November 2019 Volume 73, No. 4

Promoting public interest and educational support in the geological sciences

The Geological Society of Minnesota News

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

From the President's Desk…

Greetings, GSMers. Fall has arrived, and so has our lecture season. As I write this in late October, we have already had four lectures, including the Fall Banquet and Annual Meeting at U Garden Restaurant. Average attendance for those four was 92, with around 8 new attendees at each. So once again we are off to a great start. Thank you, **Steve Erickson**, for putting together another informative and diverse program. As we approach winter, please review our **lecture cancellation policy** on the GSM web site.

Our field trip program for 2019 has pretty much ended, although I will schedule another tour of St. Anthony Falls Lab this autumn if there is sufficient interest. Unfortunately, our trip schedule was fairly sparse this year. Out biggest trip this year was the Sand & Sandstone three-day trip in early September, planned by **Dave Peters, Randy Strobel**, and myself, in which many of you participated. Look elsewhere in this issue for articles by **Mary Helen Inskeep** and **Dave Peters**. We hope to plan a larger number of activities for 2020. Some are currently in the early planning stages, and I'll send information by e-mail as it becomes available. This is a good time to mention that we are always looking for field trip ideas and for people to help organize field trips. GSM is a volunteer organization; field trips and other activities can only happen with your input and assistance. If you have never participated in planning a field trip before, no worries – I and many others have the experience to assist with that.

September marks the start of our fiscal and membership years. We have already had a great number of renewals; thank you, as your membership dues are what make the lecture series, this Newsletter, and other GSM programs possible. If you have not already renewed, see Membership Chair **Joanie Furlong** or Treasurer **Dave Kelso** during one of our lectures, or follow instructions on the web site for renewing by mail.

Our next **GSM Board meeting** is Thursday, November 21 at 7 PM at the Minnesota Geological Survey building, 2609 W Territorial Rd, St. Paul, MN. This is one week later than our usual 2nd Thursday, to allow us to attend the Freshwater Society presentation on November 14. Board meetings are open to all GSM members. If you are interested in seeing how your Board operates, please come and observe.

Have a happy Thanksgiving and a great winter. I look forward to seeing you at our lectures and other events.

Dave Wilhelm

GSM President, Dave Wilhelm

Upper photograph: Mark Ryan

Inside this issue:

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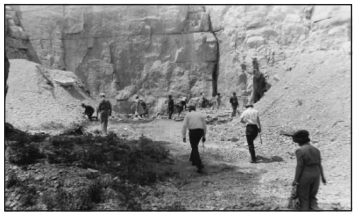
from the GSM archives: Quarry—Galena Limestone, Root River Mn,, 1941



GSM

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Lecture Recording: Joe Wright

Web Site: gsmn.org

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.

Please note the GSM change of address: Send all GSM membership dues, change of address cards, and renewals to: Joanie Furlong, GSM Membership Chair, P.O. Box 141065, Minneapolis, MN 55414-6065; Membership dues are: $10 Full-time students; $20 Individuals; $30 Families GSM News is published four times a Year during the months of February, May, August and November. Deadline for article submission is the first of the month, before the date of publication. Newsletter contributions welcomed.

Newsletter contributions welcomed

Of interest to our GSM enthusiasts: While out and about enjoying your vacation time – when you visit a site that you find interesting, please consider sharing your experiences with us by writing up a few words and sending it to Theresa Tweet at phoenix8185@gmail.com. Thank you in advance!

New GSM Members!

Sarah Parker & Bob Seavey, Minneapolis
Raymond Schmidt, North Mankato
Abigail Wilwerding, Freeport
Rose Keller, Brooklyn Center
Edwin Sheperd, Eden Prairie
Steve Fox, Hastings

GSM Board Membership

The GSM Board consists of members who have a special interest in advancing the goals of our society, including lectures, field trips, and community outreach. The Board currently has nine members. Our bylaws limit the terms of Board members to four years, to encourage a turnover of perspectives and ideas. The Board typically meets quarterly, on the second Thursdays of February, May, August, and November, or a different date if conflicts arise. We typically meet from 7 to 9 PM at the Minnesota Geological Survey at 2609 W Territorial Rd, St. Paul MN 55114.

