

Minnesota Ground Water Association

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President's Column

by Ray Wuolo

Last year, a manufacturing client asked me what local "trade" organizations I belonged to and I dutifully began to recite a litany of professional organizations to which I paid dues. "No!" the lady interrupted, "I don't care about your licenses and certifications. I want to know where you get the latest news on the things you work on every day. You know, your 'trade'." What I work on every day? Some days, I'm drawing geologic cross sections and on others, I'm working up an engineering analysis. There are those days when I feel like I'm a lawyer and days when I'm glad I'm not. Sometimes, I'm a chemist and sometimes I get to be a writer, a graphics designer, or an artist. But the one thing that all of those days have in common is "the thing I work on": ground water. I told her that my "trade" organization is the Minnesota Ground Water Association.

I occasionally need to be reminded that ground water is not a discipline or a profession but a natural resource; and a vital one, at that. It never ceases to amaze me how many different professions, backgrounds, and view points are involved in ground water issues. If you don't believe me, try sitting with a group of geologists and engineers and ask them to agree on the definition of "hydrogeologist". It won't happen. Ground water is not the exclusive domain of geologists, engineers, chemists, planners, or lawyers. Understanding, protecting, remediating (and sometimes eliminating) ground water requires an extremely eclectic mix of skills. Many of us are very knowledgeable in one or several disciplines that we can apply to the study of ground water but none of us can, with a straight face, claim that we are "experts" in "ground water".

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Along the Great Wall: Mapping the Springs of the Twin Cities

by Greg Brick

"It is to this ignorance or oblivion that the city spring-hunter owes much of the charm and enjoyment of a quest which yields in a measure the excitement of a voyage of discovery. Greatly satisfying indeed is the draught from a spring where none is said to exist, and which has been come upon after patiently and inductively following a trail marked only by a moistened stone here, a willow farther on; and then a piece of watercress." James Reuel Smith (1852-1935)

The modern groundwater professional can become so accustomed to associating groundwater with wells as to forget that there is another whole side of the subject, the study of springs. While no longer an important source of drinking water in this country, springs are still useful for monitoring groundwater pollution, or in defining aquifer characteristics, as shown in a recent article by Werner (1996).

Water wells drilled in Minnesota since the mid 1970s have been assigned unique numbers by the Minnesota Department of Health. Older wells also are being located and assigned unique numbers. No such database exists for springs. USGS quadrangles usually omit them. The nearest thing to a description of the springs of the Twin Cities was George M. Schwartz's *Geology of the Minneapolis-St. Paul Metropolitan Area* (1936), which included a classification scheme and chemical analyses. There were major omissions, however. Neither the largest nor the most famous springs in Minneapolis, for example, were mentioned. It was toward filling this void that Professor Calvin Alexander, at the University of Minnesota, suggested,

as a research project, that I should (re)locate and map the springs of the Twin Cities.

I found inspiration in one of the greatest spring-hunters of all time, James Reuel Smith, whose *Springs and Wells of Manhattan and The Bronx* was published in 1938. Smith bicycled around Manhattan at the end of the nineteenth century describing and photographing springs just before they were obliterated by the tide of urbanization that swept northwards up that island. After an area becomes covered with paving and buildings most rainwater is carried off by sewers, and there is little recharge.

Smith's account was full of picturesque detail. How surprising it is, for example, to look at a photograph of what appears to be a doghouse or an out-house on a street corner, only to read that it was in fact a springhouse—one of the ancestors of the modern refrigerator! According to Smith, the New York City Health Department put Paris Green, a deadly poison, in springs and wells, to discourage the use of these fever-inducing waters. They preferred that everyone drink water from the Croton Aqueduct. Not surprisingly, Smith found that local residents often were reluctant to tell him where their springs were.

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President's letter, cont.

MGWA is an organization devoted, not to a profession, but to a natural resource, the "thing" we work on every day.

On that note, the dream (or nightmare, depending upon your point of view) of geoscience registration is finally at hand. Whether you're a proponent, opponent, or indifferent to the concept, registration will soon be a reality, probably during this calendar year.* The prospect raises a lot of questions: Who can register? Who must register? You mean, I might have to take a test? How much is it going to cost me? What do you mean I can get sued? What is "grandfathering" and why isn't it called "grandmothering"? Who can legally design a well? Do I get a cool stamp? I hope you get my drift — many of us probably haven't seriously considered how geoscience registration may affect us but now we probably should think about it some. The spring MGWA meeting will focus on the upcoming geoscientist registration requirements. Stay tuned for time and place. Hopefully, this will be your opportunity to ask that probing question that didn't seem so important when registration was a concept that didn't cost you anything.

I'm looking forward to this upcoming year as your president. This organization has been very fortunate to have had so many dedicated Board members and volunteers. We will miss the regular assistance of our outgoing past president, Cathy O'Dell, and our treasurer, Paul Putzier. They devoted much time to MGWA and deserve our gratitude. We welcome Paula Berger as our new President elect and Paul Bulger as our new Treasurer. I have checked the bylaws and have been assured that the initials "PB" are not a prerequisite for service on the Board. Sometime during the life of every organization, the membership gets a plea from a new president, asking for input. You know, "Help me make this organization your organization." When I read that, I generally think, "You must've wanted the job, so you come up with the ideas!" Well folks, I have a lot of ideas but your concept of relevant and mine could be differ-

ent. How many of you really want a two-day symposium on automated inverse optimization methods for flow model calibration? Let me hear what you think would be a good (fun) fall field trip or an interesting topic for a fall short course.

**Editor's Note: At press time, the draft rule developed by the Geoscience Licensure Task Force was scheduled to be published in the March 3, 1997 State Register for a 30-day comment period.*

Springs, cont.

Smith had described some very minor springs (including dry ones), referencing their locations according to the Manhattan street grid. My own mapping project, using topographic quadrangles, could not aim at such completeness. Surficial springs at low points in glacial drift, a consequence of poorly integrated post-glacial drainage, were far too common, and required extensive access to private property. I chose to limit systematic prospecting to springs visible in the gorge of the Mississippi River. This wall of bedrock exposure, 80 feet high, stretching from St Anthony Falls to Hastings, became an enduring motif.

My first attempt at mapping, in January, 1993, lasted all of a day. I had framed the plan of locating the springs in wintertime. Springwater freezes to form icicles on the bluffs, and in the absence of leaf cover, mapping should be as easy as strolling along the opposite bank with a clipboard. But I found that at a distance of a quarter mile (the width of the gorge) it was difficult to distinguish, even with binoculars, ice formations created by springs, from those by culverts, etc. It also appeared that the size of an ice formation was inversely proportional to the discharge. Small seeps, which I didn't care to map, create large formations because their output freezes on the formations themselves, while large springs melt everything nearby. For these reasons, I had to be right up at the outcrop.

The close-up approach proved fatiguing—and dangerous. I spent more time mountaineering than mapping. I had to walk along the top of a wedge of loose stones that mantled the foot of the bluffs. This material, at the angle of repose, was concealed by snow.

