GEOLOGICAL SOCIETY OF MINNESOTA

NEWS

SPRING 2002
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http://www.geo.umn.edu/orgs/gsm/

Kimball Memorial Banquet

Monday, April 29, 2002
Old Country Buffet
3000 White Bear Avenue
Maplewood Minnesota

Dinner 5PM, Program 7PM

History of Minn Mining: NonFerrous Metals

Dave Dahl, MSc, DNR – Hibbing

*** * * First Field Trip of 2002 * * ***

May 18th – One-day field trip, led by
Tony Runkel, Minnesota Geological Survey

HydroGeology of the Paleozoic Bedrock in the Rochester Area

Field trip fee is $10 for members, $15 for non-members. Details of the trip will be mailed to all members approximately two weeks before the trip. Mark your calendars now!

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WALLACE'S LINE

British naturalist and explorer Alfred Russell Wallace independently invented the theory of evolution by natural selection in 1858, nearly scooping Charles Darwin, who published first. Nevertheless, Wallace's research led him to another important discovery, one that geologists still enshrine on their maps: Wallace's Line.

While exploring the vast 2,500-mile Malay Archipelago, Wallace noticed what kinds of animals lived on each island as he traveled farther from the mainland peninsula. He found that he could draw a boundary down the narrow Macasser Straight, which runs a twisted course between the islands of Bali and Lombock, and between Borneo and the Celebes group. Wallace's Line -- an ocean channel only 15 miles wide – separates tigers from marsupials and trogons from cockatoos. The animals on either side of it, he wrote in 1858, "differ as much as those of South America and Africa. Yet there is nothing on the map to mark their limits. I believe the western part to be a separated portion of continental Asia, the eastern the fragmentary prolongation of a former Pacific continent."

Wallace had no way to observe the sea floor directly, and in his day nothing was known of tectonic plates. On the basis of animal distribution alone he deduced that the eastern island groups must have been separated from the western for much longer than any individual islands were separated from each other.

A hundred years later, geologists and oceanographers found the reason and the proof: Wallace's Line traverses an area of intense crustal activity, where the northward-moving Australian plate interacts with the western-moving Pacific (Asian-derived) plate. In addition to bringing two different geographic clusters of animals and plants close together, the plates' enormous pressures on each other and on the Eurasian continent has given rise to the most concentrated volcanic activity on Earth.~

Announcements

The remaining lectures in the 2001-2002 series will be held in the Electrical Engineering & Computer Science Bldg. (EE Comp Sci) Room 3-210, just a few steps N.E. of Amundson Hall.

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Add this newly scheduled lecture to your lecture schedule calendar:

Apr 8 Finding and Forming Diamonds
7:30 pm Robert Kirk, PhD. (Bob is a GSM member and was on the team at General Electric that made the first authenticated artificial diamonds, in the mid 1950s).

GSM *NEWS*
Editor: Katy Paul
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Reporter: Tom Smalec

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.

Officers: Steve Erickson, *President*; Paul Martin, *Vice President*; Ted Chura, *Treasurer*; Judy Hamilton, *Secretary*.

Directors: In addition to the officers listed above: Gail Marshall; Rose Mary O'Donovan; Katy Paul; Nina Ward

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

News from the Board...

Greetings!

So, it's my turn to write the President's Letter! I am looking forward to a great year as the President of the Geological Society of Minnesota, and I hope we have a great turnout for the rest of the lectures and the summer field trips. We are trying to set up four trips this year, including two trips to Lake Superior. We have some dedicated people working to set these up. The trips will depend on whether we can get the guides to go and when they are available. Stay tuned for more later.

I'd like to take this opportunity to thank Bill Robbins for his fine work running the show the last two years. Also, there are many fine people who have been active in the organization over the last twenty plus years, and I'd like to thank all of these. I have heard from them that the organization nearly died in the early 1960's, but a few people stepped up and held it together. Now, many of these people are reducing their work with the group, due to health reasons, travel reasons and grandchildren reasons. We really need a new group to step up in the next few years. I am particularly interested in getting some of the geological teachers in the secondary schools to become active members in the group.

