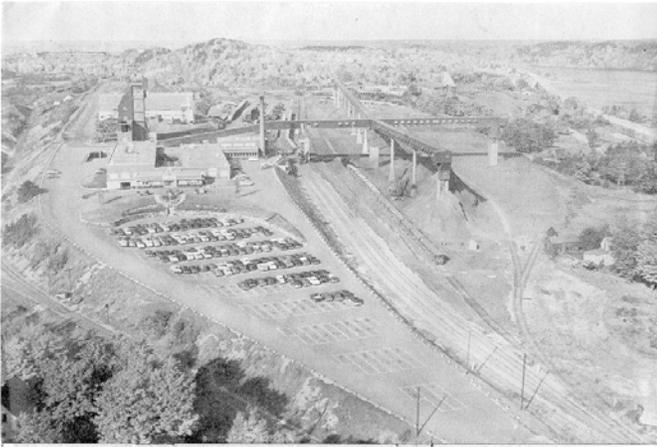


THE DEPARTMENT OF
CONSERVATION
STATE OF MICHIGAN



Geological Survey Division

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A symbol of Michigan's century old contribution to the industry of the world is this iron mine in the Upper Peninsula.

GEOLOGICAL SURVEY DIVISION

W. L. DAoust, *State Geologist*

INTRODUCTION

Demands upon the Division for assistance and advice regarding the best uses of mineral resources were increased.

Expansion in all types of building and chemical processing made greater demands for data regarding the availability of our non-metallic resources. Particular emphasis was on limestone and allied rocks required for Portland cement manufacture; salt and brines for chemical products; sand, gravel and stone for building. Increased building, industrial and chemical activity generated a marked increase in demands for data on fresh water supplies. Application of modern hydrologic methods in locating new sources of supply and extensive additions to existing facilities meant additional responsibilities.

The Survey observed and assisted in a program of maintaining an adequate reserve of iron ore. Beneficiation of low grade ores is in progress with encouraging results. Mining of low grade copper ores is in the development stage at the White Pine Mine. A cooperative project with the U. S. Geological Survey involving mine drainage problems was completed and other mineral reserve programs with the U. S. Geological Survey are in progress.

The Lakehead Pipe Line Company's 563 miles of 30-inch crude oil line across the state from Ironwood to Port Huron not only established several construction records for length, size, deepest water crossing, etc., but also provided a fresh rock cross section across the state for geological study.

Oil and gas well operations experienced a trend toward drilling to deeper formations. Facilities were expanded for natural gas and liquefied petroleum gas storage. New plans were developed for the underground storage of petroleum products for economy and security reasons.

The program of acquainting people with the everyday uses of mineral resources met with continuing success. The graphic presentation of such factual data by means of television should promote even more complete understanding of such uses.

Late in 1953 the Survey, with other divisions, moved into the new Stevens T. Mason Building, providing more efficient and improved working conditions. Cooperative efforts with other divisions, state and federal agencies, and with the universities and colleges continued and expanded. Work with the Interstate Oil Compact Commission and the member states was extended, and improved results enjoyed.

Subsurface data in the Survey files will no doubt be found useful in the construction of the Mackinac Straits Bridge. Data on surface geology have been requested by and made available to the Office of Civil Defense, and to superhighway and port authorities.

At the close of the biennium, William L. Daoust, who had served as acting State Geologist, was appointed State Geologist.

NON-METALLIC MINERAL RESOURCES

Annual collections of mineral statistics were made for the years 1951 and 1952 in cooperation with the U. S. Bureau of Mines. In replying to questionnaires sent them by the Bureau of Mines and returned to this division, mineral operators reported on production and value of minerals, business conditions, and old and new ones for which their products are suitable. This information furnishes an important supplement to field investigations in keeping the Survey abreast of trends in mineral resource operations.

Two reports, "Michigan's Mineral Industries," for 1951 and 1952 were published. These present a summary of each of the mineral industries, a break-down of mineral production and value by county, and a directory of mineral producers. The reports not only furnish, statistical data to those interested in Michigan's mineral production, but also are of value to mineral resource operators regarding outlets for their products or new locations for raw materials.

