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Summary Report, 1918, Part C

CONTENTS

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SUMMARY REPORT, 1918, PART C.

CRETACEOUS, LOWER SMOKY RIVER, ALBERTA.

By F. H. McLearn.

CONTENTS.

INTRODUCTION.

Field work for the season of 1918 consisted of an examination of the section exposed on Smoky river, Alberta, from the ferry below Bezanson to the mouth of the river. Acknowledgment is made to Dr. T. W. Stanton for aid in the interpretation of the fossils and to A. J. Childerhose for efficient assistance in the field.

Location. From Bezanson downstream the Smoky pursues a course slightly east of north. At the mouth of Bad Heart river it turns abruptly and flows in an easterly direction to a point about one mile east of the east boundary of range 25. Thence to its confluence with the Peace it follows a course a little east of north. The river, therefore, expises three sections, two a little east of north, and one east-west.

STRATIGRAPHY.

General.

Stratigraphic Range Represented. The Cretaceous succession begins in the Lower Cretaceous and extends into the Montana group of the Upper Cretaceous. The Lower Cretaceous is represented by a single group, provisionally designated the "Lower Cretaceous" group. It comprises two formations, the marine Loon River and the partly subaerial Peace River. In the Upper Cretaceous both the Colorado and Montana groups are recognized. The former, as here delimited, consists of three formations—the marine St. John, the largely non-marine Dunvegan, and the lower part of the marine Smoky River. The Montana group embraces the upper part of the marine Smoky River and the subaerial Wapiti; its upward extension is not known.

Characteristics. Some characteristics of the local succession are revealed by comparison with the Cretaceous of southern Alberta and Montana: marine deposits are present in the Lower Cretaceous; the Dakota cannot be recognized and is probably not present in its normal subaerial development; subaerial delta beds (Dunvegan) are present in the Colorado group; and there is no sandstone member (Eagle, Milk River) at the base of the Montana group.

Interpretation of Lower Cretaceous. Lower Cretaceous is here given the tentative interpretation of pre-Cenomanian Cretaceous. This is pre-Dakota in terms of the North American interior Cretaceous. In southwestern Alberta this rendition interprets as Lower Cretaceous both the Kootenay and the lower Blairmore (i.e. the pre-Dakota part of the Blairmore). This classification is not presented as a final interpretation of Lower Cretaceous.

Correlation Table.

System.		Group.	Smoky-Peace section.		Athabaska section.
Cretaceous.	Upper.	Montana.	Wapiti.		
			Upper shale.	Smoky River.	La Biche.
		Colorado.	Bad Heart sandstone.		
			Lower shale.		
			Dunvegan.		Pelican sandstone.
			St. John.		Pelican shale.
	Lower.	"Lower Cretaceous."	Upper sandstone.	Peace River.	Grand Rapids.
			Middle shale.		
			Lower sandstone.		
			Loon River.		Clearwater.
					McMurray (tar sands.)
Palæozoic Limestone series.					

Lower Cretaceous, "Lower Cretaceous" Group.

Loon River Formation. The Loon River is the basal Cretaceous formation and overlies Palæozic limestone. It does not outcrop on Smoky river, but would be penetrated by any bore-hole drilled to the oil horizon. A description of this formation is given in an earlier report.[1] The thickness in the Smoky section may exceed the 1,100 feet[2] measured farther north, near Peace river,; the basal sandstone beds may also be thicker and more massive. The fauna include *Desmoceras affine* Whiteaves and *D. affine* var. *glabrum* (Whiteaves).

Peace River Formation. The Peace River formation follows the Loon River and, like it, would only be encountered in drilling. It is described in an earlier report,[3] The thickness is 320 feet in the north on Peace river, but is probably greater in the south on Smoky river. The fauna contains *Desmoceras affine Whiteaves, D. affine* var. *glabrum* (Whiteaves), *Hoplites mcconnelli* Whiteaves var., *H. canadensis* Whiteaves, *Tellina dowlingi* McLearn, *Pinna curvimarginata* McLearn, *Trigonia albertaensis* McLearn, *Dicranodonta dowlingi* McLearn, *Nemodon mcconnelli* McLearn, *Panopaea*

[1] Geol. Surv., Can., Sum. Rept., 1917, pt. C, p. 15C.
[2] Geol. Surv., Can., Sum. Rept., 1917, pt. C, p. 15C.
[3] Geol. Surv., Can., Sum. Rept., 1917, pt. C, p. 15C.

cf. *subovalis* Whiteaves, *Panopaea* sp., *Entolium* sp., *Oxytoma* sp., *Inoceramus* sp., *Nucula* sp., and *Yoldia* sp. The similar fauna of the Clearwater formation (Athabaska valley) contains also *Hoplites mcconnelli* Whiteaves, *Inoceramus dowlingi* McLearn, *Brachydontes athabaskaensis* McLearn, *Cyprina* sp., *Cardium* (*Laevicardium*) sp., *Protocardium* sp., and *Pecten* sp.

Correlation and Lower Cretaceous Sea. The Loon River is correlated with the McMurray (tar sands) and Clearwater formations and the Peace River with the Grand Rapids of the Athabaska section. The McMurray has a small non-marine fauna of undescribed species. The Clearwater, Loon River, and Peace River contain the marine fauna of the "Lower Cretaceous" group. It is quite unlike any described American fauna and, therefore, its correlation is difficult; the general affinities of the ammonites and *Inoceramus* are Lower Cretaceous and apparently post-Neocomian; no *Aucella* has been found. As far as studied no resemblance is shown either to the Lower Cretaceous of the Pacific coast and Alaska or the Comanchean of the south; this indicates the presence of barriers of some nature in these directions. Indeed to the west the Lower Cretaceous sea did not extend to the present site of the foothills on Peace river; for there the marine Lower Cretaceous of the east is replaced by non-marine sediments. The sea probably came in from the north or northeast.

Much work must yet be done before these marine, Lower Cretaceous deposits of the northern interior can be correlated with the subaerial, plant-bearing deposits of the south and of the foothills; but what evidence[1] there is favours comparison with the lower Blairmore rather than with the Kootenay of the Crowsnest district.

Upper Cretaceous, Dakota.

Dakota Not Recognized. The Dakota is not recognized in the local succession. The equivalent horizon is near the Peace River-St. John contact. A part of the St. John may be a coeval marine phase.[2]

Upper Cretaceous, Colorado Group.

St. John Formation. The St. John formation succeeds the Peace river and outcrops on the valley sides from the mouth of Smoky river upstream to within about 2 miles of Racing creek. It consists principally of dark, friable, and paper-thin carbonaceous shale, with some ironstone bands and concretions; where the bedding shows it is on a scale of about 2 inches and indicates marine conditions. Marine fossils are present on the Peace and include *Acanthoceras cornutum* Whiteaves, *Nucula dowlingi* McLearn, and *Inoceramus* sp. The top of this formation consists of thin-bedded standstone and shale which, in places, by increase in thickness of the sandstone layers upwards, shows a gradation into the massive sandstone at the base of the Dunvegan. The thickness is 560 feet (estimated).

Dunvegan Formation. The Dunvegan follows the St. John. It underlies the higher valley sides and adjacent plateaus, from Sixmile point to Racing creek; and the lower valley sides, from Racing creek to Smoky. It forms intermittent cliffs. Thick zones of subaerial, concretionary, massive and crossbedded sandstones, with beds of subaerial shale, alternate with thick zones of thin-bedded sandstone and shale which may in large part be of marine origin. The fauna includes *Unio dowlingi* McLearn, *Corbula pyriformis* Meek, *Brachydontes multilinigera* Meek, *Tellina dunveganensis* McLearn, *Inoceramus* sp., and *Melampus* sp. On Peace river the following also are found: *Ostrea anomioides* Meek, *Barbatia micronema* (Meek), *Corbula* cf. *nematophora* Meek, *Tellina* (*Moera*) *peaceriverensis* McLearn, *Corbicula* sp., *Volsella* sp., and *Pachymelania* sp. The estimated thickness below Smoky is 440 feet.

[1] Geol. Surv., Can., Sum. Rept., 1917, pt. C, p. 17C.
[2] Geol. Surv., Can., Sum. Rept., 1917, pt. C, p. 16C.

Smoky River Formation. The Smoky River Formation succeeds the Dunvegan. It underlies the higher valley sides and adjacent plateaus from about 12 miles below Racing creek to Smoky, the entire valley sides and adjacent plateaus from Smoky to within about 10 miles of Bad Heart river, and the lower valley sides from Bad Heart river to within about one mile of Kleskun creek. The Smoky River formation may be divided on lithological grounds into three members, a lower shale, a middle sandstone—the Bad Heart Sandstone, and an upper shale. The lower shale and Bad Heart sandstone members are referred to the Colorado group and the whole or a part of the upper shale member to the Montana group. The lower shale consists below of paper-thin carbonaceous shales with concretions; the fossils are *Acanthoceras* cf. *coloradoensis* Henderson, *Prionotropis hyatti* Stanton, *Prionotropis* sp., and *Inoceramus labiatus* (Schlotheim). Above are dark, friable shales with concretions and at the top shale and thin-bedded sandstone and shale; *Inoceramus umbonatus* M. and H. and *In.* cf. *deformis* Meek are found in this part. The Bad Heart sandstone member consists of 10 to 25 feet of coarse sandstone, weathering reddish brown. It stands out prominently in all the cliffs from Puskwaskau river to within a few miles of the Little Smoky and forms a horizontal, frieze-like band in the cliff walls of shale. This member is abundantly fossiliferous and contains *Baculites* cf. *anceps* Lamarck, *B.* cf. *asper* Morton, *Scaphites ventricosus* M. and H., *Oxytoma nebrascana* (E. and S.), *Anomia subquadrata* Stanton, *Pteria linguiformis* (E and S.), *Gervillia stantoni* McLean, *Nucula* cf. *cancellata* M. and H., *Goniomya* cf. *americana* M. and H., *inoceramus* sp. *Anatina, (Anatimya)* sp., *Pecten* sp., *Cardiastor* sp. The Combined thickness of the Bad Heart sandstone and lower shale is 550 feet. The upper shale will be described under Montana group.

Correlation and Dunvegan Delta. The St. John is correlated with the Pelican shale, the Dunvegan with the Pelican sandstone, and the part of the Smoky River described above with the lower La Biche of the Athabaska section.

Four fossil zones can be recognized in the local development of the Colorado group. They include the faunas of the St. John and Dunvegan formations, the fauna in the lower part of the lower shale member of the Smoky River, and the fauna of the upper part of the upper shale member and the Bad Heart sandstone member. The St. John contains a small fauna of species not known elsewhere, but has the type of ammonite and of *Inoceramus* which do not appear in North America earlier than the Colorado. The difference between the faunas of the Dunvegan and lower part of the lower shale member of the Smoky River can be explained, in part at least, by the difference in environment conditions. The Dunvegan contains the Coloradoan *O. anomioides, B. micronema,* and *Br. multilinigera;* the Bear River *C. pyriformis* is not later than Colorado. The lower part of the lower shale member of the Smoky River formation is correlated with the Colorado on the basis of *A.* cf. *coloradoensis, P. hyatti,* and *In. labiatus.*

A later fauna of upper Colorado age is found in the upper part of the lower shale member and the Bad Heart sandstone member, with *S. ventricosus, B.* cf. *anceps, B.* cf. *asper,* and *In. umbonatus.* A few bivalves identical with, or closely related to, characteristic Montana forms here range down into the upper Colorado: *O. nebrascana*[1], *P. linguiformis, G.* cf. *americana, and N.* cf. *cancellata.* This later fauna may be compared with that of the upper part of the Colorado shale of the Crowsnest River section and the upper 400 or 500 feet of the Colorado shale of Montana.[2] It holds also about the time of the Niobrara and Austin limestone.

Attention is called to the presence of subaerial delta deposits (Dunvegan) in the Colorado group of this section. The Pelican sandstone may also be so interpreted and, with the Dunvegan, records a delta built out in the Coloradoan sea, similar to,

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[1] Found also in upper Colorado of Crowsnest section. See: Stewart, J. S., Geol. Surv., Can., Mem. 112.

[2] Stanton, T. W., personal communication.

but more restricted than, the Foremost-Pale Beds (Judith River) delta of the Montanan sea. In the United States interior non-marine deposits of this age are found in northern Utah and southwestern Wyoming.

Upper Cretaceous, Montana Group.

Smoky River Formation. The higher part at least of the upper shale member of the Smoky River formation is Montanan. The upper shale member is made up of dark, friable shale with thin bands of sandstone near the top; ironstone concretionary bands are present. The thin banding and marine fossils indicate marine deposition. The thickness is 300 feet. *Nucula* cf. *cancellata* M. and H., and *Oxytoma nebrascana* (E. and S.) are found 250 feet above the base of this shale member and *Baculites ovatus* Say, 100 feet above the base.

Wapiti Formation. The Wapiti succeeds the Smoky River and, in the section studied, 900 feet of it are exposed; its upward extension is not known. It is a cliff-marker and is intermittently exposed from Bezanson almost to the mouth of Bad Heart river. The sandstone beds are thick, massive, and crossbedded. They contain rootlets and, in places, flat concretions. The shales vary from a couple of feet to over 50 feet in thickness, are grey to dark carbonaceous, and show vertical rootlets. A coal bed with a maximum thickness of 4 inches occurs 580 feet above the base and a second coal seam 3 inches to 4 inches thick, 180 feet above the base. This formation is evidently of subaerial origin. The sandstone walls occasionally weather into grotesque forms; the flat concretions form caps to detached or partly detached pillars and irregular buttresses. No fossils were collected.

Correlation. The upper shale member of the Smoky River formation is correlated with the Montana group on the basis of the presence of *Baculites ovatus.* In the Athabaska valley it may be compared with the upper La Biche; in southern Alberta, with about the time of the Milk River and Pakowki; and in Montana, with the Eagle and Claggett. The absence of a sandstone at the base of the Montana group makes it difficult to fix the exact location of the Montana-Colorado contact. The Wapiti occupies the stratigraphic position of the Foremost and Pale beds of the southern Alberta section and of the Judith River at Montana, but how the upward range of this formation compares with them is not at present known.

STRUCTURE.

The major structure is a south dipping homocline or half-fold, the north side of a large synclinal basin whose axis is south of Bezanson and outside of the area studied. No undulating structure of anticline and syncline is superposed on this major structure. There is considerable change of dip, however, and a few miles above the mouth of the river, a rather poorly defined terrace. Details of dip are given in the table below. Attention is called to the almost flat structure revealed by the east-west section from Bad Heart river to the great bend one mile east of the east boundary of range 25; this shows that the general strike is practically east-west.

	Dip to south, feet per mile.
Mouth to one mile south of north boundary, tp. 81	12
Latter to south boundary, tp. 81	Flat.
" middle, tp. 79	25
" south of Smoky	50
" " boundary, tp. 77	20
" to within one mile east boundary, range 25	12
Mouth Bad Heart to Puskwaskau river	60
Latter to horseshoe bend above Puskwaskau river	15
" 2 miles below Kleskun creek	30
" middle tp. 72	45
Latter to ferry below Bezanson	60
	Dip to east, feet per mile.
Mouth Bad Heart river to one mile east of east boundary, range 25.	1

Oil Horizon. In the wells north of the town of Peace River oil occurs in sandstone near the base of the Loon River formation. The problem to be considered is the extension of the oil-bearing strata to the south of the Smoky section and the likelihood of the presence of oil there.

Influence of Structure. No especially favourable structure for oil is present in the Smoky section studied; the flat terrace in township 81, range 23, is the nearest approach to one, but the dip on the north side is not very pronounced. If the oil horizon on Peace River proves productive as far south as the town, then exploration can be extended to the south limit of this terrace with some prospect of similar success. Beyond this, the dip, though varying, is everywhere to the south and rapidly carries the oil-bearing beds into the depths of the great synclinal basin to the south.

Influence of Change of Sediment. It is assumed that the oil is of Cretaceous origin; then its occurrence requires the presence of carbonaceous marine shales interbedded with porous sandstone. These conditions are fulfilled in the north near Peace River. Somewhere to the south or southwest, however, the marine deposits of the Lower Cretaceous pass over into subaerial sandstones and shales. In such strata the presence of oil is improbable. It may be concluded, with a reasonable assurance, that this change will not be effective as far south as township 81. Some changes in the lithological succession should be expected, however; more numerous and thicker beds of sandstone are probable and the vertical distribution of oil, gas, and water horizons will likely differ in detail from that in the wells below Peace River.

