GEOLOGICAL SURVEY

OF CANADA

UPPER ~~LATE~~ PALEOZOIC STRATIGRAPHY OF THE EAGLE PLAIN BASIN, YUKON TERRITORY

H.L. MARTIN

DEPARTMENT OF ENERGY, MINES AND RESOURCES

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ABSTRACT

Upper
~~Late~~ Paleozoic strata are present in the southern part of the Eagle Plain basin where they are termed the Imperial Formation of Late Devonian age, the unnamed shale unit of Devonian and Mississippian age, and the Hart River Formation of Chesteran age. The latter is herein formally subdivided into the Birch, Canoe River, and Chance Sandstone members. Both the Birch and Chance Sandstone form reservoir rocks where oil and gas have been discovered in commercial quantities. The hydrocarbons are present in mud-free conglomeratic sandstones whereas the intervening Canoe River Member is a siliceous shale in the southeast and grades into a siliceous limestone in the central and western parts of the basin. The strata are believed to have been deposited in a deep water trough sub-paralleling the present-day Richardson Mountains which form the eastern border of the basin, and turbidite flows were responsible for the influxes of the conglomeratic sandstones.

INTRODUCTION

The Eagle Plain intermontane basin lies mainly between latitudes $65^{0}45'$ and $67^{0}15'$ N, and between longitudes 136° and 139° W, embracing an area of about ~~10,000~~ 9,500 square miles within the northern Yukon Territory, which straddles the Arctic Circle. The basin is bordered on the west and south by the Northern and Central Ogilvie Mountains, respectively; its eastern limit is defined by the Southern Richardson Mountains, and its northern limit by the ~~Dave Lord Ridge~~ Keele Range (Figure 1).

Data, available as of January 1, 1971, from the fourteen wells drilled into and through the Carboniferous and Upper Devonian strata in the basin, were used in this study, as well as surface section studies by Bamber and Waterhouse (1971), and Norris (1968). The purpose of this study was to subdivide the Carboniferous-Upper Devonian rocks sequence in the Eagle Plain subsurface into stratigraphically significant units, to describe the various rock types encountered, to provide the paleontological evidence for age assignments, to present the sedimentary history of these rocks, to discuss the economic potential of the basin, and to correlate the subsurface stratigraphic units to the surrounding surface exposures.

Oil and gas have been discovered in commercial quantities in strata of Carboniferous age in five wells in the southern Eagle Plain. The reservoirs are composed of mud-free conglomeratic sandstones of the Chance Sandstone Member and the Birch Member (new names, this paper) of the Hart River Formation, but partial to complete cementation by silica and carbonate has largely destroyed or reduced the initial high porosity of these rocks. The finely divided limestones and shales are characterized by a large amount of silica content and practically no clay-mineral content as determined by X-ray diffraction and wet chemical methods.

J.B. Waterhouse of the University of Toronto identified and dated the brachiopods discussed in this report; T.P. Chamney and M.S. Barss of the Geological Survey of Canada identified and dated the microfossils and palynomorphs, respectively, from well samples submitted by the author; B. Mamet of the University of Montreal provided a tentative identification on forams present in two thin sections from well cuttings; and W. Nassichuk of the

Geological Survey of Canada identified and dated an ammonite found in a core sample.

The writer is indebted to A.F. Foscolos of the Geological Survey of Canada, Calgary, for providing the X-ray diffraction and chemical analyses on rock samples.

STRATIGRAPHY

Carboniferous rocks in the subsurface are confined to the southern part of the basin as they were either not deposited or removed by pre-Cretaceous erosion over most of the Eagle Plain. They are exposed in the southeast along the Peel River and in the southwest in the Ogilvie Mountains (Bamber and Waterhouse, 1971). Upper Devonian strata underlie Cretaceous rocks in the central and northern Eagle Plain, and Carboniferous rocks in the south; they outcrop in the southern Richardson and Ogilvie Mountains which border the basin (Norris, 1968).

TABLE OF FORMATIONS

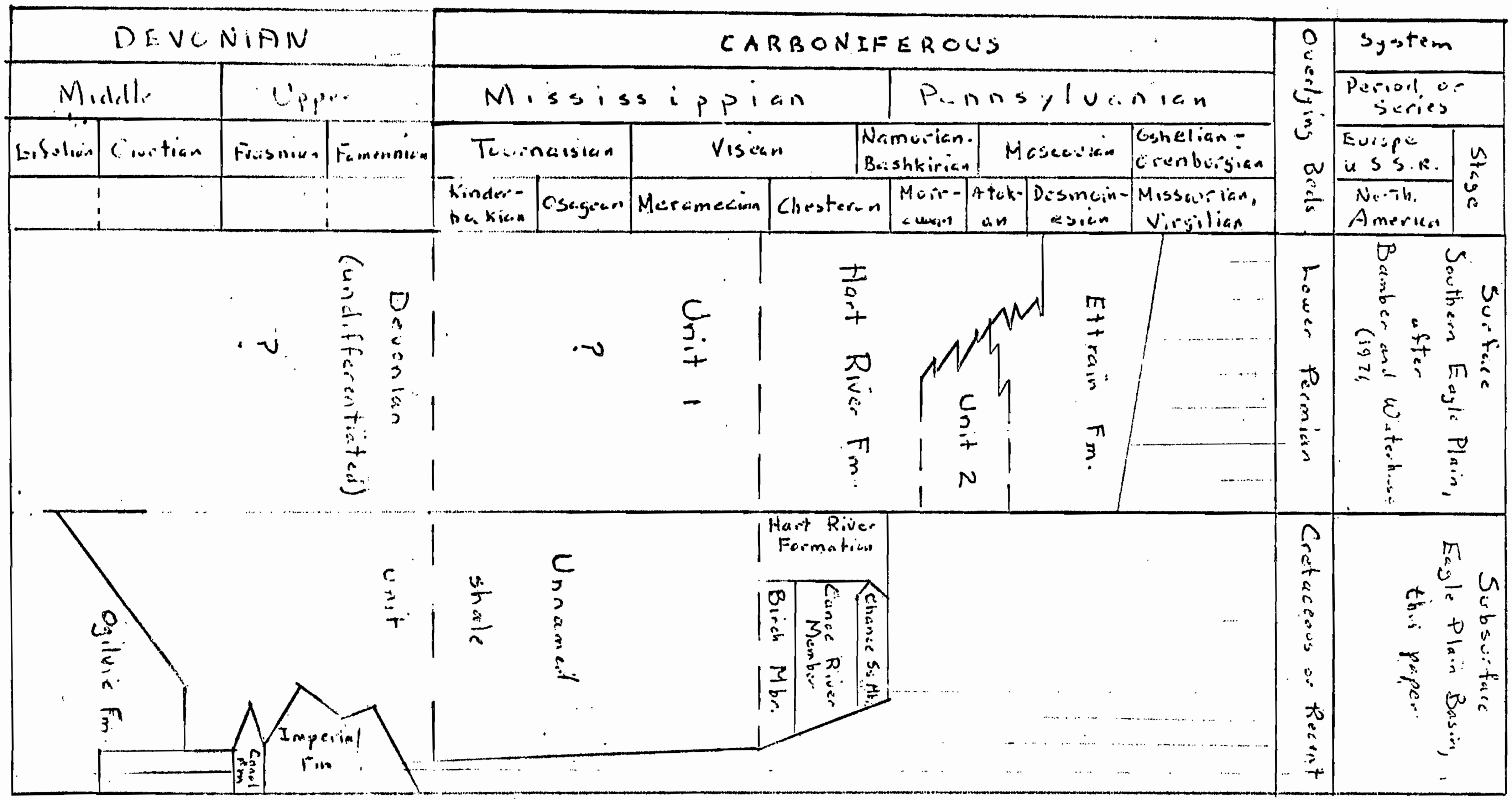
Period	Formation	Member	Thickness (feet)	Lithology
Cretaceous				Shale, Siltstone, and Sandstone.
Carboniferous	Hart River	Chance Sandstone	0-1016	Conglomeratic sandstone, with siliceous and calcareous cement.
		Canoe River	0-2237	Siliceous shale and siliceous micritic limestone.
		Birch	0-1576	Conglomeratic sandstone, siliceous shale, and siliceous limestone.
	Unnamed shale unit		0-4400+	Siliceous shale
Devonian	Imperial		0-4261+	Siliceous shale, siltstone, and sandstone.

(insert diagram "Late Paleozoic Stratigraphic Nomenclature ---" here (pg 25)

DESCRIPTION OF FORMATIONS

Imperial Formation

The name Imperial Formation has undergone several modifications since being erected by Hume and Link, 1945 (see Tassonyi,



Late Paleozoic Stratigraphic Nomenclature, Eagle Plain area, Yukon Territory.

1969). In the Eagle Plain area, the formation is confined to the eastern edge of the basin where it outcrops as a sequence of shales, siltstones, and sandstones of Late Devonian age; ~~a siliceous shale and chert bed of the Devonian Upper Canol Formation (not shown)~~. On GSC Map 10-63 (Norris, et al, 1963), map-unit 8 represents the Imperial Formation only along the east side of the basin, ~~as the formation is not present in outcrop on the west or south side of the Eagle Plain~~. The western limit of the Imperial Formation is ~~parallel, and slightly west of the~~ at its outcrop expression (Figure 3 ~~4~~), as to the west and southwest, ~~the Imperial Formation~~ it passes laterally into a sequence of rocks known informally as the unnamed shale unit and ~~is~~ discussed under that heading below.

Socony Mobil Western Minerals South Tuttle YT N-5 (latitude 66°24'51.2" N, longitude 136°46'22.7" W), located on the east flank of the Eagle Plain basin, is the only well in the area that penetrated strata of the Imperial Formation. The well spudded into the Imperial and penetrated the underlying siliceous shales of the Devonian ~~Canol~~ Canol Formation at 4,316 feet drilling depth. The Imperial consists of two units, an upper 1,000-foot shale, sandstone-siltstone sequence (which is about 25% sandstone), and a lower 3,300-foot unit which is shale with some siltstone. The sandstone, which is composed of medium-sized varicoloured chert grains with lesser quartz, is poorly sorted, and cemented by silica and carbonate. The shale is dark grey-brown, dolomitic in part, and has hairline fractures infilled with dolomite and lesser anhydrite. Pyrite spheres are present as are plant imprints.

Unnamed shale unit

The informal term, unnamed shale unit, was applied by Norris (1968, p.39) to "a recessive interval comprising from place to place a variety of shales that overlie the Middle Devonian Ogilvie Formation and are overlain by relatively resistant clastic and carbonate rocks of late Mississippian age and other as yet undated beds". He found that the surface sections were largely covered intervals and therefore the unit's lateral relationships were not clear, but it did appear to contain equivalents of the Upper Devonian Imperial Formation. Furthermore, the thickness of the unnamed shale unit appeared to vary inversely as the thickness of the underlying Ogilvie formation, and the age of the uppermost beds of the latter carbonate unit varied from lower Middle Devonian (Eifelian) to upper Middle Devonian (Givetian) which suggests an erosional break between the shale and carbonate.

In the Eagle Plain area, only one well penetrated a complete section of the unnamed shale unit. The well, Standard Oil Company of British Columbia Blackstone YT D-77 (latitude 65°46'10.77" N, 137°14'54.78" W longitude), can be considered a subsurface reference section and is described in the Appendix of this report (see also Figure 2). Insufficient data as to its lateral continuity and age precludes erecting a formal name for the stratigraphic interval. The unit lies between 1,532 and 3,614 feet drilling depths in the reference well; samples of this well are available for examination at the Institute of Sedimentary and Petroleum Geology, Calgary, Alberta. Cores were not cut in the unnamed shale unit, but the well cuttings are of excellent quality.

In the Blackstone D-77 well, the shale is non-calcareous, generally dark grey to black, and very to slightly bituminous in most of the interval. A few samples contain traces of white crystalline and milky blue-white anhydrite which is thought to represent veinlet infillings. The ubiquitous pyrite is present as pods, blebs, spheres, disseminated, and as massive whole chips in the well cuttings. Some of these resemble replaced plant fragments. In the upper half of the unit, fragments of ironstone are present; these are composed of medium brown, very pyritic, siliceous dolomite.

Also in the upper half of the unit are persistent cuttings of sandstone and siltstone which are thought to occur as thin interbeds; some of these cuttings are composed of thin sandstone and siltstone laminae. The sandstones are generally siliceous, but are sometimes dolomitic as well, while the framework is composed of fine to coarse sub-rounded medium and dark grey chert grains. Two ten-foot intervals, 2,120 to 2,120 feet, and 2,370 to 2,380 feet, are porous and have a light oil stain. The basal 300 feet of section contains sandstones which are quite different from the above. These are "dirty", poorly sorted, and consist of fine to coarse grained sub-rounded dark and medium chert grains in an argillaceous-appearing matrix. These sandstones grade into sandy shale and shale. The unit overlies micritic-skeletal limestone of the Devonian Ogilvie Formation, and underlies siliceous and cherty limestone and shale of the uppermost Mississippian and lower Pennsylvanian Hart River Formation.

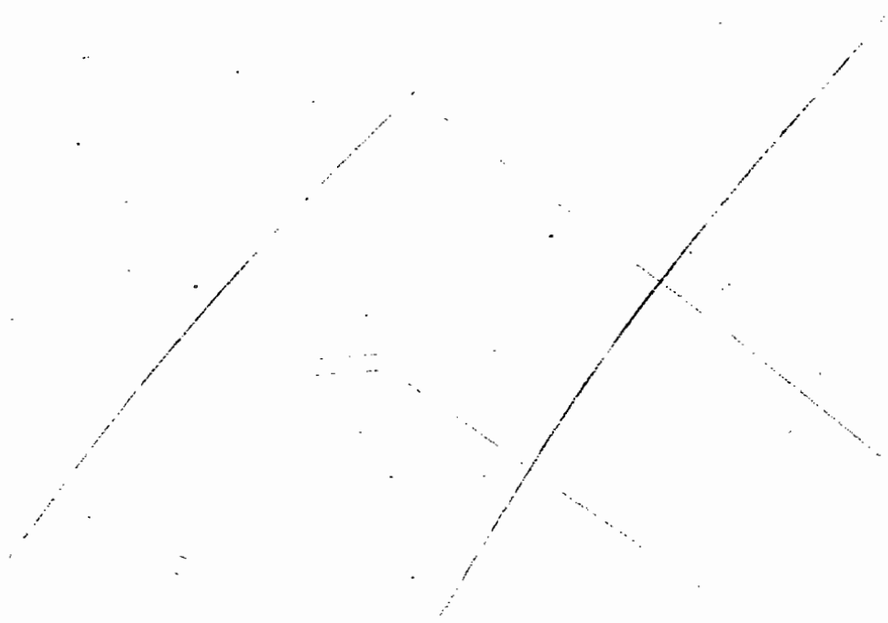
Distribution and Lithology. On the west flank of the basin, Socony Mobil Western Minerals North Cath YT B-62 (latitude 66°11' 13.5" N, longitude 138°41'53" W) was spudded in the unnamed shale and penetrated 2,630 feet of this unit before reaching the Ogilvie Formation. A computed continuous dipmeter log indicated that the shale dips generally about 18° to the northeast, but at and below the contact with the Ogilvie Formation, the dips declines abruptly to about 8° suggesting an angular unconformity. The shale thickness is thus somewhat exaggerated due to the structural dip and the true vertical thickness is about 2,500 feet. Two sandstone intervals, about 175 and 150 feet thick, are present in the uppermost 600 feet while the remaining 2,000 feet are almost all shale, with lesser sandstone interbeds in the basal 600 feet. The underlying Ogilvie Formation is a micritic-skeletal limestone.

About 17 miles west of the Cath B-62 well, Norris (ibid.) measured a section where he found 1,657.4 feet of unnamed shale (less than 10% was exposed outcrop, the remainder being covered) underlying 125.7 feet of sandstone to which he assigned an Upper Devonian or younger age. This sandstone is possibly equivalent to the sandstone found in the uppermost part of the Cath B-62 well, which is here considered to be a part of the unnamed shale unit.

At Western Minerals Chance No. 1 (latitude 66°07'46" N, longitude 137°31"27" W), located about 33 miles east of Cath B-62, 1,952 feet of unnamed shale were found; the well did not penetrate the underlying Middle Devonian Ogilvie Formation. The rocks consist of dark brown and grey, non-calcareous, pyritic shale, bituminous in part; the uppermost 400 feet of section do not contain ironstone fragments, while the remainder contains abundant fragments throughout. Siltstone fragments are present throughout most of the interval; these cuttings are dark brown, and pyritic, with coarse silt-sized quartz and chert grains, and rare milky white floating chert grains up to 0.25 mm. in size. A few thin siliceous conglomeratic sandstone beds are also present, which? and consist of light and dark sub-rounded chert fragments up to 4 mm. in size, with lesser fine-sized quartz grains.

