


ILLINOIS STATE GEOLOGICAL SURVEY



3 3051 00004 0489



Digitized by the Internet Archive
in 2012 with funding from
University of Illinois Urbana-Champaign

<http://archive.org/details/mineralresourcer175leig>

STATE OF ILLINOIS
ADLAI E. STEVENSON, *Governor*
DEPARTMENT OF REGISTRATION AND EDUCATION
NOBLE J. PUFFER, *Director*

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

CIRCULAR NO. 175

MINERAL RESOURCE RESEARCH AND
ACTIVITIES OF THE STATE GEOLOGICAL
SURVEY, 1950-1951

BY

M. M. LEIGHTON, *Chief*

Preprinted from the Annual Report of the Chief to the Director,
Department of Registration and Education,
for Fiscal Year 1950-1951



PRINTED BY AUTHORITY OF THE STATE OF ILLINOIS

URBANA, ILLINOIS
1951
ILLINOIS GEOLOGICAL
SURVEY LIBRARY

FEB 7 1952



Figure 1.

The Natural Resources Building, on the University of Illinois campus, houses the offices and laboratories of the Geological Survey and the Natural History Survey Divisions of the Department of Registration and Education. The central unit of the structure was built in 1940 and wings added to east and west ends were first occupied in the spring of 1950.



Dr. M. M. Leighton

ILLINOIS STATE GEOLOGICAL SURVEY

By M. M. Leighton, Chief

Many millions of years have gone into the making of the great mineral wealth with which the State of Illinois is endowed, and thanks to judicious legislation, devotedly rigorous research, and enlightened industrial know-how, hundreds of millions of dollars are derived each year from Nature's original endowment. And from this basic wealth of materials many great enterprises spring. Though generally known as an outstanding producer agriculturally, few perhaps realize how much of Illinois' wealth is derived from its mineral materials. In 1950, minerals produced in Illinois were valued at more than half a billion dollars, distributed as follows:

Coal	\$236,576,000
Oil and gas.....	180,000,000
Clay and clay products.....	49,133,000
Limestone and dolomite.....	21,762,000
Cement	17,810,000
Fluorspar	6,111,000
Silica sand	4,958,000
Sand and gravel.....	10,986,000
Zinc and lead.....	7,422,000
Lime	4,465,000
Ground silica	2,278,000
Mineral wool }	200,000
Other minerals }	
	<hr/>
	\$541,701,000

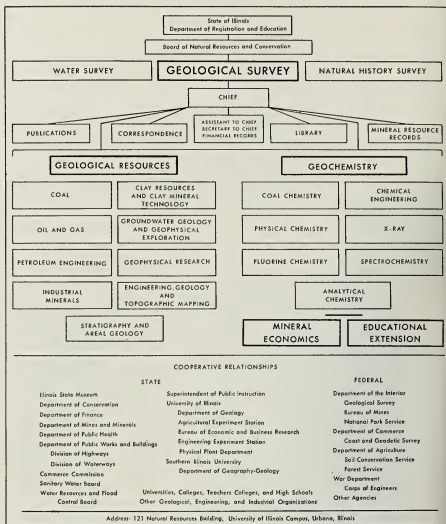


Figure 2.

In addition to the above, minerals processed in Illinois, though for the most part mined elsewhere, were valued at \$380,000,000 in 1950. These include pig iron, coke and by-products, slab zinc, sulphuric acid, and others. It is significant also that minerals and mineral products accounted for 54.2 per cent of the revenue freight originating in Illinois in 1950.

Purpose and Organization

Geologic investigations, sponsored by State Government, were first undertaken in Illinois as long ago as 1851, but they were, of necessity generalized in character and of brief and intermittent duration. The

State Geological Survey, in its present form, was organized in 1905, and fundamental work of ever increasing scope and sharpness has been in progress continually since that time. The Survey is charged with the responsibility of securing and distributing information on the mineral resources of the State. Research and investigation of a high scientific order is carried on both in the field and in the laboratory, and close contact is maintained with industries with respect to modern technological developments and needs. Through letters and personal conferences and its many publications, the Survey provides accurate information on the State's mineral materials and products, to land owners, producers, manufacturers, consumers, and interested citizens.

The Survey's organizational pattern is shown diagrammatically in Figure 2 and is designed to coordinate research in varied but closely related fields in order that the fruits of its effort may be well rounded and rooted in firm scientific soil. In 1950, its scientific and technical staff included 49 geologists, 21 chemists, 7 engineers, a mineral economist, a physicist, editors, librarians, and more than 20 specially trained research and technical assistants. The Natural Resources Building (see Figure 1), in which the Survey's research is carried on, was erected on the University of Illinois campus in Urbana in 1940 and enlarged in 1950. In it the Geological Survey has 40 laboratories equipped with the most modern scientific apparatus for geological, chemical, and physical research; x-ray and spectrography; photography; and administrative and research offices. A separate building (see Figure 3) provides facilities for large-scale experimental work on the commercial feasibility of processes developed in the Survey's laboratories.

Financial Statement

The following is a statement of funds available and expenditures for the fiscal year beginning July 1, 1950 and ending June 30, 1951.

The amount appropriated to the State Geological Survey for the biennium beginning July 1, 1949 and ending June 30, 1951 was as follows:

Personal Services:	
Regular Positions	\$1,095,730
Extra Help	30,010
Contractual Services	27,190
Office Expenses:	
Postage	5,425
Other	3,100
Travel	40,150
Commodities	64,525
Stationery, Printing, and Office Supplies.....	55,000
Equipment	66,675
Topographic Surveys	62,500
Employer Contributions to University Retirement System	28,225
	\$1,478,530

The amount appropriated to the State Geological Survey for the biennium beginning July 1, 1949 and ending June 30, 1951 was \$1,478,530. The unexpended balance on July 1, 1950 was \$799,923. Of this amount \$736,646 was allotted for expenditure, the balance of \$12,216 was allowed to lapse.

The actual expenditures and estimated expenditures on contracts through the year ending June 30, 1951 were distributed among the following activities:

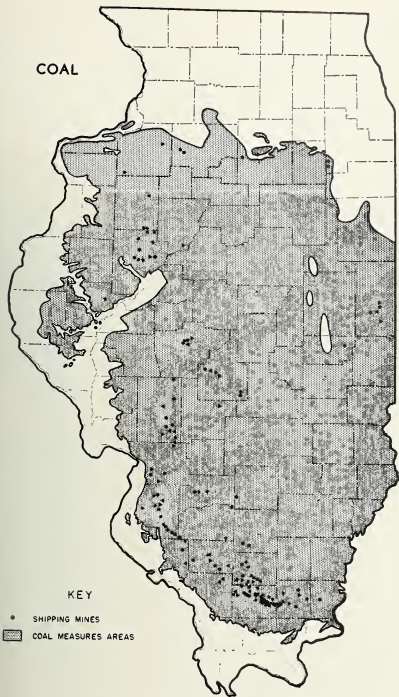
Coal (Geology and Chemistry).....	\$121,397
Oil and Gas and Petroleum Engineering.....	49,196
Industrial Minerals (Geology and Chemistry).....	45,125
Clay Resources and Clay Mineral Technology.....	14,531
Fluorspar—Fluorine Chemistry	12,729
Ground-Water Geology and Geophysical Exploration..	38,745
Engineering Geology	7,977
Topographic Mapping	32,965
Subsurface Geology	36,091
Areal Geology and Paleontology.....	18,480
Analytical Chemistry	49,183
X-ray	7,460
Physics	11,327
Mineral Economics	14,429
Educational Extension	12,073
Mineral Resource Records.....	25,089
Library	10,740
Publications, including printing.....	47,462
Geological and Geochemistry Administration.....	25,658
General Administration, including Chief's Office, Financial Records, Correspondence Files, General Information Office, Clerical Services, Technical Supplies, Postage, Retirement, and some Contractual Services	111,537
Other Technical Services, including Photography and Equipment Design	16,914
Automotive Service	15,322
	\$724,430

