Minnesota Ground Water Association

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President's Column

By James Piegat

This is my last column as president of MGWA. I would like to thank all of those people who show up at board meetings early on Thursday mornings to run this organization. More importantly, it is their efforts after the board meetings that actually make things happen for MGWA.

One of the missions that I hoped would continue was our promotion of not only scientific but also public policy aspects of ground water and our providing a forum for persons from different backgrounds who are concerned with ground water. This mission has been expanded in the past year. MGWA now has the goal of providing conferences and field trips that will qualify for continuing education credits for those registered as professional geologists.

Last spring, I received an education about conferences. We have all seen advertisements for one- to three-day conferences about geology or computers that have seemingly astronomical costs. Where does all of that money go? How can a conference possibly cost \$500 per day or more? MGWA conferences cost significantly less than \$100. Why can't everyone else do the same?

Then I found out when I worked on the MGWA spring conference. The difference is simple. Those expensive for-profit conferences must pay for every minute of every person who works on the conference.

Choose a conference topic, identify speakers, contact speakers (several times), obtain material from speakers, prepare an advertising brochure, get a mailing list, stuff envelopes, mail the brochures, update the web page, schedule a meeting place, obtain refreshments, prepare a conference program, have the program printed, keep track of pre-registration, organize on-site registration, arrange transportation and housing for out-of-town speakers, identify and obtain audio-visual needs, pay bills, follow up on invoices, file Internal Revenue papers with payors, deposit checks, deal with credit cards, keep track of all the money. These are just a few of the things behind a conference, things that you pay for when you attend an expensive conference.

For us, these things are done by people who donate hours and hours of their time to MGWA. Even the professionals with whom MGWA contracts for administrative services wind up spending far more time on an MGWA conference than they bill. So the next time you attend an MGWA conference, give those bleary-eyed people behind the registration desk a hug. Their hard work is the reason that you are paying only \$50 instead of \$500 for a conference.

One of the challenges for MGWA that I identified a year ago is the attracting of more students to the Association. Unfortunately, this challenge is still largely before us. We need to communicate more effectively to students the value of the information we disseminate through our newsletters and conferences. Just as importantly, we need to help students understand the value of building person-to-person relationships with the professionals they will work with after graduation.

In short, significant challenges still remain for MGWA. I have confidence that as an organization, we will continue the good fight.

Ballot and Survey Enclosed. Please return them by December 31, 1999.

High-Resolution Flow Logging In Minnesota

By Frederick L Paillet, U.S. Geological Survey, Denver, fpaillet@borehole.cr.usgs.gov

The development of new classes of high-resolution borehole flow logging equipment like the heat-pulse and electromagnetic flowmeters represents a real technical revolution in hydrogeology. Conventional geophysical logs provide precise depth control and in situ measurements in subsurface exploration, but generally give measurements that are only indirectly related to hydraulic parameters of interest. In contrast, flow logs give direct measurements of hydraulic properties that can be interpreted with little or no ambiguity. Until high-resolution flow logging became widely available about 1990, "production logging" was conducted with impeller flowmeters under rates of discharge often exceeding 100 gallons per minute. These large discharges were required to spin the blades of the impeller. But such discharges also induce significant complications related to inlet turbulence and pipe flow

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The primary objectives of the MGWA are:

Promote and encourage scientific and public policy aspects of ground water; Protect public health and safety through continuing education for ground water professionals Establish a common forum for scientists, engineers, planners, educators, attorneys, and other persons concerned with ground water; Educate the general public regarding ground water resources; and Disseminate information on around water.

The Capillary Fringe

Charles Tiller

On a September Saturday, I completed one of the two exams now required for State licensure as a Professional Geologist. Following weeks of diligent preparation, the exam was not as difficult as anticipated and was even somewhat...fun. Afterward, I left the exam room, my mixed emotions aroused to the point of having to share my feelings – good and bad – about professional licensure and its role in groundwater protection.

First, the sour grapes: frankly, I carry a little chip on my shoulder because I missed the grandparenting period during which practicing geologists with a minimum of five years applicable experience could obtain licensure without any testing requirement. Setting aside the issue of how many grandparented geologists would actually pass a test of their geologic knowledge, one immediate concern is the definition of "applicable" experience. Three years of teaching and research in a Master's Degree program magically condense to about one year of professional experience, even though I gathered an incalculable amount of knowledge and understanding of geology during that period. Everyone knows that graduate students work 60+ hour weeks. Why does this not count? And what about degreed geologists working in peripheral fields - wetland ecology or hydraulic engineering, for instance? Where are the bounds for appropriate cross-training in geology, particularly with regard to water resources?

On more cynical days, the licensing standards appear symptomatic of an insiders' game, where the well established — many of them business managers and engineers by primary training — decided the hoops through which newcomers must leap. This is somewhat akin to Little League Baseball, where the younger kids are usually made to play in the outfield, and the infielders and coach have forgotten that the plays in the outfield usually make or break games. Geologists and environmental progress are made out in the field, not in the dugout/office suite. Where may the insiders' game lead? Is a licensure requirement down the road for entry-level and technician jobs, as in other professions? Would such strictures strangle the source of promising young geologists and lead toward further stagnation of opportunities and wages in an already shrinking field? Would the brain drain actually hurt groundwater protection in the long run? Such potential outcomes are little discussed by licensing proponents. Even as the positives of licensure, and even testing, come into focus for me, these questions continue to nag.

Now the positive side of the story: as the end of my apprenticeship period approaches, the wisdom of accountability arises as the primary result of professional licensure. A non-geologist can still complete the bulk of investigation and remedial work on environmental/groundwater projects, but a Professional Geologist should review the final product. Both ideally and in reality, the experience of a Professional Geologist enhances the quality of the work.

In fact, perhaps a Professional Geologist should be more heavily involved in all aspects of environmental/ groundwater projects from beginning to end. For illustration, consider field classification/logging of soil borings. This work is typically completed by technicians or drilling staff using the Unified Soil Classification System (USCS), a simplistic scheme designed to provide some degree of uniformity in soil descriptions for structural engineering purposes. Having been there myself, I would be among the last to criticize these valuable staff members. Unfortunately, however, any seasoned geologist visiting a polluted site during the third or fourth round of investigation is all too familiar with the "uniformity" and "detail" of previous soil descriptions and will question the value of sending out anyone less qualified next time. (Geological aside and pet peeve: "Soil" is really an inaccurate term, referring to any fill, litter, soil, regolith, or sediment that is not bedrock).

