

Minnesota Geological Survey

newsletter

SUMMER 1990 RECEIVED

AUG 28 1990

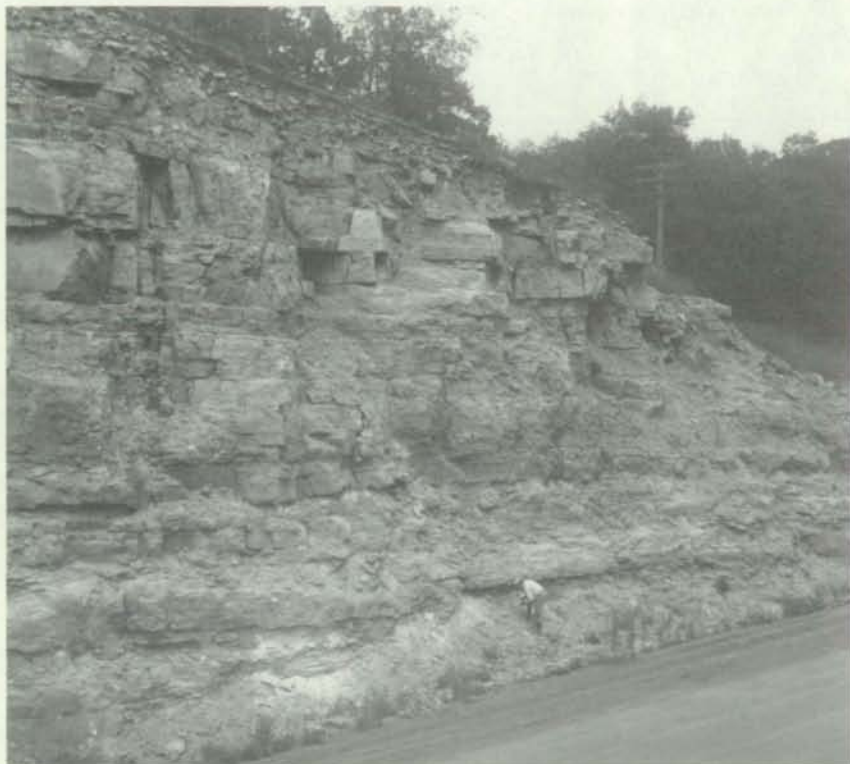
DELAWARE GEOLOGICAL SURVEY

MINNESOTA GEOLOGICAL SURVEY, UNIVERSITY OF MINNESOTA
2642 UNIVERSITY AVENUE, SAINT PAUL, MINNESOTA 55114-1057, (612) 627-4780

THE PRAIRIE DU CHIEN-JORDAN STUDY

The Minnesota Geological Survey is participating in a multi-agency cooperative effort to identify natural geologic and hydrogeologic factors that affect the sensitivity of ground water to contamination. The intention is to develop criteria and methods for assessing ground-water sensitivity and to generate a handbook and other educational materials, which will be used by planners to make such assessments. The Survey's contribution is the investigation of the distribution of contamination in aquifers and the geologic factors that affect its introduction and migration. The subcrop area of the Prairie du Chien-Jordan aquifer was chosen for the pilot study.

The project involves several separate activities. Howard Hobbs is serving on a committee that has generated preliminary criteria and drafted guidelines for assessing ground-water sensitivity. John Mossler, Roman Kanivetsky, Howard Hobbs, Jane Cleland, Bob Tipping, and Tony Runkel are mapping the geology and hydrogeology in the subcrop (first bedrock beneath glacial deposits) area of the Prairie du Chien Group and Jordan Sandstone, which together form the aquifer. Various maps are being generated at the scale of 1:250,000; they include bedrock thickness and structure, potentiometric surface of the aquifer, glacial-drift character and thickness, and nitrate levels. The physical characteristics of the bedrock units are being investigated with gamma logging and outcrop studies. The mapping of geologic conditions will be correlated with the



ROCKS OF THE PRAIRIE DU CHIEN GROUP AND JORDAN SANDSTONE along a road cut for U.S. Highway 14 west of Winona in southeastern Minnesota. The man in this 1934 photograph is standing near the contact between the Jordan and the overlying Oneota Dolomite of the Prairie du Chien Group. Photo from Survey files.

map of nitrate contamination and the results used to test and refine the final sensitivity criteria and guidelines. The Survey mapping is also being used as a framework for more site-specific studies, which are being conducted by other cooperating agencies.