RESEARCH ACTIVITIES

Coal

More than 60 million tons of coal were produced in Illinois during 1950, an increase of some 17 million tons over 1949 production. Although four important mining operations in the State were closed during the year, having reached the economic limits of their properties, four new mines were opened and exploratory drilling was carried on a large tract east of Taylorville in Christian County and in an area in eastern Williamson County.

COAL



KEY

- SHIPPING MINES
- ▨ COAL MEASURES AREAS

ore than half of Illinois is underlain by the Coal Measures. Dots show locations of shipping coal mines as of 1947.

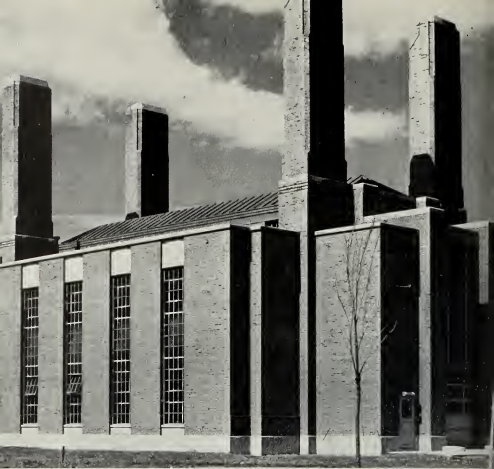


Figure 3.

The Geological Survey's Applied Research Laboratory where semi-plant-scale experiments work toward improved products from Illinois mineral resources. Located near the University's power plant.

1. *Locating commercially important coal beds* must continue if Illinois' most valuable industry is to thrive and to maintain its significant contribution to the Nation's production. The Geological Survey lends every assistance to this search for new coal by assembling records from widespread drilling activity in the State, evaluating areas for prospecting, interpreting diamond-drill tests carried on by the operators, and furnishing information on the rank of the coal. This service is based not only on the vast assemblage of records already in the Survey's files, but on continuous aggressive research to determine the position, extent, character, availability, and quantity of our coal resources. During the past year, reports were completed and prepared for publication on White County and on Shelby, Moultrie, and parts of Effingham and Fayette counties, and manuscript reports were completed on Wabash and on Jackson counties. A report on Vermilion County is nearing completion. Diamond-drill cores from 65 holes totaling 6,360 feet were logged. Information contained in these comprehensive reports is valuable also in the search for underlying geological structures favorable to the accumulation of oil and gas.

2. *A special inventory of coal resources* was undertaken a year ago at the request of the National Bituminous Coal Advisory Council of the Federal Government, in accordance with their adopted plan as recommended by the Chief of the Illinois Geological Survey for inventorying the Nation's coal reserves. Maps on a scale of 1 inch to the mile of 33 areas covering all the territory in Illinois underlain by coal (see Figure 4) were completed, showing the coal resources in four classes of occurrence. Class IA, proved; Class IB, probable; Class IIA, strongly indicated; and Class IIB, weakly indicated. Coal is further classified in terms of thickness at steps of 28, 42, 54, 63, 78, 90, 102, 114, 126, and 132 inches of thickness. The maps also show mined-out areas and the locations of oil pools or other areas closely drilled for oil and gas. Data relative to the coal resources in the different areas have been recorded on IBM punched cards.

3. *Nearly a million tons of Illinois coal per year* is now being used in the manufacture of metallurgical and foundry coke, as a direct result of the State Geological Survey's experimental work on the use of Illinois coal for this purpose. This investigation was begun in 1943 under the sponsorship of the War Production Board in order to materially reduce, if possible, the long freight haul of Eastern coal to Mid-Western coke and steel plants, and thus release rolling stock and personnel for other critical wartime needs. This initial objective accomplished, the Survey has continued its experimentation in order to extend both the percentage of Illinois coal that can be introduced into coking blends and the number and variety of Illinois coals from various parts of the State which can be so used.

This work has been of great interest to the large steel and coke companies of the Chicago and St. Louis areas, as well as to the coal producers, and members of the Survey chemical engineering staff keep in close touch with these industries, their technological problems and needs. One large steel company in the Granite City area has increased the percentage of Illinois coal in its blend to 75 per cent (20 per cent of this is from the Illinois No. 5 seam and 55 per cent is Illinois No. 6 seam), and now uses about 960 tons of Illinois coal per day.

The pilot oven of 500-pound capacity which was used for all this work was designed and constructed by members of the Survey's Geochemical staff, and proved so efficient an instrument of research that requests for blueprints of its design have come from many laboratories and plants in this country, as well as from Chile, South Africa, England, and Japan, and many actual installations have been made. A steel company in Pennsylvania has reported that its new oven, built last year from the Survey's design, is giving results nearer to those obtained in regular commercial plant ovens than can be obtained in any other experimental unit. A by-product recovery train makes possible the collection and evaluation of tar and gas products.

4. *Preparation of char from Illinois coals* and its use in metallurgical coke blends as a substitute for low-volatile coals is a companion project to the coking studies described above. A pilot plant, capable of continuous production of char at the rate of approximately one ton of

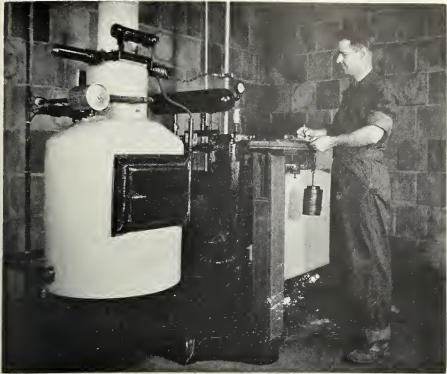
coal consumed per day, has been designed and constructed in the Survey's Applied Research Laboratory and work has been in progress developing char from different coals and evaluating them in blends for metallurgical coke.

5. *The development of improved stoker fuels* for domestic stokers has been the subject of continuing investigation in the Survey's Applied Research Laboratory. Earlier studies under carefully controlled conditions demonstrated the relationships between the combustion characteristics of coal and its chemical and physical composition, as well as the effect of coal size on combustion characteristics. Subsequent work carried on cooperatively with the Eastern Gas and Fuel Associates, the Stoker Manufacturers Association, and Battelle Memorial Institute has been directed toward the establishment of a standard stoker-boiler set-up and a standard code for testing domestic stoker coals.

