake limestone. The contact is readily determined from the small deflexion of the self potential and the low resistivity of the electric-log curves. To the west, as shown in the Imperial Dapp No. 1 and in several of the wells of Figure 4, the contact is placed at the top of a section of dense, argillaceous limestones and shales overlying the upper limestone unit of the Beaverhill formation and in turn overlain by a section of fissile greenish grey shales that form the off-reef equivalent of the Cooking Lake member of the Woodbend formation. This horizon appears to correspond with the top of the Beaverhill formation as defined in the type section, although some of the greenish grey shale section here included with the Woodbend formation may be more closely related to the Beaverhill; or, conversely, some of the shaly limestones included with the Beaverhill may be basal Woodbend. The horizon chosen as the contact may not be constant, but there is considerable evidence to support it as the best choice; in the Imperial Dapp and Barnsdall West Wabiskaw wells, in which the whole of the Beaverhill is represented, the thickness of the formation, between 690 and 710 feet, is comparable to the 722 feet of Beaverhill in the Anglo-Canadian Beaverhill Lake No. 2 well; also, the upper part of this formation in the wells shows the same interbedding of

dense limestones and shales as in that section.

WOODBEND FORMATION

Overlying the Beaverhill and beneath the Winterburn formation is a succession of beds complicated by the occurrence of a wide variety of rapidly changing facies associated with a maximum development of reef-building organisms resulting in the formation of numerous reef complexes. This sequence has been described for the Edmonton area (2, pp. 1,816 et seq.) as the Woodbend formation. In analysing the stratigraphy of this formation, reef and off-reef areas were separated. Off-reef, in the Edmonton area, the Woodbend has been divided in ascending order into the Cooking Lake, Duvernay, and Ireton members, the last being further subdivided into a lower calcareous shale and an upper argillaceous dolomite unit. In the reef areas, the term Leduc member was applied to the reef complexes resting on the Cooking Lake member. The Woodbend formation as a whole can be traced laterally over considerable distances, but it contains members of widely varying lithology and complicated age relationships. Further study of the relationship between the reef and off-reef deposits, now all included in the Woodbend formation, may result in the modification of present contacts and the division of the Woodbend into small time-rock units.

So far as possible, the units described in the type Edmonton area have been identified in the area north of township 60; as these units vary in some details from their type sections they will be described briefly in the following paragraphs. Comparison of the facies developed in the Woodbend formation and the overlying Winterburn formation in the north-central Plains seems to show that a change in the type of sedimentation occurred following the close of Woodbend deposition. In the reef areas and to the east and northeast of them there is usually evidence of a minor break in deposition between the two formations.

Cooking Lake Member

The lowest member of the Woodbend formation in the type Edmonton area (1, pp. 1,819-1,820; 1,823) is the Cooking Lake. To the north, in the area covered by Figures 3 and 4, the Cooking Lake member retains essentially the same lithological characteristics as in the type area. It seems to be a bedded limestone unit that spread at least over a large part of eastern Alberta as a shelf or bank deposit. The western edge of the shelf appears to cross the north-central Plains about in the position shown in Figure 1B, although lack of well data north of township 71 makes the location of the line indefinite. To the west of this line, the Cooking Lake limestone is replaced by a green shale unit, which will be described on later pages.

In what may be described as its typical development, the Cooking Lake consists of fine- to medium-grained, buff or light yellowish brown limestones, usually chalky and finely porous; commonly the grains are cemented by clear crystalline calcite. Dense limestones with various amounts of very thin,

fragile, fossil fragments, such as small gastropods, ostracods, pieces of crinoids, and characterless brachiopod shells are common; many of the shells appear to have been partly dissolved and many, perhaps, to have been partly destroyed by scavengers. Where the fossil remains are prolific they form what may be termed 'shell hash' or fossiliferous-fragmental limestone. Small stromatoporoid-coral-algal zones are represented in the Cooking Lake in nearly every well examined; but whether they form one or several wide-spread units cannot be determined. Pelletoid structures, such as those described in connection with the Beaverhill formation are abundant in the upper part of the Cooking Lake and are especially common in zones overlying stromatoporoid-coral-algal growths. Small spores are commonly associated with the upper Cooking Lake beds. A detailed description of a typical section is given in the Appendix to this report from the cores of the Bear Biltmore No. 1 well between depths of 850 and 987 feet. Similar sections are illustrated in Figure 3 in the Bear Biltmore, Bear Beaumont, and Barnsdall Lyle Lake wells.

Cooking Lake strata show considerable lateral variation both in composition and in thickness. Sporadic reef expansions occur within the Cooking Lake member in places where subsidence and other conditions, such as light, temperature, and food supply, were favourable for the continued upward growth of reef-building organisms. In many places reef complexes continued to develop while sediments of the Duvernay member were being deposited elsewhere. A typical Cooking Lake-Duvernay reef sequence is described from the Barnsdall Honolulu Seaboard Pelican Lake No. 1 well between depths of 2,375 and 2,755 feet (See Appendix), and a similar situation is illustrated in Figure 3 by the Imperial Grosmont No. 1 well. In other places, such as at the Imperial Clyde well, the development of a reef complex commencing in the Cooking Lake has continued to the upper part of the Woodbend formation, forming a reef complex of the Leduc type of the Edmonton area. Similar reef complexes commencing in the Cooking Lake are known to occur in what may be called the area of maximum reef growth in the north-central Plains. Examples, such as at Morinville and Meadowbrook, may be cited, the latter possibly commencing below the Cooking Lake member, that is, within the Beaverhill formation. In most of these occurrences the Cooking Lake limestone has been altered to a crystalline, vuggy dolomite.

The top of the Cooking Lake in this area is placed at the top of the relatively pure, buff, fossiliferous and algal-pelletoid limestones that contain abundant, minute, brown spores. The spores, and their association with the top of the Cooking Lake member, were first noted and described in a paper for limited distribution by J. M. Mitchell of the Canadian Stratigraphic Services of Calgary. In the normal off-reef areas, the Cooking Lake is overlain by the Duvernay member (2), as described by Imperial Oil Limited (1) for the type section. Similarly, in the north-central Plains area, where the Cooking Lake strata present a shelf or bank facies, they seem to grade upward into the Duvernay. This relationship is illustrated in Figure 3 by the Stanolind Rochester No. 1, Barnsdall Lyle Lake No. 1, and Bear Biltmore No. 1 wells, in all of which dark brown shales are interbedded with buff, fine-grained, spore-bearing limestones at the top of the Cooking

Lake. In the Bear Beaumont well, a sharp contact is discernible in the cores at 1,665 feet, where Cooking Lake limestone is overlain by dark brown shale. In the reef complex area, as shown by the Imperial Grosmont and Imperial Clyde wells in Figure 5, reef growth, which commenced in the Cooking Lake, continued or had a rebirth through the period during which the Duvernay was being deposited in the area of the Stanolind Rochester well and in the Edmonton area. In places, as at the Imperial Grosmont well, the continued growth of reef complexes stopped at about the same time that marked the close of deposition of the dense limestones and dark brown shales of the Duvernay. In other places, where relative subsidence and other conditions favoured the accumulation of thick reef complexes, as at the Imperial Clyde well, reefs are found throughout the Woodbend formation. In these areas it is not always possible to distinguish with certainty the Cooking Lake reef member from the overlying reef complex commonly referred to as the Leduc member. However, in this connection, reference may be made to a zone that is rich in pyrite, and possibly other, usually tarnished, iron sulphide minerals, and that contains vugs filled with selenite in the Imperial Clyde, Barnsdall Pelican Lake No. 1, and Imperial Grosmont wells. This zone occurs in a part of the reef complex that may represent the change of conditions coinciding with the close of off-reef Duvernay deposition. The writer has not made a study of this zone over a sufficiently wide area to do more than point to its presence in the area under discussion. The top of the Cooking Lake member may not be a constant horizon even in the shelf or bank area, because of its transitional nature, and in such areas it may be the equivalent of beds considerably lower than the top of the reef developed in the Cooking Lake in the area of the Imperial Grosmont well.

Green Shale Equivalent of the Cooking Lake

West of the area of maximum reef growth, as shown by the Imperial Dapp well, in Figure 3, and in the wells west of Pelican Lake No. 1 well, in Figure 4, the Cooking Lake member is represented by a shale facies that consists of greenish grey to brownish grey, finely silty, micaceous, slightly calcareous shales, with a fauna of small ostracods, the conularid Tentaculites, a few small brachiopods, and other unidentified forms. The detailed description of the shale section from the geological log of the Imperial Dapp No. 1 well, between depths of 4,930 and 5,200 feet, is given in the Appendix to this report. This well is not far from the area in which reef complexes in the Cooking Lake seem to be continuous with reef complexes that replace the Duvernay shale, and the thickness of green shale and the Cooking Lake-Duvernay reef complex is comparable. In a few wells drilled closer to the reef-area, dense limestones occur in the shale facies. These shales are probably equivalent to the lower part of the Hay River group, described by A. E. Cameron (1) on Hay River, Northwest Territories, and a small fauna collected from the cuttings of the Barnsdall West Wabiskaw well was tentatively correlated by D. J. McLaren with an horizon in the Hay River shale.

The relationship of the shale facies to the Cooking Lake member appears to be comparable to the relationship between

the green shales of the Ireton member and the reef facies of the Leduc member in the type sections described from the Edmonton area. The base of the shale facies is placed at the top of the dense limestone that underlies the shale and that is characterized by an increase in the resistivity curve of the electric log, as shown in Figures 3 and 4 and as discussed with reference to the top of the Beaverhill formation.

The upper contact of the green shale is not everywhere at the same horizon. In the Imperial Dapp well, the upper part of the shale section probably represents beds higher than the Cooking Lake, and some mottled brown and greenish grey shale above a depth of 5,040 feet in that well may be equivalent to some part of the Duvernay; northward, the shale section is thicker, and includes progressively higher beds; in the Barnsdall West Wabiskaw well, for example, the shale section replaces not only the Cooking Lake but also the Duvernay and possibly the lower part of the Ireton member. It varies in thickness in wells in the area under discussion from approximately 300 feet in the Imperial Dapp to 480 feet in the Barnsdall West Wabiskaw well. To the west, in the Lesser Slave Lake area, as illustrated by the Socony Utikuma and Imperial Grouard wells (See Figure 4), the whole Woodbend section is composed predominantly of shales, with some interbedded shaly limestones, including both the off-reef Cooking Lake and the Ireton in a continuous sequence. These beds seem to form the southward extension of the Hay River group of northern Alberta and the Northwest Territories.

Duvernay Member and Equivalent Beds

The Duvernay member of the Woodbend formation has been described from the Edmonton area (2, p. 1,817 et seq.) as a succession of dense brown limestones and dark brown shales topped in most wells by a characteristic dark brown bituminous shale, which contains abundant conodonts, fish scales, unidentified calcareous spines, and large flat spores, and gives a high impedance on the resistivity curve of the electric log. In the Edmonton area, the Duvernay facies is widespread. To the north, in the area under present discussion, the characteristic lithology of the Duvernay apparently varies to, or interfingers with, dense limestone and the Ireton type of greenish grey shale. A dark brown bituminous shale, which may be the top dark brown shale of the Duvernay, forms a useful horizon marker and is referred to on Figure 3 as the "top Duvernay shale". Those changes in the Duvernay that appear to indicate changes in the environment of deposition are illustrated by the section across the basin, Figure 3. As shown by the Stanolind Rochester well in the southern part of the area adjacent to the reef complex, the lower part of the Duvernay resembles that of the type Edmonton area, and dark brown bituminous shales are interbedded with the upper part of the Cooking Lake limestone indicating a transitional or interfingering relationship with the Cooking Lake; beds seemingly correlative with the upper part of the Duvernay of the Edmonton area have become greenish grey shales and limestones. To the northeast, a dark brown shale, probably continuous with some shale of the Duvernay of the Edmonton area, continues as

far east as the Barnsdall Lyle Lake well. Below it, greenish grey shales and dense limestones similar to those of the Ireton extend down to the top of the Cooking Lake member, except for a few dark brown shales immediately overlying the Cooking Lake. None of the dark brown shales were encountered in the Bear Beaumont or Bear Biltmore wells, and the greenish grey and grey Ireton facies in these wells must be considered to rest directly on the Cooking Lake. The relationship between the Duvernay and the Ireton in this area is uncertain; it seems to be one of the interfingering lithologies as the environment of deposition changes with increasing distance from the areas of maximum reef growth.

In the area where upgrowth of stromatoporoid-coral-algal zones began with Cooking Lake time, as in the Imperial Grosmont, Barnsdall Pelican Lake, and Imperial Clyde wells, the Cooking Lake reefs continued to grow during the time when the Duvernay was being deposited in the off-reef areas. As in the bank or shelf areas, a thin, dark brown shale over the Cooking Lake reefs, as illustrated by the Grosmont and Pelican Lake wells, may represent the "top Duvernay shale". In the Imperial Clyde well, reef growth was continuous and the Duvernay cannot be differentiated with certainty.

