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### **Table of Contents**

Geology Crossword #5 Solution	3
From the President's Desk	4
Student Undergraduate Research Project: Trace Element Analysis of Spodumene Mega Crystals Using Portable X-Ray Fluorescence	6
Golf Outing	8
Experiences of an Intern: Connecting Education To the Real World	10
Did You Know?	11
Section Website Reminders	11
Minerals for Sale	11
Where in Michigan?	14
Update Your Information	14
Regulatory Roundup	16
Geology in Michigan	17
Scholarship Awards!	27
Welcome New Members	28
Coming Events	28
Interesting Geology Links	28
Member's Corner	28
Annual Meeting Planning	29
ASBOG Exam Update	30
Member Input Sought	30
Support Our Sponsors	30
Environmental Risk Management Workshop	31
Geology Crossword #6	32

**Front Cover:** Photo of a wall in the Osborne Materials Quarry on Drummond Island. The rock is the Silurian aged Engadine Formation. Photo taken by Sara Pearson during Michigan Section AIPG field trip in July 2015.

### **Geology Crossword #5 Solution**

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### Across

- 1 Basal Chocolay Group
- 6 Lowest Formation at Stoneport
- 8 Lowest Formation at Kelly's Quarry
- 9 Not swimware
- 10 Basal unit of the RASA Project
- 13 Common evaporite
- 14 Seventh day quartzite
- 15 Quartzite equal to Mesnard
- 18 Abbreviation; geologic time
- 19 No criminals here
- 20 Not out
- 21 Uppermost formation at Kelly's Quarry
- 23 Gassy shale
- 24 Form the ledges

#### Down

- 2 Oronto Group shale
- 3 A tree found in Michigan
- 4 Lowest Cataract Group
- 5 Viagra is the cure for this
- 7 Eastern equivalent to the Ellsworth
- 11 Roman god of fire
- 12 Law enforcer?
- 15 Light bulb manufacturer
- 16 Ordovician shale
- 17 Mid-grade metamorphic
- 18 Very widespread formation
- 21 Oronto Group siltstone/sandstone
- 22 Tropical tree

### From the President's Desk

Hello AIPG Michigan,

It finally appears that we are making progress in our battle against the Covid virus. Restaurants are fully open, gatherings of people are allowed again, and life as we knew it is beginning to resemble what we once had.

With that being said, I am looking forward to our annual joint meeting with AIPG and MAEP, and the AIPG Annual Conference. Those that I have spoken to are very much looking forward to having an in-person meeting. Socializing with friends and colleagues has been missed. Catching up with others over a cold beverage and nice meal is very much being looked forward to by many of us.

The AIPG Annual Conference this year will be held in Sacramento California in October. I always anxiously look forward to this event. Last year's cancellation was very disappointing. My first occasion to attend the annual conference was in 2005 in Lexington Kentucky. I really had no idea what to expect and did not know anybody else who was attending. A trip to Mammoth Cave with the National Park Geologist was my first field trip to start the conference. It was an incredibly interesting and fun day which included lunch at the park lodge. The following day I attended technical sessions, although there were many presentations that I had interest in and each was very well done, from a personal standpoint, it is very hard for me to sit all day and listen to others speak. That evening, I was in the hotel socializing with other attendees, and someone indicated that they had signed up for the field trip on the following day but could not attend. They asked if anyone was interested in taking their place, so I quickly spoke up that I would be willing to take their place. It was a great trip, exploring the natural arches in eastern Kentucky. It was something that I was not aware was present in this area of the country. Another great day in the field learning, touching, and experiencing geology. I was hooked!

Since this first trip participating in our national conference, I have been fortunate to attend most of these meetings since. The locations move around the country, so it is great to experience new places, or on occasion revisit places I have been to before. I always learn something new by attending each conference, mostly through participating in the great field trips which are offered. For myself, the best way to learn about geology is getting out in the field and experiencing the rocks. The field trip leaders are always incredibly knowledgeable and always willing to answer questions from people like me, who know little to nothing about the area we are exploring.

The best thing about attending the National Conference, by far, is the people! I have met some incredible individuals from all over the country of varying geological disciplines. Some of which I have become very good friends with over time. This is something that I am very thankful for! It is always great to see them, catch up on how they are doing, and reminisce about the good times we have had in the past. Often times staying up till the

wee hours of the night (or maybe more accurately, the early hours of the morning).

I would strongly suggest to anyone to attend any of our annual conferences! Granted it takes some of your time and is not inexpensive, but each one I have attended has been well worth the effort and incredibly enjoyable. Sacramento might not have the pizazz that maybe a Colorado Springs or Santa Fe may have, but incredible geology is all around! Plus you can add pre and/or post conference places like Yosemite or San Francisco to your agenda and see as much as you can!

No excuses next year! Marquette hear we come!

Bill Mitchell

# Check Out the AIPG Mentoring Program

Mentoring is an experience that promotes personal growth, creates meaningful connections, and sparks creative innovations. AIPG offers an opportunity to connect mentees with mentors. To sign up for the program is easy and can be done when paying your annual dues or updating your online profile. You may check the box on your paper dues renewal form that you send in via mail or log into your account at www.aipg.org and update your member profile. Be sure to check whether you would like to be a mentor or mentee and the fields of expertise. The system allows individuals to search for people with similar interests and connect via email. Check it out today!