6. *Sampling and analysis of coal* purchased by the State for its various institutions is done by the Geological Survey. A truck, equipped for taking samples and preparing them for analysis, has made the rounds of the 33 State institutions since coal shipments started on the present contracts in September 1950. The engineering staff at each institution is kept informed on sampling and preparation methods. It has been noted that the analysis of coals received by a number of institutions has

New mine of the Peabody Coal Company near Pana, Illinois.





Part of the Geological Survey's equipment used in stoker combustion studies.

improved materially during the present shipping year. From July 1, 1950 to June 30, 1951, 432 samples have been received in the Survey's laboratory.

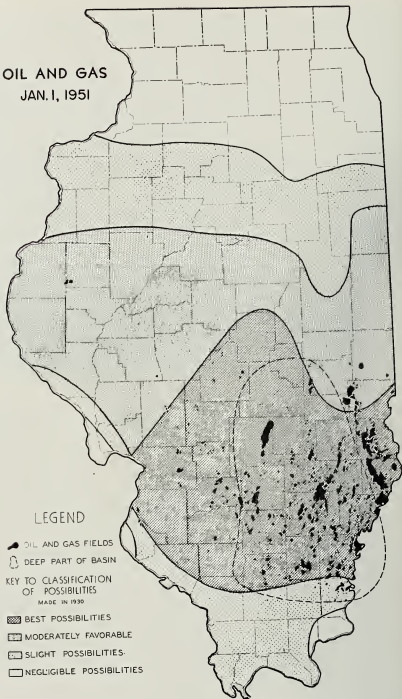
7. *Fossil plant materials* which accumulated in the bogs and swamps of ancient geologic times can still be identified under the microscope and by micro-chemical analysis. The Survey's fundamental studies on the botanical constitution of coal are outstanding among coal research laboratories. Identification of fossil plant remains reveals the nature of the original plant material, enables the geologist to interpret the conditions under which the parent coal was formed, and contributes also to the accurate correlation of the various coal beds.

8. *More complete knowledge of the real nature of coal* is being gained from fundamental chemical and physical research in the Survey's laboratories, directed toward the extended use of coal as a chemical raw material and the improvement of present methods of storage, preparation, and use.

Oil and Gas

Approximately 62,000,000 barrels of oil were produced in Illinois in 1950, keeping Illinois in sixth place among the oil-producing states of the Nation. Though no new major oil field was discovered during the year, the oil and gas industry maintained a high level of production

OIL AND GAS
JAN. 1, 1951



through the discovery of 24 new small pools, 58 extensions to old pools, and 20 new "pay sands" in old pools.

9. *Discovery of new oil resources* is essential to the maintenance of our country's present level of operation, both industrial and individual, as well as its supremacy in world affairs. To assist in this vital effort is one of the primary functions of the Survey's Oil and Gas Division. Through the collection and scientific interpretation of well records, the microscopic examination of drill cuttings, the preparation of structure maps and geologic reports, the Survey guides operators in their search for new oil pools and assists land owners in the evaluation of their properties.

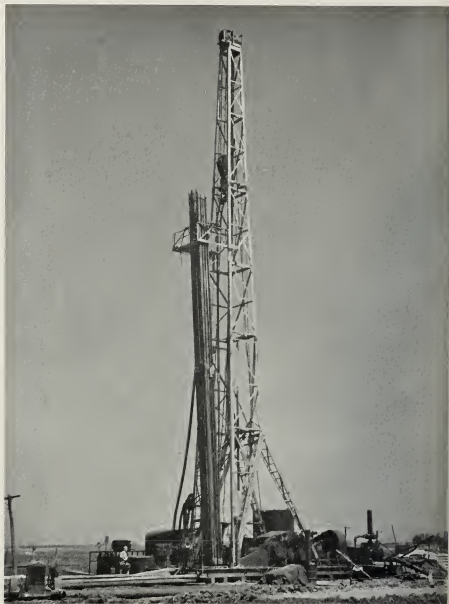
10. *A revised structure map* of the southern two-thirds of Illinois is nearing completion and will be published during the coming year. It is based on records of some 1,750 deep wells, as well as on careful extrapolations from records of shallower wells, and will be of great interest to the oil and gas operators throughout the State.

11. *Special geologic studies* of general and selected areas and of significant oil-producing formations have been made during the year. A report on the Eastern Interior Basin was prepared for the American Association of Petroleum Geologists' symposium, "Future Oil Provinces of North America," from which it is being reprinted as a Survey circular. A paper on the Waltersburg sandstone oil pools is being published in the Bulletin of the American Association of Petroleum Geologists. Another paper, entitled, "Primary Sedimentary Structures of the Aux Vases Sandstone," was presented at the November meeting of the Geological Society of America in Washington, D. C.

Coral reefs, which existed in the seas which covered Illinois during the Silurian age, have been found to be likely places for the accumulation of oil and gas and have been the object of search by oil geologists. Special attention has been given at the Survey to detailed studies of certain known fossil reefs, to learn more of the folding developed in the material which eventually buried the reefs and thus to sharpen interpretation of subsurface data.

12. *Underground storage of gas* promises to be of great interest to industry and to homes in Illinois. During the past year ten entirely separate organizations have sought information from the Survey, looking toward the storage of gas or liquid petroleum gases underground. Projects under consideration vary widely—from the storage of a billion cubic feet or less by utility companies in smaller towns, to the storage of hundreds of billions of cubic feet contemplated by the major gas pipe-line operators. The prevention of gas shortages and the great saving in steel, which would result from the successful underground storage of gas in Illinois, would be of tremendous importance during a national or regional emergency. Only from an agency such as the Survey could the mass of preliminary accurate geologic information necessary to the appraisal of such a project be secured.

13. *Monthly drilling reports* recording all current oil and gas operations are compiled, mimeographed, and distributed by the Survey and



Exploratory drilling in western Kankakee County for underground storage of gas.

are widely used by the petroleum industry, State and Government officials, landowners, businessmen, and others interested in being informed on current oil activity. At present, about 600 copies are mailed monthly.

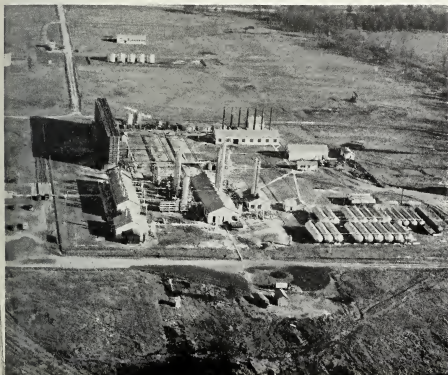
Development maps—on a scale of two inches to the mile, each 3 townships square and showing the location and status of wells—are revised every three months and are available in blueprint form at a very nominal cost. Such maps have now been completed for essentially all of the oil fields in Illinois.

14. *Annual statistical reports* on oil and gas development in Illinois are compiled, published by the American Institute of Mining and Metallurgical Engineers, and simultaneously reprinted by the State. Such reports have appeared each year since 1936 and constitute a valuable and uninterrupted record of oil and gas production and activity in the State since that time.