Influence of Water. It may be safely assumed that at some place in the south, down the dip, saturation with water of the sandstone beds at the base of the Lower Cretaceous will prevent the occurrence of oil there; this location can only be determined by drilling.

Drilling Depths. The depths given below are on the assumption that oil is present at an horizon identical with that in the No. 2 well of the Peace River Oil Company and that there is no increase in thickness of the formations southward. They should be taken as minimum figures.

—	River-level o assumed oil, horizon.	River-level to inferred limestone contact.
Terrace in north tp. 81	1370	1520
Terrace in south tp. 81	1380	1530
North boundary tp. 81	1340	1490
Middle tp. 82	1300	1450
Mouth Smoky river	1180	1330

Character of Oil. The relation, at Peace River, of oil of heavy gravity, to the gentle structure of the enclosing strata, and hence to the minimum deformative stress suffered by them, is considered to be a genetic one and is in accordance with White's law of correlation; indeed it is a confirmation of that law. Since the structure on Smoky river does not present any greater degree of undulation than that on Peace river in the north, only oil of similar heavy gravity can be anticipated in the Smoky section.

The increase in depth attained as far south as township 81 cannot be expected to bring about an increase in quality of oil, since it is not sufficient to be effective.

Stansfield and Nicholls find that the oil from Peace River "cracks" at abnormally low temperatures. This phenomenon begins at 200 degrees and is particularly active between 250 and 300 degrees. As far as present knowledge goes, this is the only oil known to suffer destructive distillation below 325 degrees. It is thought that this can be explained. The presence of constituents in this oil, stable only at low temperatures, is, like the heavy gravity, related genetically to the moderate structure of the rocks of the district and to the moderate degree of stress which they have undergone. Johnstone and Huntley explain the law of correlation of White and formulate a geochemical theory of the natural history of oil production. They offer the theory that, concomitant with the progressive deformation of the enclosing strata, there takes place a progressive devolatilization and destructive distillation of petroleum substances, whereby increasing quantities of gas and oils of higher and higher rank are produced. The character of the Peace River oil confirms this theory. The presence of the heavy constituents, stable at low temperatures, can only be explained by the minimum temperatures to which they have been subjected, made possible in turn by the minimum stress which the enclosing rocks have undergone. For, had the rocks suffered greater folding and stress, the unstable heavy compounds would have been eliminated and only the lighter constituents, stable at the higher temperatures, would have survived.

Interpreted then in the light of the law of correlation and the geochemical theory, the Peace River oil represents a stage in the natural history of oil production in which the geochemical forces have been stayed—or have been operative only to a minimum degree. As marks of this stage we recognize the heavy gravity and the presence of constituents stable only at low temperatures.

GEOLOGY OF THE SWAN HILLS IN LESSER SLAVE LAKE DISTRICT, ALBERTA.

By John A. Allan.

CONTENTS.

INTRODUCTION.

In order to connect the stratigraphy in the Edmonton district and central Alberta with that along Peace river, 250 miles to the northwest, it was necessary to investigate the districts where exposures might be expected to occur and where the glacial drifts were shallow. With this object in view the Swan Hills district lying to the south of Lesser Slave lake was chosen. The months of June and July were spent in the district and the preliminary results are contained in this report.

The area examined covers about 650 square miles and lies chiefly within the Lesser Slave forest reserve, between township 67 and Lesser Slave lake.

As there had been no topographic survey made within the Forest Reserve, it was necessary to carry a pace traverse during the whole field season. This traverse was frequently tied on to the eighteenth base-line and to the railway at Sawridge. Starting from Swan River station on the Edmonton, Dunvegan, and British Columbia railway, Swan river was followed to the Swan River Forestry station at the northern entrance to the reserve. From this station a pace traverse was continued up Swan river to the confluence of the Inverness, then up the Inverness valley to the eighteenth base-line. To the westward the trail was traversed across the Driftpile valley, over Wallace mountain, and down to the crossing of Bruce river. Side traverses were made along the Bruce, Driftpile, Inverness, and Sutherland rivers, and all outcrops were located with reference to the main traverse or the eighteenth base-line. The position of House mountain to the north of the Inverness valley was located approximately by various traverses and by triangulation from several angles.

From the mouth of the Inverness a traverse was made up Swan river to Deer mountain, a few miles south of the eighteenth base-line. From Swan river Forestry station a traverse was made eastward across the unsurveyed district to Sawridge at the east end of Lesser Slave lake.

About the middle of July a trip was made from the east end of Lesser Slave lake up Lily creek on the west end of Marten mountain. On account of weather conditions and the time available for field work only a preliminary survey could be made.

At the close of the field season a trip was made to Peace river, where the stratigraphic section was examined, in company with F. H. McLearn.

Able assistance was given by J. A. MacLean. The work was facilitated by information given by Mr. J. A. Doucet, supervisor of the forestry branch at Sawridge; by Mr. A. Foley, forest ranger at Swan River Forestry station; and by several pioneers in the district.

No previous work has been done on the geology of the Swan Hills district.

The timber conditions around Lesser Slave lake, including the Swan hills, has been reported on by D. Roy Cameron, in Bulletin 29, Forestry Branch, 1912.

Magnetic declination in the Swan hills is 29 to 30 degrees east according to the map showing lines of equal declination published by the Topographical Survey Branch, 1917.

GENERAL DESCRIPTION.

Lesser Slave lake covers 485 square miles. It occupies a long, irregular basin which extends from Grouard at the west end, to Sawridge at its outlet at the east end, a distance of over 60 miles. The width varies from less than 3 miles at The Narrows, to 12 miles north of Giroux bay. The average width is about 8 miles. Lesser Slave river is the outlet of the lake; this river enters the Athabaska at Smith, on the Edmonton, Dunvegan, and British Columbia railway about 30 miles east-southeast. The north shore of the lake is comparatively regular. The south side of the lake is quite shallow and the shore-line is irregular on account of the expansive deltas built out by Driftpile, Swan, and Assineau rivers on the southern margin. The delta of Driftpile river covers over 20 square miles, and that of Swan river is considerably larger. The south shore of the lake is very low and swampy, producing large quantities of marsh hay.

From the south shore of the lake the land rises slowly for the first 10 to 15 miles, then very abruptly to the summit of the upland, known as the Swan hills, which begins from 20 to 30 miles south of the lake.

The Swan hills represent a maturely dissected upland, forming the watershed between the streams draining northwards into Lesser Slave lake and those draining southward into Athabaska river. The summit of the upland is remarkably flat, and has an elevation of 4,000 to 4,320 feet above sea-level. This represents 2,100 to 2,430 feet above the surface of Lesser Slave lake.

The upland is irregular in outline as it has been most irregularly dissected by the various streams which drain its slopes, but the major axis of the plateau has an east and west trend. Long spur-ridges extend somewhat radially from the upland between the numerous tributary valleys of the main streams. In some cases parts of the upland have become disconnected and form independent mesas or buttes, occasionally lower than the summit level of the upland. House mountain is an example of this type.

The greater part of the north slope of the Swan hills is drained by Swan river and its tributaries, the largest of which is Inverness river. Swan River valley forms a very conspicuous break in the upland; it extends between 50 and 60 miles south of the lake and has a drainage area of nearly 1,000 square miles. The valley broadens rapidly after it leaves the hills, and the broad alluvial plain which extends down to the lake, produces large agricultural areas on which are grown vast quantities of potatoes and hay.

Along the northern face of Swan hills there is a prominent escarpment bordering the summit of the upland. This escarpment is developed in the flat-lying beds of the Tertiary and Upper Cretaceous formations.

The highest summit in the area examined is Wallace mountain which lies between the valleys of Driftpile and Bruce rivers. The eighteenth base-line crosses the south spur of the mountain at 4,280 feet, but the summit of the mountain which is reached a hundred yards north of the base-line is 40 feet higher, or 4,320 feet above sea-level. This summit stands 2,430 feet above Lesser Slave lake, which has an elevation of 1,890 feet. The top of Wallace mountain is flat, about half a mile long, and narrow; at one point the summit is only 7 feet wide, with steep slopes on each side. Wallace mountain represents the northern end of a spur from the main upland. It has become a mesa by the denudation of the valleys of Driftpile, Bruce, and East Prairie rivers.

House mountain is another example of a mesa which represents the extreme northern end of a spur-ridge between Inverness and Driftpile rivers. The position of House mountain was located approximately by track traverses and by triangulation. It is situated about 4 miles northwest of the forks where Sutherland river enters the Inverness, in tp. 70, range 11, W. 5th mer. The mesa is rectangular, about 1½ miles long, and from 250 to 700 feet across the top. The summit is quite flat and thickly wooded with balsam fir, lodgepole pine, some jack pine, and black spruce. The summit is surrounded by an escarpment from 50 to 250 feet high.

This escarpment, which is particularly pronounced on the northward slope, makes the mountain one of the most prominent topographic features in the Swan hills.

The Swan hills represent residuals of erosion from the preglacial plains level which stood upwards of 2,000 feet higher than at present. In this respect Swan hills can be compared with Hand hills and Cypress hills in southeastern Alberta.

At the east end of Lesser Slave lake the slope rises abruptly to an elevation of 3,000 feet above sea-level or 1,100 feet above the lake. This ridge is known as Marten mountain. Although lower than the Swan hills, Marten mountain is, nevertheless, a more maturely dissected part of the upland.

Between Swan hills and the alluvial plains along the south shore of the lake are numerous irregularly rounded spurs and ridges, all thickly forested, many of them poorly drained and covered or surrounded by muskegs.

The Swan hills present two types of vegetation: (1) muskeg, (2) forest type. Muskegs are omnipresent in the district. They occur at all altitudes from the lake shores to the highest summits on the upland. It is fair to estimate that upwards of 25 per cent of the area examined during the field season was covered with muskegs, some dry, most of them wet, some shallow, and many several feet in depth. On the slopes leading to the summit of the upland muskegs cover large areas, except where the underlying rock is sandstone and comes near the surface, then the muskeg is replaced by jack pine. Muskegs occur on the summits of many of the ridges and even on the summits of mesas like House mountain and Wallace mountain. The summit of Deer mountain, which is a portion of the main upland, is one large muskeg. These summit muskegs are very wet and are either open tundras or are associated with patches of scattered tamarack or lodgepole pine, black spruce, and balsam fir.

The forest type covers almost the whole of the area examined, with the exception of a few open patches in the valley floors or on the alluvial plains. With reference to the timber in the Swan hills, D. R. Cameron writes: "Nowhere on the Swan hills will the timber of this species be of use for anything more than a protective covering.

But it has an important function in this regard."[1] On the upland summits lodgepole pine, balsam, fir, and black spruce predominate. On the slopes lodgepole pine is the most common species. It grows larger on the lower slopes and along the valley bottoms. Jack pine is irregularly distributed along sand ridges or where the underlying formation consists chiefly of sandstone. Tamarack is not common, or when it occurs in muskegs it is slender and of poor quality.

Along the bottom of the valleys and also over the alluvial plains aspen and cottonwood predominate. The latter follows closely the sides of the rivers, but frequently grows over 100 feet high and measures up to 5 feet in diameter.

Between Swan river and Sawridge on the north slopes of the upland are many square miles of aspen interspersed with balsam poplar, and east of the Assineau river there are small areas of northern canoe-birch. There is much fine agricultural land, and more particularly grazing land, between Swan river and Lesser Slave river for 6 to 10 miles south of the lake. This district would be valuable for agricultural purposes if the forests were cut or burnt off. This is proved in the area within 6 miles of Sawridge where the land is cleared and settled. The whole of the Swan Hills district is included in the Lesser Slave Forest Reserve, which covers over 2,500,000 acres.

GEOLOGY.

The Swan Hills district is so heavily wooded and muskegs are so extensive that rock exposures are rare. However, in river-cut escarpments and in the prominent escarpment defining the summit of its upland the stratigraphic section shows that the Montana group and the Paskapoo are present. As the outcrops are rare it was not always possible to connect the respective sections. However, taking Wallace mountain as the highest part of the section at 4,320 feet and Lesser Slave lake at 1,890 as the base, there is a difference of 2,430 feet, which would represent the thickness of the section if the beds were lying in a horizontal position. In the upland areas the strata in general are lying horizontal or with a slight dip of a few feet to the mile, towards the south and southwest. There are local rolls of minor importance. Along Driftpile river various sections are exposed where the beds dip to the southwest as much as 15 feet to the mile. The total section represented between the summit of the Swan hills and Lesser Slave lake exceeds 2,500 feet.

The structure is simple and there are no indications of important faults or structural breaks. There are, however, many large slump blocks along the sides of the large trunk valleys. Several blocks were observed which measured upwards of 100 feet in thickness, about 1,000 feet in depth, and a quarter to three-quarters of a mile in length. In such rock slides the dips are usually most irregular.

Table of Formations.

Unconsolidated deposits	Alluvial, sand-dune, glacial, lacustrine deposits.	
Paskapoo formation	Tertiary.	
Edmonton formation		Cretaceous.
Bearpaw (not observed)	Montana group	Cretaceous.
Sawbridge formation	Montana group	Cretaceous.
Upper La Biche (Upper shale member Smoky River)	Montana group	Cretaceous.

Paskapoo Formation. The summits of the Swan hills are underlain by nearly flat-lying beds which can be correlated with the Paskapoo formation farther south in the province. The most continuous sections are exposed along the Driftpile, south of the eighteenth base-line, on the west slope of Wallace mountain, around the summit of House mountain, and approaching the summit of the upland in Deer mountain between the headwaters of the Swan and Saulteux rivers. Upwards of 1,020 feet of beds have been placed in this formation. The beds are varied in character, but indurated and semi-indurated clays, clay shales, arenaceous shales, thin beds of hard and soft grey

[1]Geo. Surv., Can., Ann. Rept., vol. V, pt. I, p. 27D.

and ferruginous sandstones, and hard, scaly, highly calcareous shales predominate. The hard, calcareous shales form creamy coloured escarpments at various points around the summits of the upland, and are prominently exposed in House mountain and Deer mountain. Laminæ of coal and thin layers of lignitic shale are common; also thin layers of dark shale enclosing carbonized and silicified fragments of wood and bark. Fragments of wood 0 to 3 feet in length, 1 foot in width, and compressed to one inch or less, occur about the middle of the formation. There are certain beds of clay shales which absorb water and become soft, greasy, greenish muds.

There are two highly fossiliferous beds of hard, calcareous shale, each 18 inches thick, exposed in the amphitheatre at the head of the east branch of Bruce river, on the west slope of Wallace mountain, about 600 feet below the summit. Several species of pelecypods and gastropods are represented in these beds, but the only species which has yet been determined by Mr. McLearn is *Viviparus leai* M. and H. J. W. Stanton has also examined this species and writes, "After comparison with the types of *V. leai* from the Fort Union formation near Fort Clark, North Dakota, I think that the Alberta specimen should be referred without question to that species. I have not seen this form nor any very closely related in collections from the Judith River or Belly River formations."

Edmonton Formation. There is no line of demarcation between the beds placed in the Tertiary and those placed at the top of the Montana group. The top of the Edmonton is placed where there are two seams of coal, 20 inches and 21 inches respectively, separated by 8 feet of carbonaceous and dark grey shale. These beds occur in Driftpile river at an elevation of 3,300 feet. There are other coal seams about 100 feet lower down, the thickest of which is about 3 feet. These are exposed along the Driftpile north of the base-line, and also at a number of points along the northwest slope of Inverness valley. The base of this formation is not exposed, but the character of the beds and the presence of a coal seam at an elevation of 2,650 feet would indicate that there are at least 650 feet of strata which may be placed in the Edmonton formation.

The character of the strata in the Swan hills is not unlike that in the vicinity of Edmonton, where this formation is typically exposed.

The best section of this formation is exposed in Driftpile river north and south of the eighteenth base-line. Upwards of 500 feet were measured along this river. The beds consist chiefly of sandstones, massive and thin-bedded, sometimes weathering into large nodular masses, arenaceous shales with bands of clay-ironstone nodules enclosing fragments of plants, semi-indurated clays, calcareous clay lenses, in the shale and shaly sandstone, and numerous thin seams of coal. The thickest seams appear to lie at the top and also towards the base of the beds placed in this formation. The thickest seam of coal observed measured about 4 feet. In a few exposures there is a tendency for the clayey sandstone to erode into badland topography.

Bearpaw Formation. If there are beds below the Edmonton which can be correlated with the Bearpaw formation, they were not observed, and the formation must also be very thin, not over 100 feet.

This part of the section may be exposed along the lower part of Driftpile river, which has not yet been examined.

Sawridge Formation. In the area examined at lower elevations between the valley of Swan river and Sawridge, no exposures were found between 2,650 feet and about 2,100 feet. Here the beds are of freshwater origin and contain seams of coal. For the purpose of reference these beds are called the Sawridge formation.

