


ILLINOIS STATE GEOLOGICAL SURVEY
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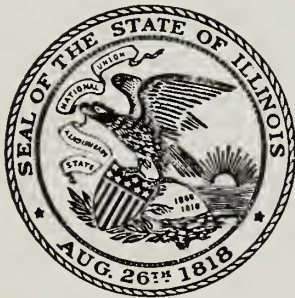
STATE OF ILLINOIS
DWIGHT H. GREEN, *Governor*
DEPARTMENT OF REGISTRATION AND EDUCATION
FRANK G. THOMPSON, *Director*

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

CIRCULAR NO. 104

- I. The Board of Natural Resources and Conservation
of the Department of Registration and Education
- II. The Illinois State Geological Survey in
War Mineral Research
- By M. M. LEIGHTON, *Chief*

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URBANA, ILLINOIS

1944

THE BOARD OF NATURAL RESOURCES AND CONSERVATION

Created by the State Civil Administrative Code in 1917, the Board of Natural Resources and Conservation governs the research activities of the Geological, Natural History, and Water Surveys. Under the law, this Board selects and appoints, without reference to the State Civil Service law, all members of the scientific staffs. Members of the non-technical staffs are subject to the Civil Service Code.

As the three Surveys are divisions of the Department of Registration and Education, the Director of this Department is *ex officio* chairman. Other members are the President of the University of Illinois, or his representative, and several scientific experts qualified by at least 10 years of experience in practicing or teaching their several professions.

Present membership of the Board is as follows:

Honorable Frank G. Thompson, *Chairman.*

Dr. A. C. Willard, *President of the University of Illinois.*

~~Professor Emeritus William Trelease, University of Illinois,~~
representing *Biology.* *Deceased - not replaced*

Professor Roger Adams, University of Illinois, representing
Chemistry.

Louis R. Howson, Chicago, representing *Engineering.*

Professor Ezra J. Kraus, The University of Chicago, represent-
ing Forestry.

~~Professor Edson S. Bastin,~~ *Norman L. Bowen*
The University of Chicago, Vice-
Chairman and Secretary of the Board, representing *Geology.*

Traditionally non-partisan, the Board serves without pay. One of the five experts has served continuously since creation of the Board in 1917. The others were appointed in 1922, 1938, 1940, and 1942, upon the retirement or death of their predecessors. Because several sciences, two 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 co-ordination 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



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.

programs, and their exercise of infinite care in selection of scientific staffs have brought national and international recognition to 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.

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 building, 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.

Efficient use of floor space is evident throughout the building. Not only is full use made of the three main floors for offices and laboratories; ingenious planning made possible the natural lighting of the basement, permitting laboratories and offices on this floor, as well as storage rooms, and a well-insulated roof allowed utilization of the fourth floor for offices, drafting rooms, libraries, and laboratories.

Geological Survey Research Facilities

It is at a very propitious time that the Geological Survey has come into the possession of its portion of the Natural Resources Building with facilities for research which are most valuable in furnishing needed new information for this new technological war period. These facilities enable the Geological Survey, in its mineral research, to employ the most modern techniques of geological, physical and chemical science including the X-ray and spectrograph.

Its portion of the five floors is fully utilized as offices, laboratories, grinding rooms, preparation rooms, machine shops, geologic collections, drafting, filing, and photography rooms, and library. All laboratories are directly serviced with distilled water, steam, vacuum, and compressed air, electric current of various voltages,

and much special equipment. Each laboratory is tailor-made for the particular kind of research to which it is devoted.

Six laboratories are especially devoted to research on coal, two for investigations directed to an understanding of the occurrence of oil and gas and groundwater, eight to studies of the non-metallic industrial minerals, two for investigations of paleontology and stratigraphy, and seven for research phases which are common to various minerals.

In addition, another building, known as the Geological Survey Laboratory, erected under an appropriation made in 1939 of \$95,000.00, is especially adapted to large-scale experimental work. It is located near the University Power Plant, and in it applied research work on semi-plant scale is carried on to test the commercial merits of successful small-scale laboratory findings.

Natural History Survey Research Facilities

With the drive for expanded food production necessitated by the war, Natural History Survey equipment associated with research on insect control has taken on added significance. Constant temperature chambers, the insecticide compounding rooms and testing rooms, and other space in the Natural Resources Building devoted to insect control investigations are answering well the purposes for which they were designed. The large reference collection of insects is proving invaluable in a survey of the state's mosquitoes and other blood-sucking insects, as well as in the determination of insects submitted by citizens of the state for identification.

Culture chambers, a specially designed refrigerator, plant dryer, and other equipment add to the efficiency of Natural History Survey botanists in their studies of grain, fruit, and other plant diseases.

One of the aquarium rooms devoted to fisheries investigations has been turned over to research directly associated with the war program. Without the well-constructed tanks, water dechlorinator, and various other modern equipment, such an investigation as that now in progress would be impossible.

Completion in 1942 of a service building adjoining the experimental greenhouse on the north has made available additional greenhouse space for insecticide and fungicide tests. This new structure conforms in style to the Natural Resources Building immediately north of it.

In a period of national emergency, when time is more than ever an important element in the solution of problems, the value to research of adequate quarters and modern equipment becomes more apparent even than in times of peace.

Natural Resources Garage

In order to provide for the care and maintenance, at a convenient location affording proper supervision, of cars and trucks required by the Geological and Natural History Surveys in their

field programs, a garage, known as the Natural Resources Garage, was built in 1942 at the rear of the Natural Resources Building at a cost of \$50,000.00. This garage has a housing capacity of 44 cars and modern equipment for repair and servicing by skilled automobile mechanics who have the responsibility of keeping the two Survey fleets of cars in excellent condition, especially during the present period when much important field work must be done with the most economy of gasoline, tires, and other restricted materials. The garage conforms in style to the parent building and contains a mezzanine floor for the storage of geological field collections and publications. It also contains a machine shop for the Geological Survey for the construction of special research equipment that cannot be purchased on the open market.