Board meetings are open to all members of GSM. So, whether you are a new member of GSM or have been a member for many years, if Board membership is something that might interest you, or you are just curious to see what our Board does and how it works, we encourage you to attend a meeting. And, if you have a topic you would like the Board to consider, please contact Theresa Tweet at phoenix8185@gmail.com.

Mark your calendars on December 7, 2019 for a Holiday Gathering!

Ed and Sandy Steffner will again be opening their doors to the GSM clan. The Steffners will welcome guests on Saturday, December 7th, at 4:00 PM for appetizers, and 5 PM for Pot Luck Dinner; for food plans and the address please contact Sandy at ssteffner41@gmail.com

GSM Position Available

If you are interested in getting more involved with the GSM, we have a volunteer position available - **Dan Japuntich's position as Chair of the Minnesota State Fair**. This position is seasonal and requires some flexibility during the months of July, August and

September. Contact phoenix8185@gmail.com for more information.

Theresa Tweet

To Our MN State Fair Volunteers and Fair Participants:

It has been my privilege to be Chair of the GSM State Fair Committee again this year! I would like to personally thank all of the volunteers for representing the Geological Society of MN this year at the 2019 State Fair. Thanks for your comments on improvements, and if you have ideas to further improve the booth and our delivery, please email me.

Dan Japuntich
2019 State Fair Committee Chair

GSM Member Spotlight– Chuck Perrin

1. **How long have you been a GSM member?** I have been a GSM member since about 1980. I became a member when I moved to Minnesota - I found the membership information at the Minnesota State Fair booth.

2. **How did you get interested in geology?** I took my first Geology course in High School in 1969 and have been an enthusiast ever since. I took additional Geology courses throughout college, although I ended up with a computer science degree.

3. **What do you dig about the GSM?** I especially like GSM for the variety of topics we cover, the field trips, the people, and of course the food at the U Garden restaurant.

NOTES FROM THE PAST

***From GSM News*, March, 1945**

Meetings: Our Society meets every MONDAY evening, not a holiday, in the large auditorium on the 4th floor of the Public Library at Hennepin Avenue and 10th Street, Minneapolis, Minnesota, at 7:30 o'clock P.M. from October to May, inclusive. From June until September, inclusive, we have a program of field trips. Visitors are very welcome, always.

Dues: For those residing in Hennepin and Ramsey Counties, $3.00 annually, plus $1.00 additional for your wife, husband, or dependent family members; for those residing elsewhere, dues are $1.00 per person.

Object ID Day

On Saturday October 5th, the Science Museum of MN (SMM) held their annual Object ID Day, where visitors are invited to bring in their 'mystery' objects for assessment. GSM was invited to represent Geology.

GSM's table, flanked by experts in archaeology and paleontology, featured an examination tray, rock and mineral samples mostly drawn from the State Fair collection, a paleogeography map from the Ordovician, Earth's timeline in 10 inches, some basic sheets on mineral identification, and the lecture schedules. In addition there were several items to help in identification; lighted magnifying glasses, pre -1982 pennies, steel nails, a glass scratch plate, vinegar dropper, magnets, a white porcelain streak plate, Mohs scales, and a couple of rock/mineral guides (detailing hardness, streak color, etc.) from the State Fair books. Special tip of the GSM cap to Dan Japuntich for making the State Fair materials available, Roxy Janezich for allowing the use of her Mohs hardness materials including a box of definitive Mohs hardness minerals, and SMM staffers Roger Benepe and Mary Helen Inskeep for the personal in-event support supplied to the author of this article as he staffed the table.

I estimate we spoke to 80-100 people over the four hours of Object ID Day; the table was well received by visitors, and a dozen lecture schedules were picked up (with particular interest in the February lab). Hopefully this can become an annual event for GSM. It was great to expand our scope of service to a new audience!

Patrick Pfundstein

GSM's straight 8' table at Object ID Day (curvature supplied by panoramic photo function)

Annual Banquet: 16 September 2019

The GSM's Annual Fall Banquet at the U-Garden restaurant is always a terrific way to start off the GSM lecture series. The food is always good, as is the company. By adding a great lecture to the mix, you get a very memorable event.