La Biche Shales. These shales are not exposed in the vicinity of Sawridge, but Mr. McConnell[1] states that "From the mouth of Lesser Slave river to Pelican river

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[1] Geol. Surv., Can., Ann. Rept., vol. V, pt. I, p. 27D.

the valley of the Athabaska is cut out of soft, dark, greyish or brownish shales (La Biche shales)." Lesser Slave river enters the Athabaska at Smith about 30 miles east-southeast of Sawridge. The elevation at this point is 1,800 feet. It seems probable that the basin of Lesser Slave lake, which follows approximately the trend of the structure, is formed in these shales.

According to McConnell[1] the boundary between the Montana and Colorado groups lies within the limits of the La Biche shale and, therefore, the upper part of that formation is of Montanan age. In the Smoky River section, to the west, McLearn[2] correlates the upper shale member of the Smoky River formation with the upper (Montanan) part of the La Biche.

Unconsolidated Deposits. Along the south side of the lake, and particularly in front of the outlets of the valleys from the Swan hills, are extensive stretches of alluvial deposits which produce agricultural areas.

Sand dunes and dune ridges border the lake along the south and east end. These have been formed from the sands blown from the broad beaches along the lake shore.

Morainal ridges of sand and gravel, and boulder clay ridges are common between the uplands and the lake. It would seem that the summit of the Swan hills formed nunataks which projected as islands from the surface of ice even during maximum glaciation. There are no indications that the glaciers ever covered the summit of the plateau.

Overlying the Paskapoo formation on the summits of the upland there is a bed of coarse gravel which varies from a few inches up to 15 feet in thickness, and which consists almost entirely of water-worn pebbles of pure white quartzite up to 6 inches in diameter. These white pebbles are widely distributed over the floors of the valleys. In many places the shingle consists almost entirely of this rock.

These pebbles might be suitable for use in ball mills, but the deposits are not large enough in any locality, and they are too far from transportation to be of economic value at the present time.

Where these gravels were examined they conform with the bedding planes in the Paskapoo. They seem to be of preglacial age and possibly might be correlated with the Miocene gravels capping similar uplands in Cypress hills and Hand hills.

SUMMARY.

The Swan hills are remnants of a maturely dissected upland which was more extensive in preglacial time. The maximum elevation of this upland is 4,320 feet, or 2,430 feet higher than Lesser Slave lake.

The structure is simple and the formations are flat-lying or with a slight dip towards the south.

The unconsolidated deposits consist chiefly of alluvial material, dune sands, and boulder clay. A bed of white quartzite pebbles caps the upland and may be of late Tertiary age.

The consolidated strata belong to the Paskapoo (early Tertiary), and to the members of the Montana group.

The Paskapoo forms the upper part of the Swan hills and has a thickness of about 1,000 feet.

The Edmonton formation underlies the Paskapoo. There is no marked break between the two formations but the presence of a persistent seam of coal underlain by a series of beds, lithologically somewhat different from those above, is regarded as the top of the Edmonton formation. This formation is of freshwater origin and at least 650 feet thick.

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[1] Geol. Surv., Can., Ann. Rept. (new ser.), vol. V, pt. I, 1890-91, p. 53D.
[2] Geol. Surv., Can., Sum. Rept., 1918, pt. C, p. 4.

Near the level of the lake there is another series of beds of freshwater origin containing seams of coal, which correspond to some of the members of the Belly River series in central Alberta. These have been called the Sawridge formation. If the Bearpaw formation is represented in the section south of Lesser Slave lake it cannot be over 100 feet thick.

At the mouth of Lesser Slave river, at an elevation of 1,800 feet, La Biche marine shales are cut across by Athabaska river. The La Biche is correlated with the Smoky River and the upper part of each formation is of Montanan age.

NORTHERN PART OF CROWSNEST COAL FIELD, ALBERTA.

By Bruce Rose.

CONTENTS.

INTRODUCTION.

The areal mapping of the Kootenay coal-bearing rocks and associated formations in the Rocky mountains of southern Alberta and British Columbia was begun in 1915 in conjunction with a general investigation of the coal resources and of the stratigraphy and structure of the various formations. Prior to 1918 the area south of 50 degrees north latitude was completed,[1] and a reconnaissance of the Upper Elk valley, British Columbia, north of the 50th parallel, was made.[2] In 1918 the mapping was carried northward in Alberta to the headwaters of Oldman and Livingstone rivers within the Rocky mountains and of Willow creek and tributaries in the foothills.

This completes the mapping of the Crowsnest coal field in Alberta (the area tributary to the Crowsnest branch of the Canadian Pacific railway); the coal-bearing strata, however, are known to continue northward beyond the limits of the Crowsnest field.

The field work covered a period of three months from July 15 to October 15. Efficient assistance in the field was given by J. A. McLennan, W. E. Abbott, and J. R. Brandon.

The investigation shows that there is a large reserve of bituminous coal within the Rocky mountains and a sufficient supply for local use at a number of points in the foothills.

GENERAL GEOLOGY.

The stratigraphic column extends from the Devono-Carboniferous to the Upper Cretaceous and probably includes Tertiary rocks. The rocks are in general similar to those in the area south of the 50th parallel of north latitude, a description of which was given in the summary report for 1916. Differences are noted below. No Cambrian or Pre-Cambrian rocks occur in this area.

[1] Geol. Surv., Can., Sum. Rept., 1915, p. 110; 1916, pp. 107-114; 1917, pt. C, pp. 28-35.
[2] Geol. Surv., Can., Sum. Rept., 1916, pp. 63-66.

Table of Formations.

Pleistocene and Recent.	Superficial deposits.
Tertiary?	
Upper Cretaceous........	St. Mary River formation. Allison formation. Benton formation. Crowsnest Volcanics. Blairmore formation.
Lower Cretaceous.......................	Kootenay formation.
Jurassic............	Fernie formation.
Devono-Carboniferous....	

Changes in Sedimentation.

Fernie Formation. The Fernie formation, which in the area to the south is principally a shale formation, maintains this character over most of the area; but in the most northerly part, on the divide between the Oldman and Highwood rivers, the typical shales are separated from the Devono-Carboniferous rocks by a quartzite layer 50 to 100 feet thick, overlying 200 to 300 feet of brown arenaceous shale, one layer of which contains spherical concretions up to 1 foot in diameter. The quartzite member has been noted at the base of the Fernie formation farther south and west;[1] and the shale member, from its stratigraphic position and lithologic character, may represent the Upper Banff shale of the Bow River section to the north, where it is 1,400 feet thick.[2]

Blairmore Formation. The widely spread conglomerate at the base of this formation is here in places represented by a coarse sandstone. This, however, is only local and over most of the area the conglomerate is present. It is present in the most northerly and easterly points examined and is known to continue northward.

A conglomerate bed occurs at a Blairmore-Benton contact along Livingstone river in the northern part of township 12, which is not known at any other locality. The river here crosses the contact at two places 1½ miles apart and these are the only two points where the conglomerate is exposed. The conglomerate is 15 to 20 feet thick and consists of well-rounded quartzite pebbles from 2 to 3 inches in diameter set in a coarse sandstone matrix. The pebbles make up approximately one-quarter of the rock. There is a probability that this conglomerate is a basal member of the Benton formation, but it is directly overlain by marine Benton shales, whereas the conglomerate itself resembles the subaerial conglomerates which occur as lenses at irregular intervals throughout the Blairmore formation. This, taken in conjunction with the fact that a conglomerate at the base of the Benton is not known at other localities, suggests that this conglomerate should be included with the Blairmore formation.

Crowsnest Volcanics. This formation, which has a maximum thickness of 1,100 feet west of Coleman, Alberta, thins to nothing in a distance of 19 miles at a point approximately 5 miles south of the 50th parallel. North of this, three small outliers

[1] Geol. Surv., Can., Sum. Rept., 1917, pt. C, p. 30.
[2] Geol. Surv., Can., Sum. Rept., 1916, pp. 63-66.

were seen, the most northerly of which lies approximately on the 50th parallel, on the ridge west of Oldman river. This outcrop is about 50 feet thick and is exposed for a distance of 400 to 500 feet along the strike of the rocks. G. M. Dawson reports an outcrop about 20 feet in thickness 6 miles farther north on Oldman river.[1] This outcrop was not seen by the writer. Over the rest of this area no volcanic rocks were found and the rocks of the Benton formation rest conformably on those of the Blairmore formation. These two small outliers of volcanic rock probably represent the northern limit of deposition of this formation.

Allison and Later Formations. The Allison formation is the equivalent of the Belly River series of the southern plains of Alberta. In the southern part of the Crowsnest area the highest beds of this formation exposed are in faulted relation with the overlying rocks, but in the vicinity of the headwaters of Oldman river the entire succession is present and is succeeded by shales and sandstones, which, though lithologically similar to the Allison rocks, contain fossils of a later age.

The contact of the Allison formation with the overlying rocks is not exposed, but, on Oyster creek, a tributary of the Oldman river from the north, there are rocks which can be correlated with the St. Mary River formation of the foothills. In the foothills, the Allison formation is separated from the St. Mary River formation by the marine shales of the Bearpaw formation. These shales are absent in this section, or are not exposed.

The lowest exposed strata of the St. Mary River formation outcrop along Oyster creek near its junction with Oldman river. They consist mainly of well-bedded, grey sandstones and soft, dark shales, containing concretions and ironstone nodules.

An unconsolidated sand bed and a thin coal seam are also exposed. Freshwater bivalve and gastropod fossils were found in the shales. Oyster creek follows the general north-south strike of the rocks and at several points along its course the shales and sandstones outcrop, dipping to the west at an angle of 30 to 60 degrees. Three miles up the creek a massive bed composed almost entirely of oyster shells outcrops. This bed is used as a horizon marker in the foothills where it occurs about 100 feet above the base of the St. Mary River formation.[2]

Following the basal beds of the St. Mary River formation there is an orderly succession of westerly dipping, soft, grey sandstones and shales which underlie the space between Oyster creek and the main Devono-Carboniferous limestone range of the Rocky mountains to the west, a distance of 2½ miles. There is in this space approximately 10,000 feet of strata above the Allison formation. This is the only locality within the southern Rocky mountains of Canada where the succession extends conformably upwards into strata higher than the Allison formation and the only horizon which can be correlated with described formations is the oyster bed near the base of the St. Mary River formation. The remainder of the section corresponds in a general way with the St. Mary River and succeeding formations of the foothills and plains, but the section there is only 3,750 feet thick. This includes the St. Mary River beds and the overlying Willow Creek beds and Porcupine Hills beds of Dawson.[3] The St. Mary River formation occupies the same stratigraphic position as the Edmonton formation which from the evidence of vertebrate remains is placed as Upper Cretaceous. The Willow Creek beds and the Porcupine Hills beds are divided from the St. Mary River formation and from one another purely by differences in the lithological characters of the beds and these differences were not noted here. They are the stratigraphic equivalents of the Paskapoo, a Tertiary formation.

It appears then that in the area from Oyster creek westward, the Allison formation is overlain by a series of sediments which are the stratigraphic equivalents of the highest Cretaceous and the Tertiary rocks of the foothills and southern plains of Alberta.

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1 Dawson, G. M., Ann. Rept., Geol. Surv., Can., 1885, p. 88B.
2 Stewart, J. S., Geol. Surv., Can., Sum. Rept., 1915, p. 113.
3 Dawson, G. M., Geol. Surv., Can., Rept. of Prog., 1882-83-84, p. 112C.

ECONOMIC GEOLOGY.

There are no working coal mines in the area and practically no prospecting has been done, so that any estimate of the value of the coal reserve must be based solely on surface indications.

Coal of economic importance is found only in the Kootenay formation. Small seams of bituminous coal occur in the Allison formation and in the St. Mary River formation; but they are too thin to be mined in competition with the thicker seams of the Kootenay formation. The coal is similar to that mined in the Crowsnest Pass mines to the south.

The Kootenay coal-bearing rocks are continuous from the area to the south and show a similar development. It is not possible to give measured sections showing the coal seams nor to correlate the seams with those of the mined area,[1] but at various points throughout the area coal seams from 16 to 5 feet and less in thickness were observed.

A west-east section across the area from the falls on Oldman river in the west to Livingstone range in the east, about on the line between townships 12 and 13, shows the Kootenay formation repeated ten times by faulting and folding in a distance of 9 miles. Three only of these bands are continuous to the north beyond this area. The others are cut off by faulting or folding about the north boundary of township 14, where the limestone of Livingstone range takes a decided bend to the west.

There is, therefore, a large area of undeveloped coal lands in the northward extension of the Crowsnest coal field within the Rocky mountains, which from surface indications, compares favourably with the producing area to the south.

The locations most favourable for coal mining lie at distances of from 50 to 60 miles from railway connexion and so the area is not likely to be developed for some time.

In the foothills, the Kootenay formation is so broken by faulting and folding that it is not likely to yield coal other than that for local use. The best locations are in tp. 14, range 3, W. 5th mer., where for a distance of 5 miles there is a continuous outcrop of the coal-bearing rocks. In section 36 of this township, a coal seam has been opened and a tunnel has been driven on it for about 500 feet. The seam is 6 feet thick and the coal is of good heating and coking quality. This seam lies at the top of the formation, just under the basal conglomerate of the Blairmore formation and probably represents No. 1 seam of the Blairmore area. There are caved-in prospect pits on seams below the 6-foot seam, and it was reported that two seams of 10 and 16 feet thickness had been found.

[1] Sum. Rept., 1916, p. 110.

GASOLINE IN NATURAL GAS.

EXPERIMENTS ON ALBERTA GAS.

By D. B. Dowling.

CONTENTS.

GENERAL DESCRIPTION OF EXPERIMENTS.

Natural gas, which is found in large quantities in Alberta and Ontario, is one of the fuel and power resources of those provinces. In most cases, the gas reserves are found in rocks overlying strata that are possibly oil-bearing and the presumption is that the gas has in some way been derived from the oil-bearing beds. In other cases there is no indication that the underlying beds are oil-bearing, but only that they contain carbonaceous material capable of giving off the more stable hydrocarbon gases. Where the gas has been derived in part from oil-bearing beds there is a probability that it may contain some of the vapours of the lighter oils. The experiments carried out in Alberta during the summer of 1918 were for the purpose of ascertaining the commercial value of these gases for the production of gasoline. The very high rock pressure found in many of the gas fields would prevent the vaporizing of much and possibly of any of the lighter oils that may have been present in the gas-bearing beds. Experiments have shown that the calorific value of the gas in a well standing capped is lower than that of the gas in the same well when it is allowed to flow freely. This is an indication that the permanent gases, when standing in a vertical pipe, slowly become arranged according to their specific gravities. If this is a correct assumption, the vapours of gasoline will not remain in the upper part of the casing when the well is capped, owing to the natural tendency of the gasoline vapour to condense under a rising pressure and the prevention of further additions of gasoline vapour by the excessive rock pressure attained. On the release of the pressure when the well is blown, heavier gases may be given off and with the lowering of the pressure the calorific value should rise. In gas wells in which the source of supply is remote from the oil reservoir, this rise in calorific value may be very slow; but in wells having oil as well as gas in the sands, the rise in calorific value should be quite apparent with the lowering of the pressure. Therefore, the present experiments are not to be taken as altogether conclusive as to the gasoline content in the gas, when the wells have high pressures but must be considered in reference to the pressure.

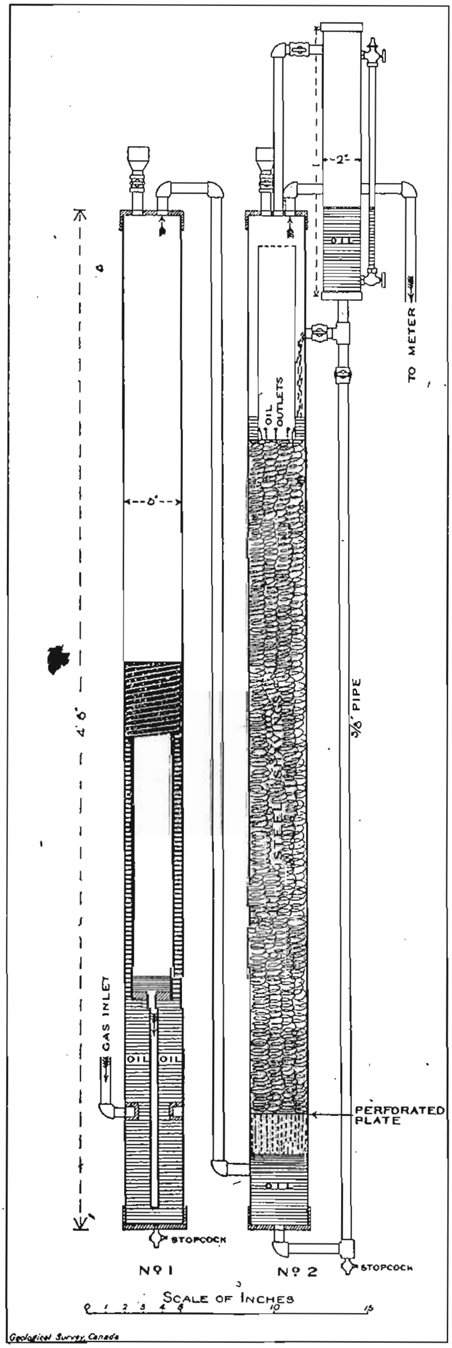

Figure 1. Diagram of cylinders used in absorption tests.

