Report No. 51.

TWENTY-EIGHTH

ANNUAL REPORT

OF THE

RESEARCH COUNCIL OF ALBERTA

1947

EDMONTON:
PRINTED BY A. SHNITKA, KING'S PRINTER
1948

CONTENTS

The following report, the Twenty-eighth Annual Report of the Research Council of Alberta, was submitted in March, 1948, 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.

Mr. R. M. Hardy, Dean of Applied Science, University of Alberta, Assistant Director of Research, Deputy Chairman.

Mr. W. D. King, Deputy Minister, Department of Trade and Industry.

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

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

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

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

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

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

Mr. A. McCulloch, Chief Research Engineer.

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

Mr. J. E. Oberholtzer, Industrial Engineer.

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, from February.
W. A. Lang, Senior Research Chemist, Fuels.
D. S. Pasternack, Research Chemist, Bituminous Sands.
M. B. B. Crockford, Geologist, Geology.
J. S. Charlesworth, Chemist, Gasoline.
A. L. Brown, Soil Surveyor, Soils, to November.
J. E. Oberholtzer, Industrial Engineer.
E. Tipman, Assistant Chemist, Gasoline.
S. H. Ward, Assistant Chemical Engineer, Bituminous Sands.
W. C. Hinman, Assistant Soil Surveyor, Soils, to November.
J. Gregory, Assistant Chemical Engineer, Fuels.
J. Fryer, Assistant Chemist, Fuels.
R. A. Leask, Assistant Research Chemist, Fuels, to May.
A. C. Bridge, Assistant Research Chemist, Fuels, from July.
E. Sherlock, Assistant Research Chemist, Fuels, from August.
M. M. Chmilar, Assistant Research Engineer, Natural Gas, from May.
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 R. J. Tate, Stenographer-Typist.
Mrs. V. L. Stover, Stenographer (part), to April.
Mrs. B. O. Archibald, Stenographer, April and May.
Miss S. M. Mackintosh, Stenographer, from June.
T. R. Gravelle, Laboratory Assistant, Fuels, to April.
A. Cameron, Laboratory Assistant, Gasoline, to September.
R. Dalby, Laboratory Assistant, Natural Gas, from July.
R. Sacker, Laboratory Assistant, Gasoline, from September.
J. Tchir, Laboratory Assistant, Fuels, from November.

The following held temporary appointments during the year:

E. J. Evans, Soils Assistant, Soils, May 1-September 24.
H. N. Hart, Soils Assistant, Soils, May 1- September 20.
C. J. McAndrews, Soils Assistant, Soils, May 19-September 20.
A. Wynnyk, Soils Assistant, Soils, May 1-September 20.
B. Hughes, Cook, Soils, May 29-September 20.
G. G. Scruggs, Assistant Geologist, Geology, May 1-September 30.
J. T. Cook, Cook, Geology, May 30-August 22.
Miss R. E. Carter, Asst. Chemist, Straw Utilization, May1-August 31.
Miss J. V. Perkins, Asst. Chemist, Straw Utilization, May 1-September 15.
Miss E. M. Weir, Asst. Chemist, Straw Utilization, May 1-August 31.
C. J. McConnell, Asst. Engineer, Highway Research, May 1-August 23.

R. C. Thurber, Asst. Engineer, Highway Research, May 19-August 31.

E. L. Coffin, Asst. Chemist, Bituminous Sands, May 5-September 15.

D. W. Langille, Laboratory Assistant, Fuels, May 1-September 30.

S. R. Wright, Asst. Research Engineer, Natural Gas, May 1-August 23.

W. R. Dimock, Asst. Research Engineer, Natural Gas, January 1-April 30.

D. E. Armstrong, Economist, Poplar Survey, May 1-September 22.

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. S. G. Davis, Natural Gas.

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

Dean R. M. Hardy, Highway Research.

Dr. J. D. Newton, Soils Surveys.

Dr. W. Rowan, Animal Cycles.

Professor A. Stewart, Poplar Market Survey.

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

Dr. F. A. Wyatt, Soils Surveys.

ANNUAL REPORT

of the

Research Council of Alberta

1947

This report summarizes the work of the Research Council of Alberta for the calendar year 1947. All investigations in progress in 1946 were continued in 1947, and a new project on highway research was begun. The Council now has under investigation geological surveys to ascertain the mineral resources of the province, soil surveys to determine the soils best suited for agricultural purposes and a highway survey to find the causes of failure in provincial highways. Investigations are in progress on solid, liquid and gaseous fuels; on the separation and utilization of McMurray Bituminous sands; on the utilization of sand, straw and poplar; and on the measurement of ultra violet light and its effect on animal cycles. The Council employs an Industrial Engineer to study the practical possibilities of new technical processes and the commercial feasibility of proposed industrial developments within the province.

The work on some of the projects has been curtailed by inability to get suitably trained personnel, by lack of space for housing the investigations and by delays in procuring supplies. During the year space was made available in a converted army hut for geology, industrial projects, drafting and storage. A building for housing the briquetting and coal preparation work was obtained late in the year and should be ready for occupancy early in 1948.

The passing of Dr. F. A. Wyatt, who had directed the soil surveys in Alberta from 1921 until the time of his death on May 24, 1947, is regretfully recorded. Dr. J. D. Newton, Head of the Department of Soils, the University, has undertaken direction of the soil survey work.

Mr. O. S. Longman, Deputy Minister of Agriculture, Dr. J. D. Newton, Head of the Department of Soils, the University and Dr. O. J. Walker, Head of the Department of Chemistry, the University, were appointed to the Technical Advisory Committee of Council.

The Council in 1947 instituted three Research Council Fellowships tenable at the University of Alberta. The fellowships were awarded to Michael M. Chmilar, B.Sc. Chemical Engineering, University of Alberta; Allan C. Bridge, B.Sc. Honors Chemistry, University of Liverpool and Edward Sherlock, B.Sc. Honors Chemistry, University of London.

Research Council of Alberta Report No. 49, "Geology of Highwood-Elbow Area of Alberta" by J. A. Allan and J. L. Carr, with Appendix on Palaeontology by P. S. Warren and Report No. 50, "Annual Report of the Research Council of Alberta for 1946" were published during the year. A number of scientific papers, ,Master of Science theses and reports were prepared by members of the

staff. A list of the major publications of the Council, since its inception, is given as an appendix to this report.

Brief summaries of the work under investigation during the year follow.