Increased demands of industry for various minerals has resulted in plant expansions and the development of new mineral areas. A number of the Portland cement plants have increased capacity by the addition of new kilns. A large chemical company has constructed a plant in Muskegon County which will use salt for raw material. In Presque Isle County a limestone quarry was reopened. A new dolomite quarry was projected for Chippewa County.

The constant search by producers for unexploited mineral deposits results in requests for geological assistance or information from this division. In addition, individuals desiring building stone, sand and gravel, or other rocks or minerals; chemical corporations needing advice on disposal of harmful waste products; oil companies seeking information on underground petroleum products storage; and others look to the Survey for necessary geological data.

To satisfy these requests for assistance and information, to gain proper knowledge of the non-metallic minerals, and to be informed about industrial problems, field reviews were made of quarries and outcrops, rock cores studied, and rock sections examined. To supplement the work of earlier surveys, up-to-date reports are to be prepared on the various rocks and minerals in the state. Studies were continued on salt, clay and shale, and sandstone. Data accumulated will be published during the next biennium. These will contain information on geological and geographical distribution of resources, data on their present and potential uses by industry, and a review of operators producing and/or using the raw material.

Construction in 1953 of the Lakehead pipe line from Ironwood to Port Huron, afforded Survey geologists an opportunity to study the character of the rock and glacial drift exposed in the 563-mile trench dug for the pipe line.

Rock and drift samples, notes on the geology of the material exposed, geological sections, and photographs of important exposures were obtained for much of the excavation. These data were cataloged, rock samples labeled and maps prepared, and all information is available for geological study. Results of the work were presented at the Michigan Academy of Science meeting in 1954.

The Division acted as geological consultant for other divisions and departments on mineral resource matters. Mineral valuations of state-owned lands containing deposits of sand and gravel, gypsum and limestone were made for purposes of land exchange or leases.

Office discussions, field conferences and assistance to industrialists to open deposits of sand, gravel, clay, shale, sandstone and limestone continued to require a considerable part of the division's work. Routine correspondence from students, teachers, and the general public on geology, geological phenomena, statistical information, and rock and mineral identification was answered.

HYDROLOGY

In Michigan, significant problems of water supply were almost unknown until about two decades ago. Large cities were so situated that ground waters or nearby surface waters, lakes and rivers, satisfied water supply demands. However, as cities grew, demands of domestic and industrial consumers began to heavily tax available sources. Complications developed through the use of such surface waters as ponds, lakes and rivers as places for disposal of waste and sewage by cities and industries.

Modern farm practices, farm and household equipment depend upon copious quantities of water that can not now be supplied by those rural wells that adequately served past generations. In searching for waters with which to augment failing supplies, municipalities, industrialists, farmers, and home owners were faced with problems that only specialized geological and hydrological data can solve. Requests for such data were properly directed to the Geological Survey. By November 1941, it was no longer possible for the State Geologist and one Associate Geologist, with other routine duties, to properly or adequately handle the requests concerning solution of water problems which were being received. A water resource section was set up in the division.

Problems of water supply steadily increased. Recreational developments around inland lakes placed increasing emphasis upon stabilization of water levels. Postwar expansion of industry and suburban movement of population created new water supply problems as existing facilities were not adequate.

As the national economic trend was downward, it was expected that ground and surface water problems in Michigan would reflect the trend. However, during the

biennium the amount of hydrogeological work conducted by this division surpassed all previous records.

Data and service for the development of new or supplementary ground-water supplies were requested by 181 home owners and builders, 92 municipalities, 40 industries, and 31 institutions—a 38% increase over the previous biennium. Requests for service from the Northern Peninsula continued to be an important part of the total. The economic development expected to follow completion of the Mackinac Straits Bridge will bring an even greater volume of requests.

The increase in water supply problems can be attributed in part to increasing per capita consumption, decentralization of industry, continued population shifts, increased air conditioning or cooling demands, irrigation developments, and need for disposal of waste without contamination of water supplies. Technical consultants throughout the state have sought and obtained data, advice and assistance on problems and practices of hydrologic ground water appraisal. Detailed guidance and considerable direct supervision of construction resulted in the improvement of more than ten department and state-supported institutional water supplies.

Continued development of recreational and resort properties adjacent to inland lakes brought requests for information and assistance with water level fluctuations and stabilization on 117 inland lakes—33% over similar duties of the previous biennium.