To the west of the reef-area, green shale beds that take the place of the Cooking Lake also replace most of the Duvernay, as shown in Figures 3 and 4. Brown shales and greenish grey and brown-mottled shales in the Imperial Dapp, Barnsdall Flatbush, and Barnsdall West Wabiskaw wells, may be equivalent to part of the Duvernay. A black, conodont-bearing shale that seems to be the westward continuation of a similar shale identified in the Edmonton area as the top of the Duvernay, occurs in the Imperial Dapp well at a depth of 4,825 feet. Similar shales occur at several higher horizons in the Imperial Dapp, Barnsdall Flatbush, and Barnsdall West Wabiskaw wells, and in some wells, such as the Stanolind Rochester, to the east of the reef area, and make correlation of the top shale of the Duvernay uncertain.

The Duvernay member, as described from the Edmonton area, seems to have restricted distribution and to interfinger with, or grade laterally into, beds that are typical of the greenish grey Ireton member. The uppermost conodont- and spore-bearing dark brown shale, the "top Duvernay shale" of Figure 3, seems to have a wider areal extent than the rest of the Duvernay facies, and forms a good horizon marker. This shale is associated, in many wells, with a coarse-grained, abundantly fossiliferous limestone, commonly glauconitic. Such an association is suggestive of a period in which the sea floor was near or above the base level of deposition, and these beds may prove, when more detailed subdivisions of the Woodbend formation are made, to be the base of a new unit rather than the top of the Duvernay.

Ireton Member

The Ireton member of the Woodbend formation, as defined for the Edmonton area (2, p. 1,821) consists of two units: "an upper argillaceous dolomite and dolomitic shale

section and a lower calcareous shale section". To the north of the Edmonton area, as illustrated by Figures 3 and 4, the Ireton contains less shale and more limestone than in the type Edmonton area; in much of this region a large part of the Ireton facies has been replaced by stromatoporoid-coral-algal reef growth referred to in this report as the Grosmont member.

The Ireton consists of a succession of interbedded greenish grey shale and limestone units containing a fauna comprising the conularid Tentaculites, bryozoa (Cladopora), ostracods, thin-shelled brachiopods and, near the top, foraminifera (Endogyra and Plectogyra). A detailed log for the Imperial Dapp No. 1 well describing the Ireton and the green shale equivalents of the Cooking Lake and Duvernay members, which cannot yet be separated from the Ireton member, is included in the Appendix to this report. Over much of the area the Ireton member rests on dark brown bituminous shales identified as the top shale of the Duvernay. Where the dark brown shales are present the unit immediately overlying them in most wells is a brown, fine-grained limestone with fine fossil fragments; this in turn is overlain by grey limestones and greenish grey silty shales and siltstones. This sequence, or cycle, is repeated one or more times in different areas in which the Ireton is developed. Thus, east of the reef area, as illustrated in the Stanolind Rochester well and in the wells drilled as far east as the Smoky Lake area (not illustrated), there are several recurrences of this sequence; similarly, west of the reef area in Imperial Dapp, Barnsdall Flatbush and other wells the same sequence of interbedded limestone and shale occurs. Farther west towards the Lesser Slave Lake area the limestones are largely replaced by shale (See Figure 4).

The upper part of the Ireton consists of greenish grey silty shales with some interbedded, fossiliferous limestones, similar to the upper Ireton of the Edmonton area. It is well illustrated in the cores of the Imperial Caslan well. In many places, for example in the Barnsdall Flatbush, Imperial Grosmont, and Imperial Darling wells, the upper part is more limy, and suggests proximity to areas of organic limestone accumulations such as stromatoporoid-coral zones or reefs. Reddish brown shales occur in the upper part of the Ireton in the Lesser Slave Lake area, as illustrated in Figure 4 by the Socony Utikuma and Imperial Grouard wells, and by the Bear Driftpile and Bear Villa wells (not illustrated). Over part of the area illustrated in Figure 10 the Grosmont reef member replaces most of the upper part of the Ireton, thin Ireton limestones and shales occuring both below and above this member. A zone containing charaphyta occurs at the top of the Ireton below the zone of continuous reef growth in many wells, the Bear Maxgeorge well providing one example. A sharp contact between the Ireton and the overlying Grosmont reef was encountered in the Bear Beaumont well.

Leduc and Grosmont Members

The Leduc member has been defined (2, p. 1,821) as "the biohermal type of reef occurrence in the Woodbend formation - 603 feet thick in the type section" (British American Pyrcz No. 1 well in the Leduc field), and this definition was extended (p. 1,822) to include any bioherm in the Woodbend

formation. The lithology of these reef deposits has been described in some detail by Layer et al. (3) and by Line (4). In some places, as in the Leduc field, the reefs seem to be almost continuous biohermal upgrowths, but in others, as illustrated in Figure 3 by the Bear Beaumont and Bear Biltmore wells, they are isolated accumulations in a green shale facies, which, therefore, cannot be correlated. In other places, small stromatoporoid-coral-algal bioherms seem to have formed in a general reef area, or are part of limestone units that spread over wide areas. Because of the variability in the nature and time of formation of this member, the usage of the term 'Leduc' has become confused. It is suggested that it be retained only for isolated reef occurrences that grew from the top of the Cooking Lake member, as in the type Leduc section. Alternatively, reef complexes may be referred to by their field or well names, as is common usage at present; thus, Leduc reef, Redwater reef, Stettler reef, Duhamel reef, Meadowbrook reef, etc. In Figure 3, the Clyde well illustrates such an occurrence. Small, isolated, stromatoporoid-coral-algal accumulations in the Ireton may be included with the Ireton until such time as more detailed work has formed a basis for subdivision of that member.

As the term Leduc has, then, been restricted in usage, the term 'Grosmont member' is suggested for the widespread biostromal coquinoid limestone and dolomitized limestones and associated reefs that spread over a large part of this area, as shown in Figure 1C. This member is named after the village of Grosmont about 6 miles northwest of the Imperial Grosmont No. 1 well. The type section was logged from the Imperial Grosmont No. 1[1] well by the writer as follows:

[1] The Imperial Grosmont No. 1 well, drilled in 1949 and 1950, is located in l.s. 13, sec. 17, tp. 67, rge. 23, W.4th mer.; and the elevation of the kelly bushing is recorded as 2,066 feet. The interval logged as the Grosmont member in this well lies between 2,875 and 3,430 feet, giving a thickness of 555 feet of strata. Drill cuttings from this section are in the collections of the Geological Survey of Canada and the Alberta Petroleum and Natural Gas Conservation Board. The following log is from the latter set of samples.

Depth	Lithology
Feet	
	Overlying beds, Woodbend formation
	Ireton Member
2,860-2,870	Sandstone and sandy dolomite: dolomite, buff and grey, sugary, argillaceous; sandstone, light grey, dolomitic; dark brown and grey shale partings; grey dolomite shows fine laminations; trace grey, crystalline dolomite with vugs

Depth	Lithology
Feet	
2,870-2,880	Dolomite and sandstone, as above; some friable, porous sandstone with dark brown bituminous shale partings; thin, green, pyritic shale partings; a little buff, coarsely crystalline dolomite with vugs
	Grosmont Member
	(Top as determined from radioactivity log, 2,875 feet)
2,880-2,890	Dolomite, grey, medium to coarsely crystalline; vuggy porosity
2,884-2,892	(Core No. 47, 3'7") Dolomite, grey, finely crystalline; small scattered vugs, some after fossils; trace pyrite
2,890-2,900	Dolomite, grey and brown, finely to medium crystalline; vuggy porosity
2,900-2,910	Dolomite, grey to grey-buff, finely crystalline; interbedded sandstone, light grey, dolomitic, fine-grained; light green, pyritic shale partings
2,910-2,920	Dolomite, grey to grey-buff, finely to coarsely crystalline; vuggy porosity
2,920-2,940	Dolomite, light grey to light grey-buff, coarsely crystalline; vuggy porosity in part filled with rhombic dolomite
2,937-2,949	(Core No. 48, 2'11") Dolomite, grey, finely to coarsely crystalline; scattered vugs lined with dolomite crystals; lower part grades from dense to granular dolomite with intergranular porosity
2,949-2,959	(Core No. 49, 2'11") Dolomite, grey, finely to coarsely crystalline; and coarsely crystalline interbedded; coarsely crystalline beds have good vuggy and intercrystalline porosity
2,950-2,980	Dolomite, as above; with good vuggy porosity
2,980-3,000	Dolomite, as above but less porosity; a little silty, coarsely sugary dolomite and light green shale
3,000-3,010	Dolomite, light grey, finely to medium crystalline; scattered pin-point porosity and vugs

Depth	Lithology
Feet	
3,010-3,020	Dolomite, light grey to light grey-buff, very finely crystalline
3,020-3,040	Dolomite, grey, coarsely crystalline; scattered vugs; thin, green, shale partings or stylolites suggested
3,040-3,080	Dolomite, as above; crystal-lined cavities
3,080-3,090	Dolomite, in part as above; in part, grey, finely to medium crystalline, slightly argillaceous; scattered pyrite; scattered vugs
3,090-3,110	Dolomite, light grey to light buff, finely crystalline, tight
3,110-3,120	Dolomite, buff to light brown, medium to coarsely crystalline; a few small vugs and crystal-lined cavities
3,120-3,130	Dolomite, grey, medium to coarsely crystalline; pin-point porosity; some bright green, silty, pyritic shale
3,130-3,140	Dolomite, as above; a little bright green shale and argillaceous, fine-grained sandstone; in part, sandstone encloses fragments of coarsely crystalline dolomite
3,140-3,160	Dolomite, light grey and buff, coarsely crystalline; scattered vuggy porosity; some vugs lined with calcite rhombs and crystals
3,160-3,180	Dolomite, light grey and yellowish brown, mottled; finely to medium crystalline; scattered vugs, some filled with calcite
3,180-3,190	Dolomite, dark grey, finely crystalline, with stringers of buff, sugary, silty dolomite carrying pyrite
3,187-3,193	(Core No. 50, 2'9") Dolomite, brownish grey to grey, finely crystalline; scattered vugs
3,193-3,205	(Core No. 51, 2'6") Dolomite, grey, finely crystalline; scattered pyrite; scattered vugs; some filled with coarsely saccharoidal dolomite
3,190-3,200	Dolomite, light yellowish brown and grey, finely to medium crystalline

Depth	Lithology
Feet	
3,200-3,210	Dolomite, light buff, and light grey, finely sugary, slightly argillaceous
3,210-3,220	Dolomite, grey and buff, finely crystalline; scattered pyrite in zones
3,220-3,230	Dolomite, grey to dark grey, finely to medium crystalline, slightly argillaceous; thin, grey, pyritic shale laminae - possibly occurring as stylolites
3,230-3,280	Dolomite, light brown, finely to medium crystalline, slightly argillaceous; scattered vugs filled with calcite; stromatoporoid at 3,240 feet
3,280-3,320	Dolomite, as above; some buff, sugary, fine-grained, very finely silty dolomite with pin-point porosity
3,320-3,360	Dolomite, light brown, finely to medium crystalline, and dark brown argillaceous dolomite with small carbonaceous specks; thin, brownish black shale partings; pin-point to small vugs; scattered crinoids; colour in part may be due to oil-stain
3,360-3,370	Dolomite, as above; some light green, argillaceous, dolomitic siltstone; abundant calcite
3,370-3,410	Dolomite, as above; carbonaceous specks; pin-point and small, vuggy porosity; scattered crinoids; stromatoporoid or coral centres at 3,370 feet
3,410-3,430	Dolomite, buff, finely crystalline, in part sugary; fair intercrystalline porosity
	Ireton Member
3,430-3,460	Siltstone, grey to greenish grey, dolomitic, pyritic

In nearly all occurrences in the wells studied the Grosmont member is seen to consist of dolomitized reef rock with coarse vuggy porosity. In some wells where it has not been completely dolomitized it consists of fine-grained clean limestones probably of organic origin and zones of coarse-textured fossiliferous limestone with abundant stromatoporoids. Variations in the thickness suggest that the Grosmont may be at least in part biohermal in character. The base of

the Grosmont member occurs at stratigraphically different horizons at different places; thus, in the Great Plains Hondo 10-1 well (Figure 3) and in the Barnsdall West Wabiskaw No. 1 well (Figure 4) accumulation of the Grosmont member seems to have begun shortly after the deposition of the top Duvernay shale; in other areas, such as at the Imperial Grosmont and Stanolind Rochester wells, commencement of Grosmont deposition seems to have occurred later, and shows some evidence of having spread out laterally. The Grosmont varies greatly in thickness from about 110 feet, where it underlies the Hondo at the Barnsdall West Wabiskaw well, to 555 feet in the Imperial Grosmont well. To the northeast of the main reef area a thin section of coarsely crystalline Grosmont dolomite is overlain by a member consisting largely of fine-grained, calcite mudstone, pelletoid and algal limestones, dolomitized limestone, and sugary dolomites with thin silt bands. This member is illustrated by the Barnsdall Honolulu Seaboard Pelican Lake No. 1 well (Figure 4); it may be included with the Grosmont member or may be more closely allied to the Hondo anhydrite member.

