CANADA

DEPARTMENT OF MINES AND RESOURCES

MINES AND GEOLOGY BRANCH

GEOLOGICAL SURVEY

PAPER 44-18

ALEXO MAP-AREA, ALBERTA

(Report and Map)

BY

G. P. Crombie

OTTAWA

1944

C A N A D A

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(Summary Account)

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Illustration

ALEXO MAP-AREA, ALBERTA

INTRODUCTION

Alexo map-area lies in west-central Alberta between latitudes 52° 15' and 52° 30' and longitudes 115° 45' and 116° 00'. The village of Alexo is situated in the northwestern corner of the area on the Canadian National Railway spur line from Red Deer to Brazeau (Nordegg). This railroad and the nearby motor road offer easy access to the district. An excellent ferry on North Saskatchewan River 1½ miles west of the village of Saunders is operated by the Shunda Ranger station. Within the map-area east-west travel is facilitated by the Saskatchewan and Allenby trails along the north and south sides of Saskatchewan River, by the Shunda Creek trail, and by the Ram trail along the north side of North Ram River near the southern limit of the area. North-south travel is afforded south of Saskatchewan River by a trail along Gap Creek and Nice Creek, and north of the river by an old trail that connects the Saskatchewan trail with the motor road on the east side of Brazeau Range.

Previous geological work by Allan and Rutherford[1] in Saunders Creek and Nordegg coal basins included that part of Alexo map-area lying north of North Saskatchewan River.

[1] Allan, J. A., and Rutherford, R. L.: Scientific and Industrial Research Council of Alberta, Report No. 6, pt. 1, 66 pp., (1922).

Capable assistance in the field was rendered by Messrs. O. A. Erdman, A. G. Jones, and A. E. Kliske. A. E. Wilson and F. H. McLearn of the Geological Survey reported, respectively, on the Palæozoic and Mesozoic fossil collections.

PHYSICAL FEATURES

Alexo map-area has a maximum relief of about 3,400 feet. Brazeau Range, the most prominent topographic feature of the area, is underlain by Palæozoic calcareous rocks folded into an asymmetrical anticline associated with strong thrust faulting north of Saskatchewan River. Most of the prominent ridges west of Brazeau Range are capped by thin but resistant Bighorn sandstone. The lowlands southwest of the range have resulted by erosion into softer strata, notably those of the Blackstone and Luscar formations. East of Brazeau Range relief is slight. Sandstones and shales of Upper Cretaceous age underlie this part of the area. All topographic features are related to differential resistance to weathering of lithologic units and to their structural disposition.

STRATIGRAPHY

Table of Formations

Era	Period	Epoch	Formation	Thickness Feet
Cenozoic	Modern	Plaistocene and Recent		
Erosional unconformity				
Mesozoic	Cretaceous	Upper Cretaceous	Edmonton	?
			Brazeau	?
			Wapiabi	1,400-1,600
			Bighorn	275 - 320
			Blackstone	1,300
		Lower Cretaceous	Mountain Park	600
			Luscar	850 - 900
			Cadomin	20 - 40
			Nikanassin	230 - 270
	Jurassic		Fernie	270 - 330
Erosional unconformity				
Palaeozoic	Carboniferous	Mississippian and ? Pennsylvanian	Rundle	645
		Mississippian	Banff	617
	Devonian	Middle ? and Upper Devonian		1,785+

General Statement

Rocks exposed at the present surface of the map-area were deposited between Devonian and late Upper Cretaceous time. Their aggregate thickness exceeds 8,500 feet. No Permian or Triassic rocks were identified in the area. Erosional contacts are suggested by conglomerate at the contact of Palaeozoic and Mesozoic strata, and by conglomerate within the Cretaceous system. Exposures of Palaeozoic rocks are confined to Brazeau Range and an outcropping of Rundle limestone on the north side of Saskatchewan River Valley west of the range.

Devonian

Approximately 1,800 feet of Devonian rocks are exposed in Brazeau Range at Saskatchewan River Gap. Division of the succession can be made easily at weathered exposures, but not as satisfactorily from the fresh rock, such as drill core.

In Saskatchewan River Gap, cut through Brazeau Range, about 300 feet of grey-weathering, black, fine-grained limestone, shaly limestone, and calcareous shale are exposed as the lowest stratigraphic zone reached by the land surface of Alexo map-area. Drift obscures the lower limit of this zone, but the upper limit is sharply defined at exposures by colour change. The uppermost 50 feet of strata are brown to black, paper-thin, calcareous shales. At 15 feet below the top the shales contain small, pustulose, linguloid brachiopods of a new genus. At 50 feet below the contact fish spines are contained in a black sandstone band. Approximately 300 feet below the contact Spirifer jasperensis Warren , Athyris sp., Murchisonia sp., and an orthocerated cephalopod (undetermined) were collected from black limestone beds.

Overlying the brown to black calcareous shales, with sharp contact, is a uniform succession of thin-bedded, medium brown-grey, silty and calcareous shales, 500 ± 25 feet thick as measured at The Gap. These shales weather a distinctive cream, which is prominent on the northeast-facing front of Brazeau Range at The Gap and in creek gullies as far as 4½ miles southeast and 3 miles northwest of The Gap. Beyond these limits the shale member is not exposed in the map-area. Fossils are rare within the shales. A gasteropod, cf. Diaphorostoma sp., was collected from a thin limestone band at about the middle of the member.

A cliff-forming member overlies the cream-weathering shales. This division, estimated to be 120 feet thick, consists of an alternation of massive, grey-brown limestone and thin-bedded, dark grey, shaly limestone in beds from 2 to 7 feet thick. Cliff faces of this member have a ribboned appearance, resembling a succession of large-scale varves. The distinctive cream colour of the underlying, weathered shales affords a well-marked lower contact, but the upper limit of the ribboned member is transitional into the more uniform shaly limestone member above. Limestone beds at the base of the ribbon member carry a prolific fauna, including the following forms: Atrypa reticularis var. A, Atrypa sp. cf. missouriensis Miller , Martinia n.sp. A, Athyris sp. B (shape like A. angelicoides Merriam, but having fine spines), Athyris sp. (young), Leiorhynchus n.sp. A, Leiorhynchus n.sp. A, var., Pugnax sp., Camarotoechia sp. A, Schizophoria sp. A, and a gasteropod, Murchisonia sp.

