Report No. 50

ANNUAL REPORT

OF THE

RESEARCH COUNCIL OF ALBERTA

1946

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The following report, the Twenty-seventh Annual Report of the Research Council of Alberta, was submitted in March, 1947, by the Director of Research Dr. R. Newton, President of the University of Alberta, to the Chairman of the Council the Hon. N. E. Tanner, Minister of Lands and Mines. The Chairman submitted the report to the Premier of Alberta, the Hon. E. C. Manning, who tabled it in the Legislature.

The offices and laboratories of the Council are situated in the buildings of the University of Alberta. Requests for information and reports should be addressed to the Secretary, Research Council of Alberta, University of Alberta, Edmonton, Canada.

MEMBERS OF COUNCIL

The Honourable N. E. Tanner, Minister of Lands and Mines, Chairman.

The Honourable E. C. Manning, Premier of Alberta.

The Honourable W. A. Fallow, Minister of Public Works.

Dr. R. Newton, President of the University of Alberta, Director of Research.

L. E. Drummond, Esq., Edmonton.

J. E. Davies, Esq., Medicine Hat.

The Council operates under the Research Council Act of 1930, as amended 1943 and 1945.

The Secretary of Council is W. A. Lang.

TECHNICAL ADVISORY COMMITTEE

Dr. R. Newton, President of the University of Alberta, Director of Research, Chairman.

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Mr. L. D. Byrne, Deputy Minister, Department of Economic Affairs.

Mr. J. Crawford, Chief Inspector of Mines, Department of Lands and Mines.

Dr. J. A. Allan, Department of Geology, The University.

Dr. K. A. Clark, Department of Mining and Metallurgy, The University.

Prof. N. C. Pitcher, Department of Mining and Metallurgy, The University.

Prof. E. Stansfield, Fuels, Chief Research Engineer.

Dr. F. A. Wyatt, Department of Soils, The University.

Mr. J. E. Oberholtzer, Industrial Engineer.

Mr. W. A. Lang, Secretary of Council, Secretary.

TECHNICAL STAFF OF RESEARCH COUNCIL

The following have held full time, permanent appointments during the year:

Edgar Stansfield, Chief Research Engineer, to September.
William A. Lang, Senior Research Chemist, Fuels.
David S. Pasternack, Research Chemist, Bituminous Sands.
Michael B. B. Crockford, Geologist, Geology, from July.
Jack S. Charlesworth, Chemist, Gasoline.
Arthur L. Brown , Soil Surveyor, Soils, from May.
John E. Oberholtzer, Industrial Engineer.
John L. Carr, Assistant Geologist, Geology.
Edward Tipman, Assistant Chemist, Gasoline.
Stanley H. Ward, Assistant Chemical Engineer, Bituminous Sands.
Willard C. Hinman, Assistant Soil Surveyor, Soils.
John Gregory, Assistant Chemical Engineer, Fuels.
John F. Fryer, Assistant Chemist, Fuels.
Raymond A. Leask, Assistant Research Chemist, Fuels.
S. Jae Groot, Draftsman-Compiler, from June.

The following held temporary appointments during the year:

Donald J. Campbell, Research Assistant, Bituminous Sands, May to August.
Edward L. Coffin, Research Assistant, Fuels, May to September.
William R. Dimock, Research Assistant, Natural Gas, from October.
Joseph A. Fraser, Assistant Soil Surveyor, Soils, May to July.
A. Harboway, Assistant Soil Surveyor, Soils, July to September.
James S. Kidd, Assistant Geologist, Geology, May to September.
J. Donald LaZerte, Research Assistant, Natural Gas, January to August.
Sam Loshaek, Research Assistant, Natural Gas, January to April.
James M. Roxburgh, Research Assistant, Natural Gas, May to September.
Donald S. Scott, Research Assistant, Natural Gas, January to April.
Martin D. Winning, Research Assistant, Natural Gas, May to September.
Stuart R. Wright, Research Assistant, Natural Gas, from May.
Andrew Wynnyk, Assistant Soil Surveyor, Soils, May to September.

The following members of the Faculty of the University of Alberta assisted in the work of the Council:

Dr. John A. Allan, Geology.
Dr. Karl A. Clark, Bituminous Sands.
Dr. Stuart G. Davis, Natural Gas.
Dr. Edward H. Gowan, Measurement Ultra Violet.
Prof. George A. Govier, Commercial Utilization of Straw.
Dr. E. H. Moss, Poplar Survey.
Dr. W. Rowan, Animal Cycles.
Prof. Andrew Stewart, Poplar Market Survey.
Dr. Osman J. Walker, Commercial Utilization of Straw.
Dr. F. A. Wyatt, Soil Surveys.

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This report summarizes the work of the Council for the calendar year 1946. Investigations in progress during 1945 were continued and a number of new projects undertaken. These included: study of a number of industrial projects; fundamental studies in connection with the commercial utilization of straw; measurement of ultra violet light in connection with the animal cycle project; and a survey of possible markets for poplar. A reconnaissance timber survey in the region of Lesser Slave Lake was planned but could not be proceeded with because a qualified leader for the field party could not be obtained. The work on several other projects was curtailed because of inability to get suitably trained personnel and by delays in procuring supplies. Space available for the work of Council is of growing concern, and it may be necessary to curtail part of the fuels investigation until suitable space can be provided. One army hut was obtained late in 1946. This will be used for storage, and to house the work of geology, drafting and industrial projects.

Edgar Stansfield retired from the staff of the Council in September. He had held the position of Chief Research Engineer and Secretary of Council since its organization in 1921. A short biography of Prof. Stansfield is included as an appendix to this report.

A. McCulloch, Victoria University, Manchester, England, has been appointed Chief Research Engineer. He will begin his duties early in 1947. Other full time appointments included M. B. B. Crockford, geology, A. L. Brown, soils, and S. J. Groot, draftsman-compiler. W. A. Lang has been made Secretary of the Council.

Report No. 48 entitled "Geology and Coal Occurrences of Wapiti, Cutbank Area Alberta" was published during the year. Several other reports are in preparation for publication.

Brief reports on the work under investigation during the year follow.

BITUMINOUS SANDS

The attention of the Council which is devoted to bituminous sand studies was given in large measure to problems connected with the design of the government sponsored separation plant at Bitumount on the Athabaska river. As indicated in the Annual Report for 1945, the main matter of design remaining unsettled was details of the unit for clearing the crude separated oil of water and mineral matter preparatory to charging it to the refinery. During the year, the various methods that have been considered for accomplishing this cleaning have been subjected to careful laboratory test. The methods were: settling under conditions of elevated temperature and pressure; settling at about 175°F. and atmospheric pressure; direct evaporation. A combination of the latter two methods was found to be most feasible. If the wet, crude oil from the separation plant mixed with a refinery distillate in amount equal to about half of the actual oil in the wet crude is run through standard continuous settling equipment at about 175°F., about half of the water and all the coarse mineral matter settles. The remaining water can be removed readily by passing the oil mixture through a conventional type of tube heater where the water is converted to steam and then separating oil and steam in a flash chamber. The design of the drying unit of the plant at Bitumount has been completed along these lines.