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# Student Undergraduate Research Project: Trace Element Analysis of Spodumene Mega Crystals Using Portable X-Ray Fluorescence



By Victoria Konieczka

My name is Victoria Konieczka, and currently, I am a senior at Central Michigan University studying to earn my bachelor's degree in Geology with a minor in Environmental Science. I have been a member of AIPG since

Winter 2019. Since then, I have been a part of the CMU AIPG chapter as both a participant and as Student Chapter Publicity chair. At the end of my junior year, I wanted to get more involved in the CMU Earth and Atmospheric Science department through undergraduate research with



Figure 1: Victoria Konieczka measuring trace element concentrations in sliced spodumene with a Tracer 5i p-XRF unit. Photo by Dr. Larry Lemke, 2020.

Dr. Mona Sirbescu. So far, my favorite part of doing research been learning about technew niques, working with high tech instrumentation, and improving my research, as well as my writing skills. In the future, I hope to take these skills and experiences with me as I plan to attend graduate school starting Fall 2022, and then, eventually, enter the geoscientific workforce. I strongly recommend that all undergraduate geology

students consider doing research, as it will greatly enhance your University and future career endeavors.

Granitic pegmatites are one of the most intriguing intrusive igneous rocks on Earth, because of their special textures including grain sizes ranging from sub-millimeter to >10-meter-long mega crystals (Fig. 2). Most important-



Figure 2: Giant spodumene, a lithium ore mineral, from the Plumbago North pegmatite in Oxford County, Maine with 1.8 m tall geologist for scale. Photo by Dr. Mona Sirbescu, 2018.

ly, they can provide economically valuable resources including industrial minerals, gemstones, and critical metals.

Spodumene is a lithium aluminum silicate (LiAlSi<sub>2</sub>O<sub>6</sub>) classified under the clinopyroxene subgroup, with a monoclinic crystal symmetry (Nesse, 2016). Spodumene is the main ore mineral of lithium. About 26% of the world's potential lithium resources are from granitic pegmatites (Bradley et al., 2017). Developing strategic energy technologies such as lithium batteries for electric cars is caus-

ing an exponential increase in lithium demand that is anticipated to continue for decades. Because of limited reserves of lithium, the USGS categorizes lithium as a critical metal (Bradley et al., 2017). Lithium-containing pegmatites are an uncommon rock type, but they are widespread throughout the world, suggesting that the conditions necessary for the formation of lithium pegmatites are not isolated to exotic geologic settings (Kesler et al., 2012). Despite spodumene's high economic importance and high purity requirements for lithium extraction, the distribution and concentrations of trace elements in industrial spodumene are poorly studied.

In this study, Dr. Mona Sirbescu and I have systematically analyzed the compositional zoning in crystallographically-oriented slices cut through subhedral spodumene crystals, as large as 20 cm in length in order to (1) document the primary magmatic chemical signature and distribution of trace elements in a single subhedral mega crystal of spodumene and (2) compare the primary chemical signature and the secondary hydrothermal alteration signature of spodumene crystals from the Oxford County pegmatite field in Western Maine and the Southern Black Hills pegmatite field (Tin Mountain and Etta Pegmatites). This research is part of a larger study at CMU led by Dr. Mona Sirbescu, aiming to better understand the formation processes of giant crystals in pegmatites (Gamet et al., 2020; Sirbescu et al., 2019).

Single crystals of spodumene were collected from the Plumbago North pegmatite in Oxford County, Maine. The Plumbago North pegmatite (Fig. 2) consists of up to 50 wt. % spodumene in its core zone, therefore it is considered the most significant lithium deposit discovery of this century in North America (Simmons et al., 2020). The preliminary exploration results indicate a reserve of 3.6 million m³ which is equivalent to 10 Mt of ore, with an average Li<sub>2</sub>O content at 4.68 wt. %, which is higher than the top ten spodumene-generating deposits on Earth (Simmons et al., 2020).

For this research, I have used portable X-Ray Fluorescence (p-XRF), a non-destructive method, to document the distribution of minor and trace elements including Fe, Mn, Sn, Rb, Ga, Cs, and Ge. The typical pyroxene directions of cleavage that intersect at approximately 90° and parallel to the c-axis direction of elongation helped me constrain the crystallographic directions spodumene samples (Fig. 3). This specimen is a subhedral termination of an approximately 1 m long prismatic spodumene crystal that has been cut parallel and perpendicular to the crystal c-axis. After the sample was cut and washed, a grid as seen in Fig. 3 was placed onto the sample to guide the p-XRF measurements.

