

STATE OF MICHIGAN
**THE DEPARTMENT OF
NATURAL RESOURCES**



**TWENTY-FIFTH BIENNIAL REPORT
1969-1970**



LETTER OF TRANSMITTAL

To the Governor and Members of the Seventy-Sixth Legislature:

Sir and Gentlemen:

In accordance with provisions of Section Four, Act No. 17, Public Acts of 1921, I am transmitting herewith the Twenty-Fifth Biennial Report, Department of Natural Resources, for the fiscal years, 1968-69 and 1969-70.

I am pleased to submit this summary of the activities and progress of this Department.

Respectfully,

DR. RALPH A. MacMULLAN, *Director*

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REPORT OF THE DIRECTOR

Environmental pollution, having emerged as an urgent challenge in the previous biennium, shaped into active confrontation during the period covered by this Report—July 1, 1968-June 30, 1970.

Public concern for the environment was dramatically expressed in November, 1968 when Michigan voters approved a \$335 million bond issue for clean water. Responsibility for administering the resultant bond program was assigned to this Department.

New laws were passed to strengthen the State's environmental effort, and new pollution prevention programs were implemented by the Department. Early in 1970 the discovery of high concentrations of mercury in Lake St. Clair fish underscored the seriousness of the pollution problem. The Governor placed a fishing ban on Lake St. Clair as a result of the discovery.

In recognition of its greatly expanded area of concern, the Department of Conservation, by legislative act, became the Department of Natural Resources on Nov. 15, 1968.

Restoration of the fishery of the Great Lakes was a historic achievement of the biennium. Lake trout were in abundance in Lake Superior and were staging a comeback in Lakes Michigan and Huron. Populations of coho and chinook salmon and steelhead in Lake Michigan reached record numbers. Sea lamprey control in Lake Huron became a fact.

At the same time that Michigan voters approved a bond issue for clean water, they voted in favor of a \$100 million bond program for recreation. Here again, this Department was assigned the responsibilities of administration.

Noteworthy among achievements of the biennium was Commission adoption of a northern forest land management policy. In this, production of timber and improved conditions for wildlife are integrated into a cooperative effort by the Department's Forestry and Game Divisions.

A geological highlight was the prospecting of an oil and gas area across the northern Lower Peninsula. Here public concern for the environment was emphatically expressed and as a result, an auction sale of oil and gas leases in the area was cancelled.

Recreation in outdoor Michigan continued its upward trend on all fronts. State park attendance reached an all-time high in 1969 with 18,956,005 visitors. Camper registration at state forest campgrounds reached 220,000 in 1969. By comparison, the figure for 1967 was 156,000. The State's tourist industry scored substantial gains, again surpassing the billion-dollar-a-year spending level by recreational travelers.

The above are some of the highlights of the biennium. Details of all activities of the Department appear on following pages of this Report.

Ralph A. MacMullan, *Director*

GEOLOGICAL SURVEY DIVISION

GERALD E. EDDY, *State Geologist*

Problems involving underground disposal of industrial wastes continued to increase in number and complexity. This growth is attributable, in part, to continued urging on the part of state and federal pollution control agencies. The Division made a significant contribution to a report on underground waste disposal published by the Interstate Oil Compact Commission. Receiving wide national distribution and acceptance, this report points out many of the complexities and ramifications involved in deep disposal of wastes.

The Mineral Well Act, Act 315, of the Public Acts of 1969, became effective on March 20, 1970. This Michigan statute covers the entire area of drilling activity not covered previously in water well drilling legislation and the oil and gas conservation law. At the close of the biennium an advisory board was appointed and the Division began preparing rules and regulations to carry out the provisions of the Act.

The State Geologist continued to serve as a member of the Water Resources Commission. Adoption of Interstate Water Quality Standards and deliberations on the creation of intrastate standards demanded the services of the State Geologist and many of his staff. The State Geologist also continued to represent the Director of the Department on the State Air Pollution Control Commission. This Commission exercised a widening influence and supervisory power in setting air pollution control standards and regional ambient air quality criteria—the latter in cooperation with the federal air pollution control agency. The State Geologist also continued to represent the Governor as his official representative on the Interstate Oil Compact Commission.