About 30 miles north-northwest of the Chance No. 1 well, Socony Mobil Western Minerals Ellen YT C-24 (latitude 66°38'08.87" N, longitude 137°50'8.15" W) penetrated 2,310 feet of Upper Devonian ~~Imperial~~ shale, siltstone, and sandstone of the unnamed shale unit before reaching total depth in this unit. ~~The~~ Shale comprises about 90% of the lithology in the uppermost 1,400 feet, while sandstone forms more than 60% of the rock sequence in the basal 900 feet. There is the possibility of a faulted sequence here and perhaps the basal sandy section is actually Cretaceous in age. The latter rock-type is poorly sorted, very fine to coarse grained and rarely conglomeratic, with sub-angular to sub-rounded light and dark chert grains, and a siliceous and carbonate cement. Pyrite inclusions are common, and some appear to be replaced plant fragments. Core examination indicated that the bedding dips varied from horizontal to about 45°. The shales are dark grey with siltstone interbeds and show abundant slickensides, fractures, and slump features. Plant remains are also present as are some siliceous triaxon spicules; pyrite is again abundant in the form of replaced wood fragments, crystals, and small spheres.

Peel Plateau Eagle Plain No. 1 (latitude 66°48'54" N, longitude 138°08'30" W) was drilled about 20 miles north-northwest of Ellen C-24 on a structural high. The well bored through a monotonous section of Cretaceous shale and siltstone (T.P. Chamney, pers. comm.) before reaching what is considered to be Devonian shale of the unnamed shale unit ~~Imperial Formation~~ at 3,514 feet drilling depth. The latter is black, bituminous, very pyritic, with white and light brown calcite veinlets, and has a high gamma ray signature. Only 78 feet of this shale are present



The unnamed shale unit is present in outcrop along the southern edge of the Eagle Plain. Towards the east, and north, it passes into rocks of the Imperial Formation. ~~Its northernmost expression is in the Cath B-62 well, and as mentioned above, Norris (1968) reported this unit to be present in the Northern Ogilvie Mountains about 17 miles west of this well.~~ On GSC Map 10-63 (Norris, et al, 1963), the unnamed shale unit was included in map-units 8 and 9 along the southern and southwestern flanks of the basin (Figure 3).

Bamber and Waterhouse (1971) used the term "Unit 1" for 1,300 feet of recessive shale of Visean age at the Peel River outcrop section (Figure 2) which is equivalent to the upper part of the unnamed shale unit.

Sixteen samples from this unit in the area were selected for X-ray diffraction analysis and carbon analysis. The results, summarized in Table 1 below, show that quartz comprises 65 to 100 per cent of the rock, while kaolinite, illite, pyrite, feldspar, and siderite comprise most of the minor constituents. Analysis for ~~total~~ organic carbon from nine of these samples gave values ranging from 0.69 to ~~5.51~~ 7.27 per cent for the shales, and 0.45 per cent for the only sandstone sample analyzed. To obtain total organic matter, it is necessary to multiply the per cent of organic carbon by an organic factor. However, this factor is difficult to obtain and is variable, although a mean organic factor of 1.22 was

assigned to sedimentary rocks by Forsman and Hunt (1958). The total organic matter is therefore somewhat higher than the percentages of organic carbon shown in Table 1.

Table 1. Mineralogy[1] and carbon[2] content of selected unnamed shale unit samples.

Location	Footage below top of unit	Rock type	Minerals[3] (semiquantitative %) Non-clays Q	C	D	S	P	F	A	Clays[5] K	I	Ch	Carbon[4] (weight %) Total	Mineral	Organic
Blackstone YT D-77	68- 168	Sh.	61	0	0	0	8	4	0	10	11	0	3.65	0.00	3.65
	618- 718	Sh.	65	tr	0	3	5	tr	0	13	14	0	2.32	0.46	1.86
	1018-1068	Sh.	74	0	0	4	3	tr	0	7	12	tr	2.32	0.24	2.08
	1228-1268	Sh.	83	0	0	0	5	5	0	1	6	0	5.79	0.10	5.61
	1668-1718	Sh.	80	1	2	3	1	3	0	3	6	1	1.12	0.43	0.69
	1798-1828	Ss.	82	0	3	4	1	5	0	2	3	0	1.05	0.60	0.45
Blackie YT M-59	2	Sh.	62	0	4	6	4	tr	0	4	8	0	8.53	1.29	7.24
	72	Sh.	68	0	0	0	7	3	0	6	8	0	5.02	0.12	4.90
Chance No. 1	4- 104	Sh.	81	tr	tr	0	6	2	tr	4	7	0	---	---	---
	320	Sh.	100	0	0	0	0	0	0	0	0	0	---	---	---
	1210	Ss.	95	0	0	0	5	0	0	0	0	0	---	---	---
	1222-1228	Sh.	93	0	0	4	0	0	0	0	0	0	---	---	---
	1814-1914	Sh.	76	0	0	1	4	0	5	9	5	0	---	---	---
East Porcupine River YT K-56	152- 332	Sh.	65	tr	tr	tr	3	7	0	13	9	3	---	---	---
Peel River outcrop	200- 400	Sh.	70	0	0	0	0	2	0	20	8	0	2.25	0.05	2.20
	600- 700	Sh.	71	0	0	0	0	2	0	19	8	0	2.38	0.18	2.20

Chemical analysis[6] (%)

Organic	Carbonate	Residue
---	---	---
---	---	---
---	---	---
---	---	---
6.3	5.6	88.1

[1] Mineralogical analyses determined by Philips X-ray diffractometer using CuKα radiation in conjunction with LiF curved crystal monochromator. Scanning rate 1°/minute; chart speed 1 cm/minute; settings 40 kilivolts, 20 milliamperes.

[2] Carbon analyses: total carbon determined by Leco induction furnace, mineral carbon determined gasometrically, and organic carbon determined by the difference between these values.

[3] Mineral abbreviations: Q, quartz; C, calcite; D, dolomite; S, siderite; P, pyrite; F, feldspar; A, anhydrite; K, kaolinite; I, illite; Ch, chlorite. All values are semiquantitative percentages based on peak-height ratios.

[4] --- indicates sample not analyzed

[5] "Kaolinite", "illite", and "chlorite", as reported here, indicate well-crystallized clay minerals of the 7 Angstrom, 10 Angstrom (non-expandable), and 14 Angstrom clay mineral groups, respectively.

[6] Determined by heating at 550°C

Age and Correlation. In the subsurface, macrofossils were not found in the unnamed shale unit. However, the following palynomorph assemblages were found and identified by Barss.

(1) Western Minerals Chance No. 1. Top unnamed shale unit at 6696 feet drilling depth.

GSC loc. 8426, core interval 7,016 to 7,022 feet.

Anapiculatisporites concinnus Playford
Anulatisporites anulatus (Loose) Potonie and Kremp
Anulatisporites cf. A. canaliculatus Playford
Convolutispora florida Hoffmeister, Staplin, and Malloy
Convolutispora cf. C. mellita Hoffmeister, Staplin, and Malloy
Densosporites bialatus (Waltz) Potonie and Kremp
Densosporites cf. D. duplicatus (Naumova) Potonie and Kremp
Densosporites rarispinosus Playford
Dictyotriletes cf. D. clatriformis (Artuz) Sullivan
Knoxisporites cf. K. hederatus (Ischenko) Playford
Knoxispobites rotatus Hoffmeister, Staplin, and Malloy
Knoxisporites seniradiatus Neves
Lycospora microgranulata Hacquebard and Barss
Lycospora cf. L. lobulata Staplin
Lycospora uber (Hoffmeister, Staplin, and Malloy) Staplin
Murospora aurita (Waltz) Playford
Murospora sublobata (Waltz) Playford
Monilospora moniloformis Hacquebard and Barss
Microreticulatisporites lunatus Knox
Perotrilites perinatus Hughes and Playford
Perotrilites magnus Hughes and Playford
Reticulatisporites cancellatus (Waltz) Playford
Reticulatisporites peltatus Playford
Reticulatisporites cf. R. rudis Staplin
Punctatisporites nahannensis Hacquebard and Barss
Spinozonotriletes balteatus Playford
Tripartites complanatus Staplin
Waltzispora albertensis Staplin

In addition specimens of the following genera were encountered:

Calamospora spp.
Apiculatisporis spp.
Punctatisporites spp.
Lycospora spp.
Stenozonotriletes sp.
Lophotriletes spp.
Granulatisporites spp.
Tricuitrites sp.
Murospora spp.
Camptotriletes sp.
Leiotriletes spp.
Densosporites spp.
Convolutispora spp.
Proprisporites sp.
Verrucosisporites spp.
Acanthotriletes sp.
Lophozonotriletes sp.
Dictyotriletes spp.

GSC loc. 8427, core interval 7813 to 7818 feet.

Anapiculatisporites concinnus Playford
Anapiculatisporites serratus Playford
Anulatisporites anulatus (Loose) Potonié and Kremp
Alatisporites tesellatus Staplin
Ghaetosphaerites pollenisimilis (Horst) Butterworth and Williams
Cincturasporites altilis Hacquebard and Barss
Convolutispora florida Hoffmeister, Staplin, and Malloy
Convolutispora mellita Hoffmeister, Staplin, and Malloy
Convolutispora venusta Hoffmeister, Staplin, and Malloy
Densosporites bialatus (Waltz) Potonie and Kremp
Densosporites duplicatus (Naumova) Potonie and Kremp
Densosporites spitsbergensis Playford
cf. Diatomozonotriletes rarus Playford
Dictyotriletes cf. D. clatriformis (Artuz) Sullivan
Endosporites micromanifestus Hacquebard
cf. Foveosporites insculptus Playford
Knoxisporites hederatus (Ischenko) Playford
Knoxisporites literatus (Waltz) Playford
Leiotriletes ornatus Ischenko
Lycospora microgranulata Hacquebard and Barss
Lycospora uber (Hoffmeister, Staplin, and Malloy) Staplin
Murospora aurita (Waltz) Playford
Murospora friendii Playford
Murospora intorta (Waltz) Playford
Monilospora moniliformis Hacquebard and Barss
Microreticulatisporites lunatus Knox
Perotrilites perinatus Hughes and Playford
Perotrilites magnus Hughes and Playford
Potoniespores delicatus Playford
Punctatisporites nahannensis Hacquebard and Barss
Reticulatisporites cancellatus (Waltz) Playford
Reticulatisporites peltatus Playford
Rotaspora fracta Schemel
Tripartites incisotrilobus (Naumova) Playford
Verrucosisporites eximuus Playford

Specimens of the following genera were also encountered:

Calamospora spp.	Apiculatisporis sp.
Leiotriletes spp.	Punctatisporites spp.
Densosporites spp.	Lycospora spp.
Convolutispora spp.	Lophotriletes spp.
Granulatisporites spp.	Acanthotriletes spp.
Reticulatisporites spp.	Dictyotriletes spp.
Camptozonotriletes sp.	Verrucosisporites ppp.

Burgess, Staplin, "The above assemblages are Visean age. They are typical examples of the Murospora aurita assemblage as outlined by Playford 1962-1963 in his work on the Spitsbergen Lower Carboniferous microfloras. Similar assemblages occur in western Canada, Yukon Territory, and in the Arctic Islands."

GSC loc. C-3359, well cuttings interval 8,500 to 8,600 feet.

The assemblage was not identified as to genus and species, but was considered to be of Visean age.

(2) SOBC Blackstone YT D-77. Top unnamed shale unit at 1,532 feet drilling depth, and top Ogilvie Formation at 3,614 feet.

GSC loc. C-4249, well cuttins interval 2,760 to 2800 feet.

Burgess, Staplin, "The spores recovered are not well preserved. Only a tentative age can be determined. The assemblage seems to be a mixed Mississippian-Devonian one, therefore a Strunian age is suggested."

[Even [illegible] Famennian or early Tournaisian]

(3) Socony Mobil Western Minerals Whitestone YT N-6. Top unnamed shale unit at 7,936 feet drilling depth.

GSC loc. C-7478, core sample at 7,940 feet.

Barss stated, "Some very dark poorly preserved spores. One specimen of Murospora cf. M. aurita. If this type is actually M. aurita then a Visean to Namurian age is likely."

(4) Socony Mobil Western Minerals Blackie YT M-59. Top unnamed shale unit at 6250 feet drilling depth.

GSC loc. C-3421, core interval 6,241 to 6,250 feet.

A specimen of Densosporites sp., possibly Mississippian.

GSC loc. C-3423, core interval 6,322.6 to 6,338 feet.

A specimen of Densosporites sp., possibly Mississippian.

GSC loc. C-7465, core interval 6,322.6 to 6,327 feet.

Densosporites sp., and cf. Stenozonotriletes sp. Possibly Mississippian.

GSC loc. C-7467, core sample at 6,336.

Densosporites spp., Convolutispora sp., Lycospora sp., Monilospora sp., Densosporites bialatus, Anulatisporites anulatus, and Murospora cf. M. aurita. Barss stated "I would consider this assemblage to be Visean age."

At the Peel River outcrop section, Bamber and Waterhouse (1971) found goniatite ammonoids of late Middle Visean age about 300 feet below the top of the unit; in the southeastern Eagle Plain, they found early late Visean (Cee, late Meramecian) ammonoids in the uppermost part of the shale. Norris (1968) found that the unnamed shale unit appeared "to contain beds ranging in age from Middle to possibly Upper Devonian or even younger" (p. 41). From the above, it appears that the unnamed shale unit ranges in age from Middle Devonian (Givetian) to late Visean. The Visean shale sequence is in excess of 1,950 feet, as determined from the Chance No. 1 well, and the Devonian part of the unit is in excess of 2,500 feet, as determined from the Cath B-62 well (T.P. Chamney, pers comm.). The Mississippian - Devonian boundary cannot be picked due to lack of faunal control and no apparent lithologic break in the succession. However, in the Blackstone D-77 well, sample interval 2,690 to 2700 feet contained very abundant pyrite as cubes, blebs, and massive dissemination, in a black, bituminous, slightly dolomitic shale. Ironstone nodules are not present below this interval but are scattered throughout the overlying section. This suggests a break or still-stand in the sedimentary record and a possible Mississippian - Devonian contact at 2,704 feet drilling depth, as picked on the gamma ray - sonic log.

(5) Socony Mobil Western Mineral Eagle [illegible]. Top unnamed shale unit at

The Devonian part of the unit appears to contain lateral equivalents of the Imperial Formation, and the Visean part contains equivalents of "Unit 1" of Bamber and Waterhouse (1971). The unnamed shale unit also appears to contain equivalents of the Ford Lake Shale Formation of Late Devonian to Late Mississippian age. This latter unit was named by Brabb (1969) for about 2,000 feet of predominantly siliceous shale and chert overlying the Late Devonian Nation River Formation, and underlying the Late Mississippian Calico Bluff Formation, exposed on the banks of the Yukon River immediately west of the Yukon-Alaska Boundary and just south of the 65th parallel of latitude.

Hart River Formation

The term Hart River Formation was introduced by Bamber and Waterhouse (1971) for 794 feet of limestone, dolomite, and shale with ironstone nodules, exposed on the Peel River about 9 miles east of its confluence with the Hart River (Figure 2). They described the formation as consisting of 483 feet of micritic-skeletal limestone and microcrystalline dolomite, overlain by a recessive, largely covered interval 311 feet thick which appeared to be dominantly dolomitic and calcareous shale containing nodules with skeletal fragments. The contact with the overlying Unit 2 (see Figure ~~—~~), was not seen, and the contact with this underlying Unit 1 appeared to be sharp but was not studied due to high water conditions.

In the subsurface of the Eagle Plains, the Hart River, where it has not been subjected to erosion, is considerably thicker than in the surface type section and it is herein subdivided into these members which are, in ascending order, the Birch, the Canoe River, and the CHance Sandstone. Both the Birch and Chance Sandstone form hydrocarbon reservoirs in the area. ~~Birch Member.~~

Birch Member

Definition: The Birch Member is an interbedded sandstone, shale, and limestone sequence. It conformably overlies the unnamed shale unit and underlies the Canoe River Member. Its type section (Appendix and Figure 2) is in Scony Mobil Western Minerals Birch YT B-34 (latitude 66° 03' 03.14" N, longitude 136° 51' 17.51" W). Samples of the type ~~meet~~ well are available for examination at the Institute of Sedimentary and Petroleum Geology, Calgary, Alberta.

