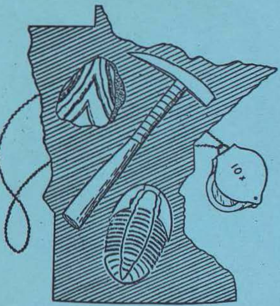
JAN-FEB 1977



Geological Society of Minnesota

NEWS

Geological Society of Minnesota

Marcia Gunville, Editor
1110 Gardena Ave.
Fridley, Minn. 55432

FIRST CLASS

RETURN REQUESTED

January - February, 1977

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From The Origin Of Landscapes
H. F. Garner, Rutgers University

There is a revolution brewing in geomorphology as profound as the one presently affecting global tectonics. It involves the concept of the environmental interface in a space-time continuum, and it may provide us with the vital conceptual tools we require to deal with our contemporary environment. One such interface is that between the atmosphere and the earth, where events are often so slow as to seem not to be happening at all. Along another interface between land and sea the changes are so rapid and continuous we are hard-pressed to monitor them, even in part. In orogenic belts, we find the ultimate of interaction, the maximum in variables, the culmination of forces. If a coast is environments in contact, a mountain system is environments in conflict; the up-building vies with the down-tearing. And whether it is a mountain range or the human form, everyone knows what happens when support is withdrawn.

There is little denying that gravity will probably have the last word on earth, but present internal activities place such a notion among those concepts which can be contemplated as a remote eventuality. Even so, for mountains, gravity is an actuality magnified by slope and elevation; as real as a boulder wildly bouncing down through space toward a fragile creature of flesh and blood. In the strand we note a change in medium that hardly alters gravity's pull upon the land, a pull effectively begun at the mountain's peak. At the start there is only frost and rock fall--from the "bare bedrock bones" to the rubble heap, and the land form is stark, angular, and conic. The debris slopes repose between truncated spurs to flank the high desert's near-static tablelands, temporarily immune to the erosional ravages wrought by climate change just below. Steep, bounding slopes of the mountains and high plateaus "melt back" under an atmospheric "surf" where climate follows climate, erosion and weathering alter and accelerate with each shift, and then wane, and the energy expended against the crust rivals that of the distant ocean shore.

SPRING BANQUET

In spite of the bitter cold weather we've been having, Spring is on the way and arrangements are being made for the Annual Banquet to be held Monday evening, April 25. Minnesota Geological Society members and guests will gather in the King's Hall of the Twins Motor Inn for feasting and fellowship. Dr. Matt Walton, Director of the Minnesota Geological Survey, will be the guest speaker - his topic: "Geological Opportunities in Minnesota".

Mark your calendar now and plan to be with us the evening of April 25th. More details to follow in the next newsletter.

Mrs. Robert Leacock,
Banquet Chairman

BOARD CHANGE

Because of the resignation of Les Collins from the Board of Directors, a vacancy has occurred as of Jan. 1, 1977. At their last meeting, the Board appointed Mark Jeffreys to fill the unexpired term.

CHANGE YOUR LECTURE CALENDAR

A reminder is in order that the published schedule of lectures has been changed. There will be no lecture on March 28. Instead it will be held on March 21.

ANNUAL FINANCIAL STATEMENT 12-31-75 to 12-31-76

INCOME				
Dues for 1976	$307.00			
1977	592.00			
	$899.00	$899.00		
Field Trips		4.00		
Banquet		417.50		
Coffee		31.70		
Badges & Nameplates		6.25		
Workshop (St.Luke's School)		34.40		
		$1392.85	$1392.85	
EXPENSES				
Bank Costs		4.03		
Membership		68.19		
Program				
Lectures		480.00		
Programs		80.29		
Public Service		20.00		
Banquet		387.98		
Workshop (St.Luke's School)		38.00		
Newsletter		177.42		
Treasury Expenses		8.00		
		$1263.91	1263.91	
CREDIT			$ 128.94	
Checkbook Balance - January 3, 1977				$974.84
Balance Savings Account(1 year @ 6½%) interest $158.68				2496.13
Balance Savings Account(90 day @ 5.75%) interest 33.87				581.13
				$4052.10

Robert V. Leacock
Treasurer

by Barbara Lundgren

Most of these magazines are available at local libraries.

