Minnesota Ground Water Association

Volume 11, Number 3: November 1992

AIPG/MGWA Fall Field Trip Had a Real "Rocky" Time

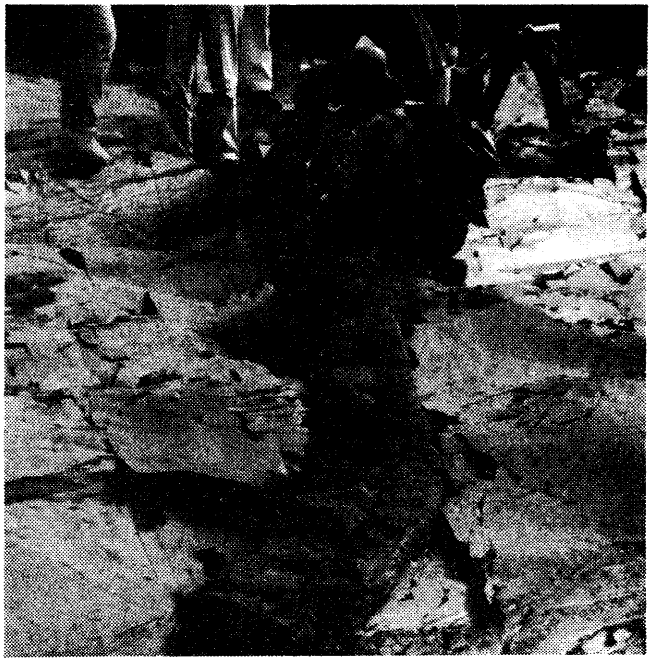
—Neal Wilson, MPCA

The day after the fall technical program, the AIPG and MGWA conducted a joint geology field trip. Doughnuts, coffee and juice were provided before the buses arrived to help jump-start the participants. The surplus doughnuts followed us to several stops before they were finally consumed, at the urging of Mike Convery. The day was pleasant, warm and sunny, and many of the trees were in their fall colors.

The first stop was at Thomson Dam. The Middle Precambrian graywacke, siltstone and mudstone near the dam were most likely deposited in a foreland basin, and were subsequently metamorphosed and folded during the Penokean orogeny (1850?Ma.) As shown in the photo, these deposits were later intruded by diabase dikes which fed the Middle Proterozoic Keweenawan lava flows.

The second stop was at an excavated face of the Cloquet Esker, which is the highest esker in Minnesota. This esker is being mined by the City of Cloquet for gravel (see photo). The esker was deposited in a meltwater tunnel at the margin of the Superior Lobe during an advance about 15,000 years ago. Agates were found by the field trippers including one "about the size of a golf ball." To the Quaternaryists in the group, till is NOT merely overburden, as hardrockers would have you believe.

Stop three at the Thompson Hill Information Center included a lunch stop of catered box lunches (and optional doughnuts!) followed by a discussion of fractionization of magma and the resultant layered olivine gabbros outcropping across the parking lot from the Information Center. The group was then treated to the fabulous view of Duluth Harbor, juxtaposing on it a view into the past of the retreating Superior Lobe and



—Dike at Thomson Dam

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Massachusetts Reviews Licensed Site Professionals Status

Massachusetts legislation would amend the state Superfund law to require that only licensed site professionals (LSP) perform waste site cleanup services. Regulated waste site cleanup services would include response actions, short-term measures, interim remedial response, temporary measures, final remedial response plans, permanent solutions, managing public participation, and providing opinions excluding legal advice or legal opinions. H.R. 5891 would require LSP's to judge when a site is clean, assign responsibility to regulators for defining LSP qualifications, and require differing responsibilities and potential liabilities for LSP's depending on the level of site cleanup difficulty.

—Briefings, NGWA, Fall, 1992

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it's associated Glacial Lake Duluth. The aviarists in the group were on the lookout for migrating hawks which can number in the hundreds, and fly through the area in a span of a couple of days.

The fourth stop was at one of the two working faces of Silver Cliff Tunnel (under construction). Large scale drilling, blasting, and utilization of rock bolts are required to "muck" through the layered, fractured diabase sill and country-rock lava flows (see photo). A specialized multi-articulated electric powered drill is employed to drill into the rock (see photo) for emplacement of rock bolts and explosive charges.

The fifth stop was at the sequence of gently dipping olivine tholeiite basalt flows at Gooseberry River. The falls below the highway reveal three gently-billowing lava surfaces which are typical of very fluid lava flows found in Quaternary basalts in Iceland and Kilauea, Hawaii. Infilled vesicles (sometimes with agate) help to determine the tops of the flows as the vesicles were originally gas bubbles which rose to the top of the lava. One of the more sociologically observant persons in the group no-

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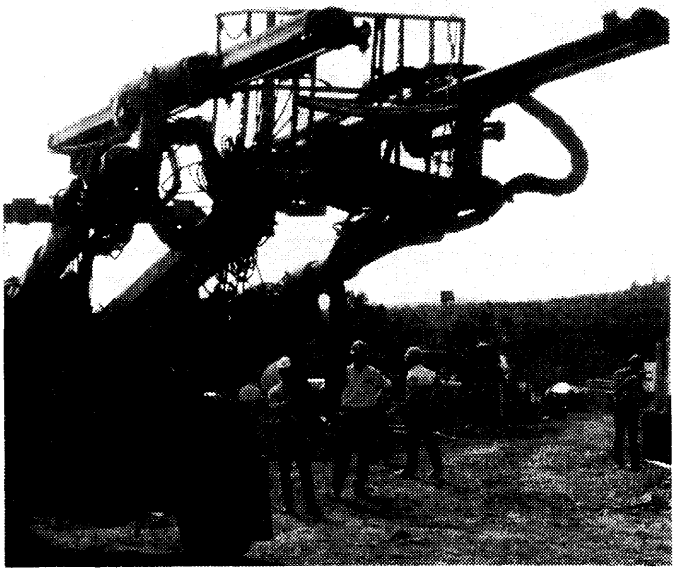
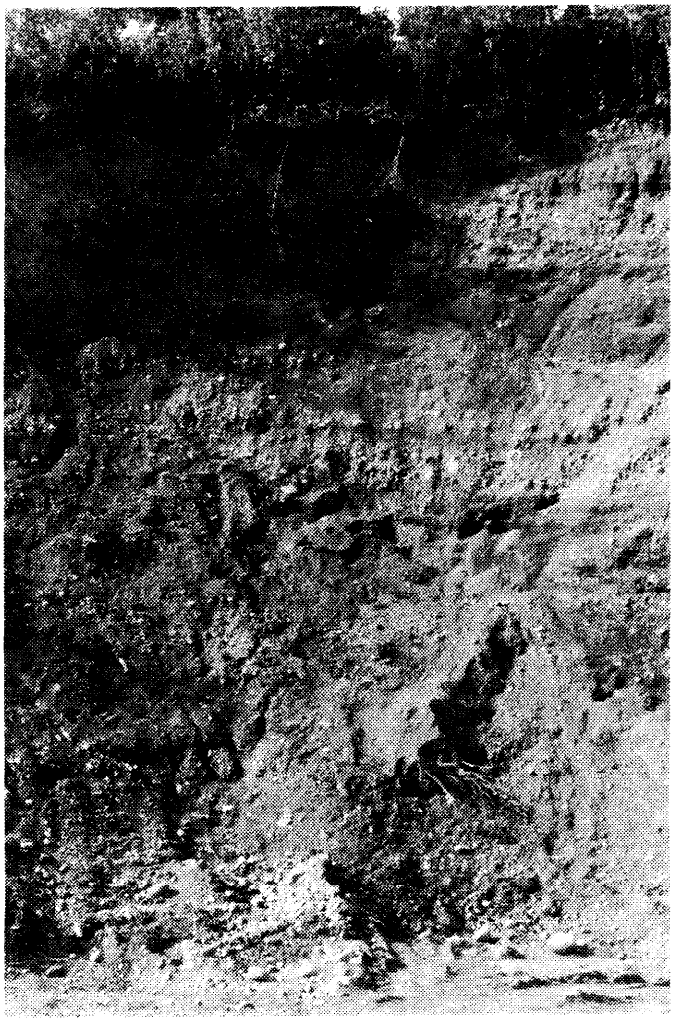