The top of the Grosmont member is marked by an abrupt change from coarsely crystalline vuggy dolomite to fine-grained silty and sandy dolomites and dolomitic siltstones or sandstones; pyrite is commonly found associated with the vugs at the top. In wells in which the Grosmont is thin and is overlain by the Hondo anhydrite member, a fine-grained sandstone or siltstone occurs at the contact.

Hondo Member

The term Hondo member is applied here to a succession of evaporitic beds consisting largely of anhydrite and evaporitic types of limestone and dolomite that were deposited over a restricted area. The general outlines of this area are illustrated in Figure 1C, although too few wells have been drilled to delineate the basin with any degree of accuracy. The member is named from the village of Hondo about 1 mile south of the Davies Decalta Hondo No. 2 well, the first well to penetrate this member; the type section is described from the Barnsdall West Wabiskaw No. 1 well[1], in which the anhydritic section is well developed and

[1]The term Wabiskaw could not be used as it has already been pre-empted for a Cretaceous formation, but the Wabiskaw well is used for describing the section as it is nearer the centre of the anhydrite basin and the samples are complete and in better condition than those for the Hondo well.

is presumably near the central part of the anhydrite basin. Variation of the anhydrite to evaporitic dolomites and limestones towards the edge of the basin in the upper part of this member is illustrated by the Sunbeam No. 1 well (See Figure 3). The following description of the type section in the Barnsdall West

Wabiskaw No. 1 well[1], as logged by the writer, follows, and the electric log characteristics of this section are shown in Figure 4.

[1]The Barnsdall West Wabiskaw well, drilled in 1949 and 1950, is located in l.s. 11, sec. 17, tp. 78, rge. 2, W.5th mer., and the elevation of the kelly bushing is recorded as 2,059 feet. The interval logged as the Hondo member lies between depths of 2,900 and 3,218 feet below the kelly bushing, giving a thickness of 318 feet of strata. The drill cuttings from which this section was logged are in the collections of the Geological Survey of Canada.

Depth	Lithology
Feet	
	Hondo Member (Top at 2,900 feet)
2,900-2,910	Anhydrite, grey to buff, finely crystalline; a little light buff, pyritic, fine-grained dolomite
2,910-2,920	Siltstone, shale, and anhydrite: siltstone, light green, dolomitic, argillaceous, micaceous; interlaminated shale, green, micaceous, fissile; anhydrite as above
2,920-2,930	Anhydrite, buff to light grey; light buff, finely sugary, argillaceous dolomite
2,930-2,950	Anhydrite as above; some interlaminated siltstone and green shale
2,950-2,960	Anhydrite; some interbedded light buff, very fine, sugary dolomite
2,960-3,000	Anhydrite, with shaly and dolomitic varieties
3,000-3,010	Anhydrite as above; dolomite, light buff, very fine grained, anhydritic, argillaceous
3,010-3,020	Anhydrite, light grey; thin, apple-green, fissile, finely micaceous shale partings
3,020-3,070	Anhydrite, light buff; stringers of light buff, very fine-grained dolomite, some with crystals of clear anhydrite
3,070-3,080	Anhydrite, light grey, crystalline; some light grey, argillaceous, pyritic, anhydritic dolomite; some thin, green, shale laminae
3,080-3,090	Dolomite, buff to light brown, finely to medium crystalline; in part anhydritic; in part with scattered pin-point porosity; scattered carbonaceous streaks

Depth	Lithology
Feet	
3,090-3,110	Dolomite, grey-buff, sugary, anhydritic; interbedded light grey anhydrite; thin, brown, shale laminae
3,110-3,120	Dolomite, light buff, very fine grained, with irregular, thin, dark brown, shale laminae, and small scattered pores; some inclusions of white anhydrite; shale, light green, silty, dolomitic, varying to shaly dolomitic siltstone
3,120-3,130	Dolomite, light brown, in part finely crystalline, lustrous; a little, white, fine-grained, quartzose sandstone
3,130-3,150	Dolomite, light brown, finely crystalline; in part tending to be sugary, with scattered, fine intercrystalline porosity; cavity fillings of white anhydrite
3,150-3,160	Anhydrite and dolomite: anhydrite, light grey to grey-buff; dolomite, light brown, finely crystalline to sugary, as above
3,160-3,190	Anhydrite, light grey; thin partings of buff dolomite
3,190-3,200	Dolomite and anhydrite: dolomite, light buff, sugary; in part tending to be finely crystalline; fine intercrystalline porosity; light grey anhydrite
3,200-3,210	Dolomite and anhydrite, as above; siltstone, light grey, coarse-grained, dolomitic, pyritic; thin greenish grey shale laminae
3,210-3,220	Siltstone and dolomite: siltstone, argillaceous, dolomitic, light apple-green, with finely disseminated pyrite; varies to light green shale
	Grosmont Member (Top at 3,215 feet)
3,215-3,220	Dolomite, light grey, medium to coarsely crystalline (reef type); scattered pyrite; a few small vugs; a little intermixed light green shale
3,220-3,230	Dolomite, brown, finely to medium crystalline; with stromatoporoids; slight porosity, with pores in part filled with gypsum; scattered brown specks and thin brown shaly laminae

The areal distribution of the Hondo suggests that it was deposited in a basin enclosed or cut off from the open sea by Woodbend reef complexes. Whether it was deposited contemporaneously with the Grosmont member or after completion of Grosmont reef growth is uncertain; it is probably equivalent to some of the off-reef shales included with the Ireton member of the Woodbend. That a period of non-deposition occurred at the close of deposition of the Hondo is suggested by the Sunbeam No. 1 well, in which slump breccias, shales, and siltstones occur at the top of the Hondo member.

Delimitation and Thickness

The basal contact of the Woodbend has been described in some detail in connection with the description of the Beaverhill formation. The upper contact of the Woodbend north of the Edmonton area is not everywhere easily determined but is complicated by changes in facies in both the Woodbend and Winterburn formations. The contact in the different parts of the north-central Plains is illustrated in Figures 3 and 4. The horizon chosen is believed to be approximately the same horizon as that defined in the British American Prycz well of the Leduc area as the contact between the Winterburn and Woodbend formations. In the Clyde and other reef areas and to the east and northeast, the contact is sharp and seems to represent an hiatus in deposition. To the west the contact is not sharp; limestones and silty and shaly beds in the Winterburn are similar to those of the Woodbend. Possibly some of these beds should be included with the Woodbend formation. The Woodbend formation varies in thickness in the north-central Plains from about 1,100 to 1,200 feet.

WINTERBURN FORMATION

In general terms, the Winterburn formation is a variable rock unit, consisting of interbedded carbonate rocks, most of them of organic origin that develop locally into reefs, and mud-silt-sand clastic materials in varying proportions. This interbedded series varies both vertically and laterally, suggesting a complicated interfingering of facies that requires careful study for detailed correlation and for indications of variations in the environment of deposition and in the configuration of the basin. Periods of non-deposition are indicated at several horizons, but whether they are local or widespread or of short or long duration could not be determined in a preliminary study of this kind. Characteristics such as the abundance of clastic material, the interfingering of deposits, and the occurrence of breccias and leached zones suggest a shallow-water environment.

The Winterburn formation, as defined in the Edmonton area (2, pp. 1,813-1,816) is subdivided into three members, which, in ascending order, are the Nisku, Calmar, and Graminia. These three members are distinguishable in the north-central Plains area, but are not as clearly defined as in the type area and show certain variations in character from that area. Contacts between them are commonly transitional in this region, and the members may only approximate the defined units of the Edmonton

area. To the west, in the Lesser Slave Lake area, the three members cannot be differentiated with certainty. A description of the Winterburn formation is given in the log of Imperial Dapp No. 1 well in the Appendix to this report and facies changes in the Winterburn are illustrated by the wells of Figures 3 and 4.

Nisku Member

The Nisku member of the Winterburn formation consists of fossiliferous carbonates, largely dolomitized, and interbedded siltstones and fine-grained sandstones. The different facies are illustrated in Figure 3 in the Stanolind Rochester, Imperial Clyde, and Imperial Dapp wells. In the Clyde area and eastward to the Smoky Lake area the Nisku consists largely of coarsely crystalline dolomite with vuggy porosity suggesting reef development; to the north and northeast, as illustrated by the Rochester well, siltstones and fine-grained sandstones are more abundant in the Nisku, and there is evidence of numerous hiatuses in deposition; westward from the area of the Clyde well, as illustrated by the Imperial Dapp well, the upper part of the Nisku is composed largely of sandy dolomite and sandstone, with some fossiliferous reef-type limestone and dolomite at the top; the lower part consists of interbedded limestone, argillaceous siltstone, and shales.

In that part of the north-central Plains where the Nisku can be distinguished with certainty, it is divisible into three units. The basal unit, a finely crystalline dolomite, is represented over most of the eastern part of the north-central Plains and is probably equivalent to interbedded limestones, shales, and siltstones west of the area of maximum reef growth. This unit seems to vary greatly in thickness, and in places may be missing. A middle, coarsely crystalline dolomite unit, probably reefal, is present in the southern part of the area, from the Imperial Clyde well eastward; to the north and to the west this unit interfingers with, and changes to, fine-grained, sandy dolomites and sandstones. A third thin dolomite and limestone unit at the top of the Nisku also varies to siltstones and fine-grained sandstones, and cannot be distinguished everywhere from the underlying unit. The Imperial Grosmont No. 1 well in Figure 3 illustrates all three units.

The Nisku member ranges from about 170 to 260 feet in thickness. In general it thickens gradually from east and northeast to west, but in places the changes are more abrupt. Thus, in the Imperial Clyde well the Nisku member is 190 feet thick and in the Seaboard British American Pacific Fortune Nestow No. 2 well, about 6 miles to the northeast, it is 255 feet thick.

Calmar and Graminia Members

The Calmar and Graminia members of the Winterburn are illustrated in Figures 3 and 4. They consist of interbedded, light green, argillaceous siltstones, fine-grained, dolomitic sandstones and sandy dolomites, light to dark green shales, and dolomite beds of varying thicknesses. The lower, siltstone and shaly siltstone unit, characterized by low self-potential and resistivity curves, probably corresponds to the Calmar. In north-central

Alberta it is gradational downward into the Nisku through a zone of interbedded dolomites, siltstones, and shales. The Graminia is thicker than in the Edmonton area, and contains some thick dolomite sections interbedded with siltstone beds. Clean, fine-grained, quartzose sandstones characterize the upper part of the Graminia in much of this area. They may represent a higher horizon than the top sands and silts of the Graminia of the Edmonton area, and the top of the Winterburn is probably gradational to the Wabamun.

Delimitation and Thickness

The Winterburn formation includes the beds of variable lithology between the Woodbend reef and off-reef deposits and the Wabamun formation. The lower contact has been described in connection with the Woodbend formation. The upper contact, marking the cessation of a period of sand influx into the basin, although distinct in any restricted area probably varies considerably over a wider area. For the present, in the area under discussion, the top occurrence of fine sand, characterized by low self potential and resistivity curves of electric logs, is a useful horizon to use as the top of the Winterburn formation, although probably not a time horizon over a broad area. The thickness of the Winterburn varies from about 350 to 450 feet over most of the area.

WABAMUN FORMATION

The total thickness of the Wabamun formation is represented only in the Socony Utikuma and Imperial Grouard wells in Figure 4. All other wells illustrated are from the region that was subjected to post-Devonian, pre-Cretaceous weathering and erosion. The log of the Socony Utikuma well, in the Appendix to this report, illustrates the Wabamun formation in this area. An upper unit about 60 feet thick consists of fine-grained, fossiliferous, glauconitic limestone and sandy and silty beds. The remainder consists largely of fine-grained, chalky, porous limestones some with fine fossil fragments; much of the limestone is of the pelletoid type found commonly in the Beaverhill formation and of which much is algal in origin; some appears to be clastic and some may contain faecal pellets. True oolite zones are present but not common; small stromatoporoid zones may occur in some areas. In most of the wells of north-central Alberta the limestones have been partly or completely altered to finely crystalline and saccharoidal dolomites, which in places retain the original pelletoid structures. The type section of the Wabamun from the Anglo Canadian Wabamun Lake No. 1 well (2, p. 1,810) represents such a dolomite and dolomitic limestone section. Thick sections of brecciated and weathered dolomite gradational to the top of the Wabamun are probably slump breccias formed during the post-Devonian erosion interval.

