

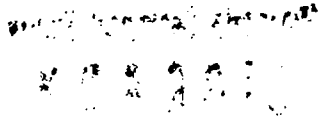
**MINNESOTA  
GEOLOGICAL  
SURVEY**

**1965**

**NEWSLETTER**



**UNIVERSITY OF MINNESOTA**



## MINNESOTA GEOLOGICAL SURVEY

Paul K. Sims, Ph.D., *Director*  
Rudolph K. Hogberg, M.S., *Assistant to the Director and Geologist*  
Rodney J. Ikola, M.S., *Geophysicist*  
Glenn B. Morey, Ph.D., *Geologist*  
Walter E. Parham, Ph.D., *Geologist*  
John E. Stone, Ph.D., *Geologist*  
Sarah Tufford, A.B., *Geologist*

James A. Grant, Ph.D., *Geologist (part-time)*  
Earl A. Ackroyd, M.S., *Geologist (temporary)*  
George Austin, M.S., *Geologist (temporary)*

Peter Stupnitsky, *Cartographer*  
Judy Sorum, *Secretary*

Part-time staff consists of 6 faculty members and 10 students of the Department of Geology and Geophysics, Minneapolis campus, and 2 faculty members of the Department of Geology, Duluth campus, who are employed during the summer.

Minnesota Geological Survey  
**LIBRARY**

**T**HE MINNESOTA GEOLOGICAL SURVEY has the responsibility for conducting investigations of the geology of Minnesota for the benefit of the citizens and industries of the State. It carries out this responsibility by geologic mapping of the rock strata, by research on the occurrence, quality and usefulness of mineral resources, and by publication of the results.

A list of publications of the Minnesota Geological Survey is available upon request. The publications include a bulletin series, geologic map series, reports of investigations, special publication series, information circulars, summary reports, reprints, miscellaneous reports, and miscellaneous maps.

The Survey welcomes inquiries concerning any aspect of the geology of the State. Inquiries by mail should be addressed to:

Paul K. Sims, Director  
Minnesota Geological Survey  
University of Minnesota  
Minneapolis, Minnesota 55455

The Survey offices are located in Pillsbury Hall, Minneapolis campus.  
Phone 373-3372, 373-4986.

## SUMMARY OF ACTIVITIES

A major objective of the Minnesota Geological Survey is to collect and synthesize data on the geologic resources of the State of Minnesota and make this information available to the citizens and industries of the State. During the past year progress was made in both of these aspects—new research was started and steadily increasing numbers of requests for information were answered.

The Survey again emphasized studies intended to aid in the development of new mineral resources. Intensive research on clays of potential economic value at several localities in southern Minnesota indicated that the State contains many deposits favorable for commercial development. Less comprehensive studies of other nonmetallics, especially dimension stone, continued during the year.

In the Minneapolis-St. Paul metropolitan area, geologic mapping and the collection of engineering and resource data were increased, to better meet the urgent needs in this rapidly expanding urban area. An assessment of the sand and gravel resources in the 15-minute Minneapolis quadrangle was started, and mapping continued in the area immediately north of the St. Paul city limits.

In cooperation with the faculty and graduate students of the Departments of Geology at Minneapolis and Duluth, basic geologic and geophysical studies were carried on at several localities. Of particular interest is the preparation of a gravity map of the State of Minnesota, which will be useful for broad analysis of the geology and mineral resources of the State.

A major highlight was the completion of a long-range plan for geologic research in the State. The plan was developed after four years of study and consultation with many individuals and groups within the State. Its purpose is to point out the needs for geologic work in the State, to propose a plan for action, and to present a schedule of anticipated costs. Release of the plan is timely, and coincides with the establishment of a State Planning Agency.

Two geologic reports were published during the year, and several were readied for publication. The report on "The Cretaceous System in Minnesota" is a synthesis of the available data on these important strata. A popular booklet "Guide to fossil collecting in Minnesota," is nearly completed, and will be published during the coming fiscal year.

Requests for information increased over the past year and were nearly double that of two years ago. More than 1,020 letters and 260 phone calls were answered, and more than 150 people visited the Survey office. Beside the usual work for State and Federal agencies, the Survey aided several municipalities, planning commissions, commercial firms, and individuals.

During the year, the Survey participated in a training program for State Park Managers conducted at Fort Snelling State Park by the National Park Service and the Department of Conservation, State of Minnesota. P. K. Sims and R. K. Hogberg, together with Merle Harris, Dr. G. M. Schwartz, and Dr. G. A. Thiel, lectured to the group on various aspects of geology of interest for interpretive programs in Minnesota State Parks.

In May, the Geological Survey and the Twin City Geologists were hosts to the 11th Annual meeting of the Institute on Lake Superior Geology. The technical sessions were held on May 6-7 in Green Hall, St. Paul campus. The field trip (May 8), led by R. K. Hogberg and Don Yardley, School of Mineral and Metallurgical Engineering, was to the St. Cloud granite district.

The VII International Congress of the International Association for Quaternary Research (INQUA), which is being held in the United States this year, will hold a technical field conference in the Upper Mississippi valley region in August as a part of a month-long program. A guidebook for the Minnesota part of the field conference was prepared under the auspices of the Minnesota Geological Survey by H. E. Wright, Jr., J. E. Stone, E. J. Cushing, and C. L. Matsch.

The increase in funds available for the forthcoming biennium marks the beginning of a new era for geological studies in the State. Geologic mapping, the research which forms the basis for a large part of our work, can now be done on a systematic State-wide basis. The first phases of this work are started. Our objective is to complete in a 10-year period a geologic map atlas of the State at a scale of 1:250,000 (four miles to the inch). During this program a wealth of data on the State's mineral and water resources will be gathered, and the maps themselves will be useful for countless other purposes, including the use of the land for recreation.

## BUDGET

The Geological Survey is largely supported by funds appropriated by the State Legislature. During fiscal year 1965, ending June 30, 1965, \$60,000 was appropriated directly to the Survey as a special item in the University budget and \$29,348 was received from University support funds.

The budget for fiscal year 1966 follows:

\$ 60,000—Special item, University budget
32,560—University support funds
57,000—1965 Omnibus Natural Resources Act
7,195—Grant from Water Resources Research Center, University of Minnesota
<hr/>
\$156,755—Total

## STAFF NOTES

In addition to his administrative duties, *R. K. Hogberg* systematically visited operations of firms in the non-metallic mineral industry. He is preparing a Directory of Minnesota Mineral Producers for 1964 and is writing (with Sarah Tufford) a pamphlet for the Educational Series, "Guide to fossil collecting in Minnesota." He and D. H. Yardley conducted a course on non-metallic minerals and rocks in the School of Mineral and Metallurgical Engineering during the spring quarter.

*Rodney J. Ikola* was appointed to the regular Survey staff on July 1, 1965. He received an M.S. degree in geophysics from the Department of Geology and Geophysics in June, 1965. He will conduct geophysical investigations related to the State geologic mapping project and to broad evaluation of mineral resources.

*Dr. G. B. Morey* was appointed to the regular Survey staff on July 1, 1965, and assigned to the State Geologic Map Project. He was awarded the Ph.D. degree in geology by the Department of Geology and Geophysics, University of Minnesota, in June.

In 1964-65, *Dr. Walter E. Parham* continued investigations of the kaolinitic clays of the Redwood Falls area, Minnesota River valley, and started studies of the Decorah Shale, a potential source of lightweight aggregate. In addition to his research, he counseled with several firms and individuals regarding potential commercial clay deposits in the State. He conducted a seminar in clay mineralogy in the Department of Geology and Geophysics during the winter quarter.

In 1964, *Dr. P. K. Sims* continued reconnaissance geologic mapping in the Hibbing two-degree (AMS) sheet, supervised Survey field parties in northern Minnesota, and visited mines on the Mesabi range. In the winter quarter, he and Bill Bonnicksen conducted a course in mineral deposits in the Department

of Geology and Geophysics. For the past two years he served as an advisor for the Minnesota Outdoor Recreation Resources Commission and as an advisor for the newly-established Water Resources Research Center of the University. He was elected Councilor of the Society of Economic Geologists for a three-year term and is serving the second year of a three-year term on the Program Committee of the Society of Economic Geologists.

*Dr. J. E. Stone* continued active field work in the Twin Cities area. During the year he spoke before several civic organizations about the geology of the area. In May he presented a paper, "Urban geology in the Minneapolis-St. Paul area," to the 13th Annual Conference on Soil Mechanics and Foundation Engineering, Minneapolis. During the year he served as an advisor to the Metropolitan Planning Commission.