—Multiarticulated drill



—Cloquet Esker

—Rock Bolts at Silver Cliff Tunnel

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New Ground Water Publications From Minnesota Extension Service

The Minnesota Extension Service has reprinted two ground water bulletins originally developed by Lyle Raymond at Cornell University. The first, "What is Groundwater?" covers the basics of ground water occurrence and movement, supplemented by clear graphics. Intended for the general public, the bulletin illustrates such tricky concepts as artesian pressure, ground water flow paths and rates, and well contribution zones.

"Groundwater Contamination" is the second newly reprinted bulletin originally developed by Lyle Raymond at Cornell University. The bulletin focuses on land use management for ground water quality protection. Similar in format to "What is Groundwater?," this companion bulletin illustrates potential problems from septic systems, landfills and land application of various products and wastes. Clear illustrations help get the concepts across to the reader.

For copies, contact the Minnesota Extension Service and ask for "What is Groundwater?", Bulletin AG-FO-5867-C, 1992 and "Groundwater Contamination", Bulletin AG-FO-5866-C, 1992.

For more information about the project, contact Fred Bergsrud, University of Minnesota, Agricultural Engineering Department.

New Ground Water Posters

Three posters featuring a robot-like Groundwater Defender are now available from Western Michigan University. the posters are primarily for the elementary school level and portray information about the water cycle, groundwater contamination and ways to protect the resource. For more information contact Western Michigan University, Groundwater Education in Michigan Regional Center, Kalamazoo, MI 49008-5150, ph. (616) 387-5505.

—Focus (International Joint Commission), July/August 1992

—from page 2

ticed that while we were at this picturesque park a marriage proposal was offered and accepted.

As it was getting late, the group was given the option of returning to Duluth or going on to the Palisade Head rhyolite rheoignimbrite at Shovel Point. Shovel Point is essentially a dip slope on top of a 95 meter thick rhyolite flow. This rhyolite was emplaced as a very hot pyroclastic flow that quickly welded and re-homogenized, and then flowed as a lava.

Michigan Aquifer Vulnerability Map Available

A new aquifer vulnerability map prepared by the Center for Remote Sensing at Michigan State University used a geographic information system (GIS) to assemble and analyze the various data sets needed to construct the map. Data was obtained from the Michigan Department of Natural Resources, the Statewide Soils Geographic Database (STATSGO) from the USDA, Soil Conservation Service, and the Michigan Statewide Ground-Water Database. Dr. David Lusch at the Center, ph. (517)355-8497, was the primary investigator. Copies of the map are available by calling (517) 353-7195. Or send $5.00 (good for up to 25 copies) to: Center for Remote Sensing, Michigan State University, 302 Berkey Hall, East Lansing, MI 48824-1111.

AIPG December Luncheon Speaker

On December 8th, 1992, Bruce Erickson, Science Museum of Minnesota, will speak on the topic: "Paleoenvironment Reconstruction Through the Use of Crocodilian Vertebrate Fossils" at the Roseville Holiday Inn, 2540 North Cleveland at 11:45 am. Lunch is $9.00 for AIPG members and students and $9.50 for others.

PCBs

Quicklime Cleanup Technique Doesn't Work

An earlier report in Focus, a publication of the International Joint Commission, noted a story based on an EPA news release that researchers had discovered that quicklime, a readily available byproduct of limestone, appeared to destroy PCBs in contaminated soil or sludge. Since that time, results published in the November 1991 issue of Environmental Science and Technology shows the quicklime cleanup technique doesn't work.

Four researchers from the University of Wisconsin-Madison reported that the precise manner in which quicklime reacted with the PCBs, and the chemical components of quicklime that caused the reaction were not identified. In two experiments, they heated PCB-contaminated solids and quicklime together in a flask, and again in simulated field conditions. In both cases, most of the PCBs simply evaporated. The PCBs were transformed from their liquid state into a vapor form and transferred to air, but were not destroyed.

The relative indestructibility of PCBs has made them one of the most persistent toxic contaminants in the environment today. PCB manufacture in the U.S. was banned in 1976, but half of the 1.4 billion pounds of PCBs produced has already entered the environment, and use and disposal of products containing PCBs continues.

For more information contact University of Wisconsin Sea Grant, 1800 University Ave., Madison, WI 53705, ph. (608)263-3259.

—Focus (International Joint Commission), July/August 1992

Laser Destruction of PCBs May be Possible

Researchers at the University of Michigan are exploring the use of ultraviolet or UV light to photodegrade PCBx and related compounds. UV light is capable of breaking down many synthetic organic pollutants, but the amount of ultraviolet light that reaches the earth's surface is relatively small. Powerful lasers, termed pulsed eximer lasers, can produce peak powers of millions of watts, at specific wavelenths, and can be highly focused on a small area. Such intense light energy is capable of destroying PCBs without the addition of other chemicals or catalysts.

Preliminary results using aqueous solutions of Aroclor 1221, a commercial PCB mixture, indicate that the PCBs degrade rapidly when exposed to laser light. Researchers hope to determine whether laser destruction might be applicable to PCBs that have been concentrated and extracted from water, soils, and sediments, or to PCB mixtures found in electrical equipment such as transformers.