At the Birch B-34 well, 1,576 feet of this member are found between 3,808 and 5,384 feet drilling depths. The basal 1,034 feet consists of about 50% sandstone, 40% shale and 10% limestone. The sandstone is medium to coarse grained, rarely conglomeratic, and usually tightly cemented with calcite and quartz (except ~~with largely calcareous cement. However,~~ at the top of this interval, where the ~~the sandstone~~ is only partly cemented ~~with silica and dolomite,~~ and poor to fair intergranular porosity is present. The coarse-sized fraction is

fine-sized components are mostly clear quartz. Trace amounts of coarse calcite crinoidal debris are present in some samples.

The shale is mostly black, bituminous, highly radioactive, slightly calcareous in part, with coarse, calcitic crinoid stem fragments scattered throughout. Near the base of the member, a slightly bituminous shale containing abundant white calcareous specks and some crinoidal debris is also present.

The micritic limestone is medium to dark brown, siliceous, and contains both calcareous and siliceous monaxon spicules; it is very cherty near the base of the member.

The uppermost 542 feet of the Birch Member is dominantly limestone with lesser dark shale and some sandstone. The limestone is similar to that described above as it is generally very siliceous and cherty, and contains abundant calcitic and siliceous spicules. The chert is dark grey ~~in colour~~ with light monaxon spicules. Some detrital very fine-sized quartz and chert grains are present in the limestone but comprise less than 10% of the rock. Rare crinoid and brachiopod shell fragments are also present. This limestone appears to grade through a silty to sandy limestone ~~and~~ a calcareous siltstone, but these ~~lithofacies~~ represent less than 5% of the interval. The shale is generally calcareous, ~~but~~ dark grey-brown, hard, and contains some calcitic crinoidal debris, and the sandstone is similar to that of the underlying, previously described clastic sequence. A core sample from Blackie M-59, located about 10 1/2 miles southwest of Birch B-34, was selected for X-ray diffraction analyses of the siliceous limestone. The sample, which was 96 feet below the ~~type~~ of the Birch Member, revealed that the rock consisted of 65% calcite and 35% quartz, with a trace amount of pyrite. Further analysis for organic carbon yielded 7.85 for total weight per cent of carbon, where 7.46% was mineral, and 0.37% organic. Similarity, X-ray diffraction and carbon analysis were conducted on selected well cuttings from

the porous dolomitic sandstone 45 to 60 feet below the top of the Birch Member in East Chance C-18, about 13 1/2 miles northwest of Birch B-34. The results indicate 68% quartz, 27% dolomite, and 5% calcite; and the total weight per cent of carbon was 4.40, where 4.24% was mineral, and 0.16% organic.

Distribution: From its type section, the Birch Member can be traced throughout the subsurface of the Eagle Plain area and to the type outcrop section of the Hart River Formation at the eastern edge of the basin (Fig. 2). At the western edge of the area, in the Cathedral Rock outcrop section, the largely covered recessive interval at the base of the Hart River Formation may contain a very thin Birch Member but probably it is absent due to non-deposition and the recessive interval lies wholly in the unnamed shale unit.

The thickest development of the member, 1,576 feet, is at its type well. It thins to about 1,100 feet at the Blackie M-59 well about 10 1/2 miles to the southwest, and is only 175 feet thick at the Chance No. 1 well about 19 miles to the west-northwest. There is a lithologic change also in that the sandstone percentage decreases with a corresponding increase in siliceous limestone and shale. Further south at the Blackstone D-77 well about 23 miles from the Birch B-34 type well, 580 feet of mostly shale with lesser limestone and only trace sandstone comprise this member; about 24 miles to the southeast at the type Hart River outcrop section on the Peel River, the Birch Member is 483 feet thick and consists of mostly micritic-skeletal limestone and dolomite but contains some very sandy limestone beds while the covered intervals may represent the shale sequences. Therefore, from a thick predominantly sandstone sequence at its type locality, the Birch Member changes to predominantly carbonate towards the southeast, and thins even more to a predominantly shale succession at the southern and western edges of the basin. It is about to the north due to pre-Cretaceous erosion.

Age. At the type outcrop section of the Hart River Formation, the Birch Member equivalent contained abundant faunal assemblages belonging to the Quadratia A Zone of Chesteran age; i.e., ~~upper~~ Late Visean to Namurian (Bamber and Waterhouse, 1971). In the subsurface, brachiopods belonging to the same Quadratia A Zone assemblage were found in the Birch B-34 well 273.5 feet below the top of the member, and identified by Waterhouse as follows:

GSC loc. C-4367, core sample at 4623.5 feet drilling depth.
Quadratia cf. hirsuteformis (Walcott)
"Leiorhynchus" carboniferum Girty

Similarily, in Chance No. 1, fauna from the same assemblage were found 60 to 80 feet below the top of the member as follows:
GSC loc. C-4361, core interval 6581 to 6591 feet drilling depth.

Orbiculoidea sp.
Quadratia cf. hirsuteformis (Walcott)
"Leiorhynchus" carboniferum Girty

Therefore, the Birch Member in the subsurface of the Eagle Plain is Chesteran (~~upper~~ Late Visean to Namurian) in age.

Canoe River Member

Definition: The type Canoe River Member consists almost entirely of shale, and its type section (Appendix and Figure 2) is also in Scony Mobil Western Mineral Birch YT B-34, where 2,124 feet of this member are found between 1,684 and 3,808 feet drilling depths. The headwaters of the Canoe River, after which this member is named, ~~is~~ are located about 20 miles northeast of the type Birch well.

The basal 350 feet is a non-calcareous, dark grey shale with much calcite crinoidal debris. It is pyritic, contains brown ironstone fragments, and contain thin beds of calcareous siltstone, also with crinoidal fragments. Overlying this sequence is about 1,150 feet of calcareous, pyritic shale with very abundant brown ironstone fragments. Skeletal content ~~is~~ consists largely of crinoidal debris, but trace amounts of punctuate and ~~spiny~~ brachiopod shell fragments, broken brachiopod spines and ostracods are also present. The crinoidal debris in both types of shale consists of light brown to off-white calcitic coarse fragments with traces of pyrite replacement; the fragments are about the same size as the well cuttings. A few thin intervals of skeletal ~~sparry~~ limestone, light brown, siliceous in part, with abundant crinoidal debris and brachiopod spines are also present, as ~~one~~ are thin interbeds of calcareous brown siltstone with trace amounts of calcitic crinoid fragments.

Distribution and Lithology. In the southeastern part of the area, the Canoe River Member can be traced through to the Blackie M-59 well where it is 2,237 feet thick, to the Blackstone D-77 well where only about 875 feet of the member is present as the remainder has been removed by erosion, and to the type outcrop section of the Hart River Formation where the 311-foot largely covered interval at the top of the formation is thought to be the lateral equivalent of the Canoe River Member. The crinoidal debris is sparse to absent at these locations and the basal part of the member in both of these wells is largely bituminous black shale.

In the remainder of the area, the Canoe River Member undergoes a lateral facies change to a siliceous, cherty, spicular, micritic limestone facies. This change is illustrated on the stratigraphic cross-section, Figure 2, where the carbonate and shale facies are identified. The carbonate facies reaches its maximum development in Socony Mobil Western Minerals East Porcupine River YT K-56 (latitude 66°05'33" N, longitude 137°55'32" W), about 30 miles west of the Birch B-34 type-section well, where about 1,800 feet of Canoe River Member are found; the section is not complete due to pre-Cretaceous erosion. Some shale beds are present in the central part of the area and the shale content increases again to the west where the section is about 35% calcareous shale containing some crinoid fragments at Socony Mobil Western Minerals Whitestone YT N-26 (latitude 66°05'59" N, longitude 138°20'00" W). At the Cathedral Rocks anticline surface section, located at the western edge of the Eagle Plain, about 1,700 feet of Hart River Formation is present (Bamber and Waterhouse, 1971) (Figure 2). Here the uppermost 550 feet of the Hart River Formation as well as about 500 feet in the middle are almost entirely covered and may represent dominantly shale intervals; this unit appears to be largely, if not entirely, equivalent to the Canoe River Member. Therefore, the member changes from a shale sequence at its type location in the east, to a limestone near the central part of the Eagle Plain, to a mixed shale and limestone sequence at its western extremity.

Table II indeicates the mineralogy and carbon content of selected Canoe River Member samples as revealed by X-ray diffraction analysis and carbon analysis.

The high percentage of quartz is apparent from Table II. It consists of siliceous spicules, detrital silt- and clay-sized quartz and chert, and finely-divided quartz of either replacement or chemically precipated origin. Thin section examination of the siliceous carbonate rocks indicated an intimate association of lime mud and silica with varying amounts of detrital quartz and lesser chert grains, some calcitic brachiopod, crinoid, and other indeterminable skeletal fragments, and abundant calcareous and siliceous monaxon spicules. The partial to complete replacement of many siliceous spicules by calcite was probably one of the silica sources leading to the chert replacement of the carbonate; indeed, for some rock ships, the only calcareous components are the spicules. Some of the limestone thin sections contain discontinuous silicified lentils resulting in a X-ray diffraction analysis reading of more than 50% quartz for a rock classed as a carbonate, as in the sample from Chance No. 1 at 1,452 feet.

The abundance of silica in these rocks points to a high-silica environment of deposition. Many sources for such silica concentration have been advanced by earth scientists, and it seems most problable that no one source could have been responsible for the diverse occurrence of the silica. For a discussion on the theories of the origin and distribution of silica in sediments, see Ireland (1959).

The rocks shown as limestones on the accompanying cross-section, Figure 2, range from a non-siliceous limestone to siliceous limestone, to calcareous chert. The distinction between the latter two is usually impossible under binocular microscope examination as even a silica content of 20% (as determined by X-ray diffraction) leaves an insoluble residue that is hard, consolidated, and clay-like in appearance, and gives the impression of constituting more than 50% of the rock. Indeed, most of the siliceous limestone listed in Table II appeared to be calcarous chert of calcareous siliceous shale based on the seemingly large amount of insoluble residue. The siliceous spicules are readily apparent in this residue, but the distinction between the detrital quartz and chet, and either replacement or chemically precipitated quartz is very difficult due to the fineness of the former and preponderance of the latter. The dark brown colouration of the carbonate rocks is due to the inclusion of organic matter which is between ½ and 1% as shown in Table II. The rocks then appear to grade from limestone to chert XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX in an irregular

fashion without much visible textural change, although the carbonates appear to be much greater in abundance.

The spiculite cherts are medium grey to creamy white megascopically. Thin section examination of these cherts indicated that the spicules comprise up to 80% of the rock mass in a matrix of cryptocrystalline silica which appears to be slightly coarser than that comprising the spicules. A rare amount, i.e., less than 5%, of detrital quartz and chert fragments are also present. Thin sections of the dark cherts were not prepared; they appeared to be largely featureless but binocular examination of cuttings submerged under water showed occasional chips with irregular laminations and possible spore material suggesting a significant organic matter content.

The shales of the Canoe River Member are all siliceous. Clay mineral content is absent or very low and the illite in Table II is mostly a measurement of green glauconite. The sample from the Peel River outcrop section had a kaolinite content five times higher than the highest reading in the subsurface, but the total clay mineral content was still under 25%. Bituminous shale, as typified by the sample for the Blackstone D-77 well, and non-bituminous shale are present; the organic content of the former is about four times higher than the latter, as shown in Table II. Thin section examination of calcareous shale samples indicated an abundance of finely divided detrital quartz and lesser chert grains in a matrix of lime mud and cryptocrystalline quartz. Organic matter ~~often~~ commonly imparts a dark brown colouration to the rock obscuring the details of the thin section. Finely comminuted calcitic skeletal debris as well as coarser fragments, such as spicules, brachiopod shells, and crinoids, are sometimes present. The non-calcareous shales are similar in that fine terrigenous quartz and chert fragments are discernable in a cryptocrystalline quartz matrix; the small amount of kaolinite and other non-clay minerals are usually obscured by the organic matter with the exception of pyrite, which is ubiquitous in the section, and green glauconite grains.

Table 2 Mineralogy[1] & carbon content of selected Canoe River Member Samples

Well Name	Footage below top of unit	Rock Type	Minerals[3] (semiquantative %) Non-Clays[4] Q	C	D	S	P	F	Clays[5] K	I	Carbon[6] (weight per cent) Total	Mineral	Organic
Chance No. 1	338	Siliceous Ls.	66	28	6	0	0	0	0	0	----	----	----
	355	Dol. Silty Ls.	12	71	17	0	0	0	0	0	----	----	----
	677	Silty Ls.	35	65	0	0	0	0	0	0	----	----	----
	1192-95	Silty Ls.	41	58	tr	0	tr	0	0	0	----	----	----
	1236	Calc. Ss.	82	18	0	0	0	0	0	0	----	----	----
	1439-44	Calc. Sh.	57	43	0	0	0	0	0	0	----	----	----
	1452	Sil. Ls.	59	41	0	0	0	0	0	0	----	----	----
	1454	Calc. Chert	88	9	3	0	tr	0	0	0	----	----	----
	1720-25	Calc. Sh.	83	16	0	0	1	0	0	0	----	----	----
	1734-39	Calc. Sh.	79	21	0	0	0	0	0	0	----	----	----
E. Chance C-18	286-336	Sil. Ls.	46	51	3	0	0	0	0	0	7.46	7.02	0.44
	1166-1266	Sil. Ls.	35	45	20	0	0	0	0	0	9.28	8.82	0.46
	1676-1746	Sil. Ls.	32	64	4	0	0	0	0	0	9.30	8.90	0.40
Whitestone N-26	869-729	Sil. Ls.	44	53	3	0	tr	0	0	0	----	----	----
	1149	Calc. Sh.	47	46	1	1	2	0	0	3	----	----	----
Blackie M-59	41	Shale	75	2	6	5	1	2	3	6	1.65	1.02	0.62
	178	Shale	76	5	4	3	3	0	3	6	1.85	1.01	0.84
Porcupine R. K-56	16-106	Sil. Ls.	29	63	8	0	0	0	0	0	----	----	----
	106-156	Sil. Ls.	32	66	tr	0	0	0	0	tr	1.2	----	----
	516-556	Sil. Ls.	30	66	tr	tr	tr	tr	0	3	2.8	----	----
	1256-1456	Sil. Ls.	43	51	6	0	tr	0	0	0	----	----	----

(Table 2 continued on next page))

(((Note: Table 2 continued here from previous page)))

Well Name	Footage below top of unit	Rock Type	Minerals (semiquantitative %) Non-Clays[1] Q	C	D	S	P	F	Clays[2] K	I	Carbon[3] (weight per cent) Total	Mineral	Organic
Blackstone D-77	630-730	Bit. Sh.	74	tr	2	0	6	tr	3	14	3.89	0.50	3.39
Parkin CK D-51	54-104	Sil. Ls.	39	57	4	0	0	0	0	0	----	----	----
Birch B-34	146-206	Calc. Sh.	54	38	4	0	1	0	0	3	----	----	----
Peel River otc section	75	Shale	76	1	0	0	0	tr	15	8	1.14	0.19	0.95

[1] Mineralogical analyses determined by Philips X-ray diffractometer using CuKα radiation in conjunction with LiF curved crystal monochromator. Scanning rate 1°/Minute; chart speed 1 cm/minute; settings 40 kilivolts, 20 milliamperes.

[2] Carbon analyses: total carbon determined by Leco induction furnace, mineral carbon determined gasometrically, and organic carbon determined by the diference between these values.

[3] Mineral abbreviations: Q, quartz; C, clacite; D, dolomite; S, Siderite; P, pyrite; F, feldspar; K, kaolinite; I, illite. All values are semi-quantitative percentages based on peak-height ratios.

[4] --- indicates sample not analyzed.

[5] "Kaolinite", and "illite", as reported here, indicate well-crystallized clay minerals of the 7 Angstom and 10 Angstrom (non-expandable) mineral groups, respectively.

Age and Correlation. At the Birch B-34 type section, brachiopods belonging to the Quadratia A Zone of Chesteran age were found in the upper half of the member and identified by Easterbrook as follows:

GSC loc. C-4357, core sample at 2167 feet drilling depth. "Leiorhynchus" carboniferum Girty

GSC loc. C-4358, core sample at 2328 feet drilling depth. Orbiculoidea sp.

Palynomorph identifications by Barss yielded age assignments for this member as follows:

GSC loc. C-4239, core interval 2161 to 2171 feet drilling depths. Barss stated, "Similar assemblage to C-4238. [see age discussion on Chance Sandstone Member at that location below] Most probably Permian although late Stephanian cannot be ruled out".

GSC loc. C-7436, core interval 2322 to 2325 feet drilling depth.