Moreover, the USCS has escaped its intended bounds in the world of engineers to be inappropriately applied to environmental/groundwater investigations. A proper understanding of groundwater flow and pollutant transport to and within groundwater reguires comprehensive and precise understanding of site geology, both vertically and laterally. The USCS is a very blunt tool intended to be applied methodically, making little use of the intuition that an experienced geologist offers. Thus, all the various sandy deposits that one may encounter are lumped into four categories (SW, SP, SM, and SC) of little hydraulic or chemical significance and devoid of geologic context. Is it any wonder that almost all the sandy deposits out there are ultimately identified as "coarse alluvium", even though I have vet to see a single alluvial fan in Minnesota? All environmental/groundwater professionals are quilty in this complicity, but a Professional Geologist still knows better at heart.

At the end of the day, the question looms: Had a Professional Geologist overseen the project from the beginning, would fewer rounds of sampling have been necessary to grasp the area geology, groundwater flow, and pollutant transport?. The experience to know when you need to undertake more or less investigation and remediation can save clients and taxpayers money and may ultimately serve to ameliorate groundwater contamination issues more effectively. Now, if only State agencies hired Professional Geologists to manage groundwater contamination projects. rather than fresh college graduates with marginally related degrees. But that is an issue best discussed another day.

MGWA Scholarship Program Benefits Many Students

One of the goals of the MGWA is to support the education of future geologists and hydrogeologists. Since 1993, the MGWA has provided scholarship opportunities to Minnesota's institutes of higher education to help finance geologic field trips or ground water-related educational events for students. Scholarships have been provided to St. Cloud State. Macalester College, Gustavus Adolphus, Carlton College, Bemidji State, Winona State, and the University of Minnesota Twin Cities, Duluth, and Morris. The scholarship funding has been used to help defray student costs of field trips to the Black Hills, Grand Canyon, Florida Keys, and other locations throughout Minnesota and the rest of the country. To date, the MGWA has provided a total of 24 scholarship awards of \$200 to \$300 each. In addition, the MGWA has contributed to the 1998 and 1999 Children's Water Festivals, the Metro Area Ground Water Alliance, the Minnesota Water Line, and the Birdsdall-Dreiss Lecture Series to further assist the education of existing and future ground water professionals.

MGWA members have contributed generously to the scholarship fund but in recent years scholarship requests have exceeded the donations. This year, when you renew your membership, we ask that you consider adding to the MGWA scholarship fund to help support this worthwhile endeavor. If each member donated \$5 to the scholarship fund, the MGWA could provide at least 5 scholarships in 2000. Help support the education of Minnesota's future ground water professionals and future MGWA members.

> Support Your Association — Invite A Student to Join

MDA and USEPA Hosts National Conference on Agricultural Chemical Cleanups

The Minnesota Department of Agriculture, in cooperation the U.S. Environmental Protection Agency Region V, sponsored the conference "State Government Approaches to Pesticide and Fertilizer Cleanups" on September 27 and 28, 1999. The 143 attendees heard excellent presentations on the many facets of agricultural chemical cleanups from the US EPA and many state agencies while enjoying their stay at the Minneapolis/St. Paul Airport Hilton. The government officials attending the conference represented 21 states (including Hawaii), Washington D.C., and the Navajo Nation. Industry representatives hailed from 12 states and three Canadian provinces.

The conference was unique in that it addressed the investigation and cleanup of areas where agricultural chemicals are mixed, loaded, or stored. Nationwide, states are recognizing the possible environmental consequences of high-volume pesticide and fertilizer handling operations at agricultural retailer sites. As keynote speaker Fran Kremer, US EPA, noted in her talk at the conference, this issue is also being recognized by the federal government.

Fortunately, Minnesota and several other states, with the cooperation and support of ag retailer groups, have created streamlined programs that reduce the impact of environmental cleanups on the agricultural retail industry, while at the same time protecting human health and the environment. Other Departments of Agriculture are instituting similar programs to address this issue or are researching such programs. The need for and success of the program is indicated by the Michigan Department of Agriculture offering to host the next Pesticide and Fertilizer Cleanup conference.

Submitted by Terry McDill, Minnesota Department of Agriculture

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Editor Tom Clark Minnesota Pollution Control (651)296-8580 FAX (651)297-7709 tom.p.clark@pca.state.mn.us

Advertising Manager Leigh Harrod Metropolitan Council (651)602-8085 mn_homebase@worldnet.att.net

Business Management & Publications

Dr. Jeanette Leete Watershed Research, Inc. (651)426-8795 FAX (651)426-5449 MGWAOffice@aol.com

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Borehole Flow Logging, cont.

losses in the well bore, even in those situations where boreholes can sustain such yields. In many applications, exploration boreholes cannot sustain such yields, and there are disposal problems associated with quantities of produced water. High-resolution flowmeters now make it possible to obtain production logs using discharge or injection rates of only a gallon per minute. Flow profiles can be obtained with almost no drawdown in the borehole, and with a small sampling pump that does not limit access to the borehole. Thus, flowmeter logging can be used to explore the plumbing of aquifers in the vicinity of well intakes without the cumbersome and time-consuming equipment associated with straddle packer isolation of individual zones. We recently explored the potential of such measurements by conducting flow logging under static and stressed conditions in a set of representative observation wells in southeastern Minnesota.

The flow logs were obtained in six different observation boreholes in the vicinity of active production wells. We



Fred Paillet, U.S. Geological Survey, Denver, prepares a logging tool. Photo by Jim Lundy

expected to infer the identity of water-producing zones and the nature of connections between those zones by observing the pattern of flow in observation wells influenced by production from nearby supply wells. We used either the electromagnetic (EM) or heat-pulse (HP) flowmeters, depending upon the availability of either probe at the time of logging. The EM flowmeter measures the electromotive force (emf) induced by flow through the coils of an electromagnet. The HP flowmeter measures the travel-time between heating grid and thermistor for a small parcel of heated water. Both probes produce a signal calibrated in units of discharge through the measurement "throat" of the logging probe. The probes are operated either with a flexible disk (flow diverter) to block flow around the outside of the probe, or the discharge rates through the probe are multiplied by a correction factor to account for the additional flow around the probe. Both probes can detect flow rates as small as about 0.01 gpm through the sensor. The EM flowmeter has no effective upper limit on flow measurement. The HP flowmeter has an upper measurement limit of about 3

gpm, but can be operated with an undersized diverter to reduce sensitivity, extending the upper measurement limit to 10 gpm or more.

