Minnesota Geological Survey

NEWSLETTER

Spring 1994

FROM THE (INTERIM) DIRECTOR

About two years ago we acknowledged our inability to produce the Minnesota Geological Survey (MGS) newsletter on a regular schedule, and started producing it on an "occasional" basis. There is no occasion of note that has prompted us to generate a newsletter now, but it was the middle of last summer when we sent out the last one and there are some things to report.

I became interim director of MGS last September, following the resignation of former director Priscilla C. Grew. Except for the office filing system she designed and I can't figure out, Priscilla left things in reasonably good shape and the transition was smooth. My appointment coincided with the appointment of Bill Seyfried as new Head of the School of Earth Sciences and of Frank Kulacki as new Dean of the Institute of Technology. Thus we had a rookie MGS Director reporting to a rookie Head of School who was reporting to a rookie Dean, and it is something of a wonder that chaos and confusion did not ensue. As a matter of fact, I think the three of us function rather well together; neither Bill nor Frank has badgered me unduly, and for that I am grateful.

The committee chaired by Professor V. Rama Murthy that was formed to conduct a search for a permanent director of MGS is on schedule for completing its work in June. The committee began the search process last October; in early March it selected a "short list" of six qualified candidates from an applicant pool of 37. Those six were here for interviews and cross-examination from mid-April to mid-May. University administration will shortly make a choice, and a new director should be on board and directing by September 1, 1994.

The new director will discover that MGS leads a precarious and schizophrenic existence. I sometimes wonder what our support base is—whether anyone really approves of what we do. We often are told that our focus is too academic or esoteric, and that we fail to meet the needs of our real-world customers for unadorned, raw data. Just as often we hear that much of our work lacks intellectual depth; that we are wasting time and effort functioning as earth-science file-clerks when we should be developing new concepts and interpretive models relevant to Minnesota's geological endowment. We are castigated for doing too much (or not enough) geologic mapping in Precambrian terranes. Our Quaternary mappers are criticized in some circles for being overly process-oriented, and in others for producing maps of materials that are intellectually vacuous because they fail to convey an adequate sense of temporal order or depositional processes for the sediments mapped.

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MINNESOTA' S COUNTY GEOLOGIC ATLAS PROGRAM

Significant decisions regarding the use of land or water are seldom without controversy. We have proof of that once again in the heated and earnest debate engendered by the proposal from Northern States Power to store spent nuclear fuel in surface casks near the Prairie Island generating plant in Goodhue County. The issues that surround the siting of a hazardous waste isolation facility, a sewage lagoon, or a sanitary landfill are always emotion-filled. Fears of possible losses due to such a facility often permeate the atmosphere of the decision-making process from the very beginning, so that the geologic and hydrologic facts of the situation—and their likely consequences—may be forgotten or never ascertained.

County geologic atlases were conceived originally by the Minnesota Geological Survey (MGS) to meet the informational needs of planners and decision-makers at all governmental levels. Atlases present the relevant, regional earth-science information at scales meaningful for both technical experts and informed citizens who have an interest in ensuring that sensible and defensible land-use decisions are made. Sadly, no such atlas has yet been produced for Goodhue County.

HISTORY The concept of the geologic atlas evolved in the late 1970s as population expanded in the Twin Cities Metropolitan Area and environmental awareness increased. Decision-makers at all levels began to recognize the importance of geologic data to rational land-use planning, and also discovered the general unavailability of such data in organized, accessible, and understandable form. The first atlas, for Scott County, was a loosely organized cooperative effort of MGS and county planning staff that was published in 1982. Funding was principally from the base budget of MGS, with modest contributions from the county and the Legislative Commission on Minnesota Resources (LCMR). The atlas maps were designed for publication at scale 1:100,000, an appropriate level of detail for summarizing regional geologic data. Atlases for Winona (1984), Olmsted (1988), and Hennepin (1989) Counties followed, and were funded through cost-sharing agreements between the counties and the Survey. Subsequent atlases for Washington (1990) and Dakota (1990) Counties were funded through cost-sharing agreements between the counties and MGS, plus cash supplements from the Minnesota Department of Natural Resources (DNR).

Major programmatic changes began in 1989. The 1989 Groundwater Protection Act directed the DNR to identify and map, in consultation with MGS, sensitive areas of ground water in both the heavily populated and agricultural regions of the state. The act also established base funding for this sensitivity mapping in the DNR Division of Waters. The MGS and DNR agreed under these new circumstances that MGS should continue to develop the basic geologic information essential for sensitivity assessment through the county atlas program, and that DNR would fund the atlas work through contracts with MGS. Furthermore, it was agreed that the technical responsibility for producing the hydrogeologic and pollution sensitivity plates of atlases would shift from MGS, which has no regulatory authority in ground-water issues, to DNR, which does.