For additional information contact Dr. Stephen J. Parus, Department of Chemistry, University of Michigan, Ann Arbor, MI 48109, ph. (313) 936-3818.

—Focus (International Joint Commission), July/August 1992

Participants Sought for New ASTM Task Force

Participants are sought for a new task group - tentatively titled Sediment Sample Extractables: Normalization of Trace Contaminant Levels - currently being organized by Subcommittee D19.07 on Sediments, Geomorphology, and Open-Channel Flow. D19.07 is a subcommittee of ASTM standards-writing Committee D-19 on Water.

All interested individuals are welcome to join the task group. It will meet in Florida in January 1993, in conjunction with the meetings of Committee D-19.

Contact Victor Janzer, U.S. Geological Survey, MS 401, Box 25046, Federal Center, Denver, CO 80225, (303) 980-5626; or Bob Held, ASTM, 1916 Race St., Philadelphia, PA 19103-1187.

Newsletter Advertising Policy for 1992

Advertising space is available in this newsletter to businesses and organizations. Display ads (4 issues = 1 year) are charged by fractional page:

Size	inches	Annual Rate
business card	3.5x2.4	$50
quarter page	3.5x5	$90
half page	7x5	$170
full page	7x10	$320

Copy should be a photostat of your camera-ready artwork.

The Editor has final determination on the acceptance of materials submitted. There are no commissions on ads. Advertising copy must be received by the publication deadlines: February 15, May 15, August 15, or November 15. The ad should be accompanied by a purchase order or a check. Checks should be payable to the Minnesota Ground Water Association. All materials should be sent to the Editor:

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Fall Seminars 1992

University of Minnesota

Department of Geology and Geophysics

Professor E. Calvin Alexander, Jr., Dept. Geology and Geophysics, University of Minnesota:

Nov. 12. *Minnesota Ground Water: How Old is it and Why Should You Care?*

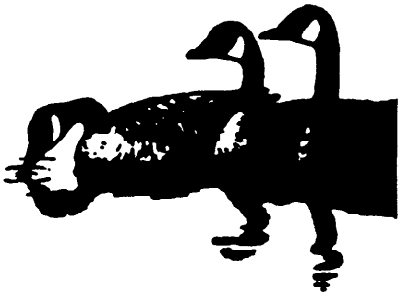
Dr. Robert Zierenberg, JOI/USSAC Distinguished Lecturer, U.S. Geological Survey, Menlo Park, CA

Nov. 19. *Seafloor Hydrothermal Systems on the Gorda and Juan de Fuca Ridges: Implications for the Formation of Massive Sulfide Deposits*

Professor Fred M. Phillips, Dept. of Geosciences, New Mexico Institute of Mining and Technology, Socorro, MN:

Dec. 3. *Cosmic Rays and Ice: A 36Cl Chronology for Sierra Nevada Glaciations*

Seminars are presented on Thursdays (unless otherwise noted) at 3:30 pm in 110 Pillsbury Hall, followed by refreshments in 121 Pillsbury Hall.



Pete Thein 1993 NGWA President

Pete Thein of Thein Well Company was recently elected President of the National Ground Water Association. A third-generation well driller, Pete runs the Spicer, Minnesota office of Thein Well, which celebrates its 100th anniversary next year.

Research Program Targets Hydrologic Sciences

The President's Budget Request for Fiscal Year 1993, announced in January, includes a request for $2.5 million to begin a new basic research program in hydrologic sciences at the National; Science Foundation. According to Robert Corell, the Foundation's assistant director for geosciences, the new program is an initial response to a report on Opportunities in the Hydrological Sciences recently issued by the National Research Council.

The new program, to be located within the Foundation's Division of Earth Sciences, will provide funding for basic research dealing with the earth's hydrologic cycle and the role of water on and near the continental surface of the earth.

Research proposals relating to water in the form of precipitation, lakes, streams, and ground water, and their interactions with landforms, climate, weather, the biosphere, and the earth's crust will be eligible for submission to the new program. Where appropriate, research proposals will be considered for joint review and possible joint funding with other Foundation programs.

Subject to appropriation of funds by congress, it was expected that the new program would receive proposals from university and college investigators beginning in May for funding during FY 1993. Proposal deadline date is expected to be December 1, 1992.

For further information about the program, about procedures for proposal submission, and about opportunities to serve as program officer or proposal reviewer, contact James Hays, Division Director, Division of Earth Sciences, National Science Foundation, Washington, D.C. 20550. Tel: (202) 357-7958; fax: (202) 357-0364.

—Ground Water Monitoring Review, Summer, 1993

EPA Regs Define Qualified Ground Water Scientist

In the U.S. Environmental Protection Agency's (EPA) final municipal solid waste landfill rule and in the final rule on ground water monitoring well locations at interim status hazardous waste facilities, the term "qualified ground water scientist" is used.

Final municipal solid waste landfill rules were published in the October 9, 1991, Federal Register. Five provisions of the final rule require certification by an independent, qualified ground water scientist: (1) no potential for migration demonstration; (2) number, spacing, and depths of monitoring systems; (3) determination that contamination was caused by another source or that a statistically significant increase resulted from an error in sampling, analysis, or evaluation; (4) determination that compliance with a remedy requirement is not technically practicable; (5) completion of remedy. The rule also allows the owner or operator to obtain the approval of the director of an approved state in lieu of the certification of an independent, qualified ground water scientist.

Under the municipal solid waste landfill rule, EPA defines a qualified ground water scientist to be: '...a scientist or engineer who has received a baccalaureate or post-graduate degree in the natural sciences or engineering and has sufficient training and experience in ground water hydrology and related fields as may be demonstrated by state registration, professional certification, or completion of accredited university programs that enable that individual to make solid professional judgments regarding ground water monitoring, contaminant fate and transport, and corrective action." [40 CFR Section 258.50(f)]

The preamble of the rule states that specialized course work and training should include,

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at a minimum, physical geology, ground water hydrology or hydrogeology, and environmental chemistry. Organizations, such as the National Ground Water Association and the American Institute of Hydrology, certify or register ground water professionals. States may establish more stringent requirements including mandatory licensing or certification. [56 FR 50978, October 9, 1991]

In a final rule allowing ground water monitoring wells to be installed at alternate locations at interim status facilities when existing physical obstacles prevent installation at the limit of the waste management area, EPA also includes a definition of a qualified ground water scientist. The rule provides that the owner or operator of an existing hazardous waste facility may demonstrate that an alternate hydraulically downgradient monitoring well location will meet several criteria. The demonstration must be certified by a qualified ground water scientist. The definition in the rulemaking is the same as that contained in the municipal solid waste rule except that it does not mention corrective action.

