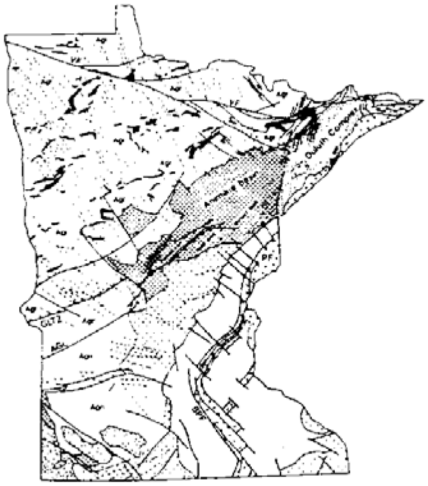

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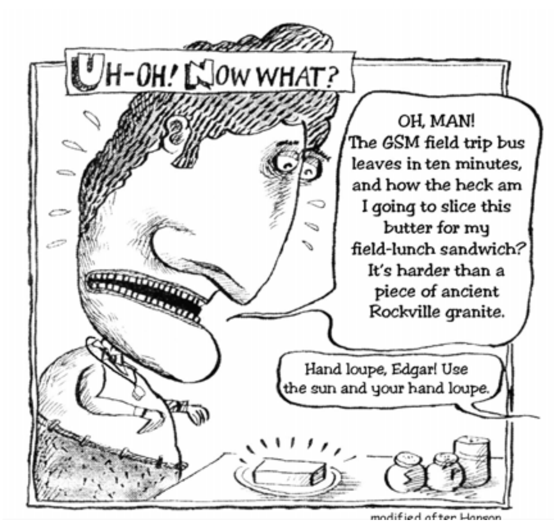

STATE FAIR JUST AROUND THE CORNER

Well, the May 3rd Kimball Memorial Banquet signaled the end of this season's lecture series and the beginning of our field trips, and of course, our sessions in the GSM State Fair Information booth can't be far behind. Although the Fair doesn't start until August 26th, it's not too early to start planning.

In the next two months the Show and Exhibit Committee will be putting together a list of workers for the Fair booth. We will need 72 people, each to work a 4-hour shift at the fair.

The Fair starts on August 26th and ends on Sept. 6th. Each day will be divided into three shifts: 9am to 1pm, 1pm to 5pm, and 5pm to 9pm. Two people will be required for each shift.

We know it's a little early, but this is your opportunity to get the best time. Call Tom Schoenecker at 952-474-4600 and he'll give you the spot you crave. Hurry! You should know, if you don't call Tom, he will call you. Be nice to him.

Remember it's a lot of fun and you don't have to be an expert. You just have to show your enthusiastic interest in Geology and if you can't answer a question, invite the person to a lecture where he or she can ask the experts. Our job at the Fair is to hand out our lecture schedules and to invite those with an interest in Geology and Rocks to join us at our lectures and field trips. Please also remember, the Fair is our main source of new members. ~

Did you ever wonder about?…

In 1947, American chemist Willard Libby (1908-1980) discovered a relatively simple, scientific way to determine the absolute age of once-living relics: measuring the amount of a type of carbon they contained. Carbon-14 is a naturally occurring radioactive element formed in the upper atmosphere, and is absorbed by plants during photosynthesis. Libby noted that as animals digest these plants, they take in the plants' carbon-14, storing the radioactive isotope in muscle tissue and, more importantly, bone. When plants and animals die, they stop absorbing carbon-14, which then begins to decay at a steady rate into carbon-12 atoms. Libby found he could measure the ratio of carbon-14 to carbon-12 atoms in a given fossil to determine its precise age. Libby's discovery earned him the 1960 Nobel Prize and gave modern archaeology one of its most powerful tools.~

EVENTS

May 22 Field Trip – St. Cloud Granites

June 6 Gem show – State Fairgrounds

Aug 14 – 15 Field Trip – Iron Ranges

Aug. 26 - Sept. 6 State Fair

Sept. 20 Annual Meeting
Kickoff 2004-2005 Lecture Series

GSM *NEWS*
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The purpose of this newsletter is to inform members and friends of the activities of the Geological Society of Minnesota. GSM *NEWS* is published four times a year: February 15, May 15, August 15, and November 15. GSM *NEWS* welcomes unsolicited Geology and Earth Science related articles and photographs. Deadline for article submission is three weeks before the date of publication. Send all material for GSM *NEWS to:* GSM c/o Katy Paul, 6901 West 84th St., #351, Bloomington, MN 55438, phone/e-mail listed above.