THE ILLINOIS STATE GEOLOGICAL SURVEY IN WAR MINERAL RESEARCH

By M. M. LEIGHTON, *Chief*

The mineral resources of Illinois, representing as they do the foundation of much of the commerce and industry of the upper Mississippi valley region, have assumed, since the United States' actual participation in the war, a new significance as raw materials for war industry and the wartime civilian economy.



M. M. Leighton, Chief.

According to recently published information of the Inter-State Commerce Commission, 71.2 per cent of the 1942 tonnage of revenue freight originating in Illinois consisted of mineral materials and manufactured products made from minerals, as did 69 per cent of the revenue freight tonnage terminating in Illinois.

The Department of Registration and Education, through the activities of the State Geological Survey Division, has thus had a splendid opportunity for valuable service through the prosecution and speedy accomplishment of research objectives in locating and developing the State's mineral resources.

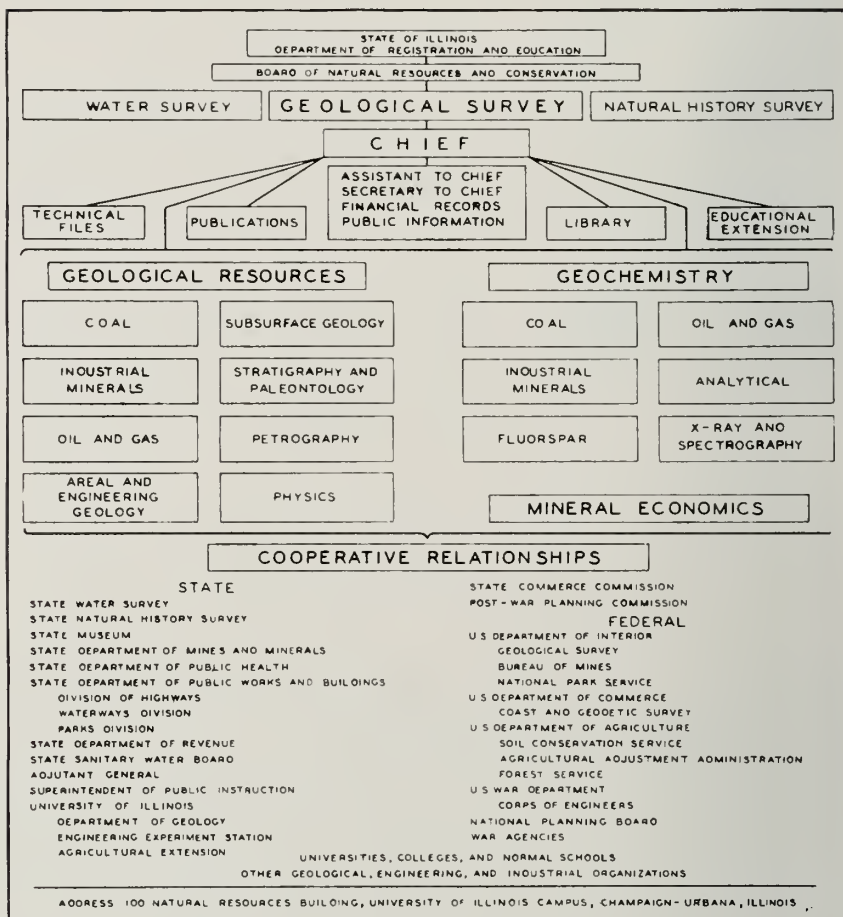
Under the guidance and control of the Board of Natural Resources and Conservation, the Geological Survey has expanded steadily through the years, in personnel, physical plant, research facilities, and in service to the mineral industries and citizens of the State. Its staff, a group research body of specialists, gives to the State as a whole the benefit of sound theoretical training and equally important practical experience. Its organization and cooperative relationships are shown in the accompanying chart. Members of its technical staff include geologists, chemists, physicists, mineralogists, petrologists, and a mineral economist—well qualified to carry on the important task of making science the servant of man and an auxiliary strength to industry.

Research Facilities Converted to the War Effort

This report deals with the accomplishments of the fiscal year of 1942-43, a year during which our participation in the war has forced almost every organization and agency to fit its functional program to the immediate needs of the nation. The outbreak of the

The new garage.

war found the Geological Survey exceptionally well equipped to contribute to the national welfare, having recently moved into greatly enlarged quarters in the new Natural Resources Building and the new Applied Research Laboratory for which the most up-to-date laboratory equipment had already been secured. These splendid research facilities have become irreplaceable tools for waging effective warfare on the home front. The survey has for many years been engaged in a program of fundamental and applied research on the mineral resources of Illinois—studying the occurrences within our borders of coal, petroleum, natural gas, fluorspar, clays and shales, special stone deposits, silica and silica sand, lead, zinc, underground