Study of the hot water separation method, in general, has been continued during the year and additional insight into it has been gained. The main factors in the process appear, now, to be known. They are these. Water tends to displace oil from the sand and other mineral surfaces by getting between the sand and oil and wetting the mineral surfaces. But this action is a slow one. It is particularly slow if the bituminous sand is acidic in nature. Neutralizing the acid present by making the bituminous sand neutral or slightly alkaline speeds the displacing action of water. Also, the presence of a few per cent of clayey material in the bituminous sand aids the water in getting between the sand and the oil. When the bituminous sand which is in the condition of having mineral surfaces water-wet is flooded with and dispersed in water, the mineral matter goes with the water and the oil gathers together and floats on the surface provided it has picked up air in the form of bubbles to make it buoyant. There is, of course, the ability of oil bubbles to retain sand particles to take into account. It is necessary to avoid excessive bubble formation if comparatively sand-free oil is to be produced. Fortunately the displacement of oil from mineral surfaces has taken place in nature in the case of most bituminous sand beds and the sand particles in the bituminous sand as quarried are water-wet. The material in the deposit is neutral although acidity develops when the bituminous sand has been quarried and has been exposed to the air for some time. Also, most bituminous sand beds have a considerable content of clayey material. As a consequence, no time has to be spent in separation plant operations in causing the displacement of oil by water to take place. Pulping with water is a necessary plant operation however, for preparing the bituminous sand for flooding with water and it provides opportunity for water displacement that nature has not completed or that has been undone by exposure in the quarry.

As part of the general study, the distribution of oil in the hot water separation plant has been examined in detail. When the bituminous sand pulp is flooded with water and washed into the separation cell, the oil separates from the sand and floats to the surface while the sand sinks as tailings. The silty and clayey mineral matter becomes dispersed in the plant water. The oil which floats is skimmed off and is thus recovered for processing into useful products. The recovery of oil is not complete. It is a matter of interest as well as of importance to know what becomes of the oil which does not float. Some probably remains on the surface of sand particles in the form of an exceedingly thin film. Some probably remains on the surface of silt and clay particles in a similar way. But because of the very much greater surface possessed by a given weight, an ounce for instance, of mineral matter in the form of clay as compared to the surface of an ounce of sand particles, the ounce of clay retains many times more oil than the ounce of sand. In any case the fact is that the very fine mineral matter which disperses in the plant water of the separation plant holds a surprising amount of oil. Since all normal, good grades of bituminous sand contain considerable quantities of silt and clay, the loss of oil because of it, in the separation process, is considerable. It would appear that the recovery of oil in the separation of good grades of bituminous sand will lie between 80% and 90%. The recovery will decrease with increased content of silt and clay.

It is obvious to anyone with any acquaintanceship with the bituminous sands that the main body of oil which this deposit contains cannot possibly be won by mining the sand and putting it through a separation plant. While very large tonnages of bituminous sand lie under conditions of light overburden which make quarrying feasible, the hundreds and possibly thousands of square miles of the deposit are too deeply buried by overlying strata to be dug into. Some method of winning the oil which does not involve mining operations must be used if the main body of the deposit is to be developed. There has been considerably thinking about and experimenting with such methods in the past but without success.

The Council is studying the applicability to the bituminous sands of the well known method of recovery of oil by means of water-flooding. This method is in quite common use on the continent, especially in depleted oil fields. The method involves drilling rows of wells into the oil sands over an area. Water under pressure is pumped down every second well. The water enters the oil sand, driving the oil ahead of it into the remaining wells from which it is recovered. On first thought one would dismiss the method as inapplicable to the bituminous sands because of the very viscous nature of the oil at ordinary temperatures. However, an experience which all who have drilled wells into the bituminous sands have encountered makes it seem that water-driving of the oil does take place. All these drillers have found that, at the odd time and place, very considerable quantities of oil have accumulated in the drill-hole. The most likely explanation would seem to be that a natural hydrostatic head of water has been operative and has caused oil to flow through the sand into the hole. The difficulty of the viscous nature of the oil probably is offset by the open, permeable sand in which it occurs. Most oil fields where water-flooding has been practiced contain a fluid petroleum. But the rock in which the oil is contained is a sandstone offering great resistance to flow through it. The bituminous sands contain a viscous oil; but the sand containing it is unconsolidated and very permeable. The viscous oil may flow as easily through the open sand as a fluid petroleum can flow through a tight sandstone.

The study so far made of the applicability of water-drive to the bituminous sands has been encouraging. Displacement of oil by a head of water, from bituminous sand packed into a laboratory experimental cell, has been obtained. Work is proceeding on the obtaining of fundamental data on the viscosity of the oil at ordinary temperatures and on the porosities and permeabilities of various bituminous sand aggregates. With these data in hand much can be done by calculations in exploring the possibilities of the method. Further work with laboratory flow-cells that is indicated as useful will be undertaken.

FUELS

The sampling and analysis of the coals of Alberta and the testing of coal mine dusts, in co-operation with the Provincial Mines Branch was continued. A large number of samples of coal, char, briquettes, etc., have been analysed in connection with investigations in progress. Determinations were made of the Swelling Index of a number of coking coals and of the effect that oxidation of the coal had on the size of the coke button obtained in the test.

The present apparatus for testing the explosibility of mine dust on a laboratory scale is far from satisfactory, but a number of earlier attempts to improve the test failed. A new apparatus has been constructed in which a definite dust explosion wave can be made to travel up a glass tube of four inches diameter and two feet in height. This apparatus gives a spectacular demonstration of a dust explosion, but it is not yet known whether a test procedure can be established to make a sharp distinction between dusts that might and dusts that would not propogate explosions in a coal mine.

The investigation to produce a high heat value storable fuel from the lower rank high moisture coals was continued. Two schemes have been studied: one the low temperature carbonization of the coal to form a char followed by briquetting of the char either alone or blended with a coking coal and with an asphalt or coal tar pitch binder; the other the drying of the coal followed by blending with a coking coal, and briquetting with a binder. Both methods give briquettes that have satisfactory handling and storage properties. They ignite easily and burn with a long flame. Because of the binder they are slightly smoky during the first part of their combustion. Briquettes made by either process can be made smokeless by a heat treatment. A quick heat treatment is satisfactory for briquettes made from blends of char and coking bituminous coal, but a slow heat treatment is necessary for briquettes made from blends of dried coal and coking bituminous coal. A large number of tests require to be made before optimum conditions for the blending, briquetting and heat treating are determined.

An hydraulic press has been set up and a small mixer built. These will allow for a greater number of blends to be tested than would be possible in the same time with the large scale equipment. When desired results are obtained on the small scale equipment similar mixes are briquetted with the semi-commercial presses.

A briquetting investigation was made for one of the coal companies who are considering the erection of a briquetting plant. Commercial aspects of briquetting, as carried out by one of the large briquetting plants in the province, were studied by a member of the staff.

One development in the blending work, which appears to have interesting possibilities, has been the production of small coal balls. The balls are made from fine coal and a binder such as asphalt but without the use of pressure. They are hard, clean to handle, and should store and fire satisfactorily. Furthermore by careful blending of the coals a fuel could be made with the desired clinkering properties for under-feed stokers. Only preliminary work has been done so far on this investigation.

In 1944 a laboratory model of a vertical shaft carbonizer for the low temperature carbonization of the lower rank, high moisture non-coking coals was designed and constructed. Subsequent work with the carbonizer indicated that although the principle on which it was designed was good, and a good quality char could be produced, certain features of the carbonizer required to be redesigned if operating data were to be obtained. A second carbonizer has now been built embodying the changes. An essential part, the baffles and baffle plates, were made to order of carborundum and give promise of being very satisfactory. A few preliminary runs made with the new carbonizer indicated that it should prove satisfactory.