I had some nasty falls (I was wearing old dress shoes at the time), and nearly ended up with frostbite. At the end of the day, as the sun was setting, I remember going down on my belly and slithering behind an icicle as stout as an oak tree, to get to the next foothold. Needless to say, I hadn't covered much ground. The mapping project disintegrated into the bleak prospect of inching across miles of treacherous scree in sub-zero weather. I decided to postpone operations until summer, and the delay proved fortunate. The year 1993 was to be notorious for heavy rainfall (and extensive flooding) in the Upper Mississippi Valley, enough water to revive even the most dormant springs, some of which I was never to see again.

When I resumed mapping, I found that the springs were not randomly distributed. After plotting just a few of them among the contour lines a striking pattern emerged. Most springs fell into one of about seven different spring-lines, each of which represented a perched water-table at a contact between rock formations, porous rocks underlain by impervious beds. I will describe the springs in terms of the spring-lines to which they belong, in descending order of elevation (see Figures 1 and 2).

The highest (and shortest) spring-line followed the **Galena Limestone-Decorah Shale contact**. The springs emerge high up on the walls of the "amphitheaters" formed by the abandoned claypits of the former Twin City Brick Company, in Lilydale Park (West St. Paul). They are most conspicuous in winter, when their frozen cascades become the most popular ice-climbing spot in the cities. In summer, a sea of cattails covers the floors of the claypits. This type of spring is common throughout Minnesota's karst regions.

The second highest spring-line followed the **glacial drift-Decorah Shale contact**. This type had been recorded by Winchell (1888) and diagrammed by Schwartz & Thiel (1954). When plotted, they formed a pattern on the map that I nicknamed, for my own amusement, "St. Paul's diamond necklace:" a great loop of two dozen springs, about eight miles long, beginning near the Cathedral in downtown St Paul, loop-

—continued on facing page

Springs, cont.

ing south round Highland Park at the 850-900 ft level, then north again to the Town & Country Club, at the Lake Street bridge, where it ends. Since the contact was not visible, its presence was inferred based on the elevation of the top of the Decorah Shale, as determined from the bedrock topography map of Mossler (1992).

Mapping the Decorah spring-line through the Irvine Street area of St. Paul, below Summit Avenue, was the most scenic part of the project. Historic houses cling to the steep slopes, and I was spring-hunting among the gables. At a place called "Rue Eugene-Dupont," water poured from a crack in the driveway, streaming downhill along the switchbacks, before vanishing into a sewer. Where the spring-line crossed Grand Avenue, I found ornate lampposts with water gushing from their bases, which were swathed with filamentous algae. Along Pleasant Avenue (as at its intersections with St Albans and with St Clair), there were retaining walls built of limestone rubble masonry, at the foot of which there were springs. A local resident recalled that his parents used to drink water from the Pleasant Street springs.

Highland Spring is the most famous Decorah spring. Located near what is today the intersection of Randolph and Lexington, this spring supplied the Nettleton dairy farm (1871-1885) and was bottled and sold by the Wardell family (1900-1965), the only commercial springwater produced in St Paul. Empson (1975), who researched the history of this spring, wrote that "Today the spring is routed into the sewer system, but the curi-

The primary objectives of the MGWA are:

- Promote and encourage scientific and public policy aspects of ground water;
- 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 ground water.

ous can walk behind [Montcalm Estates], and by peering down the manhole grating, see the flow of the spring from the hillside above, running at its constant 27 gallons a minute." Being morbidly curious, I had to remove the grating and descend into the manhole itself, where I found springwater pouring from the mouth of a pipe.

Further along, at Sunny Slope Lane, behind Sibley Plaza, I encountered a rivulet flowing in the street, and traced it to a private residence (#1760). Had I not been walking a spring-line, I would have missed this spring, because it was easy to assume that someone had left a garden hose running in the front yard. Contacting the owner, I learned that there was a trapdoor in the basement that could be lifted to view the spring. It is likely that there are many more stories of this character, that go unrecorded.

Walking the spring-line shed light on

— continued on next page

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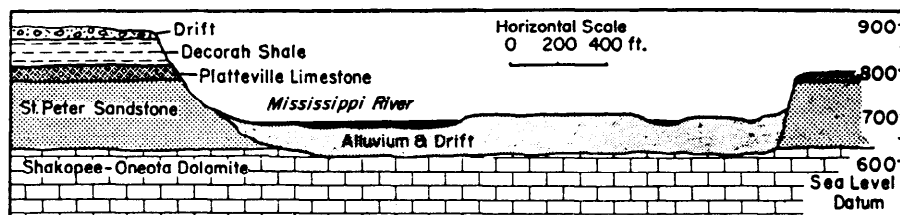


Figure 1: Cross Section of Mississippi River at Robert Street, St. Paul, Looking upstream. From: Schwartz and Thiel (1954).