BITUMINOUS SANDS

The Council, as has been explained in previous Annual Reports, has a close connection with the government-sponsored bituminous sand separation plant being erected at Bitumount on the Athabaska river. The design of the hot water separation unit of this plant is based on the results of researches of the Council on the hot water separation process. Problems that have arisen during the design of the plant have been studied in the Council's laboratories. For instance, an extensive series of tests were undertaken to determine the best available procedure for cleaning and drying the crude separated oil preparatory to charging it to the refinery. The plant is put into operation, for control purposes and for collecting operational data. During July two members of the Council staff went to Bitumount to put the laboratory in order. While doing so they had opportunity to note progress in plant construction. They were most favorably impressed with what they saw. A neat, well engineered plant with first class equipment was taking shape rapidly. Erection was going ahead steadily under the skilful guidance and supervision of the Oil Sands Ltd. engineer, Mr. W. E. Adkins. The indications were that a plant which would do credit to all concerned would be ready for operation during the season of 1948.

It was noted in the last Annual Report that the hot water separation process does not recover all the oil content of bituminous sand. The recovery of oil is between 80% and 90% for good grades of sand. It is of interest to know what becomes of the oil that is not recovered and work in the laboratory has been devoted to finding this out. The oil that is not recovered becomes dispersed in the plant water and eventually leaves the plant with the tailings. The more clay there is in the bituminous sand, the more oil that becomes dispersed in the water and that is lost with the tailings. Careful laboratory testing has made this point clear. There is the further point of just how the oil becomes dispersed. It was suggested in the last Annual Report that the lost oil forms films over the mineral particles—grains of sand, silt and clay—and leaves the plant with the mineral particles when these are eliminated as tailings. A given weight of clay, because of the extremely small size of its particles and the consequent large development of surface would have much more oil filmed on its particle surfaces than an equal weight of sand or even silt. Thus, it would be understandable why an increase of a few per cent in the clay content of a bituminous sand would result in a notable increase in the loss of oil with the tailings from the separation plant.

Further work during the past year indicates that the loss of oil is not due to filming onto particle surfaces. What seems to happen is that, during the separation process all the oil becomes dispersed into flecks of varying size. Those above some fairly critical size are collected by air bubbles and are carried to the surface of the water as a froth which is removed as recovered oil. Those of smaller size are not collected by the air and stay suspended in the water. The oil found in the tailings, then, is not there as films on particle surfaces but as flecks enmeshed among the par-

ticles. The oil flecks settle in water slowly, especially the very small ones, because the specific gravities of oil and water are so nearly equal. Thus, when tailings are redispersed in water and are separated into fractions of varying ranges of sizes of particles by varying times of settling, a high proportion of the oil flecks settle with the finest mineral matter, namely, the clay. It is the clay in the bituminous sand which causes the oil to disperse into flecks and an increase of clay content results in an increase in the proportion of the oil that forms very small flecks. Hence increase of clay content is accompanied by decrease of oil recovery in the separation process.

Work has been continued during the year on the applicability of water-flooding to the bituminous sands. The purpose of it is to collect fundamental data upon which to base a judgement about whether or not this method of recovery of oil from the bituminous beds is feasible. One item of information which is vital is the temperature of the bituminous sand formation. The Department of Mines and Resources, in its report on core-drilling operations, gives temperature data which indicated that the formation temperature is 45°F. or less. Through the co-operation of Abasand Oils Ltd., a suitable thermometer was lowered into a mud-filled drill-hole to a depth of 130 feet. The temperature recorded was 36°F. It is thus apparent that the bituminous sand beds are at a temperature that is close to the freezing point of water.

Measurements of the viscosity of the bituminous sand oil and of the viscosity-temperature relationship show that the viscosity decreases very rapidly as the temperature rises from 32°F. to about 100°F. and that it decreases slowly above about 150°F. Between 100°F. and 150°F. there is quite abrupt change in the viscosity-temperature relationship. As for values for the viscosities of the oil, it would be misleading to give any at present. The measurements are very sensitive to variations in the composition of the oil and to the presence of small percentages of clayey mineral matter. The oil must be extracted from the bituminous sand before measurements can be made and the extraction procedure either removes some of the lighter fractions of the oil or leaves some solvent in the oil or both. Also there is always some clayey material in the oil that must be used for measurements. A careful study of the effect of these conditions on viscosity and of how corrections can be applied to compensate for them is under way. Announcement of actual viscosity values is being postponed until this study has been brought to a satisfactory status.

It can be said with considerable definiteness that the viscosity of the bituminous sand oil at formation temperature is too great for water-flooding and that a successful application of this method of oil recovery will involve the heating of the bituminous sand beds, in place, to temperatures above 100°F. Water under practicable pressure gradients will flow through bituminous sand at 36°F. and will displace oil. The flow is small, however, and the ratio of water to oil in the flow is high. At 150°F., on the other hand, the flow is usefully great and half of the oil is displaced before the ratio of water to oil in the flow becomes unduly high. It is expected that these qualitative statements can be replaced by actual data by the time the next annual report is due.

FUELS

Changes in the staff of the Fuels Section during the past year have curtailed progress in laboratory investigations on coal and allied subjects.

The systematic examination of Alberta coals was continued on channel samples of coal collected by District Mines Inspectors of the Provincial Mines Branch of the Department of Lands and Mines. The examination has been extended to cover the determination of the yields of coke, gas, tar and aqueous liquor obtained under standard conditions of carbonization in the laboratory. The yields of carbonized products depend largely on the rate of carbonization. Experiments are in progress with a view to devising a satisfactory method of controlling more precisely the rate of heating of the coal by a means more convenient than any at present available. The determination of the swelling indices of coking coals is receiving attention in connection with the oxidation of coal. Washing tests have been carried out on a number of samples of coal. The classification of Alberta coals is being further studied.

Present methods of testing the explosive nature of coal dusts are of an empirical character and a precise relationship has yet to be found, which will allow the results of such tests to receive wider interpretation in relation to conditions actually occurring in coal mining. It has not been found possible to continue the experiments on the improved apparatus in which the course of a coal dust explosion can be visually observed.

