STATE OF ILLINOIS
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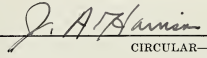
DEPARTMENT OF REGISTRATION AND EDUCATION
FRANK G. THOMPSON, *Director*

DIVISION OF THE
STATE GEOLOGICAL SURVEY
M. M. LEIGHTON, *Chief*
URBANA



CIRCULAR—NO. 143

# MINERAL RESOURCE RESEARCH, 1946-1947, BY THE ILLINOIS STATE GEOLOGICAL SURVEY

By

M. M. LEIGHTON, *Chief*

Reprinted from the Annual Report of the Chief to the Director,
Department of Registration and Education,
for Fiscal Year 1946-1947

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1948

*The Natural Resources Building on the Campus of the University of Illinois houses the State Geological Survey and the State Natural History Survey Divisions of the Department of Registration and Education*

# ILLINOIS STATE GEOLOGICAL SURVEY

*By* M. M. Leighton, *Chief*

The fact that Illinois occupies a place of distinction among the states of our Union rests in large part upon its abundant natural resources and the intelligent and judicious use to which those resources have been put.

*M. M. Leighton, Chief*

Its fertile acres — which have for years contributed so richly to the nation's food supply — are underlain by mineral wealth which places Illinois foremost among the states of the industrially significant upper Mississippi Valley area. This natural wealth, coupled with geographic location near to important market areas and at a veritable crossroads of transportation lines, assures Illinois of a prosperous and productive future.

Illinois mineral production in 1946, valued at $359,763,700, and exceeded by that of only 4 other states in the country, included the following:

| | |
|---|---|
| Coal | $ 160,763,800 |
| Oil and gas | 126,293,600 |
| Clay and clay products | 32,494,200 |
| Limestone and dolomite | 16,589,800 |
| Cement | 6,270,000 |
| Fluorspar | 5,493,600 |
| Silica sand | 3,156,800 |
| Gravel | 5,670,774 |
| Zinc and lead | 2,969,300 |
| Lime | 2,170,600 |
| Other sand | 2,750,200 |
| Ground silica | 767,200 |
| Mineral wool | 786,570 |
| Other minerals | 2,826,400 |
| Total | $ 369,002,900 |

Products of Illinois' mines constituted 50.8 percent of the revenue freight originating in the State in 1946. The remaining 49.2 percent consisted of: manufactures and miscellaneous, 32.7 percent; agricultural products, 13.1 percent; animals and animal products, 2.9 percent; and forest products, 0.5 percent.

The State Geological Survey, since its establishment in 1905, has been exploring in the field and laboratory the mineral resources of Illinois, conducting intensive fundamental research upon them with a view to increasing their usefulness and production, and has been providing accurate scientific information on them to owners, producers, manufacturers, consumers, and interested citizens.

Its scientific and technical staff includes 43 geologists, 18 chemists, 6 engineers, a physicist, a mineral economist, an editor, a specially trained librarian, and more than 25 college-trained assistants. It is organized to function as a well coordinated unit. The following chart shows diagrammatically the arrangement and integration of the various sections and divisions and the cooperative relations with other state and federal agencies (p. 98).

## Financial Statement

The following is a statement of funds available and expenditures for the fiscal year beginning July 1, 1946 and ending June 30, 1947:

| Appropriation Item | Funds Available—2nd Year | Expenditures to June 30, 1947 | Encumbrances | Lapsed Balance |
|---|---|---|---|---|
| Personal Services, Regular | 395,724 | 353,465 | ..... | 42,259 |
| Personal Services, Extra Help | 11,476 | 11,476 | ..... | ..... |
| Contractual Services | 9,148 | 7,665 | 1,483 | ..... |
| Office Expenses | 2,181 | 2,117 | 64 | ..... |
| Travel | 18,254 | 13,515 | 1,770 | 2,969 |
| Commodities | 21,117 | 19,489 | 1,628 | ..... |
| Equipment | 43,103 | 26,827 | 16,276 | ..... |
| Re-employment Reserve-Payment | 32,962 | 17,800 | ..... | 15,162 |
| Salaries Employees returning from Military Leave | | | | |
| Emp. Contribution to University Retirement System of Illinois | 2,886 | 2,886 | ..... | ..... |
| Topographic Surveys | 20,670 | 20,670 | ..... | ..... |
| Permanent Improvements | 1,400 | ..... | 1,175 | 225 |
| | 558,921 | 475,910 | 22,396 | 60,615 |
| Printing | 26,619 | 19,838 | 6,781 | ..... |
| Postage | 1,977 | 1,977 | ..... | ..... |

Cash Receipts to State Treasurer, July 1, 1946 to June 30, 1947 ..... $2,521.57

The expenditures through June 30, 1947, were distributed among the following activities:

| | |
|---|---|
| Coal | $ 92,483 |
| Oil and Gas | 33,134 |
| Industrial Minerals | 26,727 |
| Clay Resources and Clay Mineral Technology | 10,882 |
| Fluorspar | 6,997 |
| Ground-Water Geology and Geophysical Exploration | 36,672 |
| Engineering Geology and Topographic Surveys | 28,143 |
| Subsurface Geology | 35,785 |
| Areal Geology and Paleontology | 19,054 |
| Mineral Economics | 14,290 |
| Physics | 5,770 |
| Geochem. Administration, etc. | 17,588 |
| X-ray | 5,805 |
| Analytical | 17,377 |
| Educational Extension | 14,340 |
| Mineral Resources Records | 15,846 |
| Publications | 11,952 |
| Public Service (clerical, information office, mail distribution) | 30,876 |
| General Administration (Chief's office, financial records, motor cars) | 52,189 |
| | 475,910 |

## Coal

Coal production in Illinois during the current year totalled 62,554,000 tons and exceeded average annual production for the ten-year period 1937-1946 by 4.3 percent. Of this quantity, some 40,500,000 tons were shipped to other states; more than 26,000,000 tons for industrial use, nearly 14,000,000 to retail yards, and about 250,000 tons for by-product manufacture.