American Scientist - Nov., Dec. 1976
Viking on Mars: A preliminary Survey, Richard S. Young
Shedding Light on the Color of Gems and Minerals, Bruce Loeffler, Roger G. Burns

Scientific American - June, 1976
Historical Supernovas, L. Richard Stevenson and David H. Clark

Scientific American - August, 1976
Hot Spots on the Earth's Surface, Kevin C. Burke and J. Lugo

Scientific American - October, 1976
Dust Storms, Sherwood B. Idso

Science - June 25, 1976
The Shape of the Earth, D. King-Kele
The Arctic Mirage and the Early North Atlantic, H. L. Sawalsky and W. H. Lehn

Science - July 9, 1976
The Prehistory of the Egyptian Sahara, F. Wendorf et al

Science - July 30, 1976
Precambrian Geologic History, R. B. Hargraves

Science - August 6, 1976
Global Cooling, P. E. Daman and S. M. Kunen

Science - August 27, 1976
Many articles on Viking on Mars; practically the whole issue.

Science - September 17, 1976
Ancient Lithosphere: Its Role in Young Continental Volcanism C. Brooke, D. E. James, S. R. Hart

Science, September 24, 1987
Tectonic Aspects of the Guatemala Earthquake of 4 Feb., 1976 G. Plafky
Several Book Reviews.
Yellowstone: Seismic Evidence for a Chemical Mantle Plume D. M. Hadley, G. S. Stewart, J. E. Ebel

Science - October 1, 1976
Another issue primarily devoted to Mars.

Science - November 12, 1976
Episodic Strain Accumulation in Southern Camifornia, W. Thatcher

Science, December 10, 1976
Variations in the Earth's Orbit: Pacemaker of the Ice Ages J. D. Hays, J. Imbrie, N. J. Shackleton

Science, Dec. 17, 1976
Still more on Mars.

Science, January 7, 1977
Shoreline Inheritance in Coastal Histories, B. A. M. Phillips
Chronology of Hawaiian Glaciations, S. C. Porter, M. Stuiver, I. C. Young

National Geographic - August, 1976
Deep Sea Window Into the Earth, Robert D. Ballard

National Geographic - November, 1976
What's Happening to Our Climate?, Samuel Matthews

National Geographic - January, 1977
Mars: As Viking Sees It The Search For Life, Rick Gore

The Smithsonian - February, 1975
Plate Tectonics Has a Lot to Tell Us, Tom Alexander

Fossils - May, 1976
The entire issue is good; a new magazine.

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SUPERIOR'S KEWEENAW PENINSULA, THE OTHER SIDE OF THE SYNCLINE
As Viewed on the 1976 G.S.M. Field Trip

by Marcia Guwville

Michigan's Keweenaw Peninsuls is famed as copper country. Native copper has been mined here since Prehistoric times. Keweenaw rocks are famous too, well enough known to have an entire period of geologic history named after them. A G.S.M. field trip to the Peninsula might be a good idea.

Even though tucked away in the interior of the continent, Lake Superior's South Shore has the flavor of an ocean coastline. The shores of the Keweenaw Peninsula abound with beaches and coves, lighthouses and little villages. And lined up along sections of its backbone are old mining towns with their standard, look-alike buildings. Many of them now almost ghost towns, they give the Peninsula still another character. Some of the old mine shafts may be closed down and dilapidated, but mines often have large dump piles with interesting rock tailings. With luck, collecting might be possible. A G.S.M. field trip could be fun, and could turn up some good specimens to take home and talk about.

The geologic history of the Keweenaw Peninsula closely parallels that of Minnesota during Middle and Late Precambrian times. Many Minnesota rocks are similar to those on the Wisconsin-Michigan side of Lake Superior. Rocks on the Peninsula and rocks of Isle Royale, just off Grand Portage in northeastern Minnesota, could almost be thought of as mirror images of each other. A field trip here would also enlarge our view of events occurring in our own state, helping us to understand them a little better. The opportunity to have this story presented by a superb teacher who knows these rocks very well made a field trip to Michigan's Keweenaw Peninsula essential.

Dr. David Southwick, from Macalester College, helped us to put into place the slice of earth history represented by these rocks. During much of the Middle Precambrian Period (2600 - 1600 M.Y.) seas existed on this particular segment of the North American continent. Sediments from eroding land masses were deposited on the floors of these seas. Sands were left in regions of both Minnesota and Wisconsin-Upper Michigan, which later became quartzite on both the Mesabi Range of Minnesota and the Gogebic Range of Wisconsin-Upper Michigan.

Then the seas deepened, and iron-rich sediments were chemically precipitated out of the water. Iron-formations were emplaced on top of the quartzites. When the waters again became shallower, muds and dirty sands were laid down over these iron-formations, becoming units of slates and graywackes. These rocks were formed over a long period of time, probably during the latter part of Middle Precambrian times.