The presence of gasoline vapour in gases supposedly dry, or from which gasoline cannot be extracted by condensation, shows that there may be a saturation of methane gas by the heavier gases even under pressures that would be expected to condense them, and that they cannot be removed except by washing with an absorbent medium. This washing process was used in testing the Alberta gases. Two methods are adopted in commercial practice. The first consists in passing the gas through an absorbent oil and the second in bringing the gas into contact with large surfaces filmed with an absorbent oil. In the experiments both methods were adopted. Two cylinders of 3-inch steel pipe about 4½ feet long were used (Figure 1). No. 1 was reamed out and a hollow steel plug on which deep threads were cut was inserted in it. The bottom of the plug was stopped and a small pipe carried to near the bottom of the large cylinder. Caps were screwed on both ends of the cylinder and the gas was admitted near the bottom into a hollow ring having several small outlets drilled in the upper part. The absorbent oil was poured in from the top. The gas bubbles ascending through the oil were forced to follow the spiral which made a traverse of about 14 feet in ascending 18 inches. The upper part of the cylinder allowed the separation of the oil and gas and the oil was returned to the lower compartment to be used over again. The gas outlet from this cylinder, which was No. 1 of the series, was connected to the lower part of No. 2 closed cylinder which was filled with steel shavings. A chamber at the bottom was reserved for the collection of oil and at the top for the collection of gas. The steel shavings were kept filmed by oil dripping from the top. This was accomplished by having a small oil reservoir connected with the upper part of the cylinder and provided with a glass gauge to register the oil reserve. The gas pressure was utilized to force the oil collected in the lower compartment up into the reservoir and a nearly continuous flow from it was maintained, the stoppage being only the time required to refill the reservoir. Small amounts of gas were wasted in the operation, which were allowed for on the meter readings.

The apparatus used was not capable of withstanding the high pressure of most of the wells without serious leaks. Reducing valves were used where they were obtainable, but where pressures below 100 pounds could not be thus obtained the reduction was made by allowing an escape of gas through a by-pass before reaching the absorbing chambers. The gas pressure in the pipes from the well was controlled by the valve at the supply and by the vent to the air. A steady pressure was found to be essential in order to prevent the oil being driven out of the chamber or sucked back into the connecting pipes. It was found to be necessary also to provide control valves of the best make for inlet or outlet of the gas. Several of those tried in the course of the experiments were found to leak, and needle valves proved better than globe valves. In machine No. 2, where oil was kept in circulation, it was found that there were several places where some of the oil remained trapped.

In starting a new experiment some of the oil used as absorbent was put into the cylinders and a few cubic feet of gas was run through. The gas was then shut off and the cylinders drained. The oil thus used was discarded as it contained some of the oil left over from the former experiment. Carefully measured quantities of the oil were then put into the cylinders for the experiment, and the run being made, samples consisting of about 1,000 c.c. (a few about 500 c.c.) from each cylinder were put in tins with screw tops which were sealed by soldering. Similar samples of the clean absorbing oil were kept. The samples were shipped to the testing laboratory of the Department of Mines, where the distillation was made. The temperature of volatilization of the absorbing oil in its natural state was first determined and the oil through which gas had been passed was distilled at temperatures below this critical temperature and the absorbed gas and gasoline driven off and collected. The reports of Mr. R. C. Cantelo on the distillation and of Messrs. J. Moran and T. W. Hardey on the analyses of the uncondensed gases are inserted in the order of the experiments.

At the Calgary Petroleum Products Company's No. 2 well, experiments had been made with two cylinders somewhat longer than those used in Survey experiments, the dispersing and retarding of the passage of the gas through the oil being accomplished by filling the cylinders with pebbles. In one of our experiments the Calgary cylinders were put in tandem ahead of ours and designated How No. 1 and How No. 2. The results of tests with our two cylinders in one or two instances show that with a very dry gas the addition of more absorbers is necessary to obtain a maximum efficiency. In several of the experiments concurrent readings by calorimeter were made by Mr. James Stott, Acting Divisional Engineer of the Gas and Electricity Inspection Office, Department of Trade and Commerce, Vancouver.

TABLE SHOWING COMPARATIVE RESULTS OF TESTS.

Test No.	Gas well.	Absorbing medium.	Gasoline per 1,000 cu. ft.		Calorific value.		Decrease.
			C.c.	Pts.	From well. B.T.U.	After treat. B.T.U.	%
Preliminary	Bow Island pipe line	....	....	....	893·8		
"	C. P. P. Co. No. 2 upper gas	....	....	....	873·8		
"	" " " " "	....	....	...	1015·0		
"	" " " 2 lower "	....	....	....	1104·0		
No. 1	" " " " "	Mineral seal oil.	798	1·7	1146·3		
No. 2	" " " " "	" " "	969	2·1	1144·0	1113	2·7
No. 3	" " " " "	Kerosene	1396	3·0	1095·0	1021	6·76
No. 4	" " " " "	"	1406	3·0	1109·0	1008	9·1
No. 5	" " " " "	Distillate	1758	3·7	1109·0	1045	5·76
No. 6	" " " 1 lower "	Mineral seal oil.	850	1·8	870·0	771·6	11·35
No. 7	" " " 1 upper "	" " "	1098	2·4			
No. 8	Bow Island town well	Kerosene	0	......	806·3	795·4	1·35
No. 9	" " " "	Distillate	0				
Preliminary	Medicine Hat, City Hall	....	....	....	745·3		
	" " Old power sta'n.	....	....	....	678·4		
	" " Sub station	....	....	....	780·0		
No. 10	" " Old power sta'n.	Kerosene	0				
No. 11	" " " " "	Separator oil	0				
No. 12	" " " " "	Mineral seal oil.	0				
No. 13	Viking No. 6	" " "	12	0·03			
No. 14	" " 1	" " "	43	0·09			
No. 15	" " 1	" " "	45·4	0·10			
No. 16	" " 4	" " "	45·2	0·1			

In the application of the results of tests that follow, it must be borne in mind that at wells where pipe lines are connected to other plants and the gas passed through without great reduction of pressure a correction must be made for the pressure. Thus 1 cubic foot of gas at 105 pounds pressure is equal to 8 cubic feet at atmospheric pressure. Or 1 cubic foot at 45 pounds pressure = 4 cubic feet at 0 and 1 cubic foot at 15 pounds pressure = 2 cubic feet at 0. When the dry gas has to be consumed on the premises the building up of other industries would be the logical result. Many plants burn the gas to recover carbon, in the form of carbon black or lamp black. Much of the heat energy is thus wasted and other industrial operations should be installed. Where the gas is used for fuel near the wells the reduction in pressure is generally material and very often the service pipes carry pressures as low as 15 pounds. If the gas is measured at this pressure the results given in our tests would be doubled since our measurements are by a meter discharging into the air with a pressure of 3 ounces in the inlet pipe to the meter.

Material Used as Absorbent.

The use of an oil of high boiling temperature as an absorbent is the common practice. The distillation of gasoline from it below its boiling point is attended by a very slight loss of the absorbent oil. The recovered gasoline having only a small percentage of heavier oils in it, is usually quick burning and may be used in raising the burning quality of low grade gasolines. Absorbent oils of low boiling temperature seem to have better absorbent qualities than the heavier oils, but the gasoline produced is apt to be of heavier specific gravity being due to the partial distillation of the absorbing oil. The oils used in the experiments were:

Distillate from oil at Dingman well, boiling point..	80 to 120°C.	Sp. grav.	0·773
" " A. P. Con well..	110 to 150°	"	0·842
Kerosene, commercial..	150°	"	0·813
Signal oil..	269°	"	0·844
Mineral seal oil..	280°	"	0·851
Separator oil, no distillation up to..	275°	"	0·881

CALORIFIC VALUE OF NATURAL GAS USED IN CALGARY.

A series of tests were made by calorimeter of the heating value of the gas from various wells. A preliminary test was first carried out on the natural gas supplied to Calgary from the Bow Island field. Mr. Stott's report on the results obtained follows. The heating value of artificial gas used in the eastern cities is generally about 500 British thermal units per cubic foot of gas and it will be seen from the report that the Calgary gas has 1·78 times this value.

Calorimetry Field Notes.

Detail of test made at Calgary, 712-2nd st. west, on natural gas furnished by the city of Calgary (Can. Western Light, Heat, and Power Company). (Test made by J. Stott, August 20, 1918.)

—	Run No. 1.	Run No. 2.
Temperature of outlet water	25·29	25·30
Temperature of inlet water	14·22	14·24
Temperature rise	11·07	11·06
Cubic centimetres of water	1756	1752
Cubic feet of gas	0·1	0·1
Barometric pressure	25·95	25·95
Service pressure	0·77	0·77
Total pressure	26·72	26·72
Temperature of gas	74°F	74°F
Tabular number	0·854	0·854
Temperature of room	72·5	72·5
B.T.U. per cubic foot, from above	[1]895·2	[1]892·4

Average of above two runs being the total heating value per cubic foot of the above gas corrected to a pressure of 30" of mercury and a temperature of 60°F. .... 893·8 B.T.U.

Tests at Gas Wells.

WELLS IN TURNER VALLEY, SHEEP RIVER.

The first well tested was that known as the Calgary Petroleum Products well No. 2. In the notes this is called Dingman No. 2. The well is about 3,500 feet deep and the gas from the inner casing which is the lowest, is being used at nearby wells for firing boilers, stills, and heating houses. The rock pressure is probably fairly high but is much reduced by the almost open flow which is estimated to amount to 2,000,000 cubic feet per day. Gas was struck in the drilling at 1,500 feet, and was cased off; gas was also struck at 2,500 feet. At the well the upper gas between the casings,

[1] Above corrected for difference between temperature of inlet water and room temperature.

although small in amount, has been closed in and calorific readings were made to test the effect of standing in the vertical pipe. Mr. Stott's tests show an initial value of 873·8 B.T.U., rising after blowing for thirty minutes to 1015 B.T.U.

For the purposes of the test the apparatus was placed in a frame structure about 80 feet from the well, the connexion for the gas being by 1-inch pipe and reducing valve. Arrangement was made to connect the calorimeter to the gas direct or to the gas exhausted through the absorbers, the reduction of pressure required for the calorimeter being arranged by means of a by-pass and valves for control. The arrangement for securing flowing water for the calorimeter consisted of a barrel suspended from the roof, and a hand pump for filling.

Calgary Petroleum Products Company, Limited, Well No. 2, Upper Gas.

The calorimeter tests of the gas between the casings, that is, the shallow gas, was first made. This test, considered in connexion with the small flow, seemed to indicate that the gas was probably fairly dry, and no test was made of the gasoline content. Mr. Stott's readings of calorimeter value follow:

Calorimetry Field Notes.

After a preliminary test of the gas standing in the pipe, which was discarded, a detail test was made at the Calgary Petroleum Products Company, Limited, on natural gas, well No. 2, from higher level. (Test made by J. Stott, August 23, 1918.)

—	Run No. 1.	Run No. 2.	Run No. 3.	Run No. 4.
Temperature of outlet water	34·08	33·88	34·10	34·00
Temperature of inlet water	25·04	25·06	25·06	25·04
Temperature rise	9·04	8·82	9·04	8·96
Cubic centimetres of water	2045	2057	2046	2023
Cubic feet of gas	0·1			
Barometric pressure	25·60			
Service pressure	0·30			
Total pressure	25·90			
Temperature of gas	72°F.			
Tabular number	0·832			
Temperature of products	25°C.			
Temperature of room	21°C.			
B.T.U. per cubic foot, from above	882·1	865·7	882·6	864·9

Average of above four runs being the total heating value per cubic foot of the above gas corrected to a pressure of 30″ of mercury and a temperature of 60°F......873·8 B.T.U.

Calorimetry Field Notes.

Second test on No. 2 well upper gas after the gas had been blown out. Detail test made at Calgary Petroleum Products Company, Limited, on natural gas from No. 2 well, upper level. (Test made by J. Stott, August 23, 1918.)

—	Run No. 2.	Run No 3.	Run No. 4.
Temperature of outlet water	35·25	35·40	35·34
Temperature of inlet water	24·88	24·87	24·85
Temperature rise	10·37	10·53	10·49
Cubic centimetres of water	2015	2012	2004
Cubic feet of gas	0·1		
Barometric pressure	25·56		
Service pressure	0·31		
Total pressure	25·87		
Temperature of gas	76°F.		
Tabular number	0·823		
Temperature of products	25°C.		
Temperature of room	21°C.		
B.T.U per cubic foot, from above	1008	1022	1014

Average of above three runs, being the total heating value per cubic foot of the above gas corrected to a pressure of 30″ of mercury and a temperature of 60°F.....1015 B.T.U.

Calorimetry Field Notes.

Preliminary Test.

Detail test made at Calgary Petroleum Products Company, Limited, on natural gas from well No. 2 Depth 3,500 feet. Lower gas. (Test made by J. Stott, August 23, 1918.)

—	Run No. 1.	Run No. 2.	Run No. 3.
Temperature of outlet water	33·13	33·10	33·15
Temperature of inlet water	21·95	21·98	22·00
Temperature rise	11·18	11·12	11·15
Cubic centimetres of water	2126	2114	2120
Cubic feet of gas	0·1		
Barometric pressure	25·63		
Service pressure	0·34		
Total pressure	25·97		
Temperature of gas	66°F.		
Tabular number	0·850		
Temperature of products	22°C		
Temperature of room	22°C		
B. T. U. per cubic foot, from above	1110·0	1097·0	1104·0

Average of above three runs being the total heating value per cubic foot of the above gas corrected to a pressure of 30″ of mercury and a temperature of 60°F........ 1104·0 B.T.U.

Test No. 1 for Gasoline.

Well No. 2 (Calgary Petroleum Products Company, Limited).
Gas from inner casing.

Machine No. 1 was used containing 2,500 c.c. mineral seal oil. Fifty feet of gas at atmospheric pressure at the meter was passed through the cylinder under a pressure of 30 pounds at a rate of 2 cubic feet per minute. During the run the gas after washing in oil was burnt in the calorimeter.

Samples of the oil used in the test were taken for comparison with that used as an absorber. The method of distillation reported by R. C. Cantelo of the laboratory of the Fuel Testing Division, Department of Mines, follows:

"*Method of Distillation.* About 300 c.c. of the oil was distilled from a 500 c.c. Engler flask fitted with a thermometer. The flask was connected by means of a Liebig condenser and an adapter with a 100 c.c. graduated cylinder for collecting the liquid distillate. The adapter was fitted with a two-hole rubber stopper, through one hole of which the condenser passed, while through the other a piece of bent glass tubing passed a short way into the adapter. The end of this tubing exterior to this adapter was connected with a Mariotte bottle by means of which a constant (small) suction could be maintained throughout the distillation. This bottle could also be used for collecting any gas evolved during the distillation."

"Report on samples of oil used by D. B. Dowling of the Geological Survey, Canada, for the absorption of gasoline from the gas of Dingman (C.P.P. Co.) No. 2 well.

Sample of mineral seal oil used in tests 1, 2, and 6.

Specific gravity, $\frac{15·5°C.}{15·5°C.}$ 0·851.

Distillation test:

First drop distilled at 280°C.
8·4 per cent distilled up to 290°C.

"The distillation was accompanied by considerable evolution of white fumes."

Test No. 1.

Mineral seal oil used as absorbent.	
No. of absorber	1
Oil used, c.c	2500
Specific gravity of oil used $\frac{15\cdot5°C}{15\cdot5°C}$	0·851
Gas used cubic foot	50
Specific gravity of recovered oil $\frac{15\cdot5°C}{15\cdot5°C}$	0·847
Sample taken for distillation, c.c	224
Gasoline obtained from sample by distillation, c.c	3·5
Total gasoline obtained in test, c.c	39·8
Gasoline obtained per 1,000 cubic feet of gas	798
Gasoline, pints [1] per 1,000 cubic feet of gas	1·7

Distillation by R. C. Cantelo.

