Report No. 55

THIRTIETH
ANNUAL REPORT
OF THE
RESEARCH COUNCIL OF ALBERTA
1949

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The following report, the Thirtieth Annual Report of the Research Council of Alberta, was submitted in March, 1950, 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 Mines and Minerals. 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 Forests and Minister of Mines and Minerals, Chairman.

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

The Honourable Dr. J. L. Robinson, Minister of Industries and Labour.

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 offices and laboratories of the Council are in the University of Alberta. The Secretary of Council is W. A. Lang.

TECHNICAL ADVISORY COMMITTEE

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

Mr. R. M. Hardy, Dean, Faculty of Engineering, University of Alberta, Assistant Director of Research, Deputy Chairman.

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Mr. G. H. N. Monkman, Deputy Minister, Department of Public Works.

Mr. O. S. Longman, Deputy Minister, Department of Agriculture.

Mr. J. Crawford, Director of Mines, Department of Mines and Minerals.

Dr. J. A. Allan, Professor of Geology, the University.

Dr. K. A. Clark, Professor of Metallurgy, the University.

Dr. J. D. Newton, Professor of Soils, the University.

Dr. O. J. Walker, Professor of Chemistry, the University.

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

STAFF OF RESEARCH COUNCIL

The following held full time appointments on the technical staff during the year:

A. McCulloch, Chief Research Engineer, Fuels, to May.

W. A. Lang, Senior Research Chemist, Fuels, and Secretary of Council.

D. S. Pasternack, Research Chemist, Bituminous Sands.

M. B. B. Crockford, Geologist, Geology, to May.

J. S. Charlesworth, Chemist, Gasoline and Oil Testing.

W. Odynsky, Soils Surveyor, Soils.

G. W. Hodgson, Assistant Research Chemist, Bituminous Sand, from October.

J. Gregory, Industrial Engineer.

E. Tipman, Assistant Chemist, Gasoline and Oil Testing.

W. H. A. Clow, Assistant Geologist, Geology.

T. E. Morimoto, Assistant Research Engineer, Fuels, from July.

M. R. Wardle, Assistant Research Chemist, Fuels, from July.

J. F. Fryer, Assistant Chemist, Fuels.

L. G. Barrett, Assistant Engineer, Fuels, from February.

A. C. Bridge, Assistant Research Chemist, Fuels, to April.

E. Sherlock, Assistant Research Chemist, Fuels.

S. J. Groot, Draftsman-Compiler.

The following held full time appointments on the non-technical staff during the year:

Miss K. S. Wark, Accountant-Librarian.

Miss S. M. Mackintosh, Technical Stenographer.

Miss P. A. Paterson, Stenographer.

K. M. Dickinson, Laboratory Assistant, Fuels, to March.

K. A. Horne, Laboratory Assistant, Fuels, March—September.

R. M. Morrison, Laboratory Assistant, Fuels, from October.

R. C. D'Amur, Laboratory Assistant, Gasoline and Oil Testing.

The following held temporary appointments during the year:

D. E. Armstrong, Assistant Economist, Power Project, May 1—September 30.

R. E. McClary, Assistant Electrical Engineer, Power Project, May 10—September 24.

J. Basaraba, Assistant Chemcial Engineer, Bituminous Sand, May 9—September 24.

B. H. Rosenbaum, Assistant Chemical Engineer, Bituminous Sand, May 9—September 24.

G. A. Pengelly, Assistant Chemist, Bituminous Sand, May 16—September 24.

M. Worsley, Assistant Chemist, Bituminous Sand, May 16—September 24.

L. Smitten, Assistant Chemical Engineer, Bituminous Sand, May 1—September 10.

S. Romanchuk, Assistant Chemical Engineer, Bituminous Sand, May 1—September 24.

D. E. Duff, Assistant Field Geologist, Geology, May 1—September 28.

G. L. Colborne, Assistant Field Geologist, Geology, May 13—September 28.

A. Wynnyk, Assistant Soil Surveyor, Soils, May 1—September 30.

E. J. Evans, Assistant Soil Surveyor, Soils, May 1—June 25.

H. N. Hart, Assistant Soil Surveyor, Soils, May 16—September 24.

C. J. McAndrew, Assistant Soil Surveyor, Soils, May 1—September 30.

R. P. Stone, Assistant Soil Surveyor, Soils, May 9—September 30.

K. J. Spread, Assistant Soil Surveyor, Soils, May 1—September 30.

M. D. Scheelar, Assistant Soil Surveyor, Soils, May 1—September 30.

Bernard Hughes, Cook, Soils, May 1—September 30.

A. Baracos, Civil Engineer, Highway Research, June only.

H. Atkin, Assistant Civil Engineer, Highway Research, June 1—July 31, September 15 - 30.

K. S. Goodman, Assistant Civil Engineer, Highway Research, June 1—July 31, September 15 - 30.

R. W. Losie, Technician, Highway Research, June 6—July 31, September 15 - 24.

F. J. Wyatt, Cook, Geology, June 1—September 16.

Miss A. Mackenzie, Statistician, Straw Project, November 1—December 31.

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

Dr. J. A. Allan, Geology.

Dr. K. A. Clark, Bituminous Sands.

Dr. E. H. Gowan, Measurement of Ultra Violet.

Dean R. M. Hardy, Highway Research.

Prof. J. A. Harle, Power Project.

Dr. J. D. Newton, Soils Surveys.

Dr. W. Rowan, Animal Cycles.

Prof. A. Stewart, Power Project.

Dr. O. J. Walker, Utilization of Straw.

ANNUAL REPORT

OF THE

Research Council of Alberta

1949

This report summarizes the work of the Council for the calendar year 1949. Most of the investigations followed the pattern of previous years. The work on bituminous sand was largely in connection with the Oil Sands Project of the Provincial Government at Bitumount, Alberta. New investigations in fuels include a study of the cleaning of fine coal and extraction and characterization of the humic materials in coal. The geological surveys were curtailed but included a detailed survey of the Carbondale area and a water survey of the Macleod sheet. Good progress was made in the soil surveys of the Peace River district and a report and map of the Rycroft-Watino Area will be ready for printing early in 1950. Further investigations were made into the cause of failure of provincial highways and of methods of road construction which will minimize failures. A survey was undertaken to ascertain the comparative costs of power generation from coal steam, gas steam, gas turbine, gas internal combustion, oil steam, oil Diesel, and hydro power. The work on the utilization of straw was limited to a compilation and analysis of the data obtained in previous years by the chemical analysis of various straws. Little progress was made on the Biological Cycles project because of the continued scarcity of snowshoe rabbits. The Industrial Engineer maintained close liaison with various departments of the government and with industrial development within the province.