In the midst of all of this realignment and redirection, a new multi-county product called a regional hydrogeologic assessment (RHA) was designed and integrated into the program. The RHA provides mapping of the near-surface geology in enough detail (scale 1:200,000) to allow the sensitivity to pollution of the shallowest aquifer system in the region to be assessed at reconnaissance level. The shallowest aquifer system is within Quaternary sediments in most parts of Minnesota, and the emphasis of RHAs therefore is on Quaternary geology and hydrogeology.

In 1992, the Legislature, on the recommendation of the LCMR, provided supplemental funds to both the DNR and MGS to accelerate the production of

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Interim Director *continued from front cover*

We are pressured by some to take a larger, more aggressive role in the area of hydrogeology. Others advise us in no uncertain terms to avoid that field entirely, and leave Minnesota's waters to the regulatory agencies and the USGS. Crab, crab, crab.

I view all of this criticism and advice from our customers and colleagues as a healthy problem. I would be far more concerned if we heard only tepid approval or nothing at all. Our customers and colleagues represent a variety of needs and expectations within the earth-science community, and in keeping with Minnesota tradition, they are not reticent about expressing their opinions.

A good compromise has been defined as a policy that satisfies no one completely. From this definition, and the amount of constructive carping we receive, one could conclude that the MGS program is indeed a pretty good compromise. That is intentional. We know we cannot survive by pleasing only one constituency or another; we have to maintain a balanced program among competing interests and philosophies. A fully predictable consequence of a balanced program is a healthy level of competitive dissatisfaction. I sense that we have achieved that, perhaps more by happenstance than by design, during this interim year.

Many of you know that a large part of our collective effort goes into the County Geologic Atlas and Regional Hydrogeologic Assessment program. As the feature article in this newsletter reveals, the program is bureaucratically, politically, and scientifically complex. The results, however, have been rewarding in terms of practical applications and new knowledge gained, and the program has become one of our mainstays.

MGS staff scientists have been busily chugging away through the fall and winter, with good effect. I call your attention to the list of publications that have appeared in the interval since the last newsletter, and to the column headed "research highlights." There also have been some staff changes and the inevitable oscillations of the budget.

As of this writing, the MGS program is on track, we are operating within budget, and the wolves, though occasionally howling, are away from the door. All of us hope these circumstances will continue.

David L. Southwick

County atlas *continued from front cover*

atlases and assessments. The Legislature made it clear, however, that counties were expected to bear part of the cost of atlas work, as they had been doing all along. Accordingly, MGS decided that a fixed-fee county contribution of $90,000 per atlas was fair and equitable. Assessment areas, in contrast, would be mapped at no cost to the counties involved.

As matters now stand, MGS and DNR are cooperating partners in the technical aspects of the county atlas and regional hydrogeologic assessment programs. The MGS has prime responsibility for geologic mapping and DNR has prime responsibility for derivative hydrologic interpretations. An atlas for Ramsey County (1992) and an assessment for the Anoka Sand Plain (1993) have been completed under this cooperative arrangement; three more atlases (Rice, Fillmore, and Stearns Counties) and two more assessments are well along.

COMPONENTS OF ATLASES AND ASSESSMENTS The content of atlases evolved through a series of steps into a package of maps that has become more or less standard for a given county project (Table 1). Each map is presented on a county base at scale 1:100,000 and supported by the explanatory text and supplemental graphical material required for its understanding and application. The package may be expanded with maps specific to the geologic conditions in a county, such as maps showing the distribution of karst features in many counties of southeastern Minnesota.

Regional hydrogeologic assessments contain the items starred in Table 1. The maps in RHAs are designed and compiled for publication at scale 1:200,000 and are therefore reconnaissance summaries of geological and hydrogeological conditions.

TABLE 1. BASIC COMPONENTS OF A COUNTY GEOLOGIC ATLAS

•*	Water-well database map (distribution of wells used for geologic and hydrologic control)
•	Geologic map of bedrock
•*	Geologic map of unconsolidated surficial materials
•*	Topographic map of the buried bedrock surface
•*	Map that portrays the thickness of unconsolidated materials above the bedrock surface
•	Map that shows the distribution of mineral deposits
•	Map, or group of maps, that describes the ground-water regime
•*	Map that shows the relative sensitivity of the ground-water system to contamination by downward percolation of surface contaminants ("sensitivity map").