The first year of the two-year project is finished. The mapping of bedrock thickness and structure is complete, as is the potentiometric map. The glacial mapping is underway, and the data for the nitrate map are being processed. Gamma logging in the Prairie du Chien and Jordan continues and outcrop studies have started; both activities will augment the information already collected and aid its interpretation.

The ground-water sensitivity project is funded by the Legislative Commission on Minnesota Resources and administered by the Minnesota Department of Natural Resources, Division of Waters. Dale Setterholm coordinates the Survey's contribution. All work will be completed by June 30, 1991.



THE MUD-CRACKED BED OF LAKE CALHOUN, a popular recreational lake in Minneapolis, during the dry days of the 1930s. Lake levels in the state also fell during the recent drought but are now on the rise. Other early signs of recovery include high soil moisture content and rebounding water levels in unconfined surficial aquifers.

But according to Brian Rongitsch of the Minnesota Department of Natural Resources, Division of Waters, it will take two to three years of normal to above-normal precipitation before deeper aquifers fully recover.

Photo from Survey files.

ANOKA SAND PLAIN STUDY

The Anoka sand plain is the subject of the first Minnesota Geological Survey regional ground-water assessment since the adoption of the Minnesota Groundwater Protection Act of 1989. Anoka, Chisago, Isanti, and Sherburne Counties comprise most of the area of the sand plain, which is unusually sensitive to ground-water contamination because of the high permeability of its surficial sediments and the rapid pace of development in the region.

With the assistance of staff from local soil and water conservation districts, the Survey is developing a computerized subsurface data base for the counties included in the study area. Maps are being compiled and digitized to show surficial geology, hydrogeology, and sensitivity of near-surface ground water to contamination from sources at the land surface (see related article on page 3 on the new geographic information system).

This is the second year of a two-year project. Work on the data base should be completed by the end of summer. Carrie Patterson is mapping the surficial geology from soil surveys and air photos, and preliminary surficial maps for Anoka and Sherburne Counties are complete. Roman Kanivetsky has compiled preliminary water-table maps for Anoka and Chisago Counties. Other Survey staff involved with data collection and mapping include Howard Hobbs, Barb Palen, Jane Cleland, Joyce Meints, Emily Bauer, and Gina Rigatuso. Gary Meyer coordinates the Survey's activities.

The project is funded from a Groundwater Protection Act appropriation and administered by the Minnesota Department of Natural Resources, Division of Waters.

STAFF NEWS

Dave Southwick received an academic/professional appointment in April as Assistant Director/Research Associate.

Roman Kanivetsky was one of the organizers of the U.S.A.-U.S.S.R. Joint Conference on Environmental Hydrology and Hydrogeology, which was held in Leningrad, June 18-21. The conference was organized by the Minneapolis-based American Institute of Hydrology. Sponsorship in the Soviet Union came in part from the U.S.S.R. Academy of Sciences. This was the first major meeting between the U.S. and the U.S.S.R. to discuss the environmental aspects of ground-water protection.

Dale Setterholm prepared an illustrated handout, "Minnesota Geology—A View From the Drill Rig," for use by the Minnesota Department of Health in their continuing education program for well drillers. He also lectured at two regional training sessions that were sponsored by the Department of Health.

Howard Hobbs and **Rich Lively** led a field trip on the geologic history and development of the upper Mississippi River during the North-Central Section meeting of the Geological Society of America in April.

Lynn Swanson and **Dave Southwick** were the recipients of Institute of Technology Outstanding Civil Service awards this year and last.