Although it would seem simple to obtain a profile of permeability along a borehole with a flowmeter, things are not quite that simple. Impeller flow logs were analyzed by assuming that the proportion of inflow from a zone is directly proportional to zone permeability. But that assumption is based on large-capacity tests. When we use high-resolution flowmeters and conduct tests at low flow rates, the drawdown we induce may be less than the natural head differences in the well. Thus, the log's analysis has to either subtract out the effects of the head differences, or model the flow so as to account for both permeability and hydraulic head. Thus, our strategy was to obtain conventional logs, image logs, and flow logs where the inflow zones could be identified as permeable beds, solution openings, or fractures. We also obtained flow profiles under two different steady conditions so that we could account for the head differences as well as variations in permeability. With that background, the objective was to make such measurements in a representative set of observation wells, and then see what we could learn about aguifer plumbing from the results.

Logs were run at six different sites. Of these, useful pairs of flow profiles could be obtained at four. The two "failures" were attributed to logistics. At one site, the production well adjacent to the observation well had to be turned on, de-watering the observation well. At another, the water level was far too deep to allow pumping. Of the remaining four, drawdown could not be measured at two sites. Qualitative permeability profiles were generated at these sites, where producing zones could be clearly identified as permeable sandstone beds, solution openings, or bedding planes. The presence of flow under ambient conditions could also be used to identify intervals serving as aquitards within the aguifer. At the remaining two sites, all of the requirements of quantitative inversion of flow profile data were achieved. These data sets could be modeled to derive direct estimates of zone transmissivity and the far-field hydraulic head of the aquifers to which those zones were attached.

An example of the complex aquifer plumbing that can be found at some of the sites we studied is illustrated in Figure 1, obtained from a borehole in Faribault. This figure shows flow profiles made with the EM flowmeter while trolling up at about 10 feet per minute, compared to a televiewer image of the borehole wall. The "steps" in the flow profile can clearly be associated with bedding planes or karstic intervals indicated on the televiewer.

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Figure 1: Electromagnetic flowmeter profiles obtained while trolling upward at about 10 feet per minute under ambient and steady pumping conditions; the flow scale represents the calibrated flow for the probe measurement section while trolling and not true borehole discharge.

Note that though there are many such zones indicated by the televiewer log, only seven of those zones actually produce water. Also note that the log confirms that all inflow is derived from secondary permeability features rather than primary intergranular porosity of this sedimentary aquifer.

One problem with the flow logs in Figure 1 is that they were obtained while moving the probe without a diverter. Thus, the nominal flow scale on the log represents flow through the "throat" while the probe is moving, and while flow can also move around the probe. We corrected the flow scale in Figure 1 by collecting data with the probe held stationary at a few representative depth stations that were carefully calibrated to give true flow. The full profiles in Figure 1 were subsequently adjusted so that they "fit" these control points (Figure 2). Then, the flow profiles could be fit using a numerical model to provide estimates of zone transmissivity and hydraulic head (Table 1). The results show that three of the zones are much more transmissive than the other four. Even more interesting, the distribution of hydraulic head within the aquifer shows that the central part of the aquifer is drawn down with respect to the zones above and below. The total open-hole transmissivity estimated by summing the model T values for the seven zones in the observation well is about 4000 ft²/day, and is similar to the aquifer transmissivity determined for an adjacent production well.

Although the flow logs obtained in this guick study involved a good deal of improvisation on site, the method provided considerable insight into the plumbing of aquifers in several operating wellfields. In future flow logging, more careful preparation of probe configurations, and more careful planning of wellfield operations could lead to improved understanding of aquifer hydraulics. The data obtained so far demonstrate the effectiveness of combining flow logs with televiewer images and other data to identify the specific features associated with flow of water towards well intakes. Such information could be critical in designing wellhead protection measures, and in determining the completion intervals for production wells.

Table 1. Estimated transmissivity and hydraulic-head values for the seven water-producing zones in the Faribault borehole based on flow model matching.

ZONE	DEPTH (ft)	H (ft)	T(x10 ⁻³ m²/s)
7	48	2.4	1,10
6	80	2.4	0.15
5	115	2.4	0.15
4	172	0.0	0.90
3	182	0.0	0.30
2	200	0.8	0.10
1	224	1.1	0.90

COMPUTED STATIC WATER LEVEL 1.225 COMPUTED PUMPED WATER LEVEL 1.107 DIFFERENCE (DRAWDOWN) 0.118



Figure 2. Electromagnetic flowmeter profile interpretation calibrated to produce a true borehole discharge scale by shifting the profiles to fit the stationary flow data.

Ancient or Recent, It's All Fascinating: the 1999 AIPG-MGWA-AWG Fall Field Trip

With the American Institute of Professional Geologists (AIPG), Minnesota Chapter, taking the lead, the MGWA and Association of Women Geoscientists (AWG) joined in sponsoring this year's fall field trip, September 10-11, featuring the geology and geohydrology of the North Shore and Gunflint Trail. Aside from a brief shower during the first day's lunch stop, the weather was cool and pleasant. Nearly 60 field-trippers enjoyed 11 stops in Minnesota's three northeastern counties—St. Louis, Lake and Cook.

The focus of the trip was the over two billion years of geologic time recorded in the region's Precambrian rocks, although several stops examined the effects of Pleistocene glaciation on the area as well. The trip was very capably led by Jim Miller and Bob Tipping of the Minnesota Geological Survey, and Dr. John Green, Professor Emeritus of Geology, University of Minnesota, Duluth.