It had been observed that briquettes made from blends of lower rank coals and coking bituminous coals underwent shrinkage when the briquettes were heat treated. The lower rank coals, when heated out of contact with air, decrease in volume by an amount approximately equal to the amount of moisture and volatile matter driven off in the heat treatment. No entirely satisfactory test has been designed for measuring either the shrinkage of the briquettes due to the heat treatment, or the density of the carbonized briquettes but the tests used showed that the briquettes had a density equalling that of the uncarbonized briquettes. High density in briquettes is an important consideration for shipment to distant markets.

Heavy solution washability data were obtained for coals from three mines. A method for removing a large part of the bentonitic clay and shale associated with certain prairie coals was tried.

The search for montan wax in Alberta coals was continued. Previous investigations in this laboratory had shown that fair yields of extracts could be obtained by treating Alberta coals with organic solvents. The yields could be increased by using high temperatures and high pressures but neither the extractions at atmospheric or high pressures yielded material having the chemical composition of montan wax—the hydrogen content being much too low.

The present investigation was directed toward increasing the hydrogen content of the extracted materials rather than to obtaining maximum yields of extract or to making tests on a large number of coals. It was found that the chemical composition of the soluble material varied with the length of time of the extraction, i.e., the first materials extracted had the highest percentage of hydrogen and the highest percentage of carbon. It was also found that the percentage of both dropped as the extraction proceeded. The results held for several solvents. Attempts were made to increase the hydrogen content of the soluble substances by extracting with tetralin—a hydrogen carrier; by hydrolysing the coal with acids; and by extracting in acid and alkali mediums. The coal was also heated to various temperatures, before extractions were made, in order to increase the hydrogen to carbon ratio of the coal substance. Although the investigation was unsuccessful in that the desired products were not obtained, the work provided considerable valuable information on the chemical nature of materials that can be extracted from coal.

Members of the fuels staff visited mines in the Camrose, Cascade, Coalspur, Crowsnest, Drumheller, Lethbridge, Mountain Park, Nordegg and Tofield coal areas. These visits have provided the Council with information on the difficulties experienced by the coal industry; also with an opportunity to discuss recent developments in fuel research with the coal operators.

E. Stansfield and W. A. Lang gave evidence at the inquest in connection with the 1945 explosion in the Luscar mine. In preparing information for the inquest an attempt was made to trace the path of the explosion by examining microscopically, for cenospheres, samples of dust taken from different locations in the mine. The cenospheres found in these samples were unlike those found in dusts taken from sections of the Brazeau No. 3 mine following the 1941 explosion in that mine. There were also marked differences in the cenospheres in samples taken from different parts of the mine. As a result of the investigation it is suggested that cenospheres should be made in the laboratory using coal dusts from all of the bituminous coal mines in the province and the cenospheres studied for characteristic differences. This investigation should give information that will be of value should a mine explosion occur in the future and this is a possibility which cannot be overlooked.

A Coal Operators' Research Committee has been formed, comprised of representatives from the Western Canada Bituminous Coal Operators' Association, the Domestic Coal Operators' Association and the Research Council of Alberta. The purpose of the committee is to maintain liaison between the coal industry and the Research Council.

Appreciation of the assistance and co-operation received at all times from the Chief Inspector of Mines, and from the Provincial Mines Inspectors is acknowledged. Thanks is expressed to mine operators who have submitted samples of coal for investigation and for courtesies shown to members of the staff of the Research Council when visiting mines in the various districts.

The Gasoline and Oil Testing Laboratory, while continuing to test aviation fuel for the Royal Canadian Air Force, widened the scope of its work to include petroleum products other than gasoline. It is now equipped to handle the testing of almost all petroleum products other than greases. A considerable proportion of the necessary testing equipment was constructed in the laboratory.

Approximately 400 samples of petroleum products were tested during the year. These included gasolines for the Royal Canadian Air Force; Provincial Government gasoline surveys; oils of various types and a few miscellaneous samples. A report was prepared for the Provincial Government on the motor gasolines sold throughout the Province. This report covered two surveys, one during the winter of 1945-46 and the other during the summer of 1946. A survey covering the period 1946-47 is now in progress.

The investigation on the length of time gasoline samples can be stored without change is still in progress. Samples are being kept in the laboratory and retested at intervals to determine changes. This work will not be completed for some time.

Considerable time and consideration was given to revisions in the Alberta Standard Specifications for Gasoline. Close co-operation was maintained between the Research Council of Alberta and the

Sub-committee on Petroleum Specifications of the Canadian Government Purchasing Standards Committee of the National Research Council.

GEOLOGY

During 1946 the geological work of the Council was carried on under the direction of J. A. Allan, in conjunction with the Department of Geology at the University of Alberta. This work has proven to be heavy enough in late years to warrant the services of a full time senior geologist, and accordingly M. B. B. Crockford was appointed to this position in July of this year. Drafting of maps, charts, etc. has been done by S. J. Groot, who was appointed draftsman to the Research Council of Alberta in June.

Geological investigations pursued and services rendered during the year were many and varied. The more important of these were continuation of the geological mapping of the Highwood coal area, a water survey in part of the Peace River district, and miscellaneous investigations into deposits of clay, gravel, and sand for glass. In addition several maps and reports have been prepared for publication. Summary accounts of these projects are given below.

Acknowledgment is made to those who have assisted in the geological work. Thanks are particularly extended for co-operation in various ways to Mr. John Crawford, Chief Inspector of Mines; Mr. T. W. Dalkin, Superintendent, Technical Division, Department of Lands and Mines; Mr. T. F. Blefgen, Director of Forestry, and to Mr. A. G. Bailey, Chairman, Petroleum and Natural Gas Conservation Board.

1. Highwood-Elbow Area.

Geological mapping of the Highwood and Elbow River areas, which was begun in 1945, was continued and a start was made to extend the mapping to the adjoining Cascade coal basin, in which coal is mined at Canmore. The geological party in charge of John L. Carr, field geologist, went into the field May 20th and came out on September 25th. Since mapping in 1945 was confined chiefly to the eastern half of the area, i.e., that region lying between Baril creek on the south and Little Elbow river on the north, and from Highwood River and Misty range on the west to Highwood range on the east, the mapping of the western half of the Highwood River basin was the principal objective of the 1946 season. This work was completed and carried northwards into the basin of Kananaskis river, where some mapping was done on Evans-Thomas and Ribbon creeks. Special attention has been given to the Kootenay formation, which is the only coal-bearing formation in the area and which is the source of coal in the Crowsnest Pass area, Canmore, etc.

The main structural features of the Highwood-Elbow area are a wide asymmetrical syncline which extends northwestwards into the area mapped, turns westwards in the vicinity of Loomis creek, and is concealed under the overthrust of the Elk mountains. This syncline is crossed by Fitzsimmons, Carnarvon, and McPhail creeks. Another notable feature is the Misty range, which is anticlinal in structure and divides the upper Highwood valley into two branches. The third outstanding structural feature is another syncline lying between Misty range and Highwood range. The axis of this syncline approximates the position of Mist creek and upper Highwood river. Both of the above synclines are important for the coal-bearing Kootenay rocks are well exposed on their east limbs, and it is here that the coal prospects on the Burns and Ford properties have been made. Preliminary surveys in the Kananaskis River basin show a synclinal structure in the vicinity of Evans-Thomas and Ribbon creeks. Faults and minor folds are common throughout the whole area.