Reports and Mimeographed Circulars published during the year include:

Report No. 52—Geology of Ribbon Creek Area.

Report No. 53—The Role of Very Fine Mineral Matter in the Hot Water Separation Process as Applied to Athabaska Bituminous Sand.

Report No. 54—Annual Report of the Research Council of Alberta for 1948.

Mimeographed Circular No. 5—Poplar Market Survey.

Mimeographed Circular No. 6—Occurrences of Common Salt in Alberta.

Mimegraphed Circular No. 7—Geology of the Peace River Glass Sand Deposit.

Mimeographed Circular No. 8—Alberta Motor Gasoline Survey 1949.

In addition, members of the staff have contributed a number of technical papers to the scientific literature. Master of Science Theses were submitted to the University of Alberta by two junior members of the staff of the Council. A list of the major publications

of the Council since its inception is given as an appendage to this report.

Acknowledgment is here made of the retirement from the work of the Council of Dr. J. A. Allan who was one of the original group associated with Dr. H. M. Tory in launching the Council's program in 1919. He was in charge of the geological part of this program from its inception until his retirement in 1949. Under his authorship or joint authorship many important reports and technical papers on the geology and resources of Alberta have been made permanently available to those charged with responsibility for fostering the development of the province.

Thankful acknowledgment is also made of the co-operation and financial assistance extended to the Council by five coal companies and four oil companies in connection with the briquetting investigation.

BITUMINOUS SANDS

Operations at Bitumount

Bituminous sand studies for the year were centred on the operation of the separation plant at Bitumount. The Council has been closely associated with, but not responsible for, this project from its start. Its role has been to be helpful. It has equipped the laboratory at the plant and, during the 1949 season, it provided a laboratory staff of six student engineers and chemists working under the supervision of a member of the permanent staff. The laboratory made the routine analyses required for plant operation and collected all data that there were opportunity to get on plant performance.

The construction of the Bitumount plant was not sufficiently complete for trial operation until late in the fall of 1948. When operation was attempted, some unsatisfactory features were revealed. The inclined screw conveyor for removing tailings from the separation cell failed to function. This difficulty was remedied by a simple alteration in the design of the conveyor. Difficulties with the device for skimming oil froth from the separation cell, with the vessel for settling sand from the separated oil, with the settler for cleaning the circulating plant water and with the pumps for pumping separated oil to the refinery area then came to view. The Research Council assisted in devising solutions for these difficulties. A simple paddle wheel was substituted for the original cumbersome skimming device and the discharge end of the separation cell was modified. Denver Spiral Rake Thickeners were substituted for the former plant water settling tank and for the settler for removing sand from the separated oil. A Moyno pump was installed for pumping the separated oil to the refinery. These changes were made during the winter and early spring.

Operation of the plant in 1949 was commenced toward the end of May. The new equipment functioned well and overcame the difficulties that had been encountered the previous fall. New difficulties arose. They were due, in the main, to the inevitable problem of operators getting acquainted with a plant that was new to them and learning how to keep out of trouble with it. It was not until late in August that all the pitfalls had been discovered by falling

into them. From then until the plant was closed down at the end of September, operations proceeded smoothly.

At no time during the season was the entire plant operated simultaneously. The procedure followed was to run the separation plant until the supply of diluent was exhausted and then to run the refinery to get the diluent back into storage. The reason for this procedure was twofold. In the first place there was little use trying to run the separation plant and the refinery together when trouble was being had with each of them by itself. In the second place, the staff of operators was insufficient to man the entire plant for continuous operation. Efforts to secure a sufficient number failed.

Since the main preoccupation during most of the season was to get the plant running smoothly and since the separation plant and refinery ran intermittently for periods of around five days, there was not much opportunity for getting the operational data required for definitely showing the capabilities of the plant. However, results of the thousands of laboratory analyses and tests that were made in the course of routine work are indicative of what the plant can do. These data have been reviewed and an interpretation of them is in the files of the Research Council.

A few figures about plant performance that are of general interest can be stated. The bituminous sand put through the plant during the season contained about 12% oil by weight. The quarry as developed so far gives access only to the top beds of the deposit. Lower beds contain several percent more oil. But there is no evidence for expecting that the feed to the plant will exceed 15% of oil. Throughput was approximately 500 tons per 24 hours. The primary recovery of oil in the form of wet crude oil was 90%. This oil contained as little as 4.5% of mineral matter when conditions in the plant affecting cleanliness of separation were at their best (they were never really good) and rose above 10% only when conditions were distinctly poor. The water content of the crude oil varied between 25 to 45%. The dehydration unit removed the water and reduced the mineral content to less than 3%. (When the mineral content of the crude separated oil is around 4.5%, this content consists mainly of clayey material which settles very slowly.) There was a loss of oil in the dehydration unit due to emulsion formation. Due to the plant set-up, it was not possible to measure this loss with any degree of accuracy. It appeared to be about 6%.

The function of the refinery was, simply, to recover the diluent that was mixed with the wet crude oil in the dehydration unit and to provide fuel oil for the power plant. Refining of the bituminous sand oil was not under study. Once the proper operating conditions for the refinery were determined, it gave no particular trouble. The problem was to get all the diluent back along with some new diluent for makeup and at the same time to produce a fuel oil that was not too heavy to handle in the fuel oil lines that had been installed. The diluent supply decreased during the first refinery runs but the season ended with more diluent on hand than at the beginning. The fuel oil stock increased almost to the point of embarrassment.