*Included in regional hydrogeologic assessments (RHA). RHA maps are compiled at half the linear scale of county geologic atlas maps.

As of 1993, county geologic atlases and regional hydrogeologic assessments were redesigned to include digital products compatible with geographic information system (GIS) technology in addition to the traditional paper maps of prior years. The GIS format greatly increases the utility and flexibility of the map data for users who possess the required computer capability, but it also adds to the up-front cost of producing an atlas or assessment.

Although atlases and assessments are now directed explicitly toward ground-water sensitivity assessment, they still fulfill the original purpose of

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PERSONNEL UPDATE

As of February 1, ***Peter McSwiggen*** began to divide his time 50/50 between MGS and the Department of Geology and Geophysics. In the Department, Peter will become the primary operator and staff scientist in charge of the new electron microprobe. The probe was being installed as this was being written, and it should be operational by the time you receive it. At MGS, Peter continues to work on a multiplicity of mineralogic and petrologic topics. When armed with the full capabilities of the microprobe, he should be able to double his productivity and accomplish just as much as he did when he worked for MGS full-time.

Since last September we have been privileged to have ***Frank Melcher*** with us from Germany. Frank is on a one-year visiting post-doctoral fellowship sponsored by the German government. His primary interest is in ore deposits, especially manganese deposits, and he immediately fit in with the MGS group under G.B. Morey's supervision that is investigating the genesis and alteration of manganiferous iron-formation on the North Range of the Cuyuna district. Frank has made substantial contributions to the Cuyuna work and will be greatly missed when he departs next fall.

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providing the geological knowledge needed by planners and their consultants for making better decisions. The majority of planners are not highly trained in the geological sciences, and for that reason MGS maintains a County Services Office to assist them with geologic problems. This office answers direct questions about the contents of atlases and assessments and offers training in the use and interpretation of the data sets and geologic maps.

COSTS Geologic mapping is a labor-intensive task, the cost of which is proportional to the size of the area studied, the natural complexity of the geology encountered, and the level of detail chosen for the investigation. Increasing any of these adds to the time required for mapping, which translates directly into greater costs for professional salaries and associated expenses. Normally, financial realities dictate a compromise between the optimum level of geologic detail for making decisions (generally the more the better) and the substantial expense of obtaining that detail. Geologic information sufficient for regional planning is delivered at costs per square mile of about $100–$300 for assessments and $400–$1300 for the more detailed atlases.

Are atlases and assessments worth their considerable cost? This is a devilishly difficult question to answer quantitatively. Conventional wisdom says they are, if they contribute to the avoidance of even one potential environmental mistake or if they lead to practices that mitigate environmental degradation. Olmsted County officials estimate that their atlas saved at least $400,000 that would otherwise have been spent on detailed studies by consultants in the search for a new county landfill. The Olmsted County atlas cost about $200,000 in state and county funds. An elaborate benefit-cost analysis of geologic mapping was done recently for Loudoun County, Virginia. Geologic mapping in that county cost about $1.16 million. The gross savings for just two big projects (constructing a highway and siting a landfill) are estimated to have been between $2.44 and $4.66 million (Bernknopf and others, 1993). One may conclude from these examples that a conservative benefit/cost ratio for county atlas mapping is on the order of 2/1 to 4/1. Over the effective life of an atlas, the ratio could, and probably does, become substantially higher.

THE FUTURE Predicting the course of a long-term state-funded program such as this is always hazardous. The rate of progress depends largely on funding levels, which in recent years have fluctuated widely. Assuming that funding remains nearly constant or increases moderately in real buying power over the next decade, as many as 20 more counties could be mapped at the atlas level and 9 more multi-county areas could be mapped at the RHA level by the year 2005. The atlas mapping plan would result in essentially complete coverage of counties in the karst-prone region of southeastern Minnesota and the rapidly growing "urban corridor" between Rochester and St. Cloud. The RHA mapping plan would result in coverage of the agricultural lands in roughly the western half of the state. When completed, the new mapping would amount to about 35,000 square miles and bring the total fraction of the state mapped under this program to about 65 percent.

Will this ambitious plan be accomplished? Only time will tell.

REFERENCE Bernknopf, R.L., Brookshire, D.S., Soller, D.R., McKee, M.J., Sutter, J.F., Matti, J.C., and Campbell, R.H., 1993, Societal value of geologic maps: U.S. Geological Survey Circular 1111, 53 p.