Florinites visendus, Potonieisporites elegans, Florinites sp., Punctatisporites spp., Densosporites spp., Reticulatisporites cancellatus. "The presence of Florinites and Potonieisporites would indicate a Pennsylvanian or possibly younger age. However the other spores that are present appear to be the same color and preservation and together with the Florinites etc., compare with the assemblage reported by Felix and Burbridge from the Springer of Southern Oklahoma. I would think that the age is probably middle Namurian." Barss stated*

GSC loc. C-7437, core interval 2325 to 2330 feet drilling depth.

Florinites guttatus, Potonieisporites elegans, Florinites visendus, Perotrillites perinatus, Guthorlisporites sp., Rugospora sp., Schopfipollinites sp., Proprisporites sp., Densosporites rarispinosus, Murospora cf. M. aurita, Potoniespores delicatus, and others. "I would consider this assemblage similar to the one above and of probable middle Namurian age." Barss stated,

GSC loc. C-4240, core interval 2323 to 2330 feet drilling depth. Namurian, probably middle or late because of presence of Florinites.

GSC loc. C-4241, core interval 3594 to 3604 feet drilling depth. Similar assemblage to C-4240.

A single ammonoid, Nomismoceras sp., was found in a completely pyritized form in the Birch B-34 well in a core sample at 3595.4 feet (GSC loc. C-8201), and indicated a late Visean age (W. Nassichuk, pers. comm.).

In the Blackie M-59 well, foraminifera present in a thin section prepared from ~~collected from a~~ well cuttings sample between 3610 and 3620 feet drilling depth (i.e., 686 to 696 feet below the top of the Canoe River Member) were identified by B. Mamet (pers. comm.) as Eolasiodiscus sp. and Earlandia sp., and indicates an age range from late ~~upper~~ Chester to Morrowan or possibly Atokan.

Also in the Blackie M-59 well, palynomorph assemblages were identified by Barss as follows:

GSC loc. C-7450, core sample at 2963 drilling depth.

Vittatina spp., Potonieisporites sp., Limitisporites sp., Vestigisporites sp. are present.

GSC loc. C-7451, core sample at 2970 feet drilling depth.

Vittatina sp., Striatopodocarpites sp., Striomonosaccites sp., cf. Lueckisporites sp., and an unidentifiable bisaccate type.

GSC loc. C-7452, core sample at 3805 feet drilling depth.

Vittatina sp., Protohaploxypinus sp., Limitisporites sp., Striatoabietites sp., are present.

GSC loc. C-7453, core interval 3900 to 3903 feet drilling depth.

Vittatina spp., Protohaploxypinus sp., and Limitisporites sp. are present.

GSC loc. C-7454, core interval 3905 to 3910 feet drilling depth.

Vittatina spp., Florinites sp., and Vestigisporites sp. are present.

Barss stated,

"There are not many spores in the above samples and they are in various states of preservation. The immediate impression is that they belong to the same assemblage. This assemblage has been reported from the Tatonduk River in Paper 68-18 by Bamber and Barss, and is considered to be of Permian age. Some of the forms have their beginning in latest Pennsylvanian but the abundance of the striate bisaccate and striate types without any evidence of typical late Pennsylvanian types present, would favour the Permian age. There are reworked Mississippian spores in nearly ever sample."

It must be pointed out that the exact upper age limit of the Quadratia A Zone has not been determined (Bamber and Waterhouse, 1971). Furthermore, the presence of palynormorphs identified as Permian or latest Pennsylvanian in the same core interval that yielded Late Mississippian to Early Pennsylvanian brachiopods and a Late Mississippian ammonite indicates a conflict beyond the scope of this paper. However, the detailed brachioped zonations supported by foraminiferal studies in Bamber and Waterhouse (ibid.) suggests that the Chesteran age determinations based on the presence of macrofossils are preferable to the age assignments based on palynomorph assemblages.

In Socony Mobil Western Minerals Parkin YT D-51 (latitude 66°10'08.5" N, longitude 137°26'04.5" W), a core interval 404 to 413.5 feet below the top of the Canoe River Member carbonate facies

Bamber and Waterhouse (ibid.) contained the following assemblages belonging to the Quadratia A Zone:

GSC loc. C-4365, ~~core sample at~~ 4141 feet drilling depth.
Quadratia cf. hursuteformis (Walcott)
"Leiorhynchus" carboniferum Girty

GSC loc. C-4366, ~~core sample at~~ 4122 feet drilling depth.
"Leiorhynchus" carboniferum Girty

GSC loc. C-4368, ~~core sample at~~ 4124 feet drilling depth.
"Leiorhynchus" carboniferum Girty
Aviculopecten sp.

GSC loc. C-4369, ~~core sample at~~ 4126 feet drilling depth.
Quadratia hirsuteformis (Walcott)

GSC loc. C-4370, ~~core sample at~~ 4128 feet drilling depth.
Quadratia hirsuteformis (Walcott)

GSC loc. C-4371, ~~core sample at~~ 4129 feet drilling depth.
Quadratia hirsuteformis (Walcott)
Dielasmatid

The largely covered shale sequence at the type Hart River outcrop section on the Peel River that is here considered to be correlative with the Canoe River Member contained a Quadratia A Zone faunal assemblage 75 feet above its base; no other fossils were found in the shale sequence (Bamber and Waterhouse, ibid.). At the Cathedral Rocks anticline section, these authors found Quadratia A Zone assemblages in the uppermost Hart River Formation which correlates with the Canoe River carbonate facies in the subsurface.

The Canoe River Member carbonate and shale facies are thus considered to be Chesteran, i.e., late Visean to Namurian, in age.

Chance Sandstone Member

Definition. The Chance Sandstone Member is a conglomeratic sandstone unit that conformably overlies the Canoe River Member; it underlies unnamed uppermost Hart River carbonates in the south-central part of the basin, and subcrops at the sub-Mesozoic unconformity in the southeastern Eagle Plain.

Western Minerals Chance No. 1 (latitude 66°07'46" N, longitude 137°31'27" W), the designated type-section well for the member, encountered 598 feet of Chance Sandstone between 4,258 and 4,856 feet drilling depths. Samples and cores from this well are available for examination at the Institute of Sedimentary and Petroleum Geology, Calgary, Alberta. The type member is described in the Appendix of this report. Chance No. 1 was completed in 1960 as the first potential hydrocarbon producer in the Yukon Territory, with the Chance Sandstone forming the reservoir rock.

At its type section, the sandstone is conglomeratic in the uppermost 250 feet, and mostly medium to coarse grained in the remainder of the unit, with intervals of calcareous shale. Except for the uppermost 100 feet, the sandstone is calcite cemented. The coarsest fraction is composed of subrounded to rounded chert grains which are milky white, medium and dark grey, light brown, and rarely green in colour; a few quartzite grains are also present. The finer fraction is largely quartz, anhedral to subhedral, generallly fine-sized or smaller, and comprises less than 25% of the siliceous fraction. The reservoir portion is confined to the uppermost 100 feet which is porous and permeable. X-ray diffraction analyses and thin section examination of ~~six~~ core samples indicated that the reservoir rock is composed entirely of chert and quartz grains, but unlike the carbonate cemented portion, the quartz grains comprise about 50% of the rock mass and are predominantly subhedral as the crystal faces formed by unimpeded growth into the rock pores.

Distribution. In the Eagle Plain area, the Chance Sandstone has been largely removed by pre-Cretaceous erosion and is thought to be present now only in the subsurface (Figures 2, 3). It is present at the Chance No. 1 discovery well, and two step-out wells, Canoe River Chance YT J-19 (latitude 66°08'31.20" N, longitude 137°32'28.022" W), and Socony Mobil Western Minerals Chance YT G-8 (latitude 66°07'18.1" N,

longitude 137°30'50.8" W), located about 1½ miles north and ½ mile south, respectively, from it; the member is also present at the Birch B-34 and Blackie M-59 wells. At the latter two wells, 736 feet and 1,016 feet, respectively, of Chance Sandstone Member overlie the Canoe River shale facies. The uppermost 190 feet of the member at Blackie M-59 is a glauconitic, calcareous siltstone containing abundant chonetid and linoproductid types of brachiopod remains. X-ray diffraction analyses of a core sample at 1,962 feet indicated 50% quartz, 30% calcite, 16% dolomite, 2% kaolinite, and 2% glauconite.

The Chance Sandstone Member is not present in ~~Soeony Mobil Western Minerals~~ the Whitestone YT N-26 ~~(latitude 66°05'59" N, longitude 138°20'00" W)~~ and the East Porcupine River K-56 wells, which lie about 11½ miles and 22½ miles, respectively, west of the Chance No. 1 well, but its absence ~~is probably~~ could be due to erosion as the Canoe River carbonate facies immediately underlies the sub-Mesozoic unconformity in these two wells.

Age and Correlation. No diagnostic fossils were found in the Chance Sandstone Member in the subsurface. However, at the Chance No. 1 and Chance G-8 wells, a siliceous limestone sequence which overlies the Chance Sandstone and is considered to be uppermost Hart River Formation contained faunal belonging to the Quadratia A Zone of Chesteran age as identified by J.B. Waterhouse.

Chance No. 1 contained the following:

GSC loc. C-4363, core sample at 4153 feet (107 feet above top of Chance Sandstone)
Quadratia hirsuteformis (Walcott)
"Leiorhynchus" carboniferum Girty
?Crurithyris sp.

GSC loc. C-4364, core sample at 4067 feet (193 feet above top of Chance Sandstone)
?Flexaria sp.

At the Chance G-8 well, Neospirifer sp. was present at 3943 and 3954 feet (295 and 306 feet above top of Chance Sandstone, GSC locations C-4359 and C-4362, respectively).

At the Birch B-34 well, a core from near the centre of the Chance Sandstone Member contained the following palynomorph assemblages as identified by Barss:

GSC loc. C-7432, core sample at 1298 feet drilling depth.

Vittatina, Limitisporites, Pityosporites, Protohaploxypinus, Potonieisporites, and several other very poorly preserved bisaccate forms. Mississippian spores are also present. Age is Permian.

GSC loc. C-7433, 1300 feet drilling depth.
Vittatina are quite numerous. Age is most probably Permian.

GSC loc. C-4238, core interval 1298 to 1303 feet drilling depth. Barss stated, "Most probably Permian. Forms present are very similar to Tatonduk River assemblage of Bamber and Barss (1969). Reworked Mississippian spores present."

In the Blacke M-59 well, palynomorphs from the upper half of the sandstone unit belong to the same assemblages as those found in the underlying Canoe River Member, identified by Barss as follows:

GSC loc. C-7445, core interval 1960 to 1964.6 feet drilling depth.

Spores are broken and very poorly preserved. There are specimens of Vittatina, Striatoabietites, and a specimen of Laevigatosporites present.

GSC loc. C-7446, core interval 1974.3 to 1978.6 feet drilling depth. Vittatina spp.

GSC loc. C-7448, core interval 2127 to 2130 feet drilling depth. ?Potonieisporites sp.

GSC loc. C-7449, core interval 2173 to 2176 feet drilling depth.

Numerous Vittatina; Striomonosaccites sp., and Limitisporites sp. Sacs are broken very badly.

The same comments listed under the discussion of the aforementioned Canoe River Member for GSC locations C-7450 to C-7454 apply; i.e., the assemblage is considered to be of Permian age by Barss.

For core interval 2154 to 2194 feet (GSC loc. C-3417) in the Chance Sandstone Member, and 2962 to 2972 and 3900 to 3910 (GSC locations C-3418 and C-3419, respectively) in the Canoe River Member, Barss stated " The above three samples contain numerous striate bisaccate, mololete bisaccate, monolete monosaccate, striate monosaccate and forms assignable to the genus Vittatina. This assemblage of palynomorphs is indicative of a Lower Permian age, although some of the forms appear first in the Stephanian [uppermost Pennsylvanian] . In all three samples there are numerous reworked spores of Mississippian age."

A well cutting sample from about the middle of the Chance Sandstone in this well (2310 to 2320 feet, GSC loc. C-8202) contained foraminifera identified as Trepeilopsis sp. and ~~Asterinellids~~ apterrinella (B. Mamet, pers. comm.); ~~[illegible]~~ these forms have an age range from middle Chester ~~and probably~~ through Pennsylvanian. ~~It was suggested (Mamet and Mason, 1971; B. Mason, pers. comm.).~~

As the palynomorph assemblages are the same as those found in the underlying Canoe River Member, the same comments as to the

conflict of age assignments as determined from palynomorphs and invetebrate faunal assembaages are raised, and the Chance Sandstone Member in the Birch B-34 and Blackie M-59 wells is considered to be the same age as in the type member, i.e., Chesteran (~~upper~~ Visean to Namurian). There is the possibility that the sandstone units in the Chance well area and those in the Blackie-Birch area were deposited as discrete sandstone bodies of somewhat different ages, but at the present time, they are considered to be contiguous.

At the outcrop section on the Peel River, 209 feet of clacareous and dolomitic conglomeratic sandstone overlies the type Hart River Formation (Figure2). This clastic unit, which is largely covered, was called "Unit 2" by Bamber and Waterhouse (1971). The lower part was unfossiliferous, but the upper 60 feet contained fauna that they identified as Moscovian (Middle Pennsylvanian) in age. The contact with the underlying 311-foot shale unit (Canoe River Member of this report) was covered and there is the possibility of an unconformity, or even a fault, separating these two units, but this cannot be documented either way at the present time. The relationship between the Chance Sandstone Member and Unit 2 are not clear and therefore alternate correlations ~~they are~~ are ~~not~~ shown in Figure 2, ~~as contiguous units.~~

Similarily, at the Cathedral Rocks anticline near the western edge of the Eagle Plain (Figure 2), Unit 2 is younger in age than the Chance Sandstone of the subsurface. Here, Bamber and Waterhouse (ibid.) found late Bashkirian to early Moscovian fauna in a largely covered skeletal limestone and sandstone unit overlying Hart River carbonates. The latter is also poorly exposed and the contact with Unit 2 not seen. Unit 2 may be laterally continuous, but slightly younger is age, than the Chance Sandstone, but until further evidence is available, the two rock units are not ~~shown as~~ presumed stratigraphic equivalents.

If future work bears out their continuity, then the type Hart River Formation will have to be redefined to include Unit 2.

HART RIVER SANDSTONE ANALYSIS

Grain size analysis on six core samples selected at random from the Chance Sandstone Member plus two samples from the Birch Member were performed primarily to gain a better understanding of the materials comprising the sandstones. Four of the samples were porous, siliceous types, i.e., 100% composed of chert and quartz, and the other four were calcite cemented. This section examinations supplemented the size analysis.

The rocks were disaggregated by crushing and pounding with a rubber mallet, acidized if carbonate cemented, treated with ASTM Standard Hexametaphosphate solution, and scrubbed by an ultrasonic probe. They were then filtered, dried, and sieved using a half-ϕ set (from -2 to 4.5ϕ). After sieving, each size fraction was weighed, and then examined under a binocular microscope.

Histograms and grain percentages, i.e., percentages of light and dark coloured chert fragments and quartz grains, are shown on Figures 4 to 7. The results of the grain size analysis were plotted on probability paper, and the graphic mean, inclusive graphic standard deviation, inclusive graphic skewness, and graphic kurtosis, were calculated as proposed by Folk (1968); these statistical parameters are summarized also on Figures 4 to 7. Owing to the nature of the probability curve, all the graphic parameters could not be obtained for the sandy conglomerates. The geological significance of such statistical data are not fully known for ancient rocks, and they are presented here mainly as descriptive terms to aid in rock classification.