During the Keweenawan Period (Upper Precambrian, 1600 M.Y. - 600 M.Y.) parts of northeastern Minnesota and Wisconsin-Upper Michigan experienced volcanic activity. This activity took place along a narrow band extending as far south as Kansas, and became intense around 1200 - 1000 million years ago. The earth's crust began to split, and flow after flow of lava was extruded out of fissures onto the surface. It appears today as if the continent were trying to pull apart along a thin rift zone. As volcanic materials piled up higher on the surface, the crust itself began to subside. These volcanic rocks became very thick. More magma was injected into them, which did not reach the surface. Instead this large amount of magma cooled underground as a batholith, to form the Duluth Gabbro Complex.

This volcanic activity took place over a long period of time. Sometimes episodes of erosion occurred between episodes of volcanism. The crust was unable to hold the weight of the rocks being placed upon it, and as they piled up higher the crust slowly bent downward, deforming into a large syncline. And then the rifting ceased. Volcanic accumulations gradually gave way to sedimentary accumulations. However, faulting continued as the crust was forced to break in further adjustments to events of this period.

Dr. Southwick explained to us how the Middle Precambrian rocks of Minnesota's Mesabi Range had their counterparts in the Gogebic Range of Wisconsin and Michigan. We could recall other field trips to the Mesabi Range and the open pit iron mines of Minnesota, and seeing there the Pokegama Quartzite directly below the Biwabic Iron-formation, which gives Minnesota much of its productive iron ore. On top of this iron-formation lies the slates and graywackes of the Virginia Formation. In road cuts at Ballou Gap of the Gogebic Range, east of Mellen, Wisconsin, we saw rocks in the same relationships but with different names, the Palms Quartzite below the Ironwood Iron-formation, and overlain by the Tyler Slate. There was no doubt about the iron-bearing quality of the rocks there. They were able to grab and hold our magnets.

In Minnesota we knew about the Upper Precambrian (Keweenawan) lava flows of northeastern Minnesota, and the large amounts of magma intruding into them, which became the Duluth Gabbro. We would see many Keweenawan lava flows in Wisconsin and Michigan as well, and Wisconsin's much smaller body of intrusive magma, the Mellen Complex. We stopped to see it at an old quarry, and also at road cuts near Mellen. This complex is tiny in comparison to the Duluth Gabbro, but we could recognize many of the same rock types; gabbro, anorthosite, granite, and porphyritic granite.

We remembered seeing along Minnesota's North Shore a few small sedimentary rock units interspersed in the great number of basalt lava flows, evidence of periods of erosion between periods of volcanic extrusion. In Michigan the sedimentary units were much more extensive, and as the geologic column here moved upward in time, the rocks graded from predominently basaltic to predominently sedimentary in nature. Much of the rock is conglomerate, composed of large pebbles and rock pieces. Apparently this side of the syncline was once close to the eroding highlands. At the top of the geologic comumn on the Keweenaw Peninsula the rocks are entirely sedimentary. We do not find these top sedimentary units on the Minnesota side of the lake.

The rocks of the Keweenaw Peninsula are tilted. They dip sharply toward the northwest, in the direction of Lake Superior. On the Minnesota side they also dip toward Lake Superior, but do so at a more shallow angle to the southeast. Dr. Southwick showed us how a stratigrapher interprets this puzzle. By measuring the angles of dip all around the zones of tilted rocks, he can outline the syncline which goes under Lake Superior like a shallow bowl. These rocks were pushed downward as a huge sag was formed in the earth's crust. This sag was not symmetrical. The warping was steeper on the Michigan side, and we could see how beds here dipped at a sharper angle than do those we remembered seeing across the lake in Minnesota.

We quickly learned to recognize individual lava flows as Dr. Southwick carefully pointed out to us the tops and bottoms of several of them. In Copper Falls State Park, Wisconsin, these flows sometimes were positioned at an almost vertical angle. Basalt once had been forced out as lava onto a flat surface. The gases contained within the lava bubbled to the top of each flow, with some of these gas bubbles becoming entrapped as the lava cooled quickly at the upper surface. Later, when more basalt was extruded onto this new surface, its gases again bubbled to the top. Flow tops thus are characterized by bubbly appearances while flow bottoms appear more solid and massive.

Lava flows did not always follow one another in rapid succession. When a long enough period of time had elapsed between flows, erosional processes had time to form beds of sandstone and conglomerate. The next flow then covered over these new layers. We saw many such sedimentary units interbedded within the lava flows, and we looked for top and bottom indicators in these as well. All these rocks were dipping out of their original horizontal orientation. Dr. Southwick helped us to learn how to determine the direction in which they dipped by deciding which way pointed to the younger beds. Younger beds point toward the center of a synclinal formation. When the reverse anticlinal formation exists, younger beds point to its edges. We were to see similar tilted-up beds of basalt and sedimentary rocks almost everywhere we went on the field trip. Their tops predominently point to the northwest, toward the middle of Lake Superior.