CHANGES IN WELL-LOG ACCESS

Minnesota law requires well drillers to submit descriptive logs of the wells they drill to the Minnesota Department of Health (MDH). The law further requires MDH to send copies of those logs to the Minnesota Geological Survey (MGS) so that the geological information they contain can be applied to our various subsurface mapping projects. As time has gone on, other users of well data in the state agencies and the private sector have found our well records to be convenient and systematic, and have consulted our files of flimsy blue-paper well logs extensively.

The paper well-log files at MGS are slowly but surely being supplanted by a computerized database called County Well Index (CWI). We maintain CWI for all 87 of Minnesota's counties. The database contains an abbreviated record of every well log housed at MGS; entries include the well location as reported by the driller, the owner, the use, the depth, the static water level, and the aquifer pumped (if known). A subset of CWI, called CWI/WL, contains well-construction and geological details for wells whose locations have been verified in the field.

The CWI/WL databases are most complete for counties where geologic mapping has been done recently, and are complete enough in 20 counties that the paper files are effectively redundant. Therefore we have removed the paper well records for these counties, including those for all of the metropolitan Twin Cities counties, from public access. If you want well information for any of the dead-filed counties, you must now access it through CWI, either from our office or yours. MGS sells CWI on floppy diskette at modest cost. We also offer CWI training and trouble-shooting services.

Although we endured a certain amount of grumbling when paper logs were withdrawn at the beginning of March, the transition to computerized access has generally been well received. We look forward to the time when all the well records for the remaining 67 counties in Minnesota are put up in CWI and the blue-paper files are a thing of the past.

For more information on CWI, call our publications sales office at 612-627-4782 or our water-well records office at 612-627-4784.

RESEARCH HIGHLIGHTS

The following is a selection of research findings from among the many ongoing activities at MGS. Interested readers are encouraged to contact the responsible staff members for further information on the topics mentioned.

Val Chandler has been using gravity methods to locate buried bedrock valleys beneath Quaternary glacial deposits in southwestern Minnesota. This work has implications for water prospecting in the area, because valleys cut into the Sioux Quartzite by pre- or interglacial stream erosion are likely to contain remnant river gravels that may be local aquifers. Locating these valleys by gravity is much less costly than finding them by drilling. Results of the gravity study are being published as Report of Investigations 44.

Continuing investigations of the mineralogy and petrology of altered, manganiferous iron-formation in the North range of the Cuyuna district are turning up more and more indications of former hydrothermal activity. Mineralogical and geochemical attributes associated elsewhere with seafloor exhalative systems suggest that there ought to be a sedex deposit lurking somewhere in the North range. ***G.B. Morey, Jane Cleland, Peter McSwiggen,*** and ***Frank Melcher*** are writing up a series of papers on these findings for submittal to *Economic Geology*, *Canadian Mineralogist*, and *Mineralogical Magazine*.

Research highlights *continued on back cover*

NEW PUBLICATIONS

The following items have been released since the last newsletter:

MISCELLANEOUS MAP M-72: Geologic map of the Doyle Lake and Finland quadrangles, Lake County, Minnesota, scale 1:24,000, by J.D. Miller, Jr., and others, 1993. *This map extends detailed coverage of the Beaver Bay intrusive complex and associated rocks of the Midcontinent rift on the North Shore of Lake Superior.*

MISCELLANEOUS MAP M-73: Bedrock geology of Waseca County, Minnesota, scale 1:62,500, by B.A. Bloomgren, 1993.

MISCELLANEOUS MAP M-76: Surficial geologic map of parts of Koochiching, Itasca, and Beltrami Counties, north-central Minnesota, scale 1:250,000, by G.N. Meyer, 1993. *This map portrays the Quaternary glacial deposits in a large quadrilateral area in which the Precambrian bedrock was mapped in 1990 as MGS map M-67.*

MISCELLANEOUS MAP M-77: Quaternary geologic map of Sherburne County, Minnesota, scale 1:100,000, by G.N. Meyer and H.C. Hobbs, 1993.

MISCELLANEOUS MAP M-78: Quaternary geologic map of Chisago County, Minnesota, scale 1:100,000, by G.N. Meyer, 1993.