Delimitation and Thickness

The lower contact of the Wabamun formation, as discussed under the Winterburn formation, is placed as in the type area, at

the highest occurrence of fine-grained sandstone or sandy dolomite. This seems to be the top of a transitional zone from the Winterburn to the Wabamun and may not represent a constant horizon over a wide area; thus, the upper siltstones and sandstones in the north-central Plains may occur at a higher horizon than the uppermost occurrences of silt and sand in the Edmonton area. In many wells a zone of weathered Devonian rock and breccias of limestones and dolomites show the effect of exposure of the Upper Devonian beds during post-Devonian time. Pre-Cretaceous erosion has truncated progressively older Devonian rocks eastward from the Lesser Slave Lake area to the Alberta-Saskatchewan boundary. The surface is very irregular, and is shown roughly on the contour map, Figure 1A. In the Lesser Slave Lake area the Wabamun is overlain by the black shales of the Exshaw formation. Where there is a complete section of the Wabamun, as in the Lesser Slave Lake area, it is about 800 feet thick.

APPENDIX

LOG OF ELK POINT GROUP IN IMPERIAL GROSMONT NO. 1 WELL

Location: l.s. 13, sec. 17, tp. 67, rge. 23, W.4th mer.

Elevation: 2,066 feet Total depth: 6,406 feet

Spudded: October 27, 1949 Completed: January 24, 1950

Core and samples examined by Helen R. Belyea, 1951

Depth	Lithology
Feet	
	Overlying beds, Beaverhill formation
	Elk Point Group
4,680–4,690	Limestone, dense, slightly argillaceous; some greenish grey, dolomitic shale; a little grey anhydrite
4,690–4,700	Anhydrite, grey and buff-grey, in part granular, dolomitic; greenish grey shale
4,700–4,710	Siltstone, greenish grey, dolomitic, argillaceous; a little anhydrite; a little brown, fine-grained limestone and limestone sand, with small rounded grains of brown limestone in shaly, anhydritic matrix
4,710–4,720	Shale, and siltstone, mottled red and green; some siltstone, in part with limestone grains as above; anhydrite; abundant charaphyta
4,720–4,730	Dolomite, buff, dense, with spots of anhydrite; limestone, buff to brown, cryptocrystalline (cavings?); some light green and red, argillaceous, anhydritic siltstone
4,730–4,750	(Poor samples) Limestone, cream, dense, argillaceous
4,750–5,035	Salt reported by Imperial Oil Limited and corroborated by radioactivity log
5,020–5,030	Salt; dolomite, light brown, fine-grained, with salt casts; some anhydrite
5,030–5,040	Dolomite, cream, finely sugary, argillaceous, spotted with white anhydrite; light brown anhydritic shale and anhydrite

5,040-5,050 Dolomite, as above; mudstone, light greenish grey; charaphyta

5,050-5,060 (Poor sample) Dolomite, buff, anhydritic and anhydritic, dolomitic shale

5,060-5,110 (Poor samples) Shale, greenish grey; dolomite, as above; anhydrite stringers

5,110-5,130 Dolomite, light brown, argillaceous, dense; brown shale partings and laminae; stringers of anhydrite

5,130-5,140 Dolomite and shale: dolomite, brown, argillaceous dense, varying to dolomitic shale; some drab dolomitic shale; dark brown shale partings

5,140-5,150 Shale, greenish grey to brownish grey

5,150-5,160 Shale as above; dolomite, buff, argillaceous, dense

5,160-5,180 (Poor sample) Buff, anhydritic dolomite and shale

5,180-5,190 (Poor samples) Limestone, brown, cryptocrystalline; some dolomite, buff, sugary, anhydritic; white and light grey anhydrite

5,190-5,200 Limestone, brown, cryptocrystalline; light grey anhydrite; buff, finely sugary dolomite

5,200-5,210 Limestone, brown, cryptocrystalline; dark brown, argillaceous dolomitic limestone, with thin dark brown shale laminae

5,210-5,240 Limestone, stromatoporoid-coral; brown, dolomitic, argillaceous limestone, with brown shale laminae; brachiopods

5,240-5,260 (Poor sample) Shale, greenish grey and green

5,260-5,270 (Poor sample) Dolomite, argillaceous, brown, smooth textured, dense

5,270-5,290 Dolomite, argillaceous, as above; shale, green, grey, brownish grey; white clay residue

5,290-5,310 Argillaceous dolomite and dolomitic shale, brown, greenish grey, pinkish grey, red, dense

5,310-5,320 Shale, bright green and buff-grey; abundant charaphyta - Sarcella(?) and Trochiliscus(?)

5,320-5,370 Dolomite, pinkish buff, cryptocrystalline, finely silty; red shale stringers

5,370-5,390	Dolomite as above; shaly dolomite, light greenish grey and creamy grey, dense; in part with large sand grains; red argillaceous streaks and scattered small pores
5,390-5,420	Dolomite, mottled pinkish grey and pinkish red, argillaceous, silty; in part with large quartz grains
5,420-5,430	Dolomite, as above; some coarse sandy dolomite, in part with large quartz and dolomite grains
5,430-5,470	Dolomite, as above; shale, dark red, silty, dolomitic
5,470-5,480	Shale, red, silty, dolomitic; spots of anhydrite
5,480-5,490	Shale, dark red, silty, dolomitic; siltstone, red and green, dolomitic; stringers and anhydrite
5,490-5,500	Anhydrite; shale, dolomitic, light greenish grey and red
5,500-5,520	Shale and siltstone, dark red and greenish grey; small black specks; white anhydrite
5,520-5,530	Anhydrite, white; stringers of brown, finely crystalline limestone; red siltstone and shale, as above
5,530-5,540	Dolomite, buff, sugary; granular structure and intergranular porosity
5,526-5,753	Salt reported by Imperial Oil Limited; corroborated by radioactivity log
5,536-5,551	(Core No. 56, 13'7") Salt
5,750-5,760	(Poor sample) Shale, green
5,760-5,770	(Poor sample) Shale, green, red; dolomite, grey, shaly; anhydrite stringers
5,770-5,800	(Poor samples) Shaly limestone, grey, dense; white anhydrite; shale, brick-red, silty
5,800-5,810	(Poor sample) Probably shale, limestone, and anhydrite, as above
5,810-5,830	(Poor sample) Dolomite, light greenish grey, shaly; shale, light green and red, silty; limestone, grey-buff, cryptocrystalline
5,820-5,830	Siltstone and fine-grained sandstone, light grey to brick red, argillaceous, dolomitic, anhydritic; small green and red grains; green and red shale

5,830-5,840	Anhydrite and gypsum; red shale and siltstone as above; greyish brown, fine-grained limestone
5,840-5,920	(Poor samples) Shale, brick-red, and greenish grey, anhydritic; some anhydrite and gypsum
5,920-5,950	(Poor samples) Shale, as above; anhydrite; some fine-grained, light grey sandstone
5,930-5,950	Shale, brown, green; anhydritic, brick-red, dolomitic, blocky shale
5,950-6,050	Salt reported by Imperial Oil Limited; corroborated by radioactivity log
5,957-5,972	(Core No. 57, 10') Salt, crystalline, pink along fractures
6,050-6,060	Shale, brick-red, anhydritic, silty; spots of gypsum; varies to shaly siltstone and fine-grained sandstone.
6,060-6,070	(Poor samples) Dolomite, buff, cryptocrystalline, argillaceous, in part sandy; anhydrite, anhydritic shale
6,070-6,090	Siltstone and fine-grained sandstone, brick-red, argillaceous, spotted light greenish grey; a little anhydrite and gypsum
6,909-6,100	Sandstone, as above; a little light red, quartzose, fine-grained sandstone
6,100-6,110	Sandstone, as above, in part fine- to coarse-grained poorly sorted
6,110-6,120	Shale, dark red, micaceous, fissile
6,120-6,130	Sandstone, light grey, quartzose, glauconitic
6,130-6,170	(Poor samples) Sandstone, grey and light red, fine-grained, quartzose; in part brick-red, argillaceous
6,170-6,180	Sandstone, as above; some dark red shale
6,175-6,189	(Core No. 58, 12'11") 0 to 7'6" Shale, dark brick-red, sandy; large rounded sand grains in fine, dark red, argillaceous matrix, in part micaceous; scattered green spots; varies to coarse shaly sandstone; grains chiefly quartz and some red, green, and dark grains; poorly sorted, small to large pebbles and cobbles up to 9 inches in diameter

Cambrian

7'6" to 7'10" Sandstones, pinkish red, quartzose, fine- to medium-grained, glauconitic; abundant fragments; 1 inch green glauconitic, argillaceous, fine-grained sandstone

7'10" to 10' Shale, maroon and greenish grey, mottled; inclusions of green, glauconitic, fine-grained, non-calcareous quartz sandstone

10' to 12'11" Sandstone, dark red, fine- to medium-grained, quartzose, argillaceous matrix; very glauconitic fragments enclosed by non-glauconitic shaly sandstone; maroon and green shale partings

LOG OF BEAVERHILL FORMATION IN BEAR BILTMORE NO. 1 WELL

Location: l.s. 7, sec. 11, tp. 87, rge. 17, W.4th mer.

Elevation: 1,445 feet Total depth: 2,863 feet

Spudded: June 21, 1949 Completed: September 29, 1949

Cores examined by Helen R. Belyea and R. deWit, 1951

Depth	Lithology
Feet	
	Overlying beds, Cooking Lake member of Woodbend formation
	Beaverhill Formation
987-944	(Core No. 52) Limestone, grey, increasingly argillaceous to finely silty downwards; lower part greenish grey; scattered brachiopods - athyris and spiriferoid types; scattered pyrite; in part with intensive, fine flowage(?) structure
994-1,022	(Core No. 53, 10') Shale, greenish grey to buff-grey, calcareous, silty; scattered spiriferoid brachiopods
1,002-1,010	(Core No. 54, 8') Shale, as above, fissile; abundant lingulas in zones; scattered crinoids and brachiopods

1,010-1,020 (Core No. 55, 10') Shale and limestone, interbedded in bands 1 foot to 6 feet wide; shale, greenish grey as above; limestone, grey-buff, cryptocrystalline, medium-grained, fossiliferous-fragmental

1,020-1,032 (Core No. 56, 10')

1,020'-1,022½' Shale and limestone, interbedded as above

1,022½'-1,032' Limestone, buff, dense, fossiliferous-fragmental, medium-grained; scattered brachiopods

1,032-1,044 (Core No. 57, 10') Limestone, argillaceous, buff-grey, dense, fine-grained, finely silty; shale, greenish grey, calcareous, silty, firm; brachiopods and scattered crinoids; pyrite

1,044-1,054 (Core No. 58, 10') Limestone and shale, as above; scattered crinoid fragments; lingulas and small brachiopod

1,054-1,064 (Core No. 59, 10')

1,054'-1,062' Shaly limestone, as above, in bands 4 to 12 inches thick; interbedded greenish grey shale with flowage(?) structure; abundant crinoids in zones; scattered brachiopod fragments; Tentaculites(?) in shale

1,062'-1,064' Limestone, shaly, grey to greenish grey, fossiliferous-fragmental, fine- to coarse-grained; abundant crinoid and brachiopod fragments; greenish grey and green shale showing flowage(?) structure

1,064-1,074 (Core No. 60, 10')

1,064'-1,065½' Limestone, as above

1,065½'-1,074' Limestone, buff, fine- to medium-grained, fossiliferous-fragmental; crinoids and small fossil fragments; irregular, grey, shaly stringers

1,074-1,084 (Core No. 61, 10') Limestone, with shaly stringers, as above; crinoids; scattered large brachiopods

1,084-1,094 (Core No. 62, 10')

1,084'-1,086' Limestone, as above

1,086'-1,092' Limestone, buff-grey, silty, argillaceous; greenish grey shale showing flowage(?) structure; comminuted fossil fragments in thin bands; abundant scattered crinoids

1,092'-1,094' Shale, greenish grey to grey, calcareous, finely silty

1,094-1,104 (Core No. 63, 10')
1,094'-1,096' Shale, as above

1,096'-1,104' Limestone, buff-grey, argillaceous, finely silty; zones 2 to 3 inches thick of fossiliferous-fragmental limestone; abundant crinoid fragments; brachiopod; irregularly interbedded, greenish grey to grey, calcareous shale

1,104-1,114 (Core No. 64) Missing

1,114-1,124 (Core No. 65, 10') Shale, greenish grey to grey, finely silty, calcareous, in part laminated; scattered brachiopods

1,124-1,134 (Core No. 66, 10') Limestone, buff-grey, silty, argillaceous, fine-grained; abundant crinoids; scattered brachiopods; thin, irregular, stringers of greenish grey shale

1,134-1,144 (Core No. 67, 10')
1,134'-1,142' Limestone, as above; scattered ostracods

1,142'-1,144' Limestone, buff, dense, fine- to medium-grained; scattered crinoids; flowage(?) structure

1,144-1,154 (Core No. 68, 10')
1,144'-1,145' Limestone, as above

1,145'-1,150' Limestone, buff-grey, silty, argillaceous, dense; irregularly interbedded with greenish grey to grey, calcareous shale; abundant crinoid fragments

1,150'-1,154' Shale, calcareous, silty, grey to greenish grey

1,154-1,164 (Core No. 69, 10') Shale and shaly limestone, as above, with fine laminations and fine flowage(?) structure