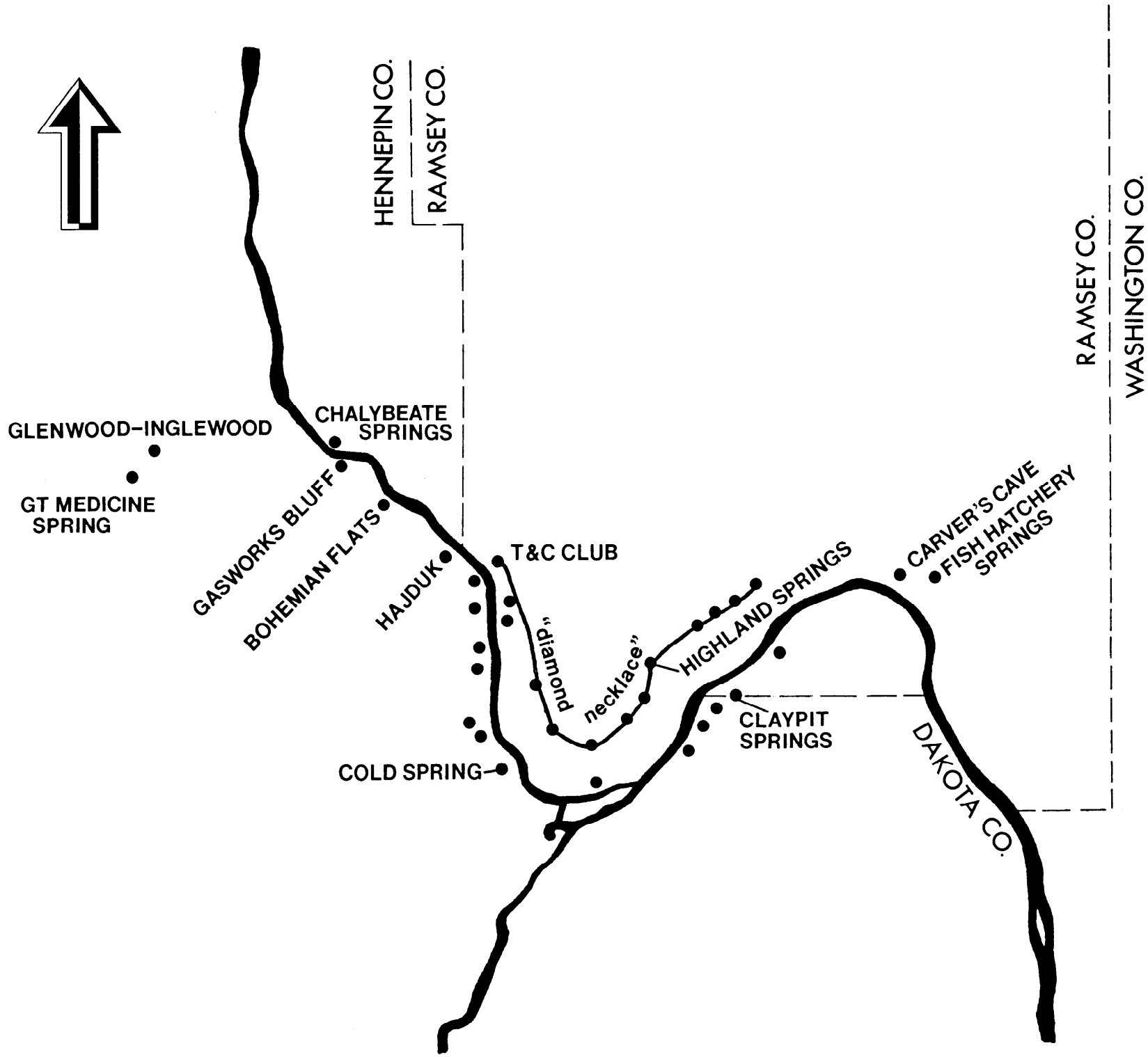


Figure 2: Spring locations in the Twin Cities area. Many small springs omitted for clarity.

Springs, cont.

other features. At St Catherine's College there is Dew Drop Pond, about an acre in size, which I had known about for years. Its 890-ft elevation now suggested to me that it was fed by Decorah springs. It has the melancholy distinction of being the only local spring in which people have drowned.

Finally, the "necklace" ended at the Town & Country Club, where there was a spring in the golf course rough. Surrounded by giant willow trees, the scenery here probably best recreates the appearance of the Decorah springs back in the early days of St Paul. A sign on the gatepost dated the club to 1888.

The third highest spring-line followed the **glacial drift-Platteville Limestone contact**. It was most noticeable along Mississippi River Boulevard in St Paul where the springs, eroding headward, have carved ravines, necessitating a series of bridges and bends in the road. By far the most spectacular of these was Shadow Falls, at the west end of Summit Avenue.

Initially, I was skeptical of the claim by Nason (1932) and others that Shadow Falls was a spring, because I had traced the water upstream from the falls to a point near the head of the ravine, where it gushed from the earth, and when I applied a shovel to this so-called spring, the blade struck a buried object. Clearing the soil away, I saw water gushing from the joint between two segments of vitrified pipe. Sewer maps at the St Paul Public Works Department did not depict a pipe in this location, but I surmised that one had been laid down the axis of the ravine to drain local runoff, its outfall had become plugged, and the water erupted at a loose joint. Hardly a spring! But when I came across Plympton's 1839 map of the Fort Snelling Military Reserve, which identified Shadow Falls as "Spring Leap," I changed my mind. Even before human modifications there was a spring here.

The St Paul Seminary spring belongs to the same type. At the head of the ravine associated with this spring

there is a grotto and basin, constructed of cobbles mortared together.

The fourth highest spring-line followed seams of bentonite in the **Platteville Limestone**. This bentonite, a clay, resulted from volcanic ash-falls in Ordovician times (Sloan, 1987). While all the springs hitherto discussed were found in St Paul, this type was confined to Minneapolis. Thus, generally, while St Paul is a city of Decorah springs, Minneapolis is a city of Platteville springs.

The spring with the longest recorded history in Minnesota is Cold Spring (a.k.a. Baker's Spring), a Platteville spring near Fort Snelling. Its name arose because soldiers at the fort, from 1820 onwards, preferred drinking cold spring water rather than warm river water. The spring gave its name to Camp Coldwater, which they inhabited while the fort was under construction. In 1853, a hotel was erected. Prior to the 1890s, a wall of limestone rubble masonry was built around the spring, creating a reservoir. After World War II the Bureau of Mines took over the site and stocked the pool with trout (U.S. Department of the Interior, 1991). Using a 5-gallon bucket and a stopwatch, I determined the discharge to be 60 gallons per minute, at a point where the pool spilled over a weir. Cold Spring is

presently in danger of being obliterated by a realignment of Highway 55. The 1839 Plympton map depicted other springs in the vicinity, such as Big Spring and "Four Springs," near where the Mall of America now stands.

But of all the springs in the Twin Cities, the only one to achieve *national* fame was Chalybeate Springs, a Platteville spring just below St Anthony Falls. Previous to the Civil War a hotel called the Winslow House was crowded by the wealthy and fashionable of the South who came hither to escape the heat and drink from the chalybeate (iron-bearing) springs (O'Brien, 1904). After the war, a special purpose structure, the Chalybeate Springs Resort, was built. The state geologist, himself, pronounced the waters "medicinal" (Winchell, 1877). Located in Pillsbury Park, the springs flow today as copiously as ever.

Platteville springs also supplied drinking water to the Bohemian Flats community that once existed on the floodplain below the west end of the Washington Avenue bridge. However, springwater is too hard for doing laundry, so barrels were set out to catch the soft rain water for washday (Work Projects Administration, 1986). These springs are the reason why Riverside



ST. ANTHONY FALLS
MINERAL SPRINGS.

Figure 3: Chalybeate Springs Resort in Minneapolis

Springs, cont.

Park is often closed in winter: water spills out over the road and freezes, causing automobile accidents.

Hajduk Spring, located near the old Milwaukee Road trestle, north of the Lake Street bridge, is probably the only Platteville spring from which people still drink. First described by Schwartz (1936), it was officially named after its chief promoter, Harry Hajduk (pronounced Hi-duck), by the Minneapolis Park Board, in 1977. At the same time, a platform was erected at the foot of the cliff to make it easier to fill jugs (Meier, 1977). This is our best example of a falling spring, i.e., a spring that creates a waterfall. (Shadow Falls flows as a stream before taking the plunge, rather than falling straight from the cliff face.) So colorfully had this spring stained the cliff face red, that it inspired me to a naive color classification scheme for springs!

Other Platteville waters are not so potable. At Gasworks Bluff, near the west end of the I-35 bridge, I found springs which, because of their sulfide aroma and the appearance of the material they had deposited, I recorded in my fieldbook as "bird-dropping springs." You get the picture. Cheers!

In winter the big Platteville springs become thermal oases for wildlife. Springwater, above the freezing point as it resurges, melts snow at the foot of the bluffs, creating areas where the ground remains unfrozen. I frequently observed robins in these places.

The fifth highest spring-line, along the **Platteville Limestone-Glenwood Shale contact**, was a disappointment. You would expect to find springs at the top of an impervious shale (as at the top of the Decorah Shale), but there were only a few miserable seeps at this contact, probably because the bentonite seams in the Platteville have already pirated most of the water.

The sixth highest spring-line occurs where the water table in the **St Peter Sandstone** intersects the river gorge. Most famous in this category were the two cave springs, Carver's Cave and Fountain Cave. There are St Peter springs along Minnehaha Creek,

below the falls, where a bronze plaque affixed to a glacial erratic boulder, draws attention to them.