When I was in 8th grade, I asked my Earth Science Teacher about this new theory of "Continental Drift". The great plate tectonic revolution of the 1960's had exploded onto the scene at a geophysical conference. My teacher didn't think much of it, and thought it would go away. If he had been active in a group like ours, he might have known more about it. We can give the teachers in our schools a great way to get a better working knowledge of their subject, and in turn, increase the excitement the students have. So, if you know any teachers, let's get the message out to them about the opportunities we can give them.

I hope you enjoy the rest of this lecture set and the new series starting in the fall.

~Steve Erickson, President

From Molehill to Mountain

The 10,000-foot peaks in western Oregon known as the Three Sisters were once a flat stretch of real estate. Then the ground began to tremble and bulge, and the first in a long series of volcanic eruptions spewed ash and debris as far south as California and out into the Pacific Ocean. Such eruptions have been building the Sisters from lava and cinders for about 700,000 years. The last one occurred 2,000 years ago, at South Sister; it's been pretty quiet ever since.

These days all the action is west of the Three Sisters Range in a wilderness area distinguished only by its formidable mosquitoes. There the Earth's crust is heaving up in a bull's-eye pattern 10 miles wide. At its center is a four-inch rise, a veritable molehill compared with the nearby mountains. But geologists think it could be the start of something big: the birth of another volcano.

The U.S. Geological Survey in Menlo Park, California found the uplift last May by comparing satellite images taken in 1996 and 2000. Perhaps the Oregon event may provide the first opportunity to track a volcanic eruption from its inception, long before the smoke and pyrotechnics begin.

The uplift was most likely caused by a sudden influx of molten rock more than four miles below the surface. That thick, liquid rock, called magma, melts deep within the Earth and then floats upward into fissures in the Earth's crust, where it pools in underground reservoirs called magma chambers. When the pressure in a chamber gets high enough, the magma pushes through existing cracks in the Earth's surface or creates new ones. The eruptions can be slow and deliberate or sudden and catastrophic; both kinds have occurred countless times in the turbulent past of the Three Sisters Range.

Magma upwelling often produces telltale signs that help researchers forecast eruptions and protect human life. Swarms of small earthquakes occur, for instance, when the pressure of rising magma becomes forceful enough to crack rock. The ground above a supercharged magma reservoir may get pushed up by more than two feet. Magma upwelling releases carbon dioxide and other gases from liquid rock, and these gases can be detected at the surface. Escalation of any of these factors – seismic activity, ground deformation, or gas anomalies – may portend an eruption.

In the past decade, geologists have figured out how to use satellite-borne radar imaging, called InSAR, to spot subtle deformations on the Earth's surface. By comparing images of the same place taken at different times, they can detect changes as small as one inch in the elevation of the ground. Terrestrial instruments can track ground deformation too. The problem is that such instruments are often installed only after an active volcano has made its intentions clear. They're rarely in place at the site of dormant volcanoes such as the Three Sisters, let alone in areas with no eruptive history, like the adjacent wilderness. And ground-based instruments measure only deformation at isolated points; they don't give a 3-D picture that helps scientists model what's happening in magma chambers miles below.

Now geologists hope to use InSAR to pinpoint and monitor potential hot spots earlier in the volcanic progression. Because of technical limitations, InSAR's coverage is far from global, and the Oregon uplift is the first ominous-looking site found on American soil. Thus survey scientists spent much of last summer in the Three Sisters Wilderness collecting water from backcountry springs, sampling carbon dioxide levels by helicopter, and airlifting instruments that can transmit data on ground deformation and seismic activity continuously.

Carbon dioxide levels over the bulge are higher than expected, and the concentration of chloride and sulfate in springs and streams is well above normal levels also. Both elements escape rising magma as gases before dissolving in groundwater. So far the monitors have detected just one earthquake: a magnitude 1.8 tremor in August 2001 that originated three miles underground at the eastern boundary of the bull's-eye.