*Sarah P. Tufford* joined the Survey staff in February, 1965. She is studying the subsurface geology of the Twin Cities area, assisting with editing of technical reports and, with R. K. Hogberg, is writing an educational pamphlet for popular use.

*Dr. James A. Grant* was appointed Assistant Professor in the Department of Geology and Geophysics and Geologist, Minnesota Geological Survey, in September, 1964. He presented a paper, "Rubidium-strontium isochron study of the Grenville Front near Lake Timagami, Ontario, Canada" at the Geological Society of America meetings in Miami Beach, November, 1964. In June, 1965 he began an investigation of the geology and geochronology of Precambrian rocks in the Minnesota River valley.

*George A. Austin*, Instructor, College of St. Thomas, St. Paul, Minnesota, again joined the Survey staff for the summer. He will begin geologic mapping of the Fairmont 1° x 2° Army Map Service sheet in late summer.

Dr. George M. Schwartz, Professor emeritus of the Department of Geology and Geophysics and former Director of the Survey, has "retired" to a vigorous schedule of geologic and civic activities. In addition

to consulting work, he has worked with Professor P. W. Manson of the Department of Agricultural Engineering in an interesting study of the hydrology of potholes.

## TACONITE AMENDMENT

A new era in mining in Minnesota was initiated with passage of the Taconite Amendment to the State Constitution in November, 1964. The effect of the amendment is to provide that occupation and royalty taxes imposed by the State upon taconite companies should not hereafter, for a period of 25 years, be increased in such an amount as to exceed the taxes such companies would be required to pay if taxed like other business corporations in Minnesota. The

amendment promises a more favorable tax climate for all metals, not just iron ore.

Immediately following passage of the amendment, four new plants were announced for the Mesabi range. This brings to six the total number of plants in operation or under construction (see map below), and assures Minnesota of its share of the taconite industry. The plants have a rated capacity in excess of 28 million tons of taconite pellets annually. When com-

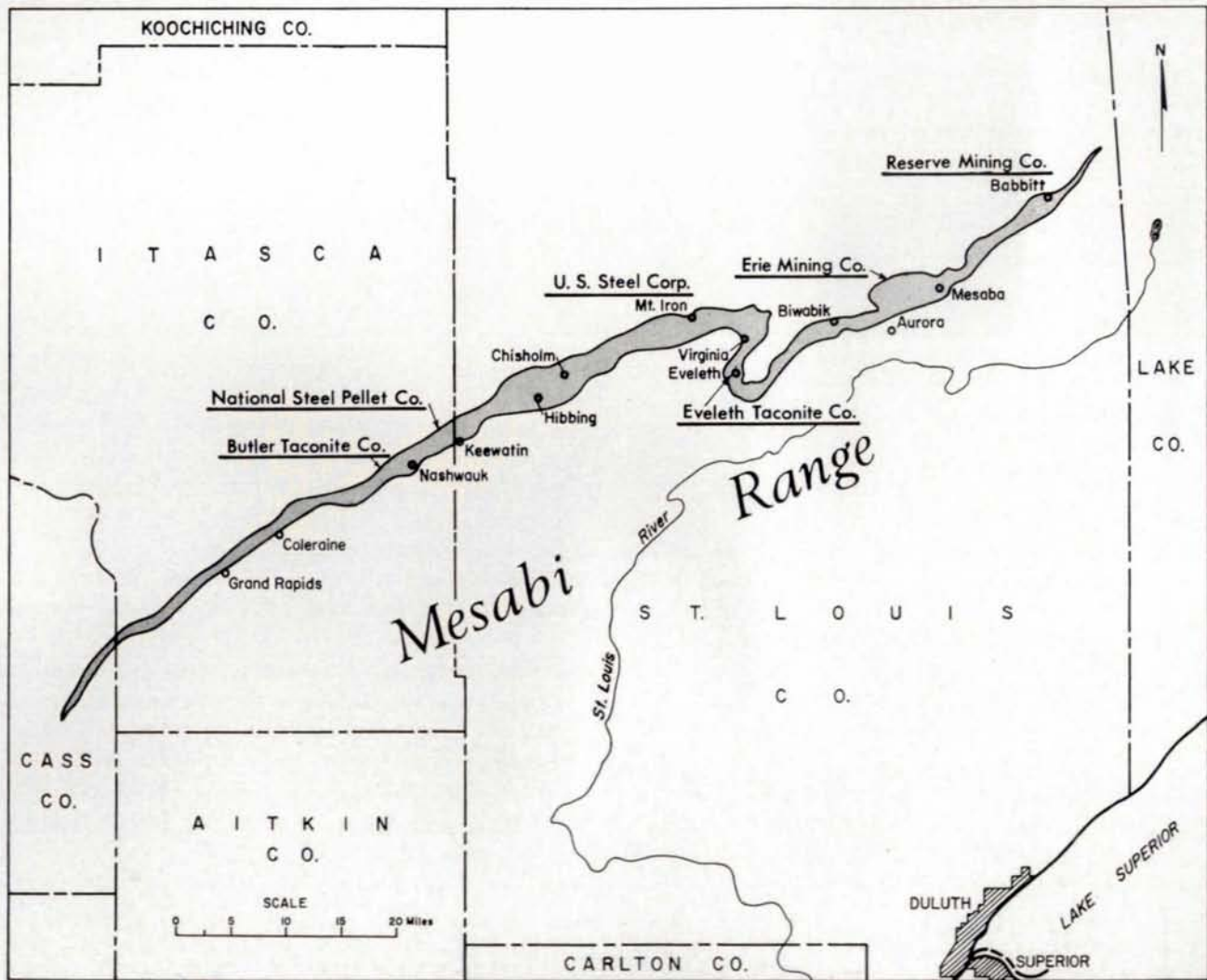


Figure 1—Minnesota taconite operations, 1965.

After Pfeider, 1964

pleted, the output of taconite concentrate will be increased one-third over present production (see accompanying graph of iron ore shipments).

Reserves of taconite are adequate to support many more plants. Professor Eugene P. Pfeider of the

School of Mineral and Metallurgical Engineering forecasts a possible future production of 90-100 million tons per year. However, a realistic goal for the State is a production of 55 to 60 million tons of pellets annually by 1990.

### MINNESOTA MINERAL INDUSTRY—1964

(Furnished by Bureau of Mines, U. S. Department of the Interior)

Mineral output in Minnesota in 1964 was valued at \$493.9 million, a 9-percent increase over 1963. Principal reason for the gain was a 9-percent increase

in iron-ore shipments. Iron-bearing ores (including manganiferous ore) continued to furnish the bulk of the State total value, comprising 91 percent in 1964.