Paralleling national trends, oil and gas activities continued to decline due to a lower success ratio for wildcat wells, an unfavorable price situation with respect to crude oil, uncertainties concerning federal import quota regulations, and the attack upon the depletion allowance. However, in Michigan, during the latter part of the biennium, an important new geological area across the northern part of the Lower Peninsula was prospected and developed. Developments here have been hindered by objections of local citizenry. As a result, a public oil and gas lease auction scheduled by the Lands Division was cancelled. Changes in rules and regulations and in the oil and gas conservation law are anticipated.

Passage of a solid waste disposal act administered by the State Department of Public Health gave the new Glacial and Environmental Geology Section an added responsibility. The Section serves as liaison and in an advisory capacity to the Public Health Department in checking all sites to make sure that surface and ground water resources will not be polluted in the development of solid waste disposal dumps.

Underground mining activities in both the copper and iron ranges continued to decline with the closing of all except one copper mine and three underground iron mines. The latter have found it increasingly

difficult to compete with open pit, beneficiated, and imported high-grade foreign ores. Beneficiated iron ore production continues to increase.

The topographic mapping program, started in 1964-66, continued at a modest level. At the close of the biennium, the Legislature reduced the program substantially. This reduction had the effect of eliminating all departmental contributions, leaving the Department of State Highways as the only Michigan contributor.

With the completion of the first phase of development of the Capitol complex and the general allocation of many agencies to new quarters within the area, the Division moved back into permanent offices in the Mason Building on July 16, 1969.

OIL AND GAS

Development and production of oil and gas in Michigan is administered by the Supervisor of Wells (the State Geologist) with the assistance of this Section. The efficient recovery of these resources is the over-all objective. The Section is made up of the following units: Regulatory Control, Petroleum Geology, and Production and Proration. During the latter part of the biennium, the Pollution and Fire Control Unit was transferred to the Department's new Water Quality Control Division in the Bureau of Water Management.

The head of the Section, serving as secretary to the Oil and Gas Advisory Board, scheduled 49 hearings (80 cases considered) pertaining to oil and gas matters. A total of 72 orders, or directives, was issued by the Supervisor of Wells following these hearings. Of these orders, 27 involved permits to drill off-pattern wells, 38 well spacing and proration, 3 unitizations of pools, 2 determinations of reservoir status, one water flood project, and one gas-oil ratio project.

Oil production declined from 27,324,751 barrels to 24,400,505 barrels, due to a minimum of new pool discoveries. Gas production, on the other hand, continued with little change due largely to a considerable amount of gas produced with oil.

During the second half of the biennium several important oil and gas discoveries were made in northern counties of the Lower Peninsula. Three were completed as oil wells and two as gas-condensate wells. These wells, producing from the Niagaran strata at 5,000 to 7,000-foot depths, are located along a line extending from Manistee County to Presque Isle County. The oil and gas occurs in pinnacle reef reservoirs of very limited areal extent. These discoveries, resulting from increasingly precise interpretation of seismicographic data, point up the possibility of developing numerous additional new pools on the north and northwest flanks of the Michigan basin. These recent developments have been a source of much anxiety among conservationists concerned with damage to water, wildlife, and recreation resources of this forested area of the State. Much of the opposition is based upon objection to odors, noise, and general industrial activity. Special efforts, however, are being made to develop safeguards for reducing the possibility of pollution, loss of esthetic values, damage to the environment, or otherwise detracting from the natural resources of the area.