The p-XRF trace element analysis, along with the 2D mapping of spodumene (Fig. 4A, B), have shown compo-



Figure 3: Spodumene from Plumbago North, Maine, cut perpendicular to the c-axis. The Miller crystallographic indices are shown in yellow. The 5 mm x 5 mm grid of >360 points was used for portable XRF analysis.

sitional variations that follow major crystallographic directions. These patterns can be explained by compositional changes in the magma as the crystal was growing. In other words, we interpret these chemical gradients as growth zoning of primary origin. Fe and Sn (in Figs. 4A, B) along with Mn, Ga, and Ge (not shown here) appear to be less unaffected by dark staining discoloration and white fracturing (seen in Fig. 3) of secondary origins. Surprisingly, these trace elements appear to preserve the primary chemical signature even after all the hydrothermal alteration and weathering that the crystal went through. This finding relates back to objective 1 mentioned above. It suggests that trace elements in spodumene can reveal significant compositional variations in the pegmatite magma at the magmatic-hydrothermal transition in the highly fractionated core of lithium rich pegmatites.

However, for the results of this study to fulfill an important gap in the lithium exploration industry, we will need to convert from semi-quantitative results to quantitative results. In the next phase of research, I will continue to process the raw p-XRF data as part of my senior thesis. We will utilize reference spodumene samples independently analyzed with Laser-Ablation ICP-MS to convert from photon counts to absolute concentrations. Additionally, we plan to present the results at the Geological Society of America Annual Meeting in fall 2021.

We acknowledge Mr. Gary Freeman, Freeman Resources LLC, for allowing access and sample collection at

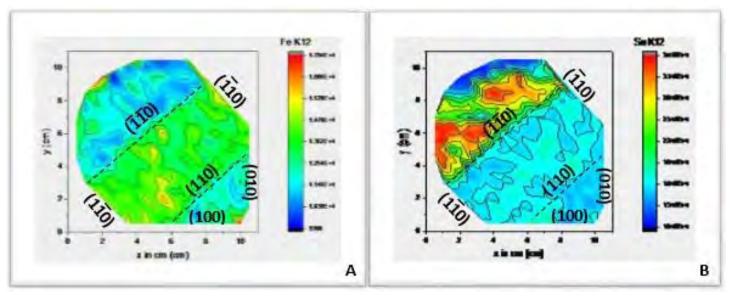


Figure 4: Two-dimensional compositional maps of Fe () and Sn (B) suggesting well-preserved asymmetrical growth zones in the mega crystal of spod-umene cut perpendicular to its c-axis illustrated in Figure 3. Values are in photon counts.

the Plumbago North pegmatite open pit. This project was initially funded by a research grant from CMU - Office of Research and Graduate Studies to Mona Sirbescu.

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# 17th Annual Golf Outing is Fast Approaching!

The Michigan Section Annual AIPG Golf Outing is right around the corner! Please consider joining us for a great day of networking and fun. The event takes place on Tuesday August 24, 2021, at Lyon Oaks Golf Course in Wixom, Michigan. The 18 -hole course was designed by Arthur Hills and opened in 2002. If you come, you won't be disappointed.

This year we will be having "closest to the pin", and "longest drive" contests for men and women, hole-in-one prizes, and a "putt-for-dough" contest. The registration includes pastries and coffee for breakfast, lunch at the turn and dinner



following golf. Prizes are being raffled and we will also hold a 50/50 raffle.

Please consider a sponsorship this year. There are several different levels of sponsorship still available. Time is running out and these sponsorship opportunities offer great exposure to some of the most influential professionals in our industry. If you don't play golf, we are always looking for volunteers to assist with the outing. The money raised is put toward the AIPG Michigan Section's K-12 Educational Grant recipients.

This event is a great opportunity to spend time with colleagues. It is open to everybody, so please take advantage of the opportunity.

The registration and sponsorship forms are included in the newsletter and on the Michigan Section web site. Additionally, registration can be completed via the Eventbrite event page. We hope to see you August 24, 2021. Email Bob Reichenbach at <a href="mailto:bob.reichenbach@ergrp.net">bob.reichenbach@ergrp.net</a> or Kalan Briggs at <a href="mailto:briggsk2@michigan.gov">briggsk2@michigan.gov</a> if you have any questions or to sponsor and/or register.



Above: Fibertec group 2020: left to right, Rick Dunkin, Robert Anderson, Cheri Delyon, and Jeff Lanier.

Below: 18th green and clubhouse of the Lyons Oaks course.



# **Experiences of an Intern: Connecting Education to the Real World**

By Joel Harris, SA-10444

My name is Joel Harris, and I am currently a senior Environmental Science and Society major (Environmental Hydrology concentration) at Eastern Michigan University (EMU). I have been a student member of EMU'S AIPG Student Chapter since early 2020. I am extremely grateful for the opportunities and con-

nections this organization has made possible. Being a full-time student and someone who needs to work full-time to support financial needs is often not an easy task. I am very fortunate to have been able to find an internship at U.S. Silica that accommodates my school and financial needs, while providing hands on experience using many of the skills acquired through my education at EMU. I am currently considering graduate school and am interested in attending a forestry program that will allow me to apply my knowledge of hydrology and geology in the field, helping to protect and improve the conservation of our forests.