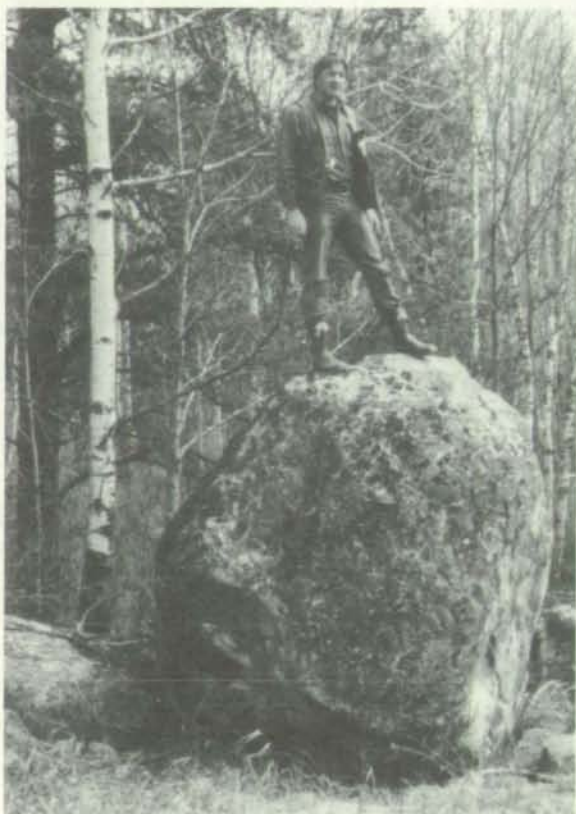
Val Chandler is organizing a geophysics workshop with co-convenors Rodney J. Ikola (private consultant), William J. Hinze (Purdue University), and Thomas G. Hildenbrand and Bruce D. Smith (U.S. Geological Survey). The international workshop, which will take place next winter, will mark the completion of the aeromagnetic program and address the future of geophysics in Minnesota. Sponsorship comes from the Legislative Commission on Minnesota Resources through the aeromagnetic program. Contact Val Chandler for further information.

Howard Hobbs is representing the Survey on a committee whose goal is to issue criteria for identifying areas of ground water in the state that are sensitive to pollution. The committee, which was organized by the Minnesota Department of Natural Resources, Division of Waters, has already prepared a draft "how-to" manual for mapping ground-water sensitivity at two levels of complexity. It has been reviewed by potential users and is now being revised. The final version will be released next year.

Jim Miller taught an Elderhostel course (sponsored by the University of Minnesota, Duluth) on geology at the Gunflint Lodge from April 29 to May 4.

PROJECT UPDATES

BEDROCK GEOLOGIC MAPPING IN THE COOK AREA of west-central St. Louis County continues this summer. Field mapping of outcrops by Mark Jirsa, Terry Boerboom, and Dave Southwick is being augmented by test drilling. This is an area of Archean bedrock with a very complex structural, metamorphic, and intrusive history. Mapping is now about half complete. The final product will be a 1:48,000-scale map of the 10-quadrangle area (about 20 x 30 miles) in about a year.



BOULDERS LEFT IN THE WAKE OF RETREATING GLACIERS during the last Ice Age are abundant in areas of bedrock outcrop in northern Minnesota and commonly reflect local bedrock types. Most glacial transport of boulders was from north to south. A field geologist notes a boulder's size, shape, and rock type as part of the mapping process. For example, if many large boulders of pillow basalt are found in the vicinity of a granite outcrop, the geologist can infer the presence of basaltic bedrock to the north.

In the accompanying photograph, geologist Terry Boerboom stands atop a boulder of pyroxene monzonite, which rests on a large outcrop of the same rock type in the Cook mapping area. Although this boulder has not moved far from its place of origin, other similar boulders to the south provided the clues that led to the discovery of this outcrop.

MAPPING NEAR THE NORTH SHORE OF LAKE SUPERIOR. Jim Miller and Eric Jerde are mapping in the Cramer 1:24,000-scale quadrangle this summer. Last summer Jim and his field crew—Nancy Nelson, Roberta Lamons, and Eric Jerde—finished field work in the Cabin Lake quadrangle.

SCIENTIFIC TEST DRILLING IN ST. LOUIS AND COOK COUNTIES SUPPORTS GEOLOGIC MAPPING. This is a two-phase drilling program to test geophysical models and augment outcrop mapping in an area of poorly known bedrock geology. Phase 1 involves drilling of about 20 to 35 holes near Cook. Phase 2 involves an area near Isabella in Cook County to assist interpretation of geophysical data by Val Chandler and Jim Miller. Others involved in the drilling and geophysical interpretation are Dave

Southwick, Terry Boerboom, Joyce Meints, Bryan Schaap, and Peter McSwiggen. Peter will elucidate the metamorphic history of the Cook area. This is a field of interest that has been lacking in Archean studies to date. A summary of the drilling will be published in about a year.