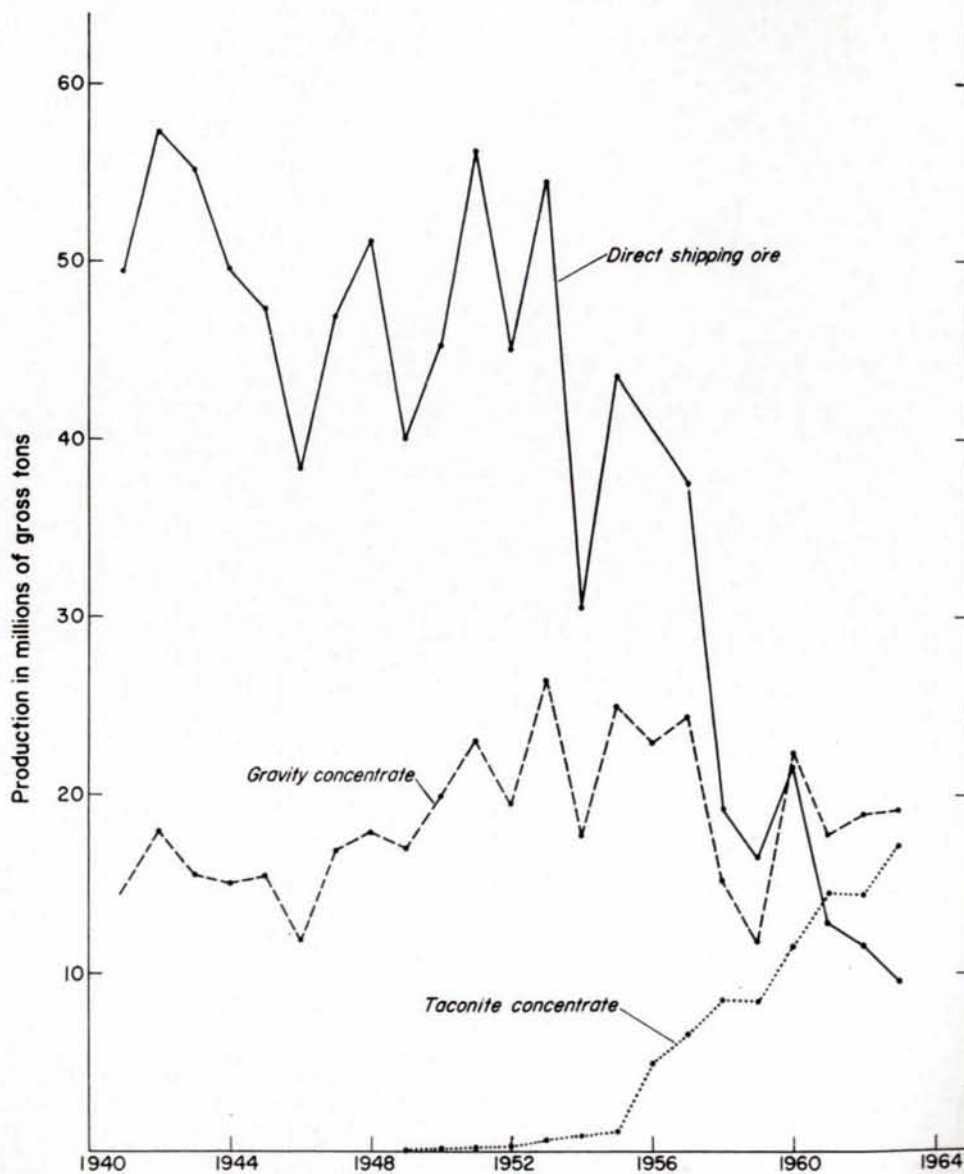


Figure 2—Iron ore shipments, in gross tons from Minnesota, 1941-1963.

Increases in total values of production were reported for portland cement, clays, grinding pebbles, iron ore, peat, sand and gravel, and stone. Decreases were recorded for masonry cement, lime, manganiferous ore and tube-mill liners.

Shipments of usable iron ore (excluding ore containing 5 percent or more manganese, natural) were estimated at 49.3 million long tons compared with 45.4 million tons in 1963. Mine value of the shipments was estimated at \$449 million, a 10-percent increase over that of the previous year.

The tempo of Minnesota iron mining increased, due to the overwhelming approval given the Taconite Amendment by voters in the November general election. Subsequent to the passage of the amendment, United States Steel Corp., National Steel Corp., and The Hanna Mining Co. (the latter in conjunction with Inland Steel Corp. and Wheeling Steel Corp.) announced plans to build taconite plants near Mountain Iron and Cooley, respectively. Plants in planning stages have a proposed 9 million ton annual capacity. The Eveleth Taconite Co. began construction of a 1.6 million ton-per-year taconite plant near Forbes, expected to be in operation in late 1965. The Eveleth Taconite Co. is owned by the Ford Motor Co. (85 percent) and the Oglebay Norton Co. (15 percent).

The Jones & Laughlin Steel Corp. is engaged in evaluating a magnetic taconite property near Biwabik.

Shipments of taconite concentrate set a new record high of 19 million tons, or about 39 percent of the State's total shipments of iron ore. Erie Mining Co. (Pickands Mather & Co., operating agent) and Reserve Mining Co. each set new production records. The United States Steel Corp. continued operations at its pilot taconite facilities near Mountain Iron.

Nonmetallic mineral production comprised 9 percent of the total value of mineral production. Sand and gravel production and value increased slightly and continued to account for the major nonmetallic production value. Sales of grinding pebbles increased substantially in both quantity and value whereas tube-mill liners recorded a decrease in both quantity and value. Shipments of portland cement increased slightly in quantity and value. Bulk cement distribution centers were built in the Minneapolis metropolitan area by several major companies, indicating the importance that bulk facilities will play in the future of the industry. Clay production increased 5 percent in quantity and value chiefly because of increased lightweight aggregate production. Total output of lime decreased slightly in quantity and value. Stone production increased 2 percent in value and

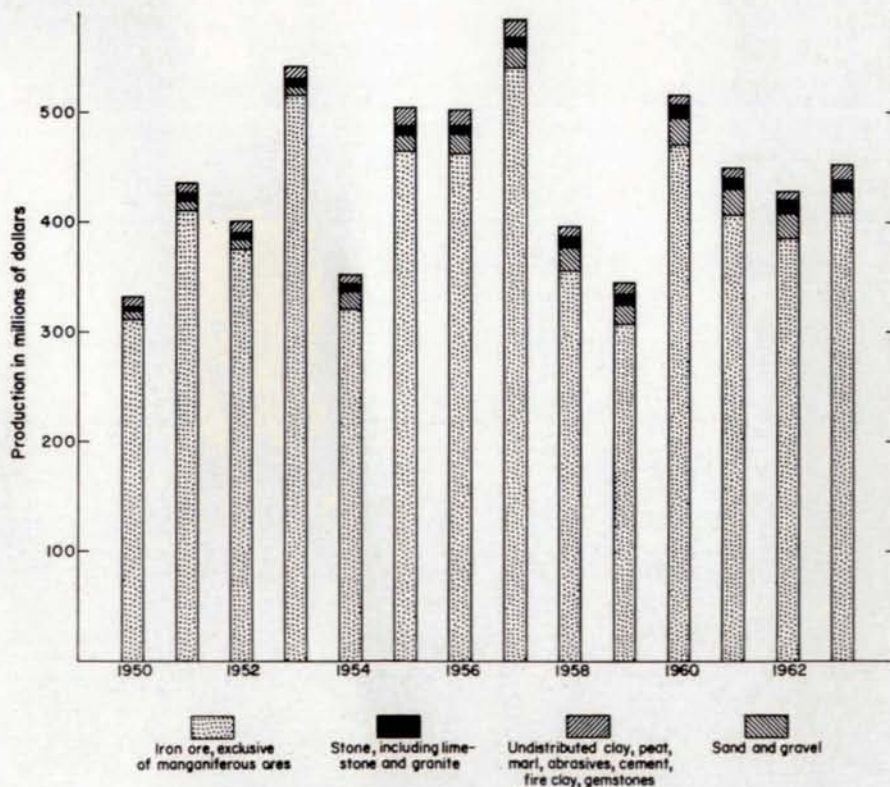


Figure 3—Value of mineral production, Minnesota, 1950-1963.



decreased 4 percent in quantity. The gain in total value was attributed to increased sales of dimension granite for architectural uses. Production of crushed limestone decreased slightly. Quantity and value of

dimension limestone production remained essentially the same. Peat production increased 48 percent in both quantity and value due to increased use for horticultural purposes.

## THE 1965 OMNIBUS NATURAL RESOURCES ACT

Passage of the 1965 Omnibus Natural Resources Act by the State Legislature assures Minnesota of a progressive long-range program of development of our natural and recreational resources. The program was developed as a result of two years of comprehensive study by the Minnesota Outdoor Recreation Resources Commission, a legislative body established by the Omnibus Natural Resources and Recreation Act of 1963. It was strongly endorsed by Governor Rolvaag, both political parties, and many groups and individuals in the State.

A major element of the program is mapping. A long-range mapping program recommended by the Minnesota Geological Survey, the State Mapping Advisory Board, and other State and Federal groups, and approved by the Resources Commission, calls for completing topographic mapping in the State in 10 years and for accelerating geologic and soils mapping. Details of the plan are published in Report No. 7 of the Minnesota Outdoor Recreation Resources Commission, entitled *An accelerated mapping program for Minnesota*. The report is available for purchase from the Documents Section, State of Minnesota, Room 140C, Centennial Building at a price of \$2.00.

For the biennium beginning July 1, 1965, \$940,000 was appropriated for topographic mapping. This will be matched on a 50-50 basis by the U. S. Geological Survey.

For the same period, \$200,000 was appropriated for geologic and related mapping. Allocation of these funds by the Department of Administration, State of Minnesota, are as follows:

1. Geologic mapping (Minnesota Geological Survey) ..... \$100,000
2. Aeromagnetic mapping (U. S. Geological Survey on 50-50 matching basis) ..... 60,000
3. Soils mapping (Agriculture Experiment Station) ..... 40,000

A total of \$14,000 for the biennium was appropriated to the Minnesota Geological Survey to begin a systematic program of paleontological studies of Pleistocene materials. The program will be conducted cooperatively with the Museum of Natural History, University of Minnesota, and will be coordinated with an archeological program established by the same legislative act and with palynology studies of the Pleistocene by the Limnological Research Center, University of Minnesota.