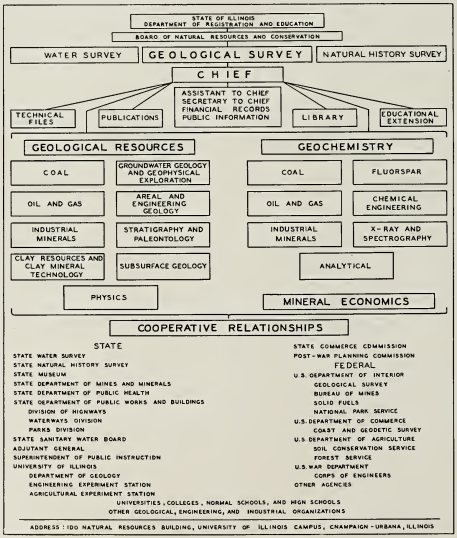
The year was marked by the opening of 15 new mines in Bureau, Clinton, Madison, St. Clair, Saline, and Williamson counties, helping to compensate for the closing of 14 mines which had reached their productive limit in Christian, Franklin, Fulton, Gallatin, Macoupin, Madison, Perry, St. Clair, Saline, Schuyler, and Vermilion counties. Exploration for additional workable deposits has been carried forward by diamond drill in Christian, Saline, Madison, and Edgar counties, and large-scale new developments are being started in Christian, Sangamon, Saline, and Jefferson counties.

1) *The search for new coal* has been given every assistance by the State Geological Survey in evaluating areas for prospecting, interpreting the results of diamond-drill testing, and in making available to operators and land owners information from the large assemblage of technical data in its files.

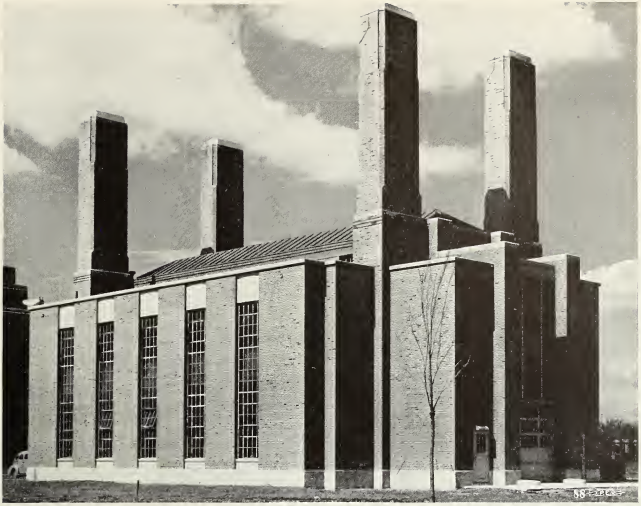
2) *A comprehensive inventory of the State's coal resources* has been appreciably increased during the current year through studies in the field and laboratory. This work has included the completion of a report on the "Coal Measures" strata of Clay, Edwards, Gallatin, Hamilton, and Richland counties; advancement of similar reports on Jasper and White counties; completion of the mapping of the No. 6 and No. 7 coal beds in Vermilion County with tabulation of drill-hole data; and the logging and study of 27 complete diamond-drill cores (9,300 feet) and of more than 8,000 feet of oil-well rotary drill holes.

Out of this systematic assembling, analysis, and interpretation of data comes a natural picture of the extent, quantity, and quality of our coal resources—a picture which is of inestimable value to coal operators and which is also instrumental in the location of structures favorable to the accumulation of oil and gas.

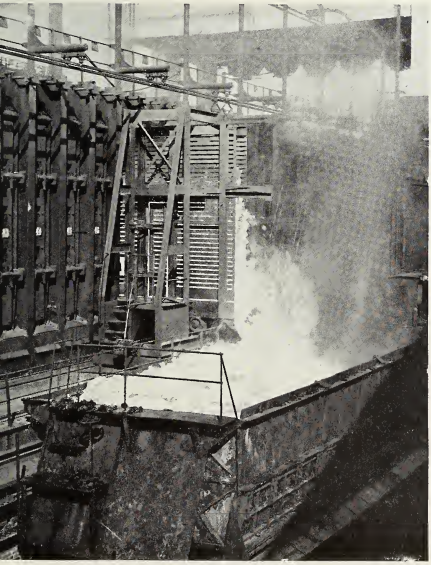
3) *Greater safety in mining* and possible reduction of costs are the goals of field investigations, undertaken during the year, of the rock strata composing mine roofs and secondarily the mine floors. A mining engineer and geologist of the Survey staff has visited numerous operating mines throughout the State and has conferred with mine inspectors and mining engineers in order to secure data which will lead to more complete knowledge of




*Organization chart.*



*The Geological Survey's Applied Research Laboratory where semi-plant scale experiments work toward improved products from Illinois mineral resources.*



*A battery of commercial coke ovens at a Southern Illinois plant.*

*Pulling a charge of coke from the Survey's experimental oven.*


*More than half of Illinois is underlain by the Coal Measures.*

the role which geologic information may play in increasing the safety of mining conditions.

