The Geological Society of Minnesota News

President's Message: A Paradox

Volunteer opportunities, field trips, lectures, and public service, since 1938

I would like to thank the many GSM members who volunteer their time and efforts to keep our programs and events first rate. As your outgoing President I would like to report that all is well in all areas of the GSM except for the recruitment of new leaders. As a Board Member for 4 years and as your President for the last 2 years I have observed an interesting paradox: on the one hand, we have a core of hardworking GSM members who volunteer their time, talents and energy to keep the GSM's programs and events first rate. On the other hand, finding diamonds in Minnesota seems to be easier than finding new Board Members.

As I reported in the Spring 2011 Newsletter, the GSM has a significant challenge to replace long term committee chairs and board members. In December the new 2012 Board will take over leadership of the GSM. The Spring challenge remains, as we need four new Board Members, as well as a Newsletter Editor, Publicity Committee Chair and Public Service Chair.

I ask you to consider joining the Board. The future of our organization, the Geological Society of Minnesota, is at stake. Many people feel that they may not be qualified to be on the GSM Board of Directors. A geology degree is not required (of the 8 current members, 3 have geology degrees and not all have degrees). What is required is a desire to help oversee, grow and improve the GSM and a commitment to attend the meetings every other month. Please contact me or any Board Member if you are interested.

Dick Bottenberg

Upper photograph: GSM field trip to Minnehaha Falls, July 12, 1942;

Inside this issue:

from the archives:

GSM field trip, Mankato, Mn., Dr. L.O. Dart, Examining Cretaceous gravel on the LeSueur River, September 30, 1945,

GSM News

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Editor: Harvey Thorleifson

The Geological Society of Minnesota is a 501(c)3 nonprofit organization. The purpose of this newsletter is to inform members and friends of activities of interest to the Geological Society of Minnesota.

Send all GSM membership dues, change of address cards, and renewals to:

GSM Membership Chair
P.O. Box 390555
Edina, MN 55439-0555

Membership dues are: $10 Full-time students; $20 Individuals; $30 Families

GSM News is published four times a year: **February 15, May 15, August 15, and November 15**. Deadline for article submission is the first of the month, before the date of publication. Send all material to:
Harvey Thorleifson,
thorleif@umn.edu

GSM Winter Social Event and Board Meeting

On Saturday December 3, 2011, all GSM members and previous members, including the present board members, all previous board members, officers, and committee chairpersons, are invited to the Winter Social and Board meeting! Please arrive and enjoy hors d' oeuvres between 2:30 and 4:00 pm. The Board of Directors meeting will be from 3:00 to 4:30 pm, and the Pot Luck Buffet will begin at 5:00 pm. These festivities and events will be held at the home of Ed and Sandy Steffner, 9619 Briar Circle Bloomington MN 545437, phone 952-831-5165. All are welcome to attend the GSM Board of Directors Meeting.

A Celebration of Agates!

From July 26th to 29th, 2012, the Minnesota Mineral Club will host an agate show at Lindbergh Center, Hopkins High School, in Minnetonka, Minnesota. According to the club, thousands of people are expected to attend the event, the first of its kind to be held in Minnesota. The show will showcase exhibits, book signings and agate-related vendors and dealers. Presentations will include "Agates 101," a program for beginning agate collectors, and "Iris Agates," a memorial presentation prepared by Pete Rodewald. More information is available from The Minnesota Mineral Club at http://minnesotamineralclub.org/