In the area studied, the coal seams do not occur at the same horizons or in the same part of the formation. In the eastern part of the area, i.e., in those Kootenay beds lying closest to the Highwood range, the coal seams occur in the lower part of the formation, but in the western part of the area coal seams are found to within 75 feet of the top of the Kootenay. The coal occurrences in the eastern part of the area include the prospected areas which have already been described in the 1945 report to Council, but may be briefly restated here. The coal at the south end, near Sentinel Ranger Station, is found in seams from 4 feet to 18 feet thick which have an aggregate thickness of about 48 feet. On Sheep creek on the Burns property an open cut has exposed 28 feet of coal in two seams, separated by an 11-foot shale break. These seams are exposed in three more or less parallel fault blocks. Another coal area is situated in the southwestern part of the map sheet and lies between Muir and Loomis creeks. The coal-bearing strata are part of the west limb of the large syncline, described above. These strata vary from vertical to overturned in attitude, an indication of considerable pressure. Hence the coal, which occurs in at least seven seams, each over three feet thick, is badly crushed and is powdery in outcrop. It is evident that the exploitation of this coal would be attended by great difficulties.

Another and larger coal area begins on the central part of the map sheet in the vicinity of Loomis creek, and extends northwestwards to Mist mountain. There it divides, one branch extending northwestwards along Storm and Pocaterra creeks and finally terminating at Mount Wintour.

The eastern branch follows along the eastern side of Misty range, and wedges out near Tombstone mountain. In the western branch of this coal area, two seams, each about five feet thick, occur on Storm creek, south of Mist mountain, and six seams, varying from 3 to 10 feet in thickness, outcrop on the west slope of Mist Mountain. The coal is crushed in outcrop, but some coal was found which factured into small blocks. West of Storm creek little coal is exposed, the only notable seam being one six feet thick near the top of the formation. Along Pocaterra creek, about five miles above the mouth, 18 coal seams from 3 to 14 feet in thickness were observed at an elevation of approximately 8,000 feet, or about 2,600 feet above the mouth of the creek. The coal in these seams is badly crushed for the most part, but some blocky coal is present.

That branch of Kootenay strata skirting the east side of Misty range consists of highly contorted beds. Therefore, the contained coal seams are badly crushed and distorted. No good seams were observed.

Along Evans-Thomas creek, which is at the south end of the Cascade coal basin and at an elevation of about 7,500 feet, eight seams, and possibly more, are present. These seams vary in thickness from 4 to 15 feet. Most of the coal is crushed. Few coal seams were observed along Ribbon creek. One four-foot seam is present at the very top of the Kootenay formation.

In 1946, District Inspectors from the Mines Branch were taken into the Ford Property on Highwood river, and the Burns property, on Sheep creek for the purpose of taking official samples. W. G. Heeley took 11 samples from three of the open cuts on the Ford property and W. E. G. Hall took four samples from the only open cut on the Burns property. These samples have been analysed in the Fuel Laboratory of the Research Council. It should be understood that these samples were collected from only four shallow cuts and therefore may not represent the character of the coal seams throughout the Ford and Burns properties. The character of the coal seams may vary slightly at depth from the outcrop.

2. Peace River Water Survey.

Acting at the request of the Dominion Government, a water well survey was conducted in conjunction with the soil survey which was being carried on in the Peace River district. The area covered by the water well survey lies between townships 73 and 83, and from Smoky river east to and including range 21. The principal towns in the area are Peace River, Fahler and Girouxville. S. J. Kidd, assistant geologist, worked under the direction of W. Odynsky, chief of the soil survey party. Kidd spent four months in the field studying the various phases of the water supply problem, which in many places in the area is difficult of solution. Records were obtained from 67 wells, and water samples from 10 of these were collected and analysed; traverses were made along important streams in order to determine the relation of bedrock to the quantity and quality of the water; observations were made regarding the use of streams as a source of water for domestic use; and the nature and distribution of glacial deposits and their relationship to water were given particular attention, since most of the area is covered with these deposits.

Adequate supplies of potable water are difficult to obtain in the greater part of the area, and several expedients are used to satisfy the demand. Wells, either bored or dug, yield sufficient water in some places; in a few places springs supply enough for stock or domestic use; many farms depend on dams or dugouts, which catch the spring run-off. Sometimes wells are dug beside dugouts, and the water which seeps from the dugout into the well, is utilized for human consumption.

In general, the survey shows that little difficulty is encountered in obtaining adequate supplies of water in the southern part of the area, i.e., that part south of township 75. This part is underlain by the continental Wapiti formation, the sandstone strata of which are water-bearing. Wells in this part usually obtain good water at depths less than 100 feet. The area north of township 75 is for the greater part, underlain by marine shales. These beds do not yield much water, and the water that is obtained is usually hard, and in some cases it is not fit for use. Some small areas in this northern part have no water problem, since shallow wells in the glacial drift give sufficient water of good enough quality for farm use.

There is a pressing need in many parts of the province for guidance with respect to water supply. Since there is little information on this subject, and since the demand for this information is increasing and will tend to increase, it is extremely desirable that accurate records be obtained in order to render service to the province in this important matter. Hence, it is proposed to spend at least a part of each field season in water surveys, until eventually the whole province will have been covered.

3. Sand for Glass.

Investigations into the use of Alberta sands for making glass were continued. The higher costs of sand as laid down in Alberta, together with uncertainties regarding shipping space have made this problem an urgent one for the glass industry of Alberta. Since the requirements of a sand for glass making are exacting, few sands can meet them without purification. It is unlikely that any lake beach sands in Alberta could be used without purification, but a search is being made for sands that will need only a minimum of treatment. Any such sands must also be present in large quantities, must be near a railroad, and must also be available to the glass industry. This last factor may need explanation, but when it is realized that most sand beaches are utilized as summer resorts, the import is then clear.

Several lakes in central Alberta have been examined in the search for sands for glass, but to date no sand deposit has been found which could be considered large enough for, or available to the industry. Some samples have been taken, and if suitable arrangements can be made, they shall be sent for treatment in order to give the geologist a working criterion as to the value of our sand deposits. It would appear that abandoned lake beaches offer the best prospects of supplying this sand; but the finding of such beaches involves the detailed study of local topography and also the drilling by hand of numerous shallow auger holes.

Other prospects of obtaining silica sands in Alberta are in the rock formations. One of these formations in Peace River valley, and another in the Rocky Mountains will be investigated next spring.

4. Clay and Gravel Deposits.

A trip was made to Medicine Hat, the centre of the ceramic industry of Alberta, in order to examine the clay deposits used in the industry, and also to maintain contact with the operators. Samples of various types of clays used in the industry were obtained. In response to an inquiry, a clay deposit at Sandstone, near Okotoks and formerly operated by the Canada Cement Company, was investigated and sampled.

Since the demand for gravel for road surfacing is increasing year by year, and since many of the gravel deposits are being worked out, it is imperative that new sources of this material be found. In many areas known gravel deposits are rare and inadequate, thereby necessitating the hauling of gravel for considerable distances. Hence, the discovery of new deposits should appreciably reduce the cost of road building to the province and municipalities. A start in that direction has been made by this division. All known gravel quarries in the province have been compiled on a reference map. Their relationships to existing and abandoned stream channels and glacial deposits are also being studied. It is planned in future to devote part of the time spent in the field to the study of gravel deposits.

5. *Special Investigations and Services.*

In response to a request from the Stettler Board of Trade, a reported occurrence of "limestone" along Red Deer river was examined. It was thought that this deposit might be of value in the manufacture of cement. However, no limestone was found to be present. The rock was the common sandstone in the Edmonton formation.

Another trip was made to a farm east of Ponoka where a cave-in had occurred in the middle of a field. Upon examination, it was concluded that other cave-ins were unlikely. On another occasion a newly slumped block along Pembina river was examined and valuable information was gathered regarding the process of slumping. The geologist is often called upon by interested persons to give information regarding geological matters and to identify mineral and rock specimens.