Schwartz (1936) described St Peter springs between St Paul and Mendota. While walking the Chicago & Northwestern tracks near Lake Pickerel, dodging the occasional train, I saw several of these. I came to expect one wherever I saw a culvert crossing under the tracks.

The largest springs in the Metro area occur where the Mississippi cross-cuts its own, **preglacial channels**. The St Paul Fish Hatchery springs, below Dayton's Bluff, with a discharge of 400 gallons per minute, were the most famous of these (Castle, 1912). Between 1974 and 1976 (when records were kept) the chloride concentrations of this springwater increased, peaking in winter, presumably a result of salt applied to nearby Warner Road. These springs serve as a clandestine water supply for the homeless, who live in the woods along the Point Douglas Trail.

The Pine Bend springs, which gave Spring Lake its name, belong to the same type. Driving down to a landing on the lake (in fact, an expanded reach of the Mississippi), I found a boat-rental shop called "Bud's Place," bearing a sign depicting a fountain spouting into the air. Perhaps an allusion to the springs? When I asked "Bud" where I might see the springs so romantically depicted, however, he replied that they were actually in the bed of the river, and that I would have to come back in winter, when ascending columns of springwater melted holes in the ice. I had recently acquired a SCUBA certification, and Calvin suggested that I dive down and fetch a sample with an upside-down jar. In fact, the situation is more complicated than Bud knew, as there are probably three types of springs at Pine Bend (Schwartz, 1936).

Our most famous **surficial spring** is Glenwood-Inglewood Springs, known at office coolers throughout the Metro area. Winchell (1905) drafted a cross-section of the geology of this spring, showing how the water emerged from a gravel-clay contact on the banks of Bassett Creek, in Minneapolis. The water utilized at present is not derived from the original spring but from pipes driven through the clay into a

water-bearing sand bed. Other surficial springs feed the Minneapolis chain of lakes.

Nearby, in Glenwood Park, was the Great Medicine Spring. In 1874, Col. John H. Stevens, the first settler in Minneapolis, said that this spring was frequented by Native Americans, "who came hundreds of miles to get the benefit of its medicinal qualities" (Gallagher *et al*, 1992). By the time I arrived on the scene, the spring seemed to be in need of some medicine itself. It dripped from the mouth of a pipe with all the gusto of a leaking faucet.

The so-called "boiling springs" on the Hattenberger farm, southeast of Shakopee, "boil" vigorously at intervals of a few minutes. The "boiling" is merely an upwelling of water, probably due to suspended sediments in the pool, which settle down and confine the water until the pressure builds up sufficiently to burst through.

The **lost springs** of the Twin Cities are a subject in their own right. By "lost" I mean dried up or unlocatable. They are a mixed bag, geologically speaking, and it is not always clear from the literature what types of springs they were. What was the Rum Town spring across from Fort Snelling, for example, or the Ninth Street springs in downtown St Paul, or the Swede Hollow spring? But of all places, the University of Minnesota area was most densely populated by these ghosts. The University Spring, for example, was located on the banks of Tuttle's Creek, whose dry gulch still separates Eastbank Campus from Dinkytown. This spring was used to supply water to the early University, a hydraulic ram raising the water to the buildings. The class of 1885 built a wall about the spring and fixed it up as a memorial (Johnson, 1908). The spring became contaminated with sewage, the student newspaper lampooned the contents of the water, and when the Northern Pacific tracks were laid along the creek bed in 1924, it vanished altogether. Again, there used to be springs flowing in a former botany greenhouse at the university. After much detective work, involving examination of old maps in the university archives, interviewing retired botanists, etc., I finally identified this former spring with a dried cal-

MGWA Spring Meeting Set for April 28

The MGWA's annual spring meeting will be held in the afternoon of April 28 at the Thunderbird Hotel in Bloomington. The topic should be of interest to many MGWA members: Licensing of Geoscientists in Minnesota. The President's Letter in this newsletter summarizes the current status of the licensing program in the state.

Speakers will include the geologist and soil scientist representatives on the licensing board, speakers from state government and industry who will discuss what licensing is likely to mean to them (and you!), and a possible speaker from the national board which is developing the exam which Minnesota is likely to adopt in the licensing process. Watch for a special mailing to members in early April giving a detailed agenda and registration information.

1997 AGWSE Darcy Lecturer Comes to Minnesota

On March 6, Dr. Philip C. Bennett, associate professor in the Department of Geological Sciences at the University of Texas at Austin, presented the 1997 Darcy Lecture, "Water, Microbes and Rocks: The Geochemical Ecology of Contaminated Ground Water." The meeting at the University of Minnesota, co-sponsored by the Department of Geology and Geophysics and the MGWA was attended over 50 people. Each year, the Association of Ground Water Scientists and Engineers of the National Ground Water Association supports a distinguished lecturer (named after the father of ground water science, Henri Darcy) to allow him or her to tour extensively through the college and university circuit to present topics of current interest in the field of hydrogeology. In his introduction, Dr. Pfankuch noted that Dr. Bennett is his academic "grandson", a second generation PhD, who is now producing academic "great-grandchildren". Dr. Bennett "gamely" held forth at the same time as the Gophers (Big 10 champs!) vs Michigan game (which the Gophers won).

Dr. Bennett described various chemical pathways that result in oil degradation in ground water and discussed the degradation products and the transformation of organic toxicants by native microorganisms which is considered one of the most promising remediation approaches for contaminated ground water.

The talk generated many thoughtful questions and the discussion was still going full-speed at 9 p.m.

Springs, cont.

careous tufa deposit behind Boynton Health Center, in what had been the old University limestone quarry. Other springs recorded by Winchell (1877), such as the Russell Mineral Spring, which bubbled up into a cellar in Dinkytown, and a "Petrified Moss" spring, somewhere on the bluffs near Campus, were unlocatable.

I maintain files (with photographs) of the springs of the Twin Cities as an on-going project, so if anyone has something they would like to share, I would like to hear from them. Address: P.O. Box 152, Willington, CT, 06279. Email: gab94002@uconnvm.uconn.edu.

Greg Brick holds degrees in biology and geology from the University of Minnesota, and a master's degree in geology from the University of Connecticut. He has worked for environmental consulting firms in Massachusetts, and presently seeks employment in Minnesota. Have any leads?

References

Castle, H. A. (1912). *History of St. Paul and Vicinity*. Chicago and New York: Lewis Publishing Co.

Empson, D. (1975). "History resided at Nettleton-Wardell home." *St Paul Dispatch*, March 4, p. 10.

Gallagher, S., et al (1992). *Eloise Butler Wildflower Garden and Bird Sanctuary*. Minneapolis Park and Recreation Board.

Johnson, E. B. (1908). *Dictionary of the University of Minnesota*. Minneapolis: The University Press.

Meier, P. (1977). "Spring puts spring in discoverer's step." *The Star-Tribune*, September 16, p. 1.

Mossler, J. H. (1992). Bedrock topography. *Geologic Atlas of Ramsey County, Minnesota*. County Atlas Series, Atlas C-7, Plate 4. Minnesota Geological Survey.

Nason, G. L. (1932). "Visiting Around St. Paul Parks." *St Paul Dispatch*, July 21.