4) *Recent use of Illinois coal in metallurgical coke* has resulted from experimental work on the coking properties of blends of Illinois coals with Appalachian coals. Normally 12 to 15 million tons of coal from West Virginia, Pennsylvania, and eastern Kentucky are shipped into the coke plants in the Chicago and St. Louis areas each year. The diversion of 1,000,000 tons of this market to the Illinois coal industry is an achievement resulting from the fact that the Survey's new experimental coke oven successfully duplicates the results of commercial ovens so that the experimental data obtained from it have attracted the interest of several large coke producers. At present prices it remained for experiments to demonstrate that certain Illinois coals of certain chemical and physical properties and of a certain size range were satisfactory for use in blends with Appalachian coals.

The oven, designed and constructed by members of the Survey staff, has itself aroused considerable interest, and requests for detailed plans of it have been received from various places in this country and from points as distant as India, Chile, and the Union of South Africa.

5) *The chemical nature of coal* is receiving fundamental study with a view to extending the use of coal as a chemical raw material and to improving present methods of storage, preparation, and utilization.

6) *Better stoker coals* are the objective of another line of investigation by the Survey. Systematic studies during the past several years have demonstrated the relationship between combustion characteristics of coal and its chemical and physical composition, with coal-size range held constant. During the past year, tests have been made and a report prepared on the effect of coal size upon its combustion characteristics, when chemical and other characteristics are held constant. Tests are currently being run on out-of-state coals to provide a basis for comparison with results obtained on Illinois coals. The results of these carefully controlled studies have proved of great interest to combustion engineers and stoker manufacturers, and will contribute to the improvement of commercial coals for domestic stokers.

7) *Briquetting of Illinois coal fines* without the use of binder at elevated temperature and pressure has been the subject of extensive research by the Survey, and a final report has been completed. This work has been in progress for several years and has proceeded from the experimental development of method on a laboratory scale through the design of large-scale equipment to determine the limiting factors in the commercial feasibility of the Survey's process.

8) *Microscopic examination of plant spores* contained in coal has proved a very valuable tool in correlating various beds of coal. This type of work has now been done on more than 900 samples of coal representing 48 counties.

9) *Coal is not of uniform texture* but is composed of bands of slightly different materials known as vitrain, clarain, fusain, and durain. This fact has long been known to research workers. Specialists on the Survey staff have for many years been studying these "banded ingredients" of coal, their combustion characteristics, ash content, heat value, physical separability, etc., and have published numerous reports of value to the coal industry. This work has been continued and during the past year has been focused on the development of a technique for producing coal rich in vitrain for stoker fuel.

## Oil and Gas

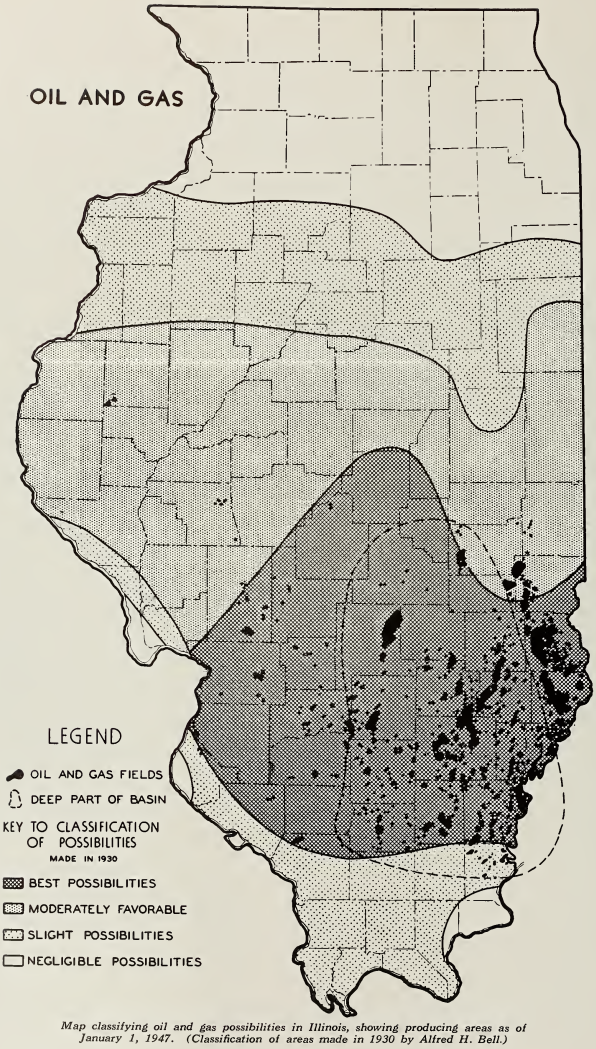
Illinois continued to hold 6th place among the oil producing states, with a total production of 71,734,000 barrels during the twelve months ending June 30, 1947. This has been made possible largely by the discovery of new small pools, extensions to old pools, and new "pay sands." From July 1, 1946 to June 30, 1947, 40 pools, 57 extensions, and 53 new pays in pools were discovered—a marked increase over the preceding twelve months.