Experimental work was continued on the carbonization of low-rank subbituminous coals in the pilot-plant low-temperature retort designed on the principle of a vertical shaft carbonizer. Practical experience shows that considerable operational difficulties may arise in plants of this type in which gravity flow is employed, if the coal undergoing carbonization contains a substantial amount of finely-divided material. Whilst the plant at present under investigation has been found unsatisfactory for the treatment of fine coal alone, coal containing a fairly high proportion of such fine material can be handled satisfactorily. If, however, the coal undergoing carbonization contains only a relatively small amount of superficial water, clogging of the retort occurs and carbonization is interrupted. These operational difficulties apart, the retort will only function within limited rates of air supply and coal feed dependent on the type of coal undergoing treatment. Experimental work is continuing to relate these latter factors to the throughput of the retort, to establish the thermal efficiency of the system and to determine the probable performance of a large-scale plant in comparison with the performance of established carbonization processes used in Canada and elsewhere for a like purpose.

Briquetting investigations were continued during the early part of the year with the main emphasis being given to the briquetting of blends of coking and non-coking coals, the carbonization of briquettes made from the blended coals at different temperatures and at different rates of heating, and the study of the physical and chemical characteristics of the uncarbonized and of the carbonized briquettes. Judged by compression strength, density and calorific value, a satisfactory product can be produced from blends of 70 to 80 per cent of a suitable non-coking subbituminous coal, 30 to 20 per cent of a suitable coking bituminous coal and a 7 mixing ratio of the usual asphalt binder, by carbonization at a slow rate

of heating to a final temperature of 700°C. Carbonization at a somewhat higher temperature gives increased density and compression strength at the expense of decreased calorific value, increased ash content and a less reactive fuel. A product with a density of 1.2 was obtained by carbonization of the briquettes to 900°C. High density is a desirable quality for a fuel that has to be shipped to a distant market. The results of the investigations are sufficiently promising to warrant continuation. It is proposed to design and construct a retort suitable for the carbonization of larger quantities of briquettes and to study the yields and nature of the tar products which might be used as binder in the briquetting process. Owing to the space housing the briquetting equipment being required for University purposes, the briquetting equipment has had to be dismantled and moved to No. 1 University Power plant where it will be reassembled and the briquetting investigation resumed in 1948.

Assistance has been given to the Mines Branch of the Department of Lands and Mines of Alberta in connection with the introduction of a Diesel locomotive for underground coal haulage in one of the mines in the Crowsnest area. In operation such locomotives produce noxious and poisonous gases which pollute the mine atmosphere. Strict attention has then to be given to adequate ventilation of any section of the mine in which the Diesel locomotive is in use. Preliminary tests have shown that ventilation was satisfactory in this mine. Under certain conditions of operation, however, and especially after a locomotive has been in use for a considerable period, the extent of the pollution may increase.

Investigations in two fields of work have been commenced during the past year. The first investigation relates to the preparation of Alberta coals for the market and the second deals with certain aspects of the chemical constitution of coal. The sizing and cleaning of coal are very important not only with regard to the requirements of different coal markets, but also as major factors in practically every method of coal utilization. For example, when Alberta subbituminous coals are carbonized at low temperatures, only approximately 50 per cent of the coal undergoing treatment is obtained in the form of a char. The char will thus contain twice as much ash as is present in the original coal. Since many of the available coals contain as much as 10 per cent ash, the char obtained by the low temperature carbonization of them will have an ash content of 20 per cent. A clean coal is thus a sine qua non of the production of a reasonably high quality char.

A survey of the present practice with regard to the sizing and cleaning of coal in Alberta is being made with the co-operation of the Bituminous and Domestic Coal Operators' Associations. In this connection, a survey has been commenced of the scientific literature relating to the preparation of coal for the market prior to determining the line of investigation which can best be pursued. It is hoped shortly to install a certain amount of small-scale coal cleaning apparatus. The studies in coal constitution are to follow original lines. It is hoped that these studies may provide means of improving the coal hydrogenation process. It is possible that by modifying the chemical structure of the coal substance the conditions for hydrogenation may be improved and the degree of hydrogenation of the coal considerably increased. It is also anticipated that the experimental work will provide better knowledge of coal proper-

ties on which, in the ultimate, all methods of utilizing coal must be based.

In the 1946 report of the Research Council the formation of a Coal Operators' Research Committee was mentioned; the purpose of the Committee was to maintain liaison between the Coal Industry and the Research Council. As a result of discussions with representatives of the Domestic Coal Operators' Association and the Western Canada Bituminous Coal Operators' Association it is proposed that representation of the Coal Industry should be increased so that the Committee may have available the views of those who are actively engaged in the mining and preparation of coal.

Coal mines in the Fernie and Michel districts of British Columbia and in the Coleman, Blairmore and Drumheller districts of Alberta have been visited. The Secretary of the Research Council attended the technical sessions of the Coal Division of the 75th Anniversary Conference of the American Institute of Mining and Metallurgy held in New York during March, 1947. He also visited a number of government laboratories, research institutions and industrial plants in the United States. These visits were made primarily to investigate recent developments in the briquetting, carbonization and gasification of coal and they provided an opportunity to study many other phases of the Coal Industry.

The Research Council of Alberta awarded Research Fellowships to two graduates of British Universities, who at the time of the awards were resident in Great Britain. Prior to departure from Great Britain, these graduates visited H.M. Fuel Research Station, the laboratories of the British Coal Utilization Research Association and a number of collieries where the practice was representative of recent developments in coal cleaning and in the preparation of coal for the market. The visits were made possible through the kindness of the Director of H.M. Fuel Research Station, the Director of the Research Laboratories of the British Coal Utilization Research Association and the Chief Coal Preparation Officer of the National Coal Board.

A paper entitled, "Some Recent Conceptions of Coal Structure" was presented at the Annual Meeting of the Chemical Institute of Canada, Banff, June, 1947. This paper was printed in Canadian Chemistry and Process Industries, November 1947, pp. 1012-1016.

The Chief Inspector of Mines and Provincial Mines Inspectors have on all occasions given every assistance. Mention should be made in particular of the cordial way in which members of the staff of the Fuels Section of the Research Council have been received during visits to the coal mining areas. It is also desired to express appreciation of the courtesies shown to them by Coal Operators and by members of the staffs of the coal mining companies.

GASOLINE AND OIL TESTING

The Gasoline and Oil Testing Laboratory has continued its analytical work for the Department of National Defence and for Provincial Government Departments. A certain amount of analytical work has been carried out for oil companies, other industrial firms and private individuals. The scope of the work has widened considerably and now comprises the examination of aviation, turbo-jet, diesel and other fuel oils, motor gasoline, lubricating oils,

hydraulic fluids and solvents. Approximately 520 samples of petrolem products were tested during the year.