15. *Information service* of great value to professional geologists, operators, and land owners alike is rendered by the entire staff of oil and gas specialists of the Survey. During the past year, requests for this type of assistance by long distance telephone or office conference totalled more than 1,500. In addition, correspondence in response to written requests averaged about 100 per month. The extent to which the Survey's facilities are called upon is striking evidence of the significant contribution it is making to the welfare of the State. Only painstakingly accurate and thorough work through the years could lay the foundation and develop and correlate the data which makes such service possible.

Petroleum Engineering

To meet the continually increasing need for more comprehensive engineering data a new separate Petroleum Engineering Division of the



Gasoline and repressuring plant of The Texas Company at Salem, Illinois.

Survey was organized in February 1951, and two highly trained men with practical experience in petroleum engineering were brought to the staff. This new division will specialize in studies of secondary recovery problems, with particular reference to Illinois fields, interpret the expanded work in the measurement of gas-oil ratios, evaluate gas volume measurements, determine the porosity and permeability of oil reservoir rocks, and derive other engineering data designed to aid in the most efficient development and in prolonging the life of one of the State's most valuable resources. Apparatus has been purchased to equip the new oil, gas, and core-testing laboratory, and additional needed equipment is on order.

16. *The secondary recovery of oil*—whereby oil remaining in the ground after natural flow and pumpage have approached the limit of commercially profitable production is forced out of the rock by injection of water or gas—is becoming of ever-increasing importance to the Illinois oil industry as the discovery of new major pools declines. The Geological Survey was instrumental in promoting the adoption of the water-flooding method in Illinois some years ago. It is estimated that since the introduction of this method in 1943, 19 million barrels of oil have been added to the State's total production. During the past year a report entitled, "Summary of Water-Flooding Operations in Illinois in 1950" was prepared and published jointly by the Illinois State Geological Survey and the Interstate Oil Compact Commission.

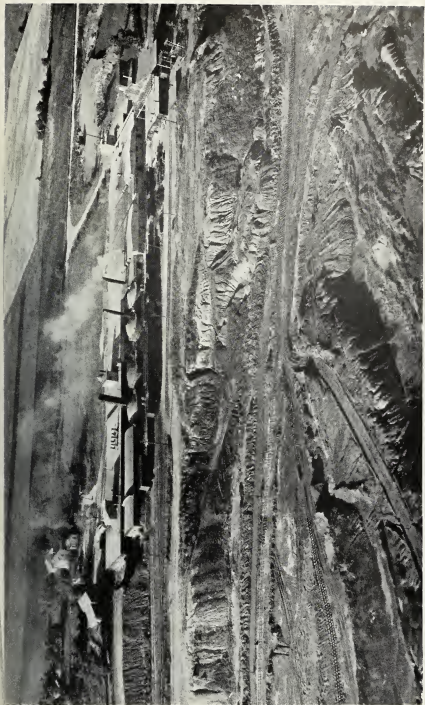
17. *Other petroleum engineering field studies.* During the year volume measurements have been made on 66 gas wells and over 100 samples were collected and analyzed; gas-oil ratio determinations were made on 138 wells; 76 samples of oil-field brines were collected for analysis.

Clay and Clay Products

Though unspectacular in the popular concept, and seldom, if ever, making "news" as do oil and coal, clay and clay products in Illinois in 1950 were valued at more than 49 million dollars and constitute one of the State's major mineral industries. The value of 1950 production represents an increase of more than 28 per cent over 1949 production and was made up as follows: Structural clay products (common, face and paving brick; drain, structural, and ornamental tile, etc.), \$18,707,755; refractories, \$9,227,648; and whiteware and pottery, \$20,019,908. Approximately 10 per cent of the brick output of the entire Nation is produced in Illinois.

18. *Survey's research world famous.* Aware of the importance of these homely materials to the industrial welfare of the State, the Geological Survey initiated a comprehensive program of clay research in 1931. In the 20 years that have elapsed since this was undertaken, the Survey's investigations have become so well known that research workers from many foreign countries have come to Urbana to visit its laboratories and observe its techniques.

19. *Information of great value to the clay industry* is derived from the Survey's fundamental research. Mineralogic and x-ray studies have



Airplane view of Illinois Clay Products plant in northern Illinois.

revealed that clays are composed of a variety of clay minerals, the predominance of any one exerting a strong influence on the properties of the clay. Laboratory investigation of the behavior of the various clay minerals at elevated temperatures, or of the effect upon the clay of the addition of small amounts of certain chemicals, have developed information of great importance to the clay industry in the firing of ceramic ware and in solving many other processing problems. Close contact is maintained with the industry to keep the Survey's laboratory work oriented to current technological problems and thus to serve the general good most effectively.

20. *A complete inventory of clay and shale resources* of the State continues to be the goal of another long-range project of the Survey. Information on the occurrence and properties of all types of Illinois clay materials is essential background to the application of detailed knowledge to specific problems of utilization of these resources and to the possible development of new or improved uses for them. Field sampling and laboratory analysis of clay deposits continue to increase the Survey's ability to guide operators in locating deposits of clay having the special properties needed to meet industrial specifications.

During the year, the outline of a report on the resources and properties of high-grade clays in western Illinois was refined, the part dealing with Adams, Brown, and Cass counties was completed, and that on Fulton County is in progress. The mineral composition and properties of approximately 25 miscellaneous samples of clay from various parts of the State were determined.

21. *Plastic and high-temperature properties of certain clays* are being studied in a project carried on cooperatively with the Engineering Experiment Station of the University of Illinois and a large clay products company. Results to date indicate that bonding sands, bonded with certain Illinois clays, exhibit flow and compaction properties superior to those of sands bonded with the costlier bentonite which comes from outside the State. Study is also being made of the fundamental properties of a number of flint-like refractory clays forming the basis of the huge refractory industry in the country. These clays occur in Illinois as well as in several other states.

22. *Special studies* are in progress on the efflorescence on brick to throw light on the relationships between efflorescence and the materials used in the construction of brick masonry walls, and to apply scientific information to the solution of efflorescence problems related to the manufacture of bricks and their use in the building and construction industry. During the year tests were made on about 200 bricks and analysis of the efflorescent salts is in progress.

23. *Information critical to the oil industry* lies in the determination of the amount and kind of clay mineral content in an oil-producing sand. This is of particular significance in connection with water-flooding operations, which would be doomed if clogging of the pores of the oil sands were to occur. A representative series of cores of oil-producing beds is being gathered and separation of the clay mineral content is being made by the use of an ultrasonic vibrator, constructed by a member of

the Survey's technical staff, to enable tests to be made of their tendency to swell.

24. *Clay mineralogy affects soil mechanics*, which in turn, are of vital importance to the construction engineer who must be able to predict how a particular soil will settle in the course of time under the consolidation of load, drainage, etc., which are superimposed upon it. The Survey is conducting a special investigation of the soil mechanics properties of pure clay materials to develop information which will assist the engineering profession in meeting these types of problems.