"The gas collected during the distillation had a composition equivalent to butane (C_4H_{10}). The volume of this gas contained in solution in 1 gallon[1] of oil after use as an absorbent was calculated to be 0·2 cubic feet."

Gas analysed by J. Moran and T. W. Hardey.

Calorimetry Field Notes.

Well No. 2. Gas from lower level, 3,500 feet.

Detail test made at Calgary Petroleum Products Company, Limited, on natural gas passed through gasoline absorber G.S.C. No. 1; after 30 cubic feet had passed the absorber meter. (Test made by J. Stott, August 26, 1918.)

—	Run No. 1.	Run No. 2.	Run No. 3.
Temperature of outlet water	30·38	30·42	30·57
Temperature of inlet water	18·88	19·00	19·14
Temperature rise	11·50	11·42	11·43
Cubic centimetres of water	2050	2052	2050
Cubic feet of gas	0·1		
Barometric pressure	25·38		
Service pressure	0·18		
Total pressure	25·56		
Temperature of gas	76°F		
Tabular number	0·813		
Temperature of products	20·4°C		
Temperature of room	22°C		
B.T.U. per cubic foot, from above	1151	1144	1144

Average of above three runs, being the total heating value per cubic foot of the above gas corrected to a pressure of 30″ of mercury and a temperature of 60°F......1146·3 B.T.U.

Test No. 2.

Well No. 2 (Calgary Petroleum Products Company).
Gas from inner casing.

Machines 1 and 2 were connected in tandem series. In No. 1 was placed 3,000 c.c. of mineral seal oil and in No. 2, 2,000 c.c. of mineral seal oil. A pressure of 27 pounds was maintained in the cylinders. Amount of gas used, measured at outlet at atmospheric pressure, 200 cubic feet. Rate of run 1·6 cubic foot per minute. During the run the waste gas from the meter was run through the calorimeter. The readings by Mr. Jas. Stott, which follow, show the gas to have retained the high fuel value of 1,113 B.T.U. The value of the gas direct from the well was found to be 1,144 B.T.U. There was, therefore, a decrease in the heating value of the gas after the extraction of gasoline, of 2·7 per cent. The distillation of the absorbing oil shows a recovery of 969 c.c., equal to 2·1 pints of gasoline per 1,000 cubic feet of gas at atmospheric pressure.

[1] American measure.

Test No. 2.

Mineral seal oil used as absorbent.		
No. of absorber	1	2
Oil used, c.c.	3000	2000
Specific gravity of oil used $\frac{15\cdot5°C}{15\cdot5°C}$	0·851	0·851
Gas used cubic foot	200	200
Specific gravity of recovered oi $\frac{15\cdot5°C}{15\cdot5°C}$	0·836	0·843
Sample taken for distillation, c.c.	292	286
Gasoline obtained from sample by distillation, c.c	14·0	6·0
Total gasoline obtained in test, c.c.	151·0	42·8
Gasoline from each absorber, c.c. per 1,000 cu. ft. gas	755 c.c.	214 c.c.
Pints per 1,000 cu. ft. of gas	1·6	0·5
Total gasoline from two absorbers, c.c. per 1,000 cu. ft. gas	969	
Total gasoline from two absorbers, pints per 1,000 cu. ft. gas	2·1	

Distillation by R.C. Cantelo.

"In the distillation of the above samples, it was noted that the temperature indicated by the thermometer increased gradually until about 150 degrees C. was reached. During this time, also, the gasoline distilled over. However, after this point had been reached, the temperature rose suddenly to 250 degrees to 275 degrees C.; 150 degrees C., therefore, was taken as the end-point of the gasoline distillation.

"The gas collected during the distillation had the composition of butane. Volume dissolved in 1 gallon of oil after use as absorbent: from absorber 1, 0·3 cu. ft.; from absorber 2, 0·4 cu. ft." Gas analyses by Messrs. Moran and Hardey.

Calorimetry Field Notes.

Detail of test made at Calgary Petroleum Products Company on natural gas straight from well ahead of absorber G.S.C. Nos. 1 and 2. (Test made by J. Stott, August 27, 1918.) Well No. 2, depth 3,500 feet.

—	Run No. 1.	Run No. 2.	Run No. 3.
Temperature of outlet water	25·55	25·51	25·54
Temperature of inlet water	12·12	12·12	12·12
Temperature rise	13·43	13·39	13·42
Cubic centimetres of water	1902	1900	1890
Cubic feet of gas	0·1		
Barometric pressure	25·73		
Service pressure	0·26		
Total pressure	25·99		
Temperature of gas	52°F.		
Tabular number	0·883		
Temperature of products	13°C		
Temperature of room	13°C		
B.T.U. per cubic foot, from above	1148	1144	1140

Average of above three runs, being the total heating value per cubic foot of the above gas corrected to a pressure of 30″ of mercury and a temperature of 60° F. .... 1144 B.T.U.

Calorimetry Field Notes.

Detail of test made at Calgary Petroleum Products Company, Limited, on natural gas after passing through gasoline absorber G.S.C. Nos. 1 and 2. After the absorber had been in operation one hour and forty minutes and 106 cubic feet of gas had passed through. (Test made by J. Stott, August 27, 1918.) Well No. 2, lower level, 3,500 feet.

—	Run No. 1.	Run No. 2.	Run No. 3.
Temperature of outlet water	23·34	23·35	23·28
Temperature of inlet water	11·22	11·22	11·22
Temperature rise	12·12	12·13	12·06
Cubic centimetres of water	2047	2061	2054
Cubic feet of gas	0·1		
Barometric pressure	25·72		
Service pressure	0·77		
Total pressure	25·99		
Temperature of gas	50°C		
Tabular number	0·887		
Temperature of products	12°C		
Temperature of room	12°C		
B.T.U. per cubic foot, from above	1110	1119	1109

Average of above three runs, being the total heating value per cubic foot of the above gas corrected to a pressure of 30″ mercury and a temperature of 60°F..... 1113 B.T.U.

Test No. 3.

Well No. 2 (Calgary Petroleum Products Company).
Gas from inner casing.

The absorption test was made in this instance with commercial kerosene as absorber. Both cylinders were used in tandem—Nos. 1 and 2 with 2,000 c.c. of kerosene in each. Pressure maintained, 27 pounds per square inch. Amount of gas used 160 cubic feet at atmospheric pressure, run through at rate of 1·14 cubic feet per minute. The calorific tests show a decrease in B.T.U. of 6·76 per cent.

Test No. 3.

Kerosene used as absorbent.		
No. of absorber	1	2
Kerosene used, c.c.	2000	2000
Spec. grav. of kerosene used $\frac{15\cdot5^\circ C}{15\cdot5^\circ C}$	0·813	0·813
Gas used, cu. ft.	160	160
Spec. grav. of recovered kerosene $\frac{15\cdot5^\circ C}{15\cdot5^\circ C}$	0·812[1]	0·806
Sample taken for distillation, c.c.	250	275
Gasoline (distillate to 150°C) obtained from sample by distillation, c.c.	17·0	10·5
Total gasoline obtained in test, c.c.	146·0	79·3
Gasoline from each absorber, c.c. per 1,000 cu. ft. gas	905	491·6
Gasoline from each absorber, pints[2] per 1,000 cu. ft. of gas	1·9	1·1
Total gasoline from two absorbers, c.c. per 1,000 cu. ft. of gas	1396·6	
Pints per 1,000 cu. ft. of gas	3·0	

"The gas collected during the distillation had the composition of butane. Volume dissolved in 1 gallon of kerosene after use as absorbent from absorber 1, 0·2 cu. ft., from absorber 2, 0·2 cu. ft. Gas analyses by Messrs. Moran and Hardey.

"It is evident, however, from the following considerations, that with the end-point of distillation at 150 degrees C. the distillate contained some of the constituents of the kerosene.

"A liquid boils or distils when its vapour pressure is equal to the atmospheric pressure; and the vapour pressure of a solution is equal to the sum of the partial vapour pressure values of its constituents. Hence a solution such as that of gasoline

[1] This sample was evidently contaminated by mineral seal oil left in the absorber.
[2] American measure.

in kerosene boils when the sum of the vapour pressure values of its constituents is equal to the atmospheric pressure. The constituents of the kerosene exert a considerable vapour pressure below 150 degrees C. and hence the vapour given off must consist of a mixture of gasoline and kerosene vapours. Commercially this would be an advantage, as a less volatile product would thus be obtained.

"As no sample of the kerosene used as absorbent in test No. 3 was submitted for examination, a distillation test was made on the kerosene used as absorbent in test No. 8.

Specific gravity.. .. .. .. $\frac{15\cdot5°C}{15\cdot5°C}$ 0.813.

Distillation test:
First drop distilled at 150°C.
27·4 per cent distilled up to 200°C.

"This distillation was not entirely satisfactory as the rate of distillation varied from 2 to 5 c.c. per minute. The sample was insufficient for a duplicate distillation. The essential point is, however, the temperature at which the first drop distilled." Distillation by R. C. Cantelo.

Calorimetry Field Notes.

Detail of test made at Calgary Petroleum Products Company, Limited, well No. 2, on natural gas. Straight from well ahead of absorber. Depth, 3,500 feet. (Test made by J. Stott, August 29, 1918.)

—	Run No. 1.	Run No. 2.	Run No. 3.
Temperature of outlet water	23·35	23·35	23·40
Temperature of inlet water	12·10	12·10	12·12
Temperature rise	11·25	11·25	11·28
Cubic centimetres of water	2124	2135	2138
Cubic feet of gas	0·1		
Barometric pressure	25·78		
Service pressure	0·26		
Total pressure	26·04		
Temperature of gas	58°F		
Tabular number	0·870		
Temperature of products	13°C		
Temperature of room	16°C		
B.T.U. per cubic foot, from above	1090	1096	1100

Average of above three runs, being the total heating value per cubic foot of the above gas corrected to a pressure of 30" of mercury and a temperature of 60° F.....1095 B.T.U.

Calorimetry Field Notes.

Detail of test made at Calgary Petroleum Products Company, Limited, well No. 2, on natural gas. After passing this absorber in which kerosene was used. G.S.C. Nos. 1 and 2 after 100 feet had passed through. Depth 3,500 feet. (Test made by J. Stott, August 29, 1918.)

—	Run No. 1.	Run No. 2.	Run No. 3.
Temperature of outlet water	25·55	25·63	25·65
Temperature of inlet water	14·60	14·60	14·60
Temperature rise	10·95	11·03	11·05
Cubic centimetres of water	2010	2016	2030
Cubic feet of gas	0·1		
Barometric pressure	25·78		
Service pressure	0·27		
Total pressure	26·05		
Temperature of gas	60°F		
Tabular number	0·865		
Temperature of products	15°C		
Temperature of room	16°C		
B.T.U. per cubic foot, from above	1010	1023	1029

Average of above three runs, being the total heating value per cubic foot of the above gas corrected to a pressure of 30" mercury and a temperature of 60° F....1021 B.T.U.

Test No 4.

Well No. 2 (Calgary Petroleum Products Company).
Gas from inner casing.

In the change of the absorbing oil from mineral seal to kerosene it became evident that some of the mineral seal oil had been trapped in the cylinders. A repeat of No. 3 was then made to see what the effect would be with the cylinders cleaned out. The resulting absorption of gasoline remained practically the same. The concurrent calorimeter readings, however, show a greater reduction in the heating value, by using kerosene, than by using the heavier oils.

Test No. 4.

Kerosene used as absorbent.		
No. of absorber	1	2
Kerosene used, c.c	2000	2000
Specific gravity of kerosene used $\frac{15 \cdot 5°C}{15 \cdot 5°C}$	0·813	0·813
Gas used, cu. ft.	164	164
Spec. grav. of recovered kerosene $\frac{15 \cdot 5°C}{15 \cdot 5°C}$	0·805	0·807
Sample taken for distillation, c.c	275	275
Gasoline (distillate to 150°C.) obtained from sample by distillation, c.c.	20·0	10·0
Total gasoline obtained in test, c.c	157	75
Absorber, c.c. per 1,000 cu. ft. gas	951·4	454·5
Gasoline from each absorber, pints per 1,000 cu. ft. of gas	2·0	1·0
Total gasoline from two absorbers, c.c. per 1,000 cu. ft. gas	1405·9	
Pints per 1,000 cu. ft. of gas	3·0	

Distillation by R. C. Cantelo.

Calorimetry Field Notes.

Detail of test made at Calgary Petroleum Products Company, Limited, on natural gas ahead of absorber. (Test made by J. Stott, August 30, 1918.)

—	Run No. 1.	Run No. 2.	Run No. 3.
Temperature of outlet water	23·08	23·15	23·30
Temperature of inlet water	11·20	11·30	11·38
Temperature rise	11·88	11·85	11·92
Cubic centimetres of water	2077	2084	2090
Cubic feet of gas	0·1		
Barometric pressure	25·78		
Service pressure	0·28		
Total pressure	26·06		
Temperature of gas	52°F		
Tabular number	0·883		
Temperature of products	12°C		
Temperature of room	15°C		
B.T.U. per cubic foot, from above	1098	1110	1120

Average of above three runs, being the total heating value per cubic foot of the above gas corrected to pressure of 30″ of mercury and a temperature of 60°F ..1109 B.T.U.

Calorimetry Field Notes.

Detail of test made at Calgary Petroleum Products Company, Limited, well No. 2, on natural gas after passing through absorber, using kerosene after 175 feet passed through. Depth, 3,500 feet. (Test made by J. Stott, August 30, 1918.)

——	Run No. 1.	Run No. 2.	Run No. 3.
Temperature of outlet water	24·15	24·15	24·16
Temperature of inlet water	13·41	13·42	13·43
Temperature rise	10·74	10·73	10·73
Cubic centimetres of water	2057	2070	2074
Cubic feet of gas	0·1		
Barometric pressure	25·75		
Service pressure	0·26		
Total pressure	26·01		
Temperature of gas	56°F		
Tabular number	0·874		
Temperature of products	14°C		
Temperature of room	16°C		
B.T.U. per cubic foot, from above	1004	1009	1010

Average of above three runs, being the total heating value per cubic foot of the above gas corrected to a pressure of 30″ mercury and a temperature of 60°F. .1008 B.T.U.

Test No. 5.

Well No. 2 (Calgary Petroleum Products Company). Gas from inner casing.

Experiments having been previously made at this well with an absorber of simple design consisting of two cylinders containing pebbles, a run was made in which they were utilized. In order to further ascertain the efficiency of this simple method the gas after treatment was also passed through the two machines used in the former tests, and it seems to prove that there should be for a conclusive test at least four absorbers, as gasoline was retained in the fourth one of the series. The absorbing medium in this experiment, which it was hoped would prove its effectiveness, was a heavy distillate obtained at the still at the Prudential well, which was used in treating the oil from the Alberta Petroleum Consolidated Company's well No. 2.

Sample of absorbent used, viz., distillate from Prudential still, oil from Alberta Petroleum Consolidated Company's well No. 2.

Specific gravity at $\frac{15\cdot5°C}{15\cdot5°C}$ 0·842.

Distillation test—0·5 per cent distilled between 110 and 150°C.

Test No. 5.

Distillate.	How machine	How machine	G. S. machine	G. S. machine
No of absorber.	No. 1.	No. 2.	No. 1.	No. 2.
Mineral seal oil used, c.c	2839	2839	2000	2271
Spec. grav. of oil used $\frac{15°5°C}{15\cdot5°C}$	0·842	0·842	0·842	0·842
Gas used, cubic feet	166	166	166	166
Specific grav. of recovered oil $\frac{15\cdot5°C}{15.5°C}$	0·834	0·837	0·839	0·837
Sample taken for distillation, c.c	200	200	200	200
Gasoline (distillate to 150°C) obtained from sample by distillation, c.c.	10·0	5·0	3·5	3·0
Total gasoline obtained in test, c.c	149	73	36	35
Gasoline, from each absorber, pints per 1,000 cubic feet of gas	1·9	0·9	0·5	0·4
C.c. per 1,000 cubic feet gas	894	438	216	210
Total gasoline from four absorbers, pints per 1,000 cubic feet of gas	1758			
C.c. per 1,000 cubic feet of gas	3·7			

Distillation test by R C. Cantelo.