The outcome of the season at Bitumount constitutes a distinct advance beyond what has been accomplished heretofore in bituminous sand separation plant design and operation. The design of the Bitumount plant proved to be sound and practical. When the operating staff had acquired the necessary experience, the plant ran continuously until it was shut down voluntarily. While it is true that the whole plant was not run simultaneously, it was only the lack of operators that prevented this being done and continued indefinitely. The completeness of the separation of sand from oil was far in advance of that shown by any former plant. The reduction of diluent losses to an amount well below the production of new diluent from crude bituminous sand oil by the simple topping refinery was a result that had not been reached before. It is still necessary to establish the cost of production of oil by the method used in the Bitumount plant. It is also desirable that a more thorough study of the detailed performance of the plant under best operating conditions be made than was possible during the past season. The reaching of these objectives, however, should be just straightforward work now that any uncertainty about the effectiveness of the process and plant has been removed.

Percent of Voids and Percent Saturation with Oil and Water of Bituminous Sand in the Bitumount Quarry.

Quarrying operations at Bitumount and laboratory facilities close at hand presented the opportunity for determining the percentage of voids and the percent saturation with oil and water of undisturbed bituminous sand in about twenty feet of beds exposed in the quarry face. A summary of results obtained is as follows:

Specific Gravity of the bituminous sand varied between 2.03—2.08. Consequently a cubic yard of bituminous sand in place in the quarry weighs about 3,450 lbs.

Total Voids vary between 33.0—35.5% of the volume of the undisturbed sand.

Total Saturation of the voids of undisturbed bituminous sand with both oil and water varies between 86.5—91.5%.

Percent Water Saturation varies between 3.5—14.5%.

Percent Oil Saturation varies between 72—86%. When water saturation is high, oil saturation is downward in this range.

On the basis of these results, one would not expect the oil content of bituminous sand from the Bitumount quarry to rise above 15.5%. Only a few analyses have shown a larger oil content than this. They are to be explained either by more complete saturation of the void space than has been found, so far, by direct determination, or by a local disturbance of the natural packing of the bituminous sand resulting in increased space and enrichment of the oil content by seepage from adjoining beds.

Appearance is a misleading criterion for judging the richness of bituminous sand. If the voids are well filled with oil the bituminous sand looks rich. Also the larger the sand grains and, consequently, the larger the individual void spaces, the richer the sand appears to be. The amount of oil that can be present is determined by the void space. Bitumount bituminous sand looks richer than sand from the Abasand quarry near McMurray. Yet analyses of

Abasand samples generally showed oil contents greater than 16%. The sand grains in the Abasand bituminous sand are finer than those at Bitumount and the void spaces are about 40% of the volume of the sand.

FUELS

Work undertaken in 1949 on solid fuels includes chemical and physical studies of coal, upgrading of bituminous and subbituminous coal, cleaning of the finer sizes of coal and the extraction and characterization of humic materials in coal. Requests for information on a large number of topics related to fuel technology have been received and answered.

The securing of up-to-date information on the coals mined within the province, an important function of the Council, was realized by chemical and physical examinations of channel samples of coal submitted by Provincial Mines Inspectors when new mines were opened and when mining had advanced to new locations in mines which already had been sampled. In addition, coals were obtained by the Council for special investigations. These and/or various fractions of them require to be analysed. Samples of coal from consignments purchased by the Federal Department of National Defence were also tested. The silica content of a number of rock dusts, submitted by the Provincial Mines Inspectors, was determined in order to assess the silicosis hazard of these dusts.

The graphical studies of coal referred to in the Annual Report for 1948 were completed. Arising from the results of the graphical treatment of analytical data on Alberta coals, and from reflectivity measurements of Dr. C. A. Seyler in England, a series of experiments were conducted to determine the reflectivity, density and porosity of certain selected coals. Measurements of reflectivity were carried out on both polished blocks and powdered specimens: unfortunately, because of the necessarily unrepresentative nature of the block samples, it was not possible to accurately compare the results of the two methods. The results of these measurements, however, served to confirm the observation of other workers that reflectivity increases with the rank of coal. Also there were some indications that the change is stepwise rather than continuous, which tends to confirm measurements made by Seyler. It was not found possible to use measurement of reflectivity for purposes of classification.

Determinations of the density and porosity of certain coals led to the evolution of an equation relating true specific volume to ultimate composition. Porosity measurements, together with partial evaluation of the distribution of pore size, led to the envisagement of the fine structure of coals as a collection of large flat molecules, separated by fairly rigidly defined distance into layer planes, the spaces being permeable to fluids. Such a conception agrees with the conclusions of workers in the X-ray examination of coals. A linear relation was also found between "fine" porosity and powder reflectivity, indicating that, if reflectivity varies in a stepwise manner with rank, it seems probable that fine porosity must also do so. This provides an explanation for the stepwise change in capacity moisture content previously noted. It has been found possible by means of the conception that periodic, step-

wise change occurs in the lattice dimensions of coal crystallite, to link a number of hitherto unrelated observations on the physical properties of coals—properties such as density and porosity, moisture content, reflectivity and crystal structure.

An investigation of the solvent extraction of both "natural" and "regenerated" humic materials from Alberta coals, with a view to determining their characteristics and possible uses, has been initiated. It is hoped that the results of this work may throw new light on the fundamental structure of coal. The initial work is being done on subbituminous coals but the work may be extended to include other ranks of coal. Preliminary results indicate that Alberta subbituminous coals, even when weathered, contain only small amounts of acetone-water soluble humic acids, but that oxidation with nitric acid produces considerable amounts of soluble material. Both weathered and unweathered coals have also been extracted with aqueous ammonia. Unweathered coals give only negligible quantities of soluble material, while weathered coals give up to 50 percent yield of material soluble in ammonium hydroxide. The techniques of paper and column chromatography have been used to separate the extracted humic compounds. The results to date have been encouraging and the properties of pure compounds isolated indicate a close relationship to humic bodies.

The investigation of the upgrading of the fines of non-coking and coking bituminous coals by briquetting, and of blends of non-coking subbituminous coal and coking bituminous coal by briquetting and carbonization was continued. Raw and carbonized briquettes were examined for abrasion loss in the rattler tests, for shatter index in the drop test, and for crushing strength in the compression test. A retort capable of carbonizing batches of 50 pounds of briquettes was built and used.