Strata overlying the ribboned member are thin-bedded, buff-grey-weathering, drab brown-grey, fine-grained limestone and shaly limestone, containing some massive beds of crinoidal buff-brown limestone in the upper part. On a ridge ½ mile north of Dizzy Creek where Devonian, Banff, and Rundle rocks have steep dips, this succession measures 267 feet in thickness. Contacts with the ribboned member below and the distinctive saccharoidal dolomite above are transitional. Where these members form cliffs, as they tend to do, the intervening shaly limestone forms a scree slope easily recognized in the field. Numerous fossils are contained in thin limestone bands near the base of the shaly limestone, including large Atrypa n.sp. A, Atrypa reticularis var. A, Atrypa sp. cf. missouriensis Miller , a Cyathophyllum-like coral, and a Diphyphyllum-like coral.

Relative to the faunas of all the preceding lists, A. E. Wilson of the Geological Survey reports that they are of Middle Devonian or lower Upper Devonian age. Atrypa is the most prominent genus, but because the forms are new, it is not feasible to place the age more accurately.

Resting upon the thin-bedded shaly limestone, with transitional contact, is a distinctive uniform member consisting of dense to porous, medium- to fine-grained, brown-grey, saccharoidal dolomite 419 feet thick as measured by tape on the ridge north of Dizzy Creek. Porosity is accentuated on weathered surfaces by development of irregular cavities. This rock is recognized in Ram River No. 2 well (diamond drill) in sec. 1, tp. 37, rge. 11, W. 5th mer., in Tay River map area, 25 miles southeast of The Gap. No fossils were observed in the saccharoidal dolomite.

Immediately overlying the saccharoidal dolomite is 97 feet of softer, cream-buff-weathering, brown-grey, fine-grained shaly limestone, containing a few, dense, grey, fine-grained limestone bands between 1 and 3 feet thick. The lower contact with the saccharoidal dolomite is transitional, but the upper limit is well defined against massive, fine-grained, dark brown-grey limestone 41 feet thick. It is overlain by 16 feet of thin-bedded, cream-weathering, cream, fine-grained, shaly limestone. At the top of these beds is an horizon carrying a prolific and diagnostic fauna, chiefly brachiopods. Between this horizon and the base of the Banff formation above is 25 feet of cherty, massive, grey-weathering, brown-grey, fine-grained limestone. The fauna collected includes the following forms:

Brachiopoda

Rhipidomella sp.
Schizophoria striatula Schlotheim
S. striatula cf. australis Kindle
S. sp. A and B
S. sp. C, cf. iowensis Hall,
Schuchertella sp., cf. girtyi Shimer
Productella coloradensis Kindle
P. sp. cf. spinulicostata Hall
P. sp. A and B
Camarotoechia cf. nordeggi Kindle
C. sp. cf. nordeggi Kindle
C. cf. banffensis Warren
C. sp. D
Leiorhynchus cascadensis Warren
L. n.sp. B
Spirifer whitneyi Hall
S. whitneyi var.
S. whitneyi animasensis Girty
S. whitneyi cf. monticola Haynes
S. cf. hungerfordi Hall
S. sp. cf. hungerfordi Hall
S. sp. cf. utahensis
S. sp. cf. raymondi
S. cf. argentarius Meek
S. sp. A, B, C, and D
Platyrachella sp.
Martinia n.sp.
Cyrtina n.sp.
Athyris parvula Whiteaves
A. sp. A
A. sp. B, shape like A. angelicoides Merriam , but having fine spines
A. sp. C and D

Pelecypoda

Aviculopecten sp. (?)
cf. Macrodon sp.
Pectenid pelecypod

Gasteropoda

Straparollus
Euomphalus cf. inops Hall
E. sp. A
Loxonema sp.
Diaphorostoma sp.
cf. D. sp.
Gasteropods indet. (minute)

Cephalopoda

Orthoceras sp.
Michelinoceras
M. ? sp. cf. accelerans Raymond
cf. Orinoceras sp.
cf. Offleyoceras sp.
? Agoniatites sp.

The above fauna is of Upper Devonian age according to A. E. Wilson of the Geological Survey. Relative to all the Devonian collections listed above, it is pointed out that the lower beds are characterized by the genus Atrypa, the upper beds by the abundance and persistence of Spirifer whitneyi and its variations, Schizophoria striatula with its variations, and the Camarotoechia of the nordeggi type. Only one species, Athyris sp. B cf. angelicoides Merriam, crosses the dividing line and it is rare in the lower beds and prolific in the upper beds. The upper beds referred to in this analysis are those at 25 feet below the base of the Banff formation and the lower beds lie between 600 and 1,800 feet below the base of the Banff.

Banff Formation

No Exshaw shale was identified between Banff and Devonian rocks at any place in Alexo map-area. It is possible, however, that it is present as a thin band. In Ram River No. 1 well, 15 miles southeast of The Gap in Saunders map-area, 6 feet of black shale is found at the base of the Banff. This may be Exshaw shale.

The Banff formation, immediately overlying the Devonian succession described, is softer than the Devonian rocks below and the Rundle strata above. It consists essentially of dark, thin-bedded limestone and shaly limestone, and generally forms gentle slopes, broken only by a few thin ledges of more massive, coarse-grained, crinoidal limestone. Weathered exposures have a distinctive buff colour and a rubbly surface of thin platy fragments. Outcrops of Banff strata are confined to Brazeau Range. Along Dizzy Creek, south of Saskatchewan River, the formation is included in two anticlinal folds. Its thickness on both limbs of the west fold is 615 to 620 feet, by measurement. Estimates of thickness at other places along Brazeau Range are close to this figure.