Minnesota Bedrock Geology Quilt

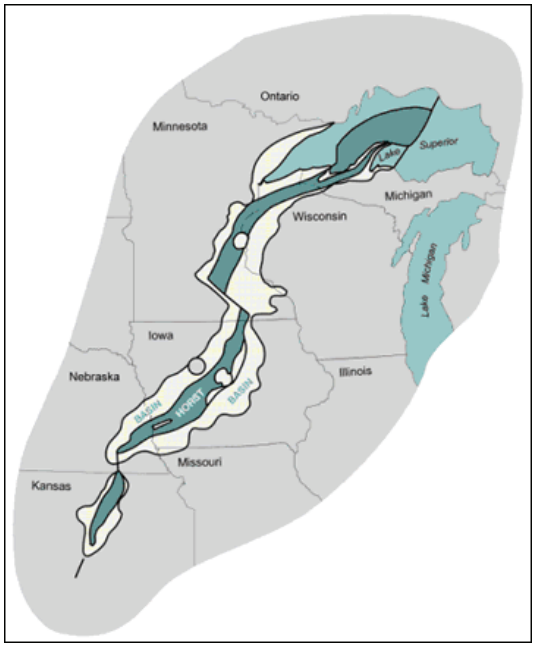
Aileen Lively, spouse of MGS staff Rich Lively, has created an absolutely incredible quilt based on the new 2011 Minnesota bedrock geology map. The quilt is a batik appliqué and contains over 80 separate colors, all 87 county outlines, and an inset showing the distribution of Cretaceous rocks. It was prominently displayed at the GSA meeting, and you can now see it hanging in the foyer at MGS!

GSA meeting a great success

The Geological Society of America Annual Meeting that took place at the Minneapolis Convention Center from October 9 – 12, 2011, was a great success, with 6300 delegates in attendance, and 3700 presentations given. GSM members participated in the Subaru Outdoor Life Lecture on Monday, 10 October, featuring polar explorer Ann Bancroft. The meeting included a broad array of sessions, exhibits, short courses, events, and field trips. The committee At-Large Team included GSM President Dick Bottenberg.

Potential for Geologic Carbon Sequestration in Minnesota

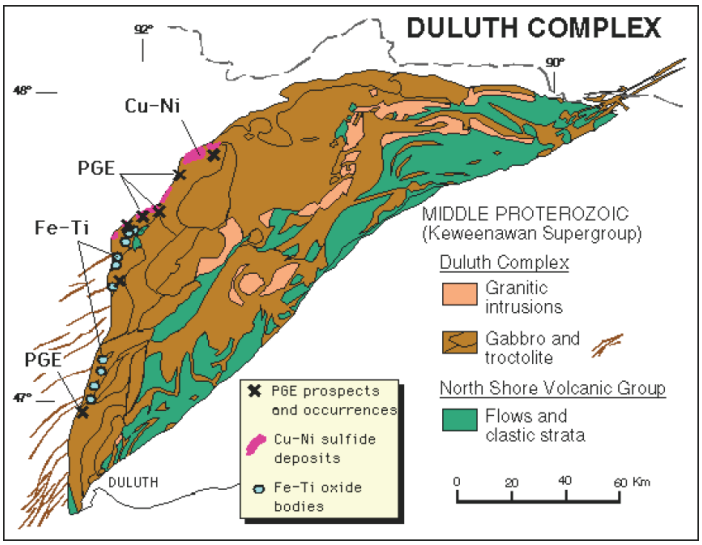
The Minnesota Legislature and the US Geological Survey have supported evaluation of the potential for geologic carbon capture and storage (CCS), also known as carbon sequestration, in Minnesota. This involves capture of CO2 from sources such as coal-fired electrical generating stations or ethanol plants, transportation of the CO2, and storage in a geologic medium to provide long-term isolation from the atmosphere. The method could involve injection into deep saline underground formations, or mineral carbonation, a reaction of CO2 with minerals such as olivine to produce a stable solid product.



The Midcontinent rift, sedimentary rocks show in yellow (Iowa Geological Survey)

The only reservoirs in Minnesota with depth and storage properties that might possibly be adequate for deep injection are sedimentary rocks associated with the Midcontinent Rift, which extends from the Lake Superior basin to Kansas. A 2008 report by the Minnesota Geological Survey concluded, however, that these rocks, which occupy two north-south belts averaging about 40 km wide on either side of the Twin Cities between Pine County and Iowa, have attributes that make them far less suitable for sequestration than sites being considered elsewhere. The report therefore concluded that there is a very low probability of success in confirming suitable geologic conditions for this option.