From the figures, it can be seen that dark coloured chert dominates the coarse sand to gravel-sized range, while quartz grains comprise most of the medium sand-sized and finer fractions. The chert grains are varicoloured, with black, medium grey, and off-white predominating, and light green, tan, yellow, and light orange, present in much lesser amounts, with rare spiculite grains; rare grains of quartzite were also seen. Most of the chert grains are sub-rounded and near-spherical. A few of the coarser off-white grains are pitted from pressure contact with adjoining grains. Pyrite cubes were commonly found still attached to the chert grains. Thin section examination showed that most of the chert grains are composed of microcrystalline quartz but some radiating fibres of chalcedony are

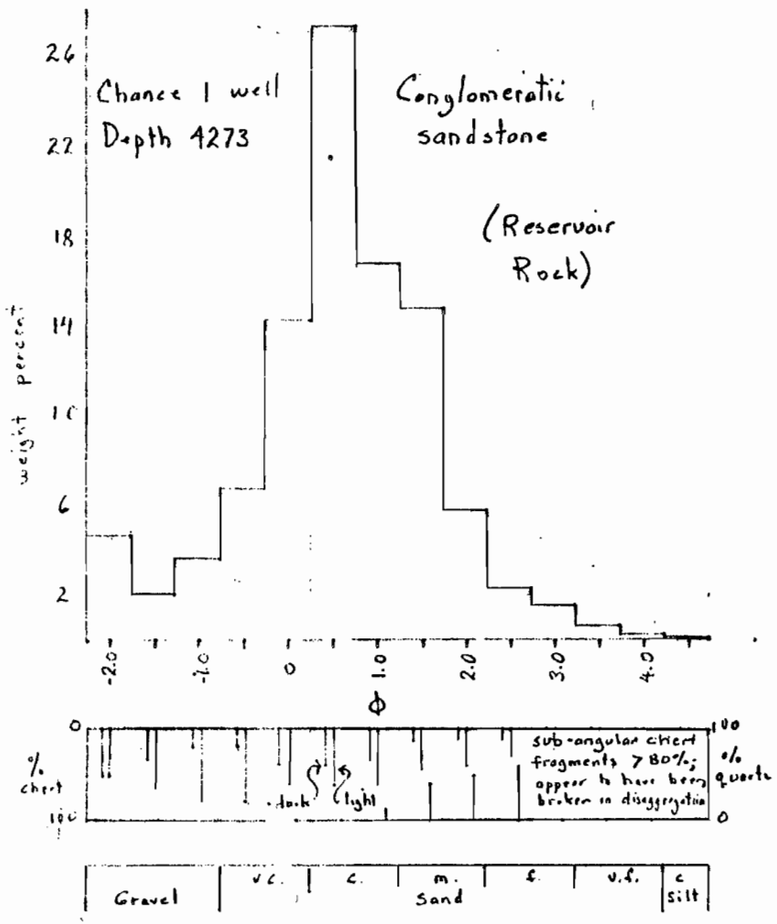
also present. The grains are often fractured with megaquartz vein fillings. Rounded and near-spherical quartzite grains, although sparse, were present in most of the thin sections examined.

Quartz grains are clear, and both subhedral to rarely euhedral, and anhedral. Thin section examination indicated that the crystal faces are a diagenetic phenomena in that they are overgrowths in optical continuity with the quartz nucleus and formed by unimpeded growth into the rock pores. The weight percentages of quartz grains shown in Figures 4 to 7 are therefore somewhat higher than initially deposited. Although most of the quartz crystal showed no visible demarcation line between overgrowth and nucleus, some grains were seen with dust lines separating sub-angular nuclei from overgrowths. They are assumed to be the result of direct precipitation as they do not contain inclusions. The primary porosity of the sandstones has been somewhat diminished by the quartz grain growth; indeed, in some thin sections the quartz formed interlocking grains completely destroying the porosity. However, most of the non-porous sandstone is predominantly calcite cemented, and it is apparent that the spar was deposited after some quartz growth had previously occurred. Where calcite and quartz cementation is sparse to absent, porosity values ~~XXXXXXX~~ in excess of 20% can be expected.

The coarse, rounder fraction consisting largely of varicoloured chert grains is thought to have come from older re-worked sandstones, while the more angular, and finer, quartz grains are probably primary, suggesting a multiple source for these sandstones. The sandstones from the Birch Member and Chance Sandstone Member appear much the same in composition, texture, and diagenetic history, suggesting that they were deposited under the same sedimentary conditions.

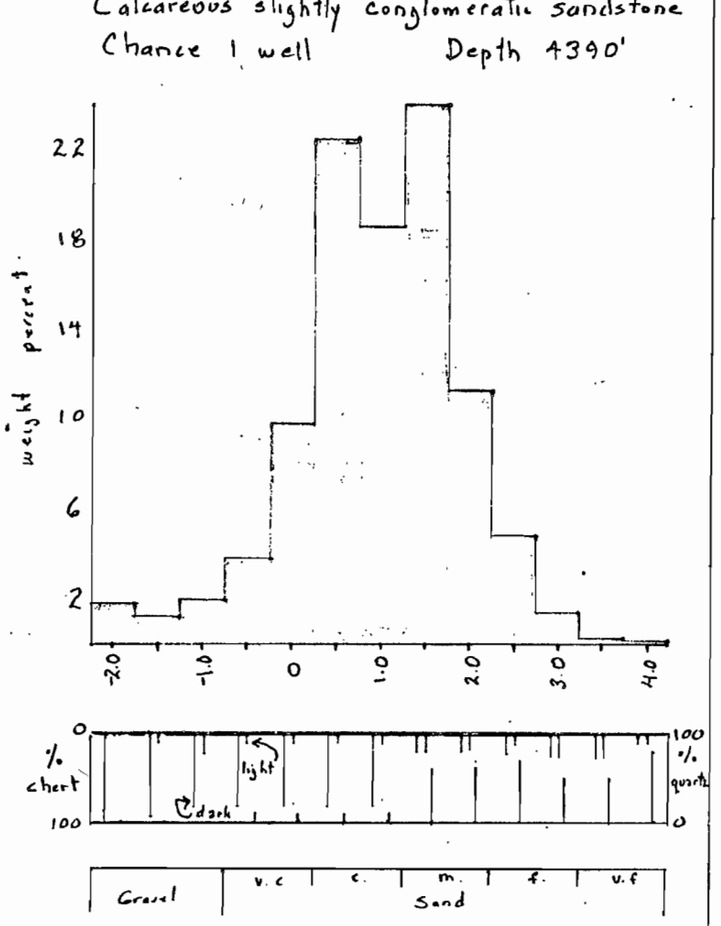
The pictorial histograms show in Figures 4 to 7 are innaccurate with respect to the finer fractions. The latter are in excess due to splitting of the coarser grains in disaggregation; the coarser fractions contain aggregates of both fines, and fine and coarse, but the percentages of aggregate was less than 20% in each size range and these were subtracted from the individual sample weights. Some of the finest size ranges contain green glauconite grains and black pyrobitumin which slightly affects the sample weight.

Finally, the quartz overgrowths, being a diagenetic change, have masked the original size of the deposited quartz. In view of the type of sandstones encountered, i.e., from slightly conglomeratic sandstone to sandy conglomerate, it is not surprising that the statistical parameters should show wide fluctuations. The graphic mean, being a measurement of overall size, ranges from -0.19 to 1.73 ϕ, which is very coarse to medium sand-sized; the standard deviation, a measurement of sorting, ranges from 0.66 to 1.69 ϕ, which indicates moderately well-sorted to poorly sorted. The skewness, a measurement of the degree of asymmetry and whether a curve has an asymmetrical tail on the left or right, ranges from -0.06 to 0.55, which is near -symmetrical to strongly fine-skewed. The kurtosis, a measurement of the ratio between the sorting in the tails of the curve and the sorting in the central portion, ranges from 0.75 to 1.12, i.e., from tails better sorted than the central portion to about equal sorting. The bimodal nature of some of the curves and histograms reflects the quartz and chert relationships as shown on the grain percentages chart for each size range.



Mean: 0.68 ϕ Standard Deviation: 1.04 ϕ

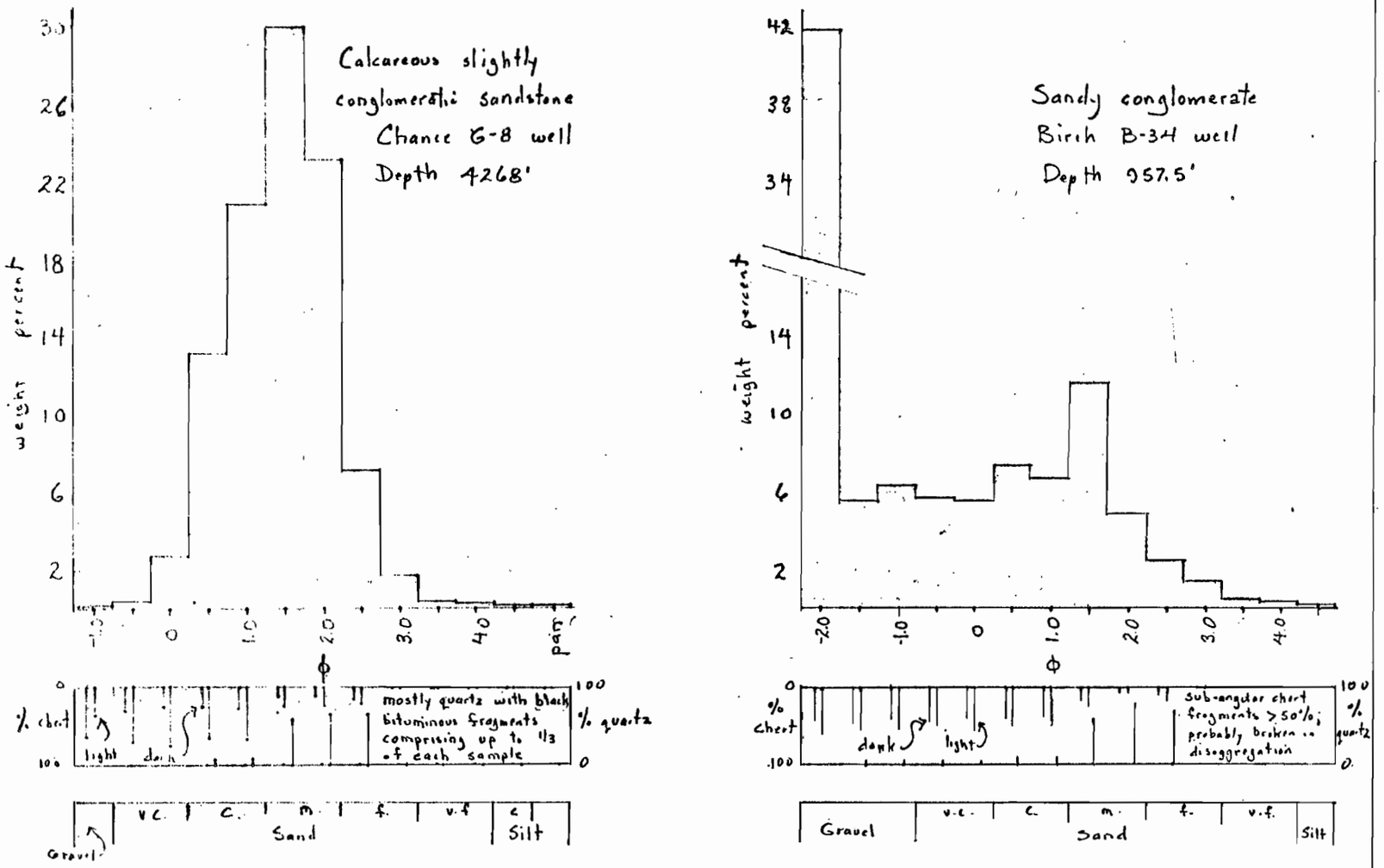
Skewness: +0.06 Kurtosis: 0.87



Mean: 0.76 ϕ Standard Deviation: 0.86 ϕ

Skewness: -0.06 Kurtosis: 1.12

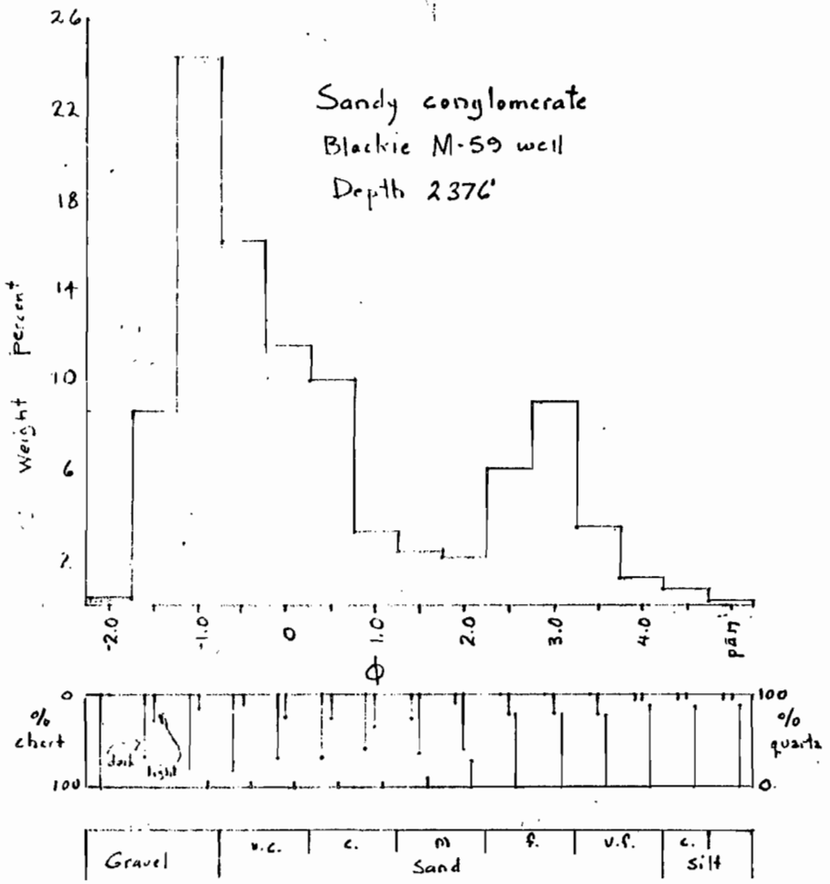
Figure 4 Histograms and grain percentages, Chance Sandstone Member.



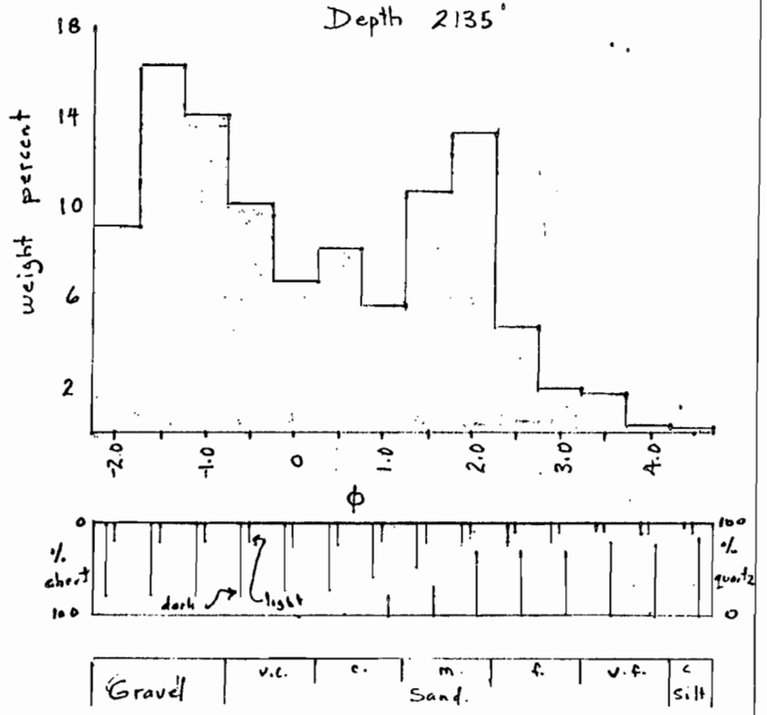
Mean : 1.17 ϕ Standard Deviation : 0.66 ϕ

Skewness 0.18 Kurtosis 0.75

Figure 5 Histograms and grain percentages, Chance Sandstone Member



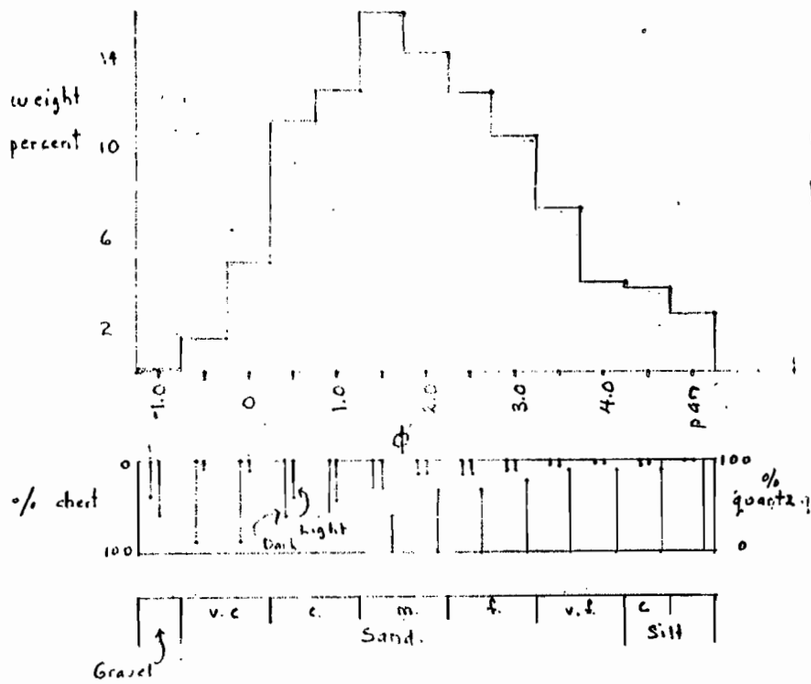
Mean: 0.15 ϕ Standard Deviation: 1.63 ϕ
Skewness: 0.55 Kurtosis: 0.92