The gas collected during the distillation had the composition of butane (C_4H_{10}). Volume dissolved in 1 gallon of oil after use as absorbent: from How machine No. 1, 0·2 cu. ft.; from How machine No. 2, 0·3 cu. ft.; from G.S. machine No. 1, 0·2 cu. ft.; from G.S. machine No. 2, 0·2 cu. ft. Gas analyses by Messrs. Moran and Hardey.

Calorimetry Field Notes.

Detail of test made by Calgary Petroleum Products Company, Limited, well No. 2, depth 3,500 feet. On natural gas after passing through four absorbers using distillate. Test made after absorber in use one hour. (Test made by J. Stott, August 30, 1918.)

—	Run No. 1.	Run No. 2.	Run No. 3.
Temperature of outlet water	29·65	29·70	29·73
Temperature of inlet water	18·50	18·52	18·53
Temperature rise	11·15	11·18	11·20
Cubic centimetres of water.	1983	1996	1970
Cubic feet of gas	0·1		
Barometric pressure	25·65		
Service pressure	0·27		
Total pressure	25·92		
Temperature of gas	68° F		
Tabular number	0·842		
Temperature of products	19° C		
Temperature of room	23° C		
B.T.U. per cubic foot from above	1042	1052	1040

Average of above three runs, being the total heating value, per cubic foot of the above gas corrected to a pressure of 30″ of mercury and temperature of 60°F....1045 B.T.U.

Calgary Petroleum Products Company, Well No. 1.

In drilling this well gas was obtained at several horizons, the first being at about 1,300 feet. Gas and oil were obtained at 1,556 feet. Other flows of gas are reported at 2,718 and several below 3,650, with oil at 3,794. A large flow of gas was reported at 3,982. The gas now in the inner casing would seem to be that from below 3,600 feet. The gas between the casings is called the upper gas and is spoken of as from about 1,800 feet. At the time the test was made, the well was open and the driller was fishing for tools in the bottom. For the tests, the well was capped on the afternoon of August 30, and the tests were made the next day. The low calorific value of the inner gas must be attributed to inert gases, probably nitrogen; for there is enough gasoline vapour to have raised a methane gas to a much higher value. As the well was just being drilled in the oil at the bottom no water was in it so that water vapour could have had no part in the depreciation of its calorific value.

Test No. 6.

Calgary Petroleum Products Company, well No. 1.
Gas from inner casing.

A 1-inch pipe line was laid from the well in the derrick to the tool house at the rear, a distance of about 100 feet. A valve was added on the end of this pipe and gas was taken from an elbow. The pressure in the well rose slowly and stood at about 80 pounds during the test. For the calorimeter the outlet valve was nearly full open, so that the pressure could be reduced to about 2 ounces. For the absorption test, a pressure of 65 pounds was maintained by partly closing the escape valve. The flow of the well while open gave about 2,500,000 cubic feet per day.

Test No. 6.

Mineral seal oil used as absorbent.		
No of absorber	1	2
Mineral seal oil used, c.c	2000	3000
Spec. grav. of oil used $\frac{15 \cdot 5°C}{15 \cdot 5°C}$	0·851	0·851
Gas used, cu. ft	140	140
Spec. grav. of recovered oil $\frac{15 \cdot 5°C}{15 \cdot 5°C}$	0·836	0·844
Sample taken for distillation, c.c	200	200
Gasoline obtained from sample by distillation, c.c	8·5	2·0
Total gasoline obtained in test, c.c	89	30
Gasoline from each absorber, pints per 1,000 cu. ft. of gas	1·3	0·5
Gasoline from each absorber, c.c. per 1,000 cu. ft. gas	636	214
Total gasoline from two absorbers, c.c. per 1,000 cu. ft. gas	850	
Total gasoline from two absorbers, pints per 1,000 cu. ft. of gas	1·8	

Distillation by R. C. Cantelo.

Calorimetry Field Notes.

Detail test made at Calgary Petroleum Products Company, well No. 1, inside gas. On natural gas straight from well ahead of absorber. (Test made by J. Stott, September 1, 1918.)

—	Run No. 1.	Run No. 2.	Run No. 3.
Temperature of outlet water	27·55	27·60	27·92
Temperature of inlet water	18·52	18·55	18·62
Temperature rise	9·03	9·05	9·30
Cubic centimetres of water	2120	2124	2115
Cubic feet of gas	0·1		
Barometric pressure	25·94		
Service pressure	0·26		
Total pressure	26·10		
Temperature of gas	52°F.		
Tabular number	0·886		
Temperature of products	18°C.		
Temperature of room	9°C.		
B.T.U. per cubic foot, from above	858·0	861·3	881·3

Average of above three runs, being the total heating value per cubic foot of the above gas corrected to a pressure of 30″ of mercury and a temperature of 60°F., 866·9 B.T.U. (Note: Correction for temperature of water and room gives B.T.U. 876·5.)

Calorimetry Field Notes.

Detail test made at Calgary Petroleum Products Company, well No. 1, on natural gas straight from well (check on test above). (Test made by J. Stott, September 1, 1918.)

—	Run No. 1.	Run No. 2.	Run No. 3.
Temperature of outlet water	27·63	27·61	27·59
Temperature of inlet water	18·03	18·04	18·02
Temperature rise	9·55	9·57	9·57
Cubic centimetres of water	2000	2000	2000
Cubic feet of gas	0·1		
Barometric pressure	25·92		
Service pressure	0·30		
Total pressure	26·22		
Temperature of gas	50°F.		
Tabular number	0·887		
Temperature of products	17°C.		
Temperature of room	10°C.		
B.T.U. per cubic foot, from above	855·0	856·6	856·6

Average of above three runs, being the total heating value per cubic foot of the above gas corrected to a pressure of 30″ of mercury and a temperature of 60°F., 856·1 B.T.U. (Corrected for temperature 864·5.)

Calorimetry Field Notes.

Detail test made at Calgary Petroleum Products Company, well No. 1, inside gas, on natural gas after passing the G.S.C. absorbers 1 and 2. (Test made by J. Stott, September 1, 1918.)

—	Run No. 1.	Run No. 2.	Run No. 3.	Run No. 4.
				Absorber in operation.
Temperature of outlet water	27·24	27·58	27·62	27·68
Temperature of inlet water	18·66	18·67	18·68	18·68
Temperature rise	8·58	8·91	8·94	9·00
Cubic centimetres of water	1912	1912	1900	1895
Cubic feet of gas	0·1			
Barometric pressure	25·92			
Service pressure	0·26			
Total pressure	26·18			
Temperature of gas	52°F			
Tabular number	0·883			
Temperature of products	18°C			
Temperature of room	12°C			
B.T.U. per cubic foot, from above	737·6	766·0	763 7	767·0

Average of the above three runs, being the total heating value per cubic foot of the above gas corrected to a pressure of 30″ of mercury and temperature of 60°F., 765·6 B.T.U. (Corrected for temperature 771·6).

Test No. 7.

Calgary Petroleum Products Company, well No. 1.
Gas from outer casing.

This gas, from leaks or other causes, was at only about 10 pounds pressure, but was run through the absorber for a test.

Test No. 7.

Mineral seal oil used as absorbent.		
No. of absorber	1	2
Mineral seal oil used, c.c	2000	3000
Spec. grav. of oil used $\frac{15\cdot5°C}{15\cdot5°C}$	0·851	0·851
Gas used, cu. ft.	166	166
Spec. grav. of recovered oil $\frac{15\cdot5°C}{15\cdot5°C}$	0·841	0·841
Sample taken for distillation, c.c	200	200
Gasoline, obtained from sample by distillation, c.c	11·5	4·0
Total gasoline obtained in test, c.c	122	61
Total gasoline from 1,000 cu. ft. gas, c.c	732	366
Gasoline from each absorber, pints per 1,000 cu. ft. of gas	1·6	0·8
Total gasoline from two absorbers, c.c. per 1,000 cu. ft. of gas	1098	
Total gasoline from two absorbers, pints per 1,000 cu. ft. of gas	2·4	

Distillation by R. C. Cantelo.

BOW ISLAND WELLS.

The wells north of Burdett and Bow Island, over twenty in number, are connected to a pipe line which extends to Calgary. Details of the wells and of the gas horizons are given by S. E. Slipper in the Summary Report of the Geological Survey for 1916, pages 131-134. The maximum capacity of the pipe line is given as 39,000,000 cubic feet per day. The value of this gas in a test made at Calgary for its heating value was found to be 893·8 B.T.U. per cubic foot. Other tests of gas for helium and for radium emanations[1] of samples from this and other parts of the field, show the following:

Bow Island field.	Date of collection.	Amount of radium emanations per litre of gas. The unit = 10^{-12} curie.	Percentage of helium.	Uncondensed, mostly nitrogen.
Well No. 4	April 1, 1916	16	0·29	7
Pipe from wells Nos. 3, 11, 14	" 1, 1916	93	0·29	9
Well No. 6	" 1, 1916	10	0·34	9
Pipe line at Calgary	" 4, 1916	46	0·33	8

The gas from the town well, situated near wells Nos. 3 and 11 of the Canadian West, Natural Gas, Light, Heat, and Power Company, is piped to Bow Island. A pressure of about 250 pounds is maintained in some of the pipes to the reducing stations. Pipes were laid from one of these and gas at 53 or 54 pounds pressure was supplied and the general arrangement of the apparatus was similar to that for the previous tests. Kerosene (commercial) and a light distillate from Dingman well were used as absorber.

Municipality of Bow Island.

Test No. 8.

Bow Island town well.
Sample of kerosene used as absorbent.

Specific gravity $\frac{15\cdot5°C}{15\cdot5°C}$ — 0·813.

Distillation test: first drop distilled at 150°C.
27·4 per cent distilled up to 200°C.

Test No. 8.

Kerosene use as absorbent.		
No. of absorber	1	2
Kerosene used, c.c.	2000	2000
Spec. gravity of kerosene used $\frac{15\cdot5°C}{15\cdot5°C}$	0·813	0·813
Gas used, cu. ft.	333	333
Spec. grav. of recovered kerosene $\frac{15\cdot5°C}{15\cdot5°C}$	0·813	0·814
Sample taken for distillation, c.c.	200	200
Gasoline obtained from sample by distillation, c.c.	0·0	0·0
Gasoline from each absorber, pints per 1,000 cu. ft. of gas	0	0
Gasoline from two absorbers, pints per 1,000 cu. ft. of gas	0	

Only a trace of gas was found dissolved in the kerosene after use as an absorbent.
Distillation by R. C. Cantelo.

[1] Satterly and McLennan, Roy. Soc., Can., Trans., vol. xii, p. 158. See III.

Calorimetry Field Notes.

Detail of test made at Bow Island on natural gas furnished by the Bow Island municipality. (Test made by J. Stott, September 9, 1918.)

	Run No. 1.	Run No. 2.	Run No. 3.	Run No. 4.
Temperature of outlet water	25·40	25·70	25·80	25·80
Temperature of inlet water	14·50	14·55	14·58	14·60
Temperature rise	10·90	11·15	11·22	11·20
Cubic centimetres of water	1612	1630	1643	1660
Cubic feet of gas	0·1			
Barometric pressure	26·95			
Service pressure	0·17			
Total pressure	27·12			
Temperature of gas	66°F			
Tabular number	0·884			
Temperature of products	12°C			
Temperature of room	20°C			
B.T.U. per cubic foot, from above	788	817	828	834

Average of above four runs, being the total heating value per cubic foot of the above gas corrected to a pressure of 30″ of mercury and a temperature of 60°F......817·0 B.T.U.

Calorimetry Field Notes.

Detail of test made at Bow Island on natural gas furnished by the municipality of Bow Island. (Test made by J. Stott, September 10, 1918, before absorption.)

	Run No. 1.	Run No. 2.	Run No. 3.	Run No. 4.
Temperature of outlet water	23·75	23·75	23·80	23·83
Temperature of inlet water	12·75	12·80	12·90	12·95
Temperature rise	11·00	10·95	10·90	10·88
Cubic centimetres of water	1725	1728	1725	1733
Cubic feet of gas	0·1			
Barometric pressure	27·18			
Service pressure	0·26			
Total pressure	27·44			
Temperature of gas	52°F			
Tabular number	0·930			
Temperature of products	13°C			
Temperature of room	14°C			
B.T.U. per cubic foot, from above	809·7	807·7	802·7	805·0

Average of above four runs, being the total heating value per cubic foot of the above gas corrected to a pressure of 30″ of mercury and a temperature of 60°F......806·3 B.T.U.

Calorimetry Field Notes.

Detail of test made at Bow Island on natural gas furnished by the Bow Island municipality. After passing through absorbers G.S.C. Nos. 1 and 2, using kerosene. (Test made by J. Stott, September 10, 1918.)

—	Run No. 1.	Run No. 2.	Run No. 3.
Temperature of outlet water	25·28	24·34	25·40
Temperature of inlet water	14·15	14·20	14·26
Temperature rise	11·13	11·14	11·14
Cubic centimetres of water	1644	1638	1638
Cubic feet of gas	0·1		
Barometric pressure	27·17		
Service pressure	0·26		
Total pressure	27·43		
Temperature of gas	64°F		
Tabular number	0·902		
Temperature of products	16°C		
Temperature of room	22°C		
B.T.U. per cubic foot, from above	805·3	803·1	803·1

Average of above three runs being the total heating value per cubic foot of the above gas corrected to a pressure of 30" of mercury and a temperature of 60°F......803·8 B.T.U. (795·4 corrected for low temperature of water.)

Test No. 9.

Gas from Bow Island town well.
Sample of absorbent used, viz., distillate from Dingman No. 1 well.

Specific gravity $\frac{15\cdot5°C}{15\cdot5°C}$ 0·773

Distillation test: First drop distilled at 80—120°C.
32·0 per cent distilled up to 150°C.

Test No. 9.

Distillate from Dingman No. 1 well, used as absorbent.		
No. of absorber	1	2
Distillate used, c.c.	2000	1500
Spec. grav. of distillate used $\frac{15\cdot5°C}{15\cdot5°C}$	0·773	0·773
Gas used, cu. ft.	513	513
Spec. grav. of recovered distillate $\frac{15\cdot5°C}{15\cdot5°C}$	0·776	0·776
Sample taken for distillation, c.c.	200	200

Distillation results. First drop distilled at	110-130°C	100-120°C	Original distillate 80-120°C
% distilling to 150°C	24·0	23·5	32·0

Distillation by R. C. Cantelo.

It is evident from the above results that the passage of the gas through the "distillate" caused evaporation of some of the lower boiling fractions.

MEDICINE HAT GAS FIELD.

The wells at Medicine Hat obtain their gas at a sand about 1,000 feet below river level. The supply is under a pressure of 500 pounds and over, except in the older wells from which gas has been drawn for a long time. The city mains are served at several stations where reduction in the pressure is made. A few wells are devoted to industries direct. The gas is considered as a dry gas, as it is derived from a much higher horizon than at Bow Island. The wells are discussed in the Summary Report for 1916, which should be consulted as to their capacity. Physical and chemical examinations previously made as to radium emanations and helium content are given in the paper by Satterly and McLennan.[1]

Extracts from their table are reproduced below.

—	Date of collection.	Amount of radium emanations per litre of gas. Unit=10^{-12} curie.	Percentage of helium.	Per cent uncondensed at temperature of liquid mostly nitrogen.
Cousins and Sissons well	Mar. 31, 1916	57	0·13	3
Electric park	May 2, 1916	69	0·12	5
Central park	" 2, 1916	67	0·11	5

Calorimeter tests were made by Mr. Jas. Stott at the City hall, at the old power station, and at one of the service stations in the eastern part of the city. His reports show lower heating values than were expected, and it is suspected that the gas contained water vapour. The experiments for gasoline were made at the old power station and gave negative results. The details for calorimeter tests by Mr. Stott and chemical tests of absorbent oils by Mr. R. C. Cantelo follow:

Calorimetry Field Notes.

Detail test made at Medicine Hat, municipal office, on natural gas furnished by the city of Medicine Hat. (Test made by J. Stott, September 11, 1918.)

—	Run No. 1.	Run No. 2.	Run No. 3.
Temperature of outlet water	32·50	32·45	32·52
Temperature of inlet water	22·02	22·02	22·02
Temperature rise	10·48	10·43	10·50
Cubic centimetres of water	1596	1596	1596
Cubic feet of gas	0·1		
Barometric pressure	27·36		
Service pressure	0·26		
Total pressure	27·62		
Temperature of gas	72° F		
Tabular number	0·890		
Temperature of products	22·5° C		
Temperature of room	22° C		
B.T.U. per cubic foot, from above	746·0	742·5	747·5

Average of above three runs, being the total heating value per cubic foot of the above gas corrected to a pressure of 30" of mercury and a temperature of 60° F... 745·3 B.T.U.