The survey of the quality of motor gasoline on sale in the Province of Alberta was continued. Survey reports have been submitted to the Provincial Government.

Close contact continues to be maintained with the Petroleum Sub-committee of the Canadian Government Purchasing Standards Committee of the National Research Council through the representative of the Research Council of Alberta. Progress in methods for the analysis of petroleum products and the revision and formulation of petroleum product specifications are under constant review by this committee which includes representatives of the Dominion Government and of the Petroleum Industry. In this way a close control is maintained on the uniformity and accuracy of standard analytical methods. Investigations have been and continue to be carried out by the Gasoline and Oil Testing Laboratory in connection with the work of the committee.

Technical assistance has been given to the Provincial Fire Commissioner in connection with the drafting of new regulations governing the installation and handling of domestic and commercial oil burning equipment. Advice has also been given on other matters of a technical nature.

A short article entitled "A Laboratory Time Switch" was published in "Chemical Engineering", in May 1947. A report on the "Significance of Tests on Petroleum Fuels and Lubricants" has been prepared and copies are available on application to the Gasoline and Oil Testing Laboratory.

GEOLOGY

Included in the geological work of the Council for 1947 were investigations of coal, clays, sand, water and a number of miscellaneous mineral deposits. The major project was a geological survey along Evans-Thomas, Ribbon and Pigeon Creeks, to determine the coal measures in that area.

Report 49 "Geology of the Highwood-Elbow Area, Alberta" by J. A. Allan and J. L. Carr, was prepared and published during the year. This report covers an area situated at the headwaters of the Highwood and Elbow rivers in which important coal deposits occur.

Geological Survey along Evans-Thomas, Ribbon and Pigeon Creeks.

The area mapped in 1947 was between townships 21 and 24, in a north-south direction and in ranges 8 and 9 in an east-west direction. The mapping of the coal measures that occur behind the front range of the Rocky Mountains between the Highwood and the Bow Rivers has now been completed, since the area mapped in 1947 adjoins on the south the Highwood-Elbow Area mapped by J. A. Allan and J. L. Carr in the years 1945 and 1946, and on the north the Canmore area mapped by B. R. McKay in 1934. The area under consideration lies between two mountain ranges, prominent mountains on the west being The Wedge and Wind Mountains and on the east Mount McDougall, Mount Lorette and Mount Pigeon. Pigeon creek is a tributary of the Bow river, whereas the others flow into the Kananaskis river.

The occurrences of Mesozoic strata in the area, viz., the Blairmore, Kootenay, Fernie and Spray River formations were studied in detail. Special attention was given to the coal-bearing Kootenay formation. Paleozoic strata, including the Rocky Mountain, Rundle, Banff, Exshaw, Palliser and Fairholme formations are also exposed but little time was spent in studying them. The rock succession studied is as follows:

Mesozoic	Lower Cretaceous	Blairmore—sandstone and shale
		Kootenay—sandstone, shale and coal
	Jurassic	Fernie—marine shale, sandstone
	Triassic	Spray River—shale, dolomite

The Blairmore is the youngest rock formation which outcrops in this area, but it did not permit of much investigation since only the lower few hundred feet are present, the remainder having been eroded. The rocks of this formation form the crests of some of the higher ridges. Underlying the Blairmore and forming a band up to two and one half miles in width is the economically important Kootenay formation. It contains the only important coal seams of the area, and these occur in the lower part of the formation. The Kootenay in this area is over 3,500 feet thick. Below the Kootenay is the Fernie formation, composed mostly of marine shale, but becoming sandy towards the top. No complete section was observed in the area studied, but a composite section showed it to be about 1,100 feet thick. A nearly complete measured section of Spray River formation on Evans-Thomas creek indicated it was about 670 feet thick. This formation is composed essentially of shale with some dolomite.

The structure of the area is that of a northwesterly trending trough or syncline which extends from the headwaters of Evans-Thomas creek in the south to and beyond Wind creek in the north. The coal measures at Canmore, Anthracite and Bankhead are all part of the same structure. The south end of the trough pitches or dips to the northwest, and accordingly, outcrops of Spray River and other rocks are found at progressively lower elevations in that direction, so that in the vicinity of the Bow River, which is north of the area, coal seams may be found close to river level. The east limb of the trough dips at about 20 degrees to the southwest, and it is this part of the structure that is most favorable for coal mining. Here the dips are moderate, faults are small and blocky coal occurs. The west limb has been subjected to greater pressure than has the east limb. In most places it is vertical or overturned. It is also faulted and crumpled, so that coal seams may be greatly thinned or thickened, and are in many places discontinuous. Moreover, the coal is badly crushed.

Coal seams within the area are exposed in relatively few places since they occur in the lower part of the Kootenay formation which in most of this area is below tree-line and therefore covered by a thick mantle of soil and vegetation. On some of the steeper slopes however coal seams are exposed in stream channels or lie beneath a thin layer of wash. These may be readily exposed by trenching and the thickness of the seams, and character of the coal determined. In one 500-foot section measured in township 23, range 9, west of the fifth meridian, there are 11 seams totalling 32.8 feet of coal. Six of the seams are three feet or more in thickness. In this section all important coal seams occur in the lower 850 feet of the formation.

Another section containing considerable coal is located on a small tributary of Evans-Thomas creek in township 22, range 9, west of the fifth meridian. Here a 360-foot measured section showed 55 feet of coal in 11 seams and of these seams 7 are over 3 feet thick. Some of the coal is blocky but the remainder is friable either on account of weathering or crushing.

Clay and Bentonite.

Clays suitable for the manufacture of brick and tile, are fairly common in Alberta, but there are in the province no known deposits of high grade clays from which whiteware, stoneware, firebrick or sewer-pipe can be made. Clays used in the pottery industry of Medicine Hat, where these latter products are made, are imported from Saskatchewan, Eastern Canada, and the United States. Since the same rock formation, the Whitemud, which furnishes the high grade clays in Saskatchewan, extends into Alberta, it is thought that similar deposits might be found in this province and that this possibility should be investigated. Accordingly, a preliminary examination of this formation, which outcrops in the Cypress Hills, was made late in 1947. The clay beds sampled vary in thickness up to 7 feet, and some of the clays appear to be of good quality, so that the results of this hasty survey are quite encouraging. The clay samples are now being tested to determine their possibilities.