A gazetteer of geographic names for Gogebic County was prepared and submitted for approval to the U. S. Board on Geographic Names. This publication is the first complete county gazetteer ever made. The project was carried out by the county authority and state committee. Names of some 40 lakes and streams in other parts of the state were considered, approved, and submitted to the U. S. Board on Geographic Names.

More than 40 requests for general geologic and hydrologic information required individual attention other than supplying copies of printed material. The graphic booklet, "You Never Miss the Water", designed to answer some requests continued to increase in popularity.

Concern over the lack of sufficient data and technology to solve critical water problems focused public attention on the fact that water is an important mineral resource and that the public has been too little concerned about it. Division representatives have participated in several educational programs designed to remedy this situation. A public demand is growing for enactment of adequate statutes to control development of groundwater resources and to provide for collection of geologic data pertinent to ground water and its reservoirs. Assistance has been given in drafting suitable legislative proposals.

Under the continuing cooperative program with the U. S. Geological Survey, several state agencies and industrial contributors, basic water data are compiled pertaining to

surface water runoff, groundwater storage and production, surface and groundwater temperatures, and the quality of surface and of ground waters of the state. The current ground-water part of this program includes tabulation of groundwater withdrawals for 30 areas of intensive use, changes of storage in principal groundwater reservoirs, 15 daily stations, and 253 periodic measurement stations; and water temperatures for 80 wells and one spring.

The stream gaging and surface water part of the cooperative program, started in 1930 by the Stream Control Commission, has been expanded with inclusion of additional participants to currently operate 145 stream gaging stations—a net increase of 18 stations during the biennium. At the beginning of the biennium, 65% of all stations were of the continuous recorder type. Contributions from industry made it possible to increase the number to 75%, thus substantially increasing the pertinent data collected.

Pioneer studies on small drainage basin areas ranging from 8 to 10 square miles were started. At three of these stations artificial controls were installed to provide for more accurate runoff data collection. The U. S. Weather Bureau has installed recording rain gauges near the center of each basin to provide further basic data in these grades.

A considerable amount of additional data has been added for the 110 square mile Rifle River stream improvement project. Continuing studies and the collection of enough significant data on precipitation, runoff and temperature make possible preparation of a progress report.

'The quantity of water' part of the program continued with periodic collection of data from various sources. Water samples for analysis were collected from 116 wells, nine streams or lakes, and one spring. It is expected that increased drafts on groundwater sources will focus additional attention on this phase of the program.

In addition, U. S. Geological Survey Water Supply Papers entitled "Michigan Section, Water Levels and Artesian Pressure in Observation Wells in the United States in 1952" and "Michigan Section, Water Levels and Artesian Pressure in Observation Wells in the United States in 1953" are in press. Other Water Supply Papers published are 1174 and 1207 which are compilations of surface water runoff data collected during the preceding biennium.

Two urban areas of Michigan were of sufficient national significance to warrant inventory type survey's through the facilities of the U. S. Geological Survey without the expenditure of state funds. These studies were published as Geological Survey Circular Number 183 "Water Resources of the Detroit Area, Michigan," and Geological Survey Circular Number 323 "Water Resources of the Grand Rapids Area, Michigan."

The publications on discussions of program, accomplishments and data compiled for publication are listed under "Publications."

MINES AND MINING

The Mines and Mining section made two annual valuations of the iron and copper mines of the state for tax purposes. Prior to 1945 mine valuations were recommended to the Michigan State Tax Commission. Since that time, valuations determined by the State Geologist or his authorized deputy have been certified directly to the local assessors who place them on the assessment roll. Mine valuation work involves an examination of the drill hole records, maps, cross sections and ore estimates of the mining companies as well as surface and underground examination of the physical properties. More than 125 iron ore and 17 copper mining properties, including approximately 40 active iron ore mines and eleven copper mines, were valued during each of the years of the biennium.

The recognized need for a resurvey and comprehensive study of iron-bearing regions of Michigan was met by a continuance of the cooperative magnetic and geological mapping program with the U. S. Geological Survey. Essential field work was completed in Iron County and in central Dickinson County and final work was begun in southern Dickinson County. Upon completion of all field work, a comprehensive report on the Menominee Iron Range will be published.