6. *Reports and Maps.*

A report on the Wapiti-Cutbank area was compiled from the results obtained by John L. Carr in the field season of 1944. A map showing coal occurrences and columnar sections showing the relative positions of the coal seams were prepared and printed. The report (No. 48) was received from the printer late in 1946, and has been released for distribution.

Two maps, the Red Deer sheet and the Rosebud sheet, Maps 8 and 9 to accompany Report 13, were distributed a number of years ago, so that the supply was not sufficient when the report was published in 1945. A revised edition was prepared in one sheet, and is now in the hands of the printers.

Coal mines in the vicinity of Edmonton have been visited, and stratigraphic sections there described. The data have been assembled and a report and map of the Edmonton Coal Basin are being prepared for publication.

The geological map of the Highwood-Elbow area has been compiled from the data obtained by J. L. Carr during the field seasons of 1945 and 1946. The drafting of this map is nearing completion, and it will be ready for printing in January, 1947.

Information obtained on water wells during 1946 has been compiled, including the reports of water wells examined under the direction of the Petroleum and Natural Gas Conservation Board. The Board sent duplicate copies of all water well reports to this office. The interpretation of the water well data is the concern of the geologist with the Research Council.

INDUSTRIAL PROJECTS

The activities of the Industrial Projects section have fallen into four main divisions during the year: the establishment of contacts with various government offices, the inspection of industrial plants and research laboratories, the investigation of proposed industrial projects, and the dissemination of technical information in reply to private inquiries, and to requests from government departments.

Satisfactory working relations have been established with the provincial government departments concerned in this type of work, and personal contact with a number of federal offices has resulted in a ready exchange of information.

A number of plants in the province, planning expansion with government aid, were inspected, and reports were submitted in each case. A number of other plants were visited as part of a program to become better acquainted with existing Alberta industries.

Detailed reports were submitted on 13 industrial projects. In some cases a request was made for a definite recommendation as to whether or not the proposal was feasible, while in other cases a general informative outline of the proposed industry was desired. Ad hoc committees were appointed by the Director of Research to advise the Industrial Engineer on the major problems. A number of the projects are still under consideration by the government, and further work may be involved in the development of the industries. Besides these detailed reports, a large number of brief reports and/or letters were sent in reply to miscellaneous inquiries, providing a rather informal technical information service.

NATURAL GAS RESEARCH

The natural gas research is under the direction of S. G. Davis of the Department of Chemistry. This project is concerned mainly with the study of catalysts that can be used in the conversion of carbon monoxide and hydrogen to hydrocarbons of the gasoline range. The carbon monoxide and hydrogen are prepared from natural gas and oxygen.

Six catalyst testing units have been in operation since the summer of 1944. Details of the investigation up to April 1946 are included in Master of Science Theses by Messrs. J. H. A. Donald, D. Quon, J. D. Lazerte, S. Loshaek, and D. J. Scott.

During this period 17 catalysts were prepared and used in tests which lasted from 6 to 15 weeks for each catalyst. The yield of hydrocarbon products from the tests have been low compared with published yields. However, in tests during the last few months, yields up to 78 grams of hydrocarbons per cubic meter of synthesis gas have been obtained. These compare favorably with yields of between 55 to 100 grams of hydrocarbons per cubic meter of synthesis gas obtained for similar catalysts in other laboratories. Yields are the average of one week's operation.

The first catalysts were tested at an operating pressure of 100 p.s.i. Later catalysts have been tested at atmospheric pressure. The lower pressure has given smoother operation. Furthermore the reduction to the lower pressure does not appear to have changed the catalytic reaction and does give higher yields.

Three types of catalysts have been studied: iron base, cobalt base, and nickel base catalysts. The iron base catalysts tested did not give good yields but this may be due partly to the fact that a carbon monoxide to hydrogen ratio of 1:2 was used instead of the 1:1 ratio recommended for iron catalysts. The only nickel base catalyst tested gave very poor yields and no further work was done on this type. The cobalt base catalysts were the most successful. The highest yields so far obtained were with cobalt catalysts. The two best were: (1) a Fischer type catalyst consisting of cobalt, thorium dioxide and kieselguhr in the proportions of 82:18:100, respectively, and (2) a Hall type catalyst consisting of cobalt, thorium dioxide, magnesium oxide and kieselguhr in the proportion of 100:6:12:200 respectively. A sample of a catalyst now being used with fluid catalytic technique has been received. Preliminary investigations have been made of the properties of this catalyst and of its behaviour in a gas stream.

Three different procedures of reduction, induction and operation of catalysts are being tested. Different types of kieselguhrs are also being used in compounding the catalysts. Hyflo Supercell has been used for most of the catalysts. An untreated natural kieselguhr is now being tried. It is reported that natural kieselguhrs give best results.

A modified Emmett apparatus has been built for measuring the surface areas of catalysts and of kieselguhrs. The modified apparatus allows for the measurement of the adsorption of carbon monoxide and hydrogen on the catalyst, in a reduced or unreduced state and at various temperatures. It has already been shown that the surface area of a reduced catalyst is less than half the area of an unreduced catalyst. The surface area of the catalyst may be related to the activity of the catalyst in the testing unit. A theoretical consideration of the reaction indicates that such a relation may exist, but results so far obtained do not indicate a direct relationship.

Surface areas of the kieselguhrs used in preparing the catalysts have been determined. The "HSC" grade has a surface area of 1.8 sq. m. per gram; the natural kieselguhr "F.C." an area of 22.7 sq. m. per gram and the natural kieselguhr "Snow Floss" an area of 18.8 sq. m. per gram. The natural kieselguhrs with surface areas ten times that of the treated kieselguhrs should result in better catalysts.

S. G. Davis visited the Bureau of Mines at Pittsburgh during the summer of 1946. Many new ideas and improvements in catalyst testing were observed and much information gained on the latest developments in engineering researches now being conducted on the Fischer Tropsch process in the United States.

POPLAR PRODUCTS MARKET SURVEY

A poplar products market survey under the direction of G. W. Govier and A. Stewart, of the University staff, was started in 1946. Information on the markets for poplar was obtained from two sources (a) a survey of Edmonton and Calgary wood using and handling firms, and (b) a survey of firms outside Alberta. In (a) information was obtained by direct interview with between 70 and 80 firms. The questions asked were designed to discover the extent to which Alberta poplar was being used, and the experience of firms in the use of poplar wood. In (b) letters were sent to more than 200 firms, listed in the Canada Trade Index as producers of wood products under 51 product classifications. The letters requested answers to four questions, viz. (1) Do you use poplar wood? (2) Do you distinguish between white and black poplar? (3) Do you expect to use more poplar wood in the future? (4) What properties of poplar wood do you believe are advantageous or disadvantageous for your purpose? Replies were received from 117 firms.

The information secured although far from complete showed that considerable quantities of poplar are used in construction, for making boxes and crates, for grain car doors and as mine props. Poplar has qualities which make it particularly suited for the manufacture of excelsior or wood wool. An increasing quantity is being used in the manufacture of plywood and its use for veneer and plywood appears capable of further expansion. The evidence is against its use for packing foods which are susceptible to taint. Subject to availability and price of other woods, poplar will have a limited use for pulpwood, and in the manufacture of furniture and novelties.

Poplar is generally considered an inferior wood. An increase in the use of poplar has occurred recently but this is attributable mainly to the shortages of other preferred woods. The main markets for poplar are adjacent to areas in which it is produced, but a considerable amount of Alberta poplar is sold outside the Province.