O'Brien, F. G. (1904). *Minnesota Pioneer Sketches*. Minneapolis: H. H. S. Rowell.

Schwartz, G. M. (1936). The geology of the Minneapolis-St Paul metropolitan area. *Minnesota Geological Survey Bulletin No. 27*.

Schwartz, G. M., and Thiel, G. A. (1954). *Minnesota's rocks and waters*. Minneapolis: The University of Minnesota Press.

Sloan, R. E. (1987). Tectonics, biostratigraphy, and lithostratigraphy of the Middle and Late Ordovician of the Upper Mississippi Valley. In Sloan, R. E., ed., "Middle and Late Ordovician lithostratigraphy and biostratigraphy of the Upper Mississippi Valley." *Minnesota Geological Survey Report of Investigations 35*, pp. 7-20.

Smith, J. R. (1938). *The springs and wells of Manhattan and The Bronx, New York City, at the end of the nineteenth century*. New York: The New-York Historical Society.

U. S. Department of the Interior (1991). *Bureau of Mines, Twin Cities Research Center: A history, the first three decades*.

Werner, R. L. (1996). Assessing ground water flow-type using spring flow characteristics. *The Professional Geologist 33* (8): 4-7.

Winchell, N. H. (1877). The geology of Hennepin county. In *Fifth Annual Report of the Geological and Natural History Survey of Minnesota*, pp. 131-201.

Winchell, N. H. (1888). The geology of Ramsey county. In *Final Report of the Geological and Natural History Survey of Minnesota*, v. 2, pp. 345-374.

Winchell, N. H. (1905). Deep wells as a source of water supply for Minneapolis. *The American Geologist 35* (5): 266-291.

Work Projects Administration (1986). *The Bohemian Flats*. St Paul: Minnesota Historical Society Press.

MGWA Legislative Open House a Success

On January 27, 1997, the MGWA sponsored an educational reception for state legislators and their staff at the Capitol. Legislators were invited to stop by and learn about ground water flow, characteristics and regulation. Representatives of several state agencies were present with information on their respective roles in ground water protection and management.

MGWA had an impressive display set up which got good attention. This display was put together by Watershed Research, Inc., and will be used at future events as well (look for it at our spring meeting). Approximately thirty legislators and twenty staff members stopped by in spite of a heavy hearing schedule in the opening days of the session.

This was the first event that MGWA has sponsored which was targeted at educating a specific group of non-

members about ground water. Legislators were chosen for this first effort because they are key decision makers, and holding an event like this at a single location is simpler than trying to reach large or more diffuse audiences.

All participants felt the effort was worthwhile, both as a forum to present state ground water programs and as an tool to educate legislators and their staff on ground water issues. This event may be repeated in coming years, and there will be other opportunities to spread the word about ground water. If you are interested in participating in such events, or have ideas of other educational "Happenings" that you'd be interested in seeing brought to life, contact Gretchen Sabel at (612)297-7574.



MGWA Fall Conference Summary

MGWA's Fall Conference was held on November 12 at the Radisson South in Bloomington. The conference theme was datalogger concepts and applications in hydrogeology.

Clyde Best of Campbell Scientific, Inc. gave the participants a brief grounding in how data loggers work from the perspective of an electrical engineer who knows water resources applications. Owen Israelson of Design Analysis Associates, Inc., and Steve Amrine of In-Situ Inc. presented general information on datalogger technology, specific information on sensors for measurement of water levels and flow, and data transmission options.

Scott Alexander of the U of M relayed his experiences using dataloggers in Minnesota's harsh climate, not without a generous dose of good humor.

Newsletter Advertising Policy for 1997

Display ads:

Size	inches H x V	Quarterly Newsletter	1996 Membership Directory
		Annual Rate 4 issues	Annual Rate 1 issue
Business Card	3.5 x 2.3	\$60	\$45
Quarter Page	3.5 x 4.8	\$110	\$90
Half Page	7.5 x 4.8	\$205	\$170
Full Page	7.5 x 9.75	\$385	\$325
Inside Cover	7.5 x 9.75	Not Available	\$360

Classified ads:

Classified ads in the newsletter are charged at the rate of \$3 per 45 characters (including spaces and punctuation) per newsletter issue.

E-Mail notices:

A one-time e-mailing to the membership costs \$10 for an individual (e.g. seeking a job), and \$50 for an organization (e.g., announcing a job opening). The advantage of e-mail is the speed of dissemination.

The Advertising Manager has final determination on the acceptance of materials submitted. There are no commissions on ads. Advertising copy must be received by the publications deadlines: 14 February, 16 May, 15 August, or 14 November. Since we do not do any art or camera work ourselves, and we reuse copy from issue to issue, your copy should be a photostat of your art work at the exact insertion size. Photostats give the highest quality print reproduction. If a photostat is not available, high-quality copies of the ad on plain paper must be submitted for each issue published (e.g. four copies for the quarterly newsletter).

Please make checks payable to the "Minnesota Ground Water Association" or "MGWA." Direct your orders and questions concerning advertising rates and policy to the Advertising Manager:

Jim Almendinger, MGWA Advertising Manager, c/o St. Croix Watershed Research Station, Science Museum of Minnesota, 16910-152nd St. N. Marine on St. Croix, MN 55047.

Phone: (612)433-5953; Fax: (612)433-5924; E-mail: dinger@sci.mus.mn.us

Teaching the Teachers: Ground Water Education in Minnesota

Jim Lundy

Environmental education for elementary students has come a long way since high school junior Tom Brasch visited my seventh grade class, admonishing us not to let the water run while brushing our teeth. Environmental issues are more complicated these days, and while there is a great deal of student interest, few elementary school teachers are trained in geoscience, fewer still in ground water. Consequently, several organizations offer teacher training in ground water in the realization that effective teaching of environmental concepts of ground water to students begins with training teachers.

After 21 years as an earth science teacher, Martha Barber of the **Denver Earth Science Project (DESP)** knows that earth sciences needs to attract students at the elementary and secondary education level. "However, it's usually taught in 8th or 9th grade, and includes meteorology, planetary science, geology, and so on. Students don't always see the relevance."

Make it relevant and fun, she says, and students will flock to it. In coordination with the Colorado School of Mines, DESP has developed several teacher training modules (ground water studies, radiation, paleontology and dinosaurs, energy, oil and gas exploration, and an environmental case study). Teachers attend workshops to become trained in one of the modules and receive the teaching materials, which feature hands-on activities promoting problem solving using real data from industry and government agencies.

During the ground water workshop, the teachers perform the same 20 projects they will later require of their 7th to 9th grade students, using plastic ground water models, aquifer maps, and other visual aids. The first projects are designed to increase awareness of the importance of water (the hydrologic cycle; audit your own water use). "Each activity

builds on the next," says Barber. "How does an aquifer work? What happens when it is contaminated?" The more advanced activities simulate the effects of leaking underground storage tanks using buried film canisters containing colored water in the plastic ground water models.

According to Barber, it costs about \$8500 to offer the three day long ground water module teacher training; each teacher pays approximately \$35 to attend. DESP seeks support from local companies and professional organizations to offset the remaining costs, which arise partly from the cost of the plastic ground water models. Each teacher receives a notebook with all the activities and eight of the plastic aquifer models for use with their own students; of course the price per student of the initial teacher training decreases each year. You can reach DESP at (303)273-3494.