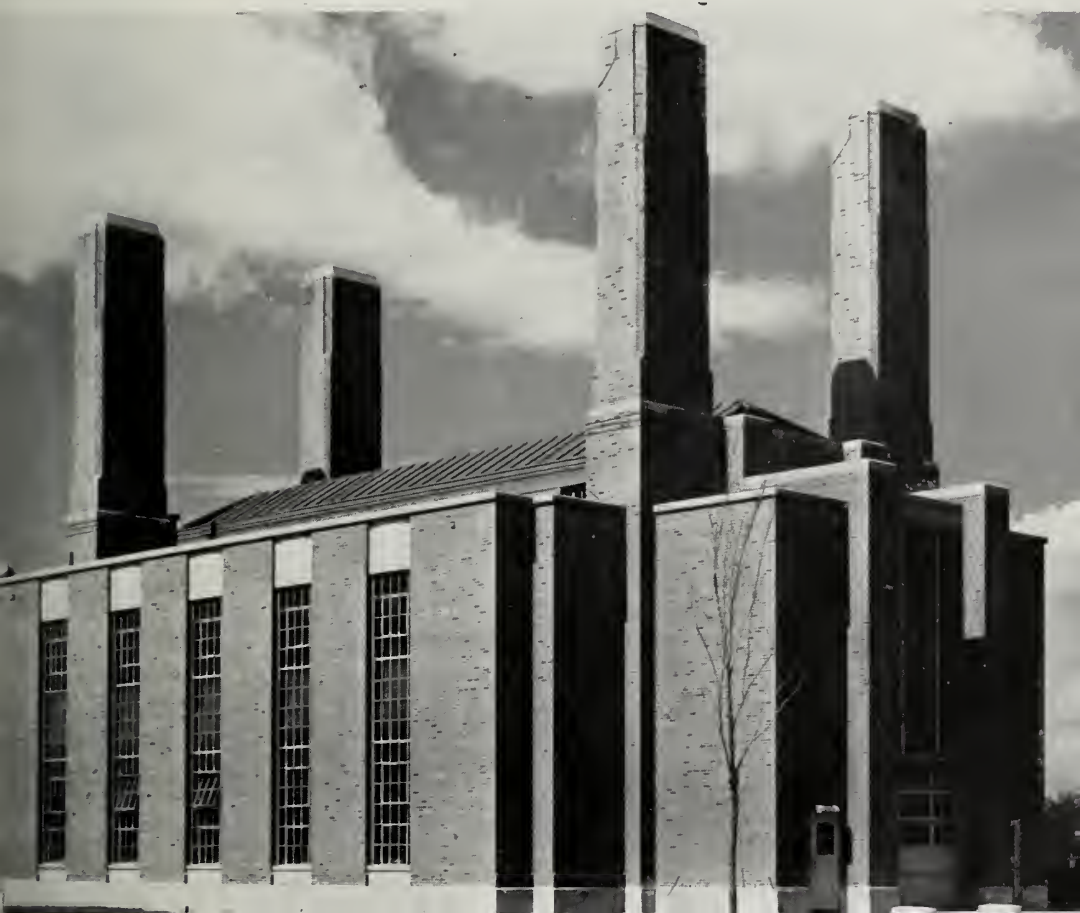


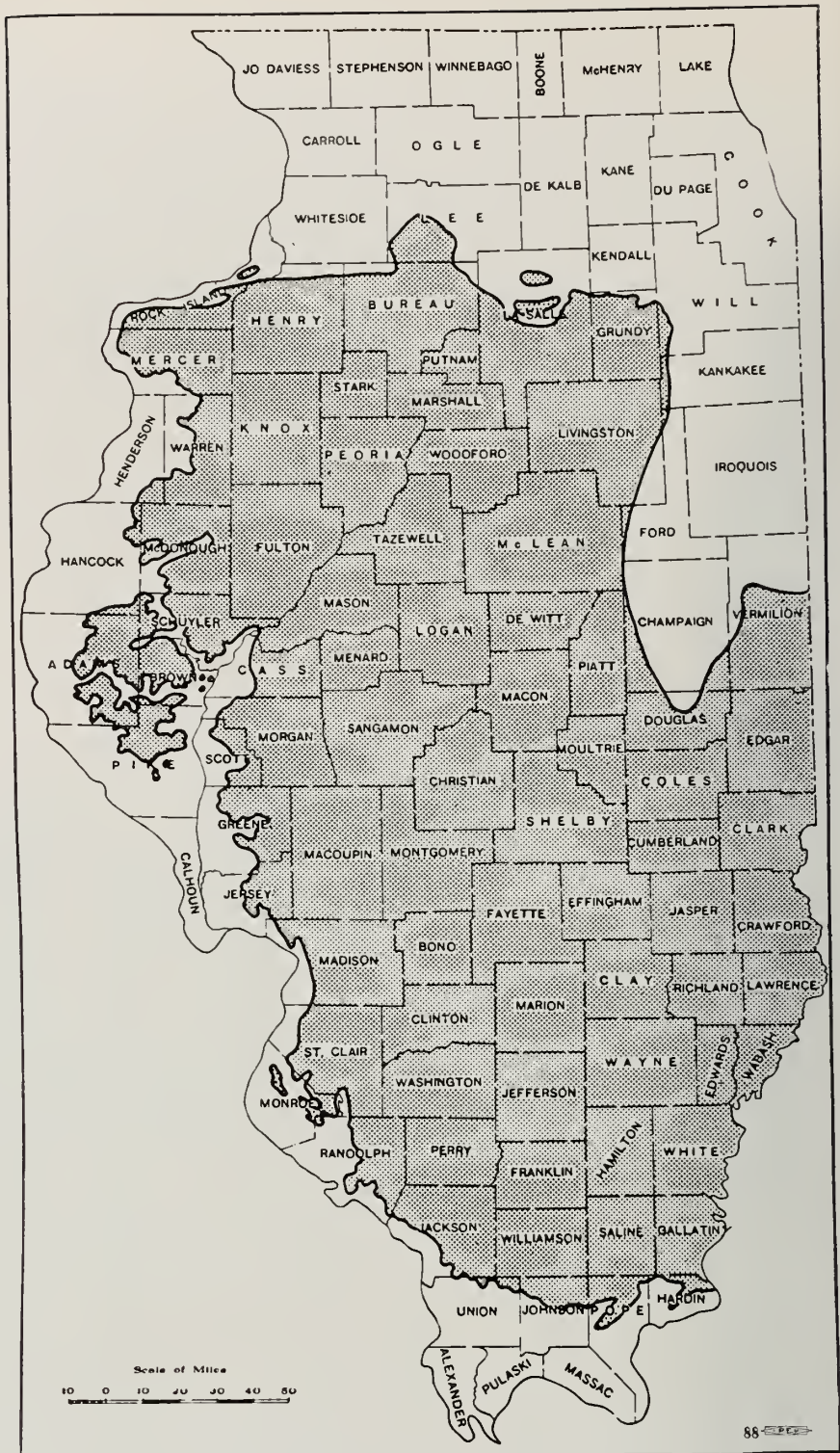
Organization chart.

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

waters, and industrial minerals of future importance still awaiting development.