## LONG-RANGE PLAN

A long-range plan that sets forth the needs for geologic studies in the State and a proposed schedule for action was released during the year. The plan calls for (1) a marked speed-up in geologic mapping, (2) intensive studies of both nonmetallic and metallic mineral deposits, (3) increase in engineering and urban geology studies, (4) broadening of the scope of water research, and (5) preparation of pamphlets and guidebooks on the geology and scenery of the State and of study materials for secondary schools.

Emphasis in the plan is given to geologic mapping. This is needed to provide a basic foundation for research on mineral and water resources and use of the land for countless purposes; also, information gained by geologic mapping assists in attracting new industries.

Through funds available from the Natural Resources Act (see previous section), the first priority in geologic mapping—geologic mapping of the bedrock on a state-wide basis at a scale of 1:250,000 (four miles to the inch)—was started July 1, 1965. Continuation of this appropriation at a level at least equivalent to the present would guarantee completion of a geologic map atlas of the State in 10 years. Other aspects of the long-range plan will be undertaken as funds become available.

The report, "Our land and mineral resources—a long-range plan for geologic research in Minnesota," is available free upon request from the Survey.

## GEORGE MELVIN SCHWARTZ GEOLOGICAL SURVEY FUND

A fund to be used primarily to increase the distribution of technical reports issued by the Survey was initiated during the year by gifts from Minnesota alumni Lee C. Armstrong, Samuel S. Goldich, Robert M. Grogan, Frederick C. Kruger, and Maynard M. Stephens. The fund was named in honor of Dr. G. M. Schwartz, Professor Emeritus, Department of Geology and Geophysics and former Director, Minnesota Geological Survey.

The Minnesota Geological Survey has always had a strong publication program. We have an exchange list of 370 institutions and libraries, many of which

are from foreign countries. However, some countries do not regularly receive our publications. Some of the funds will be used to remedy this gap.

A part of the fund will be used to increase our output of publications. Currently, about 25 manuscripts are completed or nearly completed and await publication. These cannot be published promptly with the available funds.

Additional contributions will be solicited from alumni and friends of the University to assure continuing growth in our publication program.

### CURRENT PROJECTS

#### 1. DULUTH GABBRO COMPLEX, LAKE COUNTY

Project chief—Dr. W. C. Phinney

Geologic mapping of Duluth Gabbro Complex in the Gabbro Lake and Greenwood Lake 15-minute quadrangles, in the central part of the gabbro body; studies of the petrology, structure, and origin. The map of the Gabbro Lake quadrangle is completed, and has been placed in open-files. The Greenwood Lake quadrangle will be completed this summer. Silicate minerals are being studied by using microprobe analysis. Project is supported in part by grant from National Science Foundation.

#### 2. ENGINEERING AND GLACIAL GEOLOGY OF THE MINNEAPOLIS-ST. PAUL METROPOLITAN AREA

Project chief—Dr. J. E. Stone

A long-range comprehensive restudy of the surficial deposits. The study is intended to result in a new geologic map of the area and a comprehensive summation of the engineering properties of its rocks and soils as related especially to urban development. A reconnaissance geomorphic map has been completed for fifteen 7½-minute quadrangles. A report on the New Brighton quadrangle will be published this year as GM-2. Mapping of the Centerville, White Bear Lake West, and Hugo 7½-minute quadrangles will be completed during the coming year.

#### 3. CLAY MINERAL RESOURCES

Project chief—Dr. W. E. Parham

Continuing research on clay deposits in the State. Areas of known or potential clay resources are being examined and mapped; clays are studied by X-ray and other laboratory techniques. During the year emphasis will be given to kaolinite deposits in the Minnesota River valley, the Decorah Shale, and clay deposits near Austin, Mower County.

#### 4. SAND AND GRAVEL RESOURCES, MINNEAPOLIS 15-MINUTE QUADRANGLE

Project chief—R. K. Hogberg

The objective of this study, begun in 1964, is to determine the sand and gravel resources in an area of rapid urban growth.

#### 5. INDUSTRIAL MINERAL RESOURCES

Project chief—R. K. Hogberg

A long-range investigation of the State's known and potential industrial minerals and rocks. This study, begun in 1963, is intended to result in an inventory of the nonmetallic mineral deposits and a comprehensive summary of the controlling geologic factors of the deposits.

#### 6. GEOLOGICAL AND GEOPHYSICAL INVESTIGATIONS OF MID-CENTRAL GRAVITY HIGH

Project chief—Dr. J. C. Craddock

Detailed studies in Minnesota and adjacent parts of Wisconsin are continuing. Project is supported mainly by a grant from the National Science Foundation.

#### 7. PETROLOGY AND METAMORPHISM OF PRE-CAMBRIAN ROCKS, EMBARRASS-BABBITT AREA, ST. LOUIS COUNTY

Project chief—W. L. Griffin

An investigation to determine metamorphism and age of Precambrian rocks that lie north of the Giants Range. Knowledge of the rocks is needed to determine the geology between the Mesabi and Vermilion iron ranges. Project is financed partly by a National Science Foundation Fellowship.

8. GEOCHEMICAL STUDY OF THE PLATTEVILLE  
FORMATION

Project chief—Ghassan Rassam

A mineralogic and chemical study of carbonate rocks. Project will be completed this year.

9. RECONNAISSANCE GLACIAL GEOLOGY IN PARTS  
OF PINE AND KANABEC COUNTIES

Project chief—Dr. E. J. Cushing

Geology and palynology of surficial deposits of the Superior Lobe and Grantsburg Sublobe of late Wisconsin age. Part of current

restudy of the glacial geology of the State, intended to provide a basis for reclassification of the Pleistocene materials and investigations of the resources and engineering properties of the surficial deposits.

10. GRAVITY MAP OF MINNESOTA

Project chief—Dr. J. C. Craddock

Compilation of available gravity measurements. Project is supported in part by a grant from the National Science Foundation. To be completed in 1966.

Projects which Began July 1, 1965

1. COPPER-NICKEL MINERALIZATION, DULUTH  
GABBRO COMPLEX

Project chief—Bill Bonnichsen

A study of the sulfide mineralization in the Duluth Gabbro. The first phase will consist of geologic mapping of the Babbitt NE 7½-minute quadrangle and study of available drill cores in the Dunka River area. Project expected to continue at least 3 years.

2. GEOLOGY AND GEOCHRONOLOGY OF PRE-  
CAMBRIAN ROCKS, MINNESOTA RIVER  
VALLEY

Project chief—Dr. J. A. Grant

A study of the geochronology, using Rb/Sr methods, of a complex sequence of ancient Precambrian rocks. First phase will include geologic mapping of the exposed Precambrian rocks in the Echo NE 7½-minute and adjacent quadrangles.

3. SEDIMENTOLOGY OF THE PRECAMBRIAN KNIFE  
LAKE FORMATION

Project chief—Dr. R. W. Ojakangas

First phase will include geologic mapping (with P. K. Sims) of the Tower 7½-minute quadrangle, at the west end of the Vermilion iron district.

4. GROUND-WATER CONTRIBUTION TO STREAM  
FLOW AND ITS RELATION TO HYDROGEO-

LOGIC BASIN CHARACTERISTICS AND RE-  
CHARGE RATES TO AQUIFERS IN MINNESOTA

Project chief—Earl A. Ackroyd

A State-wide analysis utilizing available published records. Supported by grant from the Water Resources Research Center, University of Minnesota.

5. GLACIAL GEOLOGY OF SWANVILLE QUADRANGLE,  
CENTRAL MINNESOTA

Project chief—Bjorn Andersen

A study of a complex area containing 4 Pleistocene drift sheets.

6. STUDIES OF PATTERNED WETLANDS NORTH OF  
THE RED LAKES

Project chief—Dr. H. E. Wright, Jr.

Part of a combined geological, biological, and hydrological study of the area. Mainly financed by a grant from the National Science Foundation.

7. MINERALOGY OF THE BIWABIK IRON-FORMATION

Project chief—Dr. George R. Rapp, Jr.

Studies of the mineralogy and chemistry of the oxides, silicates, and carbonates of the iron-formation. First phase will emphasize research in the central and western parts of the Mesabi range.

State Geologic Map Atlas Project

A formal project to complete a geologic map (bed-rock) atlas of the State in a 10-year period was initiated on July 1, 1965, with funds available through the 1965 Omnibus Natural Resources Act. Mapping

will be at a scale of 1:250,000, using Army Map Service 1° x 2° sheets as bases. Thirteen sheets will be mapped and upon completion assembled into a map atlas.