Regulatory Control

This Unit issues permits to drill for oil and gas and is staffed largely with geologists who implement compliance with statutes and rules pertaining to oil and gas operations. Field offices are located in Mt. Pleasant, Cadillac, Imlay City, and Plainwell. Special attention is given to the location and spacing of wells, drilling, casing and cementing, disposal of brine produced with the oil, and abandoning and plugging of wells. A total of 780 permits to drill was issued. At the end of the biennium the Legislature approved establishing a field office in Gaylord to more closely supervise new oil and gas developments in the northern part of the Lower Peninsula.

Production and Proration

Primary functions of this Unit are assembling and evaluating engineering data on petroleum reservoirs, and surveillance of producing operations of fields under proration control. Staff members carry out a comprehensive long range program of testing and evaluation over the life of all major oil reservoirs in Michigan.

Ten crude petroleum reservoirs, consisting of 674 wells, were under proration control. These reservoirs yield 58% of Michigan's current daily oil production of 32,000 barrels. Records also were kept on 3,911 additional wells not under proration, as well as on the production of liquid petroleum gas (butane, propane, etc.). Proration orders were promulgated for four new petroleum reservoirs while orders for two other fields were abrogated.

Unitization agreements were approved by the Supervisor of Wells for three petroleum reservoirs under a program of secondary recovery by water flooding. Currently 16 projects of this type are being studied by this Unit. In seven of the active floods, the State participates as a major royalty interest. A cooperative study with industry showed that Michigan's crude petroleum reserves, as of December 31, 1969, were about 51½ million barrels. New reserves developed were insufficient to offset production. A comprehensive quarterly report on the continuing performance and historical analysis of prorated fields was also prepared. In addition, contributions were made to the Division's annual statistical report on oil and gas fields.

Petroleum Geology

The major work of this Unit is collecting geological and engineering data on oil and gas wells drilled in Michigan; processing and distributing this information in the form of well logs, technical reports and maps; and serving as a geological consultant to the Supervisor of Wells, government agencies, universities, and the public. The Unit also manages and maintains libraries of well sample sets, mechanical logs, and published geological and driller's logs. Although 138 new sets were added to the sample library, selection had to be curtailed for lack of space and funds. The log libraries continued to expand. These facilities were used extensively by oil and gas industry personnel, university students, and the Division staff.

Information was given by phone, letter, and office visit to approximately

2,000 persons, including industry personnel, universities, landholders, geologists, students, and others interested in petroleum geology. Geological advice was provided to the Public Service Commission, Department of State Highways, Corporation and Securities Commission, United States Geological Survey, and other agencies.

Members of the Unit again prepared the comprehensive annual summaries of Michigan oil and gas field activities and statistics. These documents are widely used by the oil and gas industry. In addition, reports were prepared for the American Association of Petroleum Geologists, Michigan Basin Geological Society, Interstate Oil Compact Commission, National Petroleum Council, and several other industry-related periodicals.

The Unit continued to work with Michigan State University and University of Michigan in connection with computer storage and retrieval programs involving a wide range of geological information. Staff members participated in several geological lectures, provided assistance in field mapping and study of outcrop geology, and served on several oil and gas industry committees.

A summary of logs and records received, processed, and distributed by the Unit follows:

Oil and Gas Well Logs

New geological and driller's logs received	702	Logs from file sold or distributed by special order to companies and public	20,580
Deepening and rework records received	209		
New logs published	844	New logs distributed free to the three principal universities	2,532
New logs sold by subscription (estimated)	27,800		

Mechanical Log Library

New mechanical log sets received 611

Well Sample Library

New sample sets received..... 138
 Sample sets loaned or inspected:
 Companies 231
 Consultants 271
 University students 63

Note: Several cabinets of sample sets were damaged by rain water seeping through the basement ceiling and by accidental discharge of the fire sprinkling system. Most sets were repaired, but a number had to be discarded. A recataloging of the oil and gas sample library, excluding water well samples, shows 9,039 sets available.

Maps

New oil and gas maps constructed.... 8 Oil and gas maps available for sale . 258
 Miscellaneous maps constructed 3 Miscellaneous maps available for sale 55

Note: Oil and gas field maps are maintained and dispensed by Engineering Division from data assembled by Petroleum Geology Unit.