Faced with the necessity of devoting all its energies to the national emergency, the Survey temporarily suspended work on a few of its fundamental research studies which held less promise of immediate application and transferred the personnel engaged in such studies to those lines of investigation more intimately related to the war effort to which their training and experience made them most valuable. In spite of this necessary shift of emphasis, every effort is being made to preserve a program of fundamental research essential to the sound prosecution of applied research that will outlive the war and be ready to meet the inevitable problems of post-war conditions. In fact, it was the careful and exhaustive work of past years that made it possible for the Survey to readjust its program so quickly to wartime requirements. It already had available in its files, its published bulletins, and its "mental bank" a vast accumulation of data and experience on which to draw. The continuation of such a well balanced program guarantees a harvest of fundamental data of inestimable value for the work that will be done after the war.





More than half of Illinois is underlain by coal.

Coal Studies—A Year of Accomplishment

The great coal beds that underlie 3/5 of the surface of Illinois have long been and are likely to remain our most valuable and continually important single mineral resource. There is plenty of coal in Illinois; but there is likewise plenty of work to be done on it to utilize its potential values to the utmost.

Essential to such utilization is an accurate inventory of the State's coal resources—particularly of the No. 6 (Herrin) coal bed, which is the most important and widespread commercial coal in the State, since approximately 75 per cent of all the coal mined in Illinois is taken from that bed. Experienced Survey geologists are engaged in the determination and mapping of the distribution of this coal and of its depths and thicknesses below the surface in southern Illinois. At the present time mapping of this bed, on the detailed scale of one inch to the mile, has been completed for all of the area of its occurrence, from southern Sangamon County southward, as far as the Belleville region, and southeastward to the Ohio River at Shawneetown, an area containing billions of tons of excellent coal.

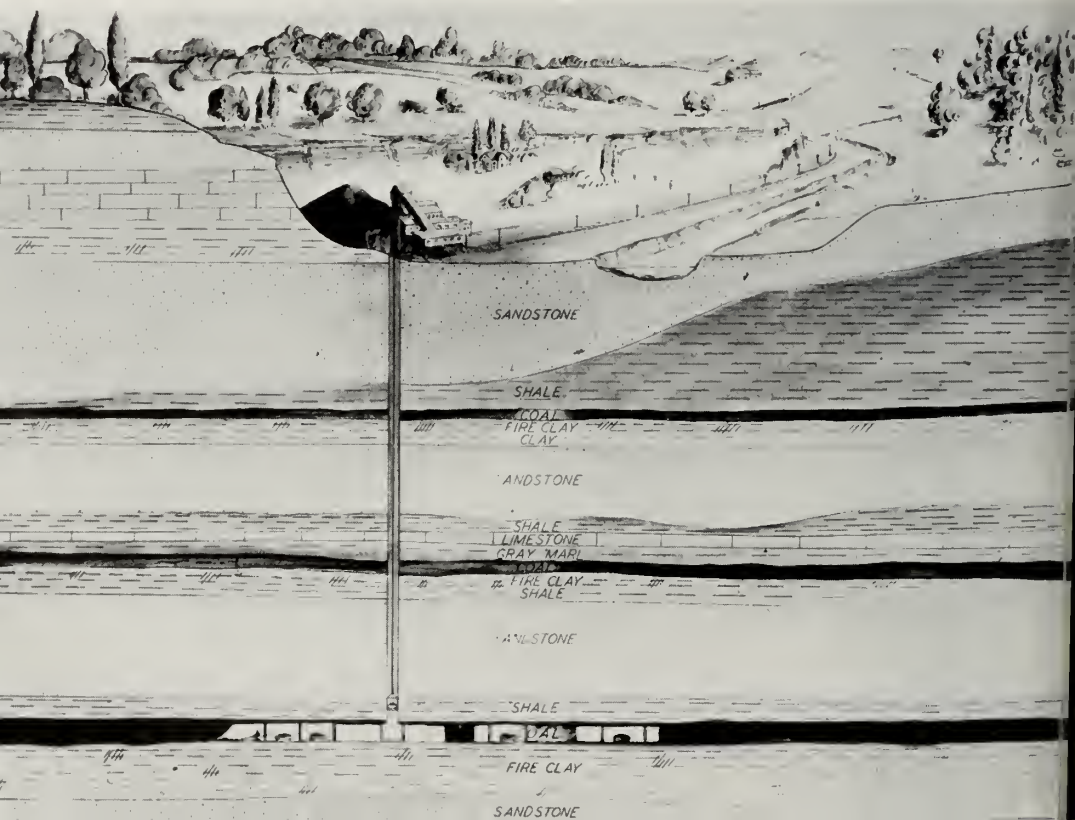
Another area receiving study for coal resources is the oil-producing area known as the "Illinois basin," where coal beds of commercial thickness were suspected, but where there has previously been little information available concerning them. In oil well drilling operations in that part of the State the holes penetrate coal-bearing rocks before they reach the oil pay zones. By carefully checking drilling progress at oil well sites and by studying the cuttings as they are flushed out at the surface, accurate and detailed records are being made of the coal beds in southeastern Illinois, where mining has not yet been attempted. This work is carried on from a portable field laboratory which affords sleeping quarters for the men, saves much otherwise necessary automobile travel, and insures the securing of immediate first-hand information. A most important objective of these studies is the protection of our coal beds from damage resulting from the improper plugging of wells drilled for oil. Some 140 wells scattered through eastern counties, from Moultrie County southward to Gallatin County, have now been logged in the field and their cuttings collected for more detailed study later. Evidence to date indicates that considerably more workable coal is present than was formerly known and it seems probable that the known reserves of coal have been increased to the extent of many hundred million tons.

A special study is being made of the extent and distribution of strippable coal in the State, and of exploration, development and mining methods particularly in comparison with underground methods in order to gain definite information on the comparative value to the State of coal that can be mined by stripping methods, and of the soil that is disturbed by such mining.

During the last year also the Geological Survey has made important contributions to the knowledge of the chemical and botanical components of coal. Studies of this kind are fundamental to an understanding of our coals and the determination of their ultimate usefulness.



This portable field laboratory enables scientists to collect needed information "on the spot."