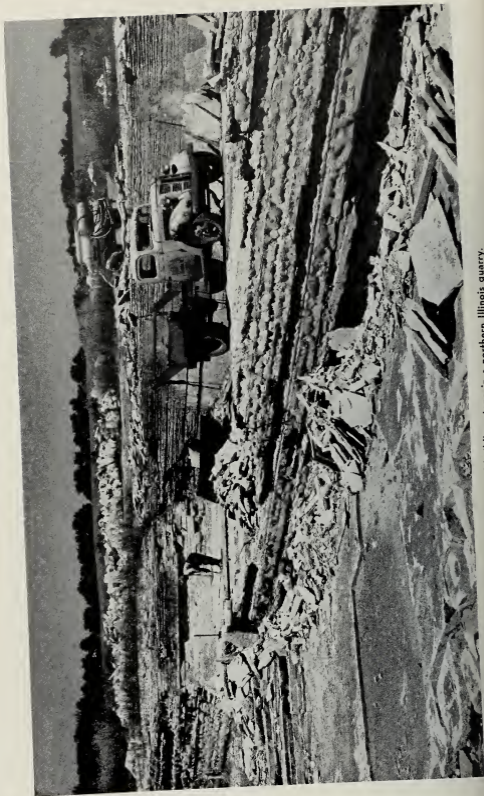
Rock and Rock Products

More than 450 plants in Illinois produced rock and rock products, and sand and gravel, valued at more than \$62,000,000 in 1950.

25. *Location of new quarry sites* is a continuing need in the stone industry, and the Survey renders valuable assistance to producers in this search. From no other source can interested persons secure authoritative information on the extent, thickness, and quality of deposits of stone, sand or gravel. Through the years, Survey geologists have been exploring, sampling, and testing the various rock formations over the State in order to secure the analytical information necessary to the location of deposits having the properties which will meet the needs of industrial specifications for particular uses.



Pit producing chert gravel for road material—Alexander County, Illinois.



Production of building stone in a northern Illinois quarry.



Loading limestone in a large Illinois quarry for the production of concrete aggregate, road material, agricultural limestone, and other purposes.

Particular attention was given this year to limestone and gravel resources within a radius of about 25 miles of Joppa, Illinois, in response to numerous requests for data on sources of concrete aggregate and road materials in connection with the announced plans of the Atomic Energy Commission for the construction of a \$500,000,000 uranium plant near Paducah, Kentucky, and the projected \$73,000,000 power plant to be built near Joppa, Illinois.

26. *Agricultural limestone* is used in larger quantity in Illinois than in any other state. The Survey tests samples of stone free of charge, and thus assists land owners and producers in developing deposits of suitable stone. A new map showing in detail those areas wherein limestones more than 3 feet thick crop out was completed during the year. This map classifies limestone resources into 9 different categories, according to the character and composition of the deposits, so that it is valuable not only in connection with agricultural limestone resources but also as a guide to limestone resources for other purposes. During the past year, also, there has been increased interest in the kind and amount of trace elements such as zinc, copper, magnesium, boron, cobalt, and iodine, in limestones used for agricultural stone and mineral feeds for stock, in connection with plant and animal nutrition. The Survey has accordingly undertaken an investigation to obtain trace element data on Illinois limestones.



Gravel pit near Shelbyville, Illinois.

27. *High-purity limestones* are much in demand for flux, lime, carbide making, and other purposes. In recent years, interest in such limestones has focused on deposits near water transportation in southern and western Illinois. To increase the Survey's fund of knowledge regarding such resources, samples were obtained from exposures of the Ste. Genevieve limestone in southern Illinois, and the Kimmswick limestone in western Illinois. Promising thicknesses of high-purity stone were found in both areas.

28. *Fundamental research on Illinois limestones and dolomites* is in progress to develop comprehensive information on the mineralogy, lithology, composition, and properties of various limestones and dolomites in order to develop a better knowledge of these rocks and to extend their use.

29. *The State's sand and gravel resources* continue to receive study in order that the Survey may assist operators, construction engineers, and foundries in their search for deposits which will yield materials adapted to their particular needs. During the past year, a gravel resources map was prepared of Kane County showing the distribution and general commercial characteristics of the deposit.

30. *Basic information on the silica resources* of the State, available only through the Survey's research, is furnished to operators and producers both on the "ground quartz" silica produced in northern Illinois, and on the "soft," or micro-crystalline quartz of southern Illinois. In recent months, an investigation of the occurrence and character of the iron oxide in the deposit of a large producer of silica sand in the Ottawa district revealed the presence of certain beds having an especially low iron content. Subsurface hydraulic mining is now in progress to produce sand from these beds for uses requiring a very low iron content.

31. *Chemical research on silicate melts* (mixtures of lime, magnesia, alumina, and silica at high temperatures) is in progress in the Survey's laboratories to apply fundamental information obtained to the study of industrial problems encountered in the manufacture of mineral wool, ceramic products, pig iron, and steel. Two reports on this work have been published, and two further reports are planned.

Fluorspar

Shipments of fluorspar at Illinois mines in 1950 amounted to 154,623 tons which was slightly more than 51 per cent of the total amount produced in the entire United States. Production in 1950 exceeded that of 1949 by approximately 28 per cent. Though used principally as a flux in the steel industry, half of the fluorspar produced in Illinois—and the more valuable half—goes to the ever-widening chemical market where it is in demand for manufacture of refrigerants and other fluorine compounds, for atomic research, for insecticides, and for medical research.

32. *The search for additional deposits* of this critical mineral must be continually furthered if supply is to keep up with the increasingly important demand. The Geological Survey has made extensive field

studies in this area of southeastern Illinois in the past and continues to assist operators and producers by the geologic interpretation of exploratory drilling and by investigation of new field methods for the location of veins of spar. During the past year manuscript was completed for a bulletin on the flourspar district, illustrated with drawings and maps, and early publication is planned.

33. *Research on the chemistry of fluorine* and fluorine compounds carried on in the Survey laboratories has gained nation-wide prestige in this highly specialized field. The primary objective is to develop through fundamental studies of fluorine and the synthesis of organic fluorine compounds more diversified use of Illinois spar as a chemical raw material. Many important applications of the results of this work have already been made. The furnishing of a sample of a rare fluorine compound produced in the Survey's laboratories, for example, contributed to the early success of the Manhattan Project. Experimental samples have been requested from the Survey for use in cancer research and other medical and pharmaceutical fields. Currently, also, cooperative work is under way to furnish a fluorine compound to a member of the State Natural History Survey's research staff for research he is performing on fungicides under a special grant by the U. S. Air Corps.



Head frame for bringing zinc ore to the surface at a northwestern Illinois mine and plant for separating ore from waste rock.

Zinc and Lead

Revival of the old lead and zinc producing area of northwestern Illinois—which played so important a role in the early settlement and history of this part of the Middle West but which fell into comparative oblivion shortly after the turn of the century—has resulted largely from field work of the Geological Survey in this area in 1943 under the impetus of wartime need for these minerals. Prospectors and operators were encouraged to re-enter the area, and large bodies of zinc ore have been discovered.

34. *A field office in Galena* is maintained by the Survey where a small staff is permanently stationed. Survey geologists assist operators by the geologic interpretation of their findings, study ore deposits and their relationships to surrounding rock, map geologic structure, and furnish other pertinent information.