Send all GSM membership dues, change of address cards, and renewals to the GSM Membership Chair: Gail Marshall, 12232 Allen Drive, Burnsville, MN 55337 phone 952-894-2961. Membership levels are:
$10 Full-Time Students; $20 Individuals, $30 Families

From the President, Paul Martin:

We have just finished this year's series of lectures, "labs", and demonstrations with the unifying theme of Geologic Landscapes. In looking back on them, I can say we're extremely fortunate to have so many excellent geology professionals available and willing to speak to us. A huge thank you to them and to Steve Erickson and Rick Uthe for assembling this fine series.

As a grand finale, at our annual Spring Kimball Memorial Banquet, on May 3, we experienced a particularly interesting lecture-show by Dr Howard Mooers from the Geology department at UMD. His presentation on the "Evolution of Minnesota's Landscapes Through Time" was a four billion year trip around Minnesota complete with six animated visions of what parts of the state looked like at important times in our geological history, all in one hour! We can understand why the University of Minnesota system recently presented Howard with one of its coveted Horace T Morse awards for "contributions for undergraduate instruction".

We expect that next year's series of lectures and labs on the geology of some major parks in North America will also be educational and very popular. Steve Erickson is now busy finalizing the schedule. Check the new GSM directory when it comes out this summer for details of next year's schedule.

I hope you'll all plan to attend the annual meeting and fall banquet on Monday September 20, at the Old Country Buffet in Fridley. It promises to be especially memorable since Harvey Thorliefson, director of the Minnesota Geological Survey, will be our guest speaker. Some of us have already met him and found him to be enthusiastic and very easy to talk to. He'll be talking about the new work being done by the survey department.

Carefully check your mail this summer; not all of it will be junk! In addition to the new GSM Directory, you should find at least one and probably two notices about GSM field trips: one scheduled for mid-August to the Iron Range and Duluth, and another, in mid-July, probably a day-tripper in the Twin Cities area. Finally, my sincere thanks to Katy Paul for agreeing to edit this edition of the newsletter, when Tom Smalec was unable to do it for medical reasons.

I hope you all have a great summer.

2004-2005 LECTURE SERIES IN PLANNING STAGES

In January, the planning group met to discuss next year's Lecture program. The theme for next year is "Parks of North America". This will include not just National Parks, but any well known park you might visit on any trip you take. We have an interesting group of lectures so far. The finalized program will be published in the next newsletter (August).

The first meeting for the 2004-2005 season will be our traditional Fall Banquet, which is scheduled for Sept. 20th. It will be at the Old Country Buffet in Fridley. We have asked Harvey Thorleifson, the new director of the Minnesota State Survey, to attend, and speak about what the Survey is up to.

Dr. Thorleifson was appointed Director of the Minnesota Geological Survey on July 1, 2003. He came to Minnesota from Canada, where he was a Research Scientist with the Geological Survey of Canada. He completed undergraduate and Masters education in Winnipeg, and did his Ph.D. in geology at University of Colorado in Boulder. He has specialized in the development of mineral exploration methods for diamonds as well as 3D geological mapping methods. He is the current President of the Geological Association of Canada.

On Sept. 20th, Dr. Thorleifson will give us some insight into **New Frontiers in Geological Mapping**. Geological survey agencies are developing methods for geological mapping in the post-paper map era. Maps are being digitized and reconciled, while legends are being made accessible in a categorized format. 3D geological models that integrate soils and geology, surficial and bedrock geology, as well as onshore and offshore are increasingly in demand as the information, technology, and protocols to build them progress.

Be sure to mark your Calendars and attend this kickoff for the 2004-2005 Lecture Series.

ROADSIDE GEOLOGY OF WISCONSIN

Robert H. Dott Jr. and John W. Attig, both University of Wisconsin geology professors, wrote this book to help residents and visitors alike "envision mastodons roaming in front of glaciers 12,000 years ago, feel storm waves pounding sea cliffs 500 million years ago, and hear volcanoes exploding 1,900 million years ago." With lively prose, detailed maps, black-and-white photographs, and shaded-relief images, the authors succeed in their goal: unraveling the 2,800 million years of geologic history recorded in Wisconsin's rocks.