A second report produced in 2011 by the Minnesota Geological Survey evaluated the potential to use mineral carbonation as a means of carbon sequestration in Minnesota. It notes that although the method has not been tested at field scale, experiments indicate that large tonnages of mafic rock near Duluth could be appropriate source material. These rocks are also potential sources of copper, nickel, and platinum group elements that might be mined in proximity to existing infrastructure. Depending on the degree of serpentinization, one mine at currently anticipated production rates could



The Duluth Complex, mafic rocks shown in brown (Minnesota Geological Survey)

provide enough waste rock to sequester ~1% of Minnesota's CO2 emissions, at a cost of ~100 million dollars per year, or over $50US/t CO2. Costs could potentially be reduced if future research increases the efficiency of the method, or if it turns out that metals could be produced from the mineral carbonation circuit. Implementation would only happen if incentives relative to

cost were favorable. Sequestration of additional CO2 by this method would require some combination of higher mine production rates, more than one mine, or preferential mining of olivine. The report thus concludes that, as recognized in previous evaluations of the process, the principal drawback of mineral carbonation is its high cost compared to other methods of sequestration.

SME Twin Cities Subsection Annual Conference

Over one hundred participants attended a full-day program at the Society for Mining, Metallurgy, and Exploration (SME) Twin Cities Subsection Annual Conference, held in Minneapolis on October 27th. Good attendance and a superb list of speakers reflected the upbeat state of Minnesota iron ore production, other booming industrial mineral production such as frac sand, along with progress in permitting potential copper, nickel and PGE production from the immense Duluth Complex in Northern Minnesota.

The meeting took a comprehensive look at the state of the mineral industry in Minnesota – the #4 non-fuel mining state in the US according to the May 2011 edition of Mining Engineering – including contribution to the state economy, potential, as well as regulation. The moderator was Subsection Chair Gregory Beckstrom of Golder Associates, and the lead-off speaker was SME President-Elect Drew Meyer, who gave an impressive overview of much activity at SME National. The featured speaker for the day was Tony Sertich, Commissioner of the Iron Range Resources and Rehabilitation Board, who spoke on the future of mining in Minnesota.