35. *Structure mapping* was done during the past field season over a 30-square-mile area beyond the limits of previous mapping. In addition, revisions of the earlier maps in the light of data secured from subsequent drilling were placed on open file both in the Galena and Urbana offices. Many companies and individuals interested in this recent mining activity have expressed great appreciation of the work the Survey is doing and the assistance it is rendering to them in the development of the area.

Groundwater Resources

The great importance of adequate water supply to the welfare, both individual and industrial, of every community and to agricultural prosperity is evident to all. The Geological Survey maintains a full-time staff of 8 trained geologists, a draftsman, and a technical assistant, to study and report on the geology of groundwater resources.

36. *Special reports* are prepared on the geology of specific locations where water is needed. These reports tell the driller or landowner what kind of rocks underlie the area, in which of them water is likely to occur, and at what depth it will be found. During the past year, 216 such reports were prepared, of which 96 were for private citizens, 52 for municipalities, 47 for industries, and 21 for public institutions. In addition, some 56 technical and geophysical problems were handled by correspondence.

37. *Geologic interpretation of the results of test drilling* are made by Survey geologists through microscopic examination of drill cuttings and mechanical analyses of sand to assist drillers in the evaluation of their testing.

38. *Subsurface geologic studies of bedrock aquifers* are made. During the past year special study was given to the Ironton-Galesville aquifer and research on the geologic aspects of this and other water-bearing formations in northern Illinois is in progress.

39. *Glacial deposits near Mattoon* are being studied to gain more detailed knowledge of the occurrence of favorable shallow gravel aquifers in an area where major water-bearing deposits are very limited.

40. *Electrical earth resistivity surveys* are made to discover the location of extensive underlying gravel deposits which might carry large quantities of water. The Survey pioneered in this method of locating water supplies, which has proved very effective in directing the placement of test holes and has saved much needless and expensive testing in areas barren of such deposits. During the past year, 31 resistivity surveys were completed, including one to determine the presence or absence of peat in several bogs along the right-of-way for a proposed highway relocation. Of the 30 surveys made to locate water supplies, 15 were deemed unfavorable, and of the 15 which showed good prospects the 6 which have been tested were all water producing.



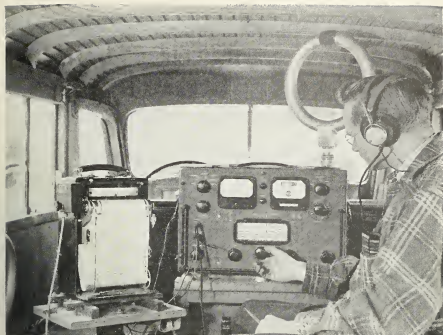
Water well in Champaign-Urbana area located by the Illinois Geological Survey through the earth resistivity method. (Champaign-Urbana Courier photo.)

41. *Field conferences* with regard to various geologic problems of groundwater resources were held at 19 different localities during the year.

42. *Cooperation with the Illinois Water Well Drillers Association* has been continued, a member of the Survey staff serving as Executive Secretary of the Association. This cooperative effort is extended to promote the science and art of water supply development.

Geophysical Research

43. *Pioneer work by the Survey* on the geologic aspects of radio-wave transmission has been recognized by the U. S. Army Signal Corps



Geophysical prospecting. Especially equipped mobile laboratory for investigating geological conditions and deposits underground by the use of radio ground waves.

and consultants are now engaged in an investigation of the propagation of electro-magnetic waves through rock formations of various lithologies. The Survey is continuing research on the subject and plans to carry out certain phases of the work in informal cooperation with the consultant to the Army's Signal Corps.

44. *Refinements of earth resistivity techniques* are the goal of another line of geophysical research. A new direct current instrument was designed and constructed by members of the Survey staff and field testing to date indicates its sensitivity to be such that it may be useful in revealing different kinds of rock materials other than water-bearing gravels.

Engineering Geology

Large engineering projects such as those involving problems of highway construction, the selection of suitable sites for dams and reservoirs, or the stability of earth materials for foundations for large structures almost invariably involve problems relating to the geologic conditions at the site of construction. The Survey's Engineering Geology Division cooperates with Federal and with other State agencies on problems of this type.

45. *Geologic assistance on engineering problems* is rendered through field and office conferences. Where necessary, earth materials are sampled and studied and reports are prepared. During the year this type of cooperation was extended to the State Division of Highways in regard to geological conditions to be expected between Rantoul and

Paxton in Champaign and Ford counties, a landslide along a State highway near Rockwood in Jackson County, and a problem of bog conditions affecting proposed reconstruction of a highway northwest of Barrington in Lake County; to the State Division of Waterways on the Mississippi Valley bottoms north of Quincy in Adams County, on flood control projects in the vicinity of Ottawa in LaSalle County, and on the location, rate and volume of beach erosion and accumulation along the shore of Lake Michigan; to the DuPage County Health Department in connection with the possibility of pollution of groundwaters by the development of proposed sanitary land-fill disposal of garbage under consideration by the Department; to the U. S. Geological Survey in connection with its sonar investigation of the bedrock surface under the glacial drift of lake sediments along the Chicago shore of Lake Michigan (in this connection, the Survey's recently published Bulletin No. 73, "Bedrock Topography in Illinois," has proved extremely useful); to the Peoria Airport regarding the subsidence of its apron into mined-out areas beneath it; and to many local groups referred to the Geological Survey by the State Department of Conservation in connection with proposed dam sites for recreational lakes.

The Geological Survey, as a matter of policy, steadfastly refrains from entering the field of the consulting engineer, and confines its assistance to furnishing geologic information basic to the engineering aspects of the problems involved. Such information was furnished during the year on proposed dam sites for a 4-H Camp at Allerton Farms, an area near Polo, another near Westville, and one in Cook County; on potential reservoir sites along Kaskaskia River and its tributaries for impounding water for use in water flooding in the Salem oil pool; on geologic conditions relating to the foundations for prospective large structures in the vicinity of Litchfield, East Peoria, Joppa, Decatur, Carbondale, and northwest Champaign; and on the geologic conditions affecting footings of a suspension bridge for a pipeline crossing of the Mississippi River in the vicinity of Grand Tower, at the request of the consulting engineers on the job.

Basic Scientific Studies

The fundamental information essential to the solution of specific practical problems can be developed only from long range basic research in geology, chemistry, and physics, and this type of work is continually in progress at the Geological Survey.

46. *Subsurface studies of rock formations* lying deep under ground are made by the microscopic examination of drill cuttings from test holes and deep wells. During the year, 26,960 samples from 487 wells, a drilling distance of more than 37 miles, were examined by the Survey's Subsurface Geology Division. Geologic logs are prepared from these studies, and the basic information obtained on the identity, character, and extent of rock formations is of inestimable value in the location of mineral deposits.