Some important announcements were made. First on the agenda was the election of new members to the Board of Directors. Two Board members will be leaving after completing their terms: Kate Clover and Dick Bottenberg. To these members, the GSM would like to say thank you for your four years of ideas, insight, and service. The GSM would also like to say "thank you" and "welcome" to our new Board members: John Westgaard and Patrick Pfundstein. Both were voted in unanimously and their terms will begin on January 1, 2020.

It is unfortunate, but we have to say good-bye to our State Fair Chairman, Dan Japuntich – thank you for the wonderful job that you did, Dan! If anyone reading this article would be interested in taking on this position, let us know. Also, every two years, Estwing hammers with the GSM logo engraved on the handle are awarded to past Presidents and volunteer members who continue to serve the GSM in various capacities. The recipients this year were Ed and Sandy Steffner: these two host the Holiday Celebration, and have played major roles in the State Fair booth, the Marker Projects, and the Silent

Ed and Sandy Steffner wuth new Eastwing hammers

Auction. Finally, GSM Memberships were collected by Joanie Furlong, and the cookie sign-up sheet was made available. This was a busy and informative night of fun.

The evening's lecture presented by Randy Strobel was entitled "The Geology of the Bakken Formation, North Dakota." Randy is no stranger to the GSM lecture series; his past lectures include "Geology of the Mississippi River Gorge in the Twin Cities" (2017) and my personal favorite "Geology of The Mojave National Preserve and Death Valley, California" (2013).

Randy started off the lecture by saying that a large part of the Bakken Formation is found in North Dakota, with the deepest portion of the basin being beneath Montana. It was formed in the Late Devonian and is entirely in the subsurface with no outcrop. The oil that is found within this stratum is derived primarily from plankton and other organic marine material. As the plankton and other organisms died, their remains settled to the sea floor and decayed further. Then, as temperature and pressure increased with depth, the compression changed the mud to shale. Many layers of shale were deposited and buried by other sediments. The fluid in these sediments was expelled into the surrounding porous rock. Many thousands of meters of sedimentary layers were deposited over millions of years, and the Bakken Formation is now buried by 3-4 kilometers of younger deposits.

Randy Strobel and Oil from the Bakken Shale

Historically, there was a time when there was just one method used for drawing oil out from the ground: vertical drilling. Simply put, a well is drilled and either under its own pressure or by means of pumping, the oil is extracted from the ground. However, by 2005, the vertical method had fallen out of favor as the preferred method of drilling in this area. If a well appeared to run dry, and if it was financially feasible, the "unconventional" method of hydraulic fracturing was employed. Fracking enables oil companies to extract oil and gas that has been nearly impossible to reach. Through the high-pressure injection of a mixture consisting of water, sand, and other chemicals into the ground layers, the gas and oil is released and made available to be harvested by oil companies.

Bakken oil is considered light/sweet. "Light" refers to a grade of oil that has a low viscosity and flows easily at room temperature. The "sweet" refers to oil that needs

relatively little processing to market it. However, this complicates the transportation process because it is highly flammable.

GSM field trip to North Dakota, 2014

In 2014 Randy led a GSM group on a field trip to investigate, explore and enjoy North Dakota (see photo). Some of the areas of focus were on fossil fuels and the fracking industry. Being that the GSM Annual Fall Banquet comes right off of the State Fair and our information booth, and that social events like this are pretty laid-back, they often bring a number of new enthusiasts to our lectures. As an enthusiast myself, I was pleased with the comprehensible way that Randy was able to explain the composition and deposition of the Bakken Formation as well as shedding some light on the fracking industry.

Thank you for the presentation Randy, and thanks also to Steve for setting up another outstanding series of lectures!