U.S. EPA plans in future rulemaking to revise other ground water-related certification provisions in 40 CFR part 265 so that they are consistent.

—Briefings, NGWA, Fall 1992

Ground Water Modeling Section Started by ASTM

The American Society for Testing and Materials (ASTM) Subcommittee D18.21 on Ground Water and Vadose Zone Investigations has a Section D18.21.10 on Ground Water Modeling. The task group is developing guidelines for ground water modeling that relate to both model applications and software. A cooperative agreement between EPA, the USGS, and the U.S. Navy is sponsoring the work of a task group to accelerate development of draft standards for final development by Section D18.21.10 and subsequent balloting in Committee D18 on Soil and Rock.

Those familiar with ground water modeling are encouraged to get involved in ASTM Section D18.21.10 standards development activities. Individuals interested in participating in this activity should write to Joe Ritchey, Chairman, ASTM Subcommittee D18.21.10, Heritage Remediation/Engineering, 5656 Opportunity Dr., Toledo, OH 43612; or Jim Rumbaugh, Vice-Chairman, Subcommittee D18.21.10, Geraghty and Miller, Inc., 10700 Parkridge Blvd., Ste. 600, Reston VA 22091. The ground water modeling section usually meets the last week of January and the last week of June.

News from the "U"

Mark Person, currently on the faculty at the University of New Hampshire, will join the ground water group in the Department of Geology and Geophysics at the University of Minnesota next spring quarter as the holder of the George and Ophra Gibson Professorship in Hydrogeolgoy. Among his interests are applied hydrogeology and large scale hydrologic modeling.

Vyacheslav G. Ruminyn from the Saint Peterburg Mining Institute, Russia, is the first George and Ophra Gibson Visiting Professor at the Department of Geology and Geophysics at the University of Minnesota for the fall quarter 1992. He has an undergraduate degree in hydrogeology and engineering geology as well as a Dsc. He has written extensively on ground water contamination programs and mass transfer. In St. Petersburg he does research in hydrogeology and specifically contaminant hydrology. Presently he is working with H.O. Pfannkuch on problems of well head protection. He will be giving a series of lectures on practical aspects of investigations of groundwater pollution problems carried out in Russia. Vyacheslav can be reached in the Department of Geology and Geophysics at the University of Minnesota at 625-6516.

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 1993. Annual dues are $15 for professional members and $10 for students. Additional donations toward the use of 100% recycled paper will be gratefully accepted.

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

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Calendar

1992

November 17. *Processes of Ground Water Contamination: Field Investigations in Russia and Forecasting by Simulation.* Part 3: Interpretation of aquifer tracer tests in the field through well injection. Time: 3:35 - 4:30. Location: University of Minnesota, Department of Geology and Geophysics, 121 Pillsbury Hall, 310 Pillsbury Drive SE, Minneapolis.

November 30 - December 4. *Practical Karst Hydrogeology with Emphasis on Ground Water Monitoring.* To be held in Cave City, KY by the NGWA.

December 1. *Processes of Ground Water Contamination: Experience of Field Investigations in Russia and Results of Forecasting by Simulation.* Part 4: Mass transfer in ground water reservoirs. Conceptual models for heterogeneous porous media. Time: 3:35 - 4:30. Location: University of Minnesota, Department of Geology and Geophysics, 121 Pillsbury Hall, 310 Pillsbury Drive SE, Minneapolis.

December 1 - 3. *Corrective Action for Containing and Controlling Ground Water Contamination.* To be held in Orlando, Florida by NGWA.

December 1 - 4. *Petroleum Hydrocarbons and Organic Chemicals in Groundwater: Practical Models for Site Assessment and Remediation.* To be held in Orlando, FL by IGWMC.

December 14 - 17. .*Groundwater Flow and Well Hydraulics.* University of Wisconsin, Madison, WI. Contact: College of Engineering, UW-Madison, 432 North Lake St., Madison, WI, (800)462-0876 or (608)262-1299, fax (608)263-3160.

1993

January 3 - 8. *IBM-PC Applications in Ground Water Pollution and Hydrology: A Hands-On Short Course.* To be held in San Francisco, California by NGWA.

January 13 - 15. *9th Annual Ground Water Contaminant Transport Modelling Course.* Contact: College of Engineering and Mathematics, The University of Vermont, 109 Votey Building, Burlington, VT 05405, (802)656-1941.

January 25 - 27. *4th Mulitdisc. Conf. on Sinkholes and the Eng. and Environ. Impacts of Karst.* Panama City, FL. Contact: Barry Beck, FL Sinkholes Res. Inst., Univ. of Cent. FL, Orlando, FL 32816, (407)823-5645.

February 1 - 3. *71st Annual MWWA Convention and Exposition, Hazmat Conference.* To be held at the Minneapolis Marriott SW, 5801 Opus Parkway, Minnetonka, MN. For more information, contact Michael Maile (612)290-2823.

February 8 - 11. *9th Thematic Conference, Geologic Remote Sensing.* Pasadena, California. Information: ERIM/Thematic Conferences, Nancy J. Wallman, P.O. Box 134001, Ann Arbor, MI 48113-4001, (313)994-1200x3234, fax (313)994-5123.

March 29 - 30. *GSA North-Central Section Meeting.* Rolla, Missouri. Information: Richard Hagni, Dept. of Geology and Geophysics, University of Missouri, Rolla, MO 65401, (314)341-4616.

April 5 - 8. *2nd International Symposium on In Situ and On-Site Bioreclamation.* San Diego, CA. Contact: Phillip Wells, The Conference Group, 1989 W. Fifth St., Ste, 5, Columbus, OH 43212-1912, (800)783-6338, fax 614)488-5747.

April 17 - 21. *Canadian Quaternary Association (CANQUA).* Victoria, British Columbia, Canada. Information: Environmental Geology Section, BC Geological Survey Branch, 553 Superior St., Victoria, British Columbia, V8V 1X4, Canada, (604)387-6249, fax (604)356-8153.

April 19 - 21. *Application of GIS in Hydrology and Water Resources Management.* Baden (Vienna), Austria. Contact: HydroGIS 93, c/o Interconvention, Austria Center Vienna, A-1450 Vienna, Austria, +43 (222) 23 69 2641, fax +43 (222) 23 69 648.

May 15 - 21. *USA/CIS 2nd Joint Conference on Environmental Hydrology and Hydrogeology.* Industrial and Agricultural Impacts on the Hydrologic Environment, Arlington, VA. Contact: AIH, 3416 University Ave. S.E., Minneapolis, MN 55414-3328, (612)379-1030.