**Photo 1:** Joel Harris preparing a pellet of production sand and cellulose binder to be examined in the high-end WDXRF spectrometer for chemical analysis. Photo credit: Andrew Whaley, US Silica lab technician

Working at U.S Silica has improved my skills in understanding chemical analysis, quality control, and use of advanced equipment that can be applied to many different job scenarios. Silica is one of the most abundant elements found in the Earth's crust. When processed, silica can be used to create many things including, but not limited to glass, ceramics, and even computer chips. Here at U.S Silica in Rockwood, Michigan, we focus on creating products that can be used for glass containers and solar panels. The Michigan plant mines from the Sylvania Sandstone Formation of the Detroit River Group. The Sylvania Sandstone Formation is believed to have been deposited during the beginning of the Kaskaskia sea transgression. Transgressive sand is more texturally and compositionally mature because of the significant amount of time exposed to weathering processes, induced by the fluctuations of eustatic sea level, which would explain why this sandstone has a significant amount of silica content, from quartz sand grains.

I currently work in the lab during the night shift, where we analyze production samples to ensure the highest quality of our product. SIEVE testing is done every two hours during production to ensure the operating plants are refining the sandstone material to meet the desired specifications of our products. Chemical analysis is conducted using a wavelength dispersive X-ray fluorescence (WDXRF) spectrometer for production samples and prior to shipments upon request. Through chemical analysis we examine percent composition of Fe<sub>2</sub>O<sub>3</sub>, Al<sub>2</sub>O<sub>3</sub>, CaO, MgO, and TiO<sub>2</sub>. SiO<sub>2</sub> percent is then determined and can generally be found at 99%-99.9%. We keep records of our products for up to 10 years for customers, which requires using Microsoft Excel efficiently, a vital skill.

There were many times throughout my college career when I thought I was learning things that I would not be able to apply in a future career. This internship has made me realize that I had never been more wrong. Every class I have taken at Eastern Michigan University has helped me to become more successful in this opportunity. From classes in statistics, chemistry, mineralogy, environmental sciences, and Earth system sciences, not only am I able to complete tasks required for this internship, but I am also able to comprehend the importance of every task making this experience even more meaningful. I value this internship with U.S. Silica because it has allowed me to develop my professional aptitude while giving me an opportunity to apply the experiences I have cultivated at EMU.

### **Students - Reminder**

Don't Forget: Each Student Chapter must submit two articles for publication in *Geologically Speaking* each year to qualify for Section funding. Send the articles to Adam Heft at adam.heft@wsp.com.

## **Did You Know?**

This article is intended to remind members of various aspects of AIPG and benefits of membership. If there is something you would like to see featured in this column, please contact the Editor...

The AIPG Code of Ethics states:

### **CANON 4. Obligations to Professional Colleagues**

Members shall respect the rights, interests, and contributions of their professional colleagues.

### STANDARD 4.1

Members shall respect and acknowledge the professional status and contributions of their colleagues.

Rule 4.1.1 A Member shall give due credit for work done by others in the course of a professional assignment, and shall not knowingly accept credit due another.

Rule 4.1.2 A Member shall not plagiarize another in oral and written communications, or use materials prepared by others without appropriate attribution.

### STANDARD 4.2

Members shall be accurate, truthful, and candid in all communications with others regarding professional colleagues.

Rule 4.2.1. A Member shall not issue (a) false statement (s), (a) misleading statement(s), or (a) sensational, exaggerated, defamatory, and or unwarranted statement(s)

regarding a professional colleague. Differences of opinion occur and statements regarding opinions should be restricted to and based on logical and scientific principles and shall be made in a respectful and professional manner.

### STANDARD 4.3

Members should encourage and assist in the development of a diverse and inclusive workforce.

#### STANDARD 4.4

A respectful and fruitful working environment is fundamental for maintaining a high level of professionalism. Therefore, discrimination or harassment, either sexual or of any other kind, is unacceptable because it offends the dignity of persons and seriously undermines the atmosphere of trust essential to the work of all geologists. Such actions should be denounced immediately to authorities. It is unprofessional and unethical to condone any kind of discrimination or harassment or to disregard complaints of harassment from colleagues or staff. AIPG's Events Code of Conduct policy provides more explicit examples of acceptable and unacceptable behavior.

Rule 4.4.1 A Member who is found to have engaged in a discriminatory and/or harassing manner, regardless of kind, can be subject to AIPG discipline, including termination of membership.

Article continues on Page 13

### **Section Website Reminders**

The Michigan Section has created a database of geologic photographs on our website. Please submit photographs that you are willing to share to Adam Heft at <a href="mailto:adam.heft@wsp.com">adam.heft@wsp.com</a>. Don't forget to include your name and a short explanation of what the photograph depicts. The photographs will be uploaded to the website periodically.

If you have suggestions on other items that should be included on the History page, please let a member of the Section Executive Committee know.

### **Minerals for Sale!**

Long-time Michigan mineral collector and dealer, Bill Micols, is selling his lifetime collection of material. Bill is in Milford. For additional details, please see the full-page flyer on the following page.