A study of the properties of asphalts in relation to their use as a binder in coal briquetting was completed. Fourteen asphalts, with varying properties, and obtained from four oil refineries, were tested with four bituminous coals. The results indicate that the most important property of an asphalt briquetting binder is its penetration over the range of temperatures to which the briquette will be exposed during storage, transporation and handling. If the penetration is too low, the briquettes will be brittle and will break and abrade during handling. If the penetration is too high, the briquettes may soften and deform, and may stick together. While the viscosity of the asphalt may not be important as far as mixing is concerned, it may be of considerable importance with regard to ease of unloading from a tank car, and the facility with which it can be pumped from storage to the mixing chamber at the briquetting plant. It was not possible to draw conclusions regarding the importance of ductility or softening point. Insufficient data were available to evaluate, comparatively, the merits of asphalts made from virgin stock and asphalts made from cracked stock.

The study of factors operative in hindered settling, such as occurs for example in jigwashing, was completed. In this investigation experiments were carried out on teetering beds of sand, galena and coal in order to establish experimental data as a basis for correlation with published work on fine settling and fluidization.

The coal cleaning investigation was extended to include the cleaning of the finer sizes of coal. Tests have been made to establish the effect of close sizing on the efficiency of separation of the clean coal and refuse, and to assess the moisture-holding capacity of various sizes of coal. Arrangements are being made to obtain a Driessen Cyclone and to investigate the feasibility of cleaning a number of typical Alberta coals with this equipment.

Information on the dustproofing of coal was collected and submitted to a number of coal operators. Work was also done on producing a balled fuel from fine coal.

Visits were made to a number of coal mines and coal preparation plants in the Province and problems related to the mining, preparation and marketing of coal discussed with the operators. Close liaison was maintained with the Provincial Mines Branch, Department of Mines and Minerals; the Fuels Laboratory, Department of Mines and Resources, Ottawa, and the Dominion Coal Board. The Coal Briquetting Conference, sponsored by the Natural Resources Research Institute, University of Wyoming at Laramie, was attended.

Thankful acknowledgment is made of the co-operation and financial assistance extended to the Council by Brazeau Collieries Ltd., The Canmore Mines Ltd., Luscar Coals Ltd., West Canadian Collieries Ltd., Black Nugget Coal Co. Ltd., The British American Oil Co. Ltd., Imperial Oil Ltd., Excelsior Refineries Ltd., and Husky Oil and Refining Co.

GASOLINE AND OIL TESTING

The Gasoline and Oil Testing Laboratory continued its investigations of aviation and motor gasolines, Diesel fuels, lubricants and associated products during 1949. As in former years a considerable volume of the testing was done for the Dominion Department of Natural Defence and for Departments of the Government of Alberta. The commercial testing of petroleum products increased both in variety of material and in numbers of samples.

A detailed report, Mimeographed Circular No. 8 entitled "Alberta Motor Gasoline Surveys 1949," was printed for distribution. The report, based on the analysis of 145 samples of gasolines purchased from retail gasoline filling stations, indicates the qualities of motor gasolines sold in Alberta during the year.

A survey of lubricating oils was commenced in 1949 and for this investigation some 75 samples of various oils were obtained from retail dealers. In addition to the regular specification tests for quality all samples were examined spectroscopically for identification of addition compounds. The analytical results will be examined and studied in relation to the Canadian Government Specifications for lubricating oils.

Technical assistance was given to the Department of Industries and Labour in the revision of the Alberta Standards Specifications for Motor Gasolines. Close liaison was maintained with the Petroleum Sub-Committee of the Canadian Government Specifications Board, and with the Associate Committee on Petroleum Research of the National Research Council in the field of petroleum testing

and products specifications. The Research Council of Alberta has official representation on both of these committees.

A research project covering one phase of a low-temperature lubrication investigation was undertaken in co-operation with, and financed by, the Dominion Government Department of National Defence. This project has been completed and a confidential report submitted to the sponsors of the project.

GEOLOGY

The Chief Geologist of the Council resigned May 1, 1949 to take a position with The Petroleum and Natural Gas Conservation Board, Province of Alberta. This somewhat curtailed the work that had been planned for the year. However, a detailed geological survey was made of the Carbondale area and a water survey in the Macleod area.

Carbondale Area

The Carbondale area is bounded on the north and south by township 7 and township 4 respectively and lies west of range 2, west of the 5th meridian and extends westward to the British Columbia border. The map area is adjoined on the north by the Blairmore area, mapped by W. W. Leach (1912) and B. Rose (1915), and on the east by the Beaver Mines sheet, mapped by C. O. Hage in 1940.

The Mesozoic strata of the area was studied in detail with special attention being given to the coal-bearing Kootenay formation. The Jurassic and Cretaceous periods of the Mesozoic era are represented in the area by the following formations.

Mesozoic	Upper Cretaceous	Bearpaw—marine shale — carbonaceous layers and boistrome
		Belly River—sandstone and shale
		Wapiabi—marine shale with sandstone bands
		Bighorn—sandstone and shale
		Blackstone—shale
	Lower Cretaceous	Crowsnest Volcanics—igneous rocks with interbedded ash and reworked volcanic beds
		Blairmore—sandstone and shale
		Kootenay—sandstone, shale and coal
	Jurassic	Fernie—shale and sandstone

Due to the thick glacial mantle which covers the area, bedrock outcrop is only observed on the older stream channels and highest ridges. All horizons from the Bearpaw to the Fernie were observed and mapped. The area includes Precambrian and Paleozoic formations which were observed but not studied in detail.

Structurally the territory is complex. The Precambrian and Paleozoic formations are thrust over the Mesozic strata. The Mesozoics are shoved into a series of faults and folds which have a north

to north-westerly trend and which now are eroded to form ridges with this same general direction.

Coal has served as the sliding surface for much of the faulting and therefore the seams do not express themselves on the surface. Drilling should reveal pockets of coal at depth. One Kootenay seam is being strip-mined by the West Canadian Collieries.

A report and map on this area are in preparation.

Macleod Area

Twelve days were spent, at the beginning of the field season, in surveying the area included in the Macleod sectional sheet. This area lies between townships 8 and 17, ranges 15 and 30. The principle centres of population are Lethbridge, Macleod, Taber, Claresholm and Nanton.

The survey determined present water levels and noted that it is difficult to obtain a suitable supply in the eastern and north-eastern portion. The water that is obtained from bedrock, including the Milk River aquifer, is not potable. Upon request, the water supply of the village of Hillspring was investigated and certain recommendations made to the village council.