MINING AND ECONOMIC GEOLOGY

Mines Appraisal and Precambrian Geology

Approximately 75 iron ore and copper mines and mineral properties were appraised for general property tax purposes during each of the years of the biennium. This major function required the review and study of drill hole records, mine maps and cross sections to determine ore reserves. Also involved were examinations of the surface facilities and underground workings of the mines. These data, along with consideration of the economics of the individual properties and the metal market, are used in determining valuations. Total values of the properties reported to the State Tax Commission were:

Type Property	1969	1970
Iron ore	\$19,827,000	\$14,487,000
Copper	32,982,000	41,747,000
Total	\$52,809,000	\$56,234,000

The decreased valuation of iron ore properties is due to the continued decline in demand for underground direct-shipping ore and the resultant closing of three mines during the biennium. Although shipments of all iron ore from Michigan were the highest since 1943, direct-shipping ore constituted only 16.5 percent.

Production of iron ore pellets from low-grade iron formation and underground ore continues to be the mainstay of the State's iron ore industry. These beneficiation and agglomeration operations are subject to a specific tax in lieu of the general property taxes. The annual determination of these taxes, and especially their allocation to the assessing districts involved in the operations, is an increasingly important activity of the Section. Total specific taxes determined by the appraisers were:

Type Iron Operation	1969	1970
Low-grade ore	\$1,310,847.16	\$1,366,487.37
Underground (agglomerated) ore	452,451.47	477,448.21
Total	\$1,763,298.63	\$1,843,935.58

Geologic mapping of the Precambrian rocks of the western Upper Peninsula continued. This program, in cooperation with the U. S. Geological Survey, is coordinated by the Section. Field work was done in three quadrangles in western Gogebic County, four in Marquette County, and two in Ontonagon County. Several reports and maps relating to Precambrian geology released during the biennium were reviewed by a member of the Section.

In addition to the cooperative work with the U. S. Geological Survey, geologic mapping and the compilation of geologic data continued in other parts of the western Upper Peninsula. Most of this work was in western Menominee County where considerable field mapping was done and numerous rock specimens collected for petrographic study. The objective

is to develop basic geologic data for evaluating the general mineral potential of the area and to encourage exploration by mineral companies.

As a member of the Minerals Work Group of the Great Lakes Basin Commission, data was compiled on the geology and mineral resources for the Michigan portion of eight subareas of the Great Lakes Basin. Four subarea reports prepared by the U. S. Bureau of Mines are edited. All of these reports will comprise part of a broad study to determine the best use of water and related land resources.

Assistance was given in drafting a bill to control the drilling, operating and abandoning of mineral wells (Act No. 315 of the Public Acts of 1969). Assistance also was given in drafting rules under the Act. A bill also was drafted to provide for the reclamation of surface mined lands, but this did not become law.

Geologic consultation was given other Divisions and other state agencies. In particular, the Lands Division was assisted in appraising the mineral potential of lands involved in sales or exchanges, and in the sale of state-owned mineral rights to private surface owners. State-owned lands leased for copper, iron ore, uranium and all-minerals exploration were inspected and annual reports of exploratory work were reviewed for conformance with lease requirements.

Geological information, primarily regarding Precambrian formations, was provided innumerable interested parties including company representatives concerned with the general geology and mineral potential of the western Upper Peninsula.

Mineral Statistics and Nonmetallic Minerals

The annual canvass of mineral producers and the collecting of mineral statistics was continued in cooperation with the U. S. Bureau of Mines as directed by Michigan statute (CL '48s. 319.202). In response to questionnaires, Michigan mineral operators submitted data on quantities, values, uses, employment, and business trends on 730 places of operation. These data are the substance of annual reports on the subject. Mineral production and value continued to increase. Preliminary figures indicate a \$50 million annual increase during the second half of the biennium for an all-time record annual high of about \$627 million. In addition to the annual mineral summaries, annual directories of the mineral producers operating in Michigan were prepared.