# SALE

# 50 year life time collection



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### CANON 5. Obligations to the Institute and the Profession

Members should continually strive to improve the profession of geology so that it may be of ever increasing benefit to society.

#### STANDARD 5.1

Members should strive to improve their professional knowledge and skills.

### STANDARD 5.2

Members should cooperate with others in the profession and encourage the dissemination of geological knowledge.

#### STANDARD 5.3

Members should work toward the improvement of standards of geological education, research, training, and practice.

### STANDARD 5.4

Members should not only uphold these standards of ethics by precept and example but also encourage by counsel and advice to other Members, their adherence to such standards.

#### STANDARD 5.5

Members having knowledge of a violation of these Rules by another Member shall bring substantiated evidence of such violation to the attention of the Institute.

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# Where in Michigan?

The April 2021 edition of *Geologically Speaking* featured a photograph of the Precambrian aged, 2.2 Ga Mesnard Quartzite of the Chocolay Group. The outcrop shown is located along the west side of US-41 north of Harvey Quarry. The photograph was not correctly identified.

This edition of *Geologically Speaking* features a new photograph <u>at right</u> - not the photo on the cover page. The first person to correctly identify what the photograph depicts (feature name, location, formation, and age) will win AIPG swag! Submit your entry via email to the editor; only one per person per issue please.

Don't forget to check out the feature article "Geology in Michigan" in this issue (as well as the last several editions) that presents a geologic feature of interest as a mini field guide. One of the best parts about being a geologist is field trips, and we are hoping that in your travels around the state or country you include these featured spots as a stop. Why not incorporate them into a family vacation or bring friends who may not be geologists and share these locations that make Michigan unique? We hope you enjoy reading about it, and more importantly, go see it in person! We invite you to share unique geologic features that you know about and submit a "mini field guide" to share with our members in future editions.



# **Invitation to Our Members!**Do you have a case study to share?

The Michigan Section AIPG promotes knowledge sharing and would like to feature case studies from projects where others may benefit from successes as well as lessons learned. We feel as professionals that learning from each other is a great opportunity that AIPG offers our members. AIPG offers connection with other professionals and their experiences in the work we do every day. This case study represents what we would like to offer more to our members, not only as a way to solve problems, but unify us as professional geologists. Additionally, do you have a suggestion for other types of information to share that would be of interest to our membership?

Please send your case studies and suggestions for future publication in upcoming editions of *Geologically Speaking* to the Editor.

# **Update Your Information!**

Please be sure that you continue to receive the Section's *Geologically Speaking* publication and other announcements. Submit an updated e-mail address to Adam Heft at <a href="mailto:adam.heft@wsp.com">adam.heft@wsp.com</a>. If you move or change places of employment, don't forget to send your new contact information to both the Section and to National. If you are not receiving announcements directly from the Editor, it is because your email address is not up to date with the Michigan Section.

Please help the Editor by making sure that your email address doesn't bounce when the next announcement is sent. And be sure to cc Dorothy Combs, National AIPG Membership Director at <a href="mailto:aipg@aipg.org">aipg@aipg.org</a> when you update your contact information. Thank you!

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## Regulatory Roundup

Summer is here, and Michigan's pandemic restrictions on gathering and activities are being lifted. Michigan's EGLE team is returning to the offices in limited capacity through the summer. There may still be some limitations on visits to the office by the public so be sure to check with staff. It is good for us to get back to seeing people in person and relying less on the video conferencing while still being mindful of CDC guidelines.

In addition to returning to the workplace, other hot topics on the regulatory front include appropriations for the 2021-2022 budgets and cleanup criteria rule making for per- and polyfluoroalkyl substances (PFAS) introductions.

Springtime in Michigan is budget season when the appropriations bills are introduced to set the stage for next year's spending. Several bills were introduced with proposed budgets for state departments and programs.

One bill that has been a long time in coming and has the support of AIPG is Senate Bill SB 488 that was introduced on May 27, 2021 by Senator Outman. This bill calls for an annual appropriation of \$3 million to the Michigan Geological Survey for surveying geologic conditions in areas identified by the water use advisory council and areas identified by the department of Environment, Great Lakes and Energy as having soil or groundwater contamination. When the Michigan Geological Survey was transferred to Western Michigan University, a funding mechanism was not included, and the functions of the survey have been severely limited, existing on small grants. Support for this bill and the funding is greatly needed for geological survey work in Michigan. Michigan has not had a robust mapping initiative in decades, and with all of the new technology available to geologists for mapping, there is no better time to do this work and generate better data giving us greater insight into the unique geology of our state. Senate Bill SB 565 is the appropriations bill that also proposes this funding.

I have frequently stated in previous columns that we as scientists and experts in this area are needed to lend our voices to the legislative processes to ensure that expert knowledge is conveyed and incorporated into laws and rules. This is a clear example of one such opportunity to reach out to your senators and representatives and let them know just how important a viable geological survey is to Michigan.