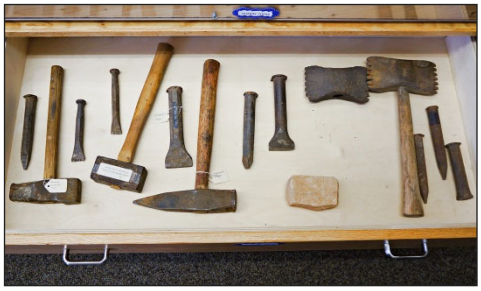
Theresa Tweet

GSM Sand & Sandstone Field Trip
Day 1, Saturday, Sept. 7, 2019

Day 1 of the trip focused on the history of sandstone mining around the aptly named Sandstone, MN. About 35 people took part in this day of the trip. We began with a visit to the Sandstone History & Art Center where Dick Vanderworth and other museum staff showed us a film and answered questions about the now-defunct local sandstone mines. We examined miners' artifacts and a detailed diorama of the mine, plus a large quilt portraying the history of both the City of Sandstone and the mines.

Sandstone mine diorama, photo Dave Wilhelm

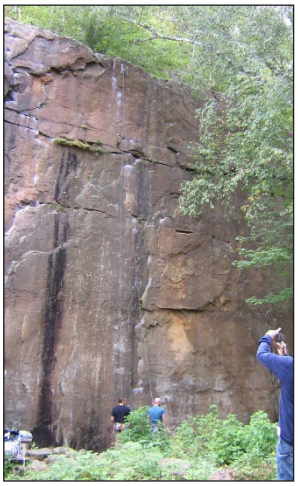
The sandstone in the area is called Kettle River Sandstone since it was mined next to the Kettle River. Rocks that were first exposed in the Midcontinent Rift were gradually eroded down into sand, with a large lake adding to the deposition, and creating ripple marks in some layers of the sand. Over time, it was cemented into sandstone, and the deposit reached a thickness of around 150 meters in this area. The sandstone is quite pure (over 98% silica), resistant to both high heat and the freeze-thaw cycles, and is described as "strong, fine-grained, and homogeneous," according to an 1899 article by Harold Johnson in the trade magazine Stone.



Tools used by the miners, photo Dave Wilhelm

The Kettle River Sandstone is a shade of light salmon pink, and was used extensively in architecture and bridge building. The big quarries that operated in Sandstone opened in 1887 and got their power directly from the river. Large sandstone blocks were sold for building projects; stone waste from the quarries was minimized by selling smaller or broken pieces for paving blocks and other small-stone uses, and by crushing the remainder for use in concrete. Some was even crushed down to get the sand itself. Kettle River Sandstone can be found in the construction of buildings from Montana eastward to Massachusetts, and from Minnesota southward to Missouri. The quarries were closed during the 1930's and 40's after structural steel and concrete displaced the use of sandstone in the building industry. The size and sharpness of the Kettle River sand grains make it unsuitable for use in fracking, so fossil fuel producers are not sourcing their sand from this area.

Our next stop was at Robinson Park, located directly on the Kettle River, where GSM's Randy Strobel and local guide Jim Larson showed us the historic sandstone quarry. Near the entrance, we saw towering, sheer rock faces and bluffs. As we traversed the park, we frequently encountered huge blocks of stone that had been ready to be sawn at the mill or squared off to become building stones. Some blocks still showed the holes drilled for the placement of black powder, which was used to blast the stone away from the bluffs. The drills drew power from the river and were operated by pressurized air being piped across the quarry from a compressor building to hoses that were connected to



Sandstone bluff face, photo Mary Helen Inskeep

the drills used at the rock walls. Throughout the quarry, smaller pieces of sandstone were scattered everywhere.

Our trail sometimes intersected with rusted iron rails upon which the rail cars that carried loads of stone were once moved around the quarry. We also saw a still-vertical guy derrick that was used to hoist stone into the rail cars. In other parts of the quarry stood several parallel ranks of lower walls from the structures which once housed the saws that milled the stone and others that housed the crushers that ground up the smaller chunks of stone. The lower walls were clearly built from the Kettle River Sandstone; their upper parts had been made of wood that long ago succumbed to the elements. An iron railroad bridge was built above the river's gorge, too massive to capture from below in just one photo frame.

Sandstone walls from long-gone building, photo Mary Helen Inskeep

One end of the railroad bridge, photo Mary Helen Inskeep

Our last stop of the day was also on the Kettle River, about five miles away at another historic sandstone quarry in Banning State Park where we traversed the Quarry Loop Trail. Banning featured large chunks of layered sandstone scattered just about everywhere; the layering in the sandstone seemed a bit more obvious at Banning than at Robinson. Banning was notable for an example of horst-faulting (as in horst-and-graben), and for the walls of huge cement buildings that once housed a rock crusher and a power house; the massive walls still stand, but their roofs are long gone, and their empty windows stare out at passers-by.