1,164-1,174 (Core No. 70, 10') Limestone and shale, as above; scattered crinoids; a few brachiopods

1,174-1,184 (Core No. 71, 10')
1,174'-1,182' Limestone, interbedded, grey-buff, fine-grained, and buff, fine- to medium-grained; fossiliferous-fragmental from 1,179 to 1,181 feet; crinoids; brachiopods throughout

1,182'-1,184' Shale, greenish grey to grey, finely silty, calcareous, homogeneous, fissile

1,184-1,194 (Core No. 72, 10') Shale, as above; interbedded limestone, buff-grey, dense; scattered crinoid fragments; brachiopods; increasingly argillaceous and silty downwards

1,194-1,204 (Core No. 73, 10') Calcareous shale, as above, with a few finely fossiliferous grey limestone bands a few inches thick; pyritic; from 1,201 to 1,202 feet, limestone, light grey to buff, dense, fossiliferous-fragmental, finely crinoidal; pyrite stain

1,204-1,214 (Core No. 74, 10') Limestone and shale: limestone, buff-grey, dense, in irregular beds about 1½ inches thick; shale, greenish grey, finely silty, in bands $\frac{1}{8}$ to $\frac{1}{2}$ inch thick; bedding disturbed by flowage(?); a few scattered crinoids and brachiopods

1,214-1,224 (Core No. 75, 10') Limestone, as above

1,224-1,234 (Core No. 76, 10')
1,224'-1,227' Limestone, as above

1,227'-1,234' Limestone, buff, cryptocrystalline, fossiliferous-fragmental; scattered pellets; a few scattered, large brachiopods; some flowage(?) structure

1,234-1,244 (Core No. 77, 10') Limestone, buff-grey, dense, argillaceous, intensely kneaded with grey, finely silty shale

1,244-1,254 (Core No. 78, 10') Limestone, buff, dense, in part pelletoid and fossiliferous-fragmental

1,254-1,264 (Core No. 79, 10') Limestone, as above, interbedded with dense limestone, buff, with grey streaks probably from pyrite stain; grey-green silty shale laminae; from 1,261 to 1,264 feet, inter-kneaded with greenish grey argillaceous limestone

1,264-1,274 (Core No. 80, 10') Shale, greenish grey to grey, silty, calcareous, with a few limestone bands; kneaded structure; 1,272-1,274 feet, limestone, grey, crystalline, fossiliferous-fragmental, and grey-buff, fine-grained; abundant brachiopods and crinoid fragments

1,274-1,284 (Core No. 81, 10')
1,274'-1,275' Limestone, fossiliferous-fragmental, largely crinoidal; grey, finely to coarsely crystalline; irregular silty stringers; abundant brachiopods

1,275'-1,284' Limestone, buff, coarse-grained; large and small stromatoporoids, thamnopora-type corals, Amphipora(?), and scattered brachiopods; matrix, brown, slightly dolomitic, argillaceous, silty, oil-stained(?)

1,284-1,294 (Core No. 82, 10')

1,284'-1,284'9" Limestone, as above

1,284'9"-1,292' Limestone, buff, crypto-crystalline, with fossil fragments; small stromatoporoids; abundant brachiopods, crinoids; irregular argillaceous partings; stylolites

1,292'-1,294' Limestone, grey-buff to buff-grey, fine-grained; greenish grey to dark grey shale partings; scattered crinoid fragments

1,294-1,304 (Core No. 83, 10') Limestone, light buff, cryptocrystalline to fine-grained, in part fossiliferous-fragmental; scattered, small stromatoporoids; abundant brachiopods; small gastropods; crinoids; thin, irregular, shaly partings; some flowage(?) structure

1,304-1,314 (Core No. 84, 10') Limestone, finely silty, argillaceous, fine-grained; thin, irregular, greenish grey to grey partings; abundant brachiopods; crinoid stems

1,314-1,324 (Core No. 85, 10')

1,314'-1,318' Limestone, as above

1,318'-1,318½' Limestone, grey-buff, fossiliferous-fragmental, interkneaded with buff-grey, dense, dolomitic, argillaceous limestone; pyrite along contacts; brachiopods

1,318½'-1,324' Shale, greenish grey to grey, calcareous, finely silty

1,324-1,334 (Core No. 86, 10')

1,324'-1,327½' Shale, as above

1,327½'-1,331½' Limestone, buff, crypto-crystalline, fine- to coarse-grained, fossiliferous-fragmental; brachiopods; scattered crinoids; irregular shaly partings and flowage(?) structure; at 1,328 feet, sharp break in deposition; irregularly kneaded, grey, dense, silty, argillaceous limestone from 1,330 to 1,331½ feet

1,331½'-1,334' Shale, greenish grey, calcareous, silty; few scattered brachiopods

1,334-1,344 (Core No. 87, 10') Shale, as above

1,344-1,354 (Core No. 88, 10')
1,344'-1,346' Shale, as above

1,346'-1,351½' Limestone, shaly, grey, finely silty, dense; flowage(?) structure

1,351½'-1,354' Limestone, buff-grey, clastic, fine- to coarse-grained, fossiliferous-fragmental; abundant large pellets outlined by pyrite; bryozoa, crinoids, and brachiopods

1,354-1,364 (Core No. 89, 10')
1,354'-1,358' Shale, silty, calcareous, grey to green-grey, unfossiliferous

1,358'-1,364' Limestone, light grey, dense; in part with kneaded, flowage(?) structure; bands a few inches wide of same limestone, coarsely clastic, with rounded grains and pellets many of which are stained by pyrite; scattered brachiopods; bryozoa

1,364-1,374 (Core No. 90, 10') Limestone, argillaceous, grey-buff, with streaks and fine laminae of grey, finely silty, calcareous shale

1,374-1,384 (Core No. 91, 10') Shale and shaly limestone, as above

1,384-1,394 (Core No. 92, 10') Shale and shaly limestone, as above

1,394-1,404 (Core No. 93, 10') Shale and shaly limestone, as above

1,404-1,414 (Core No. 94, 10')
1,404'-1,410' Shale and shaly limestone, as above; a few scattered brachiopods

1,410'-1,414' Limestone, buff, dense, fine- to coarse-grained, fossiliferous-fragmental; brachiopods and bryozoa; crinoid fragments; fair flowage(?) structure

1,414-1,424 (Core No. 95, 10') Limestone, as above, slightly more silty and shaly; argillaceous, silty, green-grey limestone from 1,421 to 1,422 feet; numerous, scattered, large brachiopods

1,424-1,434 (Core No. 96, 10') Limestone, as above; numerous, scattered, large brachiopods

1,434-1,444 (Core No. 97, 10') Limestone, buff, fine-grained, not as fossiliferous as above; streaks of light brown, dolomitic, argillaceous limestone

1,444-1,454 (Core No. 98, 10') Limestone, as above; irregular brown, silty shale partings

1,454-1,464 (Core No. 99, 10') 1,454'-1,546' Limestone, buff, cryptocrystalline, coarse-grained, fossiliferous; crinoids and brachiopods

1,464-1,474 (Core No. 100, 10') Limestone, as above; scattered, large brachiopods

1,474-1,484 (Core No. 101, 10')
1,474'-1,481' Limestone, grey-buff to buff-grey, silty, argillaceous; interbedded, calcareous, silty shale; abundant large brachiopods; interbedded shale, greenish grey, silty, calcareous; charaphyta at 1,482 to 1,484 feet

1,484-1,494 (Core No. 102, 10') Limestone, grey to buff-grey, fine-grained, in bands up to 1 inch wide irregularly interbanded with greenish grey to grey silty shale; fossiliferous in part; scattered pyrite; flowage(?) structure

1,494-1,504 (Core No. 103, 10') Limestone and shale, as above

1,504-1,514 (Core No. 104, 10')
1,504'-1,506' Limestone and shale, as above

1,506-1,512½' Limestone, buff-grey, fine-grained, finely silty, shaly; finely scattered pyrite; irregular lenses ½ to 1 inch wide of crinoidal limestone; brachiopod fragments; bryozoa; dark grey pyrite-stained(?) pellets; fair flowage(?) structure; at 1,508 feet, a 4-inch band of finely laminated limestone

1,512½'-1,514' Limestone and shale, interbanded; large, coarsely ribbed brachiopods

1,514-1,524 (Core No. 105, 10') Limestone and shale, as above, becoming more shaly and finely banded downwards; shale has thin brownish to dark greenish markings

1,524-1,534 (Core No. 106, 10') Shale, calcareous, silty, massive; scattered brachiopods; irregular blue-brown iridescent markings

1,534-1,544 (Core No. 107, 10') Shale, as above

1,544-1,554 (Core No. 108, 10') Shale, as above; scattered brachiopods

1,554-1,564 (Core No. 109, 10') Shale, as above; slightly more calcareous; abundant brachiopods

1,564-1,574 (Core No. 110, 10')

1,564'-1,566½' Shale, as above; abundant brachiopods

1,566½'-1,569½' Limestone, grey, fossiliferous; finely silty, argillaceous stringers with abundant brachiopods and crinoids

1,569½'-1,574' Limestone, grey, silty, argillaceous, fine-grained; fair flowage(?) structure with greenish grey limy shale; scattered, large brachiopods; crinoids and pelecypods

1,574-1,584 (Core No. 111, 10')

1,574'-1,578' Limestone and shale, as above; scattered brachiopods

1,578'-1,584' Limestone, buff-grey, dense to fine-grained; thin, irregular, grey shale partings; brachiopods

1,584-1,594 (Core No. 112, 10')

1,584'-1,590' Limestone, as above; scattered zones with abundant brachiopods

1,590'-1,594' Shale, greenish grey; abundant scattered brachiopods and crinoids

1,594-1,604 (Core No. 113, 10')

1,594'-1,595' Shale, as above; numerous scattered brachiopod fragments, mainly atrypas

1,595'-1,604' Limestone, buff-grey, dense, silty, argillaceous; irregular wavy interbeds of grey to greenish grey, limy, finely silty shale; some pyrite staining; many scattered large atrypas

1,604-1,614 (Core No. 114, 10')

1,604'-1,611' Shaly limestone and shale, as above; scattered atrypas

1,611'-1,614' Shale calcareous, finely silty, fissile; scattered, medium-sized atrypas

1,614-1,624 (Core No. 115, 10')

1,614'-1,616' Shale as above

1,616'-1,624' Limestone, buff-grey, dense; irregular, wavy interbeds of grey to greenish grey, finely silty, limy shale; some ½-inch bands of very silty, argillaceous limestone; some grey, crystalline limestone coquina; abundant scattered brachiopods - mainly Atrypa(?) and some Schizophoria(?); scattered pelecypods and lingulas

1,624-1,634 (Core No. 116, 10')
1,624'-1,630' Limestone and shale, as above; kneaded, flowed appearance; a few scattered brachiopods - mainly atrypas

1,630'-1,634' Shale, finely silty, calcareous, fissile and interbedded, limy, massive shale; scattered lingulas

1,634-1,644 (Core No. 117, 10') Shale, as above

1,644-1,647 (Core No. 118, 5') Shale, as above

1,647-1,658 (Core No. 119, 10') Shale, as above

1,658-1,668 (Core No. 120, 10') Shale, grey with brownish tinge, silty, calcareous, massive; abundant scattered lingulas

1,678-1,688 (Core No. 122, 10')
1,678'-1,679' Limestone, dolomitic, dense and finely crystalline, slightly argillaceous

1,679'-1,680' Shale, dark brown, fissile, slightly calcareous

1,680'-1,683' Limestone, brown, cryptocrystalline, fossiliferous-fragmental; abundant brachiopods, crinoids and gastropods; thin, wavy, brown shale laminae; scattered small black carbonaceous specks; scattered pyrite

1,683'-1,684' Dolomite, buff, argillaceous, finely laminated; brown oil stains in some laminae

1,684'-1,688' Limestone, brown, crystalline, coarse-grained, fossiliferous-fragmental; scattered carbonaceous black specks; brachiopods and crinoids; flowage structure with dark brown shale

Elk Point Group?
(Top at 1,688 feet)

1,688-1,698 (Core No. 123, 10') Dolomite and anhydrite, dense, buff to light brown, with dark mottling and laminae; scattered anhydrite crystals; thin gypsum laminae; lenses of brown anhydrite

1,698-1,708 (Core No. 124, 10')
1,688'-1,701' Dolomite and anhydrite, as above

1,701'-1,708' Limestone, buff and light brown; grains round to angular, medium- to coarse-grained, with calcite matrix; finely laminated with dark brown shale; streaks and specks of anhydrite

1,706'-1,708' Dolomite, cream-buff, fine-grained, finely porous(?)