Before a satisfactory supply of poplar can be assured to users, and this is clearly necessary if increased utilization is to be induced, more information must be obtained on the relation between size and such qualities as knottiness, soundness of heart, colour, odor, etc. The methods for seasoning poplar lumber should also be investigated. After the characteristics of available supplies and the best methods for seasoning are determined there remains the problem of grading poplar for the different uses to which it is put. Grading for particular uses may mean a substantial proportion of waste material, thereby adding to the cost of the usable product.

SOILS

The co-operative soils survey programme for Alberta begun in 1945 was continued in 1946. During the year the Dominion Government had seven men doing soils classification work, while the Research Council had four (only two full-time). Five of the Dominion employees were engaged in regular surveys under the direction of W. E. Bowser. W. Odynsky had charge of the Northern Survey. All members of the Research Council soils staff were attached to the northern survey with the exception of one month spent by Dr. A. L. Brown on the Peace Hills sheet. S. J. Kidd, asst. geologist for the Research Council, was attached to the northern party and made a study of ground water supplies in the area.

In the northern project, surveys both reconnaissance and exploratory were made of an area lying east of the Smoky River to include range 21 and extending from the town of Peace River south to include township 73. In the southern part it was only possible to complete the area lying west of the 5th meridian. That portion between the 6th meridian and the Smoky River is as yet incomplete. Information on the nature of the soils was mapped for an area comprising about 900,000 acres.

Traverses were also made in townships 70, 71, 72, and 73, range 19, west of 5th; townships 72 and 73, range 1 and 2, west of 6th; and township 80, range 19, west of the 5th meridian. Surveys were also made of an area north of Fort St. John that was under consideration for purchase under the Veterans' Land Act.

Late in August the Hon. N. E. Tanner visited the northern area, accompanied by Dr. F. A. Wyatt.

It is recommended that the Research Council should in future have sufficient full-time staff that provincial representatives could be attached to regular and irrigation surveys in addition to surveys of special areas.

UTILIZATION OF SAND

A glass industry with an annual production of manufactured articles to a value of approximately $1,500,000 has been established in Alberta for a number of years. This industry seems capable of expansion, particularly if a source of silica sand suitable for glass making could be found in the province. At present the 15,000 to 18,000 tons of sand used in this industry is imported from Illinois. Alberta has numerous deposits of sand but little is known regarding their extent or purity.

Two samples of beach sand collected in 1946 by M. B. B. Crockford, geology, were submitted for preliminary tests to the British Columbia Research Council who are equipped to carry out investigations on glass sands. The work included screening, tabling, magnetic separation and drying tests. In addition small portions of each sand were leached with acid to indicate the extent of the iron coatings on the grains of sand. Other portions were scrubbed with a caustic solution before making the magnetic separations in an attempt to remove and disperse the iron oxide coatings. Samples of the scrubbed and magnetically treated sands were dyed with a deeply coloured aqueous solution of basic fuchsin to indicate the amounts of feldspars present.

Definite conclusions cannot be drawn from the tests regarding the suitability of these sands for use in the glass industry since no chemical analyses were made. However, the tests do indicate that preparation of a low-iron sand from either sample would undoubtedly require acid treatment for removal of the iron coating. This is a rather expensive process and extensive testing would be necessary to establish the costs.

UTILIZATION OF STRAW

This investigation is under the joint direction of O. J. Walker, Department of Chemistry and G. W. Govier, Department of Chemical Engineering. Two aspects of the problem were suggested for investigation: (1) Fundamental research on the properties of Alberta cereal straws, and (2) Methods and economics of baling straw in Alberta. Progress is reported on the fundamental research but due to the critical shortage of agricultural machinery of all kinds it was not possible to procure baling equipment and consequently no progress has been made on the second investigation. A report "Summary of the Pickup Baler Operating Costs" by J. L. Thompson, Agricultural Engineer, Dominion Experimental Station, Swift Current, Saskatchewan, gives much of the information desired in relation to the baling of straw.

Samples of wheat and oat straws were collected from different soil areas in the province with the co-operation of Dr. A. G. McCalla of the Department of Plant Science, University of Alberta. Series I consisted of Thatcher Wheat straws from nine districts and Series II consisted of the straw of three varieties of wheat and of three varieties of oats from five plant test sites of the Department of Agriculture in Northern Alberta.

The samples each weighed about 25 pounds and consisted of complete plants pulled when ripe. Forty to 50 of these plants were chosen on which to carry out the various physical and chemical tests and weighed. The plants were divided into nodes, internodes, chaff, grain and leaf, and the portions analysed separately. The physical tests consist in obtaining the percentage by weight of the different physical portions of the plants, and the measurements of lengths, outside diameters and wall thicknesses of the internodes of ten plants of each sample. The chemical tests will consist of determining holocellulose, Cross and Bevan cellulose, cellulose, pentosans, ligroin, cold water soluble, hot water soluble, 1% alkali soluble, alcohol and benzene soluble, ash and silica of each of the component parts.

The physical tests have been partly completed but owing to lack of suitably trained personnel and of space little progress has been made with the chemical investigation.

ANIMAL CYCLES AND MEASUREMENT OF ULTRA VIOLET LIGHT

Little progress was made during 1946 on the study of Animal Cycles since wire netting for rabbit enclosures was not procurable. However, progress is reported on the measurement of ultra violet light being done in conjunction with the animal cycle project. A Leeds and Northrup recording apparatus with special photocell for the measurement of ultra violet light, was installed by the Research Council at the Dominion Meteorological station at the Edmonton Municipal Airport. Records of ultra violet are thus obtained under the same atmospheric conditions as other meteorological data, which will be an advantage when correlating and analysing the data on ultra violet light.

EDGAR STANSFIELD

Edgar Stansfield, born in Bradford, Yorkshire, graduated in Honours Chemistry from Victoria University, Manchester, B.Sc. 1900, M.Sc. 1903. Following graduation, he taught at Sunderland Technical College, England, until 1906 when he came to Canada to join the staff of the Dominion Iron and Steel Company, Sydney, N.S. He next was employed on the Dominion investigation of Canadian coals at McGill University, 1907-1910. From 1910 to 1921 he was Chief Engineering Chemist, Fuel Testing Division, Bureau of Mines, Ottawa, and in the last four years of this period was also Chemical Engineer to the Lignite Utilization Board. In 1921 Prof. Stansfield was appointed Chief Research Engineer and Honorary Secretary of the newly organized Scientific and Industrial Research Council of Alberta. This position he filled until his retirement in September, 1946.

During his 26 years on the staff of the Research Council his researches on coal have become known nationally and internationally. His scientific work has been a very substantial contribution to building up the prestige of the Research Council of Alberta and to the research attitude now well established within the University of Alberta.

Prof. Stansfield is a member of the Canadian Institute of Mining and Metallurgy, the Engineering Institute of Canada, the Society of Chemical Industry and is a Registered Professional Engineer of Alberta. He was a Canadian representative, and presented a paper to the World Power Conference in London in 1928, and received the Plummer Medal of the E.I.C. in 1937.

A paper to the Manchester Literary and Philosophical Society in 1901 was the first of a long series of contributions to Canadian, English and United States scientific and technical societies and journals and to government reports. A partial list of these publications follows:

PUBLICATIONS OF EDGAR STANSFIELD

1. Preliminary Note on the Preparation of Barium.
Vol. 46, Part I of Memoirs and Proceedings of the Manchester Literary and Philosophical Society, Session 1901-1902. 7 pp. illus.

2. Spontaneous Combustion of Coal.
Journal Canadian Mining Institute, Vol. XIII, 1910, pp. 145-178, illus. Also Mines Branch, Dept. of Mines, Ottawa, Report 83, Vol. VI, pp. 95-120, illus.