At the request of the U. S. Bureau of Mines, the average thickness and acre-tonnage of Michigan mineral deposits were determined. From these data the Bureau will calculate the amount of land in mineral production, and the amount expected to be exploited by open-pit mining over the next 30 years. For a nationwide investigation on strippable coal reserves, the Bureau of Mines was also provided with information on potential coal areas.

Determining the value of nonmetallic minerals on platted lots, isolated parcels and acreage properties in state ownership continued as a regular duty. Where geological evidence suggests economic deposits of gravel, stone, gypsum, or any other minerals, reserves were calculated and the

mineral value of the property determined. Assistance was provided the Forestry Division in determining the extent of gravel deposit of a state-owned property in Roscommon County. A map was prepared and reserves calculated. Recommendations were made on how the deposit should be worked, including locations for stockpiling and for disposing of overburden sand and waste.

The long-standing inventory of nonmetallic mineral resources was continued, including work on progress maps and reports retained in files. Assistance was given in field mapping and geologic studies on high grade dolomite deposits in the Upper Peninsula. A geological investigation of Menominee County was started.

The 6th Annual Forum on the Geology of Industrial Minerals, held at Ann Arbor, was co-sponsored by the Survey. This Unit played a major role in planning the program, selecting speakers and arranging the field trip. Two of the papers were prepared by members of this Unit.

Gathering information for the preparation of maps and reports, identifying rock and mineral specimens, directing industrialists to potential mineral resources, assisting consulting geologists and university personnel, responding to mineral collectors and students at all levels, and answering inquiries on all phases of industrial minerals continued as routine activities. Samples were also collected for the 1500 mineral kits made this biennium.

WATER

The Section served as geologic consultant to state agencies on pollution of ground-water resources, and on the occurrence, availability, quantity and quality of water supplies. In addition, 415 requests for information from the general public were handled. About 2700 man-hours were devoted to field investigation. Staff members attended professional and trade organization meetings to keep abreast of latest information on water-resource development and pollution, and gave nine talks to various organizations.

Ground Water

The Section is a depository of water well and pump installation records submitted under Act 294 of the Public Acts of 1965. During the biennium, 28,377 water well and 2,006 pump installation records were received and processed. Well records were reviewed for completeness to insure proper filing for quick retrieval; 761 were returned for additional information. This work necessitated working closely with the water well industry and state and local health departments. State agencies were assisted as follows:

Engineering Division: Submitted recommended bid items for proposed department wells; prepared reports on final construction and performance for 24 new wells, including installation of five 1¼" test wells to determine water quality and effects of pumping.

Bureau of Water Management: Investigated and prepared reports on 137 waste disposal sites involving possible ground-water pollution. Nine 1¼" wells were installed to collect water quality and direction-of-movement data.

Michigan Department of Public Health: Provided consultation on 53 cases involving sanitary land fill, review of proposed plats, sewage disposal, and municipal well aquifer analysis.

Michigan Department of State Highways: Prepared water-supply recommendations and consultation on 12 roadside rest areas.

Other state agencies: Seventeen requests were concerned mostly with general ground-water availability. Only one, at Camp Grayling, involved preparation of well construction details and observation during construction.

Surface Water

Relative to surface water resources, the Section provided geologic advice to the Bureau of Water Management in 29 cases involving dredging in or near inland lakes, proposed impoundments, and inland lake levels. Also, Section members installed nine 1¼" wells to collect information on ground-water levels and quality, and responded to 11 requests for geologic information relating to lake types and levels.

U. S. Geological Survey Cooperative

Cooperative programs with the Water Resources Division of the U. S. Geological Survey were continued. The work involves gaging streams, monitoring ground-water levels and water quality, and detailed investigations of local and regional water resources. Most of these studies are published when completed, either as water investigations or open-file reports.