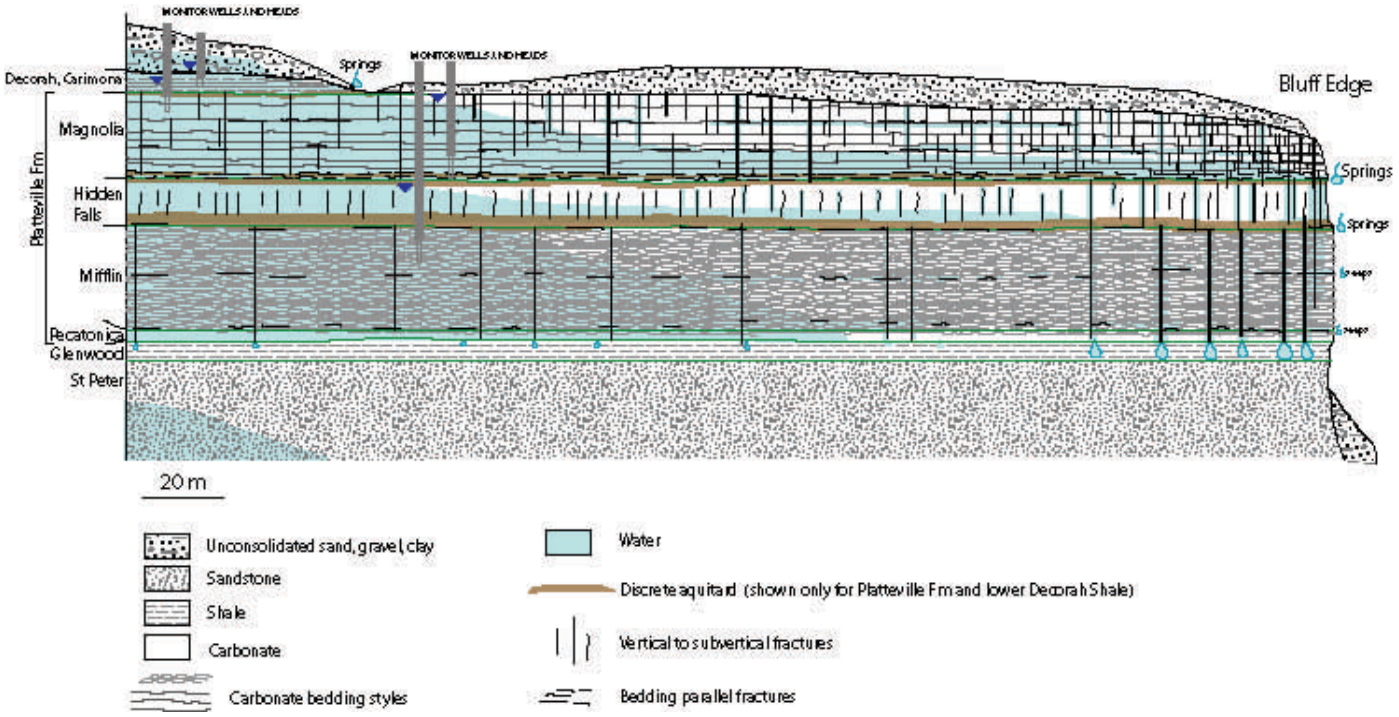
Speaking for industry were representatives of the Minnesota iron ore, non-ferrous and industrial mineral industry associations. Peter Clevenstine, Manager of Engineering & Mineral Development, Division of Lands & Minerals, Minnesota Department of Natural Resources (DNR), presented an overview of the past, present and future of iron mining in Minnesota. Frank Ongaro, Executive Director of MiningMinnesota, spoke on potential production of nonferrous metals in Minnesota, with emphasis on Duluth Complex copper, nickel and PGE. In addition, Fred Corrigan, Executive Director, Aggregate & Ready Mix Association of Minnesota, spoke on industrial mineral production in the state, including products such as glacial sand and gravel, crushed stone, dimension stone and rapidly growing frac sand production. Government was represented by Larry Kramka, Director, Division of Lands and Minerals, Minnesota DNR, who spoke on the Minnesota mineral industry: exploration, production and regulation; and by Brian Timerson, Mining Project Lead, Minnesota Pollution Control Agency, who presented an overview of environmental regulation in Minnesota mining. University-based speakers were Don Fosnacht, Director, Center for Applied Research and Technology Development, Natural Resource Research Institute, University of Minnesota Duluth, who spoke on their extensive roles in mining. Wrapping up the program, State Geologist Harvey Thorleifson of the Minnesota Geological Survey, spoke on the development of statewide geological databases that supports exploration, development and environmental protection throughout Minnesota.

Discussion focused on the very active and ongoing expansion and diversification of the Minnesota iron ore industry, the progress of Duluth Complex review and permitting, as well as several regulatory issues. The Minnesota-based SME membership now looks forward to their participation in several projects led by SME National, and to the multi-day SME Minnesota Section Annual Conference and Trade Show that will take place in Duluth on April 17 - 18, 2012.