Day 1

The first stop Friday morning was the Ulland Brothers trap rock aggregate

Field trip leaders Jim Miller, Minnesota Geological Survey, and John Green, University of Minnesota, Duluth, present key concepts. Photo by Tom Clark

quarry just west of Duluth and south of I-35. Here, lowermost basalts of the North Shore Volcanic Group (Ely's Peak Basalts) are exposed. Volcanic features observed in the basalts included vesicles and amygdules, and ropy (pahoehoe) flow tops. Secondary minerals in the amygdules which were observed included calcite, chlorite and epidote. Diabase dikes, possible offshoots of the underlying Duluth Complex, could be observed in the quarry side wall. In an area where glacial deposits are scarce, the crushed rock derived from this quarry is an important local source of landscaping stone, road ballast and asphalt filler. The chemistry of ground water in the North Shore Volcanic Group varies from high pH and relatively low total dissolved solids to brines. Finding and protecting adequate supplies of good quality water is therefore a challenge to local water planners.

From the quarry, we continued east to the Skyline Parkway overlook of the St. Louis River estuary and the city of Duluth. The gabbros and anorthosites of the Duluth Complex are exposed in roadcuts along the parkway. The view from the overlook would have been vastly different 10,000 years ago, as the icy meltwater from the retreating Superior Lobe glacier backed up to almost to the

level of our overlook. As the ice retreated from the eastern lake basin, water levels in the Lake Superior basin actually dropped to 250 feet below the present lake elevation. This caused active downcutting by the St. Louis River into the lakebed. Then, as the eastern part of the lake basin rebounded from the effect of the loading of the ice, the lake level slowly rose again to its present elevation.

From our lofty perch above Duluth, we headed next to Two Harbors and a lunch stop at a sheltered picnic area during a perfectlytimed shower. As the sun reappeared, we made our way to the shore of Lake Superior at Burlington Bay



Examining core at Finland Air Base Photo by Tom Clark

where evolved basalt flows of the North Shore Volcanic Group (iron-rich quartz tholeiites) are exposed. Here, quartz lines the vugs and pink laumontite and white calcite fill the amygdules.

Since we were running short on time, Stop 4 was a drive-by of felsic lava flows of the North Shore Volcanic Group (Palisade Rhyolite) exposed near the junction of the North Shore Highway and Highway 1. From the shore, we climbed steadily inland to the site of Stop 5, the former U. S. Air Force radar station near Finland, MN, atop Lookout Mountain. We stopped at the Finland Community Center for refreshments and a slide show by Harza Engineering Company, a consultant to the U.S. Army Corps of Engineers who is overseeing the investigation and cleanup of the site. From here, we went to the top of the mountain where Jeff Dickson, site geologist, explained the geology of the site and the ground water monitoring system which has been developed. In the over 30 years the base operated, fuel oil from underground storage tanks and chlorinated solvents used to clean equipment en-

tered the fractured granite body of the Beaver Bay Complex which forms Lookout Mountain. Ground water contamination at the site was discovered in 1992 when a water supply well was being drilled to supply local residents. The leaky tanks have been removed and an extensive set of borings into the granitic intrusion has been made to better define the geology and possible flow paths for the contamination. In addition to ground water monitoring wells, several springs on the sides of the intrusion are being monitored for signs of contamination. A cleanup plan is currently being developed by the consultant, with oversight provided by the Minnesota Pollution Control Agency.

It was back down to the lake for Stop 6 at Sugarloaf Cove, a Department of Natural Resources Scientific and Natural Area being preserved for its unique geological features. Here, lakeward dipping olivine tholeiitic basalt flows from the uppermost North Shore Volcanic Group are beautifully exposed. A wide cobble beach adds to the picturesque scene at Sugarloaf Cove. It is hoped that an interpretive center will soon be developed here to



Beautiful fall scenery at Sugarloaf Cove Scientific and Natural Area. Photo by Tom Clark

help educate visitors on the unique geology of this area.

The final stop of Day 1 was at Good Harbor Bay, about five miles southwest of Grand Marais. The highway has been recently improved here, exposing a basalt flow and a maior interflow sedimentary unit in the North Shore Volcanic Group. The interflow sediments are mainly thin-bedded siltstone and silty shale which comprise a higheryielding aquifer unit than elsewhere along the North Shore. However, water quality issues related to ele-

vated boron concentrations have been associated with this unit. Boron concentrations approaching 3000 ppb have been found in samples collected by the Minnesota Geological Survey, well over the Health Risk Limit of 600 ppb established by the Minnesota De-

partment of Health. Preliminary isotope data indicate a marine source for the boron.

With evening approaching, it was on to Rockwood Lodge on the Gunflint Trail north of Grand Marais for dinner and the evening program. David Abazs, the good-natured Lake County water planner, gave a humorous overview of his efforts to educate local residents in the importance of ground water protection, including some practical examples from his farm near Finland. Harza geologist Jeff Dickson concluded the evening by leading a continued discussion of the investigation at the former Lookout Mountain Air Base.

Day 2

Following a hearty breakfast, it was off the next morning for the End of the Trail Campground and Stop 8. Here, the tonalite of the Archean Saganaga batholith is exposed. It was intruded into



Field trip leader Bob Tipping, Minnesota Geological Survey at the Cross River gravel pit. Photo by Tom Clark

predominantly mafic volcanic rocks during the tectonism that formed the Superior Province. It was tempting to linger here, but it was time to turn around and head back down the Gunflint Trail toward Grand Marais.

Stop 9 featured an interesting unconformity between Archean metabasalts and the Gunflint Iron Formation, just off the Magnetic Rock hiking trail. The unconformity represents approximately 800 million years of the geologic record. The magnetic properties of the iron formation make it easy to identify at this location. As a part of the same stop, we viewed a well-hammered ledge of the iron formation which is rich in stromatolites, which are believed to be fossil algal mounds, one of the earliest forms of life. The appearance of photosynthesizing organisms about 2.2 billion years ago caused the buildup of oxygen in the atmosphere and oceans, and resulted in the deposition of iron formations along the margins of all the continental masses that existed during this unique period of earth history. The formations are the source of most of the iron ore which supports our economies world-wide today. By 1.8 billion years ago, the global supply of iron in the oceans was depleted and free oxygen in the atmosphere had built up to present day levels.

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At Stop 10, we examined a gravel pit near Cross River containing glacial outwash deposits of the Rainy Ice Lobe. The site is a good example of an esker being mined for sand and gravel deposits, which are relatively scarce in this part of the state.