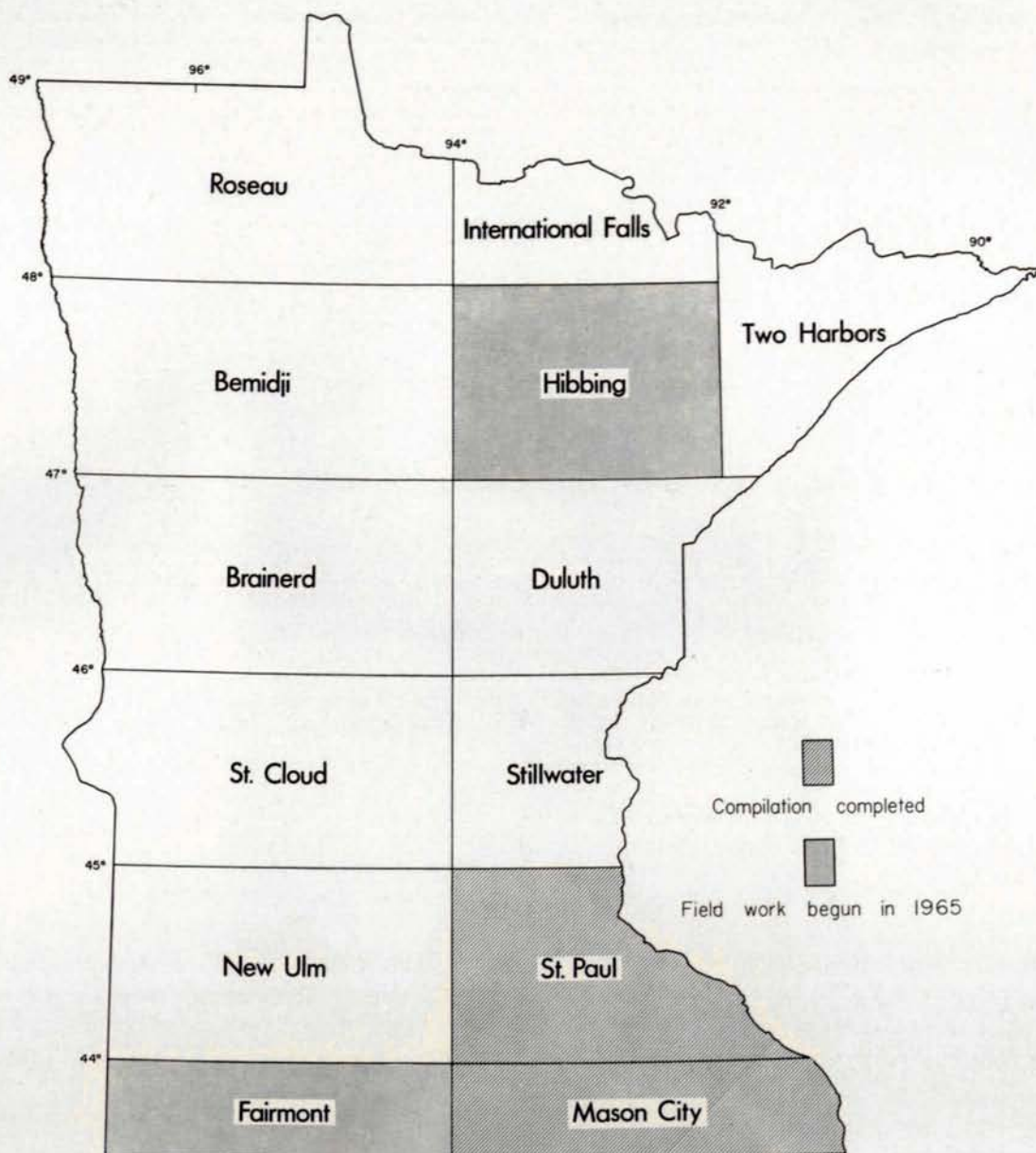


Figure 4—Status of state geologic map atlas project.

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|---|---|
| <p>1. St. Paul sheet—Project chief—Dr. R. E. Sloan<br/>Compilation completed; in drafting</p> <p>2. Mason City sheet—Project personnel—Dr. R. E. Sloan; G. S. Austin<br/>Compilation completed; in drafting</p> <p>3. Fairmont sheet—Project chief—G. S. Austin<br/>Mapping will begin in late summer</p> | <p>4. Hibbing sheet—Project personnel—Dr. P. K. Sims; Dr. G. B. Morey; Dr. J. A. Grant; Dr. R. W. Ojakangas; R. J. Ikola<br/>Reconnaissance was started in 1962; mapping will continue this field season</p> <p>5. Two Harbors sheet—Project personnel—Dr. W. C. Phinney; Dr. J. C. Green<br/>Reconnaissance will begin in late summer. Studies of the Keweenaw rocks</p> |
|---|---|

## Completed Projects, Reports in Preparation

1. GEOLOGY OF PRECAMBRIAN ROCKS, GRANITE FALLS-MONTEVIDEO AREA, YELLOW MEDICINE AND CHIPPEWA COUNTIES  
Project chief—G. R. Himmelberg  
Cooperative project with U. S. Geological Survey  
—P. K. Sims (MGS) and Isidore Zietz (USGS)
2. GEOLOGY AND ORIGIN OF BROWN IRON ORES, FILLMORE COUNTY DISTRICT, MINNESOTA  
Project chief—R. L. Bleifuss
3. CONODANT ZONATION, UPPER ORDOVICIAN ROCKS, SOUTHEASTERN MINNESOTA  
Project chief—Dr. G. F. Webers
4. SEDIMENTOLOGY OF THE PRECAMBRIAN ROVE FORMATION, NORTHEASTERN MINNESOTA  
Project chief—Dr. G. B. Morey
5. PALEONTOLOGY OF DECORAH SHALE, SOUTHEASTERN MINNESOTA  
Project chief—O. L. Karklins
6. AEROMAGNETIC AND INFERRED PRECAMBRIAN PALEOGEOLOGIC MAP OF EAST-CENTRAL MINNESOTA
7. GEOLOGY AND METAMORPHISM OF BIWABIK IRON-FORMATION, DUNKA RIVER AREA, ST. LOUIS COUNTY, MINNESOTA  
Project chief—Bill Bonnichsen
8. GEOCHEMISTRY OF ROSSBURG PEAT DEPOSIT  
Project chief—Dr. F. M. Swain
9. GEOLOGY OF PRE-KEWEENAWAN ROCKS, GABBRO LAKE QUADRANGLE, LAKE COUNTY  
Project chief—Dr. J. C. Green
10. POTASSIUM-ARGON AGES OF HORNBLENDES IN MINNESOTA  
Project chief—Dr. G. N. Hanson
11. SUBSURFACE GEOLOGY OF MINNEAPOLIS, ST. PAUL AND VICINITY  
Project chief—C. M. Payne

## PUBLICATIONS

Issued by the Survey

### *Report of Investigation Series*

- RI-4, Interpretation of Lake Washington magnetic anomaly, Meeker County, Minnesota by P. K. Sims, G. S. Austin, and R. J. Ikola, 1965 (13 p., 1 plate) .....\$0.50

The report describes a magnetic anomaly in central Minnesota of possible economic interest. Combined magnetic and gravity data are interpreted to indicate that the source is a buried basin-shaped body of either iron-formation or mafic igneous rock.

- RI-5, The Cretaceous System in Minnesota, by R. E. Sloan, 1964 (64 p., 2 plates, 11 figures) .....\$1.00

The report summarizes present knowledge of the Cretaceous System in Minnesota. Descriptions of localities of Cretaceous rocks and measured sections are given in appendices.

### *Open-file Maps*

Because of the current interest in the copper-nickel mineralization in the Duluth Gabbro Complex, the following geologic map has been placed in open-files. It can be consulted in the Survey office or copies can be reproduced by private individuals at cost.

“Geologic map of a part of the Gabbro Lake quadrangle, Lake County, Minnesota,” by W. C. Phinney and P. W. Weiblen (scale-1:31,680).