Mean: -0.19 ϕ Standard Deviation: 1.69 ϕ

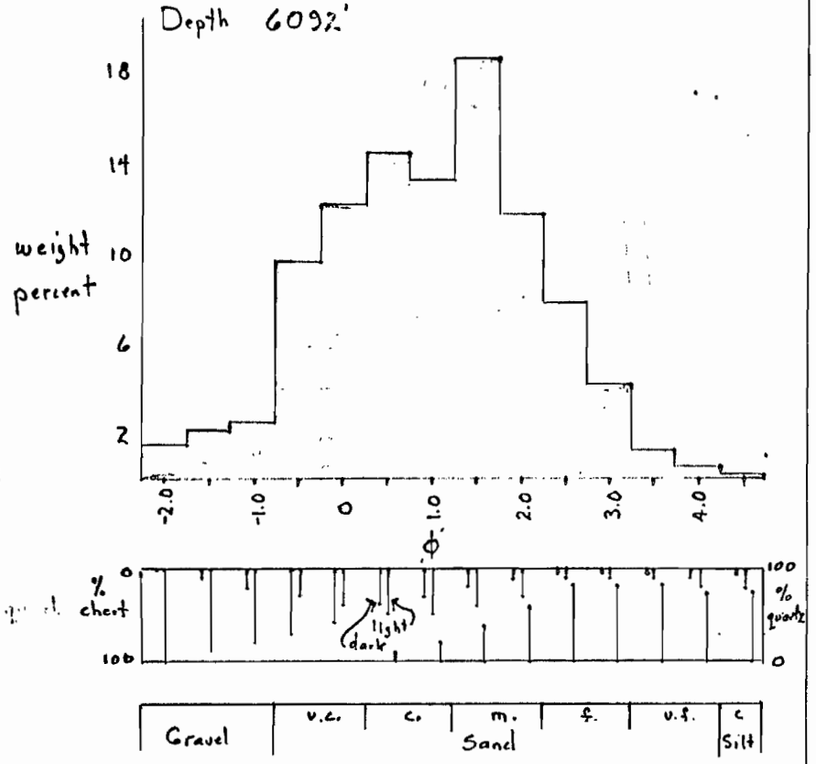
Figure: 6 Histograms and grain percentages, Chance Sandstone Member.

Calcareous slightly conglomeratic sandstone
Birch B-34 well
Depth 4896'



Mean: 1.73 ϕ Standard Deviation: 1.31 ϕ
Skewness: -0.02 Kurtosis: 0.95

Calcareous conglomeratic sandstone
Chance 1 well
Depth 6092'



Mean: 0.72 ϕ Standard Deviation: 0.18 ϕ
Skewness: -0.03 Kurtosis: 1.11

Figure 7. Histograms and grain percentages, Birch Member

SEDIMENTARY HISTORY

The highly siliceous nature of the lime mud and shale, and the conglomeratic and mud-free nature of the sandstones pose some problems in reconstructing the depositional environments. However, comparison of the sequence with actual and proposed models by Wilson (1969), Thomson and Thomasson (1969), Tyrrell (1969), and Laporte (1969), suggests an intermediate to deep water depositional environment for the Imperial-unnamed shale - Hart River sequence in the Eagle Plain basin.

All of the above authors agree that "deeper water" carbonates include such features as:

(1) dominance of lime mud

(2) dark colour due to preservation of organic material

(3) profusion of sponge spicules

(4) highly siliceous, with variable mixtures of lime mud and microcrystalline quartz.

(5) chert beds and nodules common

(6) either very specialized benthonic fauna, or more commonly, solely pelagic fauna.

The widespread Imperial Formation has been called a thick sequence of turbidites by Glenaie (1963). The few cores cut in this rock unit in the Eagle Plain area show features which support this concept, such as crude gradational bedding, highly variable dips, the highly siliceous nature of the shales, the abundant pyritized plant fragments, and the highly variable shale-siltstone-sandstone sequences.

If indeed this is so, then the deep water origin of the remainder of the sedimentary succession discussed in this paper can be argued as follows. The Devonian-Mississippian boundary is conformable but the Tournaisian is greatly condensed due to the deep-water starved basin type of environment (Adams, et al., 1951) which is thought to have been present at this time; the entire sedimentary record of the Tournaisian period may be represented by only a few feet of siliceous shale. The pyritic zone in the Blackstone D-77 well discussed above is thought to represent at least part of such a starved basin deposit. Tournaisian continental deposits were reported in Bamber and Waterhouse (1971) as occurring in the Snake River area, about 55 miles east of the Blackstone D-77 well, and suggest that relatively steep depositional slopes prevailed.

The development of the shallow to deep water facies of the Lower Pennsylvanian Dimple Limestone in Texas was discussed by Thomson and Thomasson (1969); the Hart River Formation shows a great deal of similarity to this rock unit. The Dimple Limestone is a sequence of siliceous limestone, conglomerate, shale and cherts, gradationally overlying and underlying Mississippian and Pennsylvanian terrigenous flysch facies, respectively. In the deeper water facies, chert pebble conglomerates with practically no matrix are common in the lowest part of the formation; shales are spicular and composed of lime and terrigenous mud; and the black chert beds are associated with the shales are often almost entirely composed of siliceous spicules. The authors recognized three facies, shelf, slope, and basin; the slope facies are referred to as "proximal" turbidites following the usage of Walker (1967) and the basin deposits are "distal" turbidites. The rock sequence comprising the Hart River Formation has characteristics of both the proximal and distal turbidite facies of the Dimple Limestone. In the Hart River, graded bedding is very pronounced in cores of the conglomerates sandstones; in limestone thin sections, fine sized chert and quartz grains also showed some crude gradational aspects.

Wilson (1969) in his discussion of "deeper water" limestone cited three types of microfacies be considered to be deposited below wave base. These are also found in the Hart River carbonate facies and consist of dark, laminated lime mudstone, calcisiltite with spicules and associated quartz grains, and a much less common facies of lithoclastic grainstone or micro-breccia. The latter lithology was only found in the uppermost part of the Hart River carbonates, while the spicular calcisiltite was most common, and the sparsely laminated lime mudstones were less abundant. The laminae are caused by concentrations of organic matter. Wilson (ibid) observed many minor sequences where the finest grained material capping the strata was siliceous, and replacement chert nodules and thin chert bands occurred as diagenetic products in these levels; such siliceous rocks are very common in the Hart River Formation. In his discussion on organic constituents, Wilson (ibid) stated that certain characteristic brachiopods occurred in the deeper water carbonates and shale and pointed out that the leiorhynchids were especially characteristic of this environment in Devonian and Mississippian sediments; *"Leiorhynchus" carboniferum* is the main diagnostic fauna of the Hart River Formation. He also stated that dark shales are found basinward of the lime mudstone - calcisiltite facies, again a feature found in the Hart River. Furthermore in his examples of sediments in cratonic basins which are of probable

deeper water origin, Wilson (ibid) printed out that in all of these sequences, the beds in question occurred in the lower part of an upward shallowing lithogenetic series and represented transgressive deposits. The Hart River forms the youngest Paleozoic strata in the Eagle Plains subsurface, but it is overlain by the shallow-water deposited Ettrain Formation in the surrounding surface sections (Bamber and Waterhouse, 1971).

Therefore, in the Eagle Plain area, the sedimentary record is envisaged as a continuing sequence from the Upper Devonian Imperial Formation, through the unnamed shale unit, Hart River Formation, and into the Ettrain Formation, with no erosional breaks. Uplift and erosion of the Middle Devonian Ogilvie Formation was followed by subsidence with the formation of a basinal trough sub-paralleling the Richardson Mountains. Slow deposition of siliceous shale with periodic influxes of turbidite deposits from the east and north-east formed the rocks of the Imperial Formation. An increase in subsidence rate relative to sea level coupled with a lowered rate of sedimentary infill initiated bottom starvation in Tournaisian time in the south central part of the basin, but it is thought that sedimentary infill continued during this time in the southeastern portion of the Eagle Plain. A return to conditions similar to that prevailing during deposition of the sediments comprising the Imperial Formation occurred, and the dark siliceous shales of the unnamed shale unit were deposited with periodic turbidite flows again bringing in sandstones.

Development of carbonate shelves to the northwest and southeast provided a source of limestone mud which resulted in the mixed carbonate-terrigenous sediments of the Birch Member. An increase in the rate of lime mud deposition led to the development of the Canoe River carbonate facies; these graded into the basinal dark shales of the Canoe River shale facies. At the Canoe River East Chance C-18 well, the Canoe River Member is a mixed carbonate-shale facies and is thought to be close to the break between the slope and basin facies, while the Birch B-34 and Blackie M-59 wells were drilled in the basin facies. The sediments were probably deposited as prograding fronts, accounting for the greatly thickened succession at the later two wells relative to the Peel River outcrop section.

Rejuvenated uplift in the east brought in these graded, mud-free conglomeratic sandstones of the Chance Sandstone Member; the abrupt lateral and ventral facies changes between the sandstones and limestones are thought to be due to multiple source areas from the east and north.

In the surface, the type Ettrain Formation is a skeletal sparry limestone (Bamber and Waterhouse, 1971). It is thought that this lithology represents the shelf

shallow water facies and that the lateral equivalents of the Ettrain in the Eagle Plain basin, were micritic limestones of the deeper water facies and thus were indistinguishable from the Hart River carbonate. The carbonate overlying the Chance Sandstone Member at Chance No. 1 and at Chance G-8 may be remnants of this Ettrain equivalent; elsewhere in the subsurface it has been ~~remained~~ removed by ~~part~~ post-Paleozoic erosion.

In summary, the Devonian Imperial Formation and unnamed shale unit are thought to have been deposited in a deep water trough where ~~turbide~~ turbidite material was intermixed with dark siliceous shale. A starved basin was present during Tournaisian time, but a resumption of shale and turbidite infill occurred in the Visean. Conglomerates, sandstones and siliceous limestones of the Birch Member and Canoe River carbonate facies are thought to represent slope and shallower basin deposits, ~~which~~ while the Canoe River shale facies represents the deeper water basin infill. The Chance Sandstone Member represents a return to slope conditions caused by uplift to the east which initiated turbidite flows of this conglomeratic deposit.

ECONOMIC GEOLOGY

In the Eagle Plain area, the economic objectives in the Upper Devonian - Carboniferous sedimentary sequence are the conglomeratic, mud-free sandstones of the Birch and Chance Sandstone members of the Hart River Formation. Their possible turbidite origin accounts for their erratic thicknessess; the Chance Sandstone is thought to be essentially continuous in the southeastern and south-central parts of the area where it has not been subjected to complete erosion, whereas the sandstones of the Birch Member thin rapidly westwards and form possible hydrocarbon reservoirs only in the easternmost parts of the Eagle Plain basin.

The shales of the basinal facies are bituminous in part or contain significant organic matter, and the limestones of the slope facies are also high in organic matter content; these are considered as the probable source beds for the hydrocarbons entrapped in the sandstone facies.

Present Discoveries

SMWM Birch B-34. A thick, porous Chance Sandstone section is present at Birch B-34 at the eastern edge of the basin, but drillstem tests conducted in this interval recovered only small recoveries of drilling fluid; this porous sandstone immediately underlies Cretaceous glauconite shale. However, in the Birch Member, a drillstem test between 4,430 and 4,501 feet recovered 5.525 mmcf/d of gas, and 300 feet of gas-cut water which was considered to be mud filtrate. Analyses of the gas indicated 86.69% by volume of methane, 6.91% ethane, 2.35% propane, 1.91% carbon dioxide, with minor nitrogen, butane, pentane, hexanes, and heptanes plus. The interval was not cored and the intergranular porosity is estimated as poor due to quartz and carbonate partial cementation. A drillstem test at the base of the Birch Member, between 5,195 and 5,412 feet, recovered 7.34 mmcf/d of gas, and 330 feet of gas cut drilling fluid. Analysis of the gas indicated 90.63% by valume of methan, 5.21% ethane, 1.65% propane, 1.13% carbon dioxide, with minor amounts of nitrggen, butane, pentane, heptanes plus, and hexanes. Again the interval was not cored, and the well cuttings of sandstone show poor porosity due to partial cementation by quartz and calcite. The present status of the

well is a Birch Member gas well protectively plugged and fitted with a wellhead. Net gas pay is 12 feet

SMWM Blackie YT M-59. At Blackie M-59, 50 feet of net pay is present in the Chance Sandstone between 2,116 and 2,170 feet drilling depths. From core analysis, average porosity is about 15%, and weighted average horizontal and vertical permeabilities are about 90 md. and 28 md., respectively. Maximum gas recovery on three drillstem tests was 2.8 mmcf/d, with no condensate, oil, or water recoveries. Analysis of the gas indicated 98.47% by volume methane, with minor nitrogen, carbon dioxide, ethane, propane, and isobutane. A 128-foot net porous zone between 2,354 and 2,579 feet was found to be fresh water wet on drillstem testing; water analyses of this zone were considered not representative as the samples appeared to be filtrate contaminated. A small unmeasured gas blow and 1,850 feet of gas cut mud was recorded in a drillstem test of the Birch Member between 6,218 and 6,338 feet; porosity is very poor as the sandstone is almost completely cemented by quartz and calcite. The well status is a suspended Chance Sandstone gas well.

Canoe River East Chance C-18. At the Chance C-18 well, the Chance Sandstone is eroded, but 155 feet of Birch Member sandstone was penetrated before the well ~~was abandoned.~~ reached total depth. No cores were cut, but two drillstem tests were conducted in the Birch Member. The uppermost test, from 4,910 to 4,980 feet, recovered 533 mcf/d of gas and 420 feet of black, watery mud, and the lowermost test, from 5,000 feet to total depth at 5,055 feet, had a recovery of 5.7 mmcf/d of gas, and 120 feet of salt water (28,600 ppm). Analysis of the gas from the uppermost test indicated the following volumes: methane 31.25%, ethane 25.13%, carbon dioxide 18.14%, nitrogen 10.92 %, propane 9.46%, butanes 3.32%, pentanes 1.21%, and minor amounts of hexanes, heptanes plus, and helium. Gas from the lowermost test consisted of 70.84% methane, 14.92% nitrogen, 5.95% ethane, 4.78% carbon dioxide, 2.14% propane, and minor amounts of butanes, pentanes, heptanes plus, and hexanes. The sandstone has ~~fair~~ porosity and is partly cemented by dolomite. The well was abandoned.

Western Minerals Chance No. 1. The "discovery" well of the Eagle Plains area was completed in 1960 as a suspended Chance Sandstone gas or oil well with 54 feet of net gas pay and 11 feet of net oil pay. Between 4,262 and 4,365 feet, core

analysis indicated continuous porosity values from 10 to 23%; below this interval the sandstone is largely calcite cemented. Weighted average porsoity of the sandstone in this pay interval is 14.8%, and weighted average horizontal permeability was 258 md. Maximum gas flow obtained from drillstem tests was between 7 and 10 mmcf/d in the interval 4,314 to 4,354 feet, and an oil recovery of 2,000 feet was recovered in the interval 4,353 to 4,387 feet. Water recoveries were obtained from the Chance Sandstone in tested intervals below 4,415 feet. In the underlying Canoe River limestone sequence, oil and water recoveries were obtained from a number of drillstem tests between 5,054 and 5,190 feet. No porosity was seen in the well cuttings and it is thought that the fluid recovery was from a fractured zone. The Birch Member was found to be very thin with only about 40 feet of non-porous sandstone present in the shale-limestone-sandstone sequence.

SMWM Chance YT G-8. About half one mile south of the Chance No. 1 discovery well, the exploratory outpost well Chance G-8 was completed as a Chance Sandstone oil well(suspended) with 17 feet of net oil pay. Perforated intervals opened to oil production are 4,393 to 4,404 feet, and 4,422 to 4,456 feet; the average oil gravity is 33° API at 60°F, and the total sulphur about 1.7 weight percent. All the conglomeratic sandstone is partly calcite cemented with some black pyrobitumin infilling, and therefore porosity is erratic in the reservoir and not as high as in the Chance No. 1 well. Porosity values obtained from eight core samples in the reservoir zone ranged from 2.0 to 13.2%, permeability from 0.2 to 27 md., and calcite cement (weight per cent soluble in acid) from 25.72 to 11.46; the total porosity plus calcite cement was between 25 and 28 per cent in all cases. Analysis of the gas obtained from a drillstem test in the reservoir indicated 83.97% methane, 7.12% ethane, 3.99% carbon dioxide, 2.93% propane, and minor amounts of butane, nitrogen, pentanes, hexanes, and heptanes plus.