Though the deformation has a well-defined center, a new volcano might not sprout there. Instead, the magma could get squeezed eastward along underground pipes and fissures to surface at one or more of the region's existing lava vents. Or it could end up reviving one of the three dormant Sisters. When the magma does surface, there's no telling how violent the eruption will be. It could ooze out of a vent with little fanfare, or explode in clouds of ash, cinder, and fire.~

~Excerpts from DISCOVER magazine, Dec. 2001

Fossils of the Alabama Black Belt

Bruce Goetteman

My late summer travels took me through Sumter County, Alabama, wherein resides the campus of the University of West Alabama. This area is considered the Upper Coastal Plain of Alabama, and is composed of geologic strata that Geologists believe were deposited near the ocean's edge during the latter phases of the era of dinosaurs. The Tombigbee River forms the eastern border of the county and over the years has carried away much of the area's rich, black, prairie-type soil. This rich prairie soil helped large cotton plantations to thrive in the region in pre-Civil War Alabama, and is also the derivation of the term the Black Belt.

Thanks to the erosive actions of the Tombigbee River the marine rocks of the Cretaceous Period are exposed in Sumter County. The most prominent of these is chalk.

Chalk is composed primarily of the limy-fossilized skeletons and body parts of microscopic organisms that lived in the rich Cretaceous seas. The name Cretaceous, itself, is derived from the Latin word for chalk. Chalk contains many tiny plates of calcium carbonate (calcite) produced by marine algae known as coccolithophorids.

Other important microscopic fossils found in chalk are the foraminifera, or "forams." These minute marine creatures also build protective skeletons of calcite that become visible under high magnification. A simple and safe test for the presence of calcium carbonate is the acid test. You can try this at home by applying a weak acid like vinegar to powered chalk.

In Sumter County, chalk sediments occur in a sequence of rocks commonly referred to as the Selma Chalk. Pure chalk is nearly white in color, but when contaminated with a varying amount of mud can be gray or greenish. If the chalk layer is impure —mixed with mud particles— it is commonly termed a marl. Other portions of the Selma Chalk are sandy, and still others are harder and more lithified, such as a rock unit that crops out in western Alabama known as the Arcola Limestone.

Chalk that is unfractured by faults is virtually impermeable to the movement of ground water. This characteristic, and the fact that in western Alabama chalk layers are several hundred feet thick, has encouraged some industries to use these Cretaceous chalks for storage of hazardous materials.

The impermeable nature of chalk also is responsible for helping create Alabama's Black Belt prairie region. The low water-holding capacity and alkalinity of the soils originating over chalk promotes tall grass meadows with many beautiful wildflowers. As I have stated earlier, much of the rich, dark topsoil that developed through time on the chalk layers is now gone. Chalk gullies, where the topsoil has eroded away, are some of the prime spots across Sumter County to hunt Cretaceous fossils. The largest of these gullies is the Tombigbee River, which is dotted with abandoned chalk quarries. And with a little effort, an out-of-stater can easily secure permission to hunt these quarries.

There is a plethora of fossils at these sites with each quarry working different geologic strata. Among the most prized of these fossils are the teeth of the numerous sharks that plied the Cretaceous seas. Otherwise, the fossils are similar to the Cretaceous fossils found here in Minnesota. But the most unusual specimens I have collected in Sumter County are marcasite/pyrite coprolite nodules. It is believed that turtle is the source of the organic matter. The floor of one particular quarry is littered with fossilized turtle remnants.

So, there is no need to travel to England to visit the white cliffs of Dover. Likewise, a chase to Alabama for Cretaceous chalk is not necessary. Chalk deposits and their store of fossils are closer than you may have imagined. As a matter of fact, there are deposits that are practically in our back yard.~

This is the text of the geological marker that describes the geology of the Hill Annex Mine. It is Located in Itasca County, 2 miles No. of Calumet, near the mine overlook next to the visitor center parking lot.