June 9 - 12. *1993 Ground Water Modeling Conference.* To be held by IGWMC.

June 24 - 25. *ASTM Symposium on Analysis of Soils Contaminated with Petroleum Constituents.* Atlanta, GA, Contact: Tracey O'Shay, Gordon and Lawton, P.O. Box 80072, Austin, TX 78727-0072, (512)475-2302.

August 15 - 20. *IBM PC Applications in Ground Water Pollution and Hydrology.* To be held in San Francisco by NGWA.

October 25 - 28. *Geological Society of America Annual Meeting.* Boston, MA. Contact: GSA, Box 9140, 3300 Penrose Pl., Boulder, CO 80301, (303)447-2020.

More details available from:

For information about meetings and seminars to be held by the American Water Resources Association (AWRA), contact Michael C. Fink, AWRA, 5410 Grosvenor Lane, Suite 220, Bethesda, MD 20814-2192, (301)493-8600, Fax: (301)483-5844.

For information about meetings and seminars to be held by the National Ground Water Association (NGWA), formerly the National Water Well Association, contact NGWA at 6375 Riverside Drive, Dublin, Ohio 43017 (614) 761-1711.

For information about Short Courses held by the International Ground Water Modeling Center (IGWMC), contact the IGWMC, Institute for Ground Water Research and Education, Colorado School of Mines, Golden, Colorado 80401-1887, (303)273-3103, Fax (303)273-3278.

Tritium In Ground Water As A Tool To Estimate Well Vulnerability

By James F. Walsh, Minnesota Department of Health

Comprehensive ground water and wellhead protection (WHP) efforts in Minnesota are hampered by limited hydrogeologic information for many of the state's aquifer systems and by an inadequate understanding of the interaction between land-surface activities and ground water resources. State programs have begun to determine hydrogeologic conditions at the county level, to evaluate the geologic sensitivity of water table aquifer systems, and to collect baseline water level and water quality data. While these programs provide invaluable information, it may be some time before statewide coverage is attained.

An interim approach must be developed to examine the interaction between surface water and ground water and to directly assess the geologic sensitivity of well sites so that public water supply wells can be prioritized for WHP.

The time required to recharge an aquifer is a measure of the degree of inter-connection between surface water and ground water. The "age" or residence time of ground water is the time required for infiltrating precipitation or surface water to recharge an aquifer and be pumped from a well. ground water age or residence time can be estimated by measuring the concentrations of radioactive isotopes of elements such as carbon and hydrogen. The best methodology to determine the short-term residence times of ground water is tritium age dating (Hendry, 1988).

Tritium is an isotope of hydrogen with a half-life of 12.43 years. Trace amounts occur naturally in the atmosphere as a result of cosmic ray inter-action with nitrogen atoms. Atmospheric testing of nuclear weapons in the 1950s and 1960s introduced large amounts of tritium into the environment. Atmospheric concentrations of tritium increased from a pre-1954 level of a few tritium units (a tritium unit is one tritium atom per 10^{18} atoms of hydrogen) to peak levels of between 1000 and 2000 tritium units at North American monitoring stations. Maximum tritium levels occurred in 1954, 1959, and 1964 at Ottawa, Canada. Pre-bomb tritium, with its short half-life, has now decayed to less than one tritium unit.

The short half-life of tritium and the large fallout peaks associated with atmospheric testing of nuclear weapons make tritium an excellent indicator of water that has recharged aquifers since 1954. Conversely, the absence of tritium indicates ground water dominated by pre-1954 recharge. Although hydrogeologic mapping and aquifer characterization studies are needed to identify the geological pathways that recharge aquifers, tritium surveys provide a means to identify sensitive ground water areas and are a first step in understanding local ground water conditions.

From June to December of 1991, MDH sampled 212 wells for tritium and a suite of inorganic chemical parameters. The sampling program was structured to provide broad geographic coverage of the state, while ensuring that some of the major hydrogeologic settings were investigated in some detail. Prior to this study, over 500 wells and springs

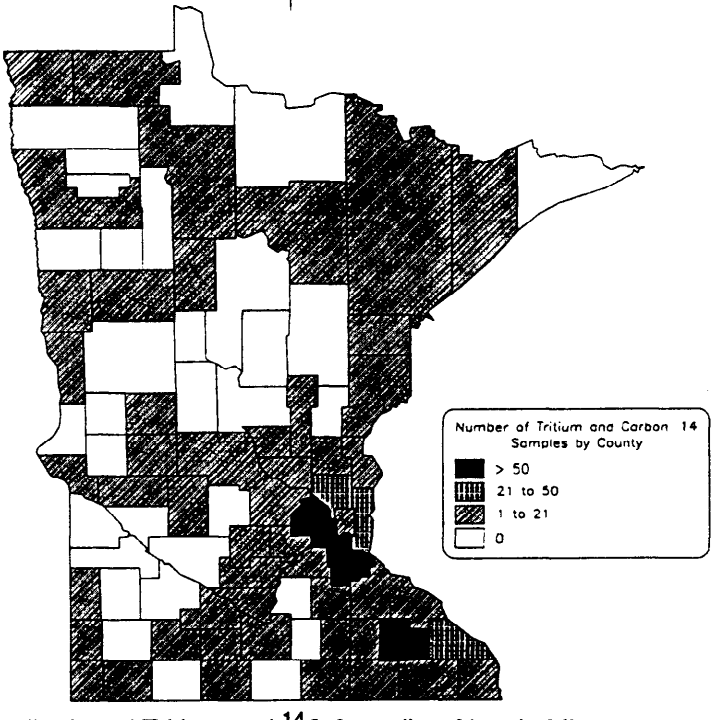

Figure 1. Distribution of Tritium and ^{14}C Sampling Sites in Minnesota (n=735).

Table 1. ground water residence classification methodology (Alexander, 1990).

Residence Classification	Tritium Concentration (TU)	^{14}C (% Modern Value)	Residence Time
Recent	>10	>50	Post-1953
Mixed	1 - 10	>50	Mixture of Post-1953 and Older Water
Vintage	<1	>50	Pre-1954

had been sampled for tritium or ^{14}C in Minnesota as a result of other ground water studies (Alexander and Alexander, 1989; Tipping, 1992). The distribution of tritium and/or ^{14}C sampling sites in Minnesota as of December, 1991 is shown in Figure 1. The data gathered in this study were evaluated along with ground water age data from other studies to more thoroughly examine relationships between ground water residence and geologic sensitivity in Minnesota. Tritium analytical results were interpreted according to the classification scheme of Alexander, 1990 (Table 1).