We also learned from Dr. Southwick some of the guidelines followed by stratigraphers when they try to map lines of contact between two different rock units. Formations seldom are neatly separated at a distinct horizon. They more often grade from one type of rock to another, and the mapper must determine where he thinks the appropriate line of contact should be placed. At Bonanza Falls on Big Iron River, north of White Pine, Michigan, we saw such a gradational contact between the Nonesuch Shale and the Freda Sandstone, and discussed what deciding factors the mapper was looking at when he placed the line on his geological map where we found it. We were reminded of the gradational contact we had seen earlier at Ballou Gap, between the Middle Precambrian quartzite, iron-formation, and shale.

We saw another line of contact at Kettle River Falls, much farther up the Peninsula. This contact marked the uppermost bed of the Portage Lake Lava Series and the lowermost bed of the younger Copper Harbor Conglomerate. This contact marks the time during the Keweenawan Period when volcanism was waning and the types of rocks being deposited changed from mostly volcanic with interbedded sedimentary layers to mostly sedimentary containing occasional extrusions of lava. The rocks we had seen at Bonanza Falls are still younger than these.

Glaciers had been the most recent invaders of the landscape of the Peninsula. During the recent Pleistocene Period glaciers had overrun even the high, upturned hills of the Porcupine Mountains. We climbed up the hill overlooking Lake of the Clouds, where the panoramic views of the countryside were spectacular, and we followed with our eyes the valleys down which the ice had flowed as these glaciers moved down the Lake Superior basin. Glacial striations and chattermarks indicated that all of this landscape had been covered by ice. The Porcupine Mountains are very high hills, and well appreciated by skiers. They are the upturned beds of lava, sandstones, and other sedimentary rocks of the Copper Harbor Conglomerate. The layers of lava stand highest, as the softer sedimentary rocks tend to erode and become the valleys of the Porcupine Mountains. But even the highest of these hills were not high enough to escape the onslaught of the glaciers.

Copper mining has been an important industry on the Keweenaw Peninsula since the mid-1800's. Most of the mines are located along a long ridge within the Portage Lake Lava Series. This ridge goes up the Peninsula from Rockland through Houghton, to Calumet, and beyond. Mining also was active farther south near White Pine and the Porcupine Mountains, ans minor prospecting has been done in a number of places.

The native copper deposits on the Keweenaw Peninsula were among the richest in the world. Copper bearing beds are steeply inclined, as are all the layered rocks we saw going up the Peninsula. The old mine shafts ran deep as they followed these mineral bearing beds. One of the mines was excavated over 8,000 feet underground, well over a mile and a half below the surface.

Eons ago, some time after the beds of both lava and sedimentary rocks had been laid down here, mineral-rich waters percolated through certain layers, depositing in these layers not only copper but many other interesting minerals too. These hydrothermal solutions were able to move through the porous tops of the lava flows, through the sedimentary layers, and through fractures. Native copper can be found in these sites.

Many kinds of secondary minerals also were left by the percolating solutions. As we searched the dump piles of the Minnesota Mine and the Osceola Mine, we learned to look for such minerals as calcite, chlorite, epidote, and some of the different zeolites, in addition to copper. Many of us collected attractive examples of the conglomerate itself.

However, the native copper in these dump piles was the prize we most wanted to find. We learned how to look for its characteristic blue-green coloring as a clue to its presence. Sometimes we found it laminated in copper colored layers within small rock openings. A few of us were sharp eyed enough to find loose pieces of twisted, weathered copper fragments of what we considered a respectable size. At least they could be carried in our pockets without being lost.

The mines of the Keweenaw Peninsula are largely inactive now. Economic factors have determined the feasibility of continued mining operations. There is still plenty of copper on the Peninsula, but these rocks dip steeply, and copper bearing beds run deep. Today the Peninsula itself is quiet and pleasant, and tourism now is a valuable resource, especially for skiers in the winter.

We considered ourselves rather unusual tourists with a special reason to be here. Dr. Southwick gave us many insights into this unique country, and the earth history to be read in its rocks. With his thoroughness and care in teaching this geologic story, he not only has given us a better perspective of events on this ancient part of the continent. He also has helped us to understand the information scientists are still developing. He showed us that the story is not a simple one. We will be interested to learn more, and to follow it further.

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