It was recommended to the Technical Advisory Committee of the Council that the type of survey carried out in the Macleod area was not of great value unless followed by a more detailed survey in the localities where water supply difficulties existed.

Geological Reports

During the year Report No. 52, "Geology of the Ribbon Creek Area," was printed and distributed. A report on salt deposits of Alberta and one on the Peace River sand deposits have been published as Mimeographed Circulars No. 6 and No. 7 respectively. Data have been compiled on the clay deposits of Cypress Hills and a report is pending. The data obtained by the water survey of the Rainy Hills area have been prepared in report form but the report has not been published as it was felt the number of requests for this information did not warrant the issuing of a report. The information on water supply in the Blackfoot and Macleod areas has been compiled and filed for reference purposes.

Acknowledgments

Acknowledgment is made of the assistance rendered by the Petroleum and Natural Gas Conservation Board in allowing M. B. B. Crockford to give general supervision to the geological survey; of the assistance given at all times by Dr. J. A. Allan, Department of Geology, University of Alberta and of the cooperation of Mr. T. W. Dalkin, Superintendent, Technical Division, Department of Lands and Forests.

HIGHWAY RESEARCH

A three-man party was engaged in field work during the summer months. They continued field studies on compaction problems on several new construction projects. A survey was also conducted of the conditions existing at the sites of two major slides which occurred in the Valley of the Pembina River on the No. 16 Highway west of Edmonton. One series of load bearing tests on a pavement on a silty type of soil was also run.

The program was extended into Saskatchewan and Manitoba for a two-month period. Work was conducted on four projects, two in each of the Provinces of Saskatchewan and Manitoba. The work in these Provinces was financed by grants from the National Research Council, the Canadian Construction Association and the Prairie Roadbuilder's Section of the Canadian Construction Association.

Laboratory work on the analysis of soil samples has been continued and a detailed analysis of five projects has been completed. Work on the remainder of the data is still in progress.

The results from one project on which the field work was done during the summer of 1948 were reported to the Annual Meeting of the Canadian Good Roads Association incidental to the presentation of a paper entitled "The Compaction of Soils." These results precipitated a very interesting and thorough discussion.

The results of the projects on which analyses have been completed emphasize the advisability of careful moisture control on compaction jobs. They also show very markedly the advantage in increased quality of highway foundations which results from field compaction. A number of interesting points are also evident with respect to the inspection and control of compaction procedures during compaction. The relative merits of different types of compaction equipment are also indicated.

The results of the four projects covered in Manitoba and Saskatchewan were presented to the Annual Meeting of the Prairie Roadbuilder's Section of the Canadian Construction Association in Regina in January, 1950. A final report on all projects is now in process of preparation and will be available very shortly for distribution to all of the sponsoring organizations.

INDUSTRIAL PROJECTS

The Industrial Projects section continued its assistance to government departments in encouraging industrial development within the province. Reports were prepared for the Department of Economic Affairs on the feasibility of establishment of such industries as oil expelling, cement manufacture, calcium carbide manufacture, paint and varnish making and the utilization of straw for chemical cellulose. Assistance was rendered the Provincial Industrial Development Board in drafting replies to inquiries from interested industrialists on possibilities of manufacture in Alberta of brick and tile, fertilizers, beet sugar, establishment of knitting mills and metallizing industries. The Industrial Engineer participated in the Advisory Committee in investigating, for the Alberta Industrial Corporation, the advisability of extending loans to a number of applicants. Follow-up visits were maintained to check on the operations of the developments.

Requests for technical information from individuals and industry are continually received. Nearly one hundred such requests were dealt with during the year.

A number of inspection trips and visits to industrial plants in Alberta were made during the year. Such visits serve to promote better acquaintance with industry and encourage it to make wider use of existing technical information.

ELECTRICAL POWER DEVELOPMENT AND COST STUDY

During 1946 approximately 600 million kilowatt-hours of electrical energy were sold in Alberta to the following consuming groups:

Large and small power users	68%
Domestic Service	16%
Commercial light	14%
Street lighting and miscellaneous	2%

From a study of past consumption curves it was estimated that the energy required in 1955 will be 745 million kilowatt hours. Allowing for line losses of 12%, net generation in 1955 would be 845 million kilowatt hours. Even with a higher use factor, total capacity will have to be increased from its present level of 146,000 KW's to 193,000 KW's, an increase of 47,000 KW's.

In 1946 about 56% of the power was generated by hydro plants, 42% by steam stations and 2% by diesels. These percentages may not be normal because of a water shortage in that year. Hydro has in the past supplied from 60 to 65% of net generation.

It must be kept in mind that the following results include only the cost of generation and transmission. They do not include a cost for distribution which will be practically the same for any locality whether the power is supplied by a local plant, or from a remote station by transmission line.

For small isolated loads of about 5 million kilowatt hours per year or under, supplied by generating installation of 2,000 kilowatt capacity or less, diesels generally provide the cheapest source of power (barring, of course, the situation where steam generation can be coupled with heating or the supplying of process steam). A summary of the generating costs of diesel stations of different sizes follows.

Plant Class	A	B	C	D
Capacity (KW)	40	75	300	2500
Net Output (KWHr's)	0.1 million	0.2 million	1 million	10 million
	Costs given in mills per kilowatt-hour			
Fuel	19.	16.	11.5	10.75
Labour	3.5 *	2.5 *	5.0 **	2. **
Lubrication	3.	2.	0.5	0.5
Maintenance	6.5	5.5	2.5	1.5
Miscellaneous	2.	1.75	0.75	0.25
	34.0	27.75	20.25	15.0
Interest and depreciation	20.	17.	10.5	8.0
	54	44.75	30.75	23

* Unattended Plants.

** Continuously attended Plants.

The generation of power using steam results in charges as summarized in the table below:

Plant Class	E	F	G
Capacity (KW)	3000	10000	50000
	7 million	40 million	200 million
	Costs given in mills per Kilowatt-hour		
Labour	5.0	1.5	0.7
Fuel (Standardized at $.15 per million B.T.U.'s)	6.0	3.2	2.5
Maintenance	1.2	1.2	.6
Water and Supplies	1.3	.2	.2
Depreciation	1.7	.8	.8
Return on Capital	3.4	1.6	1.6
Total Charge	18.0	8.5	6.4

From this table it is seen that fuel represents about one-third of the total cost of generation. Depreciation and interest charges per kilowatt-hour are relatively independent of capacity but are somewhat lower for larger plants because of the higher use factor of the generating equipment in such plants.