1,705-1,715 (Core No. 125, 10') Anhydrite, dolomitic, brown and brown-grey, and fine-grained anhydritic dolomite

1,718-1,729 (Core No. 126, 10')
1,718'-1,727' Dolomite, grey to light brown, very fine-grained; in part with fine, dark brown laminae

1,727'-1,728' Siltstone, interlaminated with dolomite, grey, in part with a greenish tinge, argillaceous

1,728'-1,729' Dolomite, buff-grey, fine-grained

1,729-1,739 (Core No. 127, 10') Shale, finely silty, grey to greenish grey, dolomitic; in part silty dolomite; scattered charaphyta

1,739-1,749 (Core No. 128, 10') Silty shale, as above, flowage(?) structure; scattered, small anhydrite inclusions

1,749-1,759 (Core No. 129, 10') Shale and dolomite, intermixed, mostly greenish grey to greenish buff

1,759-1,770 (Core No. 130, 10') Anhydrite, silty and dolomitic; siltstone; anhydritic dolomite, greenish grey, in part with red mottling

LOG OF WOODBEND FORMATION IN BARNSDALL HONOLULU SEABOARD PELICAN LAKE NO. 1 WELL

Location: l.s. 1, sec. 27, tp. 79, rge. 22, W.4th mer.

Elevation: 1,908 feet Total depth: 3,200 feet

Spudded: January 26, 1950 Completed: February 26, 1950

Samples examined by A. B. Gray and Helen R. Belyea, 1952

Depth	Lithology
Feet	
	Overlying beds, Nisku member of Winterburn formation
1,635-1,655	Dolomite, grey to buff, finely crystalline; scattered vugs with heavy oil stain

Woodbend Formation

1,655-1,665	Dolomite and siltstone: dolomite, buff, sugary, silty; siltstone, light grey, dolomitic, micaceous, thin-bedded, pyritic; irregularly stained with brown oil
1,665-1,675	Dolomite and siltstone, as above; abundant pyrite; small vugs stained with black oil; some vugs seem smoothed and-worn
1,675-1,685	Dolomite and siltstone; dolomite, light grey, sugary, in part silty, argillaceous, pyritic; siltstone, light grey, dolomitic, with finely disseminated pyrite; a few fossil fragments; brachiopod casts; a few vugs, in part after fossils; rare oil stain
1,685-1,705	Dolomite, buff, finely crystalline, slightly pyritic; a few small vugs with oil stain; a little light grey, dolomitic siltstone
1,705-1,745	Dolomite, light grey, finely crystalline, in part sugary, finely silty, argillaceous, pyritic; small, imperfectly dolomitized fossil fragments including brachiopods; a little oil stain; trace pyrite
1,745-1,755	Dolomite, light grey to buff-grey, finely crystalline, slightly argillaceous, finely silty; a little, small vuggy and pin-point porosity
1,755-1,765	Dolomite, as above; a little siltstone, light grey, dolomitic, pyritic
1,765-1,775	Limestone and siltstone: limestone, light grey, finely crystalline, silty, micaceous, pyritic; a little, small, vuggy porosity; siltstone, light grey, with a little greenish argillaceous material, calcareous, pyritic
1,775-1,805	Limestone and siltstone, as above, thinly interbedded with greenish grey, micaceous shale along partings; grades to light grey, fine-grained, calcareous sandstone with intergranular porosity
1,805-1,815	Limestone, cream to light buff, finely sugary, argillaceous, dolomitic; irregularly mixed with light grey, micaceous, fine-grained sandstone and wavy, thin, brownish grey shale laminae
1,815-1,835	Limestone, as above; sandstone, light grey, quartzose, micaceous, slightly dolomitic; good intergranular porosity

1,835-1,845	Limestone, cream to pale grey, fine-grained, "chalky", slightly argillaceous and silty; interbedded, grey, calcareous siltstone and fine-grained sandstone
1,845-1,855	Dolomite and limestone, cream to light grey, fine-grained, in part argillaceous, silty, pyritic; some siltstone, light grey, argillaceous; brown and grey shale partings
1,855-1,875	Dolomite, light buff to cream, finely to medium crystalline; a little pyrite; some dark pyrite-stained inclusions; a few, thin, fine-grained dolomite stringers (possibly algal); vuggy porosity and fair intercrystalline porosity; a little calcite filling vugs
1,875-1,885	Dolomite, buff, mottled grey, finely crystalline
1,885-1,905	Dolomite, buff, finely crystalline; pin-point and small vuggy porosity; scattered pyrite
1,896-1,898	(Core No. 107, 10") Dolomite, buff, sugary; a little fine, intergranular porosity
1,898-1,901	(Core No. 108, 26", broken) Dolomite, buff, poorly consolidated, granular, slight to good porosity; dolomite, buff, dense, argillaceous, finely banded; vugs in upper foot
1,901-1,905	(Core No. 109, 2'4", broken) Dolomite, grey, granular; vuggy porosity, much of it after fossils suggesting fossiliferous-fragmental rock; some buff, finely sugary dolomite; one piece grey, finely crystalline dolomite has vugs after corals; poorly consolidated at top
1,905-1,925	Dolomite, cream to light grey, finely sugary, pyritic, in part finely banded, finely silty and micaceous; a little sandstone, pale grey, fine-grained, slightly dolomitic, pyritic; fair porosity
1,925-1,935	Dolomite, buff to grey-buff, finely crystalline; a few brownish black shale partings; scattered small vugs
1,935-1,945	Dolomite, buff, finely crystalline; scattered, small vugs
1,945-1,955	Dolomite, light grey to light buff, dense, argillaceous, finely silty; small brown fragments of organic material; small calcite veins
1,955-1,965	Dolomite, buff to grey-buff, finely crystalline; much is sugary; scattered small vugs

1,965-1,975	Dolomite, buff, finely crystalline to sugary, the latter with good intercrystalline porosity; scattered pyrite
1,975-1,985	Dolomite, buff to cream, dense, very slightly calcareous; brown shaly partings
1,985-2,025	Dolomite, buff to light brown, finely crystalline, slightly argillaceous; small dark organic specks; some of the dolomite has intercrystalline porosity and small vugs; slight oil stain; a few dark brown shale laminae
2,025-2,035	Dolomite, brown, finely crystalline, slightly argillaceous; a few bituminous black flecks; rare vugs; trace of pyrite; dark brown shale partings
2,035-2,055	Dolomite, light brownish grey, finely crystalline, finely silty, argillaceous; abundant carbonaceous specks and streaks; scattered small vugs
2,055-2,065	Dolomite, buff-brown, finely to medium crystalline and with small vugs; crinoids; some finely silty, argillaceous dolomite with carbonaceous specks, as above; a little pyrite; calcite veins
2,065-2,105	Dolomite, brown to grey-brown, finely crystalline; trace pyrite; good vuggy porosity; a few small spores at 2,085 feet

Ireton Member

2,105-2,115	Dolomite, as above; some dolomite, pale grey, dense to finely crystalline, finely silty, argillaceous, micaceous, in part slightly pyritic; crinoids; small organic specks
2,115-2,125	Dolomite and shale: dolomite, light grey, dense to finely crystalline, silty, argillaceous, in part slightly pyritic; shale, dolomitic, light greenish grey, with black carbonaceous flecks; bryozoa and crinoids
2,125-2,135	Dolomite, argillaceous, light greyish brown to grey, finely crystalline; small organic specks; traces of pyrite; a few vugs; irregular partings of light green, argillaceous siltstone
2,135-2,155	Dolomite, grey, medium to coarsely crystalline; in part sugary; scattered crinoids; grey, silty dolomite and siltstone with carbonaceous specks; greenish grey pyritic shale
2,155-2,165	Siltstone and shale: siltstone, grey, dolomitic, pyritic, micaceous; shale, light green, micaceous, finely silty; some dolomite and shaly dolomite, as above

2,165-2,175 Siltstone, light grey, dolomitic; carbonaceous specks and streaks; dolomite, brown to grey, finely crystalline

2,175-2,205 Siltstone, light greenish grey, pyritic, dolomitic; shale, light green, finely silty, micaceous

2,205-2,215 Limestone, buff to brown, crystalline; in part argillaceous and mottled with dolomite rhombs; bituminous, black, organic flecks; trace of pyrite; in part slightly oil stained; ostracods and crinoids

2,215-2,255 Limestone, cream to light brown, dense; in part mottled with dolomite rhombs; varies to sugary, limy dolomite; a few small fossil fragments

2,255-2,275 Dolomite and limestone: dolomite, dark yellowish brown, finely crystalline to sugary, slightly argillaceous; limestone, as above

2,275-2,295 Dolomite, dark yellowish brown, finely to medium crystalline, in part sugary, argillaceous, pyritic; some limestone, light brown, dense, pyritic; dark brown, thin, shale laminae

2,295-2,305 Dolomite, brown, medium to coarsely crystalline; some white chert; some brown, porous, sugary dolomite, possibly recrystallized cavity fillings; small carbonaceous(?) specks; interbedded, argillaceous, sugary dolomite

2,305-2,315 Dolomite, cream to light grey, coarsely crystalline; vuggy porosity

2,315-2,325 Dolomite, light grey, finely to medium crystalline; in part granular; silty, pyritic, argillaceous matrix; Tentaculites

2,325-2,365 Dolomite, silty, argillaceous, light grey to light brown, finely sugary, slightly pyritic; varies to argillaceous, dolomitic siltstone; Tentaculites

"Top Duvernay Shale"

2,365-2,375 Dolomite and shale: dolomite, brown, finely to medium crystalline, with some vuggy and intercrystalline porosity; a little white chert and conodonts; shale, dark brown, bituminous; varies to brown, fine-grained, shaly dolomite

Cooking Lake Member

2,375-2,385	Limestone and dolomite: limestone, cream to light buff, dense, dolomitic; varies to buff, finely sugary dolomite; rare, small spores; a little white chert replacing limestone
2,385-2,395	Dolomite, yellowish grey to pale grey, finely to medium crystalline; vuggy porosity
2,395-2,415	Dolomite, pale yellowish brown to cream and greyish yellow, finely to medium crystalline; fossiliferous -- abundant crinoid disks and suggestion of stromatoporoids and bryozoans; small vugs; greenish grey siltstone partings
2,415-2,435	Dolomite, light yellowish brown, finely to medium crystalline; a few small vugs; selenite filling cavities
2,435-2,465	Dolomite, cream to white, finely to medium crystalline; a few small vugs, in part filled with selenite
2,465-2,485	Dolomite, white to pale yellowish grey, finely to coarsely crystalline; cavities filled with gypsum fibres; abundant pyrite and tarnished sulphides in part replacing crinoids and algal growths
2,485-2,515	Dolomite, pale yellowish brown, medium crystalline; scattered small vugs in part filled with gypsum
2,515-2,525	Dolomite, cream to pale yellowish brown and grey, finely crystalline; possible recrystallized granular structure
2,525-2,555	Dolomite, cream to pale grey, finely to medium crystalline; a few scattered vugs
2,555-2,575	Dolomite, as above; grey, pyritic streaks
2,575-2,605	Dolomite, light yellowish brown, finely crystalline; scattered carbonaceous specks; suggestion of stromatoporoid-coral structures; cavity filling(?) of coarsely sugary, porous dolomite; vuggy porosity; brown partings
2,579-2,584	(Core No. 110, 11") Dolomite, brown, finely crystalline; inclusions of white secondary anhydrite; spots of heavy black oil
2,605-2,645	Dolomite, yellowish brown, finely to medium crystalline; scattered, vuggy porosity
2,645-2,685	Dolomite, yellow-brown, finely crystalline; in part slightly argillaceous and with brown, carbonaceous specks; vuggy porosity; shaly partings

2,685-2,705	Dolomite, as above; brown shaly partings more common than above
2,705-2,725	Dolomite, light grey to buff, finely crystalline, in part finely sugary, slightly silty and argillaceous
2,725-2,735	Limestone, greyish buff, cryptocrystalline, argillaceous and slightly silty, slightly dolomitic
2,735-2,755	Limestone, greyish buff, cryptocrystalline, slightly dolomitic, trace of pyrite; some greyish brown, dense, argillaceous limestone

Beaverhill Formation
(Top at 2,755 feet)

2,755-2,765	Limestone and shale: limestone, light grey, dense, finely silty, argillaceous, pyritic; shale, greyish brown to grey; brachiopods

LOG OF COOKING LAKE MEMBER, WOODBEND FORMATION, IN BEAR BILTMORE NO. 1 WELL

Location: l.s. 7, sec. 11, tp. 87, rge. 17, W.4th mer.