3. Two Simple Forms of Gas Pressure Regulator.
Trans. Faraday Society, Vol. VII, Part I, 1911. pp.116-118, illus.

4. An Investigation of the Coals of Canada—Manufacture & Testing of Coke*. Mines Branch, Dept. of Mines, Ottawa, Report 83, 1912. Vol. I, Part VI, pp. 205-233 and Tables XXIX-XLIV, illus. and Vol. VI, Appendix IV, pp. 23-75.

5. An investigation of the Coals of Canada—Work of the Chemical Laboratory. Mines Branch, Dept. of Mines, Ottawa, Report 83, 1912. Vol. II, Part IX, pp. 121-184 and Tables LIV-LXXI, illus. And Vol. VI, Appendix V, pp. 79-93 and Tables XIV-XIX, illus.

6. Work of the Chemical Laboratories of the Fuel Testing Division, Annual Summary Reports, Mines Branch, Department of Mines, Ottawa, 1910-1919. Includes: The Determination of Moisture in Fuels, 1911, pp. 123-137. An Electrically Heated Tube Furnace, 1911, pp. 138-140, illus. Automatic Regulator for Electric Water Still, 1916, pp. 73-75, illus. Nitrogen Distillation Apparatus, 1916, pp. 75-78, illus. Lignite Carbonization*, 1918, pp. 87-106. Lignite Carbonization*, 1919, pp. 30-39. Carbonization of Peat*, 1920, pp. 39-42.
7. Products and By-Products of Coal*.
Mines Branch, Dept. of Mines, Ottawa, Report 323, 1915, 51 pp.
8. The Carbonization of Lignites*.
Part I, Trans. Royal Society of Canada, Series III, 1917, Vol. XI, pp. 85-100, illus. Part II, Trans. Royal Society of Canada, Series III, 1918, Vol. XII, pp. 121-130, illus.
9. Low Temperature Carbonization of Fuels.
Journal of the Engineering Institute of Canada, Vol. I, 1918, No. 1, pp. 19-23.
10. Analyses of Canadian Fuels*.
Mines Branch, Department of Mines, Ottawa, 1918.
Part I, Report 479, The Maritime Provinces, 28 pp.
Part II, Report 480, Quebec and Ontario, 28 pp.
Part III, Report 481, Manitoba and Saskatchewan, 15 pp.
Part IV, Report 482, Alberta and the Northwest Territories, 68 pp.
Part V, Report 483, British Columbia and the Yukon Territory, 24 pp.
11. Principles and Practices of Fuel Briquetting.
Trans. Canadian Institute of Mining and Metallurgy, Vol. XXIII, 1920, pp. 324-335, illus.
12. Carbonization of Canadian Lignite.
Journal of Industrial & Engineering Chemistry, Vol. XIII, 1921, No. 1, pp. 17-23, illus.
13. Work of the Fuels Division*.
Annual Reports (Scientific and Industrial Research Council of Alberta). Research Council of Alberta, 1921-1940. Note: 1936-1940 tabled in Legislature but not yet printed.
14. Notes on the Classification of Coal.
Western Canada Coal Review, January 1922, pp. 23, 24 & 40.
15. A Standardized Method for Air-Drying Coal.
Trans. Canadian Institute of Mining & Metallurgy, Vol. XXVI, 1923, pp. 292-297, illus.
16. The Scientific & Industrial Research Council of Alberta and its More Recent Work.
The Press Bulletin, University of Alberta, Vol. VIII, 1923, No. 17, 4 pp.
17. Appendix 18, First General Report of the Lignite Utilization Board of Canada, 1924, pp. 154-175 and figs. 27-42.
18. A Chemical Survey of Alberta Coals.
Trans. Canadian Institute of Mining & Metallurgy, Vol. XXVIII, 1925, pp. 252-269, illus.
19. Analyses of Alberta Coals*.
Report 14, Scientific and Industrial Research Council of Alberta, 1925, 63 pp.
20. A Study of Post-Carboniferous Coals.
The Transactions of the Fuel Conference (World Power Conference), London, 1928, Vol. I, pp. 54-61.
21. Principles in the Briquetting of Coking & Non-coking Bituminous Coals*.
Proc. of 2nd International Conference on Bituminous Coal, 1928, Vol. I, pp. 508-526, illus.
22. The Classification of Canadian Coals*.
Trans. Canadian Institute of Mining & Metallurgy, Vol. XXXII, 1929, pp. 360-388, illus.
23. The Drying of Wheat*.
National Research Council, Canada, Report 24, 1929, pp. 18-32, 45-65 and 109-113, illus.
24. Determination of Mineral Matter in Coal and Fractionation Studies of Coal*. Trans. American Institute of Mining & Metallurgical Engineers, 1930. Coal Division, pp. 614-626, illus.

25. Yard Sticks for Fuels.
Canadian Chemistry & Metallurgy XIV, 1930, pp. 234-236.

26. Determination of Carbon and Hydrogen*.
Canadian Journal of Research, Vol. III, 1930, pp. 318-321.

27. Oxygen Bomb Calorimeter*.
Canadian Journal of Research, Vol. III, 1930, pp. 464-472.

28. Report by Committee of Enquiry into Motor Fuel & Lubricating Oils in Alberta*. Legislative Assembly of Alberta, Sessional Paper No. 50, 1931, 19 pp.

29. Low Temperature Carbonization of Alberta Coals.
Research Council of Alberta, News Letter to Coal Operators of Province, 1931, No. 6, 3 pp.

30. Composition and Classification of Canadian Coals.
McGill University, Proc. Symposium on Fuel & Coal, 1931, pp. 35-72, illus.

31. Determination of the Alkali-Soluble Ulmins in Coal*.
Trans. American Institute of Mining & Metallurgy, Coal Division, 1932, pp. 165-170. Also, Fuel in Science & Practice, 1932, pp. 347-349.

32. Moisture Determination for Coal Classification*.
Trans. American Institute of Mining & Metallurgy, Coal Division, 1932, pp. 125-147, illus.

33. The Drying of Wheat*.
National Research Council, Ottawa, Report 25, 1932, 104 pp., illus.

34. Oxidation of Coal and the Relation to Its Analysis*.
Trans. American Institute of Mining & Metallurgy, Coal Division, Vol. 108, 1934, pp. 243-254, illus.

35. Effect of Oven Humidity on Accelerated Weathering Tests of Coal*.
Trans. American Institute of Mining & Metallurgy, Coal Division, Vol. 108, 1934, pp. 237-242, illus.

36. The Oxidizability of Coal*.
Fuel in Science & Practice, Vol. XV, 1936, pp. 12-14, illus.

37. Carbonization and Briquetting of Alberta Coals.
Trans Canadian Institute of Mining & Metallurgy, Vol. XL, 1937, pp. 35-44.

38. Classification of Coal & the United States Tentative Standards.
National Research Council, Ottawa, 1937. Mimeographed report, 18 pp.

39. The Burning of Low Rank Alberta Coals—Combustion and Control.
The Engineering Journal, 1937, pp. 545-554, illus.

40. Coal Combustion, Analysis and Classification.
American Chemical Society—Symposium on the Combustion of Solid Fuels. Boston, September, 1939. Mimeographed publication, pp. 41-67 & figs.

41. Humidity Data Expressed in Grains Water Vapour per Pound of Dry Air. Canadian Journal of Research, A 21, 1943, pp. 51-55.

42. Coals of Alberta—Their Occurence, Analysis and Utilization*.
Report No. 35, Research Council of Alberta, 1944, pp. 174.