Randy had warned me in advance that the trail at Banning would be "extremely bumpy and off-road" by scooter standards and he wasn't kidding in the least. I've never scooted a more difficult or bumpier terrain, and that's not even counting the newly storm-fallen tree we discovered blocking the trail, plus a bridge being reconstructed! By the end of the day, I felt like I was a martini--very thoroughly shaken (but not stirred). I want to send out a special Thank-You and Kudos to the people who "portaged" my scooter--twice--over and around those obstacles!

Cement building shell and box turtle, photo Mary Helen Inskeep

Besides geology, it should be noted that both parks could be good places for biological observations. Robinson Park featured white birch trees and multiple ferns; fungi growing on other species of trees; and mosses and lichens growing on many of the scattered stones. Banning State Park included even more birches; varieties of "shelf" fungi growing on both the trees and the rocks; lots more lichens and mosses, and even a box turtle to round out the day!

Mary Helen Inskeep

GSM field trip
Days 2 and 3, September 8-9, 2019

Day 2 of the "Sand and Sandstone" field trip took us from the Midcontinent rift, formed 1.1 billion years ago, to glacial times only 12,000 years ago. We began at 9 a.m. Sept. 8 at Amnicon Falls State Park 15 miles southeast of Superior, Wis., and were guided by Tom Fitz, geology professor at Northland College in Ashland.

Day 2, Barrens group

Fitz noted at the outset that the 20 vehicles and 44 participants made up the longest geology caravan he'd ever led in his 20 years at the college.

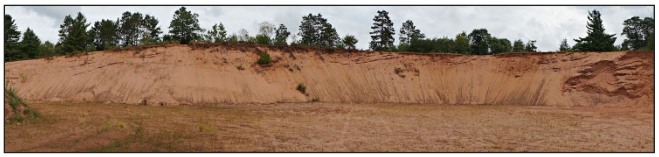
Amnicon Falls is one of the spots in northern Wisconsin where you can see the basalt and rhyolite resulting from

the lava flows associated with the great rift. The lava flowed for some 25 million years, first doming up and then cooling and shrinking down. This trough filled with

Amnicon Falls, Wisconsin

sediments – we could see both the basalt and the overlying conglomerates and sandstone at the falls.

Ultimately, a thick layer of flat rock was laid down, the Bayfield and Jacobsville sandstones, and it remained mostly undisturbed for about a billion years until the glaciers came along. They ground the sandstone to sand and streams issuing from the glacier front carried it south and west in enormous volumes, creating a 150-mile long band of northwestern Wisconsin sands. Fitz showed us a commercial sand pit near the tip of Lake Nebagamon, a



Sand pit

glimpse of how this sand piled up to hundreds of feet thick.

Our lunch stop overlooked the St. Croix-Brule river spillway carved by the rushing glacial meltwater. A rebound of the land after the glaciers retreated raised the continental divide to a point near Solon Springs, from which the Brule runs north and the St. Croix runs south.

GSM caravan

We spent the afternoon examining the distinctive sandy landscape of the Namekagon Barrens Wildlife Area (NBWA) in northeastern Burnett County. The glacial outwash yielded mostly flat "uncollapsed" plains where the meltwater deposited its loads on flat bedrock. The sand drains quickly today, creating a fire-prone brush prairie, or "barrens," of scrub oak and jack pine that the Wisconsin Department of Natural Resources manages for sharp-tailed grouse by conducting controlled burns regularly. The cores Fitz dug were proof of the thin soil and deep sand, and members of the Friends of the Namekagon Barrens Wildlife Area (FNBWA) helped the group understand the unique and globally significant nature of the area. We could see places where the sand had been deposited, not on bedrock, but on blocks of ice that subsequently melted. So in these spots, "collapsed" plains were created with pits that stay wetter and become home to aspen and even sphagnum moss and pitcher plants.