Another opportunity that we as practitioners in the environmental industry have is to lend our knowledge and experience through the currently open public comment period on the promulgation of cleanup criteria for seven PFAS compounds. A public hearing was held on July 8, 2021 offering the opportunity for comment on proposed Administrative Rules for Cleanup Criteria Requirements for Response Activity Rule Set 2020-130 EQ. The seven compounds are Perfluorononanoic Acid (PFNA), Perfluoroctanic Acid (PFOA), Perfluoroctanic Acid (PFOS), Perfluorobexane Sulfonic Acid (PFHxS), Hexafluoropropylene Oxide Dimer Acid (HFPO-DA) (a GenX Compound), Perfluorobutane Sulfonic Acid (PFBS), Per-

fluorohexanoic Acid (PFHxA).

The link to the rules above also includes instructions for providing comments on the rules in the Notice of Public Hearing and emailed comments may be sent to EGLE-RRD@michigan.gov. Be sure to take advantage of these opportunities when they arise. The deadline for these comments was August 9, 2021.

There are many more bills that have been introduced this year on the topics including water and infrastructure, solid waste, bottle deposit funding, fracking, and more.

As a follow-up to the last Regulatory Roundup column, we featured the recycling and solid waste bills reporting on the nearly unanimous approval by Michigan's House of Representatives in March 2021. House bills, HB 4454 through HB 4461, were referred to the Senate Committee on Regulatory Reform on April 27, 2021. There has been no additional activity on this set of bills.

Be sure to look through the list of bills for items of interest to you and the work you do.

Proposed Rules

Natural Resources and Environmental Protection Act, PA 451 of 1994, as amended, bill search

> Safe Drinking Water Act, PA 399 of 1976, as amended, bill search

> Gas Safety Standards, PA 165 of 1969, as amended, bill search

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# Geology in Michigan – Field Guide to Fossil Collecting on the Stonington Peninsula in Delta County, Michigan

By Dave Adler, CPG-11377

FIGURE 1 | REGIONAL MAP

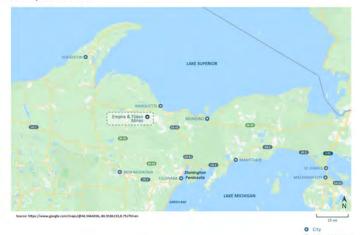
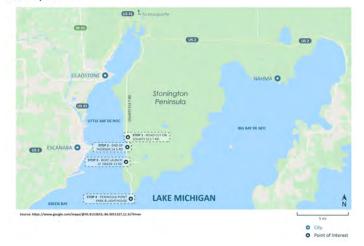


FIGURE 2 | AREA MAP



### **Directions**

The Stonington Peninsula juts out into the north shore of Lake Michigan just south of the City of Rapid River in Delta County in the south-central portion of Michigan's Upper Peninsula (Figure 1). It is most easily accessed via US Highway 2 (US-2), the primary paved road that runs east-west along the south side of the Upper Peninsula. The four stops described in this article are accessed from County 513 T Road, the paved two-lane road that traverses the west side of the Stonington Peninsula from north to south. County 513 T Road (CO 513) can be accessed from US-2 approximately 2.5 miles east of Rapid River (Figure 2).

From Marquette, take US-41 south for approximately 50 miles to US-2 in Rapid River. Proceed east on US-2 approximately 2.5 miles to the intersection of CO 513 and US-2. Turn right (south) onto CO 513 and proceed southward along the west side of the Stonington Peninsula to the four stops described separately below.

From St. Ignace on the north side of the Mackinac Bridge, take US-2 west for approximately 125 miles to the intersection of US-2 and CO 513 (approximately 2.5 miles east of Rapid River). Turn left onto CO 513 and proceed south towards Stops 1-4. From the west, take

US-2 eastward through Rapid River. Turn right (south) onto CO 513 and proceed southward toward Stops 1-4.

### Introduction

The Stonington Peninsula is a quiet, lightly populated and mostly rural area of the south-central Upper Peninsula. It is surrounded on three sides by the waters of Lake Michigan - Little Bay De Noc on the west side, Big Bay de Noc on the east side, and Green Bay on the south side. CO 513 is the primary paved road allowing access along the west side of the Stonington Peninsula where there are bedrock cliffs that overlook Little Bay De Noc and the cities of Escanaba and Gladstone. The area has a rich history related to the Upper Peninsula's logging and iron mining industries. If you drive along CO 513 near dusk, you're likely to see hundreds of white tail deer in the fields on the east side of the road. If you travel all the way to the south end of CO 513 to Peninsula Point (Stop 4), you'll find a public park with a picnic grounds and a historic lighthouse. Monarch butterflies have been known to congregate here in the thousands in the fall where they rest for a short time during their migration to Mexico, a journey of nearly 2,000 miles. Over 200 bird species have been observed at Peninsula Point.