A clay deposit at Beaverlodge was also examined. A small sample of this clay had been tested previously and found to be suitable for brick and tile. However, upon examination the deposit was found to be too small to be of commercial value. Should similar deposits be located nearby, a brick plant could possibly be operated profitably.

A deposit of bentonite near Sion in township 57, range 1, west of the fifth meridian was investigated. The bentonite bed is reported to be about 15 feet thick and to be about 15 feet below the surface. Since it had been encountered in digging a well for water, and the hole had long since caved, these reports could not be substantiated. However the quantity of bentonite lying about the well site indicated that a thick stratum had been encountered.

Sand for Glass.

Since sand for glass must be brought into the province from the United States, with attendant high costs and uncertainty of delivery, the finding of such sand locally would be of the utmost importance. In the past few years the Geologist of the Research Council has given attention to this problem. Sand from several lake beaches has been sampled and tested with disappointing results, for the sand was either too high in impurities or too small in quantity to be of value.

During the 1946 season a promising sand bed was observed by a geological assistant with the Research Council. This sand was further examined and sampled in 1947. The sand occurs in the Peace River formation and outcrops along Peace River about six miles below the town of that name. The sand is a fairly clean, fine to very coarse grained quartz sandstone which is easily crumbled. The bed has a maximum thickness of 55 feet. In most places it is badly iron-stained, a feature that may render those parts unfit for glass sand. However, it is probable that a sand

body of commercial size is present, but this assumption can only be proven by extensive trenching and perhaps core-drilling.

Water Supply.

A few weeks were spent in the Peace River district so that the geologist might acquaint himself with the broader aspects of water supply conditions. Since the field season was nearly over when this trip was begun, time did not permit of more than a general survey. The Research Council is now in a better position to advise persons from that area who ask for guidance in regard to obtaining water for domestic purposes.

The collection and dissemination of water supply information should receive more emphasis since supplies of ground water are gradually diminishing, and consequently the need for technical advice is increasingly great. It is proposed that in this and following years surveys will be carried on regularly to improve the value of this service.

Miscellaneous Projects.

Investigations were made into an occurrence of a thick bed of fossil oyster shells. The bed outcrops in a number of places in an area west of Cardston, but it can be seen to best advantage along the Belly river in legal subdivision 5, section 3, township 4, range 27, west of the fourth meridian. Here the bed is about 13 feet thick and is exposed over a distance of 800 feet. Its stratigraphic position is 59 feet above the base of the St. Mary River formation. The composition of the material in the bed was found by analysis to be fairly uniform but the quantity easily available was not considered to be sufficient to warrant the establishment of a cement plant to process this material.

A deposit of tufa and travertine occuring on the north bank of the Bow river in section 18, township 25, range 5, west of the fifth meridian, about one mile below the Ghost River dam was re-examined at the owner's request. This deposit had been examined by J. A. Allan in 1935 and is described in detail in the Annual Report of the Research Council for that year, so that little can now be added. In the intervening years some travertine had been quarried, cut, polished and sold, so that a market is in the process of being established. Enough marketable rock is in sight to warrant development in a small way in order to supply the local market.

HIGHWAY RESEARCH

The project involved a survey of the conditions existing at selected spots on main highways of the Province. Test locations were selected at spots where there was evidence of deterioration of the pavement as well as at locations where the road appeared to be standing up satisfactorily in service. Stretches where considerable surface patching had been necessary or where there were signs of rutting or cracking of the surface asphalt course were taken as evidence of deterioration. Forty-seven locations were investigated. A number of these were on the Calgary-Edmonton Highway between Edmonton and Ellerslie, in the vicinity of Leduc, between Wetaskiwin and Ponoka, in the vicinities of Olds and Crossfield and immediately north of Calgary. Others were on the Macleod trail 10 miles south of Calgary, on a new grade about 15 miles west of Calgary on the Calgary-Banff Highway and on the Edmonton-

Jasper Highway immediately west of Edmonton and in the vicinity of Wabamun.

At each location the following data were secured; thickness of pavement, base course and sub-base; density of base course; and moisture contents at one foot intervals to a depth of approximately 6 feet below the surface. Strength tests of the type of the California Bearing Ratio test were also run at each location on the base course and on the sub-base or subgrade material at a depth of 1½ feet below the surface. Loose samples of the base course material, sub-base material and in cut sections, of the subgrade material were taken for laboratory tests to classify the soil types and also to determine their compaction characteristics. Relatively undisturbed samples were also taken at each location of the sub-base and subgrade materials for the purpose of determining densities and running laboratory strength tests in the form of triaxial compression tests and consolidation tests. The results of these will enable the work to be integrated with the results of several very comprehensive research programs now underway in the United States and Canada for the purpose of evaluating the strength of runways and highways.

The laboratory program is not yet completed and therefore it is not possible to submit a detailed final report on the project at this time. However there are one or two extremely important general conclusions that may be drawn from the available results of the survey.

In general the quality of the asphalt pavements, including "blotter surfaces", seems to be excellent. The grading and densities of base courses also in general are good. However the densities of the sub-base courses are in general low when compared to the presently accepted standards on this continent. Evidence of failure of pavements in most cases examined can be traced to low density of sub-base material. Moreover the best information available indicates that, with the average densities existing in sub-base courses, the base course and pavement are not adequately supported to successfully carry under all weather conditions, the wheel loads and density of traffic presently on the main highways. It is realized of course that this statement is not applicable to all cases where trouble has been encountered on the Provincial highway system. There are many locations which have been damaged by frost action. The present practices however by which the finished grade is built well above the level of the surrounding ground in low areas, and by which soils highly susceptible to frost action are replaced, should in general be adequate to control damage from frost action.

Improvement in the density of sub-bases can be secured by compaction of the soil during the construction. The specifications for grading of the Department of Public Works were modified two years ago to require a minimum density of "90 per cent of Standard Proctor density". Previous to this no definite minimum density standard was specified. One possible solution is to raise the minimum density requirement of the present specifications to say 100 per cent of the "Standard Proctor density." However in the opinion of the writer this procedure would not secure the results desired except at a considerable increase in unit costs for handling "common excavation" and with a considerable increase in inspection staffs. It is, therefore, recommended that the program should

be continued for another year but that the emphasis should be placed on a study of the quality of construction that can be readily obtained without a major increase in the unit costs. This will require a study of compaction procedures in the field and will involve measurements to determine the efficiency of compaction methods for the soil types generally encountered in the Province. It would be essentially a matter of providing the inspection on at least one project in which the work was being done to a specification modified somewhat from that presently in use as regards compaction of sub-base courses.