Geographic Names

The Section served as a clearing house for information and procedures on selecting and revising geographic names. New and proposed names are processed through the U. S. Board of Geographic Names. Altogether, 39 board decisions were reviewed and promulgated.

GLACIAL AND ENVIRONMENTAL GEOLOGY

This Section, activated at the start of the biennium with one geologist assigned full time to the work, was created because of increasing requests for detailed surface maps, and for geological assistance in solving problems involving the environment. Principal activities were: Providing consultant services to the Michigan Department of Public Health and the Water Management Bureau, reconnaissance mapping and preparation of reports on surface formations, conducting field investigations and preparing geological reports, giving talks to school and professional groups, and providing information on surface formations to office visitors. Numerous letters requesting information on glacial geology and the environment were answered. These services were requested by state employees, consultants, planners, municipal, township, and county governmental groups, students, teachers, and individual citizens. Several professional meetings were attended.

Environmental Geology

About 70 percent of the Section's time was devoted to assisting with a variety of rural and urban problems. Some of the most serious environmental problems are created by surface disposal of solid and liquid wastes. Thirty-three proposed sanitary land-fill sites, including five industrial land fills, were investigated to evaluate the ability of underlying materials to transmit ground-water pollution to nearby wells or surface waters. Almost half these sites were judged to be unsuitable. About one-third were judged suitable with engineering improvements such as clay dikes, clay base material, or perimeter dikes. Only five were suitable in their existing condition.

Eight sites for the disposal of sewage effluents and industrial chemicals were evaluated. Relocation or improvements were recommended for seven.

Assistance was given in investigating three cases of ground-water contamination: The Tobico Marsh State Game Area, Bay County; Michigan Chemical Company, Midland County; and the Butterworth Land Fill, Grand Rapids.

Activities also included: preparation of bedrock topography and surface geology maps of the Marshall area; advice on geologic conditions for highway drain construction; assistance in locating a site for a seismograph; field investigation of land subsidence caused by solution of gypsum beds; advice in relocating a stream bed in a land-fill area; participation in a conference with Nuclear Industrial Services Corp. to discuss general areas to explore for low-level solid radioactive waste disposal sites on state or federal land in Michigan.

Glacial Geology

Surface geology was mapped, and a report prepared on surface and bedrock features, for a water resources publication on Houghton and Keweenaw counties. Field reconnaissance mapping for a similar report on Baraga County was mostly completed. Surface geology open-file reports were prepared for Craig Lake State Park, Laughing Whitefish Falls area, and Lake County. Also a surface geology map of a 13-county area in the northwest Lower Peninsula was compiled as part of a Division report for a planning group.

GENERAL GEOLOGY

The work of this Section was general and varied in scope. Principal activities were: acquisition of general geologic information, responding to inquiries relating to the geology of the State, providing consultant services to state agencies, editing and distributing Division publications, coordinating mapping programs, giving occasional talks, maintaining a reference library, participating in training programs, appraising geologist trainee candidates, assisting in several field investigations, and providing counsel on state boundary problems. The most typical recipients of these services were teachers, students, planners, developers, state employees, legislators, vacationers, and hobbyists. A significant additional activity

this biennium was managing affairs of the Michigan Natural Resources Council. Another special project was assuming an active role in preserving the Douglass Houghton grave in Elmwood Cemetery (Detroit). Houghton, first State Geologist of Michigan from 1837 to 1845, contributed importantly to Michigan's early pre-eminence and development.

Information and Education

Service performed in this area comprised a substantial activity as indicated by the following counts: about 1500 letters written, 1490 publications requests filled (separate from the foregoing letters), and about 1800 office visitors.

The geologic exhibit used extensively in the previous biennium was displayed at the Ionia County Free Fair, and then turned over to the Region III office for modification and use by the regional interpreter. Lectures were given to about 200 persons, mostly teachers.

Training

Though budgetary considerations precluded division in-service training sessions, this Section continued to represent the Division in Department training discussions. Also, section geologists attended geological conferences and field trips, and participated in the affairs of several state and national professional organizations.