From here, it was back to the Rockwood Lodge area and a final stop to look at several roadcuts showing the lower units of the Duluth Complex , including Nathan's Layered Series and the Rove Formation. Several homeowners in this area have reported methane gas in their wells. The occurrence of sulfides in this area, along with graphite in the underlying Rove Formation, supports a model of anoxic, highly-reduced waters infiltrating through the Rove Formation to produce methane.

After lunch at the lodge, it was back on the bus for the six-hour drive back to the Twin Cities after another very successful fall field trip. Andrew Nichols of AIPG and the three field trip leaders deserve a special thanks for making the trip possible. A few extra copies of the field trip guidebook are available for \$10 through MGWA, c/o Watershed Research, Inc., 4779 126th St. N., White Bear Lake, MN 55110-5910. Checks should be made out to **MGWA**.

— contributed by Tom Clark

Midwest Ground Water Conference Draws 270 to St. Paul

By all accounts, the 44th annual Midwest Ground Water Conference in St. Paul, October 13-15, was a big success. Over 270 people attended the day-and-a-half of technical sessions and the Wednesday afternoon field trip along the Mississippi River corridor from St. Paul to Minneapolis proved especially popular, filling two buses. The Midwest Ground Water Conference, begun in 1956 in Urbana, IL, promotes the exchange of ideas and perspectives among ground-water professionals working in the midwestern states. This year's attendees came not only from the 14 states which have traditionally supported the conference, but ranged from the east coast to Canada and beyond. This was the fourth time the conference has been held in Minnesota, the last time having been in 1985. Next year's conference will be held in Columbus, Ohio. Sarah Tufford of the Department of Natural Resources, this year's conference chair, and the planning committee of representatives from Minnesota's water resource agencies, deserve thanks for a well-attended conference and a job well done.

- contributed by Tom Clark

Students Learn Importance of Vital Resource

Some 1200 metropolitan area fifth grade students attended the Second Annual Metro Children's Water Festival on October 6th at the Minnesota State Fair Grounds to learn how to care for something that is as common as the air we breathe and just as important: Water.

The students participated in 24 learning stations and in presentations by the Science Museum of Minnesota. meteorologist Paul Douglas, and Mississippi River folksinger Charlie McGuire. Hands-on opportunities were offered to learn about such things as where water goes when the toilet is flushed, how tiny bugs can serve as an indicator of water quality, the importance of wetlands, and the way that water's movement through different soils can affect what comes out of our kitchen faucets, to name a few. Materials were distributed to each teacher after the Festival to use and to share with other teachers in their school. A curriculum guide "The Water Source Book", prepared by the Tennessee Valley Authority Environmental Education Section, was also provided to each class in attendance.



The 1999 Fall Field Trip was a great time for all! Photo by Paul Putzier

Sponsored by the Metropolitan Area Groundwater Alliance (MAGWA), the Children's Water Festival is aimed at raising students' awareness of water as a vital resource that must be protected and used wisely. MAGWA, a consortium of state and local government agencies, patterned the festival after similar events held by The Groundwater Foundation.

There were approximately 50 Festival sponsors who donated money or product for the event. And there were over 150 volunteers and presenters who help make this festival a success. They included staff from the seven Metro Counties, State Departments of Health, Natural Resources, Pollution Control and Agriculture, Metropolitan Council Environmental Services, several Soil and Water Conservation Districts, Minnesota Extension Services and the Board of Water and Soil Resources, among others. Festival chair Cindy Weckwerth said, "We have received such positive evaluations and comments from sponsors, educators and students who attended this year's Festival that we are already enthused about planning for next year."

Contributed by Joe Enfield, Carver County Environmental Services



At hands-on work stations, students learn in ways not usually allowed in the classroom. Photo by Beth Oman

Kids' Thank You Letters

Each student in Pat White's fifth grade class at Bellaire Elementary sent letters of thank you to the MGWA for supporting this year's Children's Water Festival. Here's a sample:

Dear Dr. Piegat,

Our fifth grade was one of the lucky classrooms to be chosen to go to the fairgrounds on Oct. 6, 1999. We had a super time.

I had the best time yet! I loved all the stations. The water festival was super. I learned that 1% of all water is usable. I also learned that water started about 5,000,000,000 years ago.

Sincerely,

Jennifer Wallenberg

Dear Dr. Piegat,

Our fifth grade class was one of the lucky classrooms to have been chosen to attend The Children's Water Festival at the Mn. Fairgrounds on Oct. 6th, 1999. We had a super time.

> The last session we went to was the arcade. We went to the bubble station at this station. We could stand in a pool and they pull a bubble around you. We also went to water JEOP-ARDY. You can win posters and stickers and other good stuff. There was also a diorama of a farm. On the right there was a good farm and it saved the land. The bad farm did not save the land. We also saw Paul Douglas and we all got his autograph and we all had lots of fun!

My classmates and I would like to thank you for sponsoring this super event. We had some super classes, free lunch, and we received a free t-shirt. Please keep sponsoring this great event. We appreciate your efforts.

Sincerely,

Alan Fackler

Dr. Scott Bair Presents Birdsall-Dreiss Lecture

Dr. Scott Bair appeared before a packed lecture hall at Pillsbury Hall to present the Birdsall-Dreiss lecture on Friday November 7. His presentation focussed on a fairly extensive technical post-audit of a civil lawsuit surrounding the Wells G and H Superfund site in Woburn, Massachusetts. The lawsuit was the subject of the best-selling book *A Civil Action* by Jonathan Harr.

The book tells the now famous story of a civil court proceeding in which a group of plaintiffs (Woburn families) sue industries located near a wellfield (wells G and H) operated by the City of Woburn for municipal supply. Elevated levels of chlorinated solvents are discovered in the municipal well water in 1979 and the wells are subsequently shut down. The plaintiffs choose to sue industries that they allege caused the ground-water contamination, which in turn the families feel caused the unusually high incidence of leukemia among children in a portion of Woburn that receives water from the wells in the well field.