Bedrock of the Ordovician Bill's Creek Formation and

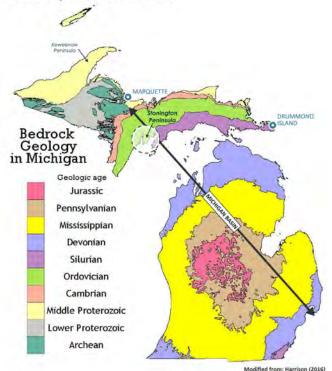
the overlying Stonington Formation is exposed at several locations on the west side of the Stonington Peninsula. The Bill's Creek Shale and the Stonington Limestone are highly fossiliferous and yield numerous Ordovician invertebrate fossils. The Bill's Creek Shale is especially rich in fossils and tends to weather easily, allowing for great fossil collecting on the beaches of Little Bay De Noc and other areas where bedrock is exposed, including the cliffs along the west side of the Stonington Peninsula.

This field guide describes four stops where the Bill's Creek Shale and the Stonington Limestone can be observed and where fossils can be readily found and collected. It's a great place to introduce children to the fascinating wonders of geology and the history of life on earth. As always, discretion, attention to safety (your personal safety and the safety of those around you), and respect for private property are encouraged. Have fun and enjoy!

### **Geologic Setting**

The Stonington Peninsula is located on the northwest side of the Michigan Basin geomorphic province. The regional geologic setting is depicted on Figure 3. The flanking rocks to the northwest include Archean, Lower Proterozoic, and Middle Proterozoic rocks along the southern margin of the Canadian Shield. The Middle Proterozoic (Huronian/Animikian) rocks include the economically significant iron ore deposits of Michigan's three iron ranges the Marquette Iron Range (Negaunee Iron Formation), the Menominee Iron Range (Vulcan Iron Formation) and the Gogebic Iron Range (Ironwood Iron Formation). The extensive native copper deposits of the Lake Superior Copper District (the Late Precambrian Portage Lake Lava Series and the Nonesuch Shale) are also located off the northwest flank of the Michigan Basin. From approximately 1880-1910, the Lake Superior Copper District supplied much of the country's industrial copper supply. Iron ore is still being mined on the Marquette Range.





The Michigan Basin is a bowl-shaped intracratonic crustal depression that contains several thousand feet of sedimentary rocks deposited during the Paleozoic era. These sedimentary rocks overlie older Precambrian age crystalline basement rocks. The maximum thickness of accumulated Paleozoic sedimentary rocks in the Michigan Basin is approximately 15,000 feet in the Midland area near the center of Michigan's Lower Peninsula. The Paleozoic sedimentary rocks include dolomite, limestone, shale and sandstone. Dolomites and limestones are the primary Paleozoic lithologies of the Michigan Basin.

Formation of the Michigan Basin began in the early Cambrian by erosion of ancient highlands formed during the Cambrian-Penokean Orogeny, followed by subsequent deposition. Later effects of the Appalachian orogeny may have caused the structural deformation and downward movement in what had been a relatively stable continental interior. As a result, several intracratonic structural basins developed in the central lowland areas of North America creating domes and arches. The Michigan Basin is bounded on the north by the Canadian Shield, on the west by the Wisconsin Arch and Wisconsin Dome, on the east and southeast by the Algonquin Arch and the Findlay Arch, and by the Kankakee Arch to the south in northern Illinois and Indiana (Michigan Department of Transportation, 2008).

Shallow seas covered most of the Michigan Basin during the Ordovician and Silurian. The rocks deposited during this time were mostly chemical precipitates and evaporites. During the middle and late Silurian, significant halite deposits were formed within the Silurian age Salina Formation, a relatively thick sequence of evaporite and carbonate rocks. The Salina is an important source of rock salt, especially in southeast Michigan (Detroit/ Windsor, Ontario area) and has also produced oil and gas.

As shown on Figure 3, the Ordovician rocks of the Michigan Basin occur in an east-west trending arc-shaped belt extending from the Stonington Peninsula eastward across the Upper Peninsula (UP) to Drummond Island at the eastern edge of the UP. The Ordovician rocks dip gently to the south and east towards the interior of the basin. These rocks are primarily fine-grained carbonates and shales. According to LaRowe (2000), the paleolatitude of the Great Lakes region in the Late Ordovician was approximately 20 degrees south, thereby providing environmental conditions suitable for carbonate deposition.

Late Ordovician age marine bedrock of the Richmond Group underlies the Stonington Peninsula (Dorr and Eschman, 1970). The Richmond Group includes, in ascending order (from oldest to youngest), the Bill's Creek Shale, the Stonington Formation, and the Big Hill Formation. Both the Bill's Creek and Stonington Formations are exposed at several locations along the west side of the Stonington Peninsula, and offer some excellent opportunities to observe the Ordovician lithologies and their rich assemblages of well-preserved Ordovician invertebrate fauna.

The Bills' Creek Shale has been described in the published literature as:

Thin-bedded gray to brown soft shale with occasional

layers of hard shale. The shale becomes bluish when weathered. Thin layers of argillaceous, fine-grained limestone are interbedded with the shale. The shale and limestone grade into each other laterally. A total thickness of 245 feet has been observed in the Cleveland-Cliffs core from a location 32 miles northeast of Escanaba. (LaRowe, 2000). LaRowe (2000) goes on to state that the deposition of the Bill's Creek Shale was likely in relatively deep water, as shown by both the lithology and the fauna.