The following section is exposed on the steep east limb of the most westerly anticlinal fold on the ridge just north of Dizzy Creek:

Character of beds	Thickness Feet
Overlying beds--Rundle formation	
Limestone, fine-grained, dense, dark grey-brown to buff-brown, thin-bedded; cream-buff and reddish weathering near Rundle	104
Limestone, crinoidal, moderately coarse, dense, brown-grey, ledge-forming	8
Limestone, fine-grained, dense, dark grey-brown to grey, thin-bedded; cream-grey and pink weathering	66
Limestone, crinoidal, medium- to fine-grained, grey-brown, dense, ledge-forming	5
Limestone, fine-grained, grey-brown; cream-grey to pink weathering	13
Limestone, crinoidal, medium fine-grained, dense, brown-grey, thin-bedded, ledge-forming	6
Limestone, fine-grained, dark grey-brown, argillaceous and thin-bedded; buff-grey to pink weathering	28
Limestone, medium fine-grained, dense, medium grey-brown, containing cherty bands, crinoid disks, and calcite veinlets transverse to bedding	16
Limestone, fine-grained, dense, dark grey-brown, containing black cherty nodules and bands	42
Limestone and shaly limestone, fine-grained, dense, dark grey, thin-bedded; cream to buff weathering	40
Limestone and shaly limestone, fine-grained, dense, dark grey, thin-bedded; limestone bands become more prominent toward the base; cream-buff weathering	69
Limestone, fine-grained, dark grey-brown, thin-bedded, containing black chert bands	9
Limestone, fine-grained, dark grey-brown, thin-bedded	15
Limestone, fine-grained, grey, thin-bedded and shaly, alternating with thin, dark grey chert bands; undulatory bedding	95
Limestone, fine-grained, dense, dark grey, thin-bedded, and shaly; cream weathering and forming scree of platy fragments; colour distinctive on weathered exposures	101
Total thickness	617
Underlying beds--Devonian	

Fossils contained in the interval from 100 feet to 170 feet below the Rundle include the following forms: Lophophyllum profundum, Syringopora aculeata Girty , Productus sp. B, P. arcuatus Hall Echinocconchus (poor), Productid (new), Rhynchopora sp. B and C, and Composita athabaskensis Warren . At 363 feet below the Rundle the following forms were collected: Crinoid plate sp. A, Bryozoa, undetermined, Rhipidomella cf. pulchella Herrick , Productus arcuatus Hall , cf. Rhynchopora pustulosa White , Spiriferina sp., Ambocoelia sp., Cleiothyridina cf. hirsuta (Hall).

At other localities in Alexo map-area the forms listed below were collected from the Banff formation:

Anthozoa

Lophophyllum profundum (Edwards and Haime)
Syringopora surcularia Girty
S. pennsylvanica Shimer

Bryozoa

Fenestella sp., indet.

Brachiopoda

Productella cf. pyxidata Hall
P. sp.
Productus minnewankensis Shimer
P. arcuatus Hall
P. fernglenensis Weller
P. sp. A, B, and C
Camarotoechia cf. metallica White
C. cf. allani Warren
C. sp. A and B
Moorefieldella sp. cf. parva Warren
cf. Moorefieldella sp. A
Composita athabaskensis Warren
C. humilis (Girty)
C. cf. subtilita (Hall)
C. cf. ozarkana Mather
C. sp.
Dielasma sp.
Camarophorella cf. missouriensis (Winchell)
Cleiothyridina parvirostris Meek and Worthen
C. hirsuta (Hall)
C. lata Shimer
C. sp. A
Chonetes cf. illinoisensis Worthen
Schizophoria sp. (poor) and S. (fragment)
Spirifer albapinensis Hall and Whitfield
S. sp. cf. marionensis Shumard
S. cascadensis Warren
S. n. sp. aff. subrotundus Weller
S. rutherfordi Warren
S. cf. centronatus Winchell
S. sp. cf. centronatus but finer striae
S. sp. A and C
? Spiriferina sp. (poor)
Reticularia pseudolineata Hall
R. sp.
Squamularia depressiplicata Shimer
Leptaena analoga (Phillips)
Echinoconchus sp.

Rhipidomella n.sp.
cf. Strophalosia sp.
Brachythyris sp. A and B
Martinia sp. and Martinia sp. (poor)
Athyris sp. cf. lamellosa (Leveille)

Gasteropoda

Bellerophon sp.
Gasteropod (minute) and gasteropod indet.

Crinoidea

cf. Platycrinus sp.
Crinoid, indet. and crinoid disks

Trilobita

Proetus sp. cf. occidens Hall and Whitfield

Pisces

Fish plate

Rundle Formation

Massive limestone beds of the Rundle formation form an almost continuous dip slope on the southwestern flank of Brazeau Range, and dip steeply on the northeastern flank. Upper Rundle strata also outcrop on the north side of Saskatchewan River Valley near the western margin of the map-area.

The Rundle formation in Alexo map-area overlies the Banff formation and underlies strata assigned to the Jurassic period. Both lower and upper contacts are distinct. The formation is essentially limestone, and is divisible into three lithologic units. The following section measuring 645 feet in thickness along Dizzy Creek is considered representative of the Rundle in Alexo map-area:

Character	Thickness Feet
Overlying beds--Fernie conglomerate	
Limestone, fine- to coarse-grained, buff grey, massive; weathers white to ash-grey; small, numerous cavities in the uppermost 200 feet contain "pyrobitumen" and double-end quartz crystals	**347**
Limestone, thin-bedded, shaly, buff-grey; weathers buff; forms gentle scree slopes; colour is prominent on weathered exposures	**130**
Limestone, coarse-grained, buff-brown, massive, poorly bedded, crinoidal at base and cherty near top; weathers white to ash-grey	**168**
Total thickness	**645**
Underlying beds--Banff formation	

The buff weathering, shaly limestone member is much less resistant than the massive limestone beds, and generally forms a shoulder or notch between these harder members. The upper massive limestone is not markedly different from limestone below the shaly middle member, but it contains bands and flattened ellipsoidal nodules of black chert near the top.

A sample of the "pyrobitumen" found in cavities at 200 feet below the top of the Rundle by the writer was submitted by B. R. MacKay of the Geological Survey to the Division of Fuels, Bureau of Mines, Ottawa. An analysis of 9 grammes of this material is as follows:

Moisture	0.9 per cent
Ash	23.9 " "
Volatile matter	23.3 " "
Fixed carbon	51.9 " "
Sulphur	6.6 " "
B.T.U./lb., gross	9,050

The report accompanying the analysis states that the low B.T.U. value precludes classification of the material as bitumen. Furthermore, when heated in a test tube, only a light deposit of oil or tar formed on the walls of the tube. No smell of oil or tar was noticed, and the residue was not coherent, as would be expected with a bituminous material. It is apparent, however, that the substance has been derived from a liquid, as small bubbles may be observed on some fractured surfaces. Other reports of occurrences of similar material indicate that it is widespread in the Foothills belt. In these reports it is referred to as pyrobitumen or dried-up bitumen. It is a black, brittle, amorphous substance of coaly appearance, having dull to moderately bright lustre and conchoidal fracture. Double-ended quartz crystals are found in the cavities with the "pyrobitumen", and the crystals contain black specks that may be "pyrobitumen" enclosed in the process of crystal growth. In places a few feet of limestone at the top of the Rundle are black as a result of permeation by this material.