The technical details surrounding ground-water movement, well hydraulics, surface water - ground water interaction, and contaminant transport factored heavily in the case. Details on these issues are of considerable interest to ground-water professionals reading the book, not least of which because much of the case swings on the judge and jury's ability to assimilate complicated technical information relating to ground water. The judge and jury are not the only ones that have difficulty interpreting factual data from the site. The technical experts hired separately by the plaintiffs and defendants often present conflicting testimony. Work conducted by Dr. Bair and his students allow him to evaluate, with the benefit of hindsight (and perhaps slightly more objectivity than those involved in the case), the analyses and interpretations made at the time of the trial in 1986.

Dr. Bair quickly reviewed the presentations made by the various technical

Birdsall Dreiss, cont.

experts in the case. The bulk of his lecture was used to present his understanding of the site based on extensive study of the area after the case had concluded. The investigation he and his students conducted focussed on extensive stratigraphic characterization, subsequent re-analysis of hydraulic testing done during the test, and computer modeling.

His findings show that the site is guite heterogeneous. Geologic materials include crystalline granodiorite, which underlies surficial, unconsolidated materials. Glacial drift comprises most of the surficial material and varies from overcompacted ground till to highly permeable sands. In addition, peat is present in many areas under wetlands that are adjacent to the Aberjona River, which winds through the site. Hydraulic conductivity values of the materials present at the site vary over several orders of magnitude. Ground water moves toward the Aberjona River at rates that vary depending on the materials. While the wells were in service they induced flow from the river, changed hydraulic gradients and increased ground-water flow velocities. Dr. Bair has the benefit of being able to review data from contamination sites not investigated in 1986, and thus is able to construct a conceptual model that is likely much improved over what was available at the time of the trial.

Dr. Bair and his students are using the site conceptual model as the basis of three new ground-water models of the site: a steady-state ground-water flow model, a transient ground-water flow model, and a contaminant transport model. Each of these is being used as part of ongoing efforts to understand the dynamics of the ground-water system at the site. Some of the preliminary results are that water from most of the nearby ground-water contamination sites (including several not included in the lawsuit) was entrained by pumping at the well field. In addition, travel time analysis shows that one of the original defendants definitely contributed contaminants during the exposure period identified by the plaintiffs. This company, owned by Beatrice, was cleared in the trial. Analysis shows that contaminant travel times from the W. R. Grace site (the other principal defendant) are more ambiguous, and there may not be a preponderance of evidence that Grace contributed contaminants during the exposure period, although they surely did afterwards. Grace settled the lawsuit for some 8 million dollars. Finally, Bair's analysis shows that, of the ground water pumped from the wells, the greatest single source of water is the river and the site that likely contributed most heavily to the wells is one that was never a party to the original civil action. The area is currently the subject of ongoing investigations into the distribution of heavy metals in the river sediments and adjacent peat deposits.

Dr. Bair concluded with a slide that showed how the chlorinated solvent concentrations in the Woburn water distribution system likely varied over time depending on whether wells G and H were in service. His analysis shows that the gestation periods of the mothers whose children later contracted leukemia correspond reasonably well with periods of elevated solvent concentrations in the water supply system.

Dr. Bair maintains a web site where you can learn more about the Woburn sites. Check it out at http://www.geology.ohio-state.edu/ courtroom/

- Submitted by Steve Robertson

MGWA Board Meeting Minutes

August 5, 1999, Egg & I, University and 280, St. Paul, MN, 7:30 a.m.

Attending: Paula Berger, Past-President; Jim Piegat, President; Jim Lundy, President-Elect; Lee Trotta, Treasurer; Jan Falteisek, Secretary; Jeanette Leete, Sean Hunt, WRI; Tom Clark, Newsletter Editor; Leigh Harrod, Advertising Coordinator.

Approval of Minutes — Jim Piegat called the meeting to order at 7:35

am. Minutes for the regular Board meeting held July 1, 1999 were approved.

Treasurers Report — Jennie Leete provided updated accounting reports (attached). She reported the contributions had been made to the Children's Water Festival and the Midwest Ground Water Conference. In response to a question by Jim Piegat, Jennie noted that about \$100 was still due on the spring conference. Jennie announced that WRI costs may be increasing in the future. The possibility of internet delivery of services, particularly membership renewals, was discussed.

Fall Conference — Preparations for the Fall Conference . November 19. were discussed in detail including the list of potential speakers. The Board approved a full-day geophysics program, "Surface Geophysics: Applications for Ground Water Professionals", tentatively scheduled for the PCA Board Room. Jennie said she would check whether the US F&WL facility in Bloomington would work for the program. The conference announcements, such as in the newsletter, would include a statement that the program is being designed to meet continuing education requirements for Professional Geologists.

Midwest Ground Water Conference — Since the MGWA is a sponsor, the program materials will include a brochure. Extra copies of the newsletter will be printed and distributed to attendees.

Fall Field Trip — Jennie provided an update of field trip expenses and income.

Membership — It was noted that efforts to follow up on member changes has had some payoff in renewals. The next conference mailer will include a panel for joining MGWA.

Administration — Jennie reported about changes at WRI. In response to those changes, the Board approved keeping the VISA machine and review expenses and benefits for the 2000 budget, voted to discontinue the postage meter, and approved telephone services (special ring for incoming calls) for WRI.

MGWA Board Meetings, cont.

Newsletter — Jennie reported on Directory progress.

Meeting adjourned 9:00 a.m.

September 9, 1999, Egg & I, University and 280, St. Paul, MN, 7:30 a.m.

Attending: Paula Berger, Past-President; Jim Piegat, President; Jim Lundy, President-Elect; Lee Trotta, Treasurer; Jeanette Leete, Sean Hunt, WRI; Leigh Harrod, Advertising Coordinator; Tom Clark, Newsletter Editor (acting secretary for the day)

Excused — Jan Falteisek, Secretary

Approval of minutes — Jim Piegat called the meeting to order at 7:35 am. Minutes of the regular Board meeting of August 5, 1999 were approved.

Treasurer's report — Lee received a request from a student at Vermilion Community College for a breakdown of MGWA's budget. Since this is public information and is published annually in the newsletter, the Board saw no problem providing this information. Lee will follow-up. Lee noted that the MGWA account balance as of July 18, 1999 was \$13,694.39. Lee will cut a check to Andrew Nichols for \$151.20 to cover the cost of campground reservations for the fall field trip. Jennie distributed a copy of the latest balance sheet.