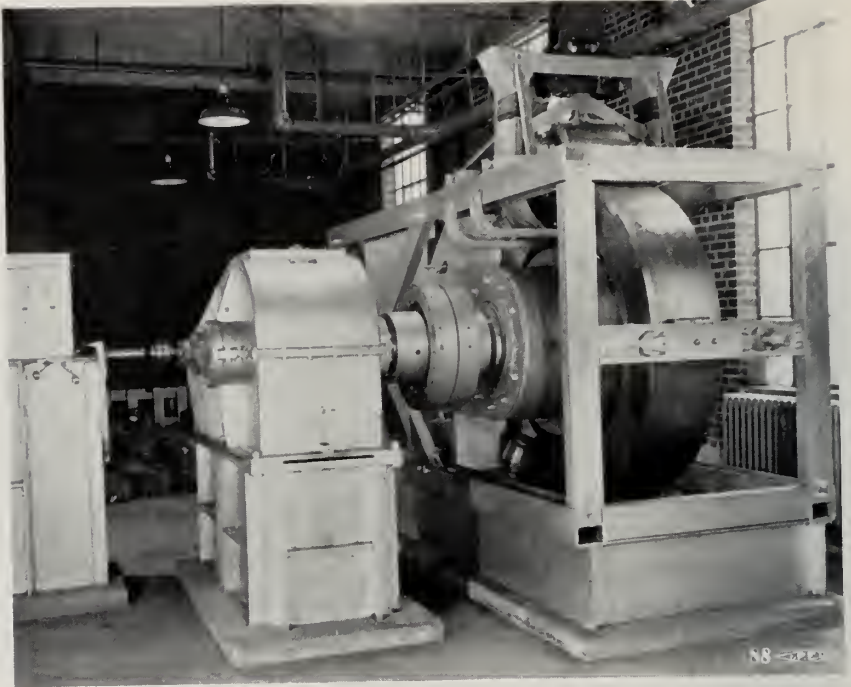
Improved Stoker Fuels—The Goal of Special Research

To help meet the specialized demands on our coal resources from the greatly increased use of modern stoker equipment, the Geological Survey is making rapid progress in the study of the combustion behavior of Illinois coals. Microscopic investigations in the past have demonstrated that coal is not a simple homogeneous substance but is composed of different ingredients which occur in bands. These banded ingredients, known technically as vitrain, clarain, fusain, and durain, have been discovered to possess different combustion characteristics. They have also been discovered to be mechanically separable. In its special Research Laboratory the Survey has installed such preparation and combustion equipment as a large concentrating table with automatic feed bin, equipment for large-scale float-and-sink tests, a stoker-boiler equipped with complete instrumentation enabling the operator to keep a large number of continuous mechanically recorded observations from which can be determined the amount of heat obtained per pound of coal, the uniformity of heat release, the ability to hold fire, the amount of clinker formed, the relative density of smoke given off, etc. These studies are in the hands of a highly trained mining engineer and an experienced research combustion engineer and are designed to establish the best methods of stoker coal preparation to accomplish the best combustion performance for each type of coal produced within the State. The design and construction of the testing apparatus as well as the studies themselves are new contributions in the field of coal research and their importance is well appreciated by the coal and stoker industries. From results to date it is anticipated that there are commercial possibilities in the preparation of coal which may result in the production of better stoker fuels.

Smokeless Products from Illinois Coal

A major problem for Illinois operators is to produce fuels for both domestic and industrial use that will meet the specifications set up by smoke abatement ordinances in the larger metropolitan areas. The Geological Survey has for several years past been conducting research designed to help industry meet this problem. The past year has seen progress made in the installation of large-scale equipment to test the commercial feasibility of the Survey's process for the manufacture of smokeless briquets from Illinois coal "fines." Following the Survey's important recent discovery that the very fine dust of coal burns with a low smoke production and can be made into a smokeless briquet without driving off any portion of the volatile matter, further study is being given to this problem. Since it is estimated that over a million tons of deduster dust were produced in Illinois in 1942, it is evident that the discovery of a use for this otherwise waste product will be of real benefit to Illinois producers.

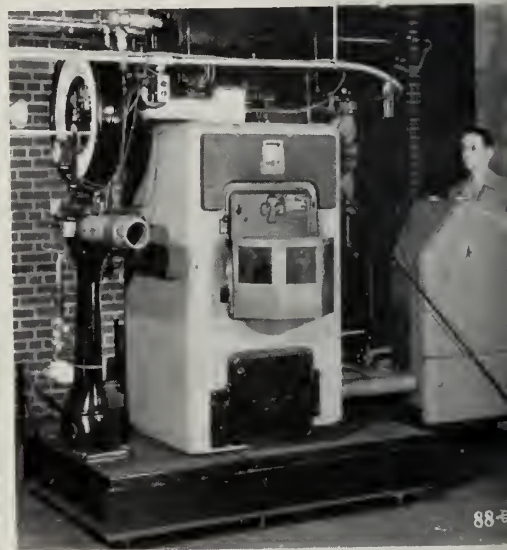
The shafts of Illinois coal mines penetrate rock strata which record hundreds of thousands of years of earth history.



Experimental briquetting machine used in research to produce smokeless briquets



Experiments conducted in modern stoker equipment under controlled conditions may develop improved stoker fuels from Illinois coal.



Coking oven in the Geological Survey's Applied Research Laboratory with charge ready to be drawn.

Equally promising and equally important is the work being done in our Applied Research Laboratory on the coking of Illinois coals, to establish the best methods of preparing a cheap and satisfactory fuel for hand-fired furnaces and stoves; and, at the same time, to provide data on the tars, gases and oils that are yielded as by-products from coking operations—to demonstrate the values of such by-products and recommend the most promising means of utilizing them. The results of researches along these lines, carried on at Urbana, during the past few months, have been so satisfactory that an enlarged Illinois coke industry seems assured for the future.