The fuel costs above are based on a standard charge of $0.15 per million b.t.u's which is equivalent to the following fuel prices.

$2.67 per ton for 8,000 b.t.u. per lb. slack coal. (As from Drumheller. Current price $1.55 delivered at plant.)

$0.13 per M.C.F. per 900 b.t.u. per cu. ft. gas. (As from the Viking-Kinsella field. Current price $0.115 to $0.120 per M.C.F. delivered at Edmonton.)

$0.028 per gal. for 18,500 b.t.u per lb. bunker oil. (As from the Edmonton refinery. Current price $0.0675 per gallon at refinery.)

The cost of hydro power generation (following) indicates that the water power development in this province has resulted in cheap power. The use of storage has made the Bow River a good power stream and it will continue to provide cheap power until fully developed. At present about 32% of the estimated ultimate development of 500,000 H.P. (320,000 KW) has taken or is taking place. However, when it comes to the use of other waterways, unless projects such as irrigation can be included, the costs of water power will probably be somewhat higher.

Hydro costs are summarized as follows:

Labour, Maintenance, Supplies and Expenses	0.51 mill
Interest Charges on Investment	1.63 mills
Depreciation Charges	0.54 mill
Total production cost	2.68 mills
Overall average transmission charge (100 miles)	2.7 mills
Total Charge	5.4 mills

In all the foregoing cost summaries, the interest charge was based on a fair return on capital of 6%. Depreciation was calculated on the average life expectancy of the plant and equipment. Labour costs were standardized in the case of diesel plants on the basis of time and wages allowed while fuel costs were standardized in the case of both steam and diesel installations on the basis of cost per unit of fuel. Other costs such as maintenance etc. were taken on the average of those reported by different companies.

This study has indicated that, for very small loads, diesel generation provides the most inexpensive power, that for larger loads hydro is usually the cheapest but will be approached by the cheap power of gas-steam plants.

Of the fuels, gas is undoubtedly the key to the cheapest power, with oil and coal following in an order determined by price, b.t.u. content, thermal efficiency, and savings in labour, depreciation and capital. Lately the advantage seems to be in favour of oil.

The advantage of interconnections and a division of capacity between hydro and steam has been frequently demonstrated during this study.

In considering the foregoing summaries, it must be remembered that a local steam plant can be built up as the local load develops, whereas a bulk supply from a hydro station located at a distance may mean the incurring of the major portion of the capital investment before the load can be built up. The investment charges during the initial stages of development, then, might result in an entirely different cost ratio between the two situations.

SOILS

During the summer of 1949 the McLennan and High Prairie Sheets (in townships 70 to 80 and ranges 14 to 20, west of the 5th meridian) were completed, and a start made on the Sturgeon Lake Sheet (in townships 70 to 74 and ranges 20 to 26, west of the 5th meridian). The area surveyed consisted of the north-west portion of the McLennan Sheet, the south half of the High Prairie Sheet and the south-east portion of the Sturgeon Lake Sheet, comprising in all about 700,000 acres of land. The areas consist of grey podsolic and degraded black soils that have a light to heavy fire-killed tree cover and an appreciable extent of moss peat bogs. For the most part the areas are not readily accessible by car and much of the summer's work was done by wagon and saddle horses. Probably at least half of the High Prairie Sheet consists of arable land.

In addition to the above, the incompleted portions of the Rycroft and Watino Sheets were surveyed, and a considerable amount of checking was done in this area preparatory to the publication of the Soil Map and the Soil Report this winter.

A large part of the High Prairie Sheet is at present withheld from settlement, and recommendation will be made to the Department of Lands and Forests to alter some of the boundaries of the area at present withheld from settlement.

Early in May the Senior Alberta Soil Surveyor went with Department of Agriculture officials to assist in the preparation of a farm management plan for a typical farm in the Donnelly district. On his return he went to Southern Alberta to familiarize himself with the detailed survey work being done in the areas now being considered for irrigation. The classification system of rating soils for irrigation purposes were studied and compared with those used by the U.S. Bureau of Reclamation. Representatives of the United States Reclamation Service accompanied the Alberta representatives on a tour of the Alberta and the Northern Montana

projects that are being considered by the International Water Commission.

During the latter part of June and early July, the Senior Surveyor attended the A.I.C. Convention at Vancouver and participated in a panel discussion of the use of power machinery in land improvement. Immediately after the convention he left on an international soil survey correlation trip through parts of British Columbia and Washington. Representatives of the U.S.D.A., the Dominion Experimental Farms Service and provincial soil surveys made the trip for the purpose of studying and classifying various grey wooded, brown podsolic and grey-brown podsolic soils.

In the latter part of July a very broad reconnaissance survey was made by the Senior Soil Surveyor of the part of Alberta that is adjacent to the Grimshaw-Hay River highway and that in the vicinity of Fort Vermilion. Representatives of the Dominion Experimental Farms Service were the other members of the party on this trip. There would appear to be very little potentially arable land north of the Upper Hay River post. However, south of there and particularly in the vicinities of Fort Vermilion and Keg River there is a very appreciable acreage of potentially arable land. Following this trip, the senior soil surveyors from Ottawa, British Columbia and Alberta made a trip to check and correlate the soils of the Peace River block in B.C. with those in the area now being prepared for publication. Some time was also spent in checking over portions of the area completed this year.

During July the Associate Director of the U.S. Soil Survey at Washington, visited Alberta together with soil survey correlators from the Great Plains and Pacific Coast regions of the United States. Representatives of the Alberta Soil Survey accompanied them on an inspection trip into the grey wooded soil zone, southwest of Edmonton. It seems likely now that these grey wooded soils will be recognized by the U.S. Soil Survey as a previously unrecognized Great Soil Group. In late July the Head of Soil Surveys in Britain visited Alberta and was accompanied on a soil inspection trip by representatives of the Alberta Soil Survey.

Early in September the Administrator of Alberta Soil Surveys made a soil survey inspection trip in the Peace River district, and spent a few days at the soil survey camp near Snipe Lake, inspecting that area. He observed that the survey was being carried on efficiently.