TRACE ELEMENTS IN INSOLUBLE RESIDUES OF CARBONATE ROCKS are being studied as a possible tool for evaluating mineral potential by John Mossler and G.B. Morey (of MGS), and Steve Hauck (of the Natural Resources Research Institute, University of Minnesota, Duluth). During a pilot study using the method, which was developed by the U.S. Geological Survey (USGS), anomalous levels of zinc in residues from the Galena Formation were found. The study will be expanded with funds recently received from the USGS for additional analyses.

COMPLETED COUNTY GEOLOGIC ATLASES are Washington, Dakota, Hennepin, Olmsted, Winona, and Scott Counties. Work on the latest, Ramsey County, begins this summer with completion expected in mid-1992. Other counties expressing interest are Stearns, Rice, Sherburne, Polk, Fillmore, and Carver.

Other atlas news. Bruce Bloomgren is overseeing the upgrading of the well-log data base for the three most

recently completed atlases (Dakota, Washington, Hennepin). Many of the logs date to the mid and late 1970s; interpretations of the geology have been revised in the years since, and these revisions must be traced on both the paper and computer logs.

GIS AT MGS. After many years of relying on homegrown computer-assisted mapping, the Minnesota Geological Survey is experimenting with a full-featured GIS (geographic information system) for use in geologic mapping projects. With funding through the Minnesota Department of Natural Resources, Division of Waters, for the Anoka sand plain regional aquifer study, the Survey has supplemented existing hardware and acquired the ARC/INFO GIS software. The two resulting work stations consist of 386-based PCs and large-format digitizers; output is generated via a wide-media color pen plotter.

Work by Tim Wahl and Joyce Meints is underway to convert existing Survey geographic feature data to the new format. The Anoka sand plain project calls for maps to be provided in digital form; it will serve as a pilot study for Survey digital map products. Future projects—county and regional atlases, in particular—may feature digital maps as an optional part of the product. When fully integrated with existing computer operations at the Survey, the new GIS capabilities are expected to play an increasingly important role as tools for geologic map production.

Other computer news. Val Chandler and Bryan Schaap are setting up a Macintosh-based student work station for geophysical filtering and display. The hardware for the project was provided through Project MinneMac (Minnesota Macintosh), a joint development effort of the University and Apple Computer, Inc. They are also setting up a PC-based professional work station for the processing of gravity and magnetic data, which is supported by the basic research component of the Minerals Diversification Program.

THE SIXTH AND FINAL BIENNIUM OF THE AEROMAGNETIC SURVEY began in southeastern Minnesota last fall. The contractor for the acquisition of data, Aerservice Incorporated, flew about one quarter of the survey area before winter hit. They will be in the air again starting sometime in July (after the worst of the thunderstorm season has passed). The compilation of data will take several months before survey products are ready for release in late 1990 or early 1991.

Other geophysical work by Val Chandler and Bryan Schaap includes a continuing study of the paleomagnetism of the Sioux Quartzite and other Minnesota rocks, interpretation of GLIMPCE (Great Lakes International Multidisciplinary Program on Crustal Evolution) data in the western Lake Superior region, and a geophysical investigation of the Cook (in cooperation with Mark Jirsa and Terry Boerboom) and Isabella (in cooperation with Jim Miller) areas of northern Minnesota.

SURVEY STAFF

Priscilla C. Grew, *Director*
G.B. Morey, *Associate Director and Chief Geologist*
David L. Southwick, *Assistant Director and Research Associate*
Nancy H. Balaban, *Editor*
Suzanne L. Bakke, *Secretary*
Emily J. Bauer, *Laboratory Technician*
Bruce A. Bloomgren, *Geologist*
Terrence J. Boerboom, *Geologist*
Val W. Chandler, *Geophysicist*
Jane M. Cleland, *Geologist*
Richard B. Darling, *Graphic Designer*
Gail K. DeShane, *Secretary*
Kenneth L. Harris, *Geologist*
Howard C. Hobbs, *Geologist*
Mark A. Jirsa, *Geologist*
Roman Kanivetsky, *Hydrogeologist*
Richard S. Lively, *Geochronologist*
Linda L. McDonald, *Assistant Administrator*
Peter L. McSwiggen, *Geologist*
Joyce P. Meints, *Geologist*
Gary N. Meyer, *Geologist*
James D. Miller, Jr., *Geologist*
John H. Mossler, *Geologist*
Barbara M. Palen, *Geologist*
Carrie J. Patterson, *Geologist*
Salina M. Renninger, *Senior Office Assistant*
Gina M. Rigatuso, *Laboratory Technician*
Anthony C. Runkel, *Geologist*
Bryan D. Schaap, *Geophysicist*
Dale R. Setterholm, *Geologist*
Lynn M. Swanson, *Editor and Librarian*
Timothy E. Wahl, *Analyst/Programmer*
Paul W. Weiblen, *Professor, Dept. of Geology and Geophysics*
Matt Walton, *Professor Emeritus*