INDUSTRIAL PROJECTS

Three main lines of activity were followed by the Industrial Engineer: the investigation of industrial projects, the inspection of industrial plants and laboratories, and the maintenance of a technical information service.

The increased activity of the Provincial Industrial Development Board was reflected in increased requests for the services of this section. Consideration was given to four major projects with favorable recommendation being made in three cases. Of these, two plants are in operation and the third is nearing completion. Detailed information reports were submitted on nine other possible industrial developments, without final recommendations being made. Further work may be required with regard to some of these projects.

A number of inspection trips and visits to industrial plants in Alberta were made during the year as well as visits to plants and laboratories in Vancouver. Such visits have proven to be of definite value, from the point of view of obtaining a wider knowledge of existing industries and in encouraging them to make use of available technical assistance.

More than one hundred general requests for technical information were dealt with, which was more than double the number of requests received in 1946.

NATURAL GAS RESEARCH

The Natural Gas project is concerned with the conversion of carbon monoxide and hydrogen, prepared from natural gas and oxygen, into a product resembling crude oil from which gasoline and other hydrocarbon products can be made. Two problems are being investigated: the testing of catalysts and a study of the mechanism of the synthesis reaction.

Catalyst Testing.

The influence of operating conditions, catalyst structure and catalyst composition on the yields of liquid hydrocarbons in a one pass convertor was further studied.

The catalyst testing units have produced yields with a Hall type catalyst up to 137.5 grams of liquid hydrocarbon per cubic meter of synthesis gas. Yields of 90 grams or better are average for a good catalyst with the procedure used here. Yields, which are determined at the end of one week's continuous operation, vary between these two limits, and so an average of a number of weeks' operations must be used to compare catalysts. As a standard, to

which others are compared, a Hall type catalyst Co 100, ThO_2 6, MgO 12, and Filtercel 200, is kept "on stream" at all times.

The following have been or are being tested: the use of pelleted and unpelleted catalysts; the use of Filtercel and Hiflo Supercel grades of kieselguhr as carriers in the catalysts; the use of bentonite as a catalyst and as a catalyst carrier; and the effect of silver as a promoter. The operating conditions, the rate of synthesis gas flow, and the amount of the contractions have been varied to determine optimum conditions of operation.

The rate of synthesis gas flow was varied over the range of 0.26 to 1.02 litres per hour per gram of cobalt charged in the catalyst. The optimum yield was found at a rate of about 0.5 litre per hour per gram. Above or below this rate the yields decreased rapidly.

One catalyst was tested in the form of pellets 1/8" thick and in unpelleted form in separate units. The yields, expressed as grams per cubic meter of synthesis gas were the same although a greater yield per unit of time was obtained from the pelleted catalyst since the space velocity of the synthesis gas was greater when the more compact form was used. In other words during the same period of operation, 1,678 hours, 418.0 grams of hydrocarbons were produced using the unpelleted catalyst and 526.9 using the pelleted catalyst.

Catalysts were prepared using Hiflo Supercel and Filtercel grades of kieselguhr. They were alike in all other respects. The yields found in each case were the same within experimental error.

Silver was tried as a promoter in this reaction. Three different catalysts were prepared which had silver as one of the constituents. The yields from these were much less than the yields obtained from the standard catalyst. The best had a composition of Co 100, Ag 8, MgO 12, Filtercel 200. However, this catalyst gave yields only one half those of the standard catalyst. It was also necessary to operate at higher temperatures when using catalysts containing silver.

Two bentonite catalysts were tested. In addition, three catalysts were prepared with bentonite replacing kieselguhr as the carrier. Two of these had silver as one of the constituents, the third had a composition of Co 100, ThO_2 6, MgO 12, Bentonite 200. The two with silver as one of the constituents gave yields that were the same as those obtained from the corresponding catalysts in which kieselguhr was used. The yield with the third catalyst were however about 10-15 per cent lower than those obtained with the standard catalyst.

Fundamental Measurements.

A modified Emmett apparatus was used to measure the surface areas of various catalysts. These areas were between 100 and 160 square meters per gram. Pelleting of the catalyst was found to reduce the surface area by about seven per cent. So far no relation has been found relating the surface area to catalyst activity.

The surface areas of two catalysts were found to be reduced by almost fifty per cent on reduction of the catalyst with hydrogen.

The apparatus was modified to enable the rates of carbiding and the rate of reduction of the carbided catalyst to be measured. The

results so far obtained show that on a good catalyst, the rate of reduction of the carbide is much faster than the rate of carbiding of the reduced catalyst. Further modification of the procedure is necessary to give a greater accuracy.

POPLAR PRODUCTS MARKET SURVEY

During 1946 information was secured from wood-using and wood-handling firms in Alberta and in other parts of Canada. This information disclosed the actual uses to which poplar is being put, and the opinions of users as to the suitability of the wood for various purposes. In 1947 work was directed toward estimating the quantities of poplar being cut for commercial uses in Alberta, and the quantities being absorbed in different uses. Further attention was given to the possibility of expanding the use of poplar for various purposes.

Accurate data on the amount of poplar cut and used for different purposes are not available and estimates had to be built up from scattered sources. These sources included the files of the Forestry Branch, Department of Lands and Mines; publications of the Dominion Bureau of Statistics; and information obtained from the surveys conducted under this enquiry.

Total accessible merchantable timber of saw log size in Alberta is estimated at approximately 2 million M. cu. ft., including spruce 55%, pine 19%, and poplar 22%. Total accessible merchantable timber under saw log size is estimated at over 12 million M. cu. ft., including spruce 18%, pine 53%, and poplar 27%. From these estimates it appears that, as the forest matures, pine will ultimately replace spruce as the main species; and, taking account of its more rapid growth, poplar will increase in relative importance.

Utilization of coniferous timber is estimated at approximately 100,000M. cu. ft. per year. Fire losses, based upon the average estimated losses 1930-45, are estimated as about 60,000 M. cu. ft. The annual loss from disease and insects is estimated at over 4,000 M. cu. ft. Total annual depletion is therefore estimated at over 160,000 M. cu. ft. It appears that the annual growth of conifers is sufficient to offset the over-all rate of depletion. However, the more accessible and perhaps the better stands of softwoods are being cut out; and local scarcities are therefore occurring.