Elevation: 1,445 feet Total depth: 2,863 feet

Spudded: June 21, 1949 Completed: September 29, 1949

Cores examined by Helen R. Belyea and R. deWit, 1951

Depth	Lithology
Feet	
	Overlying beds, Ireton member
829-839	(Core No. 37, 10')
	829'-837½' Shale, calcareous, greenish grey, finely silty, fairly fissile; few thin layers of dense, dark grey, argillaceous limestone; lower 1½ feet thinly laminated
	837½'-839' Limestone, brown, dense, medium-grained, nodular; dark and light brown, finely laminated, shaly limestone; abundant pyrite
839-849	(Core No. 38, 10') Limestone, brown, dense, nodular; with wavy, dark brown, bituminous(?) shale laminae; scattered, small, crinoid fragments

849-859 (Core No. 39, 10')

849'-850' Limestone, as above

Cooking Lake Member
(Top at 850 feet)

850'-859' Limestone, light brown and buff, cryptocrystalline, in part pelletoid, medium-grained, in part fossiliferous-fragmental; rubbly zone with abundant small spores; scattered, fine, dark laminations

859-869 (Core No. 40, 10') Limestone, light buff, fine- to medium-grained, fossiliferous-fragmental; scattered small vugs; thamnopora-type corals, pelecypods

869-885 (Core No. 41, 10') Limestone, as above

885-895 (Core No. 42, 10') Limestone, as above; abundant stromatoporoids; medium to coarsely pelletoid; scattered small brachiopods; flowage(?) structure

895-905 (Core No. 43, 10') Limestone, as above; crypto-crystalline, with brown carbonaceous specks and fine calcite veins; in part coarsely pelletoid (algal?); abundant small fossil fragments -- brachiopods, ostracods, stroma-toporoids, or corals; irregular brown shaly partings

905-915 (Core No. 44, 10') Limestone, as above, with small calcite veins; rare scattered crinoids, brachiopods, gastropods, and ostracods; fair flowage(?) structure; some shale

915-925 (Core No. 45, 10')

915'-922' Limestone, as above

922'-925' Limestone, grey-buff, dense, slightly dolomitic, in 2-inch bands interbedded with dark brown to brown-grey, shaly limestone in $\frac{1}{2}$- to $\frac{1}{4}$-inch bands, with wavy, dark brown laminae; few stylolites

925-935 (Core No. 46, 10')

925'-927' Limestone, as above

927'-933' Limestone, buff, cryptocrystalline, with small calcite veins, in part oolitic, with ooliths about $\frac{1}{2}$ mm. to $\frac{1}{4}$ mm., finer in upper part, more concentrated in middle part, scattered in lower part; scattered stylolites

933'-935' Limestone, grey-buff, dense; interbedded with thin, brownish, shaly streaks

935-945 (Core No. 47, 10') Limestone, buff, cryptocrystalline, with fine calcite veins; small fossil fragments; interbedded, grey-brown, argillaceous, dolomitic limestone interkneaded with cryptocrystalline limestone; brachiopods, gastropods, and crinoids

945-954 (Core No. 48, 9') Limestone, as above; crinoids rare or lacking; good flowage(?) structure in brown shaly limestone

954-964 (Core No. 49, 10') Limestone, as above; few scattered crinoids

964-974 (Core No. 50, 10') Limestone, as above; from 970 to 972 feet, limestone, light brown, dense, medium-grained, pelletoid; with fossil fragments

974-984 (Core No. 51, 10')

974-981 Limestone, as above; fossil fragments

981-984 Limestone, buff-grey, slightly argillaceous, with dark grey streaks and pyrite specks; upper 1 foot fossiliferous — gastropods

984-994 (Core No. 52, 10')

984'-987' Limestone, as above; scattered brachiopods

Beaverhill Formation

987-994 (Core No. 52) Limestone, grey, increasingly argillaceous and finely silty downwards; lower part greenish grey; many scattered brachiopods -- athyris and spiriferoid types; scattered pyrite; in part with intensive, fine flowage(?) structure

944-1,002 (Core No. 53, 10') Shale, greenish grey to buff-grey, calcareous, silty; scattered spiriferoid brachiopods

LOG OF WINTERBURN AND WOODBEND FORMATIONS
IN IMPERIAL DAPP NO. 1 WELL

Location: l.s. 5, sec. 29, tp. 62, rge. 1, W.5th mer.

Elevation: 2,086 feet Total depth: 7,575 feet

Spudded: August 16, 1947 Completed: December 6, 1948

Samples and cores examined by Helen R. Belyea, 1949 and 1952

Depth	Lithology
Feet	
	Overlying beds, Wabamun formation
	Winterburn Formation (Top, from electric log, at 3,745 feet)
	Graminia and Calmar Members
3,750-3,755	(Poor sample) Sandstone, light grey, fine-grained, quartzose, slightly calcareous; a little, bright apple-green shale
3,755-3,770	Missing
3,770-3,775	Dolomite, grey, finely crystalline, tight; some light buff, sugary, pyritic dolomite
3,775-3,780	Dolomite, light buff, sugary, pyritic as above; sandstone, light grey, quartzose, slightly calcareous, fine-grained; bright green shale partings
3,780-3,785	Dolomite, light buff, sugary, and light grey, finely crystalline
3,785-3,790	Dolomite, buff, finely crystalline to sugary, the latter with fair, small vuggy porosity
3,790-3,795	Dolomite, light grey, sugary, silty to sandy; some sandstone, light grey or white, fine-grained, quartzose, with scattered pink grains; calcareous cement; bright green shale partings
3,795-3,810	Dolomite, buff, finely to medium crystalline; vuggy porosity
3,810-3,815	Dolomite, light grey, coarsely crystalline; pin-point and vuggy porosity
3,815-3,820	Dolomite, as above; some yellowish buff, sugary, finely sandy dolomite

3,820-3,825 Dolomite, light yellow-brown, finely to medium crystalline

3,825-3,830 Dolomite, as above, and buff, sugary, silty dolomite

3,830-3,845 Dolomite, buff, sugary, fine-grained, limy sand matrix; crinoid(?) fragments, 3,830 to 3,840 feet

3,845-3,850 Dolomite, light brown, finely crystalline; small calcite veins

3,850-3,860 Dolomite, buff, finely crystalline, in part sugary, finely sandy, slightly calcareous

3,860-3,865 Dolomite, sandy, buff to grey-buff, fine-grained, in part sugary, argillaceous; some buff-grey, dolomitic, fine-grained, quartzose sandstone

3,865-3,870 Dolomite, in part, as above; in part grey-brown, finely crystalline, slightly argillaceous; thin, shale partings

3,870-3,905 Siltstone and silty, grey, fine-grained, argillaceous dolomite, probably interbedded; scattered pin-point vugs and pyrite

Nisku Equivalent

3,905-3,910 Dolomite, light brown, sugary, silty, pyritic; grey, argillaceous, silty dolomite and siltstone, as above; a few fragments of bright green shale

3,910-3,925 Dolomitic limestone, light brown, cryptocrystalline to finely crystalline, grades to buff, calcareous dolomite; some light grey, fine-grained, dolomitic limestone with fine, scattered pyrite

3,925-3,930 Limestone and dolomitic limestone, as above; grey, calcareous, pyritic, very silty dolomite and dolomitic siltstone with a grain size of 0.01 to 0.1 mm.

3,930-3,935 Siltstone, grey, dolomitic, pyritic, micaceous

3,935-3,940 Siltstone, as above; limestone, grey, finely crystalline, silty; argillaceous partings; scattered brachiopods

3,940-3,955 Siltstone, grey, calcareous, argillaceous, pyritic, micaceous; argillaceous partings; brachiopod and coral fragments; scattered carbonaceous specks; some grey silty limestone

3,955-3,960 Siltstone, grey, as above; argillaceous partings; carbonaceous specks; scattered calcitic organic fragments

3,960-3,995	Siltstone, greenish grey, more argillaceous than above, micaceous, pyritic, calcareous; grain size up to 0.1 mm.; in part becomes more calcareous and has scattered fossil fragments
3,995-4,000	Limestone, light brown, very fine-grained, argillaceous, very finely silty
4,000-4,010	Argillaceous limestone and shale: limestone, buff-grey, dense, silty; shale, greenish grey to buff-grey, limy, silty, massive
4,010-4,020	Limestone, light brown, cryptocrystalline; buff-grey, and brown, argillaceous, finely silty limestone and shale
4,020-4,030	Limestone, buff-grey to grey, argillaceous, dense; scattered pyrite; greenish grey, pyritic, massive, limy shale
4,030-4,040	Argillaceous limestone, grey to greenish grey, pyritic, finely silty; grades to blocky shale
4,040-4,055	Limestone, buff, dense, finely silty; some greenish grey, silty, argillaceous limestone and calcareous, argillaceous siltstone, as above; scattered, fine pyrite
4,055-4,060	Missing
4,060-4,075	Limestone, buff, dense, finely silty, finely pyritic; scattered brachiopod fragments
4,075-4,080	Siltstone, greenish grey, argillaceous, calcareous, pyritic
4,080-4,090	Limestone, buff, dense, earthy, very finely silty, pyritic
4,090-4,095	Limestone, as above; siltstone, green, argillaceous, calcareous, pyritic
4,095-4,100	Limestone and shale: limestone, light brown, fine-grained, argillaceous; shale, greenish grey, calcareous, micaceous, fissile
4,100-4,105	Limestone, in part light brown, cryptocrystalline; in part grey, argillaceous, dense, earthy; shale, greenish grey, finely silty, calcareous; scattered brachiopod fragments
4,105-4,110	Limestone, as above, with iron stained grey pebbles(?); weathered fossil fragments

Woodbend Formation
(Top, from electric log, at 4,115 feet)

Ireton Member

4,110-4,120 Siltstone, argillaceous, calcareous, greenish grey; trace dark brown limestone and brown shale

4,120-4,125 Limestone, light brown, cryptocrystalline to finely crystalline; scattered brachiopods, crinoids, and other small fossil fragments; shale, greenish grey, fissile, calcareous, micaceous; large fragments of pyrite; Plectogyra identified by R. T. D. Wickenden

4,125-4,130 (Poor sample) Probably greenish grey shale and buff, cryptocrystalline limestone, with pyrite

4,130-4,135 Siltstone, argillaceous, calcareous, grey, micaceous; varies to silty shale

4,135-4,140 Missing

4,140-4,150 Limestone, buffy, fine-grained, mottled with dolomite rhombs; silty to finely sandy; varies to buff, dolomitic siltstone

4,150-4,155 Missing

4,155-4,160 Limestone, as above

4,160-4,165 Limestone, as above; and limestone, grey, very fine-grained, argillaceous

4,165-4,175 Shale, grey, micaceous, calcareous

4,175-4,180 Shale, as above; limestone, argillaceous, grey, dense

4,180-4,220 Limestone, buff-grey, fine-grained, in part dolomitic and sandy; light brownish grey, calcareous, argillaceous siltstone and buff-grey, fissile shale

4,220-4,225 Missing

4,225-4,245 Siltstone and silty limestone, as above

4,245-4,250 Shale, greenish grey, calcareous, micaceous

4,250-4,260 Siltstone, calcareous, greenish grey to brownish grey, slightly argillaceous; light grey-buff, argillaceous, silty limestone

4,260-4,270	Limestone and siltstone: grey-buff, silty, dolomitic, argillaceous, fine-grained limestone and interbedded calcareous siltstone
4,270-4,275	Limestone, light brown, very fine-grained, slightly argillaceous; some siltstone and silty limestone, as above
4,275-4,280	Missing
4,280-4,285	Shale, greenish grey, calcareous, micaceous, silty in part, fissile
4,285-4,290	Missing
4,290-4,295	Shale, as above
4,295-4,355	Missing
4,355-4,360	Limestone, buff-grey, fine-grained, silty, pyritic, argillaceous; interbedded calcareous siltstone and greenish grey shale
4,360-4,370	Missing
4,370-4,385	Argillaceous limestone and shale: limestone, light grey to dark greenish grey, silty; shale, greenish grey, silty, calcareous, massive
4,385-4,390	Missing
4,390-4,395	Limestone, grey-buff to gfey, very fine-grained, silty, argillaceous; interbedded calcareous siltstone and greenish grey shale
4,395-4,400	Missing
4,400-4,405	Limestone, grey, very fine-grained, finely silty (silt grains less than 0.01 mm. in diameter)
4,405-4,415	Shale, greenish grey to green, pyritic, finely silty, fissile in part; some grey limestone, as above
4,415-4,420	Limestone, light buff, fine-grained, in part finely crystalline, finely silty, slightly argillaceous; thin, brown, shale laminae or partings
4,420-4,430	Missing
4,430-4,435	Shaly limestone and shale: limestone, light grey to buff-grey, shaly, dense; shale, greenish grey, calcareous
4,435-4,440	Limestone, light grey, dense to fine-grained, slightly silty; brownish grey, argillaceous, calcareous siltstone and shale, interbedded