Project WET (water education for teachers) is a nationwide program with a statewide network of approximately 80 volunteers qualified to conduct teacher training in all elements of water including ground water. According to Peder Otterson, a Minnesota Department of Natural Resources (MDNR) hydrologist and the Project WET State Coordinator, each workshop lasts a day and trains about 20 teachers, who each pay about \$20 to \$40 to arm themselves with a hefty "Project WET Curriculum and Activity Guide".

The guide is founded upon seven basic precepts, each supported by several activities: water has unique physical and chemical properties; water is essential to life; water connects all earth systems; water is a natural resource; water resources are managed; water resources exist within social constructs; and water resources exist within cultural constructs.

"The materials are written by teachers, for teachers, and they emphasize constructive learning. Plus they are fun, easy, and inexpensive to do," said Otterson. As an example, in "A Grave Mistake", Otterson's favorite, students evaluate arsenic concentrations in ground water.

Authorities think a nearby factory is the arsenic source, and shut it down. But the factory doesn't use arsenic. By plotting arsenic concentrations on a map, students discover that a cemetery is the true arsenic source. Turns out that common embalming practice at the time of the Civil War used arsenic-based solutions.

National funding for Project WET has come in part from petroleum companies and computer companies. On the state level, the MDNR funds Otterson's work as State Coordinator. For further information and a current schedule of training sessions, call Peder Otterson at (612)297-2405.

The **SEEK** database (Sharing Environmental Education Knowledge; located on the world wide web at <http://seek.state.mn.us>) is a clearinghouse for all types of environmental resources, from articles to lesson plans, from performances to displays, and has links to many other information sources. The **Freshwater Foundation** circulates several brochures on topics such as ground water protection, lake protection, water and health, and simple things you can do for cleaner water. Call (612) 449-0092.

Although the **Science Museum of Minnesota (SMM)** does not offer teacher training in ground water, it does offer several programs on water to schools and their students: museum trunks (in which the museum ships a trunk including a physical ground water model, water testing equipment, and videos directly to the classroom); and museum residency (the museum sends a program on water directly to the classroom, complete with instructor). Call (800) 221-9444 (x4748) or (612) 221-4748 for more information on museum trunks or museum residencies. And of course, the museum's large physical ground water model on "Green Street" entertains numerous practicing and future ground water scientists every day.



MGWA Board Meeting Minutes

**November 7, 1996, Egg & I,
University and 280, 7:30 a.m.**

Attending: Cathy O'Dell, Past-President; Gretchen Sabel, President; Ray Wuolo, President-Elect; Paul Putzier, Treasurer; Tom Clark, newsletter editor; Jim Almendinger, advertising; Sean Hunt, WRI.

Minutes taken by Paul Putzier.

Approval of Minutes: Approval of September and October minutes deferred.

Newsletter: Tom Clark reported issue is ready for layout except for ballots. Notes/articles to Jennie this week.

Fall Technical Conference: Fewer than 10 people have signed up to date. Need to give the hotel our head count by Tuesday.

Birdsall-Dreiss lecture: The MGWA will sponsor the Birdsall-Dreiss lecture at the University of Minnesota on January 16th. The arrangements are pretty well taken care of.

New Officers: Paul Bulger will run for Treasurer. Paul Putzier will put his name in the hat for President. Others needed.

Next meeting: December 5th, 7:30 a.m. at Egg & I. Representatives of the UM Hydrogeology Field Camp will be invited to discuss use and availability of facility.

Respectfully Submitted,
Jan Falteisek
MGWA Secretary

**December 5, 1996, Egg & I,
University and 280, 7:30 a.m.**

Attending: Cathy O'Dell, Past-President; Gretchen Sabel, President; Ray Wuolo, President-Elect; Paul Putzier, Treasurer; Jan Falteisek, Secretary; Tom Clark, newsletter editor; Jim Almendinger, advertising; Sean Hunt, WRI, Calvin Alexander, Olaf Pfannkuch, and Mark Person, University of Minnesota.

Approval of Minutes: Ray Wuolo called the meeting to order at 7:50 a.m. Minutes for September, October, and November were approved.

UM Hydrology Field Camp: Calvin Alexander, Olaf Pfannkuch, and Mark Person presented a draft description

for a proposed "Aquifer Test Analysis and Well Head Delineation Short Course" to be run this spring. Content, cost, and other issues were discussed. The UM will send out a flyer announcing the short course. The Board offered access to the membership mailing list.

Newsletter: December issue mailed.

Darcy Lecture: Olaf Pfannkuch noted that arrangements could be made to bring in Phil Bennett, the 1997 Darcy Lecturer. The Board suggested a spring 1997 date.

Training for Elected Officials: Gretchen would like to arrange in January or February a short course, "Ground Water 101 for Legislators". This would be a multi-agency effort. She asked Jim Almendinger to check with the Science Museum regarding space availability.

Fall Technical Conference: Sean Hunt presented a preliminary financial account of the fall technical conference, noting a net loss of about \$65.

Fall Field Trip: Sean Hunt presented financial account of the fall field trip, noting a net profit to the MGWA of \$119.61 after splitting proceeds with AIPG.

Connections to Greater Minnesota: Gretchen asked Sean Hunt for a list of members in Greater Minnesota to send a letter/questionnaire.

WRI Contract: New contract to start January 1, 1997.

New Officers: The draft ballot for officers was discussed. In an attempt to possibly get MDH representation on the Board, Ray and Cathy will call MDH staff to assess interest in Board participation.

Next meeting: January 9, 1997, 7:30 a.m. at Egg & I.

Respectfully Submitted,
Jan Falteisek
MGWA Secretary

**January 9, 1997: Egg & I,
University and 280, 7:30 a.m.**

Attending: Gretchen Sabel, President; Ray Wuolo, President-Elect; Jan Falteisek, Secretary; Tom Clark, newsletter editor; Jeanette Leete, WRI.

Approval of Minutes — Ray Wuolo called the meeting to order at 8:15 a.m. Minutes for December were approved.

Birdsall-Dreiss Lecture — The Birdsall-Dreiss lecture is on Thursday, January 16th at 6:30 p.m. at Pillsbury Hall. Ray Wuolo will represent MGWA and bring eats as our contribution to the sponsorship.

Training for Elected Officials — Gretchen provided an update of the preparations for "Ground Water 101 for Legislators", the legislative open house presentation of ground water issues. Gretchen has arranged a table and will attend. Ray Wuolo will also likely attend a table. MGWA will supply some snacks and bring the MGWA banner. There was discussion regarding creating a fact sheet on what MGWA is and what the membership is.

Fall Field Trip — The 1997 fall field trip was discussed. The Association of Women Geoscientists Minnesota Chapter has approached MGWA and AIPG about being a sponsor. The board agreed the sponsorship of AWG should be pursued for the 1997 field trip. Some ideas for the field trip were discussed, including an ambitious three-state review of karst hydrogeology.

WRI Contract — Jennie provided the contract to Ray and Jan to sign.

New Officers — Due to a tie for president-elect, elections of new officers is not yet final. Jennie will check the mail today and do a final count.