Demand for crude oil and its products in the United States is at an all-time high. The economics advisory committee of the Interstate Oil Compact Commission estimates that the demand for oil in the United States in 1947 will average 5,700,000 barrels daily, or 7 percent above that in 1946. With this increased demand, and the higher crude oil prices now in effect, there is every incentive for activity in exploratory drilling and development and for increased use of secondary recovery methods of production.

10) *The discovery of oil* in the deeper part of the Illinois basin in 1937, which again placed Illinois among the ranking oil producing states, was stimulated to a considerable extent by studies and recommendations of the State Geological Survey. As recently as within the past few months, four oil pools have been discovered on structures described and recommended for testing in a Survey report published in 1936. This work was based largely on surface field studies in an area where, at the time, no deep drilling had been done.

11) *The vast fund of information* in the Survey's files on the strata which underlie the State is increased annually through the study of well records, including electric logs, drilling time logs, and the microscopic examination of drill-cuttings. From the expert correla-

*Scene on rig floor of rotary-drilled oil well*




*Map classifying oil and gas possibilities in Illinois, showing producing areas as of January 1, 1947. (Classification of areas made in 1930 by Alfred H. Bell.)*

tion of data thus assembled, maps and reports are prepared which enable the Survey to guide operators in their search for new pools and to assist land owners in evaluating their properties.

12) *Oil-producing beds* in certain areas of the State have been the subject of intensive study to determine such characteristics as thickness, porosity, etc., since variations in these characters can form "traps" in which oil, if present, will accumulate, even if there is no "structure" or deformation of the strata. Ability to locate such stratigraphic traps will be an important refinement in the search for additional oil reserves as deposits become harder to find.

13) *Special regional studies* are in progress on certain oil-producing zones in order to sharpen our knowledge of their exact geologic age and help reveal what potential oil-sands have heretofore been overlooked.

14) *Secondary recovery of oil* is becoming increasingly important with the gradual decline of flush production in the Illinois basin since 1937. The Survey's studies of artificial water-flooding of oil sands to flush the oil out were instrumental in the introduction, in 1943, of this method into practice in three widely separated areas. These three floods are credited with the recovery of about 6 million barrels of additional oil up to the end of 1946, of which about 2½ million were produced in 1946. To date, secondary recovery methods have been applied in only about 7 percent of the total oil-producing acreage of the State, and such methods as artificial water-flooding and repressuring by injection of gas into the oil "sands" will become increasingly important in extracting oil which normally remains in the rock strata after natural flow and pumping methods have been exhausted.

15) *Monthly drilling reports* tabulating drilling activities throughout the State have been continued. Revision has been completed on 42 development maps, each three townships square, and is in progress on others.

*Modern derrick marks another well drilling for oil in Illinois*

16) *An annual report* on oil and gas production in Illinois in 1946 has been published. These reports constitute a complete record of oil well drilling and pool discoveries since exploration began in the Illinois basin in 1936.

*Mining fireclay at Goose Lake, Illinois.*

## Clays

The value of clays and clay products produced in Illinois in 1946 was over $30,000,000, an increase of more than 64 percent over the value of 1945 production. Clay is one of the more important industrial minerals produced in the State. It embraces a wide variety of products and materials, such as face brick, refractory brick for blast furnaces, structural tile, drain tile, and ornamental tile, non-ceramic ingredients of various manufactured products, pottery and tableware, and is also used extensively as an industrial process material.

## Survey's Studies Attract International Attention

The Illinois Survey's clay research program, which is outstanding in this country, has attracted world-wide attention. During the year, research workers from England, Sweden, Belgium, Holland, France, and Australia have visited the Survey laboratories, and requests for publications, information, and assistance have been received from Denmark, France, Italy, Czecho-Slovakia, India, New Zealand, and South Africa.

17) *Location of deposits of special clays* results from the Survey's fundamental research on the composition and properties of Illinois clays and shales. From its steadily increasing fund of technical information on the intimate clay-mineral structure of clays, the Survey is able to give invaluable assistance to land owners, operators, and manufacturers in locating deposits of clays suitable for special uses and in solving technical difficulties encountered in processing them. During the past year, for example, the Survey has located additional areas of a particular high-grade ceramic clay much in demand by the industry, and on the basis of data provided by the Survey, a prospecting program is being undertaken by the industry.

18) *Use of clay in the filling of rubber* is one of the largest non-ceramic uses for certain kinds of clays, yet one for which no Illinois clay is used at present. Special investigations by the Survey led to the discovery that a clay in southern Illinois, as well as some shales now wasted in strip-mining operation, gives promise of being suitable for this purpose. The cooperation of the rubber industry has been enlisted to try out such material on a plant scale, and it is hoped that a new market for an Illinois resource may thus be developed.