## Manuscripts and Maps in Preparation for Publication

- GM-2, Surficial geology of the New Brighton quadrangle, Minnesota, by J. E. Stone (includes colored map; scale—1:24,000).
- M-1, Miscellaneous map series—Bedrock geologic map of Minneapolis, St. Paul and vicinity, Minnesota, by C. Marshall Payne (scale—1:24,000).
- SP-2, Special publication series—Geology and origin of the iron deposits of the Zenith mine, Ely, Minnesota (100 typed p., 3 pls., 11 figs.).
- SP-3, Special publication series—Ostracoda of the Dubuque and Maquoketa Formations of Minnesota and northern Iowa, by J. H. Burr, Jr. and F. M. Swain (46 typed p., 6 fossil plates).
- Educational Series 1—Guide to fossil collecting in Minnesota, by Sarah P. Tufford and R. K. Hogberg.
- IC-2, Chemical analyses of igneous rocks in Minnesota, by A. P. Ruotsala and Sarah P. Tufford.
- IC-3, Geologic, hydrologic, and engineering data, New Brighton quadrangle, Minnesota, by J. E. Stone.

## Publications by Staff in Scientific Journals

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## Papers Presented by Survey Personnel at Institute on Lake Superior Geology, May, 1965

1. Geology of the Fillmore County district iron ores, southeastern Minnesota, by R. L. Bleifuss.
2. Structure and lithology of the metamorphosed Biwabik Iron-formation, Dunka River area, Eastern Mesabi district, Minnesota, by Bill Bonnicksen.
3. Structure and stratigraphy of the Knife Lake Group east of Ely, Minnesota, by John C. Green.
4. Ages of mafic dikes near Granite Falls, Minnesota, by Glen R. Himmelberg and Gilbert N. Hanson.
5. The sedimentology of the Precambrian Rove Formation in northeastern Minnesota, by G. B. Morey.
6. Organic geochemistry of Rossburg peat bog, Aitkin County, Minnesota, by F. M. Swain.

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## NOTEWORTHY RESULTS

### Structure and Stratigraphy of Knife Lake Group

In the Gabbro Lake 15-minute quadrangle just east of Ely, Minnesota, Precambrian Knife Lake rocks occur in two belts. The southern belt, composed of schist, gneiss, and migmatite, is derived from graywacke, conglomerate, and arkose, and is intruded and metamorphosed by the Giants Range batholith of Algoman age. It is faulted against the basal part of the older but lower-grade Ely Greenstone on the north side of the belt, along the major North Kawishiwi fault.

The northern and wider belt has been metamorphosed only to the chlorite zone. Its contact with the underlying Ely Greenstone is mostly faulted, but

locally conformable with a basal conglomerate. Above this are, successively, 0-2,500 feet of mixed felsic tuff and clastic sediments, 1,500-4,500 feet of chloritic clastic sediments, a predominantly mafic volcanic unit 0-2,250 feet thick, and a thick sequence of felsic volcanic rocks, mainly pyroclastic, as much as 8,000 feet thick. Within this unit near Fall Lake is a 500-foot bed of siliceous limestone and chert conglomerate. The felsic volcanic rocks interfinger with mafic volcanics similar to Ely Greenstone northwest of Fall Lake, and are faulted against mafic volcanics and sediments of unknown correlation in the northwest and north-central borders of the area.

Knife Lake time in this area evidently was one of great crustal disturbance, with rapid erosion of the

older greenstones and the rocks that intrude them, and extensive volcanic activity, probably mostly underwater. An active island arc type of environment is envisioned. This activity culminated in the batholithic intrusions and extensive faulting of the Algonman orogeny.

#### Magnetic Anomaly in Meeker County

A magnetic anomaly centered at Lake Washington, in southeastern Meeker County, has been outlined by a ground magnetometer survey. The anomaly is arcuate in outline, about 8.5 miles long and a maximum of 5 miles wide, and has a maximum amplitude greater than 3,000 gammas. A gravity traverse was made across the anomaly to aid in interpretation.

Combined magnetic and gravity data are interpreted to indicate that the source is a basin-shaped body having a substantially greater density than the adjacent rocks that lies at a shallow depth. The lithology of the source is not known because of a lack of subsurface data, but is inferred to be either Precambrian iron-formation or mafic igneous rock. The anomaly warrants further investigation.

The anomaly is described in RI 4.

#### Buried Bedrock Valleys, Southeastern Minnesota

As a part of the geologic mapping project of the St. Paul and Mason City 1° x 2° sheets, a topographic map of the bedrock surface is being prepared, to aid in evaluating the groundwater and surface water resources. The work indicates an intricate network of bedrock valleys, largely buried, similar to that present in the Minneapolis-St. Paul metropolitan area. These valleys are of vast potential importance as future sources of groundwater in southern Minnesota.

#### Origin of Brown Iron Ores, Fillmore County District

R. L. Bleifuss has concluded that the brown iron ores of the Fillmore County district are not Cretaceous in age as previously thought, but represent altered primary siderite-rich beds of Devonian age. He postulates that the original siderite beds were weathered, probably during the Tertiary, and gradually lowered to their present altitude by solution of the underlying Ordovician and Devonian carbonate beds. Dissolution of the carbonate left a residue of impure clay, which characteristically occurs immediately beneath the iron ore.

## STATUS OF TOPOGRAPHIC MAPPING

During the fiscal year ending June 30, 1965, 39 7½-minute quadrangles and two 15-minute quadrangles were published; this is equivalent to 2.8 percent of the State. As of March 31, 1965, about 47 percent of the State was covered by modern topographic maps; an additional 247 quadrangles, or 13.3 percent of the State, were in the process of being mapped.

A revised base map of the State of Minnesota (scale=1:500,000) is being printed by the U. S. Geological Survey and should be available within a year. This will replace the present base map of the same scale, which is out-of-date.

Topographic quadrangle maps of the Minneapolis-St. Paul metropolitan area, which were published during the early 1950's, are scheduled to be revised and updated. The U. S. Geological Survey plans to start revision of the maps within two years. Revision is

badly needed because of changes brought about by rapid urban growth and new highway construction.

Beginning July 1, 1965, topographic mapping will be accelerated greatly by funds available through the 1965 Omnibus Natural Resources Act. Under the program, topographic mapping of the State at a scale of 1:24,000 (7½-minute quadrangles) is scheduled to be completed in 10 years. As in the past, the mapping will be done cooperatively with the U. S. Geological Survey on a 50-50 cost basis.

The State Mapping Advisory Board, which has had the responsibility of programming topographic mapping in the State since 1949, was abolished by the 1965 Natural Resources Act. It will be reconstituted to include broader responsibilities for mapping as a sub-committee under the newly-created State Planning Agency in the Department of Administration, State of Minnesota.