Hill Annex Mine State Park

GEOLOGY OF THE HILL ANNEX MINE

The lowest layer visible on the mine face is a thick exposure of reddish-brown sedimentary rock called the Biwabik Iron Formation. About 1.9 billion years ago, this rock formed underwater, near the shoreline of a shallow sea. In that marine environment, blue-green algae grew. Now classified as a type of bacteria, these ancient microbes were photosynthetic: they made their own food from water, carbon dioxide, and sunlight, and gave off oxygen as a by-product. At that time, the seas contained much dissolved iron, and when oxygen was introduced, it combined with the iron. The resulting iron oxide precipitated from the seawater, mixed with silica sediments on the seafloor, and eventually solidified into sedimentary rock. Much later, groundwater infiltrated the rock and circulated, especially along the faults and fractures. The water concentrated the iron by leaching out silica and caused further oxidation, producing an enriched ore containing 55 percent or more iron by weight.

About 95 million years ago, during the Cretaceous period, another shallow sea advanced over this area. The erosive action of rivers, waves, and weather broke down the surface of the Biwabik Iron Formation and produced a layer of boulders, cobbles, pebbles, and sand-sized particles on top of the iron-formation. As the sea level rose, finer sediments were deposited on the seafloor. Fossilized clams, oysters, snails, fish teeth, turtle bones, crocodile bones, and plant debris are all found within these sediments, now called the Coleraine Formation. Most of this formation has been eroded or mined. Only a thin, patchy layer remains, and it is mostly hidden by vegetation. However, excellent exposures exist at the east end of the mine.

At the top of the mine face is a light-colored layer of glacial sediment (clay, silt, sand, gravel, and boulders), which was mixed and deposited by glaciers that repeatedly covered this area during the Ice Age of the last two million years. Meltwater streaming from the edge of a glacier has in some places sorted the glacial sediments by size. The glaciers last receded from this area 11,000 years ago.

A Commentary...

Anthropic Rocks: Made, Modified, and Moved by Humans

By James R. Underwood Jr., Professor Emeritus of Geology, Kansas State University

Each year, humans produce immense quantities of rock, e.g., brick, tile, concrete, and glass; they modify large volumes of rock by quarrying, shaping, crushing, polishing, and inscribing; and they move massive amounts of rock across continents and oceans and up and down mountains. I propose that those rocks that show the distinctive influence of humans be designated anthropic rocks and be considered a fourth basic class.

In western Iran, ancient inscriptions on a steep limestone cliff face depict in bas-relief and in trilingual texts the homage paid to Darius the Great by his defeated adversaries 2300 years ago. On the modern beaches of Libya, the coarse-sediment fraction comprises wave-rounded pieces of marble and mosaic tile from eroded ancient Roman seaside villas and cities together with pieces of modern cement-block building material derived from Libyan structures of today. In Alexandria, Virginia, twenty-first century vehicles bump along streets paved with ballast rocks brought to American shores by the sailing ships of yesterday. From place to place along the rail lines from central Texas to Texas Gulf Coast ports, massive blocks of distinctive pink granite lie where they fell off railway flatcars as the rocks were being transported to the construction sites of jetties and breakwaters. In the vast plains of central Iraq, traversed by the Tigris and Euphrates rivers, innumerable hills (tells) mark the sites of ancient villages built of sun-dried brick and later buried by the persistent, ever-blowing sand and silt of the desert. Common in cities and towns of today is the sight of dump trucks, loaded with debris from demolished structures, en route to a recycling plant or to a landfill. These and countless other occurrences testify to the abundance, variety, and widespread presence of anthropic rocks: rocks made by humans (anthropogenic rocks); rocks modified by humans (anthropotechnic rocks); and rocks moved by humans (anthropokinetic rocks).

Anthropogenic rocks, those made by humans, have been referred to as artificial rocks, as pseudo-rocks, and as synthetic rocks, suggesting that anthropogenic rocks somehow are unnatural. But are not the building materials and buildings made by humans in the course of their daily, routine activities analogous to, for example, great coral reef masses built by a complex community of invertebrates? Anthropogenic rocks, however, are unique in several ways: 1) they result from processes that can be observed and are well understood; 2) materials of which they are composed can be derived locally or can be brought from distant sources; 3) their volume and rate of production are great; and 4) once made, anthropic rocks can be used locally or moved great distances – even to higher elevations – relatively rapidly.