Library

In the move back into the Mason Building, space was again allocated for the Division library. Discussions were begun with the State Library regarding feasibility of their establishing a special reference section on geology.

Mapping

At the close of the biennium, copies of the Chicago sheet, published by the Indiana Geological Survey in cooperation with this Division, were acquired for distribution through the Department publications room. The remaining Ft. Wayne sheet is expected to be in print sometime next year.

This Section continued to handle the business of the State Topographic Mapping Advisory Committee chaired by the State Geologist. A new task assigned at mid-biennium was managing official distribution of topographic map allotments (200 copies of each new quadrangle) received from the United States Geological Survey in connection with the cooperative program begun in 1966. From July 8, 1969 to June 30, 1970 the following topographic materials were received and distributed: 47 new published quadrangles (totalling 9400 sheets), 72 new advance prints of new quadrangles in progress (totalling 360 sheets), and 53 new advance proofs (totalling 265 sheets).

Publications

Adoption of an automated publications mailing system is still being studied and expected to be operative soon. At the close of the biennium, eight reports were in press (Rpt. Inv. No. 8, No. 12 and No. 13, Water Inv. No. 10, Circ. No. 8, Pamph. No. 1, Ann. Stat. Sum. No. 12, and Misc. No. 1). Publications actually released during the biennium are listed below.

GEOLOGICAL SURVEY DIVISION PUBLICATIONS

- Bulletin 5*—Meteorites of Michigan
- Report of Investigation 3*—Geology for land and ground-water development in Wayne County, Michigan (*Wayne State University cooperative*)
- Report of Investigation 5*—Geology and magnetic data for central Iron River area, Michigan (*U.S.G.S. cooperative*)
- Report of Investigation 6*—Geology and magnetic data for southeastern Iron River area, Michigan (*U.S.G.S. cooperative*)
- Report of Investigation 7*—Geology and magnetic data between Iron River and Crystal Falls, Michigan (*U.S.G.S. cooperative*)
- Report of Investigation 10*—Geology and magnetic data for Alpha-Brule River and Panola Plains areas, Michigan (*U.S.G.S. cooperative*)
- Water Investigation 8*—Ground water in Gogebic County, Michigan (*U.S.G.S. cooperative*)
- Water Investigation 9*—Ground water in Ontonagon County, Michigan (*U.S.G.S. cooperative*)
- Annual Statistical Summary 8*—Michigan's oil and gas fields, 1967
- Annual Statistical Summary 9*—Mineral industry of Michigan, 1967 (*U.S.B.M. cooperative*)
- Annual Statistical Summary 10*—Michigan's oil and gas fields, 1968
- Annual Statistical Summary 11*—Mineral industry of Michigan, 1968 (*U.S.B.M. cooperative*)
- Annual Directory 3*—Michigan mineral producers, 1968
- List 10*—Available publications of the Geological Survey
- **Pamphlet 2*—You never miss the water
- **"Conservation Magazine" Reprint*—Michigan beach stones
- Intra-Division File 6*—Geological Survey organization chart and roster
- Twenty-fourth Biennial Report, 1967-1968*

U. S. GEOLOGICAL SURVEY PUBLICATIONS

Prepared in cooperation with Geological Survey Division

Published Reports and Maps

- Professional Paper 397*—Geology of the Marquette and Sands quadrangles, Marquette County, Michigan
- Professional Paper 570*—Geology and ore deposits of the Iron River-Crystal Falls district, Iron County, Michigan
- Bulletin 1274-F*—The Reany Creek Formation, Marquette County, Michigan
- Miscellaneous Geologic Investigations Map I-576*—Bedrock geologic map of the Mar- enisco-Watersmeet area, Gogebic and Ontonagon counties, Michigan
- Miscellaneous Geologic Investigations Map I-559*—Geochemical prospecting for copper, lead, and zinc in the west-central part of the Negaunee quadrangle, Marquette County, Michigan