Bog, Namekagon Barrens Wildlife Area, WI

Especially stunning was the view overlooking a bog that sits 100 feet below a high ridge. The day's last stop was another view of the billion-year-old basalt and sandstone near Dairyland, Wis.

Day 3 consisted of a two-hour bus tour of Crex Meadows Wildlife Area near Grantsburg, Wis., led by the DNR's Lauren Finch. There were 26 people attending. Crex Meadows lies on the southern end of the outwash sands. At one point in the glacial retreat, this area was covered by Glacial Lake Grantsburg and resulting lake deposits created thin layers of silt and clay. This makes the ground hold water better than in the barrens farther north. So, as Finch explained, it is managed for migrating waterfowl as well as the sharp-tailed grouse.

Wetland, Crex Meadows Wildlife area, WI

It is a birdwatching paradise. Among the numerous sandhill cranes feeding in the fields was a single whooping crane that had been hanging out for several months this summer.

Dave Peters

Hawaii Volcanoes

A recent bucket-list trip to Hawaii provided me with an opportunity to answer a few questions I had about the geology of the area. Of course, I knew volcanoes were involved. But is the big island a single volcano? Are each of the smaller islands volcanoes? Why are they in a more or less straight line heading northwest? Are they active? Dormant? And how about those curious words, "A'a" and "Pahoehoe"? Over the course of a six day trip with volcanologist Gary Lewis and his tour company GEOetc,

A'a lava

I finally got answers to these questions and more. We never left the Big Island of Hawaii, but

Pahoehoe lava

even six days was not time enough to make it to all the important geological destinations.

I think of my trip in two big stories. The first is about hot spots and plate tectonics, the second, lava.

First, plate tectonics. Hawaii is nearly dead center in the Pacific plate, 2,300 miles from any plate boundary. So absolutely no opportunities for any collision, sliding, or subduction. But that same millimeters-per-year northwestern motion that wreaks so much havoc at the boundary also has its effect in the center of the plate. And that's due to a huge and still active hotspot that sits (more or less) stationary off the southern coast of the Big Island of Hawaii.

As the Pacific plate--40 million square miles of rock--slides northwest past the North American plate and toward the Aleutian Islands, it also slides over the hotspot, creating enormous shield volcanoes which periodically erupt, spilling lava in all directions. This is why the island's Northern most volcano, Kohala, is the oldest, and the southernmost, Kilauea, the youngest. In between are Mauna Loa, largest by volume, Mauna Kea, the tallest, and Hualalai. Extending northwest for 3600 miles all the way to the Aleutian Trench are a series of seamounts and atolls, ancient and extinct volcanoes that have eroded and now lie far below the Pacific surface. The oldest of these formations of the so called Hawaii-Emperor Seamount trail is 85 million years. The youngest is Kilauea, although the trail extends southeast of the big island for some miles deep beneath the waves.

Reticulite

The second big story is lava—basalt. The big island is all basalt, nothing but basalt, 100% black basalt! In many places we visited, the flows were vast, exposed, and colonized only by a few hardy ferns and an occasional ohelo plant. In much of the coastline, soil had developed on the surface of the rock and supported grasses, mosses, and of course an enormous variety of tropical plants and trees.

Kaumana Caves

I never figured out the real geological significance of Pahoehoe vs. A'a lava, but it was fun (and easy!) to learn to identify the two basic types of flows that make up the island. Although the two lavas have the same chemical composition (particularly Silica and CO2), their different dissolved gas contents give them distinctly different viscosities. Solidified A'a lava, the most abundant on the island, is spiny, blocky, and rough. The A'a flows we encountered were impossible to navigate on foot. (If you tried, you would exclaim Ah! Ah! from the pain.) Pahoehoe is characterized by smooth and undulating or rolling surfaces--"hummocky" to the geologist. It was easy and fun to hike on. We encountered many intricate and complex Pahoehoe formations created as the sticky stuff cooled and twisted itself into myriad rope-like formations: curvaceous, serpentine, and beautiful!