To permit earlier release of information for exploration purposes, it has been the policy of the U. S. Geological Survey and the Division to issue preliminary reports as the survey is completed in a unit area. An open file report on the geology of an area in central Dickinson County was released and a report on geophysical investigations in a part of Dickinson County was published. Thus far, the cooperative program has resulted in the publication of nine geological, two geophysical, and six open file reports on Iron and Dickinson counties. It is expected that this work will be carried into the Marquette and Gogebic ranges in order to bring up-to-date the geological information on all iron-bearing districts in the state.

The cooperative program with the U. S. Geological Survey on mine drainage was concluded at the end of the biennium. A report on the control of water in relation to underground iron ore mines on the Marquette Range has been completed and will be published early in the next biennium.

Although much of the exploratory drilling by the iron mining companies during the biennium was to locate deposits of low-grade ore suitable for beneficiation, substantial additions to the reserves of direct-shipping ore were made either by extension of known deposits or discovery of new ore bodies. This is demonstrated by the fact that in spite of the shipment of more than 25,000,000 tons of iron ore in the period January 1, 1952

to January 1, 1954, taxable reserves decreased only about 8,000,000 tons. The number of beneficiation plants processing low-grade iron ore increased to three with the addition of a new plant on the Marquette Range, at Humboldt, and a plant on the Menominee Range, near Alpha. A fourth plant is under construction at Republic. These developments opened a new field of work for the Survey, both in geological studies and the valuation of mineral properties.

The U. S. Geological Survey continued its work in the copper district of Michigan. Field work was completed for the preparation of geological quadrangle sheets of the northern part of the Keweenaw Peninsula and four sheets were published. Geological studies also were made on the Nonesuch shale, the ore-bearing formation in the new White Pine mine. Although no direct contribution is made by the state toward this work, it has been the policy of the Michigan Geological Survey to keep in close contact with field parties and offer all assistance possible to this important program which may reveal new areas for exploration.

The section acted as geological consultant to the Lands Division in the review of exploratory work done on state land leased to mining companies and individuals. The state lease prescribes that a definite sum be expended during each of the years of the exploratory period. The report of work performed is submitted annually by the lessee and is examined to determine that the lease requirements have been met. Annual inspections were made of the Warner mine, an iron ore mine in Iron County on leased state land, for conformance with the provision of the lease.

OIL AND GAS

Oil and gas operations in Michigan continued the slow decline which was evident during the previous biennium. The accompanying table reflects this decline in nearly all phases of oil and gas activity.

Permits issued declined from 1,645 in 1951 and 1952, to 1,430 in the 1953-1954 biennium. Geological test permits dropped from 1,111 to 228. Oil production declined from 29,752,666 to 24,847,643 barrels. Gas production dropped from 27,274,271,000 to 14,387,819,000 cubic feet. Well completions decreased from 1,577 to 1,262.

	1951 & 1952	1953 & 1954
Permits	1,645	1,430
Well completions	1,577	1,262
Oil wells	532	473
Gas wells	132	76
Geological test permits	1,111	228
Exploratory wells	655	527
Oil discoveries	38	23
Gas discoveries	11	7
Oil production (bbls.)	29,752,666	24,847,643
Gas production (M.c.f.)	27,274,271	14,387,819
Producible oil wells	4,009	4,133
Producible gas wells	1,080	1,203 (1)
Cumulative oil production (bbls.)	343,063,199	367,908,806
Cumulative gas production (M.c.f.)	274,450,810	288,838,629
Producing oil pools	191	213
Producing gas reservoirs	86	82

(1) Includes 901 facility or gas storage wells.

Continued decline of oil operations has resulted in the need to prospect in deeper formations for new oil. The "Richfield Zone" of the Detroit River Formation is an important deeper source of oil which currently is producing approximately 20% of the total oil. Pays in this zone are 4,200 to 5,000 feet deep, have greater than average pay thickness, and carry high gas-oil ratios. Of the 22 Richfield oil fields, East Norwich, St. Helen and Enterprise, have been converted to unit operation. The gas in the Richfield Formation is being conserved by restricted production, repressuring, and use in lease and plant operation.

The volume of imported gas being stored in Michigan has increased greatly with the sharp decline of natural gas production in the state. The gas is stored in the reservoirs converted from partially depleted gas fields. Eight such reservoirs are in Michigan Stray Formation. Three additional Michigan Stray Formation reservoirs have been converted for storage use but the stored gas is not yet produced.