GSA Field Trip looks at a Fractured Urban Aquitard

On October 13, a day after the Geological Society of America meeting in Minneapolis, Julia (Anderson) Steenberg, Anthony Runkel, Bob Tipping, Kelton Barr, and Calvin Alexander led a trip on hydrostratigraphy of a fractured urban aquitard. The one-day trip was designed to provide an overview of the hydrostratigraphic attributes of the Platteville aquitard in the Twin Cities Metropolitan area. As a shallowly buried, extensively fractured and therefore vulnerable carbonate rock in an urban setting, the Platteville has been the subject of a wide variety of geomechanical and hydrogeologic studies over the past few decades. This work, combined with borehole geophysics and outcrop observations conducted by the Minnesota Geological Survey, has led to a comprehensive understanding of the Platteville. The field trip provided examples of what has been learned from these many different data sources, which collectively led to a characterization of the Platteville as a complex "hybrid" hydrogeologic unit. Under certain conditions, and from one perspective, it can serve as an important aquitard that limits vertical flow, while in other conditions, and from another perspective, it is best considered a karstic aquifer with conduits of very high conductivity that permit rapid flow of large volumes of water. One particular focus of the trip was demonstration of what appears to be predictability in both vertical and bedding-plane fracture patterns that in turn provides some degree of predictability of flow paths in three dimensions. These relationships appear to be operative for the Platteville in other portions of the Upper Midwest where the Platteville is shallowly buried. The field trip organizers demonstrated that effective management of such complex, karst, "hybrid" hydrogeologic units requires a sophisticated, nuanced understanding of their heterogeneous behavior.

Submitted by Julia (Anderson) Steenberg, Minnesota Geological Survey



Conceptual model of hydrogeologic attributes of the Platteville Formation and adjacent units. Each member of the formation has a distinct fracture pattern. Preferential termination of vertical fractures near the top and bottom of the Hidden Falls Member results in one or more aquitards that commonly perch a water body in the overlying heavily fractured Magnolia Member. A highly conductive bedding plane conduit occurs at the contact between the Hidden Falls and Magnolia Members. The combined Hidden Falls, Mifflin, and Pecatonica Members, despite yielding some water horizontally and having vertical fractures, serve as a significant vertical barrier to flow in areas several tens of meters away from eroded edges of the formation. Closer to eroded edges, aquitard integrity is substantially diminished in all parts of the formation.

The Volcano that Wasn't

On the morning of June 6, 1912, numerous strong, shallow earthquakes were shaking the area which is now Katmai National Monument on the Alaska Peninsula. A tremendous blast sent a large cloud of ash skyward and the most powerful volcanic eruption of the 20th Century was underway. People in Juneau, Alaska, about 750 miles from the volcano, heard the sound of the blast – over one hour after it occurred.

The inhabitants of Kodiak, Alaska, on Kodiak Island, about 100 miles away, were among the first people to realize the severity of this eruption. Just a few hours after the eruption a thick blanket of ash began falling upon the town - and over the next three days, covering the town up to one foot deep. The residents of Kodiak were forced to take shelter indoors. Many buildings collapsed from the weight of heavy ash on their roofs.

Back on the peninsula, heavy pyroclastic flows swept over 20 kilometers down the valley of Knife Creek and the upper Ukak River. These flows completely filled the valley of Knife Creek with ash, converting it from a V-shaped valley into a broad flat plain. During the eruption, Mount Katmai, six miles from another volcano called Novarupta collapsed into a crater about two miles in diameter and over 800 feet deep.

For the next 60 hours the eruption sent tall dark columns of tephra and gas high into the atmosphere. By the time the eruption ended about 30 cubic kilometers of ejecta blanketed the region. This is more ejecta than was produced by all other historic Alaska eruptions combined. It was also thirty times more than the 1980 eruption of Mount St. Helens and three times more than the 1991 eruption of Mount Pinatubo, the second largest in the 20th Century. When the eruption stopped on June 9th, the ash cloud had spread across southern Alaska, most of western Canada and several U.S. states. Winds carried it across North America. It reached Africa on June 17th. Although the effects of the eruption were far-reaching, most people outside of Alaska did not know that a volcano had erupted. Even more surprising, no one knew for sure which of the many volcanoes on the Alaska Peninsula was responsible.