Several visits were made by the Senior Soil Surveyor, for the Department of Lands and Forests, to the Wanham clearing project for the purpose of checking the area which is proposed for future operations.

Since the submission of the last progress report the soil map and the soil report for the Rycroft and Watino sheets have been revised. They will require further checking and revision to incorporate some of the recent suggestions made by the national Soil Survey Committee. Every effort will be made to get this material ready for publication this winter. In addition a start will be made in preparing the soil map and report of the McLennan-High Prairie area.

Soil survey field work was carried on actively in 1949 by the Dominion Department of Agriculture soil surveyors in three areas. These were: (a) St. Mary irrigation project, (b) Red Deer Sheet, and (c) Brazeau and Rocky Mountain Sheets.

In connection with the St. Mary project, approximately 45,000 acres were covered by detailed reconnaissance survey, and 100,000 acres by reconnaissance. The reconnaissance survey covered all the unsurveyed portion of the project. This was for the Waterton-Belly reference of the International Joint Commission. The checking of the Red Deer sheet was completed and the report is being prepared for publication. Reconnaissance and broad reconnaissance surveys were continued on the Brazeau sheet and along the northern side of the Rocky Mountain sheet; in all approximately 1,400,000 acres were mapped.

In addition, the Senior Dominion Soil Surveyor assisted with several smaller projects, as follows: (a) assisted the Dominion Forestry Service in their soil survey of the Kananaskis Forest Experimental Station; (b) spent a week in the Cranbrook area assisting in an appraisal of that portion of the Rocky Mountain trench that would be affected by the Columbia reference of the International Joint Commission; (c) attended meetings of the Engineering Committee of the International Joint Commission at Calgary and Fort Peck, and made field trips in the vicinities of Taber and Shelby to correlate the systems of land classification used by the two countries; (d) spent a week with a party from the U.S. Bureau of Soils obtaining profile samples of some of the Great Soil Groups as represented in Alberta; (e) spent two days assisting in the location of a Dominion Experimental Sub-station on solonetzic soils in the Camrose area; (f) spent three days in the Lethbridge area with Canadian and American irrigationists studying the irrigation of soils of glacial origin.

The Soil Survey Report of the Peace Hills Sheet (Report No. 14 of the Alberta Soil Survey) was distributed in 1949, after the soil maps were received from the printer.

UTILIZATION OF STRAW

Five students, supported by funds from the National Research Council, completed the chemical and physical analysis of samples of wheat and oat straws collected in 1946 and 1947. The data have been compiled and studied and a comprehensive report on the whole project will be completed for publication early in the New Year.

BIOLOGICAL CYCLES

On account of the continued scarcity of snowshoe rabbits in the Edmonton district, little progress was made in the program for the biological cycles project. A series of embryo counts, obtained at McMurray, one of the few spots where rabbits have been numerous enough to make the undertaking possible, indicated that the average litter-size was 4.1 as against the reputed 8 - 10 of literature, with the animals breeding from May to the extreme end of August. Through country co-operators it was possible to obtain a fairly complete collection of food plants at the present stage of the cycle which will provide the basis for biochemical assays next year.

ULTRA VIOLET MEASUREMENT

The records obtained from the measurement of Ultra Violet light have been integrated and studied, and a fair, continuous picture should soon be available for the three years the instrument has been in operation. It is of interest to record that auxiliary investigations of Solar Ultra Violet have been started under the National Research Council. The purpose of this investigation is to extend the knowledge of the different ranges of wave length within the Solar Ultra Violet, as isolated by special photocells, and to develop simpler apparatus for extending such measurements over the Province of Alberta, particularly from north to south. The Dominion Experimental Farms and the Entomological Branch have shown great interest in the biological effects of Solar Ultra Violet radiation.

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. **Price 35 cents.**
No. 16 (for the calendar year 1925); pp. 65. **Price 35 cents.**
No. 20 (for the calendar year 1926); pp. 53. **Price 25 cents.**
No. 22 (for the calendar year 1927); pp. 49. **Price 25 cents.**
No. 24 (for the calendar year 1928); pp. 53. **Price 35 cents.**
No. 25 (for the calendar year 1929); pp. 65. **Price 35 cents.**
No. 26 for the calendar year 1930); pp. 76. **Price 35 cents.**
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.**
No. 51 (1947); pp. 28. **Price 5 cents.**
No. 54 (1948); pp. 27. **Price 5 cents.**
No. 55 (1949); pp. 26. **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. **(Out of print.)**
Part III (1929)—Utilization, pp. 33. **Price 25 cents.**

No. 53 (1949); THE ROLE OF VERY FINE MINERAL MATTER IN THE HOT WATER SEPARATION PROCESS AS APPLIED TO ATHABASKA BITUMINOUS SANDS, by K. A. Clark and D. S. Pasternack; pp. 22. **Price 15 cents.**

No. 57 (1950); DETERMINATION OF VISCOSITIES AND SPECIFIC GRAVITIES OF THE OILS IN SAMPLES OF ATHABASKA BITUMINOUS SAND, by S. H. Ward and K. A. Clark; pp. 21. **Price 15 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. **Price 50 cents.**

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. **Price 50 cents.**

No. 56 (1950); SOIL SURVEY OF THE RYCROFT AND WATINO SHEETS. (In preparation.)

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No. 1 (1919); FIRST ANNUAL REPORT ON THE MINERAL RESOURCES OF ALBERTA, by J. A. Allan; pp. 104. **Price 25 cents.**

No. 2 (1920); SECOND ANNUAL REPORT ON THE MINERAL RESOURCES OF ALBERTA, by J. A. Allan; pp. 138+14. **(Out of print.)**

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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.)**

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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. **(Report out of print, map available.)**

No. 13 (1945): GEOLOGY OF RED DEER AND ROSEBUD SHEETS, by J. A. Allan and J. O. G. Sanderson; pp. 109. Two geological maps in 8 colors. Scale one inch to three miles. Serial No. 8 Red Deer Sheet and No. 9 Rosebud Sheet, now 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. **(Report out of print, map available.)**

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. **(Out of print.)**

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.)**

Map No. 16 (1937); GEOLOGICAL MAP OF ALBERTA (Coloured), by J. A. Allan. Scale 1 inch to 16 miles. **(Out of print.)**