Underground storage of liquid petroleum gas proved to be a practical operation in Michigan during the biennium. Storage space is obtained by drilling a well into the salt formation and dissolving or washing out a cavity in a thick salt bed. Three companies currently have such storage facilities for liquid petroleum gas and thus are able to provide "bottled" gas to areas of Michigan where natural gas is not available.

A large part of Michigan is underlain with thick salt deposits suitable for the development of underground storage cavities. Railroad, pipe line and boat terminal facilities are available to these areas. Serious consideration is being given to salt cavity storage of other petroleum products and even to the storage of crude oil. The hazards of fire and explosion, as well as war time hazards, would be eliminated by this type of storage.

Oil operators continued their excellent record of returning production brine to approved sub-surface formations. The total being returned underground at the end of 1953 was 189,409 barrels per day or 99.26% of the brine produced. Twenty oil fields each were producing in excess of 2,000 barrels of brine per day. The most satisfactory formations for the disposal of brine have been the Marshall, Traverse, Dundee and Detroit River. Waste resulting from damage to property and pollution of surface and groundwater resources were eliminated by the subsurface method of oil field brine disposal.

Casinghead gas from three Detroit River (Richfield Zone) reservoirs is being returned to the producing formation in unitized pressure maintenance programs of considerable interest from the standpoint of oil conservation. The performance of a pilot plant in the East Norwich field (Missaukee County) indicates an anticipated 50% increase in ultimate recovery of oil.

The three gas injection-pressure maintenance plants injected a cumulative total of 4,799,891,000 cubic feet of casinghead gas by July 1, 1954.

Seven scrubber-booster plants were operating and processed for delivery to pipe lines 3,137,685,000 cubic feet of casinghead gas and recovered 8,956,012 gallons of liquid petroleum gases and natural gasolines. The Kimball Lake (Newaygo County) and Pentwater (Oceana County) oil field gas plant operations were discontinued but two new plants were constructed and put into operation in the Hamilton (Clare County) and Eden (Midland County) oil fields.

The Division participated in eight general hearings before the Supervisor of Wells. The hearings resulted in promulgation of 11 oil and gas well spacing orders and the abrogation of 24 orders. During the same period, two amendments to Proration Order No. 23 were placed in effect, and orders affecting the allowables from six fields were terminated. At the close of the biennium, six oil fields producing 37% of the state's production were being operated under Proration Order No. 23 and its amendments with allowables ranging from 50 to 100 barrels daily.

The constantly expanding oil and gas producing area of the state required the preparation of new maps. The Division has more than 180 oil and gas maps which are posted to date and available for distribution.

Twelve-hundred new well logs, including more than 100 sample logs were prepared for distribution. Many old logs were revised in order to keep the files to date.

The sample library was expanded by some 600 new sets of samples and now contains more than 5,300 sets. The library is becoming increasingly popular for consultation as new prospecting areas expand and as wells are drilled to deeper zones.

The Division prepared annual reports on oil and gas operations for distribution to the public. Staff members prepared reports for the American Institute of Mining and Metallurgical Engineers.

GENERAL GEOLOGY, RESEARCH, EDUCATION

The visible result of research conducted for the past several years on the origin and character of the surface features of Michigan, that is, on the glacial or Pleistocene geology of the state, is the new revised map of the surface formations. This glacial geology map is now ready for printing. It is expected to be of use to agriculturists, as earlier editions have been in the past, of more use in the search for water supplies, gravel, sand, and similar resources, and as a guide to soil conditions and management. Teachers will find it valuable as a teaching and field trip guide and tourists and resort owners will use it. In manuscript it has been of such use and also been of aid to radio station engineers, the Highway Department, soil conservationists, for stream improvement and flood control planning, and for waste and sewage disposal projects.

Data have been collected, compiled and a revision made of the Centennial Geologic Map of the Southern Peninsula. The supply of the Centennial Map is nearing exhaustion but a revision is in preparation. Also, a surface geologic map and a bedrock geologic map of the Northern Peninsula are in preparation.