Tritium Content of Contaminated Ground water

The tritium content of contaminated ground water may be used to calibrate a tritium-based well vulnerability rating scheme. Previous studies had established the correlation between ground water dominated by post-1953 recharge and elevated concentrations of contaminants such as nitrate-nitrogen, chloride, and sulfate (Alexander and Alexander, 1989; Tipping, 1992). The results from this study corroborate and expand on those data, suggesting that the same relationship holds for VOC and pesticide impacted ground water. Each of the 13 wells in this study that have yielded VOC or pesticide contamination or nitrate-nitrogen concentrations in excess of the drinking water standard had tritium signatures indicating the presence of a component of post-1953 recharge. With one exception, the tritium concentrations from these wells exceeded 7 tritium units, near the high end of the mixed water category. This relationship could be used in evaluating the contamination potential of wells. Wells that yield water with a significant component of post-1953 recharge should be prioritized for WHP and contaminant monitoring efforts.

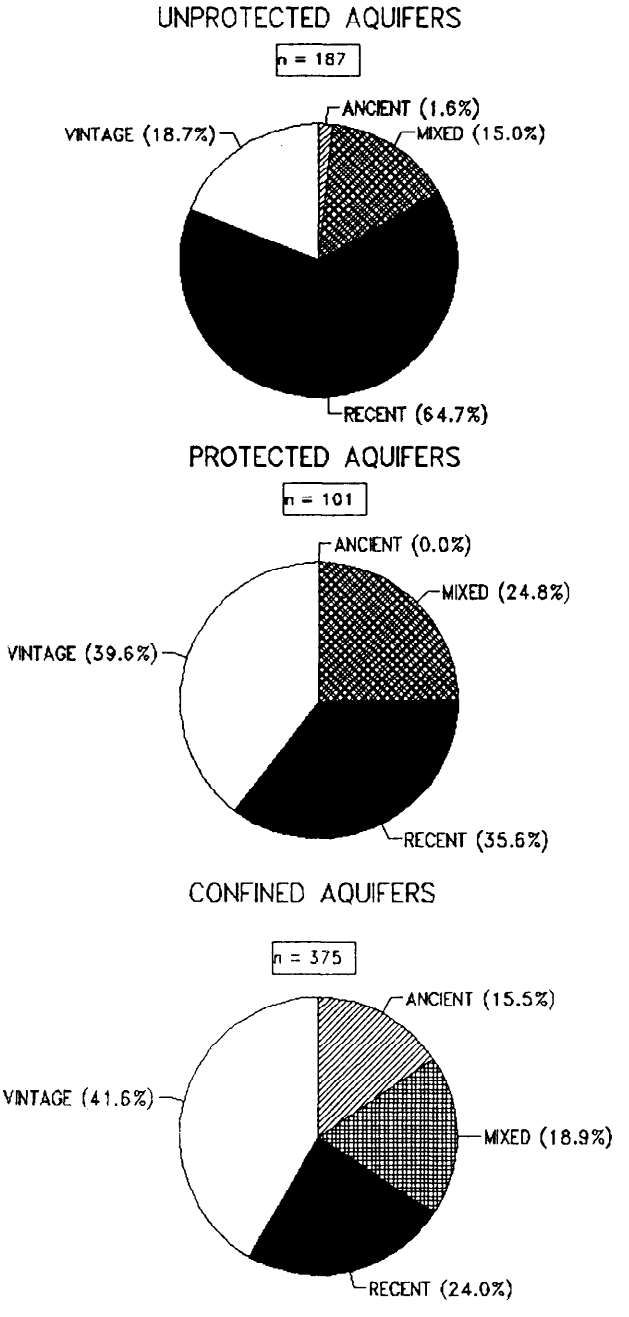

Figure 2. Ground water residence as a function of hydrogeologic setting.

A tritium concentration between 1 and 5 tritium units, as determined by enriched tritium analyses, might be used as a cut-off for indicating vulnerable wells. Such values are high enough to eliminate questions of analytical uncertainty regarding results near the enriched tritium method detection limit. Also, Tipping (1992) has proposed that tritium concentrations up to 5 tritium units may represent a subset of the mixed category of ground water known as "low-mix." It is proposed that this subset represents ground waters that are dominated by vintage water with a small admixture of recent water.

Ground Water Age vs. Geologic Sensitivity Assessments

The wells evaluated in this study were divided into two general categories, protected and unprotected, on the basis of the presence or absence of low permeability units (clay, till, shale) overlying the aquifer as described in well construction records. Protected conditions were further subdivided into confined and unconfined categories. Confined conditions were defined by the occurrence of the static water level, as indicated on the well record, above a fully saturated aquifer directly overlain by a low permeability unit; whereas, unconfined conditions were defined by the presence of the static water level within a less than fully saturated aquifer overlain by a low permeability unit.

Geologic sensitivity was determined for each well used in this study based on criteria developed by the Minnesota Department of Natural Resources (DNR) that estimate the time of travel for water moving vertically from the land surface to an aquifer (Minnesota Department of Natural Resources, 1991). In this methodol-

ogy, time of travel is a function of the distance and the composition of the geologic materials through which the water must travel. The sensitivity of wells in geologically unprotected settings was classified as very high or high. Wells completed in protected aquifers were classified as moderate to very low in sensitivity. Such wells were assigned "L" scores ranging from less than (<) 1 to greater than (>) 30, depending on the cumulative thickness of all low permeability units at least 10 feet in thickness that overlie the aquifer (an "L" score was determined by dividing the thickness of each low permeability unit by ten, rounding the value down to the next whole number, and summing the total; this scoring methodology reduces the "L" score to a manageable and relatively conservative whole number). Scores of 5 or higher are the basis for assigning a very low sensitivity rating.

Figure 2 demonstrates that the relative proportion of wells yielding recent water decreases from unprotected to unconfined protected and finally to confined settings. The proportion of wells with mixed water remains at about 20 percent so the decrease in wells yielding recent water is accompanied by a corresponding increase in the number of wells yielding vintage or ancient water. This indicates that ground water in confined aquifers probably has a longer residence time than ground water in unconfined aquifers. This should be regarded as a gross generalization because accelerated local recharge may occur through breaks in confining layers or along improperly constructed, maintained, or sealed wells.

Figure 3 shows the decreasing occurrence of recent water with increasing protective geologic cover. Recent water was a major to dominant component in waters from wells rated very high (VH), high (H), moderate (M), and low ("L" scores ranging from through 5) indicating relatively short residence times in many of these settings. These results are generally in agreement with the time-of-travel estimates used in the DNR methodology, although they suggest that a geologic sensitivity rating of "low" might imply a greater degree of protection than actually exists, given the correlation between recent water and contamination that is documented in this and previous studies. The occurrence of vintage and even ancient water in wells rated very high to high in geologic sensitivity may suggest the upwelling of older waters in discharge areas.