Fossils collected from the Rundle formation in the map-area are: cf. Diphyphyllum astraeforme Warren, Productella sp. cf. pyxidata Hall, P. cf. concentrica (Hall), P. n.sp., Spirifer banffensis Warren, S. cf. centronatus Winchell, S. sp., Composita cf. athabascensis Warren, C. humilis (Girty).

Palaeozoic-Mesozoic Contact

A thin band of pebble conglomerate 1 inch to 1 foot thick, and 3 to 9 feet of soft black shale overlying the conglomerate, intervene between the Rundle formation below and Jurassic limestone above. The conglomerate and shale may include equivalents of Rocky Mountain (Pennsylvanian ?) and Spray River (Triassic) formations, recognizable in part of Brazeau map-area west of Alexo area[1]. For mapping purposes the thin conglomerate and shale are included with the overlying Jurassic.

[1] MacKay, B. R.: Geol. Surv., Canada, Map 41-4 (1941).

Pebbles of the conglomerate band immediately overlying the Rundle formation are black chert, less than ½ inch in size, generally between 3/8 and 1/4 inch, embedded in a fine-grained, calcareous and sandy matrix, from which they tend to break out rather than to fracture. They may have been derived from erosion of chert in the underlying Rundle. A close study of the surface upon which the conglomerate was deposited could not be made because it was everywhere covered by drift or shale slumping from above.

Fernie-Nikanassin Strata

Strata between the Rundle and Cadomin formations have an estimated aggregate thickness of between 500 and 600 feet, of which the lower 270 to 330 feet are considered to be Fernie (Jurassic) on the basis of general lithology. Limestone and dark soft shale predominate in this interval and sandstones predominate in the overlying strata, 230 to 270 feet in thickness, called Nikanassin (Lower Cretaceous). Thinning of Fernie and Nikanassin strata takes place in a southeasterly direction across Alexo map-area. Cherty black phosphatic limestone beds, 120 to 160 feet thick, in the lower part of the Fernie formation, are distinctive and uniform throughout the area. The character of the alternation of shale and sandstone bands above the limestone, however, changes laterally within short distances, so that no section of them can be considered representative for the area. Jurassic fossils are found above the cherty limestone in thin sandstone beds, but no faunal boundary between Fernie and Nikanassin was ascertained.

The following section of estimated thicknesses occurs in the creek crossing Gap Trail from the east at 2,300 feet north of Gap Lake:

Character	Thickness Feet
Overlying beds--Cadomin conglomerate	
Concealed, but known to consist of light yellowish sandstone in massive beds, shaly sandstone, and carbonaceous shale	157
Sandstone, fine-grained, light brown, rusty weathering; some thin dark shale beds	95
Shale, dark grey	40
Sandstone, calcareous, light grey, weathering buff; contains Tancredia sp. at base	20
Shale, black and soft, partly concealed	50
Limestone, black, fine-grained, cherty and phosphatic, disposed in beds 2 inches to 2 feet thick; hackly fracture, buff weathering	158
Shale, black, soft	3
Conglomerate; small black chert pebbles in a calcareous and sandy matrix	0.5
Total thickness	528.5
Underlying beds--Rundle formation	

In this section the Fernie-Nikanassin contact is placed arbitrarily and on a lithological basis at the base of 95 feet of massive sandstone. Four miles north, on Gap Creek, a coquina bed 4 feet thick, 50 feet above the top of the Fernie cherty limestone and 300 feet (calculated) below the Cadomin, contains species of Ostrea, Modiolus, and Pecten (Camptonectes). F. H. McLearn of the Geological Survey states that it is not certain whether these forms, and the Tancredia sp. found in the section listed above, are of late Jurassic or very early Cretaceous age. At other places thin sandstone bands less than 50 feet above the Fernie limestone carry species of Pleuromya, Trigonia (costate group), Pecten, Arctica, and Belemnites. These forms seem to be of Jurassic age.

Cadomin Formation

The thin Cadomin conglomerate between Nikanassin sandstone below and Luscar sandstone above is an excellent horizon marker in the Lower Cretaceous. Because of its resistant character numerous outcrops can be observed. It consists of 20 to 40 feet of massive, pebble conglomerate containing discontinuous bands of cream-grey, crossbedded sandstone. In most places the conglomerate phase predominates over the sandstone.

The conglomerate consists of pebbles of white, cream, and grey quartzite and pink, green, black, and grey chert, firmly embedded in a calcareous sandstone or quartzite matrix. Pebbles of the conglomerate are worn by water action to approximate ellipsoidal shape and attain a maximum size of 2 inches. Most of the pebbles are between $\frac{1}{2}$ and 1 inch in size.

Luscar formation

The Luscar formation, between the Cadomin conglomerate below and the Mountain Park formation above, contains the Lower Cretaceous coal seams worked at Brazeau Collieries, 3 miles west of Alexo area. Lower beds of the formation enter Alexo area in this vicinity and the formation occupies a broad syncline that begins just north of Saskatchewan River at Dutch Creek and plunges gently southeast. South of the river Luscar outcrops are found along the stream bed of Jock Creek and along the southwest flank of Brazeau Range parallel to Gap Creek, swinging eastward to follow the valley of Rough Creek into Saunders map-area.