19) *Clay minerals present in Illinois oil sands* are being studied to determine their effects upon the movement of fluid through the sands, their possible use as a key to the interpretation of conditions of deposition of ancient sediments and therefore as a possible means of recognizing source beds and locating new oil fields, etc. In addition, the control of drilling muds used in the rotary drilling process is based on an understanding of the clay mineral content of the mud. The oil industry has shown active interest in this type of research, and its national professional organization, The American Association of Petroleum Geologists, has sought the cooperation of the Illinois Survey's petrographer in furthering research along this line.

20) *Clay minerals affect the strength and stability of earth materials.* Work has been in progress during the year on an investigation to determine the influence of clay mineral content on the physical properties of earth materials as related to engineering problems encountered in foundation and construction work.

## Rock and Rock Products

Rock and rock products in Illinois in 1946 had a value of $25,400,000, an increase of 23 percent over 1945 production. The crushed stone industry is working on an overtime schedule, and 1947 is expected to be a year of high production. Sand and gravel operations in the State in 1946 were 25 percent above 1945, with a total value of over $10,500,000. Increased activi-

*Illinois quarries produce large tonnages of limestone for agricultural use, road building, railroad ballast, and many other uses.*

*Special high-powered microscopes reveal details of the structure of clays and enable Survey scientists to predict their behavior and to discover new uses for them.*

ty in many lines of construction since the end of the war has resulted in greatly enlarged demand for sand and gravel, crushed stone, cement, lime, etc., as evidenced by substantial increase in tonnages of these materials produced in 1946.

21) *Practical assistance* is rendered by the Survey to the rock products industries in locating favorable quarry sites or sand and gravel pits in deposits having properties which will most nearly meet particular specifications necessary to special uses.

22) *Illinois applies a greater tonnage of "agstone"* to its soils than does any other state, and the Survey gives special attention to the development of limestone suitable for agricultural use. Samples submitted by land owners are analyzed by the Survey free of charge, and during the year numerous new quarries have been opened. One development of particular interest has resulted from a careful study made by the Survey of well drilling data which revealed the presence of an extensive stratum of suitable limestone 20 to 30 feet thick in an area where no stone crops out at the surface.

23) *A new tool for the stone industry* to use in evaluating the life of a stone for various uses may result from an exploratory study, undertaken by the Survey during the past year, of the effect of the etching of limestones with various acids to determine the constituents and detailed structure of the stone.

24) *Further use of Illinois limestones and dolomites* is the objective of studies currently in progress on the soundness of certain limestones for special uses, on the physical and chemical properties of Illinois limestones and dolomites, etc., to determine their suitability for use as filter-stone, railroad ballast, and other purposes.

25) *Studies of Illinois silicas* have been continued in order to secure basic information on both the "hard silica" produced by crushing the silica sands of northern Illinois and the tripoli or "soft silica" of southern Illinois.

*Modern hydraulic mining of silica sand in an Illinois quarry.*

Such data, heretofore lacking, are essential to the industry in order that it may more thoroughly understand its product and market it for the maximum number of uses.

26) *Solving manufacturing problems* encountered in the operation of mineral wool plants, blast furnaces, glass plants, clay products kilns, etc., will be aided by the systematic data on viscosity of silicate melts now being obtained in the Survey's laboratories.

*Large glass sand quarry in Illinois*

*Laboratory for special research on fluorine and its compounds. The Survey has many such fully equipped laboratories.*

### Fluorspar

Illinois is the principal producer of fluorspar in the United States. In 1946, some 56 percent of the nation's output came from southeastern Illinois. Used primarily as a flux in the steel industry (53 percent of total production in 1946), it is nevertheless finding an increasingly important market in the highly diversified chemical industry where it is in demand for refrigerants (Freons) and other chemicals, for enamels, glasses, etc.

27) *Location of additional deposits* of this valuable mineral has been furthered by the Survey's field investigations in the fluorspar area of southeastern Illinois, and valuable assistance has been rendered to the operators in the district through geologic interpretation of their data. Laboratory studies are also conducted to obtain a more thorough understanding of the geologic conditions under which this interesting mineral is formed.

28) *Special chemical investigations* are in progress in the Survey's laboratories on the synthesis and properties of aromatic fluorine compounds with a view to their possible industrial applications. Discovery of new and improved syntheses of organic fluorine chemicals and new uses for them will increase the use of Illinois "spar" as a chemical raw material. Part of this work is currently being carried on under contract with the U. S. Navy's Office of Naval Research.

### Zinc and Lead

The mining of lead and zinc in northwestern Illinois, first undertaken by the U. S. Government in an area ceded by the Indians in 1816, played an important role in the development of the State and of the nation. It hastened exploration and the development of such cities as St. Louis, New Orleans, and Buffalo, whither it was shipped, influenced the building of one of the first railroads in the State (the Galena and Chicago Union R. R., 1855), stimulated steamboat trade on the Mississippi, and in many other ways colored the life and settlement of the middle west. Peak production, however, was passed by 1850 and decreased to virtual insignificance by the 1920's.

Spurred by the nation's war-time need for these strategic minerals and believing that there were more deposits there to be discovered, the State Geological Survey undertook intensive field work in the old producing area in 1943 and participated in the discovery of more than a million tons of additional zinc ore.

29) *Prospecting for zinc and lead* in northwestern Illinois has been greatly stimulated by publication of the Survey's report on the geologic aspects of prospecting and areas for prospecting in the region, together with the preparation of a structure map of the principal mineralized belt. From its branch office in Galena, the Survey has continued to render every possible assistance to prospectors and operators in the district.