Introductory sections describe the geology of each region, and thirty-five road guides locate and interpret the rocks, sediments, and landforms visible from the state's highways, including the Great River Road in the Mississippi Valley. ***Roadside Geology of Wisconsin*** delves further into the geologic history of specific sites such as Apostle Islands National Lakeshore, the Wisconsin Dells, the geologically renowned Baraboo Hills, and more than twenty-five state parks. Features of and access points to the Ice Age National Scenic Trail are noted.~

WAVES: A Common Thread Weaving through Nature

Ocean waves batter shores. Seismic waves shake buildings and rattle through the earth. Tsunami waves race across oceans at speeds of jet aircraft. Electromagnetic waves probe the interior of geological samples in a laboratory. All are examples of waves existing in nature, some even shaping the earth's face. All are examples of waves that geologists observe and use for measurements. Though appearing differently in detail, all waves have quite common behaviors and similar mathematical descriptions. Waves are associated with oscillating or vibrating systems; these systems may shed waves that propagate far from localized sources. These vibrating sources may be miniscule, such as vibrating electrons radiating electromagnetic waves, or immense, such as a pair of neutron stars, each 1.4 times the mass of the sun, circling each other in a dance of death and rebirth, all the while radiating gravitational waves until their angular momentum is dissipated and they collide.

Waves travel at characteristic speeds, transporting momentum and energy away from sources. Material through which a wave travels does not travel along with the wave. After the wave has passed, any material involved is in about the same position as it was before the wave happened by. Electromagnetic and gravitational waves do not need matter to propagate; they can travel through empty space as well as through materials.

Sound waves and seismic waves (body waves) are more demanding. They do need material in which to propagate. Some waves are even fussier, needing surfaces or interfaces between different materials in order to propagate. Examples of these include ocean waves (long-period swells and tsunami), certain types of seismic waves (surface waves such as Love waves and Rayleigh waves) and capillary or surface tension waves that form small ripples (1-2 cm wavelength) around rocks in a slowly moving stream. Once waves are launched from sources, visualize the process of propagation as a handing of momentum and energy from one region of space, or material, to the next region, in a nicely organized fashion with no wasted movements, and no actual steady state drift of material along the wave direction.

Waves are a general and wonderful principle of mathematical physics. Waves existed, however, long before mathematical descriptions were developed. Such general applicability of wave phenomena permits a common mathematical description, and also arises from the common behaviors displayed by seemingly different waves observed in so many different environments. All waves reflect, refract, diffract, scatter, disperse and interfere in time and space. All waves lose momentum and energy by absorption, and all can transfer momentum and energy to other materials in which no wave propagates. Here, impedance matching is a key to how much energy is transferred; impedance is another concept threading through nature. Waves can be confined within a space or volume, bouncing inside as standing or stationary waves. Such confined waves cause water in lakes, bathtubs and dishpans to slop back and forth at resonant frequencies, a "seiche". A seiche is an oscillation of the surface of a lake and can be viewed as a wave traveling repeatedly from one end to the other end of the lake, and back again. This causes the water at one end to rise above its normal level with the other end below normal level, then the reverse to occur as the wave peak travels the other way.

Continued, next page

ELECTROMAGNETIC WAVES

Electromagnetic waves include radio waves, microwaves, infrared light, visible light, ultraviolet light and X-rays, listed in increasing energy, increasing frequency, and shorter wavelengths. All these waves tattle on the universe, telling stories of far places from long ago. News of temperatures, compositions, speeds, collisions, births and deaths arrive from stars, gas clouds and galaxies. Some of the highest quality news about the big bang arrives at microwave frequencies, telling temperatures both now and, with extrapolation, long ago, if we are reading correctly. Electromagnetic waves, specifically X-rays, provide crystalline structure and elemental composition of geological samples, and light waves, especially polarized light, convey subtle structural and property information when passed through thin (0.03 mm) rock sections. X-rays also provide much of the available information on black holes in the universe.