Part-time Staff

Philip E. Heywood, *Cartographer*
Roy A. Jameson, *Grad. Research Assistant*
Robert G. Tipping, *Grad. Research Assistant*
Alan C. Veteri, *Senior Office Assistant*
Undergraduate Research Assistants
K.A. Anderson J.M. Perala
C.J. Benedikt H.A. Sadauskis
C.G. Bratsch E.J. Thompson
J.A. Duley T.E. Verry
M.J. Olson H.P. Vu
P.M. Parris E.J. Wilkowske

FUNDING REPORT

A State Special appropriation from the Minnesota Legislature provides operating funds (salaries, benefits, supplies, travel, etc.) for the Survey. These appropriations are made by the Legislature on a biennial (24-month) schedule. State appropriations for the first year of the biennium beginning July 1, 1989, were \$1,035,000, plus \$630,000 from the Legislative Commission on Minnesota Resources for special projects like the statewide aeromagnetic survey and its accompanying scientific test drilling. The contracts and grants listed below were active in the fiscal year ending June 30, 1990, and many will carry over into the next fiscal year and longer.

FEDERAL CONTRACTS AND GRANTS

COGEO MAP (Cooperative Geologic Mapping) Program in the Duluth Complex, Northeastern Minnesota—U.S. Geological Survey.

STATE AND OTHER CONTRACTS, GRANTS, AND APPROPRIATIONS

Washington County Geologic Atlas—Washington County, Minnesota, and the Minnesota Department of Natural Resources.

Dakota County Geologic Atlas—Dakota County, Minnesota, and the Minnesota Department of Natural Resources.

Study of Radium in Municipal Water Supplies—Minnesota Department of Natural Resources.

Ground-Water Sensitivity Project (Jordan Sandstone)—Legislative Commission on Minnesota Resources and the Minnesota Department of Natural Resources.

Regional Ground-Water Assessment (Anoka Sand Plain)—Minnesota Department of Natural Resources.

County Geologic Atlas Development—Minnesota Department of Natural Resources.

Glacial Drift Stratigraphy—Minnesota Department of Natural Resources.

Public Sample Analysis Program—Minnesota Department of Natural Resources.

Regional Geologic Support for Geochemical Maps of Northern Minnesota Greenstones—Minnesota Department of Natural Resources.

County-Level Ground-Water Data Management—Legislative Commission on Minnesota Resources.

Aeromagnetic Mapping—Legislative Commission on Minnesota Resources.

Instructional Geophysical Filtering and Display System—Project MinneMac, Space Science Center, University of Minnesota.

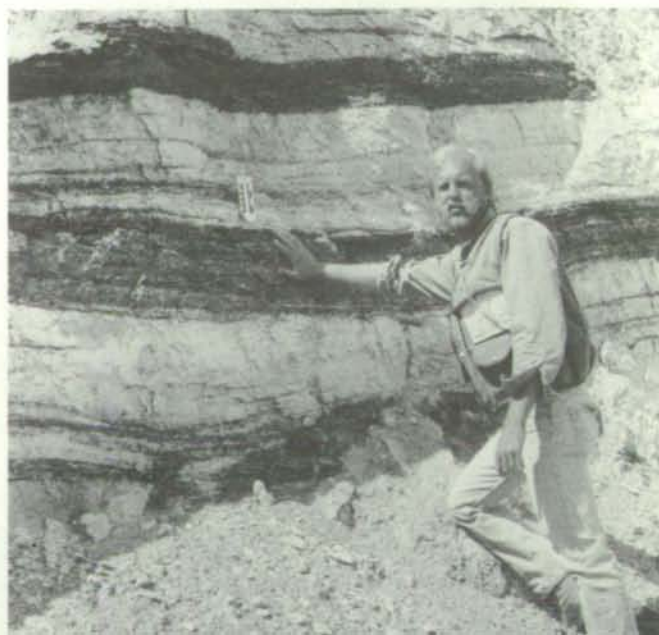
Mineral Diversification Projects

Geologic Drilling and Mapping—Minnesota Department of Natural Resources.