The growing scarcity of softwoods would be accentuated if the overall demand for forest products increases. Current demand and utilization are high because of heavy construction programs; but this high level of demand may not be maintained continuously. Both domestic and export demand are uncertain over the next few years. Taking the longer view, increased utilization of forest products is to be expected; although for certain uses, the development of wood substitutes may check expansion. Under conditions of increasing over-all demand wood users will turn, as they have done during the period of war-time shortages, to the use of the inferior wood. The reasonable expectation is that the growing scarcity of the softwoods will be accelerated, tending in the long-run to an increased demand for and utilization of poplar. The situation in the immediate future is less assured.

The total amount of poplar entering into commercial channels is estimated at 2,860 M. cu. ft. in 1945; and 2,780 M. cu. ft. in 1946. Incomplete information in 1947 suggests some decreases in the

poplar cut of sawmills this year. Of the total for 1945, the largest proportion (estimated at 40%) was used in the construction of coal car doors. Other uses included poplar cut for own use and for local sale (20%), mine timbers (15%), construction and lumber (13%). All other uses including boxes and crates, furniture, and fuel accounted for about 12% of the total. In 1946 the estimated proportions were coal car doors (31%), construction and lumber (21%), mine timbers (19%), cut for own use and local sale (14%). All other uses including excelsior, plywood, boxes and crates, furniture, and fuel accounted for about 15% of the total. The bulk of the poplar "cut for use and local sale" is cut on settlers' permits and is presumably for the operators' own use. On the other hand, no estimate can be made of the amount of poplar cut annually on privately owned lands.

From information secured from the Forestry Branch, Department of Lands and Mines, it has been calculated that, in 1945, on timber leases and permits, 75 operators cut less than 20% of the total poplar cut; the remaining 80% was cut by 18 operators. In 1946, 80 operators cut about 30% of the poplar; the remaining 70% was cut by 16 operators. The most noticeable change between the years 1945 and 1946 was the increase in the amount of poplar milled for lumber. This was largely the effect of the policy and operation of one firm. There was also a significant increase in the amount of poplar used in the manufacture of plywood. Here again only one firm was involved.

The Dominion Bureau of Statistics estimates the total manufacture of primary forest products (Alberta) as the equivalent of 133,988,000 cu. ft. of standing timber, in 1945. Using this figure along with the estimates in this report, it appears that poplar comprises only about 2% of the total manufacture of primary forest products.

The immediate prospects for expanding the uses for Alberta poplar are, on the whole, less favourable than they were one year ago. However, there appears to be increasing interest in the use of poplar for pulp. Pulp for newsprint or wallboard offers the most promising tonnage outlet for poplar. At present a small percentage of poplar is being accepted by some pulping companies. However, before poplar can be used extensively the process must be improved or the competing species must become more scarce. The semi-chemical pulping process appears to be the most promising; although the pulp obtained from this process is not at present suitable for either newsprint or wallboard.

SOILS

The soil survey program started in 1945, in which the Alberta Research Council, the Dominion Department of Agriculture, and the University Department of Soils are co-operating, was continued in 1947.

In the Peace River area during the early part of the summer, field surveys were made north of Sexsmith, covering townships 75 to 80, ranges 5 and 6, west of the 6th meridian, inclusive, or about 276,000 acres. The major part of the summer, however, was devoted to the area east of range 21, west of the 5th meridian, including townships 73 and 74, ranges 17 to 19 inclusive; townships 75 and 76, ranges 17 to 20 inclusive; township 77, ranges 19 and 20;

and townships 78, 79 and 80, range 20. The areas covered this year are extensions of previous years' work, with the object of completing townships 75 to 80, from range 20, west of the 5th meridian, to range 6, west of the 6th meridian, inclusive, in order that a soils map of this area may be prepared for publication in the near future. A start will be made this winter on a map and report of this area, and with further checking in 1948, it is hoped to have a report ready for publication next year. The survey has been continued mainly east of this area, as stated above.

Much of the surveyed land has been burned over, and consequently may be cleared rather easily. Some areas are still green and have a fairly heavy tree growth, but there is not much timber to be found in the townships surveyed. Approximately 440,000 acres have been surveyed in the High Prairie-McLennan area this summer, and about 276,000 acres north of Sexsmith, or a total of approximately 716,000 acres in the Peace River district. In the High Prairie-McLennan area only about 30% (134,000 acres) of the land has been settled and partially broken. An estimated 35% (153,000 acres) are still suitable for settlement, and an estimated 35%, including water surfaces, peat bogs, sandy and hilly areas, should be left as pasture or timber land.

Roads other than the main highway are relatively few in the High Prairie-McLennan area, except in parts of range 20. Also, it should be pointed out that the field work this summer was delayed by frequent rains. Camps were located in the vicinity of Triangle and McLennan. The field work in the Peace River area was carried on from approximately the middle of May to the middle of September.

Wm. Odynsky of the Dominion staff was in charge of the Peace River district field party, and A. L. Brown of the Research Council of Alberta took charge whenever Odynsky was absent in connection with his work on the land clearing project near Wanham. The field work was inspected by A. Leahey of the Dominion Government and C. F. Bentley of the University Department of Soils during the summer, and J. D. Newton of the University Department of Soils in September.

A revision soil survey of the Red Deer Sheet and an extension of an earlier irrigation soil survey east of Taber was carried out during the summer. The field party consisted of Dominion men under the direction of W. E. Bowser.

In August, a survey of the soils of Alberta and Montana near the international border was made by a party of American and Canadian soil surveyors, in order to correlate the American and Canadian surveys and establish the points at which the soil zone lines should cross the border. This proved to be a useful and educational survey. The Albertans taking part in the survey were J. D. Newton, W. E. Bowser, Wm. Odynsky, T. W. Peters and C. F. Bentley.

During the summer of 1947 the Dominion Government had six men doing soil classification work and one other doing analytical work in the laboratory, while the Research Council had six men doing classification work, and one cook. Of the seven men employed by the Dominion, all but two were full time employees, whereas only two of the seven employed by the Research Council were full time employees. All of the Research Council men were

attached to the Peace River survey party, but in future, as recommended last year, the Council should have sufficient staff so that some provincial representatives could be attached to soil survey parties in other parts of the province.

UTILIZATION OF SAND

Two samples of quartz sand, collected by the Research Council geologist, one a beach sand from the east end of Lesser Slave lake, the other a partially consolidated sandstone occurring on the east bank of the Peace River valley and near the town of Peace River were submitted to the British Columbia Research Council for preliminary beneficiation tests. The work included screening, tabling, and magnetic separation. Samples of the treated sand were then analysed to determine their suitability for the manufacture of glass.