The Alaska Peninsula has a low population density today but in 1912 it was even lower. Outside of early earthquake activity, the beginnings of this event were almost unnoticed. Today the stirring of an important volcano draws enormous global attention. Weeks or even months before most large eruptions a buzz circulates through an electronically-connected community of volcano scientists as clusters of small earthquakes are detected by a global array of seismographs. Many scientists working at diverse global locations interpret this data and begin to collaborate about an awakening volcano and the eruption that might follow. If the earthquakes strengthen and begin moving upwards, many of these scientists will travel to the area of potential eruption to make observations and set up a local network of data-gathering instruments.

However, in 1912, Alaska was not a US state, very few scientists had support for volcano studies and there was no worldwide network of seismic monitoring. Scientists were just starting to understand the mechanics of volcanic eruptions.

After the eruption, the National Geographic Society began sending expeditions to Alaska to survey the results of the eruption and to inventory the volcanoes of the Alaskan peninsula. Robert Griggs, a botanist, led four of these expeditions. During his 1916 expedition, Griggs and three others traveled inland to the eruption area. They found the 2-mile-wide caldera where Mount Katmai once stood and a lava dome at the Novarupta vent. These observations and eye- witness accounts stating that the eruption cloud ascended from the Katmai area convinced Griggs that Katmai was the source of the eruption. Griggs also found and named "The Valley of Ten Thousand Smokes", a fumarole field near Novarupta, and later, campaigned successfully to have the area declared a National Monument, Yellowstone-style. His book "The Valley of Ten Thousand Smokes" attributed the fumarole field and the 1912 eruption event to Katmai.

It was not until the 1950s - over forty years after the event - that investigators finally discovered that ash and pyroclastic flow thicknesses were greatest in the Novarupta area. This discovery lead to the realization that Novarupta - not Katmai - was the volcano responsible for the eruption. Novarupta's ash fall was far greater than any other Alaska eruption in recorded history and contained a greater volume than all of the recorded Alaska eruptions combined.

Submitted by Katy Paul

GSM Spring 2011 Field Trip

Julie Maxson, Ph.D., Assistant Professor of Natural Sciences (Geology) at Metropolitan State University, led our Spring 2011 field trip, on Saturday afternoon, June 11, which focused on fossil collecting at Cannon Falls, Minnesota. The trip involved fossil collecting and identification at an excellent exposure of Decorah Shale. The outcrop is located in a road cut and is very accessible. No hiking was required. A second outcrop of Platteville Limestone with excellent brachiopod fossils was also visited.

GSM Summer 2011 Field Trip

Randy Strobel did a superb job on leading our summer field trip in mid-August. The topic of the trip was 'The Mid-Continent Rift of Northwest Wisconsin and the Keweenaw Peninsula of Michigan'. The trip surveyed the geology and the mining history of the mid-continent rift outside of Minnesota. The trip began on the north limb of the rift exploring the most southern outcrops of the rift basalts in Wisconsin's Interstate park. At Pattison and Amnicon Falls State parks, we viewed a rift forming fault, the Douglas fault and three waterfalls. Next, on the Bayfield Peninsula and Apostle Islands, we examined the mid-Proterozoic rift filling sandstones of the Bayfield and Oronto groups. We then moved to the south limb of the rift. This side of the rift is more steeply dipping and more mineralized than the north side of the rift in Minnesota. The rift on the Keweenaw Peninsula was historically a major copper mining district. We observed the volcanic rocks of the rift at Copper Falls, the Porcupine mountains, and the Keweenaw Peninsula. We also examined a gabbro intruded into the volcanic rocks, the Mellen gabbro. On the Keweenaw we visited a few historic mines. The trip ended with the Copper Country Rock and mineral club annual rock show. What a success!

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