Wells yielding recent water were a minor but significant component in categories L 6 through L 12 and such wells do not effectively disappear as a significant component until "L" scores of 13 and higher are reached. The presence of recent water in these settings is contrary to the DNR time-of-travel estimates for wells rated very low in geologic sensitivity and highlights the limitations of point-method geologic sensitivity assessments. Such assessments become unreliable in areas of complex hydrogeology such as fractured rock terrains or areas with laterally discontinuous protective units. Furthermore, such assessments cannot evaluate the leakiness of confining units or wells. Geologic sensitivity assessments provide an interim estimate

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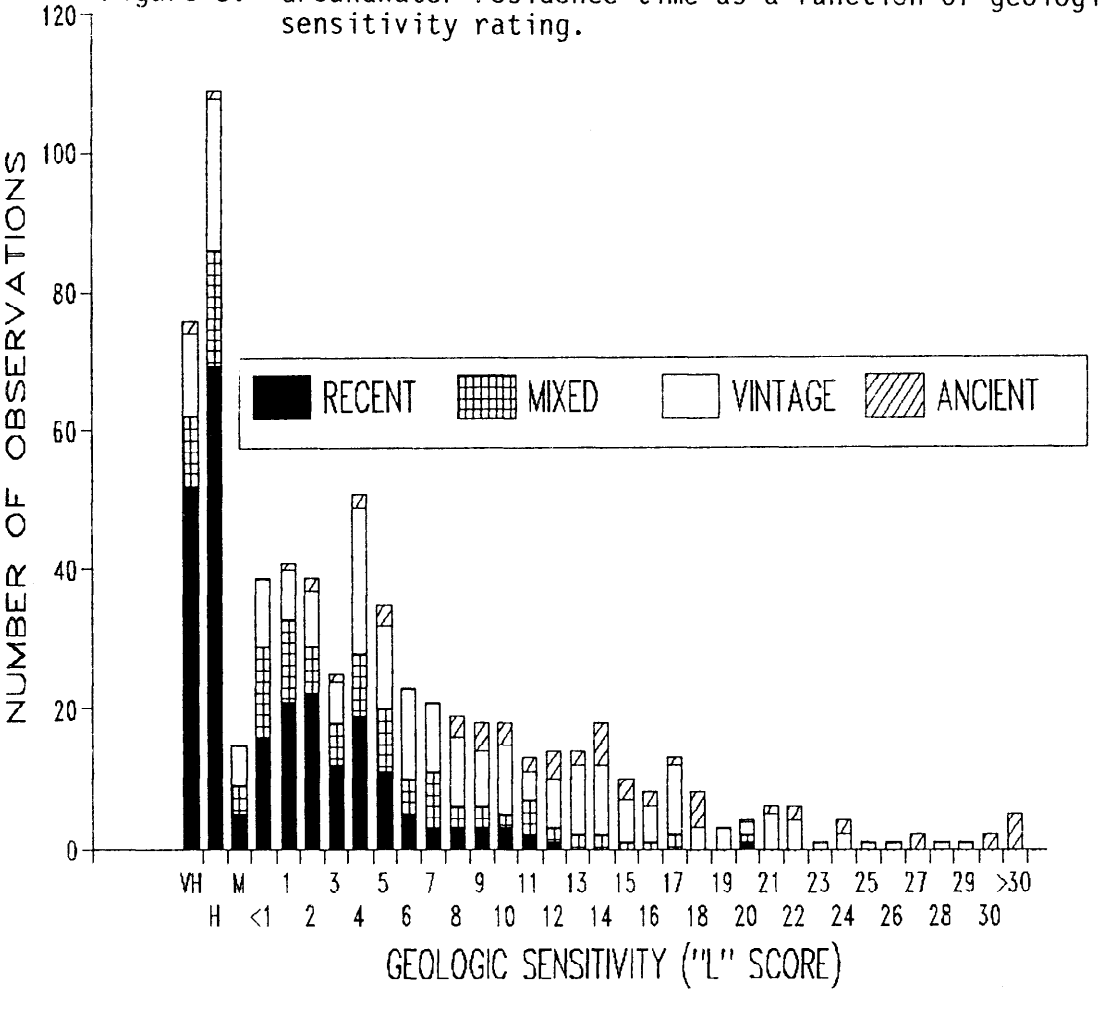
Figure 3. Groundwater residence time as a function of geologic sensitivity rating.



Tritium in Ground Water - continued

of well vulnerability but should be enhanced by incorporating well construction and water chemistry and isotopic data.

References

Alexander, E. C., Jr. 1990. Residence Time Classification of Minnesota Ground Waters Based on Tritium and Carbon-14 Data. Unpublished.

Alexander, E. C., Jr., and S. C. Alexander. 1989. Residence Times of Minnesota ground waters. *Journal of the Minnesota Academy of Science*, 1, pp. 48-52.

Hendry, M. J. 1988. Do Isotopes Have a Place in Ground Water Studies? *Ground Water*, Vol. 26, pp. 410-415.

Minnesota Department of Natural Resources. 1991. *Criteria and Guidelines for Assessing Geologic Sensitivity of Ground Water Resources in Minnesota.* Report of the Minnesota Department of Natural Resources Geologic Sensitivity Project Workgroup, pp. 122.

Tipping, R. 1992. *An Isotopic and Chemical Study of ground water Flow in the Prairie Du Chien and Jordan Aquifers, Northern Dakota County, Minnesota.* Unpublished M.S. Thesis, University of Minnesota, Department of Geology and Geophysics.

—Editor's Note: A complete copy of the report is available by calling Jim Walsh, Minnesota Department of Health, at (612)627-5166. The data-file is available from LMIC. Contact Suzanne Maeder at (612)297-4986 for more information.

Dead Rainbows - Oil On the Water

Imagine an idyllic scene of your choosing. The only requirement is that it be peaceful and contain a lake which, like a mirror, reflects the opposite shore. Only you notice the reflection is a different color than the scenery across the lake. Wait...what is that? Could it be? A glistening sheen of dirty colors like dead rainbows covers the surface of the lake. Someone must have changed their oil again and not recycled it.

Rainfall runoff produces shock effects on receiving waters as various substances, some toxic, are abruptly mixed into our water supplies. By one estimate, there are times when 40 percent of the pollution in our nation's water is old motor oil, containing lead and trace amounts of other toxic metals plus a variety of hydrocarbons, many of which are toxic to aquatic life even at low concentrations. Pouring oil into the gutter or storm sewer, or letting it leak from your car, is just like dumping it directly into the lake. Recycling used oil does not mean to use it as a fence line weed killer or on dirt driveways because it can soak through the soil, even at landfills. Used oil is not trash, it's toxic waste.