Spring Meeting — After some discussion, the Board agreed that a half-day presentation on Geoscientist Licensing would probably be timely. There was some general discussion of the program and logistics. Ray indicated that he would be able to check with some possible presenters for availability.

Fall Technical Program — Jan suggested a program on "GPS, Geodesy, and GIS". Another idea suggested was the hydrogeology of fractured media.

Next meeting — February 6, 1997, 7:30 a.m. at Egg & I.

Respectfully Submitted,
Jan Falteisek
MGWA Secretary

Dr. Mark Person Presents 1996-1997 Birdsall-Dreiss Lecture

Dr. Mark Person, Gibson Professor of Hydrogeology at the University of Minnesota presented this year's Birdsall-Dreiss lecture on January 16, 1997, a bitterly cold and windy night. Despite the weather, the lecture room in Pillsbury Hall was near capacity to hear the lecture sponsored nationally by the Geological Society of America and locally by the MGWA. The topic of the talk was Basin Scale Hydrogeologic Modeling, a long time focus of Dr. Person's research.

Dr. Person introduced the topic of basin scale hydrogeologic modeling by first reminding the audience of the importance of studying basin scale groundwater flow systems. These include economic factors such as the development of ore deposits and petroleum production. In addition, large scale flow processes have significant bearing on environmental issues such as nuclear waste siting. Experts in New Mexico are using their understanding of basin scale flow systems to predict areas of unusually warm ground water reservoirs in close proximity to the ground surface for siting of green-

houses and other similar "hothouse" industries.

After providing that context, Dr. Person began to set up the rest of his talk in which he presented the results of his research on basin-scale hydrogeologic modeling, using examples from the Rio Grande Rift in central New Mexico. The principal issues he identified in basin scale modeling involve the following:

- working out the stratigraphic and tectonic evolution of basins;
- estimating boundary conditions from geologic data;
- estimating the time evolution of rock properties such as permeability and porosity;
- de-convoluting coupled processes such as scale effects and thermal effects.

Each of these must be evaluated while conducting a basin-scale hydrogeologic investigation.

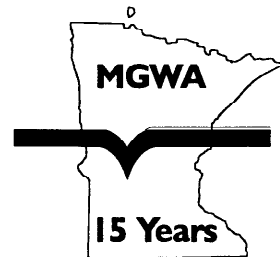
Because of the very long time frames that are involved in basin evolution (e.g., geologic time over millions of years) calibration and validation of models of such systems offers some unique challenges. There are numerous approaches, however. These include using fluid inclusions, radiometric dating of ore-

forming and diagenetic minerals, thermochronometers, and analyzing water-rock ratios of alteration mineral assemblages. He used the remainder of his presentation to discuss his studies of the Rio Grande Rift basin near Socorro, New Mexico, with particular emphasis on the use of thermochronometers.

Dr. Person's hydrogeologic modeling studies of the Rio Grande Rift Basin had a several key objectives:

- 1) to understand the role of K-metasomatism,
- 2) to evaluate the effects of tectonic controls on regional flow patterns, and
- 3) to analyze the evolution of the basin over the past 28 million years.

The results he has obtained are interesting and he presents some of them as computer-generated videos showing basin evolution. If you missed this talk, seek out another opportunity to hear Dr. Person present some of his research. It is well worth the time.



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 1997. Annual dues are \$20 for professional members and \$15 for students. Members are entitled to purchase the annual membership directory for \$7. 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 _____
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Work Address _____
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Fax Number _____
Home Address (optional) _____
City, State, Zip Code _____
Home Telephone Number _____

MGWA Calendar

March 23-26, 1997 Symposium on Application of Geophysics to Environmental and Engineering Problems
Reno, NV, Environmental and Engineering Geophysical Society
Contact SAGEEP
7632 E. Costilla Ave.
Englewood, CO 80112
(303)771-2000

April 2, 1997 MDH Annual Well Conference, Thunderbird Hotel
Bloomington, MN
Contact Ed Schneider (612)215-0827
See the agenda for this conference and a registration form elsewhere in this newsletter

April 6-9, 1997 6th Conf. Sinkholes, Eng. & Env. Impact Karst, Springfield, MO, Contact B.F. Beck, P.E. La Moureaux & Associates, P.O. Box 4578, Oak Ridge, TN 37831-4578, (423)483-7483
e-mail: pelaor@use.usit.net

April 28, 1997 MGWA Spring Conference, Registration of Geoscientists in Minnesota, 12:30 pm - 5:00 pm
Thunderbird Hotel, Bloomington, MN

April 28-May 1, 1997 In Situ and On Site Bioremediation New Orleans, LA
Contact The Conference Group, 1989 W. Fifth Avenue, Suite 5, Columbus, OH 43212-1912, (800)783-6338, e-mail: 102632.3100@compuserve.com

May 1-2, 1997 GSA North Central Section, Madison, WI, Contact: Bruce Brown, Wisconsin Geological and Natural History Survey, (608)263-3201
e-mail: babrown1@facstaff.wisc.edu

May 8-9, 1997 Institute on Lake Superior Geology Annual Meeting, Sudbury, Ontario, Canada, Contact Tracy Livingston, Resident Geologist's Office, Ontario Geological Survey
Sudbury, Ontario 93E 6B5 Canada
(705)670-5741,
e-mail: meyerw@gov.on.ca

May 16-18, 1997 University of Minnesota Pump Test Short Course, Lake Itasca area, Minnesota, Contact Dr. E. Calvin Alexander, Jr., University of Minnesota, Department of Geology and Geophysics, Room 107, Pillsbury Hall, 310 Pillsbury Dr. SE, Minneapolis, MN 55455, (612)624-3517,

(612)625-3819 (fax)
e-mail: alexa001@maroon.tc.umn.edu

July 15, 1997, Ground Water Hydrology, Dayton, OH, Contact Wright State University, Center for Ground Water Management, 3640 Colonel Glenn Hwy, 056 Library, Dayton, OH 45435, (513)873-3649, e-mail: IRIS@desire.wright.edu

July 31-August 20, 1997, U of M Hydrogeology Field Camp, Lake Itasca area, Minnesota, Contact Dr. E. Calvin Alexander, Jr., U of M, Dept. of Geology and Geophysics, 310 Pillsbury Dr. SE, Minneapolis, MN 55455, (612)624-3517, (612)625-3819 (fax)
e-mail: alexa001@maroon.tc.umn.edu

August 30-September 5, 1997 Large Meteorite Impacts and Planetary Evolution
Sudbury, Ontario, Canada
Contact: B. O. Dressler
Lunar and Planetary Institute
3600 Bay Area Blvd.
Houston, TX 77058-1113

Base maps for the 1990s Update

Cooperative work involving the state and the U.S. Geological Survey continues on the remaining two parts of the Base Maps program — statewide coverage of 1:24,000-scale Digital Elevation Models (DEMs) and 1:12,000-scale Digital Orthophoto Quads (DOQs). DEMs are now available for 84 percent of the state and the rest are in progress. DOQs are now available for 80 percent of the state; the rest is under contract. County CD-ROMs of the DOQ data are available for 54 counties; 11 more are near completion and the rest are under contract.