Fall field trip — The 55-person bus is full, with several people on a waiting list in case of last-minute cancellations. Lee will be receiving a \$130 bill to cover the cost of coffee and donuts at Stop #2. Lunch the first day will be provided by Subway in Two Harbors. Other meals to be provided by Rockwood Lodge. Field trip registration will be handled by Jennie and Sean beginning tomorrow, September 10, at 6:30 am.

Midwest Ground Water Conference — Conference planning is going well, with the next scheduled planning committee meeting for 11:30 am, September 13 at Summerfield's Restaurant in the Ramada Inn where the conference will be held. Jennie noted that the Geoscientist Licensing Board did not approve the conference for continuing education credits for license renewal. There was discussion that this was more a factor that the Licensing Board apparently was not prepared to preapprove applications for continuing education credit than the content of the application itself. The Board authorized the printing of 250 extra copies of the September newsletter and provide them to Tom for inclusion in the registration packets for the conference. Packet preparation will occur October 8 at the offices of USGS in Mounds View.

Fall conference — The conference will be held November 19 in the Pollution Control Agency boardroom. Sean reported that the room he had in mind at the US Fish and Wildlife Service building is not available. Jim Lundy raised the idea of the need for a moderator/facilitator for the conference. The Board identified the need to have someone keep the program on-track and draw out key points for a summary which should be published in the newsletter. Jim will follow-up with a facilitator who works for the state to see if he would be available and if there would be a charge for this. Sean noted the need to get a registration flyer out by the end of September. There was discussion of whether to pursue preapproval for continuing education credit for the conference, in light of the Geoscientist Licensing Board denial of preapproval for the Midwest Ground Water Conference. The Board agreed that we should pursue preapproval and put the Licensing Board on notice the Board views continuing education opportunities as an important part of MGWA's mission. Jennie and Jim Lundy will review the Licensing Board's continuing education reguirements and follow this up.

Newsletter — The September newsletter is at WRI for layout. Jennie noted the need to get a paragraph soliciting nominations for Secretary and President-Elect for the 2000 officer slate. Tom noted this oversight and will provide the language directly to Jennie and Sean. Jennie noted that several figures in the feature article do not reproduce well in black-and-white and asked the Board what they thought about printing them in color back-to-back on a single page which would be inserted into the middle of the newsletter. The maximum cost for this would be \$0.79/page, likely much less because of volume. After discussion, the Board approved the request, noting that with the extended run of this issue (750 copies), this would be a good opportunity to showcase the newsletter.

Directory — The 1999 membership directory and information referral index is ready to print after nearly 70 hours of work by WRI. It will be dated August 1999. A possibility may be to put the directory on the MGWA website in future years and only provide hard copies to those who request them.

Membership survey — Jim Lundy raised the issue of whether we should be doing more surveying of the membership to see what they want from MGWA and assess how we're doing. Items to be considered for inclusion are feedback on conferences and workshops, including the fall conference on geophysical methods, whether the membership directory should be included in the annual dues, and a survey of interest by members in volunteer opportunities with MGWA. The idea of putting the survey in a future newsletter was discussed. Jim will follow-up with a person in PCA's Customer Service Unit about design of a survey.

Leigh noted that she is redoing the advertising renewal letter to allow for mail-in renewals of ad copy, which will reduce the amount of time she has to spend on the phone.

Membership renewals — Sean noted that the time for 2000 membership renewals is fast approaching. MGWA has e-mail addresses for about 75% of the membership now and WRI has purchased the software to allow MGWA to process renewals by e-mail. The Board agreed with the idea to pilot this system for the 2000 renewals. Members who don't respond to the e-mail notice or who don't have access to e-mail will be notified by US mail as in the past.

Paula reminded the Board that the revised bylaws require an annual

MGWA Board Meetings, cont.

membership meeting. The last such meeting was held at the conclusion of last year's spring conference. There was discussion of possibly holding this over lunch at the fall conference, as the current plan is to have the noon meal catered in.

Meeting adjourned at 9:20 am.

October 7, 1999, Egg & I, University and 280, St. Paul, MN, 7:30 a.m.

Attending: Paula Berger, Past-President; Jim Piegat, President; Jim Lundy, President-Elect; Jan Falteisek, Secretary; Jeanette Leete, Sean Hunt, WRI; Tom Clark, Newsletter Editor.

Approval of Minutes — Jim Piegat called the meeting to order at 7:35 am. Minutes for the regular Board meeting held September 9, 1999 were approved with corrections.

Treasurers Report — Sean Hunt provided updated accounting reports. He also reported the results of the directory survey. Sean recommends putting the directory online. Quarterly updates would be possible, along with additional services. Advertiser arrangements will need to be reviewed for both print and online. WRI

This Newsletter brought to you by:

Tom Clark, Editor-In-Chief Steve Robertson Jan Falteisek (Issue Editor) Jim Lundy Charles Tiller tom.p.clark@pca.state.mn.us steve.robertson@health.state.mn.us jan.falteisek@dnr.state.mn.us jim.lundy@pca.state.mn.us ctiller@amengtest.com

Upcoming MGWA Newsletter Deadlines

Issue	Copy to Editor	Copy to Publisher
March (v.19, no. 1)	02/04/2000	02/11/2000
June (v.19, no. 2)	05/05/2000	05/12/2000
September (v.19, no. 3)	08/04/2000	08/11/2000
December (v.19, no. 4)	11/03/2000	11/10/2000

can make copies for the few subscribers needing paper copies. Membership renewal and other forms will need to be changed. Paula asked if there would be additional costs for online distribution; Jennie explained that in the past most of the cost was for paper and postage. The Board approved providing the Directory online on the MGWA web site to members as a member benefit. The Board also approved continuing to provide the membership directory in printed form as requested for an additional fee to be set by the Board Midwest Ground Water Conference — Tom noted that the confer-

ence (October 13-15) is as ready as it can be. The MGWA is a sponsor of student participation in the conference.

Birdsall-Dreiss Lecture — The Board approved sponsoring non-alcoholic refreshments at the November 5, 1999 Birdsall-Dreiss lecture for \$50. Jan is to send a note and Jennie is to sent a check for the amount to Mark Person at the University of Minnesota Department of Geology and Geophysics.

Join the Minnesota Ground Water Association!