To put the problem into perspective, a single pint of oil can create a glistening slick the size of a football field. A single quart is enough to pollute 250,000 gallons of water. One part oil to one million parts water is detectable to taste and smell. Average estimates indicate **240 million gallons** of used crankcase oil find their way into the nation's lakes, rivers, and streams each year, 22 times more oil than the Exxon Valdez spilled in Alaska. The nation was outraged at one oil tanker spill, yet we lamely accept the willful disposal of 22 times that much each year.

It is estimated that about half of all automobile owners change their own oil, and there's no reason they shouldn't. If you're one of them, please take your used oil to a gas station or recycling facility. Some auto parts stores will accept used oil too. You can purchase sturdy containers to store enough used oil for 3 or 4 oil changes. If you have someone change your oil for you, make sure they recycle the used oil or take it to someone who does. Most used oil can be reused as ship or industrial boiler fuel, or one of many lubricating oils.

The exciting thing is how easily we can help solve the problem, even if current pollution levels may sound discouraging. It's proven that each individual's contribution can produce noticeable results. If, during the next few months, you and your neighbors do nothing more than ensure your used automobile motor oil is recycled, you will make a major difference in the quality of your water.

—reprinted from Hydata November, 1991

Highlights of Previous Newsletter Issues

October 1982 — First Issue. Announced organization of MGWA and first fall meeting. Featured speaker was Tom Johnson, Illinois Geological Survey; *Waste Disposal and Ground Water Contamination.* Dues $10.

February 1983 — Articles by Linda Bruemmer, Tom Clark, Dale Trippler. Winter meeting topic: *Legal and Regulatory Aspects of Ground Water Contamination in Minnesota.*

April 1983 — Spring meeting featured Dr. Mary Anderson on *Ground Water Modeling: Is it true that the Emperor has no clothes?*

Article on onsite sewage treatment by Roger Machmeier. Nearly twenty short summaries of research projects underway in Minnesota.

July 1983 — Legislative summary: Superfund, peat mining, radioactive waste, waste management changes. Announced full-day summer meeting at Johnson Screens to include field demonstrations.

October 1983 — Public education committee reports on collecting available materials and designing new ones. Announced fall meeting featuring Tom Winter on *The Why's, Wherefore's .....of Piezometer Installations.*

January 1984 — Reprint of article describing 1885 hydrogeology. A special lunch-hour meeting February 9th featuring Edward Krinsky, Institute for Environmental Mediation on *Using Mediation to Settle Disputes Involving Natural Resources.*

Winter seminar on March 7th covered *The Professional as an Expert Witness.* BASIC subroutines printed in their entirety for W(u) and W(u,r/B).

Linda Bruemmer tries to coordinate ground water proposals via the Ad Hoc Minnesota Ground Water Committee.

Spring 1984 — Kelton Barr reviews the status of ground water professional certification and registration. More summaries of ground water research projects. Richard Clark, MDH, reports on VOC survey of 657 community water supply wells. Forty-eight wells had detectable VOC's with ten wells exceeding acceptable drinking water levels.

Spring meeting to feature Bob Miller on Aquifer Thermal Energy Storage, especially thermal storage in the Ironton-Galesville aquifer at the U of MN St. Paul campus. Tom Clark reports the membership totals about 250.

July 1984 —*Summer seminar on Ground Water Quality Sampling and Analysis.*

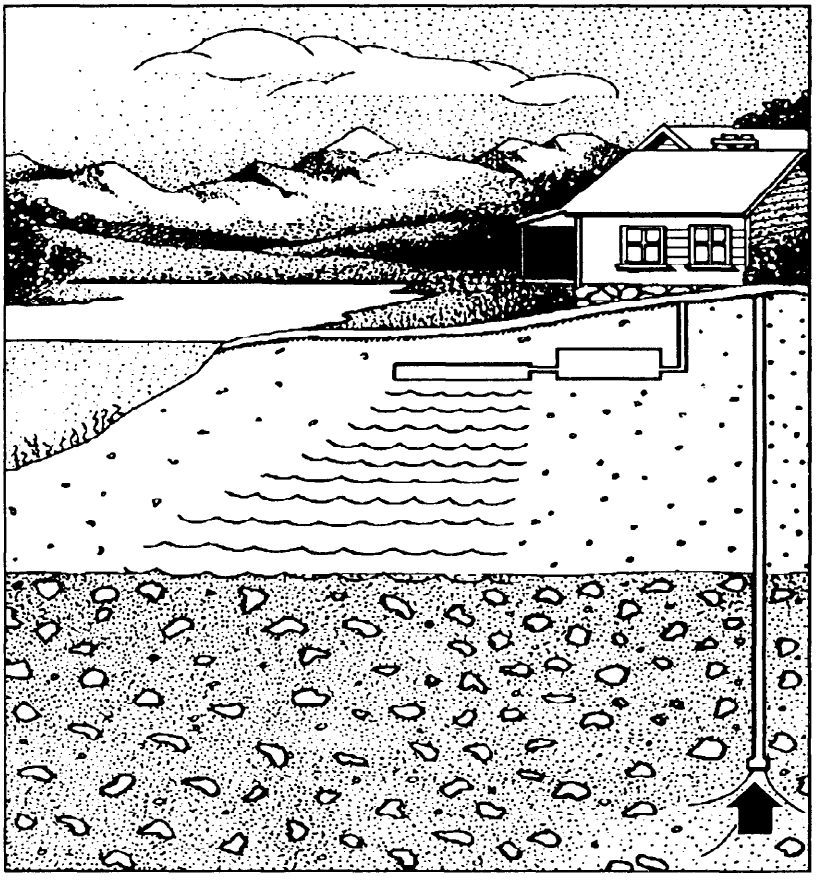
October 1984 — Joint MGWA and AWRA meeting in November on *Use of Microcomputers for Ground Water Modeling* featuring Dr. Arnold Verruijt.

MGWA to be a sponsor of the 1985 Mid-West Ground Water Conference.

Winter 1985 — Winter meeting in March featured Kevin Kessler, Wisconsin DNR, on *Implementing Wisconsin's Ground Water Law.* Tom Clark provides an article on LUST implementation.

January 1986 — Gil Gabanski passes the MGWA President's office (which he had held for four years) to Jerry Rick. Gregg Larson and Pat Leonard-Mayer provide an article on radioactive waste disposal and potential sites in Minnesota.

Winter meeting featured Bob Taylor, UW-Milwaukee, on innovative geophysical techniques.



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