The contact of the Luscar with the overlying Mountain Park formation is indefinite and cannot be used satisfactorily to locate the coal seams in the Luscar. No complete section of the Luscar formation was found in Alexo map-area. Its total thickness is estimated to be 850 to 900 feet. The following partial section was measured along Dizzy Creek, where Luscar strata have regular vertical dips:

Character	Thickness Feet
Overlying beds--Luscar, drift-covered	
Shale, black, coaly	38.5
Coal	1.0
Shale, medium green, muddy appearance	2.0
Sandstone, gritty, grey	5.0
Shale, black	4.0
Coal	0.5
Shale, black	12.0
Sandstone, shaly, brown, weathering khaki-green	10.0
Shale, weathering greenish	10.0
Sandstone, fine-grained, brown, thin-bedded, weathering khaki-green; shale partings	31.0

	Thickness Feet
Shale, sandy, weathering rusty to green.....	5.0
Sandstone, shaly, brownish grey-green, thin-bedded.....	10.5
Shale, dark grey, sandy and rusty weathering in part; carries Campeloma sp. at base.....	53.0
Shale, dark grey, sandy and rusty weathering in part.....	9.0
Shale, dark grey, hard.....	4.0
Sandstone, fine-grained, brown.....	2.0
Shale, black, containing several thin ironstone bands; shales carry Sphaerium n.sp. (cf. onestae ?) and Melania cf. multorbis.....	25.0
Sandstone, massive, hard, fine-grained, brown-grey.....	6.0
Shale, black, containing one thin ironstone band.....	10.0
Sandstone, thin-bedded, fine-grained, brown.....	5.0
Shale, black, containing 6 inches of ironstone 3 feet from the top; contains Sphaerium n.sp. (cf. onestae ?) and Melania cf. multorbis.....	16.0
Sandstone, hard, quartzitic, light brown, disposed in thin beds separated by shale partings.....	27.0
Concealed by drift, probably shale.....	60.0
Sandstone, fine-grained, brown, disposed in beds less than a foot thick, separated by shale partings....	14.0
Concealed by drift.....	270.0
Thickness of section.....	630.5

Underlying beds--Cadomin conglomerate

A partial section along the creek between Gap and Jock Creeks near Saskatchewan River is described below:

Character	Thickness Feet
Overlying beds--Luscar--concealed by drift	
Sandstone; some soft grey shale containing thin ironstone bands; partly concealed.....	60
Sandstone, grey, soft.....	5
Sandstone, shaly.....	5
Coal, sheared and slickensided.....	8 ?
Concealed by drift.....	50
Sandstone, buff, thin-bedded.....	6
Concealed by drift.....	6

	Thickness Feet
Coal, crushed	3 ?
Sandstone, carbonaceous, interbedded with shale; mostly concealed	20
Sandstone, soft, grey	4
Sandstone, massive; grey-buff weathering	24
Sandstone, thin-bedded, dirty	4
Sandstone, massive; buff weathering	4
Sandstone, thin-bedded, some carbonaceous shale	24
Shale, thin-bedded, carbonaceous; interbedded with thin sandstone bands and ironstone nodules	60
Sandstone and shale; dark, dirty	24
Shale, black, soft, carbonaceous; interbedded with buff sandstone and containing thin ironstone concretionary bands; Sphaerium n.sp. (cf. onestae ?) in shale and cf. Campeloma in ironstone	24
Sandstone, calcareous; buff weathering	10
Shale, black	4
Sandstone, calcareous; buff weathering	6
Sandstone, carbonaceous	6
Sandstone, fine-grained; buff weathering	4
Shale, sandy, thin-bedded	20
Sandstone, fine-grained, calcareous, buff, massive	30
Thickness of section	411

Underlying beds--Luscar--concealed by drift

From these and other partial sections it is estimated that the top of the zone of strata containing the small freshwater forms Sphaerium n.sp. (cf. onestae ?), Melania cf. multorbis Russell , and Campeloma sp. is to be expected between 400 and 450 feet above the Cadomin, and the lowest coal seam of mineable thickness at approximately 200 feet above the top of the fossil zone, or 600 to 650 feet above the Cadomin. No good section of the Luscar strata containing the mineable coal seams was obtained in the area. The soft beds within the Luscar have responded to deformative stresses by complex folding. This is especially true of the coal beds that, where encountered, are found to be highly sheared so that the coal breaks out in small lensy fragments.

Mountain Park Formation

The Mountain Park formation overlies Luscar strata and underlies Upper Cretaceous shales of the Blackstone formation. In Alexo area, outcrops of this formation are almost all south of Saskatchewan River, except at the east side of The Gap, where the Mountain Park passes under the main faults of Brazeau Range north of the river.

No complete section of the Mountain Park was found in Alexo map-area. In the northern part of Brazeau map-area the formation was found to be 650 feet thick[1]. It is estimated to be

[1] MacKay, B. R.: Geol. Surv. Canada, Paper 43-10, p. 3 (1943).

600 feet thick south of Rough Creek near the eastern margin of Alexo area. A pebble-cobble conglomerate band marks the upper contact throughout the area, but the lower contact, with the Luscar formation, is indefinite. One coal seam 2 feet thick occurs near the base of the formation. The main coal seams of the underlying Luscar formation occur in an interval of 200 feet of strata, the top of which is estimated to lie approximately 100 feet below the base of the Mountain Park formation as mapped. Mountain Park strata consist of thin- to thick-bedded, crossbedded, gritty grey sandstone, weathering pale greenish grey, interbedded with green to dark grey shales that weather green, grey, and near the top, maroon.

The conglomerate bed at the contact of the Mountain Park formation with the overlying Blackstone formation is apparently continuous throughout Alexo map-area, although it varies in thickness and character. On Jock Creek it consists of a veneer of bluish grey quartzite cobbles and pebbles, well worn to ellipsoids, attaining a maximum dimension of 5 inches. Along Gap Creek two veneers of such cobbles and pebbles are found, separated by 5 feet of shale and sandstone. These apparently converge and thicken southward, for as much as 8 feet of conglomerate is found in places near North Ram River, Nice Creek and its tributaries, and in Saunders map-area along Rough Creek. In these places the conglomerate consists of pebbles and cobbles of buff-grey and greenish grey quartzite, and black or dark grey chert, embedded in a green-grey, gritty, sandstone matrix. The cobbles attain a maximum size of 6 inches. Variability in thickness of this conglomerate, its poor sorting, and the character of overlying and underlying strata assist distinction from the Cadomin conglomerate at the base of the Blairmore.

No flora was collected from the Mountain Park formation. It is regarded as largely non-marine and as Upper Blairmore in age.