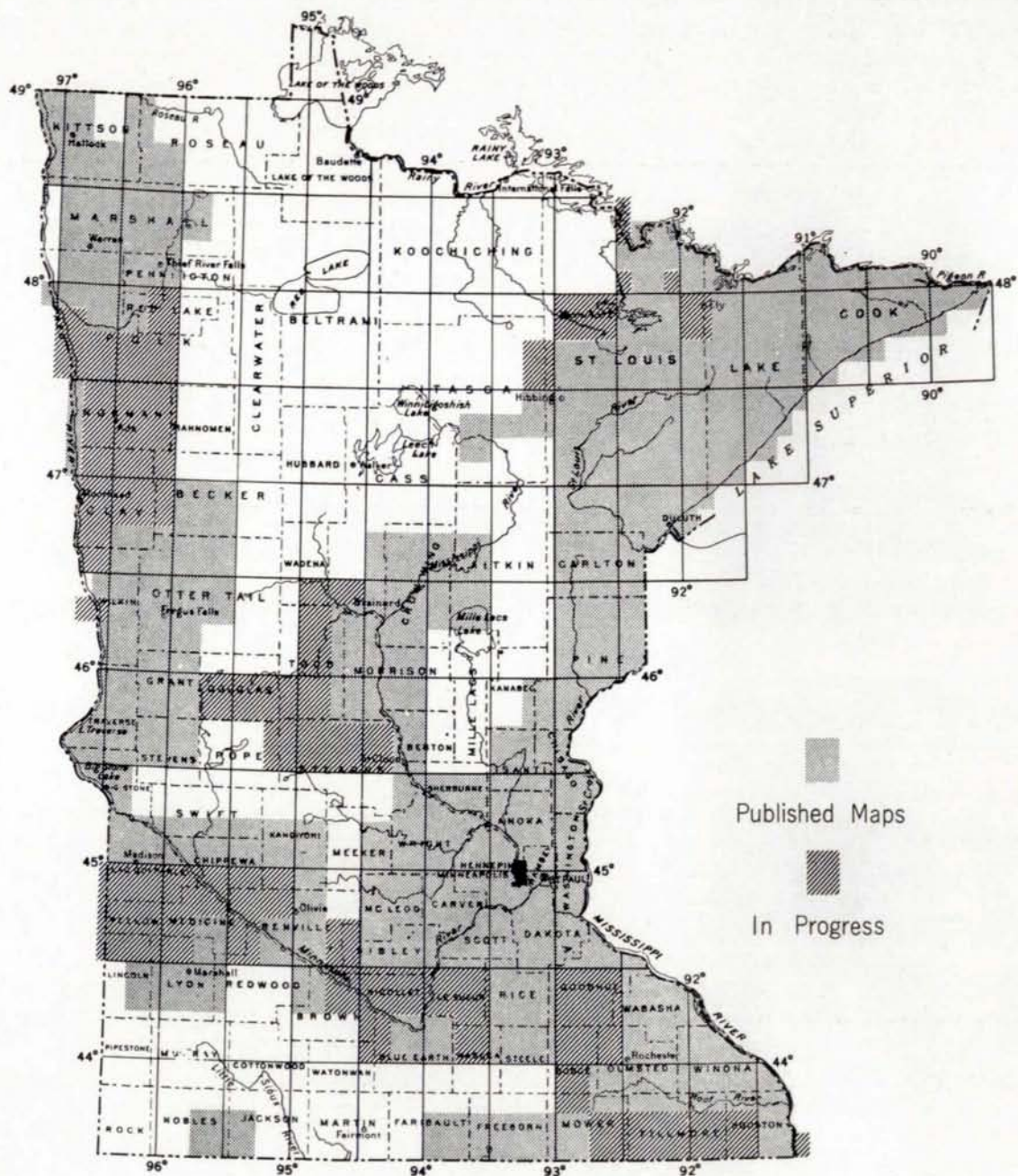


Figure 5—Status of topographic mapping, June 30, 1965.

### STATUS OF AEROMAGNETIC MAPPING

Airborne magnetometer surveying was resumed in the State during the 1964-65 biennium through funds available under the Omnibus Natural Resources and Recreation Act of 1963. An area aggregating 17,500 square miles, lying south of latitude  $44^{\circ} 30' N.$ , was completed (see map above). A total of about 12,700

square miles remains to be surveyed. The surveying was done by the U. S. Geological Survey in cooperation with the State of Minnesota, as part of their continuing research on the rocks of the Keweenaw basin and adjacent terranes.

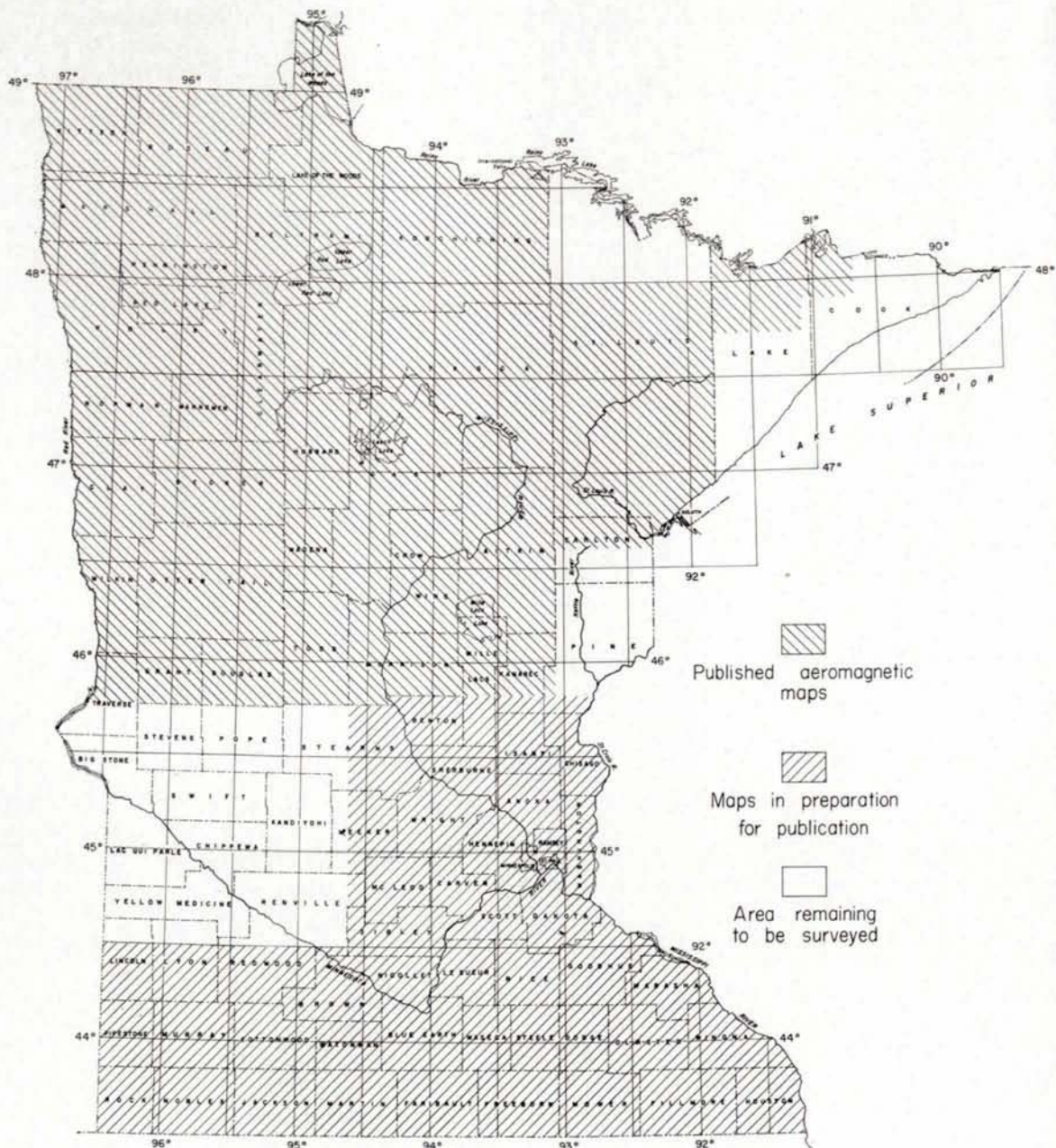


Figure 6—Status of aeromagnetic surveying, June 30, 1965.

## SURVEY EXHIBITS

In the summer of 1964, the Survey presented a display on *Clay Materials Research* at the Minnesota State Fair. The display included clay raw materials, pictures of processing plants, and finished products of selected plants. The same exhibit was on display in the fall at the University's Annual Legislators', Editors' and Broadcasters' Day, and part of it was

exhibited in Pillsbury Hall during the academic year.

The theme of this year's State Fair exhibit will be the geology and resources of the Pleistocene (glacial) deposits in the State.

A display on *Minnesota Taconite* is currently on exhibit at the Museum of Natural History, Minneapolis campus.

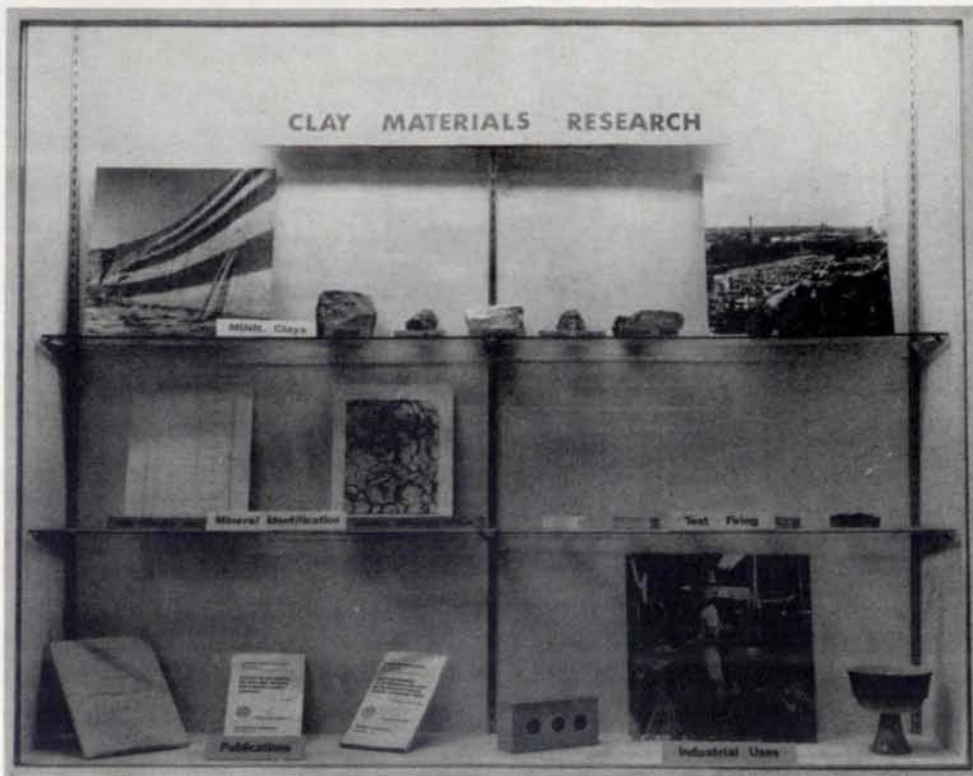


Figure 7—Clay materials research exhibit, Pillsbury Hall, University of Minnesota.