43. Alberta Coals and Automatic Domestic Stokers*.
Report No. 46, Research Council of Alberta, 1945, pp. 39.

44. Recent Work of the Research Council of Alberta.
Bulletin Canadian Institute of Mining and Metallurgy, No. 406, February, 1946, pp. 81.

Note: * Joint publication.

LIST OF PUBLICATIONS
of
RESEARCH COUNCIL OF ALBERTA
EDMONTON, ALBERTA

ANNUAL REPORTS OF COUNCIL

No. 3 (for the calendar year 1920); pp. 36. **(Out of print.)**
No. 5 (for the calendar year 1921); pp. 86. **(Out of print.)**
No. 8 (for the calendar year 1922); pp. 64. **(Out of print.)**
No. 10 (for the calendar year 1923); pp. 76. **(Out of print.)**
No. 12 (for the calendar year 1924); pp. 66. **(Out of print.)**
No. 16 (for the calendar year 1925); pp. 65. **(Out of print.)**
No. 20 (for the calendar year 1926); pp. 53. **(Out of print.)**
No. 22 (for the calendar year 1927); pp. 49. **(Out of print.)**
No. 24 (for the calendar year 1928); pp. 53. **(Out of print.)**
No. 25 (for the calendar year 1929); pp. 65. **(Out of print.)**
No. 26 (for the calendar year 1930); pp. 76. **(Out of print.)**
No. 27 (for the calendar year 1931); pp. 53. **(Out of print.)**
Nos. 28, 29 and 32 (for the calendar years 1932-1934); pp. 90. **Price 35 cents.**
No. 33 (for 1935); pp. 43. **Price 35 cents.**
Nos. 37-43 (for 1936-1942). Not published.
No. 44 (for 1943); pp. 14. **Price 5 cents.**
No. 45 (for 1944); pp. 18. **Price 5 cents.**
No. 47 (for 1945); pp. 21. **Price 5 cents.**
No. 50 (1946); pp. 28. **Price 5 cents.**

REPORTS—FUELS

No. 10A (1923); COMBUSTION OF COAL FOR THE GENERATION OF POWER, by C. A. Robb. **(Out of print.)**

No. 14 (1925); pp. 64. ANALYSES OF ALBERTA COALS, with 18 maps and 2 charts. By E. Stansfield, R. T. Hollies, and W. P. Campbell. **(Out of print.)**

No. 35 (1944); pp. 174. COALS OF ALBERTA—THEIR OCCURRENCE ANALYSIS AND UTILIZATION, by Edgar Stansfield and W. Albert Lang. In six parts. **Price $1.00.**

Parts I-V—Occurrence, classification, production, special tests, general properties, preparation, utilization and combustion. **Price 50 cents.**

Part VI—Analytical and technical data by coal areas. **Price 50 cents.**

No. 46. ALBERTA COALS AND AUTOMATIC DOMESTIC STOKERS. Edgar Stansfield and Colin A. Genge. **Price 20 cents.**

REPORTS—ROAD MATERIALS

No. 18. THE BITUMINOUS SANDS OF ALBERTA, by K. A. Clark and S. M. Blair.
Part I (1927)—Occurrence, pp. 74. **Price 25 cents.**
Part II (1927)—Separation, pp. 36. **Price 25 cents.**
Part III (1929)—Utilization, pp. 33. **Price 25 cents.**

REPORTS—SOIL SURVEY DIVISION

No. 23 (1930); PRELIMINARY SOIL SURVEY ADJACENT TO THE PEACE RIVER, ALBERTA, WEST OF DUNVEGAN, by F. A. Wyatt and O. R. Younge; pp. 33 and colored map. Scale 1 inch to 4 miles. **(Out of print.)**

No. 31 (1935); PRELIMINARY SOIL SURVEY OF THE PEACE RIVER-HIGH PRAIRIE-STURGEON LAKE AREA, by F. A. Wyatt; with colored map. Scale 1 inch to 4 miles. **(Out of print.)**

REPORTS—GEOLOGICAL SURVEY

By Dr. J. A. Allan, Professor of Geology, University of Alberta.

No. 1 (1919); pp. 104—A summary of information with regard to the mineral resources of Alberta. **Price 25 cents.**

No. 2 (1920); pp. 138+14. Supplements the information contained in Report No. 1. **(Out of print.)**

No. 4 (1921); GEOLOGY OF THE DRUMHELLER COAL FIELD, ALBERTA; pp. 72, and 6-color map (Serial No. 1). **(Out of print.)**

No. 6 (1922, Part I); GEOLOGY OF THE SAUNDERS CREEK AND NORDEGG COAL BASINS, ALBERTA, by J. A. Allan and R. L. Rutherford; pp. 76 and 2-color map (Serial No. 2). **(Out of print.)**

No. 7 (1922, Part II); AN OCCURRENCE OF IRON ON THE NORTH SHORE OF LAKE ATHABASKA, by J. A. Allan and A. E. Cameron; pp. 40; two maps (Serials Nos. 3 and 4). **(Out of print).**

No. 9 (1923); GEOLOGY ALONG BLACKSTONE, BRAZEAU AND PEMBINA RIVERS IN THE FOOTHILLS BELT, ALBERTA, by J. A. Allan and R. L. Rutherford; pp. 48, and 6-color map (Serial No. 5). **(Out of print.)**

No. 11 (1924); GEOLOGY OF THE FOOTHILLS BELT BETWEEN McLEOD AND ATHABASKA RIVERS, ALBERTA, by R. L. Rutherford; pp. 61 and 8-color map (Serial No. 7). One inch to two miles. **(Out of print.)**

No. 13 (1945): GEOLOGY OF RED DEER AND ROSEBUD SHEETS, by J. A. Allan and J. O. G. Sanderson; pp. 125. (Two geological maps in 3 colors.. Scale one inch to three miles. Serial No. 8 Red Deer Sheet and No. 9 Rosebud Sheet). (Out of print). Replaced by Map No. 9A, combination of Maps No. 8 and 9. Scale one inch to four miles. **Price 75 cents.**

Map No. 10 (1925); GEOLOGICAL MAP OF ALBERTA, by J. A. Allan. In 14 colors. Scale one inch to 25 miles. **(Out of print.)**

No. 15 (1926); GEOLOGY OF THE AREA BETWEEN ATHABASKA AND EMBARRAS RIVERS, ALBERTA, by R. L. Rutherford; pp. 29 and 3-color map (Serial No. 11). One inch to two miles. **(Out of print.)**

No. 17 (1927); GEOLOGY ALONG BOW RIVER BETWEEN COCHRANE AND KANANASKIS, ALBERTA, by R. L. Rutherford; pp. 46 and 9-color map (Serial No. 12). Scale 1 inch to 1 mile. **Price 50 cents, or map alone 25 cents.**

No. 19 (1928); GEOLOGY OF THE AREA BETWEEN NORTH SASKATCHEWAN AND McLEOD RIVERS, ALBERTA, by R. L. Rutherford; pp. 37 and 3-color map (Serial No. 13). Scale 1 inch to 3 miles. **Price 10 cents.**

No. 21 (1930); GEOLOGY AND WATER RESOURCES IN PARTS OF PEACE RIVER AND GRANDE PRAIRIE DISTRICTS, ALBERTA, by R. L. Rutherford; pp. 80 and 6-color map (Serial No. 14). Scale 1 inch to 4 miles. **Price 50 cents.**

No. 30 (1934); GEOLOGY OF CENTRAL ALBERTA, by J. A. Allan and R. L. Rutherford; pp. 41 and 10-color map (Serial No. 15). Scale 1 inch to 10 miles. **(Out of print.)**

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