Blackstone Formation

The Blackstone formation, consisting almost entirely of thin-bedded, black, fissile, soft, marine shales, overlies the conglomerate at the top of the Mountain Park and underlies the Bighorn formation. These shales underlie most of the lowlands south of Saskatchewan River on both sides of Brazeau Range. They weather easily, whereas the overlying Bighorn sandstone is very resistant. The topography south of Saskatchewan River and west

of Brazeau Range is an expression of this differential erosion. Broad, high ridges owe their stability to a capping of Bighorn sandstone, below which the soft Blackstone shales form long slopes to the lowlands. Deformative stresses have produced more complex folding in the Blackstone shales than in the Bighorn. This folding is extreme in the Blackstone on the eastern side of Brazeau Range. No complete, uniform section of Blackstone was observed in Alexo map-area. The partial section listed below occurs in the southeast corner of the area, south of North Ram River:

Character	Thickness Feet
Overlying strata--Bighorn sandstone	
Shale, dark grey, sandy at top, many thin bands of ironstone concretions near top; a few large ferruginous limestone concretions scattered throughout.....	290
Shale, grey-black, rusty and sulphurous; a few ferruginous limestone concretions, attaining a maximum size of 3 feet, near top.....	40
Concealed.....	16
Shale, sandy, dark grey, rusty weathering, hard, sulphurous.....	24
Shale, black.....	40
Limestone, dark grey.....	1
Shale, black.....	15
Concealed.....	55
Shale, calcareous, black to dark grey; limestone band at base; Inoceramus labiatus abundant near base.....	50
Concealed.....	60
Shale, calcareous, black, splintery.....	24
Concealed.....	195
Shale, dark grey, containing Inoceramus labiatus and Watinoceras sp.	60
Concealed.....	30
Shale, black to dark grey, containing two limestone bands less than 1 foot thick. Beds of this zone are involved in minor folding; repetitions are eliminated.	40
Shale, black.....	50
Concealed.....	95
Shale, dark grey, thin-bedded.....	50
Concealed.....	70
Shale, sandy and calcareous, dark grey, thin-bedded, containing fish scales, vertebrae, etc.....	3
Total thickness of section...	1,208

Strata below concealed by drift

The base of the formation is not exposed, but it is known from outcrops on Dizzy Creek that the sandstone containing fish scales and vertebrae is not far from the contact with the underlying Mountain Park formation. Folding prevents a reliable estimate of this interval. Webb and Hertlein[1] place such a platy to

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[1] Webb, J. B., and Hertlein, L. G.: Bull. A.A.P.G., vol. 18, No. 11, p. 1393 (1934).

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massive sandstone bed, containing fish remains, at about 100 feet above the base of the Blackstone on Ghost River. At this locality, the Blackstone has a thickness of only 900 feet, so that it is likely that the interval is a little greater in Alexo map-area. Assuming such a figure for the section, however, the total thickness of the Blackstone in Alexo map-area is approximately 1,300 feet.

No fossils were found in the uppermost beds of the formation, and the lower strata appear to be barren except for fish scales and vertebrae contained in thin sandstone beds near the base. Inoceramus labiatus and Watinoceras sp. are generally abundant in several hundred feet of black, hard shale at about the middle of the formation, first appearing at about 500 feet below the top. Ferruginous limestone concretions in this zone were found to contain Watinoceras sp. and Baculites cf. gracilis.

Bighorn Formation

The Bighorn formation caps the high ridges south of North Saskatchewan River and west of Brazeau Range. Although it is a relatively thin formation, it is resistant to erosion, and consequently, the ridges have a characteristic form. Bighorn sandstone makes a steep cliff at the top, facing away from the direction of dip, and Blackstone shales form long slopes below.

The lithologic character of the Bighorn formation and its response to deformative stress show clearly that it may be considered to consist of three parts. The lower and upper parts are hard sandstones, and the middle division comprises soft shales and shaly sandstones. The Bighorn sandstone members break in response to stress, but their resistance to breaking results in faults being localized in the shaly middle member, or in Blackstone shale below or Wapiabi shale above. In the southwestern part of the map-area, thrust faulting from the southwest has produced a series of overlapping plates containing either the lower or upper sandstone members, or the whole formation.

The following section is exposed on the south bank of North Ram River ½ mile east of the mouth of Lynch Creek, in the southwestern corner of the area:

Character	Thickness Feet
Sandstone, buff-brown, thin-bedded, fine-grained at base to gritty, thin-bedded, and crossbedded at top; ledge-forming; characterized by abundance of Cardium pauperculum; not exposed in this section, but estimated from outcrop ¾ mile west	30
Sandstone and shale, interbedded; shale predominates at base	37

	Feet
Shale, black, soft	10
Sandstone, dark brown, thin-bedded, shaly	5
Sandstone, shaly, and shale; green-grey sandstone interbedded with black shale; several thin ironstone bands	55
Shale, black	5
Sandstone and shale; green-grey sandstone, interbedded with black shale; several thin ironstone bands	13
Shale, black; several thin ironstone bands	17
Shale, black; some lumpy, green-grey, sandy shale	30
Sandstone, shaly, poorly bedded; 6 inches of ironstone at base	25
Shale, sandy at top to black, fissile, soft shale at base	36
Sandstone, massive, sparkling, fine-grained, dark grey at top to cream-grey at base	15
Shale, black, containing several thin sandstone bands	15
Sandstone, quartzitic, massive, thick-bedded, fine-grained, light grey; veneer of small black, chert pebbles on top; worm-tracks or root-markings common.	10
Transition; sandstone at top becoming thinner bedded, darker, and more shaly toward base	15
Total thickness	318

Underlying beds--Blackstone formation

The uppermost Bighorn strata are not exposed at this place, but it is known from partial sections on Ram River a mile to the west that about 30 feet of sandstone overlies the top of the section described above. This sandstone is buff-brown, fine-grained to gritty, and crossbedded, containing several thin ironstone bands and sparse, small, black chert pebbles. Cardium pauperculum is common. Scaphites ventricosus is found less than 20 feet above this sandstone, in black shales considered to be Wapiabi. The figure obtained for thickness is in agreement with the thickness determined by MacKay[1] in the Brazeau map-area im-