[1] Satterly and McLennan, Roy. Soc. Can., vol. XII, sec. III, p. 158.

Calorimetry Field Notes.

Detail of test made at Medicine Hat, old power station, on natural gas furnished by the city of Medicine Hat. (Test made by J. Stott, September 12, 1918.)

—	Run No. 1.	Run No. 2.	Run No. 3.
Temperature of outlet water	31·30	31·10	30·95
Temperature of inlet water	21·20	21·25	21·27
Temperature rise	10·10	9·85	9·68
Cubic centimetres of water	1565	1569	1575
Cubic feet of gas	0·1		
Barometric pressure	27·25		
Service pressure	0·41		
Total pressure	27·66		
Temperature of gas	66° F		
Tabular number	0·907		
Temperature of products	21·3° C		
B.T.U. per cubic foot, from above	691·8	676·5	666·9

Average of above three runs, being the total heating value per cubic foot of the above gas corrected to a pressure of 30″ of mercury and a temperature of 60° F...678·4 B.T.U.

Calorimetry Field Notes.

Detail of test made at Medicine Hat, sub-station, on natural gas furnished by the city of Medicine Hat. (Test made by J. Stott, September 12, 1918.)

—	Run No. 1.	Run No. 2.	Run No. 3.
Temperature of outlet water	30·23	30·13	30·10
Temperature of inlet water	19·87	19·87	19·87
Temperature rise	10·36	10·26	10·23
Cubic centimetres of water	1720	1720	1720
Cubic feet of gas	0·1		
Barometric pressure	27·20		
Service pressure	0·33		
Total pressure	27·53		
Temperature of gas	70° F		
Tabular number	0·894		
Temperature of products	21° C		
Temperature of room	27° C		
B.T.U. per cubic foot, from above	791·2	783·7	781·4

Average of above three runs, being the total heating value per cubic foot of the above gas corrected to a pressure of 30″ of mercury and a temperature of 60° F....785·4 B.T.U. (780. Corrected for room temperature.)

Test No. 10.

Gas from main at old power house, Medicine Hat.

Two absorbing cylinders were used, with kerosene as absorber. Pressure maintained in cylinders, 53 pounds. Gas used, 250 cubic feet, run through at rate of 1·3 cubic feet per minute.

Specific gravity $\frac{15\cdot5°C}{15\cdot5°C}$ 0·813.

Sample of kerosene used as absorbent.

Distillation test: first drop distilled at 150°C.
21% distilled up to 175°C.

Test No. 10.

Kerosene used as absorbent.		
No. of absorber	1	2
Kerosene used, c. c	2000	1500
Specific gravity of kerosene used $\frac{15\cdot5^\circ C}{15\cdot5^\circ C}$	0·813	0·813
Gas used, cu. ft.	250	250
Spec. grav. of recovered kerosene $\frac{15\cdot5^\circ C}{15\cdot5^\circ C}$	0·813	0·813
Sample taken for distillation, c.c.	200	200
Gasoline obtained from sample by distillation, c.c.	0·0	0·0
Gasoline from each absorber, pints per 1,000 cu. ft. of gas	0	0
Total gasoline from two absorbers, pints per 1,000 cu. ft. of gas	0	

Distillation by R. C. Cantelo.

Only a trace of gas was found dissolved in the kerosene after use as an absorber.

Test No 11.

Gas from main at old power station, Medicine Hat.

Two cylinders used, with light lubricator oil as absorbent. Pressure of gas in cylinders 55 pounds; 200 cubic feet of gas used at rate of 1·3 cubic feet per minute.

Sample of separator oil used as absorbent.

Specific gravity $\frac{15\cdot5^\circ C}{15\cdot5^\circ C}$ 0·881

Distillation test: no distillate up to 275°C.

Test No. 11.

Separator oil used as absorbent.		
No. of absorber	1	2
Separator oil used, c.c.	2000	1500
Spec. grav. of oil used $\frac{15\cdot5^\circ C}{15\cdot5^\circ C}$	0·881	0·881
Gas used, cu. ft.	200	200
Spec. grav. of recovered oil $\frac{15\cdot5^\circ C}{15\cdot5^\circ C}$	0·881	0·881
Sample taken for distillation, c.c.	200	200
Gasoline obtained from sample by distillation, c.c.	0·0	0·0
Gasoline from each absorber, pints per 1,000 cu. ft. of gas	0	0
Total gasoline from two absorbers, pints per 1,000 cu. ft. of gas	0	

Distillation by R. C. Cantelo.

Test No. 12.

Gas from main at old power house, Medicine Hat.

Two cylinders used, with signal oil as absorbent. Two hundred and fifty feet of gas used, at rate of about 1·3 cubic feet per minute. Pressure in cylinders 55 pounds at meter, 3 ounces to discharge in air.

Sample of signal oil used as absorbent.

Specific gravity $\frac{15\cdot5^\circ C}{15\cdot5^\circ C}$ 0.844.

Distillation test: first drop distilled at 269°C.
1% distilled up to 275°C.

Test No. 12.

	1	2
Signal oil used as absorbent.		
No. of absorber	1	2
Signal oil used, c.c	2000	1500
Spec. grav. of oil used $\frac{15\cdot5°C}{15.5°C}$	0·844	0·844
Gas used, cu. ft	250	250
Spec. grav. of recovered oil $\frac{15\cdot5°C}{15\ 5°C}$	0·844	0·844
Sample taken for distillation, c.c	200	200
Gasoline obtained from sample by distillation, c.c	0·0	0·0
Gasoline obtained from each absorber, pints per 1,000 cu. ft. of gas	0	0
Total gasoline from two absorbers, pints per 1,000 cu. ft. of gas	0	

Distillation by R. C. Cantelo.

VIKING GAS FIELD.

Wells of the Northern Alberta Natural Gas Development Company.

The wells drilled north of Viking have proved the presence of gas in two underlying sands. The sands are overlain by a great thickness of shales and are separated by a similar shale stratum over 100 feet thick. The upper sand has been pierced in eight wells and gas has been obtained in varying amounts in each. The depths to this gas range from 2,146 feet to 2,200 feet from the surface. In four of the wells the flow seemed to be insufficient and the wells were continued to the lower sand lying from 139 to 155 feet below the top of the upper sand. In three of these a large flow was obtained from the lower sand and the upper sand was cased off. In one, the gas is supposed to be derived from both sands. For the experiments wells were selected that derived their gas respectively from the upper sand exclusively, from the lower sand exclusively, and from the mixture of both upper and lower gas. The tests, therefore, for these wells fall into a series of three.

Test No. 13.

Gas from upper sand, Viking field.

For this test well No. 6 was selected. It is being used to provide fuel for the drilling of No. 9 well situated several miles to the north of No. 6. The capacity of the well is estimated to be 8,000,000 cubic feet open flow per twenty-four hours. The gas pressure is reduced at the well and piped to the camp where it is used in stoves, in the steam boiler, and for open lights and is, therefore, comparatively fresh. The apparatus was set up at the camp. The pressure available was only 3½ pounds though the transmission pipe carried 55 pounds. Both absorbers were used. The chemist's report (R. C. Cantelo) follows: "Sample of mineral seal oil used as absorbent. The oil was distilled under the same conditions as those for the determination of the gasoline yield. Specific gravity, 0·839 at 19·5 C. First drop distilled at 276°C; 2·2 per cent distilled up to 295°C."

Test No. 13.

	1	2
Mineral seal oil used as absorbent.		
No. of absorber	1	2
Oil used, c.c	2000	1500
Spec. grav. of oil used	0·839	0·839
Gas used, cu. ft	330	330
Spec. grav. of recovered oil	0·838	0·837
Sample taken for distillation, c.c	372	312
Gasoline obtained from sample by distillation, c.c	0·3	0·5
Total gasoline recovered in test, c.c	1·6	2·4
Gasoline from each absorber, c.c. per 1,000 cu. ft. of gas	4·8	7·2
Gasoline from each absorber, pints [1]per 1,000 cu. ft. of gas	0·01	0·02
Total gasoline from two absorbers, c.c. per 1,000 cu. ft. of gas	12·00	
Total gasoline from two absorbers, pints per 1,000 cu. ft. gas	0·03	

Distillation by R. C. Cantelo.

[1]American pints are used throughout this report.

Tests Nos. 14 and 15.

Gas from lower sand, Viking field.

For this test well No. 1 was selected. The casing of 6¼-inch diameter extends to 2,311 feet from the top, cutting off the upper gas which comes from a sand at the 2,180 to 2,215-foot level. The gas used was found in a sand at 2,335 feet. The capacity of the well shortly after it was drilled was tested through seven days open flow and decreased from 4,320,000 cubic feet per twenty-four hours to 1,930,000 cubic feet with a corresponding decrease in pressure[1] to probably below 200 pounds per square inch. Twenty-four hours after closing the pressure rose to 342 pounds and in 14 days to 373 pounds. The rate of flow in this time increased to 3,830,000 cubic feet per 24 hours. Since that time, December 5, 1914, the well has been practically standing capped, so that, judging from one of the calorimeter tests south of Calgary, the gas may be considered as somewhat stale, that is, the gas in the upper part of the casing would have a larger percentage of methane and less of the gases containing more carbon. Also the continuance of the high pressure would prevent the volatilization of the gasoline vapour above the absorption capacity of the gas at this pressure. These conditions probably account for the disappointing results obtained, namely, 1/10 of a pint per 1,000 cubic feet of gas. A duplicate run was also made to check possible errors.

Samples of gas taken by Prof. J. C. McLennan, of Toronto university, April 6, 1916, must have been from well No. 1, as it was the only one completed at that time. Prof. John Satterly carried out experiments on the radio-activity of several samples from many natural gases. The Viking gas showed a small number of units of radium emanations. The percentage of helium is also low, being only 0·05. At the temperature of liquid air there was still 3 per cent uncondensed gas, chiefly nitrogen[2]

Mr. Cantelo's report on distillation of the absorbent oil used, follows:

Test No. 14.

Mineral seal oil used as absorbent.		
No. of absorber	1	2
Oil used, c.c	1500	1500
Spec. gravity of oil used	0·839	0·839
Gas used, cu. ft	500	500
Spec. gravity of recovered oil	0·836	0·837
Sample taken for distillation, c.c.	250	317
Gasoline obtained from sample by distillation, c.c.	2	2·0
Total gasoline recovered in test, c.c	12·0	9·5
Gasoline from each absorber, c.c. per 1,000 cu. ft. gas	24·0	19·0
Gasoline from each absorber, pints per 1,000 cu. ft. of gas	0·05	0·4
Total gasoline from two absorbers, c.c. 1,000 cu. ft. gas	43	
Total gasoline from two absorbers, pints per 1,000 cu. ft. of gas	0·09	

Test No. 15.

Mineral seal oil used as absorbent.		
No of absorber	1	2
Oil used, c.c	2000	2000
Spec. gravity of oil used	0·839	0·839
Gas used, cu. ft.	500	500
Spec. gravity of recovered oil	0·836	0·838
Sample taken for distillation, c.c.	295	331
Gasoline obtained from sample by distillation, c.c.	2·0	1·5
Total gasoline recovered in test, c.c	13·6	9·1
Gasoline from each absorber, c.c. per 1,000 cu. ft. gas	27·2	18·2
Gasoline from each absorber, pints per 1,000 cu. ft. of gas	0·06	0·04
Total gasoline from two absorbers, c.c per 1,000 cu. ft.	45·4	
Total gasoline from two absorbers, pints per 1,000 cu. ft. of gas	0·10	

Distillation by R. C. Cantelo.

[1] Boyle and Tory, Roy. Soc., Can., vol. ix, 1915, sec. III, p. 139.

[2] Satterly and McLennan, Roy. Soc. Can., vol. xii, 1918, sec. iii, pp. 153-160.

Test No. 16.

Gas from upper and lower sands, Viking field.

Well No. 4 has casing to the top of the upper sand. The lower sand was reached and a reported flow of oil obtained. The gas was very rich like that from the lower sand, but as only 4 feet of the lower sand was penetrated and the bottom of the pipe plugged, gas from the sand probably does not form a large percentage of the mixture. Reports of analyses of this gas showing a gasoline content of ½ gallon per 1,000 cubic feet were published in the prospectus of a company intending to operate there. The reported gasoline can hardly have been commercial gasoline, but probably included dissolved propane and ethane, as these gases were given off in the distillation of the absorbent oil used in the Geological Survey experiments. The results obtained are similar to those obtained from the gas of the lower sand of well No. 1. This may be due to the lower gas in No. 4 being the same as that of No. 1, no upper gas coming into the well, or to the lower gas being rich enough to counteract the effect of any accession of the dryer gas of the upper sand that may have occurred.

The results obtained on the samples submitted follow:

Sample of mineral seal oil used as absorbent.

The oil was distilled under the same conditions as those for the determination of gasoline yield.

Specific gravity 0·839 at 19·5°C.

Test No. 16.

Mineral seal oil used as absorbent.		
No. of absorber	1	2
Oil used, c.c.	1500	2500
Spec. grav. of oil used	0·839	0·839
Gas used, cu. ft.	500	500
Spec. grav. of recovered oil	0·834	0·835
Sample taken for distillation, c.c.	324	286
Gasoline obtained from sample by distillation, c.c.	3·0	1·0
Total gasoline recovered in test, c.c.	13·9	8·7
Gasoline from each absorber, c.c. per 1,000 cu. ft. gas	27·8	17·4
Gasoline from each absorber, pints per 1,000 cu. ft. of gas	0·06	0·03
Total gasoline from two absorbers, c.c. per 1,000 cu. ft. gas	45·2	
Total gasoline from two absorbers, pints per 1,000 cu. ft. of gas	0·1	

Distillation by R. C. Cantelo.

NOTE BY R. C. CANTELO.

It was observed in the course of the distillation of the above sample that the oil became darkened on heating and emitted a burnt odour. These two phenomena are evidence of "cracking" or the decomposition of the hydrocarbons of higher molecular weight and boiling point in the oil, into those of lower molecular weight and boiling point. It was also observed in these distillations that after 130 to 140 degrees C. had been reached the temperature rose suddenly to about 250 to 275 degrees C. At this point the distillation was stopped. Under these conditions, therefore, the errors due to "cracking" must have been very small.

Very little stress should be laid on the slight difference between the specific gravity of the recovered oil and that of the original absorbent. The specific gravities were determined with a hydrometer at room temperature which ranged from about 18 degrees C. to 23 degrees C. at the various times the determinations were made. Corrections for temperature, therefore, would probably eliminate much of the discrepancy in the specific gravities.

In the examination of the oils in tests Nos. 13, 14, and 15, no endeavour was made to sweep the air out of the apparatus before distilling, but in examination of the oil in test No. 16 carbon dioxide was passed through for some time, as in this test an analysis of the gas was desired in order to obtain some idea of the quantity of natural gas which had been dissolved by the oil. In addition, in this latter case, a Mariotte bottle, calibrated so that the volume of the gas obtained could be read at atmospheric pressure, was used.

The gas given off during the distillation of samples of oil used in test No. 6, had a composition equivalent to that of propane (C_3H_8). It may consist of propane together with small amounts of lower and higher hydrocarbons in such proportion as to be equivalent to propane; but without low temperature fractional distillation it is impossible to settle this point. It was impossible to procure the necessary elaborate apparatus on account of lack of accommodation. The extra information to be gained would in this case, however, be of very little value. The same remarks apply to the composition of the gas collected during the distillation of other samples of oil used in the absorption of gasoline.

Assuming that no hydrocarbons other than propane were present in the gas collected during the distillation of samples from test No. 16, the total volume of propane contained in solution in 1 gallon[1] of oil after use ase absorbing medium, was 0·05 cubic feet.

SURFACE DEPOSITS OF SOUTHEASTERN SASKATCHEWAN.

By J. Stansfield.

CONTENTS.

INTRODUCTION.

The area examined during the summer of 1918 lies in southeastern Saskatchewan and extends from the Manitoba boundary west to the third meridian and from the International Boundary north to township 21. It includes the district examined in 1917.

PLEISTOCENE.

Glacial till occupies the surface of a large part of the region. In places terminal moraines of varying degrees of importance occur. Two major terminal moraines pass through the region. These were formed during periods when the ice-front was stationary or nearly so, and represent important stages in the general retreat of the ice sheet. The extreme limit of glaciation is south of the region, so that the complete series of stages of retreat cannot be studied in this region.