4,440–4,445	Limestone, shale, and siltstone, as above; trace of brick-red silty shale or siltstone
4,445–4,470	Limestone, argillaceous, light brownish grey to grey, dense; interbedded, greenish grey to brownish grey, blocky, calcareous, finely silty shale; scattered pyrite
4,470–4,485	Limestone, light buff, very finely crystalline, slightly argillaceous, and buff, silty argillaceous, speckled, fine- to medium-grained limestone, grading to fine-grained, calcareous, argillaceous siltstone
4,485–4,495	Limestone, argillaceous, buff-grey, dense; interbedded, greenish grey and brownish grey siltstone and shale; scattered brachiopod fragments and spines
4,495–4,510	Limestone, argillaceous, light grey, dense; greenish grey shale, with carbonaceous(?) streaks
4,510–4,515	Limestone and shale, as above; a few fragments grey-buff, finely to coarsely crystalline limestone with irregular dark grey inclusions -- probably fossiliferous-fragmental
4,515–4,530	(Poor samples) Limestone, grey-buff, dense; greenish grey to brownish grey shale
4,530–4,540	Limestone, buff, fine- to medium-grained, probably clastic, silty, slightly argillaceous; small fossil fragments; brownish grey, silty shale and siltstone, interbedded
4,540–4,545	Calcareous shale, light chocolate-brown, blocky
4,545–4,565	Limestone, buff to light brown, argillaceous, finely silty; dense to fine-grained, interbedded, brown, calcareous siltstone and shale
4,565–4,575	Limestone, buff, fine-grained, finely silty; in part slightly dolomitic and shaly; dark brown, coarse, shaly siltstone and shale partings
4,575–4,580	Missing
4,580–4,585	Limestone, grey-buff, dense
4,585–4,590	Missing
4,590–4,600	Limestone, buff to light brown, dense to very fine-grained; scattered brachiopod fragments
4,600–4,605	Missing
4,605–4,615	Limestone, as above; interbedded, dark brown, argillaceous siltstone and shale

4,615–4,620	Missing
4,620–4,625	Shale, dark brown to brownish black, with calcareous siltstone laminae; small carbonaceous(?) specks
4,625–4,650	Limestone, light brown, fine-grained; dark brown shale, in part specked with calcareous material; Tentaculites; a few brachiopod fragments; scattered pyrite
4,665–4,670	Limestone, argillaceous, buff-grey to grey, dense, pyritic in part; grades to blocky, limy shale
4,670–4,675	Missing
4,675–4,690	Argillaceous limestone, as above
4,690–4,705	Argillaceous limestone, as above, and brownish grey, blocky, limy shale
4,705–4,720	Argillaceous limestone, light grey to light greenish grey, dense, earthy, more shaly than above; shale, greenish grey to brownish grey
4,720–4,735	Shale, silty, dark brown, blocky, with light brown streak, calcareous; carbonaceous specks; a little light brown, dense limestone
4,735–4,750	Limestone, light brown, dense, argillaceous, slightly earthy; brown calcareous shale
4,750–4,755	Missing
4,755–4,765	Limestone, greyish brown to brown, dense to fine-grained, argillaceous; interbedded, dark brown, blocky, calcareous shale
4,765–4,795	Shale, light greenish grey, calcareous
4,795–4,800	Limestone, light brown, dense, slightly argillaceous; brown, calcareous shale and dark brownish black, brown-streaked, bituminous(?) shale
4,800–4,815	Limestone, argillaceous, light grey, dense; grades to greenish grey, limy shale; few brachiopod spines
4,815–4,825	Limestone, buff, cryptocrystalline, slightly argillaceous; light brown, smooth, massive, calcareous shale or mudstone
	Top Duvernay Shale
4,825–4,830	Shale, dark brown to brownish black, with brown streak, slightly calcareous; inclusions of crystalline calcite, probably replacing fossil fragments; conodonts; some limestone, as above, and some buff, fine- to coarse-grained limestone with abundant brachiopod spines

4,830–4,845 Limestone, buff, as above; some light brown, fine-grained, argillaceous limestone and limy shale; shell fragment limestone with brachiopods, crinoids, spines, and other small fossil fragments; in part silicified; dark brown shale partings; a few spores at 4,835 feet

Green Shale Equivalents of Duvernay and Cooking Lake

4,845–4,850 Argillaceous limestone and shale, grey and greenish grey, dense; in part silty

4,850–4,855 Missing

4,855–4,860 Argillaceous limestone and shale, as above

4,860–4,875 Limestone, argillaceous, grey, dense

4,875–4,880 Limestone, and shale: limestone, as above; shale, grey to greenish grey; grades from blocky calcareous shale to silty, fissile shale

4,880–4,885 Missing

4,885–4,895 Shale, grey to greenish grey; in part very silty to sandy, micaceous; some grey, argillaceous, dense limestone; small, black ostracods

4,895–4,920 Shale, grey to greenish grey, limy; argillaceous limestone, gray, dense

4,920–4,925 Limestone, buff, cryptocrystalline, very finely silty and argillaceous

4,925–4,935 (Poor samples) Shale, greenish grey, calcareous, fossile; some limestone, as above, with small scattered spines; some massive, smooth, calcareous shale

4,935–4,950 Shale, brownish grey and greenish grey, interbedded; in part finely micaceous, fissile

4,950–4,960 Shale, brownish grey to brown, smooth, calcareous; limestone, light brown, cryptocrystalline, finely silty and argillaceous

4,960–4,965 Shale, brownish grey to grey, as above; grades to brownish grey shaly limestone

4,965–4,980 Shale, greenish grey to brownish green, fissile, splintery, slightly calcareous; scattered carbonaceous fragments

4,980–4,990 Shale, greenish grey, slightly calcareous; few carbonaceous specks; scattered small spines

4,990–4,995 Missing

4,995-5,020	Shale, greenish grey, fissile, splintery; small dark specks
5,020-5,025	Shale, as above; calcareous, coarse siltstone, light brown, argillaceous, with abundant shiny black organic fragments; carbonaceous streaks; ostracods; small fossil fragments; appears fragmental; dark brown shale partings
5,025-5,045	Shale, dark brown, with brown streaks; green shale as above
5,045-5,095	Shale, greenish grey, finely micaceous, fissile, as above
5,095-5,100	Shale, as above; some limestone, grey, dense, argillaceous; fragment of bryozoa
5,100-5,140	Shale, as above; smooth ostracods and Primitia cf. variostriata (Clarke) identified by R. T. D. Wickenden at 5,130 feet
5,140-5,145	Shale, greenish grey to brownish grey, fissile; scattered pyrite; a little buff, crypto-crystalline limestone
5,145-5,155	Shale, greenish grey, calcareous, micaceous, fissile
5,155-5,175	Shale, as above; a little limestone, grey, dense, argillaceous; scattered tentaculites and lingulas
5,175-5,180	Shale, as above; limestone, grey-buff, dense to fine-grained, argillaceous; spines common
5,180-5,195	Shale, greenish grey and light brownish grey; scattered spines and small ostracods
5,195-5,205	Missing
5,205-5,215	Shale, greenish grey to brown; ostracods

Beaverhill Formation

5,215-5,220	Shale, greenish grey; limestone, buff, fine-grained
5,220-5,230	Limestone, buff, cryptocrystalline, argillaceous
5,230-5,235	Limestone, grey to buff, dense, argillaceous; a little fine-grained, fossiliferous-fragmental
5,235-5,240	Limestone, grey, dense, argillaceous
5,240-5,245	Limestone, grey to buff, cryptocrystalline, in part argillaceous; some fossiliferous-fragmental with spines

LOG OF WABAMUN FORMATION IN SOCONY UTIKUMA NO. 1 WELL

Location: l.s. 12, sec. 10, tp. 78, rge. 8, W.5th mer.

Elevation: 2,198 feet K.B. Total depth: 5,944 feet

Spudded: January 10, 1951 Completed: March 13, 1951

Samples examined by Helen R. Belyea, 1952

Depth	Lithology
Feet	
	Overlying beds, Exshaw formation
	Wabamun Formation (Top at 2,780 feet)
2,780-2,800	Limestone, light grey, fine- to medium-grained, speckled, fossiliferous, cherty, glauconitic, pyritic
2,800-2,830	Limestone, buff to grey, fine-grained; in part dolomitic, silty; fossiliferous-fragmental; scattered glauconite; dolomite, light grey, finely crystalline to sugary, finely silty, finely pyritic in part; a little pyritic, light greenish grey siltstone; grey chert
2,830-2,840	Limestone, light buff, finely crystalline, fossil fragments; shale, light greenish grey, with large sand grains; siltstone, light grey, pyritic; grey chert
2,840-2,880	Limestone, creamy buff, fine-grained, slightly dolomitic; in part slightly chalky; fossil fragments and possible pelletoid structures; crinoids and brachiopods; spots of dark brown oil stain
2,880-2,890	Limestone, creamy buff, fine-grained, fossiliferous-fragmental; with some small irregular pellets
2,890-2,900	Limestone, creamy buff, cryptocrystalline; with small calcite veins; some granular, fossiliferous-fragmental limestone, as above
2,900-2,910	Limestone, creamy buff, fine-grained; with fine fossil fragments; irregular stringers of light buff sugary dolomite
2,910-2,920	Limestone, as above, with dolomite stringers; crinoids common; thin brown shale laminae

2,920-2,960	Limestone, creamy buff, fine- to medium-grained, fossiliferous-fragmental; crinoids, brachiopods, and ostracods common; in part with poorly developed pelletoid structures
2,960-2,970	Limestone, buff, medium- to coarse-grained, fossiliferous-fragmental; in part pelletoid, with some ooliths; white and grey chert, some showing replacement of fossil fragments
2,970-3,000	Limestone, creamy buff, cryptocrystalline; a few fossil fragments; brachiopods and crinoids; thin brown shaly material -- possibly from stylolites
3,000-3,010	Poor sample
3,010-3,030	Limestone, creamy buff, fine- to medium-grained; in part pelletoid; some may be algal; in part fossiliferous-fragmental; thin brown shaly laminae
3,030-3,040	Limestone, as above; grey chert
3,040-3,070	Limestone, light buff, fine- to medium-grained, fossiliferous-fragmental and pelletoid; chalky matrix, mottled with calcite crystals, possibly as a result of recrystallization or possibly finely ground crystalline organic debris
3,070-3,100	Limestone, as above; light grey chert
3,100-3,110	Limestone, cream, fine-grained, fossiliferous-fragmental; less crystalline calcite than above
3,110-3,130	Limestone, cream, fine- to coarse-grained, pelletoid, fossiliferous-fragmental; ostracods, brachiopods, banded algal or stromatoporoid fragments, and crinoids; a little intergranular porosity
3,130-3,140	Limestone, creamy buff, chalky, cryptocrystalline to fine-grained; slightly pelletoid; small indeterminate fossil fragments
3,140-3,160	Limestone, creamy buff, chalky, pelletoid, fine- to medium-grained, in part algal; in part fossiliferous-fragmental; ostracods
3,160-3,180	Limestone, creamy buff, fine-grained, chalky, fossiliferous-fragmental; a little pelletoid limestone; thin, dark brown, shaly laminae
3,180-3,210	Limestone, buff, cryptocrystalline to fine-grained; in part pelletoid; fossil fragments; a few small vugs filled with calcite and pyrite; light grey chert; thin brown shale laminae

3,210-3,270	Limestone, creamy buff, chalky, fine-grained, fossiliferous and pelletoid, mottled with dolomite rhombs; thin, brown, shaly laminae; a little intergranular porosity
3,270-3,310	Limestone, creamy buff, fine-grained, fossiliferous; in part irregularly fine to medium grained and pelletoid; irregular stringers of dolomitic limestone and sugary dolomite; thin dark brown shaly laminae
3,310-3,320	Limestone, creamy buff, chalky, fine-grained, fossiliferous; in part pelletoid - algal(?); in part mottled with dolomite rhombs and grading to buff, sugary dolomite
3,320-3,350	Limestone, creamy buff, finely fossiliferous-fragmental; in part pelletoid; a little dolomite; crinoids and ostracods
3,350-3,380	Limestone, buff, cryptocrystalline, some coarsely pelletoid; abundant small fossil fragments and algal(?) structures; a few vugs lined with calcite crystals
3,380-3,400	Limestone, creamy buff to buff, fine-grained; in part finely to coarsely pelletoid; finely fossiliferous; in part chalky
3,400-3,410	Limestone, as above; dolomite, buff, sugary
3,410-3,440	Limestone, light buff, fine-grained; in part finely pelletoid; small fossil fragments; thin, dark brown, shale laminae
3,440-3,490	Limestone, buff, cryptocrystalline; numerous crinoid fragments and large brachiopods; a little fine-grained pelletoid limestone; stringers of buff, sugary dolomite; oolitic limestone at 3,450 feet; thin, brown, shale partings; scattered pyrite at 3,480 feet.
3,490-3,500	Limestone, creamy buff, fine- to coarse-grained, fossiliferous-fragmental; in part pelletoid; scattered dolomite rhombs; crinoids common
3,500-3,560	Limestone, buff, cryptocrystalline; a little buff, sugary dolomite; a few small vugs lined with calcite
3,560-3,590	Limestone, buff, fine-grained; in part medium grained and fossiliferous-fragmental; scattered dolomite rhombs; a little pyrite; thin, brown, shaly laminae

Winterburn Formation
(Top at 3,590 feet)

3,590-3,610	Dolomite, light grey, finely crystalline; in part with finely disseminated pyrite and silt; suggestion of fine-grained pelletoid structure