[1] MacKay, B. R.: op. cit., 1941

mediately west of Alexo area. MacKay finds that the thickness of the Bighorn decreases eastward to 250 feet at the headwaters of Nordegg River in Wawa Creek map-area. Twelve miles south of Alexo area, on the south fork of Ram River, the thickness of exposed strata that correspond to Bighorn in Alexo area is 284 feet.[2]

[2] Evans, C. S.: Geol. Surv., Canada, Sum. Rept. 1929, Pt. B, p. 35

Minor variations in lithology within the Bighorn formation are apparent, but the general lithological character is consistent throughout Alexo map-area. Sandstone beds may appear locally within the central, dominantly shaly part of the formation. In Alexo map-area the basal massive sandstone is characterized by a thin conglomeratic band of small, black and cream chert pebbles occurring at the top. It is only a veneer in most places. The pebbles of this conglomerate are generally less than $\frac{1}{4}$ inch in diameter, attaining a maximum size of $\frac{1}{2}$ inch. Sinuous worm-tracks or root-markings are also a common feature of the basal sandstone, and ripple-marks are present in some places in the lower Bighorn sandstones. On a ridge south of Rough Creek a local development of 20 feet of conglomerate containing red, green, black, and white chert pebbles in crossbedded sandstone is found at the top of the lower sandstone member.

The contact of the Bighorn sandstone with the overlying Wapiabi marine shales is distinct, but the lower contact is gradational from the massive, light grey, quartzitic sandstone of the lower member, through an alternation of about 30 feet of sandstone and shale into the underlying Blackstone marine shales.

Inoceramus capulus is generally abundant in ferruginous bands within the lower Bighorn sandstones. Inoceramus capulus var. corpulentis, I. leylandensis, I. leylandensis var. bighornensis, and Brachydontes multilinigera are also found in lower Bighorn sandstones of the map-area. Inoceramus sp. is found in the middle shaly member and in the upper sandstone. The upper sandstone is characterized by an abundance of Cardium pauperculum. F. H. McLearn points out in a report on this collection that Brachydontes multilinigera, previously collected only from the Dunvegan formation of Peace River region, now appears to be a species with a long range.

Wapiabi Formation

The Wapiabi formation is poorly exposed in Alexo map-area. Outcrops are found in the southwestern part of the area, and along the creek immediately west of Deep Creek, which is north of Saskatchewan River and east of Brazeau Range. In the southwestern corner of the area the Wapiabi is involved in thrust faulting that causes repetition of the lower beds and contact. No complete section is exposed and no reliable figure for thickness can be given. An estimated thickness based on outcrops in the southwestern corner of Alexo map-area, is between 1,500 and 1,600 feet. On the eastern side of Brazeau Range, north of Saskatchewan River, the thickness is estimated to be 1,400 feet.

The Wapiabi formation consists of black marine shale and sandy shale, containing concretions and concretionary bands of rusty weathering limestone. The contact with the underlying Bighorn sandstone is distinct, marked by a thin band of chert pebble conglomerate. At the top of the formation an increasing prominence of sandy beds renders the contact with the overlying Brazeau formation transitional. In the stream bed of the creek immediately west of Deep Creek, the upper contact of the Wapiabi is placed at the base of these transition beds, at a 2-foot bed of chert-conglomerate occurring in grey, shaly sandstone with ferruginous limestone concretions. These concretions contain Oxytoma nebrascensis ? and Baculites cf. aquilaensis Reeside . At about 300 feet below the contact rusty weathering, calcareous concretions enclose Baculites sp. and Anomia cf. subquadrata. Scaphites ventricosus is common in several hundred feet of shales at the base of the Wapiabi, and has been found within 20 feet of the lower contact.

Brazeau Formation

Brazeau strata are found overlying Wapiabi shales along the creek immediately west of Deep Creek north of Saskatchewan River. This belt of rocks is synclinal, bounded east and west by two major thrust faults, one at The Gap and one crossing Saskatchewan River 2½ miles east of The Gap. Brazeau rocks occur along the crest of Stolberg anticline in the northeast corner of Alexo map-area, but mapping of this structure is not complete. Lower beds of the formation cross the extreme southwest corner of Alexo area.

Outcrops of Brazeau strata are scarce in the mapped part of Alexo map-area. As no complete section of the formation was found, no estimate of thickness can be made. MacKay estimates the thickness in Wawa Creek map-area to be about 4,700 feet, exclusive of the transition beds at the base. These transition beds are included with the Brazeau in Alexo map-area. Brazeau strata encountered consist of poorly consolidated, coarse-grained, gritty, light grey to greenish grey sandstones, dark greenish grey, silty shale, poorly consolidated, dark olive-grey clay shales, and, at the base, grey sandstone alternating with grey-brown, sandy shales above the 2-foot conglomerate band that marks the Wapiabi-Brazeau contact.

Edmonton Formation

Edmonton beds underlie much of the unmapped part of Alexo map-area, where they are exposed on both flanks of Stolberg anticline. Southwest of this structure the strata are included in a synclinal fold, the southwestern limb of which is overturned. The coal beds of the Edmonton were not observed on the overturned limb of the syncline, but they outcrop on the gently dipping northeast limb 1½ miles east of the fault on Saskatchewan River. They have been removed by erosion from the crest of Stolberg anticline northeast of the syncline, reappearing on the northeast flank of the anticline at Saunders and Alexo coal mines. Discussion of structure and stratigraphy northeast of the fault on Saskatchewan River is not possible until mapping of this part of the area is completed.

STRUCTURAL GEOLOGY

Structures in Alexo map-area are typical of most of such features encountered elsewhere in the Foothills belt of west-central Alberta. All formations are involved in complex folds and fault plates that are generally parallel and, over most of the area, trend northwesterly.

The southwest corner of the map-area is underlain chiefly by Blackstone, Bighorn, and Wapiabi strata. Thrust faulting has caused much repetition of beds. The existence of these faults is attributed to notable differential response to stress of those particular beds in which they occur. It is evident that some of the faults preceded folding. This is shown by a fault plate of Bighorn sandstone, faulted over Wapiabi and Bighorn, that has been folded with the underlying beds into the syncline now containing the stream bed of Philip Creek. Two tightly folded anticlines lie on either side of Philip Creek. Eastward, in the south-central part of the map-area, Bighorn sandstone caps a wide, relatively flat highland and shows, by its attitude, that deformation in this part of the area was slight. The underlying Blackstone shales, however, reveal minor structures not reflected in the competent Bighorn above.