Consideration is being given to securing the necessary materials for constructing a type of oven for a study of the coking of Illinois coals for metallurgical purposes. Under war conditions, the transportation of eastern coals to the Chicago and St. Louis markets is a heavy burden, and therefore the benefits to be gained from this research on coking of Illinois coals are specific. Plentiful supplies of Illinois coals believed to have possibilities for metallurgical coke are obtainable within 100 miles of St. Louis. The Appalachian coals are in the neighborhood of 700 miles distant. Assuming (1) that 500,000 tons of coal per year are coked in the St. Louis area, and (2) that 50 per cent of this can be obtained in the Illinois coal fields, the net saving would be approximately the transportation of 250,000 tons for 600 miles or 150 million ton miles per year. Actually, it appears that at least as much as 70 per cent and perhaps more of Illinois coal



A new coking plant near Millstadt, Illinois.

can be used. For several years the Roberts Ovens at Granite City used 85 per cent of Illinois coal blended with 15 per cent of Eastern Kentucky coal for the production of metallurgical coke.

In the Chicago area at the present time approximately ten million tons of Eastern coal per year are being coked. Low sulfur Illinois coals are available 100 to 300 miles from these coke ovens, while the Appalachian coals are 500 miles distant. Assuming again that Illinois coals are used to the conservative amount of 50 per cent, the savings for each million tons of coal coked in the Chicago area per year would be roughly 100 million ton miles per year in transportation.

Problems of Coal Storage

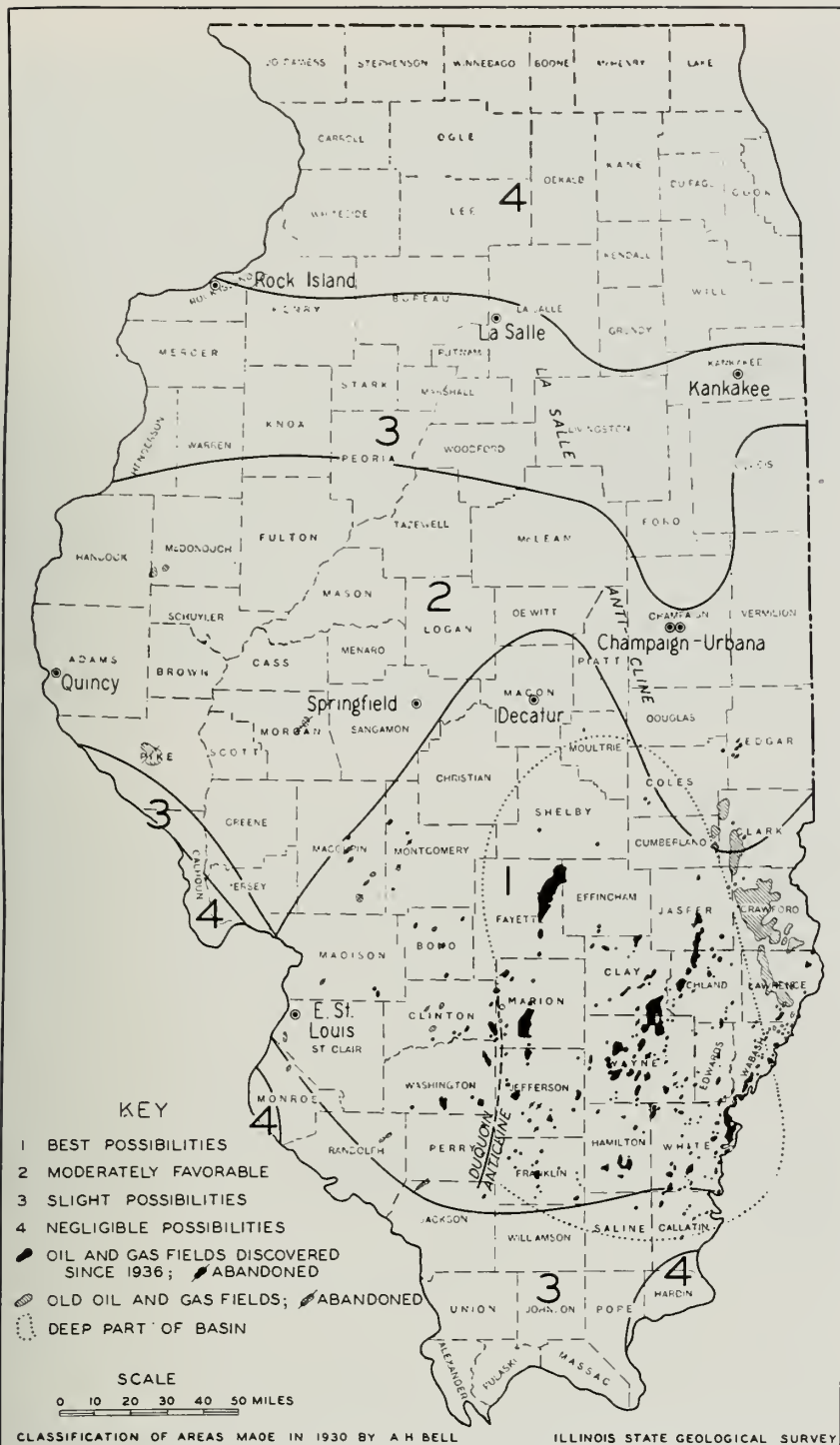
Another important coal research project that is occupying the attention of the Geological Survey at the present time deals with problems of coal storage.

Because it is necessary under existing conditions to store larger quantities of coal than normal times require, the old problem of spontaneous combustion has come to the fore. Chemists of the Survey are contributing helpful information and advice on such problems.

Research Aids Oil and Gas Production

Crude oil has been the number one mineral product of Illinois in dollar value for the four years, 1939 through 1942, and is second only to coal in value of total production to date. Almost one billion barrels of oil have been produced in Illinois and the current rate of production was 217,000 barrels per day in May, 1943. The great revival of the oil industry of Illinois through the discovery in 1937 of production in the Illinois basin placed the State in the ranks of the major producers for the second time in its history. This new oil field region had long been considered unfavorable prospecting territory, until the Geological Survey pointed out its real possibilities in 1930, and aided materially in the work that resulted in the discovery of its actual worth as a petroleum-producing area. Illinois ranked fourth in the nation in oil production for the three years 1939, 1940 and 1941, and fifth in 1942. Although production has been gradually declining for the past two years, drilling is still active and thirty-two new oil pools were discovered during the twelve months ending in May, 1943.