As humans continue at an increasing pace the inexorable cycle of construction, more and more materials made or modified or transported by humans will become involved in surficial geological processes of weathering, transport, and deposition. I suggest that the materials that bear the unique imprint of human activity constitute an ever-growing and distinct class of rocks, anthropic rocks, and that these rocks are as "natural" as traditional igneous, sedimentary, and metamorphic rocks.

As world population increases, more and more people will live in cities, where cycles of building, demolishing, and rebuilding are concentrated. There, more and more rocks of all kinds, including anthropic rocks, will be involved, and a terminology to use in recording their presence and in describing them will be useful.

Continued, next page...

Recognizing anthropic rocks as a separate class results in several advantages.

- It brings an enhanced awareness and understanding of such materials.
- It enhances communication, both oral and written, especially in the preparation of geologic maps and reports.
- It increases awareness of the role of humans in modifying the surface of Earth and its materials.
- It is a logical step in the same sense as was recognition of metamorphic rocks in the nineteenth century as rocks that originated in ways and in environments other than those of the rock classes then recognized.

A basic goal of geologic field studies and associated laboratory analysis is the determination of the geologic history of the area and of the materials under study. Today, part of that history may be represented in the study area by anthropic rocks, and their recognition and interpretation may provide insight to a significant part of that geologic history.

Finally, classifications and special terms are useful only if they enhance understanding and communication. In the present discussion, two basic but separate issues arise: 1) the concept of anthropic rocks as a basic and distinct class of rocks, i.e., those rocks that reflect, in whatever way, the influence of humans; and 2) the terms suggested to designate them. The concept is much more important than the terms.

[This commentary is reprinted from *GSA Today*, Vol.11, No. 11, November 2001]

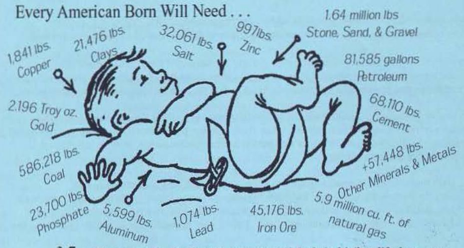
Almost Gold

Before Chemistry was a science, there was Alchemy. One of the supreme quests of alchemy is to transmute lead into gold. Lead (atomic number 82) and gold (atomic number 79) are defined as elements by the number of protons they possess. Changing the element requires changing the atomic (proton) number. The number of protons cannot be altered by any chemical means. However, physics may be used to add or remove protons and thereby change one element into another. Because lead is stable, forcing it to release three protons requires a vast input of energy, such that the cost of transmuting it greatly surpasses the value of the resulting gold.

Transmutation of lead into gold isn't just theoretically possible - it has been achieved! There are reports that Glenn Seaborg, 1951 Nobel Laureate in Chemistry, succeeded in transmuting a minute quantity of lead (possibly en route from bismuth, in 1980) into gold. There is an earlier report (1972) in which Soviet physicists at a nuclear research facility near Lake Baikal in Siberia accidentally discovered a reaction for turning lead into gold when they found the lead shielding of an experimental reactor had changed to gold.

In nature, new elements are created by adding protons and neutrons to hydrogen atoms within the nuclear reactor of a star, producing increasingly heavier elements, up to iron (atomic number 26). This process is called nucleosynthesis. Elements heavier than iron are formed in the stellar explosion of a supernova. In a supernova, gold may be made into lead, but not the other way around.

While it may never be commonplace to transmute lead into gold, it is practical to obtain gold from lead ores. The minerals galena (lead sulfide, PbS), cerussite (lead carbonate, $PbCO_3$), and anglesite (lead sulfate, $PbSO_4$) often contain zinc, gold, silver, and other metals. Once the ore has been pulverized, chemical techniques are sufficient to separate the gold from the lead. The result is almost alchemy...almost.



3.7 **million pounds of minerals, metals, and fuels in his/her lifetime**

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