Bedrock Geologic Mapping (Cook Area)—Minnesota Department of Natural Resources.

Imageworks: Image Processing for Gravity and Magnetic Data—Minnesota Department of Natural Resources and Minerals Resources Research Center, University of Minnesota.

DALE SETTERHOLM stands before a rock face that was uncovered last year in the Ochs Brick and Tile Company's clay pit near Morton in the Minnesota River Valley. Visible in this section are the first Cretaceous sediments preserved on top of the weathered Precambrian surface. The alternating light-dark layers represent freshwater river and marsh deposits of kaolin clay and lignite. Dale is the lead author of a recent subsurface study of kaolin clay deposits in southwestern and east-central Minnesota. See page 5 for further information.



RECENT SURVEY PUBLICATIONS

Aeromagnetic map of Minnesota, northwestern region, total magnetic intensity anomaly, by V.W. Chandler. 1989. Scale 1:250,000, 2 sheets, color and black and white. (Aeromagnetic Map Series A-7). **\$6.00.**

Aeromagnetic map of Minnesota, southwestern region, total magnetic intensity anomaly, by V.W. Chandler. 1989. Scale 1:250,000, 2 sheets, color, black & white. (Aeromagnetic Map Series A-8). **\$6.00.**

7.5-minute base quadrangle maps showing total intensity contours (minimum interval = 10 nT) and flight-line recovery are available for the above mentioned areas for **\$5.00** per copy on ozalid paper and **\$40.00** per copy on Cronaflex. Contact Map Sales for further information.

Digital grid tapes are also available. For information regarding their acquisition, call Val Chandler, (612) 627-4780.

Shaded relief aeromagnetic map of Minnesota. 1990. One black & white sheet. 1" = approx. 40 mi. **Free over the Map Sales Counter; \$1.00** when requested by mail.

Earthquakes in Minnesota: Are we getting a fair shake? by V.W. Chandler. 1990. Folder. **Free over the Map Sales counter; \$1.00** when ordered by mail.

Geologic atlas of Olmsted County, edited by N.H. Balaban. 1988. Scale 1:100,000 and smaller, 9 plates, color, black & white. (County Atlas Series C-3). **\$12.00.**

Geologic atlas of Hennepin County, Minnesota, edited by N.H. Balaban. 1989. Scale 1:100,000 and smaller, 9 plates, color, black & white. (County Atlas Series C-4). **\$12.00.**

Geologic atlas of Washington County, Minnesota, edited by L. Swanson and G.N. Meyer. 1990. Scale 1:100,000 and smaller, 7 plates, color, black & white. (County Atlas Series C-5). **\$12.00.**

Geologic atlas of Dakota County Minnesota, edited by N.H. Balaban and H.C. Hobbs. 1990. Scale 1:100,000 and smaller, 9 plates, color. (County Atlas Series C-6). **\$12.00.**

Scientific core drilling in parts of Koochiching, Itasca, and Beltrami Counties, north-central Minnesota: Summary of lithological, geochemical, and geophysical results, by T.J. Boerboom and others. 1989. 159 p. (Information Circular 26). **\$5.00.**

Minnesota kaolin clay deposits: A subsurface study in selected areas of southwestern and east-central Minnesota, by D.R. Setterholm and others. 1989. 99 p. (Information Circular 27). **\$4.00.**

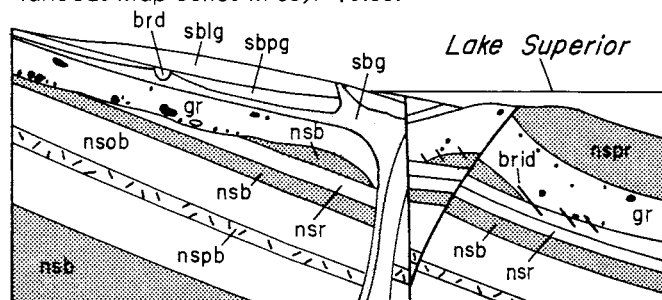
Graphite in Early Proterozoic rocks of east-central Minnesota, by P.L. McSwiggen and G.B. Morey. 1989. 68 p. (Information Circular 28). **\$4.00.**