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Map No. 18 (1940); COAL AREAS OF ALBERTA, by J. A. Allan. Scale 1 inch to 20 miles. **Price 25 cents.**

No. 34 (1943), in five parts by J. A. Allan; pp. 202. **(Out of print.)**

Part I—General Geology of Alberta, pp. 37, and geological map No. 17, scale 1 inch to 32 miles. **Price 50 cents.**

Part II—Rock Salt Deposit at Waterways, pp. 19. **(Out of print.)**
Part III—Geology of Alberta Soils, pp. 87. **(Out of pront.)**
Part IV—Relief Model of Alberta and its Geological Application, pp. 9. **(Out of Print.)**
Part V—Coal Areas of Alberta, pp. 36, and Map No. 18, scale 1 inch to 20 miles. **Price 75 cents.**

No. 48 (1946); GEOLOGY AND COAL OCCURRENCES OF WAPITI-CUTBANK AREA, ALBERTA, by J. A. Allan and J. L. Carr; pp. 43 and map (Serial No. 19). Scale 1 inch to 3 miles. **Price 50 cents.**

No. 49 (1947); GEOLOGY OF HIGHWOOD-ELBOW AREA, ALBERTA, by J. A. Allan and J. L. Carr; pp. 75 and 6-color map (Serial No. 20). **Price $1.00.**

No. 52 (1949); GEOLOGY OF RIBBON CREEK AREA, ALBERTA, by M. B. B. Crockford; pp. 68 and 5-color map (Serial No. 21). **Price 50 cents.**

REPORTS—RURAL ELECTRIFICATION

No. 36 (1944); pp. 107. RURAL ELECTRIFICATION IN ALBERTA, by Andrew Stewart. (Not available for distribution.)
Appendix I (1944); pp. 77. (Not available for distribution.)
Appendix II (1944); pp. 115 with maps. (Not available for distribution.)

CONTRIBUTION SERIES

This series comprises papers submitted to technical societies or journals by members of the technical staff. They are not available for general distribution; but can be consulted in the original publication cited.

No. 1—Fuel Investigations of the Research Council of Alberta (1919-1940), by W. A. Lang. Trans. Canadian Institute of Mining and Metallurgy, Vol. XLV, 1942, pp. 27-44.

No. 2—Humidity Data Expressed in Grains Water Vapour per Pound of Dry Air, by Edgar Stansfield. Canadian Journal of Research, A 21, 1943, pp. 51-55.

No. 3—Alternative Fuels for Motor Vehicles, by W. A. Lang, The Engineering Journal, August 1943, pp. 449-454.

No. 4—Hot-Water Separation of Alberta Bituminous Sand, by K. A. Clark, Trans. Canadian Institute of Mining and Metallurgy, Vol. XLVII, 1944, pp. 257-274.

No. 5—Some Physical Properties of a Sample of Alberta Bituminous Sand, by K. A. Clark, Canadian Journal of Research, F 22, 1944, pp. 174-180.

No. 6—Purification of Silica Sand—Alberta Tar Sands Suitable for Glass Manufacturing, by E. O. Lilge, Canadian Chemistry and Process Industries, Vol. XXIX, July, 1945, pp. 480-482.

No. 7—Bituminous Sands of Alberta, by K. A. Clark, The Oil Weekly, August 13, 1945, pp. 46-51.

No. 8—Asphaltic Road Oils from Alberta Bituminous Sand, by K. A. Clark, Canadian Chemistry and Process Industries, Vol. XXIX, September, 1945, pp. 616-618.

No. 9—Research and the Coal Industry in Canada, by W. A. Lang, Trans. Canadian Institute of Mining and Metallurgy, Vol. XLIX, 1946, pp. 51-62.

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No. 11—Some Recent Conceptions of Coal Structures, by A. McCulloch, Canadian Chemistry and Process Industries, November, 1947.

No. 12—Elimination of Water from Wet Crude Oil Obtained from Bituminous Sand by the Hot Water Washing Process, by K. A. Clark and D. S. Pasternack, Part I—Continuous Settling at Atmospheric Pressure, Part II—Continuous Settling Under Pressure; Evaporation. Canadian Chemistry and Process Industries, January, 1948 and November, 1947.

No. 13—The Oil-Sand Separation Plant at Bitumount, by K. A. Clark, Western Miner, August, 1948.

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No. 15—Geology of Kootenay Coal Measures in Southwestern Alberta, by M. B. B. Crockford, Bulletin Canadian Institute of Mining and Metallurgy, No. 443, March, 1949.

No. 16—Oldman and Foremost Formations of Southern Alberta, by M. B. B. Crockford, Bulletin American Association of Petroleum Geologists, Vol. 33, April, 1949.

No. 17—The Athabaska Tar Sands, by Karl A. Clark, Scientific American, May, 1949.

No. 18—Low Temperature Carbonization of Alberta Subbituminous Coal, by J. Gregory and A. McCulloch, Industrial and Engineering Chemistry, Vol. 41, May, 1949, pp. 1003-1011.

No. 19—Graphical Studies of the properties of Alberta Coals, by A. McCulloch and E. Sherlock, Fuel, Vol. XXVIII, No. 6, June, 1949, pp. 135-141.

No. 20—A Classification of Alberta Coals, by E. Sherlock, Fuel, Vol. XXVIII, No. 12, December, 1949, pp. 276-281.

MIMEOGRAPHED CIRCULARS

No. 1 (1947); Significance of General Laboratory Tests on Fuels and Lubricants, by J. S. Charlesworth.

No. 2 (1947); Alberta Motor Gasoline Surveys 1939-1947, by J. S. Charlesworth and E. Tipman.

No. 3 (1947); Preliminary Report on the Ceramic Importance of Clay and Shale Deposits of Alberta, by M. B. B. Crockford.

No. 4 (1948); Alberta Gasoline Survey 1948, by J. S. Charlesworth and E. Tipman.

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No. 6 (1919); Occurrences of Common Salt in Alberta, by M. B. B. Crockford.

No. 7 (1949); Geology of Peace River Glass Sand Deposit, by M. B. B. Crockford.

No. 8 (1949); Alberta Motor Gasoline Surveys 1949, by J. S. Charlesworth and E. Tipman.