### Groundwater Resources

Water supply will always be a prime necessity to human existence and development, and consequently it merits the critical and devoted attention of experts. In the past two years there has been a definite movement toward improvement of municipal water systems and plans for expansion by industries for post-war production needs. To help meet these needs and to aid in rational conservation, the Geological Survey cooperates with the State Water Survey where geological problems or information are involved.

30) *Special reports* are prepared on the geology of specific locations where water is needed. These reports tell the driller or land owner what kind of rocks underlie his land, in which of them water is likely to occur, and at what depths they will be found. During the past year the Survey's geologists have prepared 270 such

reports in response to requests from farmers, schools, municipalities, and industrial plants.

31) *Water-bearing sand and gravel* may often be detected by the behavior of an electric current when passed through the ground. The current passes more readily through dense shales and clays than through loose gravel. The higher resistivity of gravels to the electric current is noted in meter readings between the electrodes, and by making a series of such readings at regular intervals in different directions, an underground bed of gravel can be roughly mapped.

The Geological Survey pioneered in this type of scientific search for water supplies and has had great success. During the past year, electrical earth-resistivity surveys were made for 15 towns and 17 industrial plants. The Survey is scheduled many months ahead for this service.

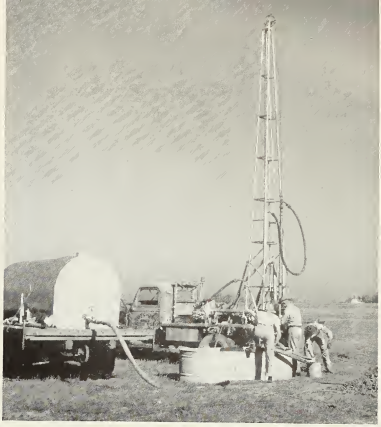
32) *Electric logging*, commonly used in oil-well engineering, was adapted by the Geological Survey a few years ago to problems of water well development and rehabilitation. Such surveys are usually made by commercial logging companies with Geological Survey representatives observing, running certain special logs where necessary, interpreting data, and recommending remedial measures. A large truck fully equipped with the necessary apparatus forms a very efficient portable laboratory. During the year, 17 geophysical surveys have been made on municipal and large industrial wells.

33) *Increased yield of water* can often be obtained from wells by injecting acid into the hole, under properly controlled conditions, so as to dissolve out deposits of lime which tend to clog the pipes and the "pores" of a water-bearing sand or gravel. The Geological Survey cooperates with the State Water Survey in administering this special treatment to water wells, and so far as could be determined, all acid jobs have resulted in increases in production.

34) *The Survey cooperates* actively with the Illinois Water Well Drillers Association, a member of the Survey staff acting as Executive Secretary and Publications Director for the Association.

## Engineering Geology

Geological conditions have an extremely important bearing on many engineering projects such as highway construction, dam and reservoir sites, foundation stability, etc. The Survey cooperates with other State and Federal agencies in problems of this type.



*Commercial drilling of a test hole for water supply. Survey staff members advise on geologic problems.*

35) *Special conferences* are held in both field and office with engineers and others relating to engineering problems. Where necessary, earth materials are sampled and studied, and many reports are prepared. During the past year, geologic information has been furnished on engineering projects pertaining to industrial plant construction, underground storage, the location of an airport, foundation materials beneath river locks, water supplies, etc.

36) *The development of conservation lakes* is an important aspect of the current program of the State Department of Conservation. The Geological Survey has cooperated extensively with its fellow State department in furnishing geologic information wherever requested. Reports were prepared on 23 sites scattered over the State, field examinations were made of 13 widely separated sites, test-boring samples were collected at 11 sites, and samples studied from eight sites.

37) *Cooperation rendered other State Departments* during the year included geologic information furnished

*The State Survey's Geophysical Laboratory.*


*Interior of the Survey's Geophysical field laboratory.*

to the Division of Highways on several highway construction projects and to the Division of Waterways on Fox River and Saline River valleys.

38) *Special reports for the U. S. Army Engineers* were prepared in connection with their projects relating to harbors, drainage districts, flood control, etc.

## Basic Scientific Studies

In addition to special projects related to individual resources, the Survey of necessity carries on a great deal of basic research in geology, chemistry, and physics for it is from new knowledge so gained that industrial enterprises multiply and more efficient operation results.

39) *Ancient coral reefs* have assumed a new significance since it was discovered by the Survey that the Marine oil pool in Madison County is located on such a "fossil" reef. Special attention has been given to strata of Silurian age in which coral reefs commonly occur, since it is now apparent that more detailed knowledge of the specific character of these ancient reef structures will prove another valuable tool in the exploration for deposits of petroleum and natural gas.

40) *Special field study* is being given to the stratigraphy of northwestern Illinois where more specific data will prove valuable in our search for additional deposits of zinc and lead and other resources.

41) *Fossils* contained in the rock strata under Illinois, as revealed in the areas of rock outcrop and in well cuttings, help in the correlation of rock formations which is basic to the discovery and interpretation of geologic structures that may control the location of mineral deposits. The Survey has continued its studies of these animal and plant forms, both large and microscopic, to increase its ever growing volume of highly specialized information.