These tests indicate that the Peace River deposit contains sandstone suitable for the preparation of a silica sand for use in the glass industry. However, before the deposit is proven, it will require a detailed geological and development survey to determine the extent of the deposit, the uniformity of the sandstone in the deposit, the depth of overburden, and the ease with which the sand can be mined and purified. The tests on the sample of beach sand from Lesser Slave lake indicated it would be unsuitable as a glass sand.

The screening and tabling tests on the Peace River sandstone showed a recovery of over 70 per cent of a fine to coarse grained quartz sand which had the following composition:

Silicon dioxide (SiO_2)	98.8
Iron oxide (Fe_2O_3)	0.1
Aluminum oxide (Al_2O_3)	0.4
Titanium dioxide (TiO_2)	<0.1
Calcium oxide (CaO)	0.1
Magnesium oxide (MgO)	<0.1
Sodium oxide (Na_2O)	<0.1
Potassium oxide (K_2O)	0.2
Loss on ignition	0.2

Eighty-two per cent of the above material was non-magnetic and would have a lower iron content than is shown in the above analyses.

UTILIZATION OF STRAW

Physical and chemical tests were continued on samples of straw collected in 1946. During the summer three students completed all of the physical tests and 836 of the chemical determinations representing 16% of the 5,273 required in these samples. No sample has been completely analyzed although the analysis of eight straws have been nearly completed while four are about half finished. Nearly all of the work has been done on three samples of wheat straw and three of oat straw from each of Athabasca and Vermilion and a wheat straw from High River. Very little work on the chemical testing of Rescue wheat has been done.

The following example illustrates the values being obtained in the physical and chemical analysis of a straw:

SAMPLE OF THATCHER WHEAT STRAW FROM VERMILION

	Inter-node 1	Inter-node 2	Lower Inter-node	Nodes	Chaff	Leaf	Sheath
Moisture	5.03	4.79	4.67	7.05	5.96	6.41	5.30
Ash	3.76	3.93	2.72	6.86	8.46	12.02	8.99
Silica	0.19	0.43	0.42	0.22	5.83	5.41	0.81
Cold water sol.	7.44	6.56	4.39	17.54	5.89	13.79	9.49
Hot water sol.	15.82	14.33	12.18	26.59	15.71	20.74	17.64
1% alkali sol	34.76	29.90	27.71	33.97	36.75	43.12	43.80
Alc.-benz. sol.	9.44	8.59	7.50	11.83	8.92	16.59	11.32
Alpha cellulose	....	36.06	38.46	28.12	25.78	....	31.16
Cross & Bevan cellulose	....	53.28	54.24	38.67	39.67	....	46.41
Holo cellulose	70.39	71.22	68.79	60.47	72.26	56.52	67.67
Cellulose	54.63	52.00	59.16	40.46	50.93	39.02	46.22
Lignin	16.41	17.36	18.99	15.04	15.84	18.44	15.10
Pentosans	23.40	26.17	22.95	25.58	27.95	15.45	27.99

	Internodes				
	1	2	3	4	5
Average length in cm.	38.4	23.1	15.8	8.1	4.2
Average wall thickness in cm. (lower end)	.020	.024	.628	.046	.048
Average wall thickness in cm. (middle)	.018	.023	.025	.042	.047
Average wall thickness in cm. (upper end)	.025	.024	.027	.042	.050
Straw-grain ratio	1.80				

Although data are far from sufficient to make a detailed statistical study some conclusions may be inferred from those already available.

The wall thickness of the internodes increased from the top to the bottom of the plant while the internode length decreased. The increase in wall thickness was greater in wheat than in oat samples. The upper internode of Rescue wheat was similar in length and thickness to that of other varieties of wheat. The lower internodes were shorter and often solid.

The internodes were found to be the best source of cellulose. They had low ash and silica contents and low solubilities in hot and cold water, 1% alkali, and the alcohol-benzene mixture. Internodes one and two had a higher pentosan content than the lower internodes. The ash content of the nodes was high and the silica low. The cellulose was lower than in the internodes. Solubility was low in 1% alkali, but high in hot and cold water and alcohol-benzene. Ash, silica and solubilities were high in the chaff, leaf and sheath. These portions contained the smallest amount of cellulose. Holocellulose and alcohol-benzene solubilities were higher in wheat chaff than oat chaff. Lignin was higher in all portions of wheat with the leaf lignin in oats being particularly low. Ash was higher in the internodes and nodes of oats and in the sheath of wheat. The cellulose and lignin content are much lower than in wood while waxes, resins and gums, pentosans, water soluble material and material soluble in one percent sodium hydroxide are much greater than in wood.

Nine samples of straw from the 1947 crop have been collected. They are now being prepared and it is expected that the physical tests on these will be completed by spring.

It is hoped that the research on this project will be completed during the 1948-49 fiscal year by using five research assistants for the summer months of 1948.

ANIMAL CYCLES AND MEASUREMENT OF ULTRA VIOLET LIGHT

No progress was made during 1947 on the study of Animal Cycles since wire netting for rabbit enclosures was still unprocurable. However progress is reported on the Measurement of

Ultra Violet Light in conjunction with the Animal Cycle project. The Leeds and Northup recording apparatus with special photocell for measuring ultra violet light has been in continuous operation since September 1946. The data so obtained have been compiled and studied. The variation with seasons seem reasonable, but no special trends are noticeable or comparisons possible from one year's observations.

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.**
No. 51 (1947); 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 (Serial 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. 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. **(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.)**

Map No. 16 (1937); GEOLOGICAL MAP OF ALBERTA (Coloured), by J. A. Allan. Scale 1 inch to 16 miles. **Price 75 cents.** Obtainable from the Dept. of Lands and Mines, Administration Building, Edmonton.

Map. No. 17 (1939); GEOLOGICAL MAP OF ALBERTA (Black and white), by J. A. Allan. Scale 1 inch to 32 miles. **Price 5 cents.**

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. **Price $1.50.**

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.

Part III—Geology of Alberta Soils, pp. 87. **Price 25 cents.**

Part IV—Relief Model of Alberta and its Geological Application, pp. 9.

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. 19). **Price $1.00.**

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.

No. 10—Recent Work of the Research Council of Alberta, by E. Stansfield, Bulletin Canadian Institute of Mining and Metallurgy, No. 406, February, 1946, pp. 121-128.

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.