If you are reading this newsletter second-hand, we'd like to take this opportunity to invite you to become a member of **MGWA** for **2000.** Annual dues are \$20 for professional members and \$15 for students. Members are entitled to purchase a paper copy of the annual membership directory for \$7; an electronic version will be available on the website for paid members. Additional donations toward our scholarships and/or the use of recycled paper will be gratefully accepted.

Dues paid to MGWA are **not** deductible as charitable contributions for federal income tax purposes. However, dues payments are deductible as ordinary and necessary business expenses to the extent allowed by law.

Just complete the form below and mail to: MGWA, c/o WRI, 4779 126th St. N, White Bear Lake, MN 55110-5910.

 Name

 Affiliation/Employer

 Work Address

 City, State, Zip Code

 Work Telephone Number

 E-mail

 Fax Number

 Home Address (optional)

 City, State, Zip Code

 Home Telephone Number

 Work Telephone Number

 Work Address should we use for Mailings and for Directory Listing?

MGWA Board Meetings, cont.

Fall Conference — The conference brochure is at the printer and is expected back tomorrow. Jennie asked for help during the conference. Jim Lundy will provide presenter information material and also a conference feedback form.

Membership — Sean reported that membership was now over 500. He had also sent out an e-mail test of the 2000 membership renewal form. Procedures on handling payments and receipts were discussed. The Board approved allowing online membership renewal beginning with the 2000 renewal cycle and authorized WRI to implement procedures for online membership renewal.

Candidates — Paula said she had contacted a suggested President-Elect candidate and he is interested. Candidate information will need to be provided to the editor by about mid-October.

Newsletter — Tom noted that the September newsletter was out. Paula said she would write a short article on the MGWA scholarship program.

Scholarship Program — Paula said she would send out invitations before the end of the year.

Membership Survey — Jim Lundy said he would send out the draft once more for comment. The membership survey would possibly accompany the 2000 membership renewal.

Meeting adjourned at 9:15 a.m.

Analytic Element Conference Announced

Third International Conference on the Analytic Element Method in the Modeling of Groundwater Flow, 16-19 April, 2000 at Madden's Resort, near Brainerd. Abstracts due November 30, 1999. Conference information at http://ce.umn.edu/AEMGroundwater/ . Or contact Josh Curlee, Conference Secretary, Department of Civil Engineering, University of Minnesota, e-mail aemgw@tc.umn.edu or phone (612) 625-5522.

MGWA Calendar

Contact information for the major event-holders is listed at the end of the column. If you become aware of a relevant event which may not be widely publicized, please send the information to the attention of the editor. Thank you.

January 18-19, 2000

Low-Cost Remediation Strategies for Contaminated Soil and Ground Water, Miami, FL. Contact: NGWA.

January 20-21, 2000

Screening Model for Natural Attenuation with Bioscreen, Biochlor and the NA Tool Kit, Miami, FL. Contact: NGWA.

January 24-26, 2000

Geostatistics and the Data Quality Objectives Process for Environmental Remediation Decision Making, Miami, FL. Contact: NGWA.

January 27-28, 2000

Environmental Aspects of Surface and Ground Water Interactions, Miami, FL. Contact: NGWA.

January 30-February 2, 2000 Minnesota Water Well Association Convention, Kelly Inn, St. Cloud, MN. Contact: Scott Franzmeier (651-290-6270).

February 14-18, 2000

Princeton Ground Water Pollution and Hydrology Course, San Francisco, CA. Contact: Princeton Ground Water.

February 20-24, 2000

Symposium on the application of geophysics to environmental and engineering problems (SAGEEP). Annual meeting of the Environmental and Engineering Geophysical Society, Arlington, VA. Contact: <http://www.sageep.com>

March 6-10, 2000

Princeton Ground Water Pollution and Hydrology Course, San Francisco, CA. Contact: Princeton Ground Water.

March 28-30, 2000

"The Watershed Approach to Improving Water Quality: Fact or Fantasy", an Upper Mississippi River Conference sponsored by the West North Central Region of Soil and Water Conservation Society, LaCrosse, WI.

March 29, 2000

Minnesota Department of Health Annual Well Conference, Thunderbird Hotel, Bloomington, MN. Contact: Kim Benson-Johnson, (651-215-0816).

April 3-7, 2000

Princeton Remediation Course, Las Ve-

gas, NV. Contact: Princeton Ground Water.

April 6-7, 2000

Geological Society of America (GSA) 34th Annual North Central Section Meeting, Indianapolis, IN. Abstract deadline December 20, 1999. Contact: <http://www.geosociety.org/ profdev/sectdiv/Northc/00ncmtg.htm>

April 17-19, 2000

Third International Conference on the Analytic Element Method, Brainerd. Contact: <u>http://www.ce.umn.edu/AEMGroundwater</u>

April 25-27, 2000

National Water Quality Monitoring Conference 2000, Hyatt Regency, Austin, TX. Contact: GWPC, 405-516-4972, jeff@gwpc.site.net, or <http://nwqmc.site.net>

April 25-26, 2000

Minnesota Water 2000 Conference: Status of Minnesota's ground and surface water as we enter the millennium, Minneapolis Convention Center. Contact: Tracy Thomas, Water Resources Center, <thoma032@tc.umn.edu> (612-625-2282)

November 5-8, 2000

AIH Meeting on Atmospheric, Surface and Subsurface Hydrology and Interactions, Research Triangle Park, NC <http://www2.ncsu.edu/ncsu/CIL/WRRI/ AIHCALL.html>

November 13-16, 2000

Geological Society of America (GSA) 2000 Annual Meeting, Reno, NV. Contact: <http://www.geosociety.org/meetings/2000/index.htm>

National Ground Water Association (NGWA)

601 Dempsey Road Westerville, OH 43081 1-800551-7379 http://www.ngwa.org

Princeton Groundwater

PO Box 273776 Tampa, FL 33688-3776 813-964-0800 813-964-0900 (fax) Info@princeton-groundwater.com <http://www.princeton-groundwater.com>

Nielsen Environmental Field School,

Inc. David M. Nielsen 4686 State Route 605 S. Galena, OH 43021 614-965-5026 614-965-5027 (fax) nielsenfieldschool@juno.com Minnesota Ground Water Association 4779 126th Street North White Bear Lake, MN 55110-5910



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