As in former years, interpretations of the glacial geology of the state were made for division geologists, the fish, lands, parks, and legal divisions of the Department, for land use specialists, radio and radar installations, teachers, youth camp leaders, industrialists, and the public. Also such interpretations and data were made for the Office of Civil Defense, superhighway and port authorities. Similar service was rendered regarding the general geology of the state to teachers and the public.

The two geologists of the section continued educational and public relations work independently and in cooperation with the Education Division. Independent work consisted of participation in on-campus and extension courses in conservation at Michigan State College, the four colleges of Education and the University of Michigan. Such participation included lectures, conducted field trips, map and exhibit preparation such as suites of rock and mineral samples. Also, requests of teacher groups, science clubs, libraries, women's organizations, 4-H clubs, scout groups, farm bureaus, achievement days and service clubs were honored as time permitted by lectures and/or demonstration lectures with slides, maps, charts, and other visual aids. All requests could not be granted. Priority is given to educators, urban teacher groups, county institutes, county normals, extension and conservation courses of the colleges, farm groups and 4-H clubs.

Cooperative work with the Education Division consisted of participation in the teacher and adult education programs conducted by that division at the Conservation Training School and elsewhere. Lectures were on

Michigan geology, mineral (including water) resources, their relation to daily living and their conservation. This type of education and public relations work requires the construction of detailed local maps, charts, pictures, slides, writing of brochures and the direction of teachers and others to available material in their localities.

The spread of the story of geology as the basis for conservation and of the importance of non-renewable resources in our way of living was state wide. More than 16,000 persons were in the groups addressed.

Toward the close of the biennium an interesting activity was added—participation in the plan for the Soo Locks Centennial, particularly in the work of the Commission's Educational Committee in the preparation, by the editorial committee, of a guide for teachers of Michigan history—The Soo Locks and Michigan History.

A comprehensive reference book on the geology of Michigan has been compiled and is now ready for the press. Publication 49, Occasional papers for 1954, a two-part report on the water resources of Van Buren and of Oakland County, by Mr. F. W. Terwilliger and Dr. Andrew Mozola, has been edited and is in press.

PUBLICATIONS

Publications prepared during the period covered by this report included:

Publication 47, Oil and Gas Conservation in Michigan.

Publication 48, Occasional Papers for 1954. In press.

Part I Glacial Geology and Groundwater Resources of Van Buren County, Michigan.

Part II A Survey of the Groundwater Resources in Oakland County, Michigan.

Publication 49, Map of the Surface Formations of the Southern Peninsula of Michigan. In progress.

Publication 50, A Survey of Michigan Geology, 1821 to 1954. In progress.

Progress Report 16, Groundwater Resources of Southeastern Oakland County, Michigan.

Technical Report 3, Groundwater Investigations of the Marquette Iron Mining District.

Gogebic County Gazetteer.

U. S. Geological Survey Circular 183, Water Resources of the Detroit Area.

U. S. Geological Survey Circular 323, Water Resources of the Grand Rapids Area.

U. S. Geological Survey Geophysical Investigations 115, Aeromagnetic Survey of Part of Dickinson County, with Preliminary Geologic Interpretation.

Michigan's Mineral Industries 1951.

Michigan's Mineral Industries 1952.

Statistics Covering Costs and Production of Michigan Iron Mines, 1952.

Statistics Covering Costs and Production of Michigan Iron Mines, 1953.

Summary of Operations, Oil and Gas Fields 1952.

Summary of Operations, Oil and Gas Fields 1953.

Open file:

Manuscript Revision of Geological Map.

Manuscript Maps of Surface Geology of Southern Peninsula Counties.

U. S. Geological Survey Pre-Cambrian Geology of the Norway Lake Area, Dickinson County.

Groundwater Conditions in the Alma Area.

Groundwater Resources of the Pendills Creek Area, Chippewa County.

Groundwater Resources of the Holland Area, Ottawa County.

Probable Effects on Groundwater Resources from Construction of the Proposed Grand River Cut-off Channel West of Lansing.

Interpretation of the Pre-Pleistocene Geomorphology of a Portion of the Saginaw Lowland.

Subsurface Correlation of Pleistocene Deposits in Gratiot County.

Articles on geology, the mineral industry, water resources, oil and gas operations were contributed to scientific, technical, and education journals and to the Department magazine. County geologic maps were prepared for field log books used in conservation education.