Oil occurs in Illinois in sandstone and limestone strata, both of which exhibit a wide variety of textures, compositions, porosities, permeabilities and fluid saturations. The most efficient methods of well spacing, drilling, completion and production in any given oil pool depend upon a thorough understanding of local geological conditions. The drilling of more than 16,000 wells in Illinois within the past six years has provided a tremendous source of information. The Geological Survey has secured logs of nearly all these wells



MAP CLASSIFYING OIL AND GAS POSSIBILITIES IN ILLINOIS SHOWING PRODUCING AREAS AS OF JULY 1, 1943 88



Illinois oil fields are important contributors to the nation's supply of this critical material.

and has collected samples of the drill cuttings, rock cores, etc., from selected wells at many locations where such information is needed. It is the careful study and correlation of well logs, samples, electric logs, etc., that enables the Survey to assist the operators and the people in exploration and drilling problems, to prepare useful maps, and to publish information which may lead to further discoveries.

This vast number of records is sorted and filed and is available to the public at all times and the results obtained from their study are published as promptly as possible. Current information on drilling is issued monthly in mimeographed form and from time to time geologic reports are published which include structure maps, cross sections, and other illustrations and which recommend certain new areas favorable for exploratory drilling and indicate possible new "pay zones" in existing fields. By such means, the people of the State receive the benefit of sound scientific evaluation of an immense amount of information not available through any other single organization.

Additional Reserves Assured

On the basis of information so far secured relative to oil-producing areas of Illinois, it is the opinion of geologists that hundreds of millions of barrels of oil are still undiscovered and it is probable that a comparable additional amount will yet be produced in existing fields with the aid of secondary recovery methods. Many of the

"new" fields of Illinois—those discovered since 1936—have now reached stages where such secondary recovery methods are needed. For the past twelve years the Survey has carried on studies of secondary recovery operations in the State—largely air and gas repressuring, and natural and accidental water-flooding. A comprehensive report on the results to date of the water-flooding studies is in press. Some large scale water-flooding operations are now under way in the old shallow fields of Clark and Cumberland counties.



"Catching samples" of drill cuttings at a well for study of possible producing reservoirs.

In the new fields a beginning of water-flooding has been made in the Patoka and Clay City pools. The Survey plans extensive studies related to secondary recovery methods because such methods promise to become increasingly important in Illinois. Thus with continued intelligent exploration and improved production methods, Illinois seems assured of an important oil industry for some decades to come.

Groundwater Supplies Given Special Study

With the greatly increased demands for groundwater to supply ordnance and war plants, army camps, and municipal areas suddenly enlarged by an influx of labor population, a special study was undertaken a little over a year ago to discover additional resources of this vital substance and to help maintain and improve previously developed supplies. Enabled by supplementary funds appropriated by the State Legislature, the Survey secured the services of several additional well-trained scientists to achieve early results. Besides making thorough-going geological studies, electric well surveying methods in common use in oil fields were for the first time employed on deep wells drilled for water and with such success that great improvements have been made in procedures of well drilling, well construction, and rehabilitation. In these studies, attention has been

given especially to locating and maintaining water supplies in the vicinity of Joliet, Kankakee, Chicago, Rockford, and Peoria. Large new groundwater resources were discovered in the Joliet and Peoria areas and geophysical surveys of certain existing wells in the Joliet and Chicago areas have yielded information which has made it possible for the owner and well-driller to proceed intelligently to improve both quantity and quality of water produced. Also, a better appreciation of the importance of the proper well spacing now prevails in the water well industry and of the geological conditions which must be taken into account to increase or maintain the proper water supplies.

In addition to these studies in defense areas, the Survey has maintained its regular service to the people of the State in furnishing reports on the geological conditions affecting groundwater resources at specified locations. During the last year the Geological Survey investigated and furnished detailed reports on 153 localities where more adequate groundwater supplies were desired. In this work electric resistivity surveys have been found to be the most effective way of determining the best location for the development of a large groundwater supply from sand and gravel of the glacial drift. Sand and gravel offer greater resistance to the movement of an electrical



current through them than does clay. Therefore the ground is systematically tested and areas of relatively high electrical resistivity are sought, and locations for test holes in these areas are pointed out. The method is of great value to large water users such as municipalities, industries, institutions, and war plants. During the past 6½ years there have been approximately 100 such surveys. In 75 surveys suitable locations for testing were found. In 50 locations satisfactory groundwater supplies were developed; 25 locations were not tested. Of the 25 unfavorable surveys, testing at eight confirmed the unfavorable reports and the other 17 projects were abandoned. Thus, the electrical resistivity survey both eliminates unnecessary testing and reveals the best locality within economical testing distance wherein to develop a large water supply.

Surveys for Industrial Minerals Speeded Up

The great need for immediate information regarding additional resources of fluorspar, lead and zinc, agricultural limestone, flux stone, and other mineral substances used by industry in great quantities, has placed a heavy responsibility on the Geological Survey staff, particularly so because in the case of certain of these resources the federal government has requested the State Survey to assume full responsibility with respect to information on Illinois' potential contribution to the national supply.

In Hardin and Pope counties, adjoining the Ohio River, and in adjacent parts of Kentucky, occur the most important deposits of fluorspar in the western hemisphere. From mines in this small area comes approximately 80 per cent of the national total produced in 1942. Fluorspar is an especially critical mineral because it is essential to the rapid manufacture of high grade steel, and because it is also extensively used in the preparation of synthetic cryolite, a substance employed in the manufacture of aluminum. It is also the only commercial source of fluorine, which, in the form of hydrofluoric acid, is one of the basic materials of the chemical industry and enters into the production of war materials in many different ways. Survey geologists and geophysicists are assisting the operators in the further development of known fluorspar deposits and at the same time are actively helping in the search for new deposits.