Analytical results of the Public Geologic Sample Program, 1987-1989 biennium, by G.B. Morey and L.L. McDonald. 1989. 66 p. (Information Circular 29). **\$7.00.**

Workshop on the applicability of gold and platinum-group-element models in Minnesota, edited by G.B. Morey. 1989. 60 p. (Information Circular 30). **\$4.00.**

Scientific test drilling in west-central Minnesota: summary of lithologic and stratigraphic results, 1987-1988, and some preliminary geological conclusions, by D.L. Southwick, D.R. Setterholm, and T.J. Boerboom. 97 p. 1990. (Information Circular 31). **\$8.00.**

Geologic map of the Silver Bay and Split Rock Point NE quadrangles, Lake County, Minnesota, by J.D. Miller, Jr. 1988. Scale 1:24,000, 1 sheet, color. (Miscellaneous Map Series M-65). **\$5.00.**



Geologic map of the Ilgen City quadrangle, Lake County, Minnesota, by J.D. Miller, Jr., J.C. Green, and T.J. Boerboom. 1989. Scale 1:24,000; inset maps, 1:6,000, 1 sheet, color. (Miscellaneous Map Series M-66). **\$5.00.**

Bedrock geologic map of parts of Koochiching, Itasca, and Beltrami Counties, by M.A. Jirsa, and T.J. Boerboom. 1990. Scale 1:250,000, 1 sheet, color. (Miscellaneous Map Series M-67 corrected version) **\$8.00.**

ATTENTION: THIS MAP HAD TO BE REPRINTED SHORTLY AFTER PUBLICATION BECAUSE THE TOPOGRAPHIC BASE WAS MISALIGNED. THE CORRECTED VERSION IS LABELED AS SUCH IN THE UPPER RIGHT-HAND CORNER OF THE MAP SHEET. IF YOU RECEIVED A COPY OF THIS MAP, CHECK THAT YOU HAVE THE CORRECTED VERSION. IF NOT, PLEASE LET US KNOW AND WE WILL REPLACE IT.

Surficial geologic map of the Greenwood Lake, Isabella, and Cramer quadrangles (northeastern Minnesota), by H.C. Hobbs, A.L. Friedman, J.M. Fenelon, and J.R. Stark. 1988. Scale 1:62,500, ozalid paper copy, 1 sheet; accompanying text, 9 p., stapled. (Open-File Map 88-2). **\$6.80.**

New model of the Midcontinent rift in eastern Minnesota and western Wisconsin, by P.L. McSwiggen, G.B. Morey, and V.W. Chandler. (Reprint Series 64). **\$2.00.** From *Tectonics*, v. 6, no. 6, 1987, p. 677-685.

History of the Minnesota geological surveys and state geologists, by G.B. Morey. 12 p. (Reprint Series 65). **\$1.00.** From Socolow, A.A., editor, 1988, *The State Geological Surveys: A History*. Association of American State Geologists, 499 p. The complete volume can be purchased from the Alabama Geological Survey. Atten.: Tom Stone, P.O. Box O, Tuscaloosa, Alabama 35486-9790. Please include with your order payment by check or money order for **\$20** made out to the Association of American State Geologists.

Recent Publications continued on back cover

Recent Publications continued from previous page

Interpretation of seismic reflection, gravity, and magnetic data across Middle Proterozoic Midcontinent rift system, northwestern Wisconsin, eastern Minnesota, and central Iowa, by V.W. Chandler and others. (Reprint Series 66). \$1.00. From *American Association of Petroleum Geologists Bulletin*, v. 73, no. 3, 1989, p. 261-275.

Seismic history of Minnesota and its geologic significance: An update, by V.W. Chandler and G.B. Morey. (Reprint Series 67). \$1.00. From *Seismological Research Letters*, v. 60, no. 2, 1989, p. 79-86.

Anorthositic rocks of the Duluth Complex: Examples of rocks formed from plagioclase crystal mush, by J.D. Miller, Jr., and P.W. Weiblen. 48 p. (Reprint Series 68). \$3.00. From *Journal of Petrology*, v. 31, pt. 2, 1990, p. 295-339.