Two additional programs continue to progress. After some start-up problems, statewide coverage of Digital Raster Graphs (DRGs) is in progress. Also, the 1996 National Aerial Photography Program (NAPP) flight was flown for more than half the state during this last summer. Current status maps, as well as informational background on all of these programs, are available from LMIC or the project home page
<http://www.lmic.state.mn.us/bmap/bmap90.htm>.

Association for Women Geoscientists is Active in Twin Cities



The Association for Women Geoscientists (AWG) is a national organization, founded in 1977, to encourage women to become and remain geoscientists. AWG focuses on three major goals: to ENCOURAGE participation of women in geosciences; to EXCHANGE educational, technical, and professional information; and to ENHANCE the professional growth and advancement of women in the geosciences.

As part of our effort to realize the Association's goals, the Minnesota Chapter of AWG has made a commitment to community outreach by providing classroom talks and meeting with interested groups ranging from Girl Scouts and Cub Scouts to senior citizens. In addition, AWG sponsors the Inga Lehmann Scholarship for an outstanding woman who shows promise as a geoscientist. AWG is in the process of starting our annual fundraising campaign for the 1998 award.

If you are interested in learning more about AWG, would like to do classroom presentations, or help with fundraising for the Inga Lehmann Scholarship, please come to one of our meetings. Membership is open to all who support AWG's goals. AWG meets the second Thursday of the month at the Egg and I at University and 280 in St. Paul. If you'd like to talk to someone for more information about Minnesota Chapter Programs, please call Kate Kleiter, President, at (612) 659-7572. For membership information, contact the Association's office:

Association for Women Geoscientists
c/o Dr. Jeanette H. Leete
4779 126th Street North
White Bear Lake MN 55110-5910
(612)426-3316, FAX (612)426-5449

**MDH WELL CONFERENCE
APRIL 2, 1997**

AGENDA (TENTATIVE)

8:00 a.m.

Registration, Continental Breakfast

**PLENARY SESSION
(Moderator: Dan Wilson, MDH)**

8:25 - 8:30	Welcome	Dan Wilson, MDH
8:30 - 8:50	MDH Well Management Unit Update	Dan Wilson, MDH
8:50 - 9:45	MDH Field Experiences and Case Histories	Robert Nielsen, MDH
		Patrick Sarafolean, MDH
		Chris De Mattos, MDH
9:45 - 10:00	BREAK	
10:00 - 11:00	Confined Space Hazards	Paul Ellringer, Tamarack Environmental Consultants
11:00 - 11:30	Trenching and Excavation Hazards	Mylon Stark, Mn. OSHA
11:30 - 12:00	Well Construction/Site Safety	Mylon Stark, Mn. OSHA
12:00 - 1:00	LUNCH	

1:00 - 3:45

AFTERNOON CONCURRENT SESSIONS

**1. FULL CONTRACTORS
(Moderator: Steve Gruber, MDH)**

1:00 - 2:00	Vertical Heat Exchangers	Scott Jones, Econar
2:00 - 2:30	Hydrofracturing	Ken Kratt, Flatwater Fleet
2:30 - 2:45	Break	
2:45 - 3:15	Sealing Unconventional Wells	Kelly Jorgensen, MDH
3:15 - 3:45	Code Compliance Issues	Mark Malmanger, MDH
		Peter Zimmerman, MDH

**2. ENVIRONMENTAL CONTRACTORS
(Moderator: Douglas Edson, MDH)**

1:00 - 2:00	Overview of Geotechnical Borings	Jim Rudd, American Engineering Testing
2:00 - 2:30	Site Investigation & Remediation - Case Study	MPCA
2:30 - 2:45	Break	
2:45 - 3:15	MPCA--Brownfields Program	Joe Otte, MPCA
3:15 - 3:45	Code Compliance Issues	Mark Hoffman, MDH

**3. LIMITED CONTRACTORS
(Moderator: Jeff Grugel, MDH)**

1:00 - 2:30	Pumps, Pump Electrical Systems	
2:30 - 2:45	Break	
2:45 - 3:15	Elevator Construction	Mark Stangret, Midwest Drilling
3:15 - 3:45	Code Compliance Issues	Michael Sutliff, MDH

Questions: If you have questions, or if you have a disability and need an accommodation to make this program accessible, please contact Edward Schneider at 612/215-0827 or Marlene Randall at 612/215-0810.

(Over for More Important Information)

Registration for the 1997 Well Conference

Name _____ Firm _____

Street Address _____ City/State/Zip _____

Minnesota Department of Health Well Contractor License Number (or occupation, if applicable) _____

Please circle which session you are planning on attending in the afternoon. 1 - 2 - 3

Fee (\$50) Enclosed ____ Will pay at the door (\$60) ____ Check/Money Order No. ____ Cash ____
Please mail by March 19, 1997, to: Minnesota Department of Health, Well Management Unit, P.O. 64975, St. Paul, Minnesota 55164-0975. Registrations postmarked after March 19, 1997, will require a \$60 fee. You may call 612/215-0811 or fax (612/215-0978) your late registration, but you must pay \$60 at the door.

- Directions: Thunderbird Hotel, 2201 East 78th Street, Bloomington. Take the 24th Avenue exit off I494, go south for less than 1/2 block, turn sharp right on the frontage road to the hotel. For lodging call the hotel (1-800/328-1931). Some of the other motels in the area are: Comfort Inn-Airport, 1321 East 78th Street, Bloomington (1-800/272-7585), Minneapolis Marriott Bloomington, 2020 East 79th Street, Bloomington (1-800-228-9290, and Motel 6, 7640 Cedar Avenue South, Richfield (612/861-4491).
- Time: Registration at 8:00 a.m. Please preregister to be certain that we will have lunch for you and to avoid the late fee. Use the registration form on this announcement.
- Cost: Fifty dollars in advance, if the registration is postmarked by March 19, 1997. Sixty dollars after that date, on the site, by phone, or by fax. No refunds unless request is received before March 19, 1997.
- Credit Hours: 6.0 hours of continuing education credit will be awarded.

(See agenda on reverse side)

IMPORTANT ANNOUNCEMENT 1997 WELL CONFERENCE APRIL 2, 1997

Minnesota Department of Health Well Management Unit Announces
Annual Well Conference

Wednesday, April 2, 1997, Thunderbird Hotel, Bloomington

Minnesota Department of Health
Well Management Unit
Metro Square Building, Suite 220
P.O. Box 64975
St. Paul, Minnesota 55164-0975

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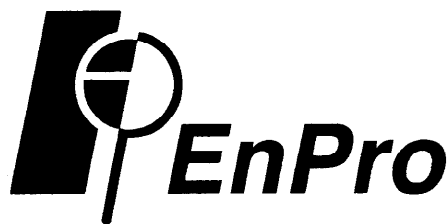
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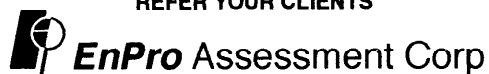
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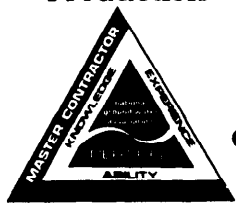
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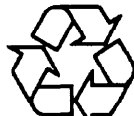
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