## Mineral Economics

The economic trends in mineral production, transportation, and marketing are critical factors in industrial development, and through the employment of a mineral economist with a small staff of assistants to follow and analyze these trends, the Survey is in a position to furnish economic information desired by mineral operators, producers, and manufacturers throughout the State.

42) *Southern Illinois* has been the object of special study by a committee composed of staff members of the University of Illinois and the State Scientific Surveys. A report on the mineral resources of sixteen counties in southern Illinois was prepared as a part of a general study of the economic conditions in these counties.

43) *Fuels for the Illinois coal market area* have been studied and a compendium of data covering the area of fuel consumption in the states of the upper Mississippi Valley has been completed for early publication. A shorter report entitled, "Coke—A Key Industrial Material," has been published.

44) *"Conservation of Natural Resources*—A Manual for Teachers" is the title of a manuscript which has been prepared and is being considered for publication and distribution to teachers by the Bureau of Educational Research.

45) *An annual statistical report* on the Illinois Mineral Industry in 1946 has been prepared for publication. This work is carried on in cooperation with the U. S. Bureau of Mines, the U. S. Bureau of Census, and the State Department of Mines and Minerals.

## Topographic Mapping

In cooperation with the U. S. Geological Survey, a systematic program of topographic mapping is carried forward in the State each year. The ultimate goal of the Federal Government is to cover the entire United States with maps of this type. Through the progressive attitude of Illinois legislators in regularly appropriating funds to carry on this work, which is done on a dollar-for-dollar basis of cooperation, our State is now more than 80 percent mapped, and completion of the entire State is contemplated within the next few years.

46) *More than 2340.0 square miles* of territory, including 59.2 square miles of revision, were mapped topographically during the past year on a scale of one inch to the mile, and 184.4 square miles were mapped on a scale of 2½ inches to the mile; 194 man-days were spent on field control for stereoscopic mapping; 166.5 miles of third-order levels and 157 miles of third-order traverse were run; 52 permanent benchmarks, including one reset, and 46 permanent traverse stations were set. Three new quadrangle maps, including one advance edition, and 19 reprint editions of quadrangle maps, were published.

## Publications

Prompt publication of results obtained from research work is essential to its greatest effectiveness. Every effort is made to furnish information to Illinois citizens as soon as possible, consistent with accuracy.

47) *Publications issued during the year* include the following:

New Geologic Map of Illinois, engraved in colors, on a scale of about eight miles to the inch.

1. Bulletin 70—Pennsylvanian Ostracodes of Illinois: by C. L. Cooper.

2. Report of Investigations 117—Southern Illinois Novaculite and Novaculite Gravel for Making Silica Refractories: by C. W. Parmelee and C. G. Harman.

3. Report of Investigations 118—Preglacial Erosion Surfaces in Illinois: by Leland Horberg.

4. Report of Investigations 119—King Oil Field, Jefferson County, Illinois: by Stewart H. Folk and David H. Swann.

5. Report of Investigations 120—Correlation of Domestic Stoker Combustion with Laboratory Tests and Types of Fuels. II—Combustion Tests and Preparation Studies of Representative Illinois Coals: by Roy J Helfinstine and Charles C. Boley.

6. Illinois Petroleum 53 — Developments in Eastern Interior Basin in 1945: by Alfred H. Bell.

7. Illinois Petroleum 54—Oil and Gas Development in Illinois in 1945: by Alfred H. Bell and Virginia Kline.

8. Circular 122—Use of Electrical Geophysical Methods in Groundwater Supply: by Carl A. Bays.

9. Circular 123—Agstone Used in Illinois in 1945: by Walter H. Voskuil and Douglas F. Stevens.

10. Circular 124—What About Our Minerals? A Quiz Book on the Geology and Mineral Resources of Illinois.

11. Circular 125—Flood Tide in Illinois: by Frederick Squires.

12. Circular 126—Operation of the Illinois State Geological Survey: by M. M. Leighton.

*Field conference for science teachers at Gratton, Illinois.*

13. Circular 127—Coke—A Key Industrial Mineral: by Walter H. Voskuil.

14. Circular 128—Trends in Coal Utilization: by Frank H. Reed, G. R. Yohe, O. W. Rees, and Harold W. Jackman.

15. Oil and Gas Drilling Reports (mimeographed), issued monthly.

## Public Service and Educational Extension

48) *Public Information.* In addition to published reports, the Survey functions as a public information bureau on matters relating to mineral resources, their occurrence, distribution, and development. Through conferences and correspondence, the Survey stands ready to assist in the development and conservation of these natural resources.

49) *Educational Extension.* For nearly twenty years the Geological Survey has maintained an Educational Extension Division designed to assist the teachers of the State in presenting accurate material on earth science. Free identification of mineral specimens, informative correspondence with both teachers and pupils, free lectures to organized groups, the publication of popular educational pamphlets, exhibits at State and county fairs, and professional meetings, comprise the routine activities of this Division. Sets of rock and mineral specimens with printed labels and study manuals are distributed free of charge (except for mailing costs) to schools, scout troops, and nature study groups. During the past year 610 such sets have been placed. In addition, field trips, primarily for high school science teachers but open to all interested persons, are conducted by a member of the Survey staff. During the past year, six such trips were conducted in widely separated areas of the State.