## OTHER GEOLOGIC ACTIVITIES IN THE STATE

### Department of Conservation, State of Minnesota Division of Waters

Preparation of reports on the water resources and water needs of several of the 39 watershed units in the State continued during the year. This work is done in part by the staff of the Division of Waters and in part by the staff of the district office of the U. S. Geological Survey, Water Resources Division, under a cooperative cost-sharing agreement. The Division published Bulletin 22, "Water Resources of the St. Louis River Watershed Unit"; a similar publication on streams that drain into Lake Superior is about ready for printing. The U. S. Geological Survey published Hydrologic Atlas, H.A. 201 on the Middle River Watershed Unit. Field work has been completed on three additional units, and is in progress on several others. The Division also has in press Bulletin 23, "Chemical quality of ground water in the Minneapolis-St. Paul area."

An inventory of lake basins in Minnesota has been compiled and is nearly ready to go to press. It lists all lakes 10 acres or more in size by counties, with identification numbers assigned to each lake. It will

include maps of each county for ready reference, tabulations of lakes by size classes, and brief discussions of the nature and geologic origin of the lakes of each county.

Surveys and field investigations made by Division personnel during the year included those concerned with the protection of lakes from encroachment or drainage, with inspection of operations under permit, and with proposals for lake and stream improvement.

Director's reports were made, as required by law, on plans for proposed public drainage projects. Reports were also made to the Water Resources Board on petitions for establishment of watershed districts under the Minnesota Watershed Act, and on overall plans for development of water resources prepared by the Board of Managers of watershed districts.

State appropriations available for topographic mapping were again \$25,000 from the General Revenue Fund and \$163,000 from the Natural Resources Fund, all of which was matched by federal funds. Additional mapping was supported entirely by federal funds. During the year 39 7½-minute quadrangles and two 15-minute quadrangles were published; also,

two 15-minute quadrangles, which were conversions from previously published 7½-minute quadrangles, were published.

State appropriations available to the Division of Waters for the fiscal year ending June 30, 1965 were as follows:

From General Revenue Fund:	
Salaries .....	\$154,548
Supplies and Expenses ..	15,445
Hydrologic Studies .....	30,000
	\$199,993
From Natural Resources Fund:	
Red River Basin Study	35,000
Hydrologic Studies and Research .....	75,000
Topographic and Mineral Mapping, and Aerial Photographs for Forestry .....	200,000*
	\$310,000

U. S. Geological Survey  
Water Resources Division

Cooperative programs for water resources investigations were continued by the U. S. Geological Survey, Water Resources Division and the Minnesota Department of Conservation, Department of Highways, and the Department of Iron Range Resources and Rehabilitation during the year ending June 30, 1965. In some instances, some of the State matching funds were contributed by municipalities and iron-mining companies. Funds totaling \$170,050 from cooperating agencies were matched by Federal funds. Water data were collected at network stations throughout the State. Water levels and artesian pressures were measured continuously in 43 wells and were measured at monthly intervals in 41 additional wells. Records of gage height and velocity of surface water were obtained from 49 full-time gaging stations, miscellaneous discharge measurements were made at four sites, and stage records were collected at 37 lakes and one river site. Streamflow discharge and stages of reservoirs and streams were collected at 60 additional sites in programs other than the cooperative programs and were made available to the State. Peak discharge data from small drainage areas were computed at 137 crest stage sites maintained in the cooperative

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\* Includes \$7,000 allocated to the Division of Forestry for the purchase of aerial photographs and \$30,000 for aeromagnetic surveying done cooperatively with the U. S. Geological Survey.

program with the Department of Highways. Base flow measurements were made at about 50 partial record sites during the year. Samples of surface water were collected for chemical analysis at 26 stations. Samples of ground water were collected from wells at 40 sites as a part of a network sampling program. An additional 150 samples were collected and analyzed from ground and surface water sources as a part of the watershed study projects.

The major part of the interpretive program of the Survey was devoted to watershed studies. During fiscal year 65 the Middle River unit of the Red River basin was published as Hydrologic Atlas 201. The Big Stone unit in the Minnesota River basin was in press and will be published shortly. Reports on the Two Rivers unit of the Red River basin and the Pomme de Terre unit of the Minnesota River basin have been completed and approved for publication. Field work has been completed for the Roseau and Mustinka units of the Red River basin, the Chippewa unit of the Minnesota River basin, and the Upper Mississippi unit of the Mississippi River basin. Field studies are currently underway in the Otter Tail unit and the Buffalo unit in the Red River basin, the Crow Wing unit in the Mississippi River basin, and the Lac qui Parle and Yellow Medicine units in the Minnesota River basin. The published watershed reports show availability of surface and ground water and the approximate total water yield of the basin. In addition, all current studies show the thickness of the glacial drift and the altitude and configuration of the underlying bedrock. Records of approximately 4,000 wells were collected during the fiscal year. Four thousand feet of test holes were augered in the Red River basin and 2,000 feet of test holes were augered in the Minnesota River basin during the fiscal year.

A study of artificial recharge in the Twin City metropolitan area including a general study of the hydrology was undertaken in fiscal year 65. Records of several hundred wells and pumpage for periods from 1910 to 1965 were collected in selected areas during the year. Records were also obtained of historic water levels as well as current water levels and several candidate observation wells were selected. Construction of an analog model was started the latter part of the year to aid in analysis of the hydrology and the effect of artificial recharge.

U. S. Geological Survey  
Geologic Division

The following projects currently being carried out by the Geologic Division of the U. S. Geological Survey directly bear on the geology of Minnesota.

LAKE SUPERIOR KEWEENAWAN GEOPHYSICAL STUDIES, M. E. Beck, Jr., in charge.

Status of work: The objectives of this new project are to apply the techniques of paleomagnetism to various geologic problems in the area, including stratigraphic correlation, structure and geologic history; provide magnetic properties data for the interpretation of aeromagnetic surveys; and furnish information for a systematic study of the effect of lithology and cooling rate on the magnetic properties of volcanic rocks.

Sampling of the Duluth gabbro near the city of Duluth and at the northeastern extremity of the body, near the Canadian border; the Keweenaw flows on the northwest side of Lake Superior, including Isle Royale; and the Mellen gabbro and associated rocks in northern Wisconsin is in progress.

LAKE SUPERIOR GEOPHYSICAL STUDIES, G. D. Bath in charge.

Status of work: Reports are being processed.

SOUTHERN MINNESOTA AEROMAGNETIC SURVEY, financed in part by the Minnesota Geological Survey, Isidore Zietz in charge.

Status of work: Survey has been completed and compiled; maps are being prepared for publication.

AERIAL RADIOLOGICAL MEASUREMENT SURVEYS, J. A. Pitkin in charge. Minneapolis-St. Paul area subproject, S. K. Neuschel in charge.

Status of work: Preparation of aeroradioactivity maps and reports is continuing; the final report will evaluate the correlation of aeroradioactivity to areal geology.

LOWER PALEOZOIC STUDIES, W. A. Oliver, Jr., in charge. Middle Ordovician cryptostome Bryozoa from the Decorah Shale formation of Minnesota subproject, O. L. Karklins in charge.

Status of work: Studies will be completed this year.

Rb-Sr DATING, Z. E. Peterman in charge.

Status of work: A vigorous program in Rb-Sr geochronology has been established. Instruments and laboratory facilities have been upgraded in order to date a wider range of samples and reduce the analytical uncertainties in the determination; greater emphasis will be placed on cooperative projects with geologists who have field problems for which radiometric ages will prove useful in solving geologic problems and processes. A major part of this work includes Rb-Sr dating of metasedimentary rocks of the Animikie Group of Minnesota.





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