Canoe River Chance YT J-19. Another exploratory outpost well, Chance J-19, was completed 1½ miles north of Chance No. 1 as a suspended Chance Sandstone gas and oil well with a net pay of ~~219~~ 187 feet, of which the lower 42 feet is oil-filled and the remaining ~~177~~ 145 feet gas-filled. Core analysis of part of the gas-bearing sandstone interval indicated a weighted average pososity of 12.26%,

and wighted average horizontal permeability of 82.05 md., whereas core analysis of part of the oil-bearing reservoir indicated a weighted average pososity of 10.79%, and a weighted average horizontal permeability of 32.23 md. Gas analysis showed 76.01% methane, 6.82% ethane, 5.33% carbon dioxide, 4.66% propane, 3,60% nitrogen, 1.90% butanes, and minor amounts of pentanes, hexanes, and heptanes plus. Oil analysis showed and API gravity of 31.8° at 60°F, and a sulphur weight per cent of 1.11.

The erratic pattern of quartz grain growth followed by carbonate cementation has largely destroyed or greatly reduced most of the porosity in the conglomeratic sandstones. In the five wells that have Chance Sandstone present, all have zones of good porosity, but the Birch Member sandstones are much more erratic in development and are usually completely cemented. As the Chance Sandstone is thought to be laterally continuous south of its erosional edge (Figure 3), the prospects of additional discoveries are excellent in and near the member's subcrop. However, the porous Birch sandstone development is thought to be restricted north of a line joining the Birch B-34 and East Chance C-18 wells. Fractured zones in the Canoe River carbonates show some promise but these at best marginal prospecting zones.

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APPENDIX

Sample logs of:

(1) SOBC Blackstone YT D-77 well (subsurface reference section of unnamed shale unit).

(2) SMWM Birch YT B-34 well (type Canoe River Member (shale facies) and type Birch Member of the Hart River Formation).

(3) Western Minerals Chance No. 1 well (type Chance Sandstone Members and Canoe River Member (carbonate facies) of the Hart River Formation.

Standard Oil Company of British Columbia Blackstone YT D-77

Location: Lat. 65° 46' 10.77" N; Long. 137° 14' 54.78" W.

Elevation: 2,116 feet K.B.

Total depth: 13,217 feet

Completed: January 8, 1963.

Status: Dry and abandoned

Log by H.L. Martin from samples stored at the Institute of Sedimentary and Petroleum Geology, Calgary, Alberta.

Sample depth (feet)	Lithology	Thickness (feet)
	Sample description begins at 1,500 feet drilling depth in Hart River Formation (Birch Member).	
1500-1530	Shale, black, bituminous, calcareous in part; traces of limestone, dark grey-brown, micritic, siliceous, with calcitic spicules and floating clear quartz grains; some black chert cuttings with vague spicular texture. Unnamed shale unit (subsurface reference section) picked at 1532 feet from logs.	30
1530-1710	Shale, black, very bituminous in upper 40 feet. slightly bituminous below, dark brown streak, fissile; abundant pyrite unclusions, from 1620 to 1640 feet, very abundant granular pyrite inclusions impart a coarse silty appearance to the shale; trace siltstone; and rare trace sandstone, light brown, grey, and medium grey brown, siliceous and about 5% dolomitic.	180
	X-ray diffraction analysis, 1600 to 1700 feet; Quartz 67%, Pyrite 8%, Feldspar 4%, Kaolinite 10%, Illite 11%; Organic carbon content: 3.65%.	
	Palynology, 1600 to 1700 feet. A few spores were recovered but no age determination was possible. (M.S. Barss).	

Sample depth (feet)	Lithology	Thickness (feet)
1710-1790	Shale, as above, with traces of white crystalline anhydrite which probably occurs as fracture infillings. From 1760 to 1770, interbedded sandstone, light brown grey, medium-grained chert and quartz framework, with siliceous and dolomitic cement.	80
1790-1800	Shale, as above; no anhydrite	10
1800-1820	Sandstone, slightly conglomeratic, chert and quartz grains in siliceous and dolomitic cement, dark chert grains are sub-to well rounded.	20
1820-1940	Shale, black and dark grey, very pyritic, ~~fossils~~ fissile. Ironstone fragments abundant, medium brown, pyritic, slightly dolomitic, traces black coaly plant ? material in some ironstone fragments. Sandstone, as above, very pyritic in part, with lesser siltstone, occurs in trace amounts and is probably present as thin lenses; a few chips were seen with thin sandstone and siltstone laminae.	120
1940-2000	Shale, dark grey, slightly bituminous, very pyritic, with soft; argillaceous brown siltstone and light brown sandstone in trace amounts.	60
2000-2110	Shale, black, bituminous, soft, fossile, with abundant pyrite as pods, disseminated, and as complete well cuttings. Trace amounts of siltstone and sandstone, much as above. Rare traces of milky white anhydrite.	110
2110-2120	Sandstone, light brown, fine grained, well sorted, poor intergranular porosity with light oil stain, dolomitic and siliceous cement.	10
2120-2260	Shale, dark grey to black, as above. ~~Strings~~ Stringers of dirty, argillaceous sandstone, shale with patches of argillaceous sandstone or floating quartz grains, medium grey siliceous sandstone, and medium brown siltstone. Sandstone fragments 2150 to 2170, very pyritic. Rare traces white anhydrite. Trace plant?	140

Sample depth (feet)	Lithology	Thickness (feet)
	X-ray diffraction analysis 2150 to 2250. Quartz 65%, Calcite trace, siderite 3%, Pyrite 5%, Feldspar trace, Kaolinite 13%, Illite 14%. Organic carbon content: 1.86%.	
2260-2280	Sandstone, light brown and grey, fine grained, dolomitic and siliceous.	20
2280-2400	Shale, dark grey to black, bituminous, pyritic, traces anhydrite veinlets; trace ironstone fragments; sandstone interbeds, meduim to coarse grained, light to medium brown, trace porosity, siliceous and dolomitic.	120
2400-2690	Shale, dark grey to black, slightly to nil bituminous; sandstone and siltstone ~~stringy~~ stringers, as above; abundant pyrite; traces shale breccia; traces black carbonaceous plant? fragments; about 10% dark brown shale with black carbonaceous imprints; rare traces ironstone fragments.	290
	X-ray diffraction analysis 2550-2600 feet, Quartz 74%, Siderite 4%, Pyrite 3%, Feldspar trace, Kaolinite 7%, Illite 12%, Chlorite trace. Organic carbon content: 2.08%.	
	Palynology, 2500 to 2600 feet. No spores recovered under normal palynological extraction techniques.	
2690-2700	Shale, black, bituminous; very abundant pyrite as ~~cakes~~ cubes, blebs, massive, and whole cuttings, slightly dolomitic.	10
2700-2740	Shale, black, bituminous, trace pyrite	40
2740-2750	Shale, black, dolomitic, resinous, contains coarse dolomite crystals.	10
2750-2760	Shale, black, bituminous, dolomitic, slightly pyritic	10
2760-2840	Shale, black, very bituminous, pyritic, brown streak, smooth, high lustre, with traces slickensides. Rare trace white anhydrite.	80

Sample depth (feet)	Lithology	Thickness (feet)
	X-ray diffraction analysis 2760-2800 feet. Quartz 83%, Siderite 5%, Feldspar 5%, Kaolinite 1%, Illite 6%, Organic carbon content: 5.61%.	
	Palynology, 2760 to 2800 feet. Spores not well preserved. Only tentative age can be determined. Seems to be a mixed Mississippian-Devonian one, (very latest Famennian or early Tournaisian) therefore a Strunian age is suggested (M.S. Barss)	
2840-3000	Shale, black, not as bituminous as above, much harder but still has brown streak, abundant pyrite, blocky, traces calcite, dolomite, and anhydrite fracture infillings.	160
3000-3180	Shale, dark grey-brown to black, slightly bituminous, softer than above, pyritic; high lustre. Traces plant? fragments, siltstone; rare trace white dolomite and anhydrite fracture infillings.	180
3180-3320	Shale, dark grey, non-bituminous, silty "granular" appearance in part, rare pyrite inclusions and spheres, traces siltstone and anhydrite.	140
	X-ray diffraction analysis 3200-3250, Quartz 80%, Calcite 1%, Dolomite 2%, Siderite 3%, Pyrite 1%, Feldspar 3%, Kaolinite 3%, Illite 6%, Chlorite 1%, Organic carbon content: 0.69%.	
3320-3500	Shale, siltstone, and sandstone. Shale, dark grey as above. Siltstone, dark grey brown; sandstone, dark grey brown, "dirty" appearance, fine to medium sub-rounded dark and medium grey chert and quartz grains. The sandstone appears to grade to shale or sandy shale. Some plant? fragments and rare beds of bituminous shale.	230
	X-ray diffraction analysis 3330-3360 feet (sandstone) Quartz 82%, Dolomite 3%, Siderite 4%, Pyrite 1%, Feldspar 5%, Kaolinite 2%, Illite 3%. Organic carbon content: 0.45%.	

Sample depth (feet)	Lithology	Thickness (feet)
3500-3610	Shale, dark grey brown to black, bituminous with brown streak, abundant pyrite as cubes, massive, and spheres. Trace anhydrite and quartz veinlets.	110
	Ogilvie Formation	
	picked at 3416 feet from logs.	
3610-3660	Limestone, micritic-skeletal, dark grey to brown grey broken fragments of brachiopods, crinoids, and other indeterminate skeletal debris, and whole ostracods in lime mud matrix.	50
	end of sample description.	

Sacony Mobil Western Minerals Birch YT B-34

Location: Lat. 66° 03' 3.14" N; Long. 136° 51' 17'51" W.

Elevation: 2190 feet K.B.

Total Depth: 5413 feet

Completed: June 8, 1965.

Status: Birch Member Gas Well (Capped). Log by H.L. Martin from samples stored at the Institute of Sedimentary and Petroleum Geology, Calgary, Alberta.

Sample description begins at 1650 feet drilling depth in Hart River Formation (Chance Sandstone Member).

Sample depth (feet)	Lithology	Thickness (feet)
1650-1680	Sandstone, salt and pepper, medium to coarse grained dark rounded and sub-rounded chert grain and lesser quartz with abundant brachiopod fragments and brachiopod spines, glauconites, calcite cemented with trace porosity and light oil stain. Grades into sandy skeletal limestone with partial siliceous replacement of skeletal debris.	30
	Type Canoe River Member picked at 1684 feet from logs	
1680-1710	Shale, dark grey brown, calcareous, glauconite, pyrite, trace calcite broken brachiopod fragments.	30
1710-1760	Limestone, medium grey-brown, glauconites, abundant brachiopod fragments and spines, siliceous, grading into chert; interbedded with shale, dark grey brown, siliceous.	50
1760-2090	Shale and mudstone, dark grey-brown, highly siliceous, calcareous, glauconites, grading into limestone micritic-skeletal, glauconite, siliceous. Abundant calcitic brachiopod spines, siliceous and calcitic brachiopod shell fragments, lesser coarse crinoidal debris; pyrite mostly as blebby with rare nodules. Scattered very fine-sized carbonaceous fragments.	330

Sample depth (feet)	Lithology	Thickness (feet)
	Thin section prepared from well cuttings collected between 1760 and 1810 feet. Most rock chips are dominantly quartz where about 10% is coarse silt-sized to very fine sandstone-sized sub-rounded terrigenous floating grains. Remanie Remants is micro-crystalline quartz, some of which appears to be of replacement origin. A few chips were seen with greater than 50% calcite where broken skeletal debris, including ~~including~~ siliceous and calcareous spicules, are in a matrix of intimately associated lime mud and microcrystalline quartz.	
	X-ray diffraction analysis, 1830 to 1890 feet; Quartz 54%, Calcite 38%, Dolomite 4%, Glauconite 3%, Pyrite 1%.	
2090-2100	Shale, dark grey-brown, abundant glauconite, very silty, trace pyrite.	10
2100-2310	Shale, dark grey brown, very slightly calcareous, pyritic, brown streaks, slightly bituminous, scattered broken fragments of calcite brachiopods spines and shells and spicules. Siltstone, calcareous, medium brown, calcitic spicules, trace glauconite, is present in minor amounts and probably occurs as thin interbeds. Rare traces of brown ironstone fragments	210
	Palynology, 2167-2171. Similar assemblage to that of 1298-1303 (see text). Most probably Permian (Late Pennsylvanian) although late Stephanian cannot be ruled out (M.S. Barss).	
2310-2320	Sandstone, and salt and pepper , colourless to white, light and lesser dark chert, coarse-sized, sub-rounded, with fine and medium-sized quartz grains, siliceous cemented in part, good intergranular porosity.	

Sample depth (feet)	Lithology	Thickness (feet)
2320-2640	Shale, dark grey-brown to dark grey, slightly to non-calcareous in uppermost 150 feet, calcareous below, pyrite in part; trace to abundant ironstone fragments, medium brown, pyrite; siltstone, trace to minor amounts; Scattered coarse-sized calcite skeletal debris, such as echinoderm, punctuate brachiopods, brachiopod spines, spiny brachiopods, ostracods.	320
	Palynology, 2323 to 2330 feet. Namurian, probably middle or late because of presence of *Florinites* sp. (M.S. Barss).	
2640-2670	Limestone, light brown, crinoidal, with some silica replacement, well cemented with spar, trace pyrite, abundant brachiopod spines, white rounded chert inclusions appear to be of replacement origin.	30
2670-3200	Shale, dark grey and brown-grey, moderately calcareous, pyrite inclusions, very abundant coarse crinoid stem fragments, lesser brachiopod spines and rare brachiopod shell fragments. Trace to moderate amounts of siltstone, brown, calcareous, with rare crinoid fragments. Ironstone fragments common, slightly dolomitic, pyrite. Limestone, as above, well cuttings noted at 2690 to 2710 feet and 2910 to 2920 feet.	530
3200-3310	Shale, medium grey, calcareous ~~in~~tent slight, shale ~~flocaites~~ flocculates in acid. Crinoid stem fragments present but in trace amounts. Ironstone fragments darker in color than above, are orange-brown in colour and very abundant.	110
3310-3360	Shale, medium grey as above with laminated or interbedded dark grey shale. Rare crinoid fragments.	50
3360-3390	Shale, dark grey, non-calcareous, hard (does not flocculate as above). Rare crinoid stems.	30
3390-3460	Shale, medium and dark grey; latter predominates, ~~but~~ appears to be interbedded as rare chips with medium and dark laminae. Medium grey shale as above, i.e.,	70

Sample depth (feet)	Lithology	Thickness (feet)
3460-3710	Shale, dark grey, non-calcareous to very slightly calcareous, crinoidal fragments more abundant than above. Traces dark grey-brown siltstone, slightly calcareous, with crinoidal fragments. Palynology, 3594 to 3604 feet. Similar assemblage to 2323 to 2330 feet, i.e., Namurian (M.S. Barss). Macropaleontology, 3595.4 feet. Single ammonoid, *Nomismoceras* sp., indicates a late Visean age (W. Nassichuk).	150
3710-3730	Shale, as above, with 20 to 30% dark brown bituminous shale.	20
3730-3750	Shale, medium and dark grey, abundant pyrite, no crinoidal debris. About 10% siltstone.	20
3750-3810	Shale, medium grey, abundant pyrite, crinoidal fragments, trace siltstone. Trace ironstone 3790 to 3800 feet. From 3800 to 3810 feet, about 35% dark grey non-calcareous shale. Note: crinoid fragments found between 2320 and 3810 feet consist of separate light brown to off-white calcite coarse fragments with traces of pyrite replacement in the centre. These fragments are the same size as the well cuttings.	60
	Type Birch Member picked at 3808 feet from logs	
3810-3830	Limestone, medium to dark grey brown, siliceous and chertified, up to 10% detrital quartz, micritic, spicular. Greater than 50% dark grey spicular chert in cuttings.	20
3830-3840	Sandstone, calcareous, cherty, coarse grained	10
3840-3850	Limestone and chert, as above	10
3850-3870	Shale, dark grey, very hard, siliceous, calcareous, with white calcite filled fractures.	20

Sample depth (feet)	Lithology	Thickness (feet)
3870-3980	Limestone and chert, as above, calcite and siliceous spicular. Interbeds of siltstone and siliceous, calcareous shale.	110
3980-4000	Sandstone, salt and pepper, coarse, poorly sorted, sub-rounded, dark chert grain with lesser quartz, calcareous cement, tight.	20
4000-4220	Limestone, medium to dark brown, micritic, trace dolomite, siliceous, siliceous and calcareous spicules common, rare trace crinoidal debris, dark chert inclusions near base, some rare chips contain up to 15% floating quartz grains, abundant calcite infilled fractures. Interbeds (about25%) of shale, calcareous and non-calcareous, dark grey, very silty. From 4130 to 70, black bituminous shale.	220
4220-4230	Sandstone, salt and pepper, coarse dark and light chert grains, sub-rounded with lesser fine clear quartz grains, siliceous and calcareous cement, tight.	10
4230-4380	Limestone and shale, as above, cherty in part, sandy in part, traces brachiopod and crinoid fragments. Calcareous siltstone, dark brown grey, 20%.	150
4380-4620	Sandstone, light brown and grey, coarse sub-rounded varicoloured chert grains with lesser quartz grains, calcareous and siliceous generally, but some dolomite cement also, scattered poor to fair intergranular porosity, interbeds of calcareous siltstone 10%, dark shale, 10%, and siliceous spicular limestone, 5%.	240
4620-4700	Limestone, dark brown, siliceous, micritic, spicular, with shale, black, slightly bituminous, in basal 30 feet.	80
	Palynology, 4622 to 4631 feet, no spores present in samples prepared for palynological analysis.	
	Macropaleontology, 4623.5 feet. *Quadratia* cf. *hirsuteformis* (Walcott) *"Leiorhynchus" carbonifercus* Girty. The age of the assemblage is Chesteran (J.B. Waterhouse).	