47. *Local as well as regional correlation of rock strata* is continually being refined through detailed studies of certain significant rock formations. During the year, particular attention was given to the

succession of shales, limestones, and silt stones in the area of Illinois adjacent to the Mississippi River, and 9 detailed cross-sections were drawn, one of them in Illinois east of the river from Henderson to Calhoun County, one in Missouri and Iowa west of the river from Burlington to south Louisiana, and seven in a west-east direction across the river but largely in Illinois. Similar studies were made of the Chester series and upper Ste. Genevieve formation in southern Illinois, of the Tar Springs sandstone in southern Illinois, and of the Chouteau limestone in Jersey and Calhoun counties and nearby counties in Missouri.

48. *Refinements of correlations* are also made possible by the study of insoluble residues and by the determination of small amounts of mineral materials in certain formations. During the year a special study was made of the insoluble residues of the Lingle-Grand Tower limestones at points of outcrop in Illinois and in Missouri, and results to date give promise of the possibility of more accurate correlation between the classic sections of Illinois and Missouri. Heavy mineral studies were also made of the Galesville sandstone in northern Illinois.

49. *Special field studies of geologic formations* as they occur at the surface continue to yield detailed information of great value in interpreting these same formations as they are encountered in mines and drill holes and in working out various problems relating to the location

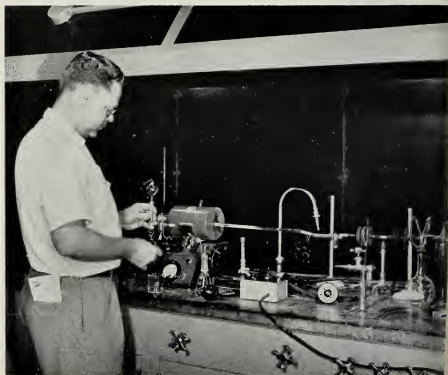


Part of the Geological Survey's rock-analysis laboratory.

of mineral deposits. Such field studies of geologic strata of Ordovician age have proved of much economic importance in connection with interpretation of problems encountered in the search for lead and zinc in northwestern Illinois. Special attention has also been given to the glacial deposits of the State and much information contributive to the correct interpretation of the geologic history of that period—particularly significant in connection with water resource studies—has been gained. A special field investigation was made of the deeply buried Cambrian aquifers of northern Illinois at their area of outcrop in Wisconsin.

50. *Spectrographic analysis* of rock and mineral samples discloses the presence of and identifies trace amounts of mineral substances in earth materials. Such substances frequently have an important bearing on the properties and use of the materials in industry and in agriculture. The Survey has a special laboratory for carrying on work of this kind. During the year, qualitative analyses were made from 52 samples of rock, clay and clay products, glass, electric furnace slag, magnetic separations from clay, mica, and other materials. Additional spectrographic equipment is being secured in order to make possible the needed extension of these studies by the Survey physicist.

51. *Analytical chemistry* is basic to fundamental research on mineral resources. In chemical laboratories for the analysis of coal, rock,



Micro-analysis of organic fluorine compounds in one of the Geological Survey's special equipped laboratories.

brine, and gas, approximately 3,000 analyses, involving more than 9,600 individual determinations, were made during the past year. A micro-chemical laboratory specially equipped for the analysis of minute amounts of organic compounds—too small to be handled by ordinary procedures—enables the Survey to make determinations of these small samples to a very high order of precision. More than 200 microanalyses were run during the year. A new enlarged oil and gas analysis laboratory is being equipped to support the Survey's expanded program of research in petroleum engineering.

In addition to this basic analytical work, senior members of the chemical staff are engaged in the development of new and improved laboratory procedures, as well as the design and construction of special apparatus, and participate officially in the activities of the American Society for Testing Materials and other societies.

Mineral Economics

The economic trends and competitive elements in mineral production, transportation, and marketing are critical factors in industrial development. Through the work of a mineral economist with a small staff of assistants to compile data for analyzing these problems, the Survey is in a position to furnish economic information desired by mineral operators, producers, manufacturers, railroads, chambers of commerce, and financial organizations throughout the State.

52. *The role of various fuels in manufacture* is the subject of a detailed analysis which has been in progress at the Survey during the past year, and the publication of a report, which should be of great interest to manufacturers throughout the State, is planned cooperatively with the Engineering Experiment Station of the University of Illinois.

53. *The national sulphur shortage*, which became widely evident in late 1950 and which is a matter for particular concern to industry in Illinois because of the large sulphur requirements, is being carefully analyzed and studied. Sulphur is not produced in Illinois, and a careful analysis of the economic feasibility of producing sulphur or sulphur dioxide from any locally available sources (such as stack gases, iron pyrites, and the smelting of zinc and lead ores) is particularly pertinent at this time.

54. *The annual statistical report* on the Illinois mineral industry, for 1950, is being prepared for publication. This work is carried on in cooperation with the U. S. Bureau of Mines, the U. S. Bureau of the Census, and the State Department of Mines and Minerals. Similar annual reports, issued since 1931, constitute an uninterrupted series on Illinois' mineral industry since that date.

Topographic Mapping

55. *Topographic maps for more than 90 per cent of the State's area* have now been prepared as the result of a systematic program of mapping the topography of the State which is carried forward each year in cooperation with the U. S. Geological Survey. Through the pro-

gressive attitude of Illinois legislators in regularly appropriating funds to carry on this work (funds so appropriated are matched dollar for dollar by the Federal Government), this ambitious and very important task is nearing completion. It is hoped that mapping of the entire area of the State may be achieved within a few years.

During the past year, 439 square miles of territory, including 114 square miles of revision, were mapped topographically in the field on a scale of one inch to a mile; 36 square miles were mapped on a scale of $2\frac{1}{2}$ inches to the mile; 8 square miles of Multiplex contouring were completed in the field; and planimetric maps were made to serve as bases for contouring of 113 square miles.

Three new quadrangle maps on a scale of one inch to a mile, 9 new quadrangle maps on a scale of $2\frac{1}{2}$ inches to a mile, and reprints of 1 quadrangle map on a scale of $\frac{1}{2}$ inch to a mile, of 15 quadrangle maps on a scale of one inch to a mile, and of 4 quadrangle maps on a scale of $2\frac{1}{2}$ inches to a mile were published during the past year as a result of this cooperative work.

Public Service and Educational Extension

56. *Public information.* Prompt and accurate handling of all requests for information relating to mineral resources, their occurrence and distribution and development, is considered by the Survey one of its major obligations to the citizens of the State. Thousands of such requests are received and handled each year.

57. *Educational Extension.* A special division of the Geological Survey has been rendering educational extension service throughout the State for more than 20 years. Designed primarily to assist teachers and through them enlighten the future citizens of the State, the activities of this division provide free identification of mineral specimens; informative correspondence with teachers and citizens; free lectures to organized groups; publication of popular educational pamphlets; the distribution of free rock and mineral collections to schools; the organization and leadership of field study conferences for science teachers; and educational exhibits at State and county fairs and special scientific meetings.

During the past year, 396 sets of typical rocks and minerals of Illinois were distributed to schools, scout troops, nature clubs, and other civic organizations throughout the State.

Field conferences, primarily for science teachers but open to all interested persons, were held in six different areas widely distributed over the State. Mimeographed guide leaflets are prepared for each trip, and 26 different ones are now available in limited stock. These provide convenient sources for local detail and geologic history for students teachers, tourists, collectors, etc.