MISCELLANEOUS MAP M-79: Geologic map of Archean bedrock, Soudan-Bigfork area, northern Minnesota, scale 1:100,000, compiled by D.L. Southwick, 1993. *This map covers a block of 26 7.5-minute quadrangles (2 x 13) in and contiguous to the Vermilion district.*

MISCELLANEOUS MAP M-80: Bedrock geologic map of northwestern Minnesota, scale 1:250,00, by M.A. Jirsa and others, 1994. *A map of the area of Minnesota north of lat. 47° N. and west of long. 95.5° W. Changes from previous interpretations of this area are substantial.*

INFORMATION CIRCULAR 37: Scientific core drilling in parts of Itasca, St. Louis, and Lake Counties, northeastern Minnesota, 1989–1991: Summary of lithologic, geochemical, and geophysical results, by J.P. Meints and others, 1993. *Data compiled in this report contributed to geologic maps of the Cook–Side Lake area (MGS map M-75, 1991) and the central Duluth Complex (MGS Open-File Report 91-4, 1991).*

INFORMATION CIRCULAR 39: Scientific test drilling, 1989–1992: Descriptions and interpretations pertinent to the bedrock geology and Quaternary hydrogeology of southwestern Minnesota, by D.L. Southwick and others, 1993. *The title says it all. Mafic intrusive rocks, skarn, and low-grade metavolcanic rocks within a terrane formerly interpreted as entirely gneiss might offer explorationists some food for thought.*

INFORMATION CIRCULAR 40: Scientific and exploration drilling in northwestern Minnesota: Lithological, geochemical, and geophysical results of drilling by the Minnesota Geological Survey, 1991–1993, and a summary of other scientific and exploration drilling, by M.A. Jirsa and T.J. Boerboom, 1993.

INFORMATION CIRCULAR 41: Geochemical investigation of minor and trace elements in the acid-insoluble residues of Lower Paleozoic carbonate and related strata, southeastern Minnesota—the data base, by G.B. Morey and others, 1994.

OPEN-FILE REPORT 93-2: Duluth mapping project, by J.D. Miller, Jr., and others, 1993. *Included in this package are a preliminary geologic map of the southern Duluth Complex (scale 1:48,000) plus geophysical and petrographic data on rocks of the map area.*

OPEN-FILE REPORT 93-4: Bedrock geologic map of Carver County, Minnesota, scale 1:100,000, by A.C. Runkel, 1993.

OPEN-FILE REPORT 94-1: Southeastern Minnesota regional ground-water monitoring study, by R.G. Tipping, 1994. *A report to the Southeast Minnesota Water Resources Board.*

REPORT OF INVESTIGATIONS 42: Industrial minerals—today and tomorrow: The raw materials to build the Upper Midwest—workshop proceedings, compiled and edited by G.B. Sidder and P.K. Sims, 1993. *Presentations and discussion at a workshop held September 10–11, 1992, in Minneapolis, Minnesota.*

REPORT OF INVESTIGATIONS 43: Short contributions to the geology of Minnesota, 1994, edited by D.L. Southwick. *Includes papers on geochronologic studies of Precambrian terranes, alkalic plutons of northeastern Minnesota, anthraxolite and manganese-rich oncolites in the Biwabik Iron Formation of the Mesabi range, and revised stratigraphic nomenclature for the Upper Cambrian Jordan Sandstone of southeastern Minnesota.*

A NEW GEOLOGIC MAP OF THE MESABI IRON RANGE, MINNESOTA *also is available from the Minnesota Geological Survey. This updated, full-color map at scale 1:62,500, compiled by D.G. Meineke and others, 1993, and published by the Mesabi Range Geological Society (MRGS), is the first readily available geologic map of the Mesabi Range ever to appear. It is based primarily on data from mining company files that were assembled through the coordination efforts of the MRGS membership.*

Any of these items may be purchased from Map and Publication Sales, Minnesota Geological Survey, 2642 University Avenue W., St. Paul, MN, 55114-1057. Write or phone (612-627-4782) for ordering instructions or further information. The Mesabi Range map also may be obtained from the Mesabi Range Geological Society, c/o Eveleth Fee Office, 301 McKinley, Eveleth, MN, 55734.

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Carrie Patterson's mapping of Quaternary deposits in southwestern Minnesota has led her to conclude that the Des Moines lobe of the Late Wisconsinan glacial advance was a thin, warm, fast-moving tongue of ice that stagnated periodically. One result: Formation of tunnel valleys beneath the ice and of tunnel-valley fans beyond the ice margins. The tunnel-valley stream deposits and associated deposits of sand and gravel are potentially valuable sources of ground water, providing that they can be located in the subsurface. Carrie and several others are trying to develop stratigraphic criteria that can aid the search. A 1:200,000-scale geologic map of Quaternary deposits in southwestern Minnesota is now in our cartographic shop and should be published in late summer or fall.

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