Sample depth (feet)	Lithology	Thickness (feet)
4700-4800	Shale, black, bituminous, brown streak, waxy in part, dolomite in part. Traces of dark grey calcareous siltstone.	100
4800-4840	Shale, dark grey, non-bituminous, dolomitic in part, with trace calcareous and pyritic siltstone, rare trace calcareous sandstone.	40
4840-4870	Shale, black, bituminous, brown streak, calcareous in part	30
4870-4930	Sandstone, light brown, salt and pepper, conglomeratic, with light and dark sub-rounded and rounded chert grains and lesser, and finer, quartz. Calcareous, with trace dolomite rhombs. Tight except for 4910 to 4920 feet when poor intergranular porosity is present. Grain size analysis from sample at 4896 feet (see text).	60
4930-4940	Shale, dark grey, pyritic, with brown ironstone fragments	10
4940-5000	Shale, black, bituminous, brown streak, traces of coarse crinoid fragments. From 4980 to 5000 feet, about 25% calcareous shale with abundant white specks. Traces calcareous siltstone.	60
5000-5060	Sandstone, light grey and brown, mostly light coloured coarse sub-rounded chert grains, with lesser quartz and trace dark chert grains, calcareous cement, poor intergranular porosity 5000 to 5010 feet. Interbeds of non-calcareous dark grey shale in basal 30 feet. Palynology, 5047 to 5052, no spores recovered under normal palynological extraction techniques.	60
5060-5090	Shale, black, bituminous, with about 25% calcareous white speckled shale, traces of coarse crinoidal debris.	30
5090-5260	Sandstone, medium grey and brown, coarse to conglomeratic varicoloured chert sub-rounded and rounded grains; crinoid fragments, both siliceous and calcitic, and brachiopod fragments are also part of framework but the latter are rare. Traces intergranular porosity	150

Sample depth (feet)	Lithology	Thickness (feet)
	but most of the sandstone is calcareous cemented. Interbedded with about 25% shale, bituminous and also white speckled calcareous shale, with rare brachiopod fragments, crinoids, and trace ostracods. Some crinoid stems are silicified and pyritic.	
5260-5370	Shale, black, bituminous, and white speckled in lesser amounts. Traces crinoidal fragments. Trace brown dolomitic ironstone fragments 5320 to 5330. Interbedded (about 10%) with limestone, dark grey-brown, siliceous, cherty, spicular, micritic.	110
	Unnamed shale unit picked at 5385 on logs.	
5370-5400	Shale, black, bituminous, brown streak, non-calcareous; pyrite nodules common.	30

Western Minerals Chance No. 1

Location: Lat. 66° 07' 46" N; Long. 137° 31' 27" W.

Elevation: 1,769 feet K.B.

Total depth: 8,648 feet

Completed: May 25, 1960.

Status: Suspended Chance Sandstone gas or oil well.

Log by H.L. Martin from samples stored at the Institute of Sedimentary and Petroleum Geology, Calgary, Alberta.

Sample examination begins at 3950 feet in Lower Cretaceous strata.

Sample depth (feet)	Lithology	Thickness (feet)
3950-4030	Shale, dark grey, micro-micaceous, pyritic, glauconitic in part, with lesser siltstone, brown grey, glauconitic.	80
	X-ray diffraction analysis of shale cuttings from 3950 to 4030 feet. Quartz 65%, Kaolinite 10%, Illite (glauconite) 8%, Feldspar 5%, Pyrite 6%, Dolomite 4%, Siderite 2%.	
	Chemical analysis: carbonates 8%, organics 3.9%, residue 88.1%.	
	Micropaleontology: 3,000 to 4034 feet.	
	Gaudryina tappanae Chamney	
	G. cf. *G. subcretacea* Cushman	
	A. cf. *A. fragmentarius* Cushman	
	Gavelinella sp.	
	Bathysiphon scintillata Chamney	
	Ammodiscus sp. (minute)	
	age: This is a Lower Cretaceous microfauna, with predominantly Early Lower Cretaceous (Neocamian) taxa.	
	From report no. Mes. 3 TPC 1968, by T.P. Chamney.	

Sample depth (feet)	Lithology	Thickness (feet)
	Hart River Formation picked at 4036 on logs.	
4030-4050	Chert, light brown, blue grey, with crinoidal texture preserved, 50%. Limestone, dark brown, siliceous and calcareous crinoids fragments and spicules in micritic dark brown siliceous matrix.	20
4050-4200	Limestone, medium brown, as above, with 20% shale, calcareous, dark brown, siliceous, with crinoidal fragments. X-ray diffraction analysis, 4063 to 4067 feet, Calcite 70%, Quartz 30%. Macropaleontology: GSC Location C-4364, depth 4067 feet, *?Flexaria* sp. GSC Location C-4363, depth 4153 feet, *Quadratia hirsuteformis* (Walcott) *"Leiorhynchus" carboniferum* Girty *?Crurithyris* sp. This assemblage belong to the Quadratis A zone assemblage and indicates a Chesteran age, as identified by J.B. Waterhouse.	150
4200-4230	Limestone, medium brown, micritic with rare crinoidal remains, silty, trace dolomite.	30
4230-4240	Sandstone, coarse to fine sized sub-rounded chert and quartz grains, calcite cemented 50%. Limestone, medium brown, silty and sandy, micritic.	10
4240-4260	Shale, dark grey-brown, calcareous, slightly bituminous brown streak, trace crinoid fragments. X-ray diffraction analysis at 4255 feet, Quartz 80%, Calcite 20%.	20

Sample depth (feet)	Lithology	Thickness (feet)
	Type Chance Sandstone Member picked at 4258 feet from logs.	
4260-4360	Sandstone, salt and pepper, conglomeratic, rare chert pebbles up to 9 mm in size, most commonly 1.5 to 2 mm, varicoloured chert grains, sub-rounded to rounded; quartz grains less than 40% of rock and less than 0.80 mm in size, sub-hedral to euhedral common due to grain growth; very friable; porosity very good, up to 25%.	100
	X-ray diffraction analysis at 4268, 4273, 4280, 4282, 4310, 4322, all indicated 100% quartz, while at 4348, 99% quartz and 1% calcite.	
	Grain size analysis at 4273 feet (see text)	
4360-4510	Sandstone, much as above but cemented by calcite, tight.	150
	Grain size analysis at 4390 feet (see text).	
4510-4530	Sandstone, light brown, fine to medium sized clear and frosted quartz grains with lesser milky white chert grains and trace dark chert grains, well sorted, calcite cemented; tight.	20
4530-4550	Shale, dark grey brown, calcareous, 90%. Sandstone, very fine sized quartz and (10%) chert grains in calcareous and dolomitic ~~amount~~; dolomite rhombs ~~replace calcite and encircle quartz~~ grains, tight.	
	X-ray diffraction analysis, 4545 feet (sandstone) Quartz 50%, Calcite 42%, Dolomite 8%.	
4550-4620	Sandstone, salt and pepper, medium to coarse sub-rounded to rounded chert grains and lesser quartz, calcite cemented, tight.	70
	X-ray diffraction analysis, 4580 feet, Quartz 60%, Calcite 40%.	
4620-4630	Limestone, dark brown, micrite, trace crinoid fragments.	10

Sample depth (feet)	Lithology	Thickness (feet)
4630-4720	Sandstone, salt and pepper much as above, tightly cemented by calcite, fine to medium grained with some coarse.	90
4720-4750	Shale, dark brown, calcareous, some crinoidal debris and rare brachiopod fragments; floating coarse silt and very fine sized quartz grains. Grades to sandy limestone, very fine sized quartz grains floating in micrite, trace calcite spicules, stylolites, 10%.	30
	X-ray diffraction analysis, 4744. Quartz 99%, trace of pyrite and dolomite	
	X-ray diffraction analysis, 4751 (sandy limestone). Calcite 65%, Quartz 35%, Dolomite trace.	
4750-4780	Sandstone, light brown, salt and pepper, coarse and rare conglomerate light and dark chert sub-rounded and rounded grains with sub-equal, medium sized quartz, calcite cemented.	30
4780-4790	Sandstone, brown, much as above but abundant dolomite replacement of calcite cement; dolomite rhombs less than 0.06 mm.	10
4790-4850	Sandstone, light brown, and salt and pepper, much as above with 10 to 15% dolomite replacement, pyrite.	60
	Top Canoe River Member (carbonate facies) picked at 4856 on logs	
4850-5240	Limestone, light to medium brown, dolomite, slightly silty, siliceous in part, calcite spicules, micrite; cherty, abundant light brown chert fragments with trace spicules content; monotonous sequence of well cuttings.	390
	X-ray diffraction analysis at 5194 feet, Quartz 66%, Calcite 28%, Dolomite 6%.	
	X-ray diffraction analysis at 5211 feet, Calcite 71%, Dolomite 17%, Quartz 12%.	
5240-5800	Limestone, dark brown, siliceous, micritic, dolomite cherty. Siliceous content varies from slight to abundant, and samples generally contain more than 10% brown chert fragments with vague skeletal texture	560

Sample depth (feet)	Lithology	Thickness (feet)
	(spicular? or radiolaran?), and dark brown to black dense chert. Dolomite rhombs, less than 0.05 mm in size and appear to be present throughout section but form less than 20% of the rock. Some traces of siliceous cemmon spicules in the highly siliceous limestone chips. Abundant fracture-filled calcite veinlets. Rare crinoidal fragments. Traces of black flecks scattered throughout interval. No pyrite.	
5800-6020	Limestone, medium to dark brown, very cherty, siliceous in part, micritic, less than 10% dolomite rhombs. Chert fragments are spicular, light brown, and dense, dark brown. Some samples left a hard siliceous residue with faint laminations on acidizing, others left only about 5% quartz silt residue.	220
6020-6070	Shale, black, brown streak, rare crinoidal debris, grading in part to siliceous limestone X-ray diffraction analysis 6048 to 6051 feet, Calcite 58%, Quartz 41%, Dolomite trace, pyrite trace.	50
6070-6100	Sandstone, light brown, and salt and pepper, conglomeratic, milky white through dark chert rounded and sub-rounded pebbles greater than 2.0 mm, with quartz and ~~variations~~ chert grains about 0.5 mm in calcite cement. Poor intergranular porosity. X-ray diffraction analysis 6092 feet, Quartz 82%, Calcite 10%, Pyrite trace.	30
6100-6320	Limestone, medium brown, cherty, siliceous in part, micritic, scattered ~~monaxon~~ siliceous spicules, less than 10% quartz silt and rare quartz grains up to 0.2 mm in size. Chert is grey, spicular, and dense, dark brown.	220

Sample depth (feet)	Lithology	Thickness (feet)
6320-6520	Limestone, shale, and chert, interbedded. Limestone, dark brown, micrite, siliceous to grading to calcareous chert; calcite filled veinlets common, 40%.	200
	Shale, dark brown grey, slightly calcareous, 25%.	
	Chert, mostly dark brown, lesser grey and medium grey-brown. 35%.	
	X-ray diffraction analysis 6408 feet. Quartz 59%, Calcite 41%.	
	X-ray diffraction analysis 6410 feet. Quartz 88%, Calcite 9%, Dolomite 3%, Pyrite trace.	
	Top Birch Member picked at 6521 on logs.	
6520-6570	Sandstone, light to medium brown and salt and pepper, coarse grained light and dark chert and quartz grain in calcite cement. Tight. Lesser interbeds of calcareous dark brown shale.	50
	end of sample description.	

GM-4

NEW NAMES PROPOSED FOR ROCK UNITS

To accompany all manuscripts and maps submitted for publication.

1. **Proposed names:** new member names for the Hart River Formation, in ascending order, Birch, Canoe River, and Chance Sandstone.

2. **Reasons for proposing name:** Birch Member is a gas reservoir

3. **Summary definition:** conglomeratic sandstone, siliceous shale, and siliceous limestone

4. **Lithology:**

5. **Contact relations:** conformable with underling unnamed shale unit, and conformable with overlying Canoe River Member.

6. **Thickness and distribution:** up to 1576 feet in the subsurface of the Eagle Plain area.

7. **Index fossils:**

8. **Age:** Chesteran

9. **Locality of type sections if applicable:** Socony Mobil Western Minerals Birch YT B-34 (Latitude 66° 03' 03.14"N, Longitude 136° 51' 17.51"W), between 3,808 and 5,384 feet drilling depths.

10. **Origin of name:** from type-section well

11. **Proposed publication:** GSC Paper

12. **Have you checked availability of proposed name?** Yes

13. **Remarks:**

Signed Mary L. Martin

Critical Reader _____

GM-4

NEW NAMES PROPOSED FOR ROCK UNITS

To accompany all manuscripts and maps submitted for publication.

1. Proposed names: new member names for the Hart River Formation, in ascending order, Birch, Canoe River, and Chance Sandstone

2. Reasons for proposing name: Chance Sandstone is an oil and gas reservoir in the Eagle Plain Basin, Yukon Territory.

3. Summary definition: conglomeratic sandstone, with silicous and calcareous cement.

4. Lithology:

5. Contact relations: conformable with underlying Canoe River Member, and conformable with overlying unnamed Hart River carbonates; underlies sub-Mesozoic unconformity in part of Eagle Plain basin.

6. Thickness and distribution: up to 1,016 feet in the subsurface of the Eagle Plain.

7. Index fossils:

8. Age: Chesteran

9. Locality of type sections if applicable: Western Minerals Chance No. 1, (lat. 66° 07' 46"N, long. 137° 31' 27"W), between 4,258 and 4,856 feet drilling depths.

10. Origin of name: from type well

11. Proposed publication: GSC Paper

12. Have you checked availability of proposed name? Yes

13. Remarks:

Signed Hans P. Meier

Critical Reader _____

GM-4

NEW NAMES PROPOSED FOR ROCK UNITS

To accompany all manuscripts and maps submitted for publication.

1. **Proposed names:** new member names for the Hart River Formation, in ascending order, Birch, Canoe River, and Chance Sandstone.

2. **Reasons for proposing name:** ~~XXXXXXXXXXX~~ Canoe River Member is the intervening member between the hydrocarbon-bearing Birch and Chance Sandstone members.

3. **Summary definition:** siliceous shale and siliceous micritic limestone.

4. **Lithology:**

5. **Contact relations:** conformable with the underlying Birch Member and conformable with the overlying Chance Sandstone Member

6. **Thickness and distribution:** up to 2237 feet in the subsurface of the Eagle Plain area, Yukon Territory.

7. **Index fossils:**

8. **Age:** Chesteran

9. **Locality of type sections if applicable:** Socony Mobil Western Minerals Birch YT B-34 (lat. 66° 03' 03.14"N, long. 136° 51' 17.51"W), between 1,684 and 3,808 feet drilling depths.

10. **Origin of name:** after Canoe River which flows into the Whitestone River and in turn into the Porcupine River.

11. **Proposed publication:** GSC Paper

12. **Have you checked availability of proposed name?** Yes

13. **Remarks:**

Signed Henry S. Hester

Critical Reader _____