Twenty special lectures were given to conservation work shops colleges, high school assemblies, night school classes, local scientific societies and clubs.

Publications

Prompt publication of results obtained from research work is essential to its greatest effectiveness. Every effort is made by the Survey to bring its information to the citizens of the State as soon as possible consistent with accuracy.

58. *Publications issued* during the year include the following:

Bulletins:

74. *Pennsylvanian Spores of Illinois and Their Use in Correlation*: Robert Kosanke. 1950. 128 pp., 7 figs., 18 pls.
 Descriptions of new genera and species, and correlations of Illinois coal beds.
75. *Groundwater in the Peoria Region—Geology, Hydrology, Chemistry*: Leland Horberg, T. E. Larson, and Max Suter. 1950. 128 pp., 53 figs., 4 pls. (Joint publication with the Illinois State Water Survey; also published as State Water Survey Bulletin 39.)
 Investigation of Peoria water-supply problems from 1941 to January 1946.

Reports of Investigations:

148. *Subsurface Geology and Coal Resources of the Pennsylvanian System in Certain Counties of the Illinois Basin*: G. H. Cady, et al. 1951. 274 pp., 30 figs., 11 tables, 11 plates, 151 pp. of tabulated data.
 Includes structure maps of top of Herrin (No. 6) Coal in Clay, Edwards, Gallatin, Hamilton, and Richland counties.
149. *Loess Formations of the Mississippi Valley*: M. M. Leighton and H. B. Willman. 1950. (Reprinted from the *Journal of Geology*, vol. 58, no. 6, November 1950.) 27 pp., 9 figs., 2 pls.
 Discussion of the stratigraphy and origin of the loess deposits of Illinois and adjacent areas.
150. *Illinois Mineral Industry in 1949*: W. H. Voskuil. 1951. 63 pp., 14 figs., 50 tables.
 Annual statistical summary and economic review.
154. *High Temperature Thermal Effects of Clay and Related Materials*: W. F. Bradley and R. E. Grim. 1951. 20 pp., 10 figs. (Reprinted from *The American Mineralogist*, vol. 36, pp. 182-201, 1951.)
 A selected series of clay minerals and related silicates are examined by thermal, optical, and x-ray diffraction methods for establishing the significance of the observed thermal effects.

Illinois Petroleum Series:

61. *Developments in Illinois and Indiana in 1949*: A. H. Bell and R. E. Esarey. 1950. (Reprinted from *Bull. Am. Assoc. Petr. Geol.*, vol. 34, no. 6, 1950.) 13 pp., 1 fig.
62. *Oil and Gas Development in Illinois in 1949*: A. H. Bell and Virginia Kline. 1950. (Reprinted from *Journal of Petr. Tech., Am. Inst. Min. Met. Eng.*, October 1950.) 42 pp., 3 figs.

Circulars:

164. *Structure of Herrin (No. 6) Coal Bed in Marion and Fayette Counties and Adjacent Parts of Bond, Clinton, Montgomery, Clay, Effingham, Washington, Jefferson, and Wayne Counties*: Raymond Siever. 1950. 100 pp., 2 figs., 1 plate.
 Structure map, description, and tabulated data are given for these Illinois counties.

165. Summary of Water-Flooding Operations in Illinois: Frederick Squires and members of the Secondary Recovery Study Committee for Illinois. 1951. (Reprinted from The Report by the Interstate Oil Compact Commission, September 1950.) 40 pp., 27 figs.
Summarizes the work of the Secondary Recovery Committee for Illinois of the Interstate Oil Compact Commission.
166. Mineral Resource Research and Activities of the State Geological Survey, 1948-1949: M. M. Leighton. 1950. (Reprinted from Annual Report of the Chief to the Director, Department of Registration and Education, for Fiscal Year 1948-1949.) 20 pp., 13 figs. (Second printing, February 1951.)
Describes the activities in various fields of the State Geological Survey for the fiscal year July 1, 1948, to June 30, 1949.
167. Aromatic Fluorine Compounds: II. 1, 2, 4, 5-Tetrafluorobenzene and Related Compounds. III. The Fluoromesitylenes and Derivatives. IV. 1, 2, 3, 5-Tetrafluorobenzene. V. 1, 3, 5-Trifluorobenzene: G. C. Finger, F. H. Reed, et al. (Reprinted from Jour. Am. Chem. Soc., vol. 73, no. 1, January 1951.) 11 pp.
The synthesis, properties, intermediates, and derivatives are reported for these aromatic fluorine compounds.
168. Reactions Accompanying the Firing of Brick: R. E. Grim and W. D. Johns, Jr. 1951. (Reprinted from The Journal of the Amer. Ceramic Soc., vol. 34, no. 3.) 6 pp., 4 figs., 2 tables.
Results of an investigation by differential thermal method of the reactions taking place when brick, particularly those made from fire clay containing some organic matter and sulfides, are fired.
169. Future Oil Possibilities of the Eastern Interior Basin: D. H. Swann et al. 1951. (Reprinted from the Eastern Interior Basin Chapter, "Possible Future Petroleum Provinces of North America," A.A.P.G. Bulletin, February 1951.) 13 pp., 8 figs.
Introduction to the subsurface geology of Illinois, Indiana, western Kentucky, and southern Wisconsin.
170. Short Papers on Geologic Subjects: J. S. Templeton, D. L. Graf, Leland Horberg, L. E. Workman. 1951. (Reprinted from the Trans. of the Ill. State Acad. of Sci., vol. 43.) 26 pp. 20 figs.
Four papers on aspects of Illinois geology which were presented at the 1950 meeting of the Illinois State Academy of Science.
171. Determination of Fluorine in Organic Compounds: Howard S. Clark. 1951. (Reprinted from Analytical Chemistry, vol. 23, no. 4, April 1951.) 3 pp., 1 fig.
A reliable and widely applicable means of determining fluorine in organic compounds.
173. Illinois Water Floods—A Summary: Frederick Squires et al. 1951. (Reprinted from Oil and Gas Journal, vol. 49, no. 43, pp. 42-48 and 66, March 1, 1951.) 8 pp., 11 figs., 1 table.
Summarizes the important work accomplished by the Secondary Recovery Study Committee for Illinois of the Interstate Oil Compact Commission. (Abstracted from Circular 165.)

Miscellaneous:

- Oil and Gas Drilling Report, mimeographed, issued monthly.
Supplementary Book of Charts for Monthly Oil and Gas Drilling Report. 1950.
Map—Physiographic Divisions of Illinois. 1950.

*The Board of Natural
Resources and Conservation*

BOARD OF NATURAL RESOURCES AND CONSERVATION

Honorable Noble J. Puffer, Chairman

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

Biology—A. E. Emerson, University of
Chicago

Chemistry—Roger Adams, University of
Illinois

Engineering—Louis R. Howson, Chicago

Forestry—Lewis H. Tiffany, Northwestern
University, Vice President and Secretary
of the Board

Geology—W. H. Newhouse, University of
Chicago

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.

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 Surveys' headquarters and principal laboratories on the University of Illinois campus at Urbana offers many advantages. Research 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.