SEISMIC WAVES

Sound waves from earthquakes and thumps made by people allow geoseismology. Low intensity waves, generated by vibrating the ground using trucks rigged to bounce up and down, allow imaging to about 3000 m (10,000 ft) depth. Explosions generate powerful waves that allow imaging to 100 km depth, tracing oil-likely formations, finding salt domes, checking dam sites and probing geophysical properties of rocks and icecaps. These waves travel at about 1 mile per second through sand, 4 miles/s through granite, imaging much the same way but on a grander scale than ultrasonic images of your heart. Underground nuclear explosions and earthquakes probe the whole earth. Earthquakes trigger fast primary (P) waves, propagating at a few miles per second, pushing forward and backward in the same direction as the propagating wave, a compressional or longitudinal wave. Remember, over most of the wave path, material is not permanently moved by the wave passage, it just vibrates fore and aft. Following the arrival of primary waves are secondary (S) waves, shaking from side-to-side, and traveling at about half the speed of the P wave. These secondary waves are fussy in that they will not pass through fluids, so the outer core of the earth, molten metal as it is, will not let them pass. The material must support shear for these transverse or shear waves to propagate; liquids do not, however, support shear as they just flow, thus shear waves cannot pass through liquids. At each layer or inhomogeneity within the earth, seismic waves are reflected, delivering information to seismographs concerning the structure of the earth. These waves are also refracted or bent by gradients in properties, providing additional information to seismologists.

WATER WAVES

Waves on seas create majesty and magic, portrayed so well musically in "Oceanides" by Sibelius and "LaMer" by Debussy. Tsunami or ocean waves that are seismically triggered traverse oceans at average speeds of 198 m/s (443 miles/hr). As long ago as 1856, this measurement of average speed allowed a determination of average ocean depth, well before many deep sea soundings had been made. The result was 4000 m (2.49 miles) deep, close to the presently accepted value of 3808 m (2.37 miles). Such tsunami have wave lengths of 100-200 km (62-124 miles) but amplitudes of only 0.3 to 0.6 m (1-2 ft), so at sea they are not sensed in passing, creating havoc only when arriving on shore.

Water waves have a trochoidal surface profile. Force of gravity and inertia of water determine wave properties on the surface of water, so they are called gravity waves; they are not gravitational waves, a totally different beast! Water waves in deep water travel at a speed proportional to the square root of wavelength. Shallow water waves travel at a speed proportional to the square root of wavelength, and this is the relationship used to determine ocean depth from the speed of tsunami across oceans. If a wave finds itself in water deeper than half its wave length, it acts as a deep water wave with that characteristic speed. If in water shallower than one fourth its wavelength, it behaves as a shallow water wave with the characteristic speed of a shallow water wave. Tsunami are always shallow water waves, as they are in water 1/10 th to 1/50 th of their wavelength.

Continued, page 6

DEAD WATER AND SLOW WAVES

A fishing smack, sailing on a Norwegian fjord at a speed of 4.5 knots (5 mph), "inexplicably" slows to a speed of 1 knot. Long ago, the cause was thought to be a sea monster or sea spirit. Science can provide a better explanation; waves that occur at an interface between fresh and salt water have a characteristic speed of about one fifth of normal surface waves in deep water. Wave speed of these boundary waves is proportional to the square root of the density ratio between fresh and salt water. Heavy, low powered boats are trapped between wave peaks of their own making, and thus have maximum speeds related to the square root of their water-line length. A thin, 1-2 meter thick layer of fresh water flows over calm sea water, and a slow wave moving at the interface may capture boats, limiting speeds to 1/5 of normal speeds. This effect has been observed not only in Norwegian fjords as mentioned above, but also near Vancouver Island, near the mouths of South American rivers and in the Mediterranean. I mention the concept of slow waves because there may be slow waves excited by seismic waves at the base of the mantle, just inside the fluid outer core, within layers of material having different densities due to composition, temperature or pressure. These slow waves propagate around the curvature of the core-mantle boundary, popping out of the core to emerge at earth's surface as a standard P or S wave, but highly delayed. This is now, I believe, an issue of hot research.

WAVE REFLECTION and NAVIGATORS

Waves of all sorts reflect and refract. As an example, ocean waves reflect from rapidly shelving islands and seawalls, just as a flashlight beam reflects from a mirror. For many generations, Polynesian and Micronesian navigators sailed reliably to and fro on the Pacific ocean, near the equator, using no compass, sextant or GPS. Sun, stars, steady trade winds, an effective oral tradition and experience were instrumental in their navigation. They could discern the presence of islands, even at night, up to 60 miles away by the change in the motion of the proas on which they sailed. The change in motion was due to waves reflected by their island destination.