Rundle limestone outcrops on the north side of Saskatchewan River Valley near the western margin of the area, surrounded by younger beds. The structure of these beds is anticlinal, with closure on all sides except to the northwest. In this direction the fold fades into a homocline of southwest-dipping strata and there is no closure.

The dominant structural and topographic feature of Alexo map-area is Brazeau Range, an outlier of Palaeozoic rocks that was thrust up from the southwest to form an asymmetrical anticline. The southwest limb dips at low angles in the northwest part of the area, increasing to a moderately steep attitude at Saskatchewan River Gap. South of the river dips on this limb become more moderate. The northeast limb is steep or overturned and associated with thrust faulting of large throw from Shunda Creek Gap to Saskatchewan River. This faulting brings Palaeozoic, Jurassic, and Lower Cretaceous strata on the west side in contact with Upper Cretaceous beds on the east side.

South of Saskatchewan River marked changes occur in the width of Brazeau Range and in the trend and nature of its structure. These changes are related to rapid fading of the main faults south of Saskatchewan River and to accommodation to stress by folding rather than by faulting. Several folds have developed, of which the most westerly corresponds to the main anticline of Brazeau Range north of the river. None of the other component folds has a counterpart on that side of the river. Each is asymmetrical, with a steep or overturned northeast limb, and each converges towards the others to plunge beneath the thrust faults at The Gap. The trends of their axes thus account for the widening of Brazeau Range south of Saskatchewan River, and the swing in structure to the east in front of the range. The axis of the main anticline of Brazeau Range does not turn abruptly east at The Gap, but continues southeast for nearly 5 miles before swinging gradually to due east as it crosses the eastern margin of the map-area.

In the stream bed of Dizzy Creek, 680 feet upstream from the point where Cadomin conglomerate crosses the creek, Rundle limestone is observed immediately overlying Luscar shale and sandstone. The Luscar outcrop is apparently a window below a folded fault as the strata above are continuous, closing over the break in an anticlinal fold (See map). On a ridge 1⅓ miles southeast of this point, Rundle limestone is again observed faulted over Luscar beds. Rundle and Luscar strata dip southwest. This structure was encountered at the end of the field season and it was not possible to complete mapping in this vicinity. The writer believes, however, that the observations made indicate a folded fault that turns down, so that Mesozoic rocks lying northeast of it with tops facing northeast, and Palaeozoic rocks southwest of it with tops facing southwest, are parts of an unbroken succession over the fault.

Northeast along Saskatchewan River 2¾ miles from the main faults at The Gap another major fault brings Blackstone beds, on the west side, in contact with Edmonton strata east of the fault. South of the river and west of the fault the succession of strata at the present topographic surface is essentially unbroken from the Blackstone at the fault to the lowest beds exposed in the core of Brazeau Range. All of these strata have been subjected to complex folding. The general structure just west of the fault is a wide syncline, modified by small and intricate folds. North of the river the strata southwest of this fault are also bounded on the southwest side by faulting at the front of Brazeau Range.

Outcrops are scarce in this block, but it is apparent that progressively younger beds occur northward. East of this block, at the fault on Saskatchewan River, lower Edmonton beds are found overturned on the southwest limb of an asymmetrical syncline. These beds rise gently on the northeast limb to form the flank of a broad anticline known as Stolberg anticline. The axis of this anticline lies close to Stolberg, trending northwest and southeast beyond the north and east limits of Alexo map-area. Upper Brazeau beds are exposed along the crest of this anticline.

ECONOMIC GEOLOGY

Until mapping of the Stolberg anticline in the northeast corner of Alexo map-area is completed, evaluation of its possibilities as a source of commercial oil production cannot be made. For the same reason disposition of mineable coal in the Edmonton formation within the area cannot be shown. The Stolberg anticline extends beyond the north and eastern limits of Alexo map-area, In Wawa Creek map-area to the northwest, Stolberg anticline is described[1]

[1] MacKay, B. R.: op. cit., p. 6 (1943)

as a fold of good closure, but one that is tightly compressed and has associated faults dipping in opposite directions on the flanks. In Alexo map-area the southwest limb has much lower dips than in Wawa Creek area, and faulting on this limb is probably not as pronounced. The drilling depth to Rundle limestone is at least as great as in Wawa Creek map-area, because beds exposed at the crest cannot be far below the Edmonton-Brazeau contact. The minimum depth to Rundle limestone under Stolberg anticline in Wawa Creek area is given as 7,000 feet.

In the southwestern part of Alexo map-area, Philip Creek flows along strike in a syncline between two anticlinal folds. An outcrop section across the more westerly of these structures was found in only one place, in the upper reaches of Jock Creek. There Mountain Park sandstone beds close over the crest of the fold, dipping as much as 55 degrees on either side. This fold extends beyond the south margin of Alexo map-area. Closure along strike was not determinable.

The anticlinal fold immediately east of Philip Creek is a tight fold. Steep dips in Blackstone and Mountain Park strata are found on both flanks near the crest. At the south margin of Alexo map-area Bighorn sandstone can be traced across the crest of this fold, but a fault occurs on the northeast limb with a throw of approximately 200 feet. This structure extends southeast beyond Alexo area. A southeasterly plunge is indicated by the differential elevation of Bighorn-Blackstone and Blackstone-Mountain Park contacts. No closure was found northwestward and a fault is found along the strike of this structure in Brazeau map-area to the west[2].

[2] MacKay, B. R.: op. cit., 1941

Coal is mined from lower beds of the Edmonton formation at Alexo by the Alexo Coal Company, Limited. Just beyond the east limit of the map-area there is a coal mine operated by the Bighorn and Saunders Creek Collieries, Limited. These mines are located on the northeast limb of Stolberg anticline. Coal seams of mineable

thickness occur in the Luscar formation in Alexo map-area, in strata that do not tend to outcrop. Where they are observed the coal is sheared, breaking out in small lensy fragments. Very little mineable Luscar coal is present north of Saskatchewan River in Alexo map-area, and deposits south of the river are less accessible than Luscar coal elsewhere in the region.