From the fluorspar district comes another critical war mineral, zinc ore; and our studies of fluorspar deposits have involved the discovery of additional resources of this ore. Another area receiving critical attention with respect to zinc and also lead resources is in Jo Daviess County, which was at one time one of the most important lead- and zinc-producing districts in the United States. Several min-

An Illinois fluorspar mine—vital to the nation's war needs. Southeastern Illinois and adjacent areas in Kentucky contain the most important deposits of this critical mineral in the western hemisphere.

ing properties are again in operation and there is every evidence that significant production of these two important minerals will develop.

High-purity dolomites have assumed special significance in the light of war conditions as refractories, as a flux in steel making, as sources of the metal magnesium, and as potential sources of magnesia. An investigation has been made of the State's resources of high-purity dolomite and a report now in press reveals that Illinois has enormous resources of dolomite of high purity and diverse character suitable for many purposes and well distributed throughout the northern part of the State.

Illinois' Vast Clay and Stone Resources Contribute to the War Effort

Although less spectacular in the popular concept of "strategic minerals," Illinois produces a large tonnage of the clay necessary in bonding the molding sands used in foundries to produce armaments. An investigation in co-operation with the University of Illinois and under the sponsorship of a large clay products company has provided a fundamental explanation of certain properties of clays and molding sands that appears to be leading to improvements in foundry practice and probably a speeding up of production. A large amount of Illinois clay is also used to make the refractory brick needed to line furnaces producing steel and other metals. Manufacturers are unable to keep up with the demand for some kinds of refractory brick caused by the demands of the war effort. As a result of the Survey's fundamental study of the composition and properties of clays, a new process for making an urgently needed type of refractory has been discovered that promises to speed up production and reduce cost.

Every clay producer knows that the properties of his clay vary slightly from place to place in his clay pit. Although this causes a large amount of trouble in manufacturing processes using clays, there has been no simple and rapid method of determining the important properties of clays before they are processed. A differential thermal analytical procedure has been developed in the Survey laboratories that discloses the components of a clay by determining their reactions when heated. It is believed that this procedure will serve as a simple prospecting "tool" for the clay industries.

Agricultural limestone, used to correct soil acidity, and thereby promote the growth of crops and pastures, is another of the less spectacular mineral materials but one of great importance on the farm production front of Illinois. Illinois is the country's outstanding user of this material and with needs for even greater agricultural production a continuing supply of agstone is necessary. To assist in providing such a supply the Geological Survey is co-operating with farmers, farm advisers and others in evaluating the worth of lime-



Car loads of Illinois limestone find profitable markets in the construction, metallurgical, chemical and agricultural industries.



Huge quarries occur in the State that yield large tonnages and convert stone resources into wealth.



A large glass sand quarry in Illinois.

stone deposits as sources of agstone and has also prepared a report dealing with the agricultural limestone resources of Illinois, their character, occurrence and methods of examining them and determining their merit. This report, soon to be distributed, is planned to aid in meeting the changes effected by the war on the normal sources of agstone within the State.

In addition to work directly related to the war effort, the Survey is devoting what time it can to certain studies which are regarded as of special significance when peace comes again. The surface clays of the State are being studied to discover what heretofore overlooked commercial uses they may have and success along certain lines already seems likely; in a report issued during the year the ordinary sands of Illinois have been shown to be a new potential source of the commercially important mineral feldspar; and the soundness or weather resistance of the dolomites of the Chicago area likewise has been given study. Also the Survey continues its ready co-operation with the mineral industries of the State on many problems relating to resources, processing, and products, its co-operation with various Federal and State agencies, and last but not least its services to the people of the State in matters relating to the character, use and value of industrial mineral resources of particular personal interest.

Geologic Studies Assist Engineering Projects

The Geological Survey has for years co-operated with other State agencies in furnishing them with reports on the geology of specific areas where engineering work is in progress or contemplated. During the year reports were prepared for the State Waterways Division, on geologic conditions affecting proposed dam sites at ten different localities in the State. Samples and test borings at these sites had been previously studied. Advice was also given on the geology of dam sites for two municipal reservoirs. Geologic conditions along several main highways of the State were investigated at the request of the Division of Highways and procedures were recommended for overcoming problems of subgrade stabilization, drainage and landslides. Other requests for information or detailed in-



Modern hydraulic mining of silica sand in an Illinois quarry.

vestigations were answered, with respect to construction projects at ordnance plants, airport sites, hospitals, leakages from municipal water reservoirs, foundation failures in large buildings, etc.

Topographic Mapping of Illinois

Topographic mapping of Illinois, carried on in co-operation with the U. S. Geological Survey, was continued without restriction, because of the great and varied usefulness of these maps to engineering, government, and numerous other agencies. Maps were completed for five quadrangle areas and approximately 75 per cent of the entire State has now been covered.

Variety of Publications Issued

The Survey has published over 100 technical and educational bulletins, 86 reports of investigations, 43 issues of *Illinois Petroleum*, 3 popular educational pamphlets for use in grade and high schools, nearly 100 issues in its "Circular" series, and 79 monthly Oil and Gas Drilling Reports. In addition to these regular publications, it has issued many special development, structural, and geologic maps.

Some of its more recent publications of especial interest are: *Geology and Mineral Resources of the Ottawa-Marseilles-Streator Quadrangles*, *Pennsylvanian Fusulinidae of Illinois*, *Correlation of Domestic Stoker Combustion with Laboratory Tests and Types of Fuels*, *Feldspar in Illinois Sands*, *Modern Concepts of Clay Minerals*, *A Field Test on the Use of Fibre Pipe as a Substitute for Steel in Cementing Wells*, *Secondary Recovery of Oil in Illinois*, *Bituminous Coal Movements in the United States*; *Geologic Maps of the Chicago Area to accompany the popular bulletin issued previously*; *Geologic Maps*, *Drilling Reports*; etc.

A complete list of publications, very thoroughly indexed, is available and will be furnished upon request.