One afternoon, Gary engaged us in a fascinating little research project. In teams, we conducted a transect of an

Kilauea Iki lava lake

Lava lake trek

acre or two of a huge flow. We soon discovered the area consisted of multiple flows of both A'a and Pahoehoe. So our research task was set: identify how many flows of what kind, and sequence them from earliest to latest. After examining many flow edges, the group finally agreed on a probable sequence, but not before some healthy debate!

Our walks on the Pahoehoe flows included a serendipitous find: reticulite. The gossamer thin and lacey structures sit delicately in the cracks of the flows. They form high in lava fountains as the dissolved gases and CO2 under high pressure separate ("exsolve" is the technical term here) as they fall back to earth. These fragile concretions of solidified froth bubbles are actually rocks--far less dense than even pumice!

Lave encased tree

Hawaii Volcanoes National Park features (at least) two spectacular formations—a 40 km lava tube, and a frozen lava lake. The Kaumana Caves lava tube was formed in an 1881 flow from Kilauea. Eventually, after melting its way through 25 miles of the surrounding rock, the volume and therefore surface level in the tube began to drop. The top surface of the underground river of lava cooled and crusted over. Some molten lava continued to flow inside the tube, leaving a smooth chocolatey basaltic bathtub ring on the sides through of portions of the tube.

A small sea of frozen lava fills Kilauea Iki, the pit crater near the summit. Walking the vast black lava lake, inside the Kilauea caldera, was a lunar-like experience. (The science teachers in the group had a lively discussion as to whether "frozen" is indeed the correct term, since the material never did pass through a temperature of O degrees C.) For 36 days in 1959, molten lava shot through a side vent of Kilauea, at times to a height of 1900 feet, filling the crater to a depth of 400 feet deep. The surface cooled and hardened, creating the "lake" which we trekked across. Some trees at the bottom of the caldera pit were entombed, then vaporized by molten lava, occasionally leaving ghostly "lava trees" that still dot the barren landscape.

Mauna Kea from Manua Loa

We learned of a type of pollution unique to areas with active volcanoes—vog, or volcano-induced fog. Vog was prevalent until Kilauea stopped erupting in May of 2018. Vog is highly corrosive to metal roofs and is costly to remediate. On the other hand, the thin SO2 layer proved beneficial to the coffee industry because it created a protective layer against solar radiation. How are the coffee growers adapting to their new vog-less conditions?

Basalt columns at Rainbow Falls

Mauna Kea Observatory protest

The trip did involve one small disappointment. Pu'u 'O'o, the cone in the eastern rift zone of Kilauea, had been erupting continuously since January of 1983, as millions of awed visitors over the years can attest. Then, on April 30, 2018, the massive crater floor collapsed. Three days later and 10 miles down rift, the lava had found a new underground pathway to the surface, eventually creating a fissure and emerging dead in the middle of Leilani Estates, a large housing subdivision. On August 9, 2018, exactly one year before our trip, the last flow stopped, but not before causing considerable destruction. So our disappointment was comparatively small indeed.

A week was sufficient for me to start getting a feel for the spiritual connection many native Hawaiians feel for their sacred land. The earth is very clearly alive here. Steam issues from giant cracks, fire jets from the mouths of mountains, hot rocks flow as rivers beneath your feet. When our two-vehicle caravan was slowed by a tent city of protesters on Saddle Road between Mauna Kea and Mauna Loa I had considerable sympathy for the native position. A consortium of universities has sited a long planned and enormous research telescope at the top of Mauna Kea. The Thirty Meter Telescope (TMT) promises to significantly advance our understanding of a broad swath of exciting questions about black holes, the early universe, exoplanets, and dark matter. But it turns out the ideal spot for scientists seeking to send signals into the universe is equally ideal for the same reason—proximity to the heavens—for native Hawaiians to commune with ancestors and Pele herself, the ancient Goddess of volcanoes and all Hawaii.

As spectacular as Hawaii is for a volcanologist, it may be even more so for a botanist. There are at least 8 separate climate zones on the big island, ranging from polar to tundra to dessert, and of course tropical. Not to mention the coral reefs, tidal zones, and marine biomes. A little aphorism comes to mind: every trip is just preparation for the next trip!

By David McGill

GEOLOGICAL SOCIETY OF MINNESOTA 1938

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FIRST CLASS MAIL