Refraction of water waves is a by-product of a deep water wave arriving in shallow water and moving slower in the shallow water. If waves happen to approach a shoreline normal to the shore, they simply slow down. If at an angle to the shore, the part of the wave to encounter shallow water first is slowed, and the part of the wave to encounter shallow water later catches up along side the slower first part. This process turns the whole wave so that it approaches the shoreline more normal to the shore. This is refraction, observed in optical systems such as lenses, in seismic waves and other sound waves as well as ocean waves. Refraction tends to concentrate wave energy and erosion on headlands or points of shoreline jutting into the sea. Conversely, refraction reduces erosion on concave beaches, such as Half Moon Bay on the California coast just south of San Francisco. Refraction contributes to littoral currents along shore, which constantly move sand along beaches.

Waves are ubiquitous throughout nature. They provide much of what we know to our senses, and they move energy to and fro, shaping our lives and the earth in the process.~

By Bill Robbins

An Unabashed plug from "The GSM Rock Shoppe®"

The GSM is starting another field trip season and like all the previous Seasons, it is filled with possibilities. Be prepared for that first field trip on May 22nd with rock collections from "The GSM Rock Shoppe®." Prerequisite collections for the first event are the ever-popular **Stearns County Granite Collection** and the **Minnesota Minerals Collection #1**. These fabulous references are designed for both the armchair geologist and the experienced field-tripper who wants to be prepared. Let these collections unravel the county's geologically complex past and give you a sense of its granite vistas.

The three major geologic components of Stearns County, from the surface on down, are glacial deposits laid down during the Quaternary Period, soft sedimentary rocks deposited during the Cretaceous Period, and varied types of hard schists, gneisses, and granites of Precambrian age. Specimens of glacial sediments typical of Stearns County are included in the **Minnesota Surficial Geology Collection**.

To learn more about the Minnesota rock collections that are available through the GSM, visit the GSM Website at the address listed on the cover of this newsletter. To place an order, contact Bruce Goetteman at bjgoetteman@worldnet.att.net or 952-448-5422.

2-Day Field Trip to the Iron Ranges

The weekend of **August 14-15** this summer will find GSMers exploring two of Minnesota's famous iron ranges, the Mesabi and the Vermilion. The field trip will be led by the nearly-as-famous Professor Richard Ojakangas, now retired from the University of Minnesota, Duluth. Trip details are still being determined and permissions sought, but stops *may* include:

DAY 1 - the NRRI taconite experimental processing facility in Coleraine (samples provided), Hill Annex State Park, Hibbing's high-grade natural ore mines, Iron World (possibly), Mineview in the Sky in Virginia, United Taconite pits and local geology, Confusion Hill (Giants Range Batholith just north of Virginia), Pike River dam (Archean graywackes), with an overnight at Fortune Bay Casino on Lake Vermilion.

DAY 2 - nearby highly folded graywackes, Archean Iron-formation outcrop near the Soudan Mine, Soudan Underground Mine State Park and a tour of the Physics experiment, the LTV pits (to see a "field of stromatolites," collecting permitted), and a classic outcrop of pillowed greenstones in Gilbert. So mark your calendars and stay tuned for details!

GSM at the Science Museum

On March 26 and 27, the Science Museum of Minnesota held a "Science Summit" where community-based science organizations were invited to staff a booth for their group to distribute information about their organization and share any educational materials or exhibits they may have. The GSM displayed one of the three large collections of rocks and fossils that are used by our college Geology students to present the School Outreach Program in elementary and secondary schools. Our booth was situated on level four in the Collections Gallery and close to the *Collector's Corner,* a counter where museum goers can trade personal natural finds for points or other items of interest the museum offers.

The summit was a very positive experience both for the museum goers who viewed our collection and our members who answered their questions. Many thanks to the GSMers who volunteered on short notice for this public service opportunity: Steve Erickson, Bruce Goetteman, Dick Heglund, Janet Hopper, Paul Martin, Carol Osterbauer, Gerry Paul, Bill Robbins, Nancy Wiens, and Doug Zbikowski.

This effort of partnering with community organizations is part of a larger program for which the Science Museum has received funding from the National Science Foundation to implement. The goal is to develop a model where science museums can more productively interrelate with science organizations in the regions they serve.

Geological Society of Minnesota 1938

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