Hydrologic Investigations Atlas HA 317—Water resources of the Belle River basin, southeastern Michigan

Hydrologic Investigations Atlas HA 327—Water resources of the Pine River basin, southeastern Michigan

Hydrologic Investigations Atlas HA 333—Reconnaissance of the Pigeon River, a cold water river in the northcentral part of Michigan's Southern Peninsula

Water Resources Data for Michigan 1967—Part 1, Surface water records

Water Resources Data for Michigan 1967—Part 2, Water quality records

Water Resources Data for Michigan 1968—Part 1, Surface water records

Water Resources Data for Michigan 1968—Part 2, Water quality records

**Oil and Gas Investigations Map-38*—Lithology and thickness of the Dundee Formation and the Rogers City Limestone in the Michigan basin

Open-File Reports and Maps

Summary of ground-water conditions in Michigan 1967

Summary of ground-water conditions in Michigan 1968

Reconnaissance of the Rifle River, a cold water river in the northeastern part of Michigan's Southern Peninsula

Preliminary geologic map of the Nagaunee quadrangle

Preliminary geologic map of the Palmer quadrangle

Preliminary report on the bedrock geology and copper deposits of the Matchwood quadrangle

Preliminary geologic map of the Florence East quadrangle

Preliminary geologic map of the Florence West quadrangle

Aeromagnetic map of the Menominee-Northland area

Aeromagnetic map of Gladstone and vicinity (4 sheets)

Regional draft-storage relationships for the Grand River basin

INDIANA GEOLOGICAL SURVEY PUBLICATION

Prepared in cooperation with Geological Survey Division

Regional Geologic Map 4—Geologic map of the 1° x 2° Chicago quadrangle, Indiana, Illinois, and Michigan (three versions available: bedrock, glacial, and combination of both)

* Re-issue

INFORMATION AND EDUCATION DIVISION

WILLIAM J. MULLENDORE, *Chief*

The Department's increasing involvement during this biennium with environmental issues was reflected in the activities of the Information and Education Division. Services in its assigned responsibility areas of public information, education and inservice training all took on a stronger environmental thrust.

Although there were no important changes in activities during the biennium itself, two major modifications were made as the biennium ended. These involved the Conservation School at Higgins Lake and the Department magazine, *Michigan Natural Resources*. Both were placed on a self-financing basis by order of the Legislature, with future operations to be paid for entirely out of receipts.

Also at the biennium's close the Division was hit by a severe budget cutback which forced significant reductions in personnel and services.

INFORMATION AND PUBLICATIONS

Publications. The Division's responsibility in preparation and production of publications was broadened by a change in procedures. Accordingly, all stages of preparation involving editing, marking copy, art work, proofing, and other details of production are handled for all Divisions. Only exceptions are the Mackinac Island Park Commission and the Tourist Council, and they also availed themselves of services of the Section in preparation of several publications.

Publications produced during the biennium covered a wide range of Department interests. Included were brochures and reports on state parks, state forests, fishing, water safety, hunting, wildlife management, forest products, water access sites, general recreation, and geology. Their addition to the inventory brought to 375 the total number of titles available from the Publications Room.

Photographs. Approximately 2,000 pictures in black and white and color were added to the photographic file. Subject matter represented activities of most of the Divisions. The file now includes about 12,000 black and white picture subjects and 9,000 in color. These pictures are in continuous demand by newspapers, magazines, television, book and report publishers, and by other divisions of the Department.

Production of still pictures was slowed somewhat during the last half of the biennium by construction work in the basement of the Mason Building where the darkroom is located. A temporary arrangement with the Mackinac Island State Park Commission provided an interim facility which made it possible to fill requests, but on a reduced volume basis.

Magazine. Financial support of the Department's magazine shifted from an annual legislative appropriation to a revolving fund at the close of the biennium. Thus production of the publication becomes solely dependent upon subscription fees.