## Geological Survey Devoted to State Industrial Development

The function of the Geological Survey as an agency through which the people of Illinois can avail themselves of accurate scientific information is of vital importance to the welfare and advancement of the State, and it is to this end that the Survey's research is devoted.

# BOARD OF NATURAL RESOURCES AND CONSERVATION

### The Board of Natural Resources and Conservation

The Geological Survey, the Natural History Survey, and the Water Survey are under the direction and control of The State Board of Natural Resources and Conservation. This board, created by the Civil Administrative Code in 1917, is composed of distinguished scientists, each qualified by at least ten years professional experience in his special field, and functions under the ex officio chairmanship of the Director of the State Department of Registration and Education. The personnel of the Board is as follows:

Chairman—Honorable Frank G. Thompson

Ex Officio Member—George D. Stoddard, President of the University of Illinois

Biology—Carl G. Hartman, University of Illinois, Vice President and Secretary of the Board

Chemistry—Roger Adams, University of Illinois

Engineering—Louis R. Howson, Chicago

Forestry—Lewis H. Tiffany, Northwestern University

Geology—W. H. Newhouse, University of Chicago

Under the law this Board selects and appoints, without reference to the State Civil Service law, all members of the technical staffs of the three scientific surveys. Traditionally nonpartisan, its members serve without pay. Membership is by appointment of the Governor, and it is a standing tribute to the broad vision of our State administration and to the abilities of the Board members that since the Board's inception, changes on the Board have been made only by the death or retirement of a member. Because several sciences, three different universities, and industry are represented by the Board membership, its points of view are broad and in the interest of the people of the entire State.

The Board, which meets at regular intervals, receives and carefully studies quarterly reports from the three chiefs of the Scientific Surveys. Members of the Board frequently make field inspections of projects with which they are most intimately concerned.

By their wise guidance of the individual Surveys and their coordination of the activities of these three organizations, members of the Board have through the years made valuable contributions to the development, intelligent utilization, and conservation of the State's natural resources. Their devotion to the responsibilities imposed upon them by law, their recognition of measures consistent with sound public policy, their comprehension of fruitful research programs, and their exercise of infinite care in selection of scientific staffs have brought national and international recognition of Illinois and its wealth of natural resources.

Although the three Scientific Surveys are administered by the State Department of Registration and Education, location of the Survey's headquarters and principal laboratories on the University of Illinois campus at Urbana offers many advantages. Research

*Frank G. Thompson*

*George D. Stoddard, President University of Illinois*

*Carl G. Hartman*

*Roger Adams*

*Louis R. Howson*

*Lewis H. Tiffany*

*W. H. Newhouse*

is furthered through the availability of the University libraries and some of the laboratories and experimental field-plots, and in like manner Survey facilities are made available to University staff members and some advanced students seeking professional training. Cordial relations and a generous exchange of information between University and Survey staffs make for prompt and effective dissemination of the results of research. Operational economy is also achieved by one system, maintained by the University, that provides water, heat, light and other services for the Surveys and the University.

### Headquarters, Offices and Laboratories

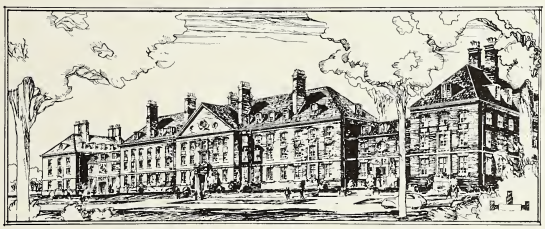
Because much of the work of the Water Survey is intimately associated with chemistry, headquarters and main laboratories of that organization are located in the William Albert Noyes Laboratory of Chemistry.

Until 1940, the Geological Survey had most of its offices and laboratories in the Ceramics Building, the Geological Survey Annex and other quarters, and the Natural History Survey, while maintaining headquarters in the Natural History Building, had many of its offices and laboratories in other buildings scattered over the campus. The need for modern scientific laboratories and centralization of staff personnel led to an appropriation of $300,000.00 by the Assembly of the State of Illinois in 1937, grants from the Federal Government of $245,454.00 and $22,000.00, respectively, and then in 1939 an additional appropriation from the State of $200,000.00 for equipment.

By July 1940, the first unit of the Natural Resources Building was nearing completion, and members of the Geological and Natural History Survey staffs were moving into their new offices and laboratories. The Natural Resources Building in its present form comprises this first unit, which was so planned that new units might be added conveniently and economically as expanding programs and staffs made necessary an increase of floor space.

Although the exterior of the building conforms to the stately Georgian design of other campus buildings, utility rather than beauty was the guiding principle in designing, constructing and equipping the interior. However, the foyer illustrates the decorative possibilities of certain Illinois building materials, and many of the laboratories exemplify the functional beauty concept of modern design.

To provide for the greatly increased needs of the Geological and Natural History Surveys growing out of natural expansion in the varied aspects of fundamental and applied research related to our vital natural resources, a post-war project approved by the Illinois State Post-War Planning Commission and made possible through legislative appropriation provides for the construction of wings to the Natural Resources Building. The final structure as planned and shown in the accompanying State Architect's sketch will constitute one of the finest and most complete units for research on natural resources in the country.



*Architect's sketch of proposed wings to the Natural Resources Building.*