The first of the major terminal moraines is the belt which crowns the Missouri coteau and runs parallel to this escarpment and only a short distance from it, extending practically from it to an average depth of 10 miles in a southwesterly direction and

[1] American measure.

being composed of a series of rough, rounded, morainic hills. Dirt and Cactus hills are covered by a part of this terminal moraine. To the southwest the older deposits are covered by a till sheet whose surface is more diversified than those of the till sheets to the northeast.

The other important terminal moraine within this region follows the northeastern side of Qu'Appelle valley from Buffalo Pound lake to Craven and, turning south a few miles east of that point, passes by Pilot Butte and ends at Moose mountain. This morainic belt is from 10 to 15 miles in width and shows a succession of morainic hills with outwash gravels and sands developed more especially along its southwestern face, e.g. at Lumsden and Pilot Butte. Qu'Appelle valley follows the foot of this moraine in the northwestern part of the region as far as Craven, at which point the valley cuts through the moraine. The reasons for this have not been studied.

Much less important stages in the ice retreat are marked by smaller morainic ridges at Estevan, Weyburn near Parry, Frobisher, and Kisbey, and others which dot the plain to the south of Moose mountain.

Thickness of the Drift.

In the southern part of the district, between Weyburn and Estevan, the average thickness of the drift is from 40 to 70 feet and this appears to hold, with local variations toward the east, almost as far as Carlyle. Toward that place the drift becomes thicker, the prairie remaining level. Well records show the drift to be more than 200 feet thick in the vicinity of Carlyle. (It is considerably thicker to the north where the Moose Mountain moraine is piled up.) Toward the east, south, and southeast from Carlyle, the drift becomes thicker, the thickest drift recorded being in the vicinity of Carievale. Toward the northeast from Carlyle the drift becomes thicker as far as Parkman, and then becomes less thick, until in the vicinity of Fairlight it is less than 10 feet at one or two points.

This evidence points clearly to the existence of a broad depression on the surface of the Cretaceous and Tertiary strata in preglacial times, which had a course approximately north-northwest-south-southeast. This depression was filled up by glacial debris. Copious supplies of water come from the coarse gravel layers in the drift along this filled-in depression, flowing wells being known between Carlyle and Cowper and in the vicinity of Carievale.

ECONOMIC GEOLOGY.

Potash.

The staking of dried-up alkali sloughs for potash salts has been continued and has extended into this region. Some staking was done toward the close of the summer at Salt lake, south of Hardy. The writer was unable to visit this locality, but there is nothing to indicate that this would differ from the many other dried-up sloughs with their white crusts of sodium salts carrying an admixture of calcium, and sometimes magnesium salts, but with only a trace of potash. The staking of alkali sloughs in the hope of discovering economic deposits of potash salts is a practice not to be encouraged.

Drilling Near Ralph. During the winter of 1917-1918 and during the summer following, a diamond drill hole was put down near Ralph, by the Saskatchewan Prospecting and Development Company, to a depth of 1,515 feet. At this depth the hole was stopped owing to difficulties encountered and another was to be started. The hole was still in Cretaceous strata at 1,515 feet and had penetrated no potash deposits.

Shale.

A light greenish-grey shale which corresponds in general appearance and characters with the Odanah shale (Pierre) occurs at a shallow depth in the general vicinity of Fairlight. At SW. sec. 35, tp. 10, range 32, W. 1st mer., the shale has a drift cover of 8 feet, and at NE. sec. 30, tp. 10, range 31, W. 1st mer., the cover is from 4 to 8 feet thick. It remains to be seen whether this shale can be successfully worked. Water is met at the former locality at 22 feet, and in the latter at 14 feet. Samples of the shale have been submitted to Mr. Keele, ceramic engineer of the Mines Branch, who reports upon it as follows:

"Re two samples of shale from south Saskatchewan submitted for examination by Mr. J. Stansfield, Geological Survey.

Sample 631. Hard grey shale from well 25 feet deep, near Fairlight, Sask., sec. 35, tp. 10, range 32, W. 1st mer.

The shale was ground fine enough to pass a 16 mesh screen. It has fairly good plasticity and working qualities when wet. Wares made from this clay must be dried slowly in order to avoid checking or cracking.

It burns to a porous red body at cone 04 or about 1,900 deg. Fahr., and to a denser body and darker colour at cone 1, 2,100 deg. Fahr.

The shale fuses when raised to the softening point of cone 7 (2,318 deg. Fahr.).

Sample 631a. Hard grey shale from vicinity of Fairlight, Sask., NE. ¼ sec. 30, tp. 10, range 31, W. 1st mer.

This shale resembles 631 in its working and drying qualities but it is not quite so plastic. The body of the test pieces is not quite so dense as those of No. 631 when burned to the same temperature. This shale is also more refractory than the above as it is quite intact at the temperature at which 631 fuses.

The following table shows the behaviour of these shales:

	631.	631a.
Drying shrinkage	6	5
Total shrinkage at cone 04	10	10
" " " 1	13	10
Absorption at cone 04	19	22
" " 1	9	18
Fusing point	Cone 7.	Cone 12.

These shales are suitable for the manufacture of building brick made either by the stiff mud or dry processes. The bricks made from these shales are lighter in weight and more porous than those made from most clays and a high temperature would be required to burn them to vitrification. The shrinkage at vitrification, however, would be too high to allow this process to be carried out in practice.

The colours to be obtained vary through various shades of red to buff according to the temperature at which firing is carried to or the amount of air allowed to enter the kiln.

These shales might also be used in the manufacture of fireproofing or hollow building blocks. The successful drying of these wares presents problems which could only be determined by using much larger quantities of shale in making full sized wares and submitting them to the actual drying process.

These samples appear to be taken from different beds, but both shales resemble beds at Tantallon which is about 50 miles north of the Fairlight occurrence. The Tantallon shales are described in the 'Report of the clay resources of southern Saskatchewan,' by N. B. Davis, published by the Mines Branch."

SOILS.

There are three chief soil types in the region, the dark heavy soils of the Regina plain, the brown till soils, and the soils of the "burn-out" area. The outlines of the areas occupied by these soils have been more clearly defined. From results of agricultural operations covering a number of years the soils of the Regina plain are found to be the most productive and the soils of the "burn-out" are the least productive. The brown till series may be divided into a heavier type in the northeaster nand western parts of the region and a lighter type in the southeastern and northern parts. In the southeastern part, considerable areas of a light till soil with gravelly subsoil occur.

The "burn-out" area contains soils of two types. The surface is hummocky, the high spots consisting of a fine, sandy loam soil 3 or 4 inches in thickness, resting on a clay sub-soil. The low spots expose the clay sub-soil, being 3 or 4 inches lower than the high spots. These make up say one-third or slightly more of the total area where the "burn-out" characteristics are most strongly developed, and constitute the non-productive parts of the land, in most seasons. The area of the "burn-out" was found to be much greater than that indicated in the Summary Report for 1917. It extends from near Avonlea to beyond Torquay, a distance of approximately 100 miles, and has an average width of about 10 miles. The area is approximately 652,800 acres. This area is served by the Canadian National railways and is very thinly settled, a large part of it never having been ploughed. The study of the best method of farming the "burn-out" to give successful results is the most important agricultural problem of the region.

UNDERGROUND WATER.

The general conclusions stated in last year's summary report are supported by the evidence obtained this year. Another case of unsuccessful deeper drilling in the district between Weyburn and Regina was noted near Kronau, at NE. sec. 35, tp. 15, range 17, W. 2nd mer., the depth reached being greater than 540 feet. The material from 537 feet is a light greenish-grey shale very similar in appearance to the Odanah shale (Upper Pierre).

South of the line Buttress-Trossachs-Stoughton, additional evidence was obtained of the general success in obtaining water from one or other of the sandy members of the Tertiary strata. A large part of the area underlain by the Tertiary strata in the southwestern part of the region is unprospected. Toward the close of the past summer (1918) tests near Brooking and Radville were successful. No deeper test has yet been made near Trossachs.

Two flowing wells have been obtained near Macoun during the past year on SE. $\frac{1}{4}$ sec. 11, tp. 4, range 11, and on the centre of section 12, tp. 4, range 11, W. 2nd mer. The water comes from a fine, sandy clay of a type that would not receive any attention from a driller inexperienced in this field. At first the yield of water was very small, but after several days of assiduous pumping the channels of supply were opened up to such an extent that a good supply of water was obtained and the water flowed over the casing at a height of $1\frac{1}{2}$ feet above the ground.

The sands of the Tertiary strata are a source of water as far east as a line running roughly from a point a few miles west of Carlyle to a few miles east of Oxbow. East of this line is the old depression filled with glacial debris, which has been mentioned above. The coarse gravels in the drift filling this old depression carry strong supplies of water. To the northeast of this the drift is thinner and is underlain by Pierre shale of the Upper Cretaceous.

Supplies of water are obtained in certain districts, apparently from slightly sandy members of the shale. This is the case south of Carnduff. To the north of Carievale water is obtained from the shale series at various localities, e.g., near Storthoaks, Redvers, Wauchope, Maryfield, Fairlight, and Walpole. In the northern part of this district, e.g. near Maryfield, Fairlight, and Walpole, the water appears to come from joint cracks in the shale rather than from sandy strata. The water from the joint cracks is probably fed in from sandy strata at a lower level. North of Stoughton the shale also carries potable water. During the past summer water has been obtained in sec. 13, tp. 11, range 8, W. 2nd mer., 16 miles north of Stoughton. The question as to how far to the northwest these conditions hold is one which should be carefully watched as drilling progresses.

The deep diamond drill hole near Ralph encountered no water to a depth of 1,515 feet.

Flowing Wells.

In addition to the flowing wells near Regina and Macoun there are several in the southeastern part of the province of Saskatchewan. Two have been struck 3 or 4 miles northeast of Carlyle in the drift filling the old depression discussed above. Under similar geological conditions a number of flowing wells have been made in the vicinity of Carievale, their depths ranging from 239 to 312 feet. This district attracted attention during the past summer by reason of a gusher drilled on the farm of Mr. S. Bellamy on SW. sec. 32, tp. 2, range 31, W. 1st mer., half a mile southeast of Carievale. The hole was drilled 3 inches diameter to a depth of 252 feet by means of a jetting rig. The work was stopped temporarily at that depth, no casing being in the hole. The well commenced to flow almost immediately, the pressure being so strong that the water was forced up in a stream to a height of 20 feet into the air. Owing to the absence of casing and the large amount of water flowing the hole was enlarged. The drillers, working under adverse conditions, succeeded in casing the well, but owing to the enlargement of the hole, water continued to flow around the casing as well as through it, so that a large, funnel-shaped opening 8 feet in diameter and about the same in depth was made around the casing. The flow of water was too much for farm use and flooded several acres of land on a low spot south of the well. Gravel and cement were dropped into the hole around the casing and after a time the flow of water abated in amount, though the water still flows from the casing 6 feet above the ground-level in a small stream and there is a much larger amount flowing around the casing.

There are a number of flowing wells drawing water from the shale beneath the drift in the southeastern part of the province. These include wells 478 feet deep 3 miles east of Carievale, 382 feet deep 3 miles southwest of Oakley, 474 feet deep 6 miles northeast of Alida, 496 feet deep 12 miles northeast of Alida, and 493 feet deep 8 miles south of Wauchope.

Quality of Water.

The typical waters from the drift of this region are hard, and contain calcium and magnesium salts, especially carbonates and sulphates. This is shown by the analyses of samples collected last season.[1] The typical waters from the Tertiary strata are softer. Some of the mare quite soft, in some cases softer than rain water. These waters have larger amounts of sodium salts than the water from the drift; in some cases the calcium and magnesium salts are in small amounts. Chlorides are more prominent in these than in the waters from the drift. There are occasional soft waters from the drift and occasional hard waters from the Tertiary strata. An example of the latter type is that at Torquay village.

The water from Topham's well, NE. sec. 11, tp. 7, range 13, W. 2nd mer., proved to be very soft, having very low calcium and magnesium contents. Another sample was taken in 1918 to see what change, if any, had taken place in its composition in the meantime. The results of the analysis have not yet been received. The water will probably receive attention as a source of supply in certain industries connected with flax fibre, which may be established in the west in the near future.

Samples for analysis fro msprings in Tertiary strata were taken at Claybank, SE. sec. 28, tp. 12, range 24, W. 2nd mer. (from a spring up on the face of the Dirt hills, the water from which is piped to the brick plant at Claybank), and at Willow-bunch village, which obtains its supply from two springs, the water being piped to the village. These waters do not show any essential differences from the others derived from the Tertiary strata.

Another interesting type of water from the Tertiary strata possesses a yellow or brown colour, having had close contact with lignite coal. One of those, with a clear

[1] Geol. Surv., Can., Sum. Rept., 1917, p. 50C.

yellow colour, and which evolves CO_2 briskly for the first minute after pumping from the well, was collected at SE. sec. 2, tp. 2, range 10, W. 2nd mer. Another sample, of dark brown colour, was collected at NW. sec. 16, tp. 6, range 3, W. 2nd mer.

The water from the Cretaceous shale in the Carievale-Walpole-Maryfield district is usually soft and in many places salty. That from the shale at a point 16 miles north of Stoughton is also soft. The question of the composition and concentration of the waters from the deep wells at Moosejaw, near Estlin and near Wilcox, is of great interest for comparison in this connexion. A sample was taken of the water flowing from the Moosejaw well, but there are no pumps attached to the two other wells. As no analyses of these waters are available, it should be pointed out that if in the future the water from these wells is pumped the opportunity should be taken to sample them.

The town supplies of Moosejaw, Regina, and Weyburn were sampled. These illustrate the characters of waters from the drift. Of these, the Weyburn water is the most pleasant to the taste and the least concentrated.

One sample was taken to ilustrate the composition of the surface waters of the semi-arid district in the southwestern part of the region. The lakes and sloughs each have their own individual characteristics, so that the example taken only serves as a general indication. The Willowbunch Lake water is of especial interest because of its concentration and because it froths when shaken or when beaten into waves by the wind.

Municipal Supplies of Water.

Arcola. The town supply is derived from Smiley spring, situated 3½ miles northeast of the town, on the front of the Moose Mountain moraine. The water is piped in a wooden conduit. It is supplied to the Canadian Pacific railway also.

Carnduff, Kisbey, and Caron have sandy soils in their immediate vicinities and water is obtainable with ease at shallow depths, sand-points being generally used for individual wells.

Carlyle, Carievale, Alida, Griffin, Colgate, Brooking. These towns draw their water supplies from wells in the drift. Carlyle has two wells each 205 feet deep and the water is very hard. Carievale has a flowing well about 250 feet deep, the water being hard. Alida, Griffin, Colgate, and Brooking have shallow wells in the drift.

Lampman, Oxbow, Tribune, Maxim. These towns have wells which draw water from the Tertiary strata. Lampman has a satisfactory supply from a well 271 feet deep, and recently a well has been sunk to 272 feet, obtaining a supply for a hospital which was in course of construction in 1918. Oxbow has a well 280 feet deep with a satisfactory supply for the small demand, but the water is very hard. Tribune has a well 280 feet deep with a good supply of soft water of dark brown colour, being derived from a lignite seam. It is not much used for domestic purposes because of the staining caused by it. Maxim has a well 78 feet deep, the water of which is strongly concentrated. It is not much used.

Fairlight, Walpole, Maryfield. Fairlight has shallow wells which get a soft water from shale. Wapole has a well 142 feet deep, drawing a soft water from shale. At Maryfield a well was drilled in 1913 to a depth of 380 feet, a supply of water being obtained which has not been used, but the surrounding district has wells from 77 to 112 feet which draw soft water from shale.

Redvers has made several attempts to obtain a water supply. Water has been met with at 250 feet in a quicksand and at 460 feet in a sandy shale, but a well has not been completed.

Tuxford, Avonlea, Froude, Wauchope, Antler, Browning. These towns have no satisfactory water supplies and in every case except that of Browning deep drilling has been undertaken unsuccessfully. Tuxford has had two holes drilled to approximately 500, and 200 to 300 feet. No water was found. Surface water is collected in a dug-out and carried along an artificial gravel lead to a pump. Avonlea has had holes put down to approximately 600 and 1,200 feet. The former is stated to have met water at 300 feet, but no accurate information is available. Froude drilled a dry hole to 500 feet passing into shale. A small supply of water was met at 180 feet at the bottom of the drift. Wauchope uses shallow wells. A small supply of water was obtained in a drilled well 232 feet deep, but it was of such quality that stock would not use it. Antler uses shallow wells. Several unsuccessful boring tests have been made, the deepest being 100 feet. Browning has a shallow well 35 to 40 feet deep, but it is unsatisfactory. No testing of the deeper strata has been carried out.

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