Mail orders must be accompanied by check or money order made out to the University of Minnesota. There is a \$1.00 postage and handling fee for three or less publications and Minnesota residents must add 6% sales tax. Please direct inquiries and orders to Maps and Publications Sales, (612) 627-4782, open 8 a.m.-4:25 p.m., Monday-Friday.

OUTSIDE PUBLICATIONS

Chandler, V.W., and Ferderer, R.J., 1989, COPPER-NICKEL MINERALIZATION OF THE DULUTH COMPLEX, MINNESOTA—A GRAVITY AND MAGNETIC PERSPECTIVE: *Economic Geology*, v. 84, p. 1690-1696.

Chandler, V.W., and Southwick, D.L., 1990, AEROMAGNETIC MINNESOTA (cover story): *Eos*, v. 71, p. 329-331.

Hinze, W.J., Braille, L.W., and Chandler, V.W., 1990, A GEOPHYSICAL PROFILE OF THE SOUTHERN MARGIN OF THE MIDCONTINENT RIFT SYSTEM IN WESTERN LAKE SUPERIOR: *Tectonics*, v. 9, p. 303-310.

Horton, R.J., Meyer, G.N., and Bajc, A.J., 1989, RECONNAISSANCE QUATERNARY GEOLOGY MAP OF THE INTERNATIONAL FALLS 1° X 2° QUADRANGLE: U.S. Geological Survey Open-File Report 89-654, 1 ozalid paper copy, scale 1:250,000.

NOTE: THIS MAP IS AVAILABLE FROM THE SURVEY MAP SALES OFFICE FOR \$8.00.

Kanivetsky, Roman, and Hoyer, M.C., 1989, AQUIFER THERMAL ENERGY STORAGE, ST. PAUL, MINNESOTA: *Journal of the U.S.S.R. Academy of Sciences "Engineering Geology"*, 6, p. 65-71.

Morey, G.B., and Morey, P.R., 1990, MAJOR AND MINOR ELEMENT CHEMISTRY OF THE BIWABIK IRON FORMATION AND ASSOCIATED ROCKS, MINNESOTA, in AIME, Minnesota Section, 63rd Annual Meeting, and Mining Symposium, 51st, 1990, Duluth, Minnesota, Proceedings: Duluth, University of Minnesota, Continuing Education & Extension, Center for Professional Development, p. 259-287.

COMING FAIRLY SOON

FOR THOSE interested in future publications of the Survey, we have listed below some of the maps, reports and papers now in preparation or review. Please note, though, that they are all a few to several months away from release. Check with Map Sales for availability before ordering.

Dale Setterholm's maps of the geology of Cretaceous rocks (scale 1:750,000) in southwestern Minnesota are in review . . . Mark Jirsa's **bedrock geologic map of northeastern Itasca County** (scale 1:48,000) is in cartographic preparation. This map is a detail of the southeast corner of the published Miscellaneous Map M-67 and forms the basis for other work in the Vermilion greenstone belt . . . Jim Miller's 1:24,000-scale **bedrock geologic maps of the Doyle Lake and Finland quadrangles** adjacent to the North Shore of Lake Superior are in preparation . . . Val Chandler has two papers in press at outside journals: the first, for *Economic Geology*, is a geologic interpretation of gravity and magnetic data over the central part of the **Duluth Complex**; the second (with Kelley Carlson Malek), for *Geophysics*, is on moving-window Poisson analysis of gravity and magnetic data from the **Penokean orogen** . . . Val Chandler and Bryan Schaap are preparing a new **color gravity map of the state** (scale 1:500,000) . . . a **catalog of the fossil collection of the N.H. Winchell School of Earth Sciences**, compiled by Bill Rice, is in preparation . . . John Mossler is preparing a Report of Investigations on **Dresbachian-age sedimentary rocks** of southern Minnesota (the Mt. Simon, Eau Claire, and Galesville formations) . . . H.E. Wright's Educational Series publication on **the geologic history of Minnesota rivers** is in preparation

MINNESOTA GEOLOGICAL SURVEY

University of Minnesota
2642 University Avenue
St. Paul, Minnesota 55114-1057

Nonprofit Org.
U.S. Postage
PAID
Minneapolis, Minn.
Permit No. 155

Delaware Geological Survey
University of Delaware
101 Penny Hall
Newark, DE 19716