 Thin bedded brown shale with occasional layers six inches thick. The shale turns a light bluish color when weathered. Alternating interbeds of argillaceous limestone occur in the shale towards the top of the section. The alternating interbeds are especially well exposed near the top of the section in exposures on the west side of the Stonington Peninsula (Hussey, 1952).

The Stonington Formation conformably overlies the Bill's Creek Shale and consists of the Bay De Noc Member overlain by the Ogontz Member. The Bay De Noc member has been described as shaly limestone by Dorr and Eschman (1970), and as mudstone and argillaceous limestone by Lamsdell et al (2016). The Ogontz member has been described as limestone with layers of chert nodules (Lamsdell et al, 2016) and as cherty limestone by Dorr and Eschman (1970).

According to LaRowe (2000), the Bay De Noc Member of the Stonington Formation is mostly tan to grey argillaceous limestone with interbedded shale and occasional mudstone, similar to the underlying Bill's Creek beds. The type section for the Stonington Formation is in the shoreline cliffs on the west side of the Stonington Peninsula where the exposed section is approximately 25 feet thick. This location is near Stop 1 described below. The total thickness of the Stonington Formation is approximately 150 feet, as observed in the above noted Cleveland-Cliffs core (LaRowe, 2000).

According to Wicander and Playford (2008), palaeon-tologic-palynologic and sedimentologic evidence indicates that the Bill's Creek Shale was deposited in a near-shore, low energy marine environment. The Bay De Noc Member of the Stonington Limestone was also deposited in a low energy marine environment, although in a more off-shore, somewhat deeper water setting.

Pleistocene age glacial drift sediments overlie the bedrock throughout most of the Michigan Basin. The exposed glacial features are the result of advancing and retreating continental glaciers during the Wisconsin glacial stage of the Pleistocene epoch (approximately 35,000 to 10,000 years before present). The glacial drift in Michigan's Lower Peninsula, where there are few bedrock exposures, tends to be relatively thick, on the order of several hundred feet thick in some areas. The glacial drift in the UP is generally thinner, and bedrock exposures are much more common.

The glacial drift on the Stonington Peninsula has been described by Jerome (2006) as lake plain sediments along the northern half of the west side of the peninsula, and as bedrock-controlled ground moraine deposits on most of the remainder of the peninsula. Western Michigan University (1981) describes the glacial drift as lakebed

sands along the sides of the Stonington Peninsula, with rock at or near the surface on the majority of the peninsula. Apple and Reeves (2007) describe the glacial sediments in Delta County as till, outwash and lacustrine with a thickness ranging from 0-200 feet. The glacial cover on the Stonington Peninsula is generally thin (0-50 feet thick) to very thin (less than 10 feet thick), especially along the west side of the peninsula where the Bills Creek Shale and the Stonington Limestone are exposed in coastline cliffs, a roadcut along CO 513 (Stop 1), and at some of the beach areas.

The Bill's Creek Shale is prolific in Ordovician marine invertebrate fossils. Its fossil assemblage includes arthropods, ostracods, conodonts, brachiopods, trilobites, bryozoans, pelecypods, and graptolites. Kesling and Hussey (1953) describe the abundance of ostracod fossils at a location on the west side of the Stonington Peninsula as containing fifteen specimens of a particular quadrilobate species in one square inch of exposed rock surface.

### **Historical Note**

According to Hussey (1926), the first known observations of the Ordovician rocks exposed on the west side of the Stonington Peninsula were made by Dr. Douglas Houghton in 1837. Dr. Houghton examined the rocks exposed along the east shore of Little Bay De Noc (the west side of the Stonington Peninsula) from Peninsula Point at the southern tip of the peninsula (Stop 4 described below) northward for approximately seven miles. He was the first to describe the argillaceous (Bay De Noc) member and the overlying cherty (Ogontz) Member of what would later be named as the Stonington Formation.

Douglas Houghton was a botanist, naturalist, geologist, and physician. He was elected mayor of Detroit in 1842. The diminutive Dr. Houghton (also referred to as the "Little Doctor") was the first Professor of Geology, Mineralogy, and Chemistry at the University of Michigan and the first State Geologist after Michigan achieved statehood in 1837. Dr. Houghton was a member of Henry Rowe Schoolcraft's 1831 and 1832 expeditions to the Lake Superior and upper Mississippi valley regions where they observed the native copper deposits of the Keweenaw Peninsula that would later become the object of America's first mining rush. Dr. Houghton's later geologic reconnaissance of the Keweenaw copper deposits and his subsequent reports are largely responsible for the copper rush in the western UP that began in 1843, several years before the California gold rush. Douglas Houghton drowned in a Lake Superior storm in October 1845 at the age of 36. His many accomplishments in those 36 years would suggest a much longer lifetime.

# Stop 1: Roadcut on the East Side of CO 513 at the Entrance to Lakewood Cemetery

Latitude: 45°45'45"N; Longitude: 86°58'34"W

Section 23, T39N, R22W, Delta County

### **Directions**

FIGURE 4 | STOP 1 - ROADCUT ON COUNTY 513 T RD



From the intersection of US 2 and CO 513, travel south on CO 513 for approximately 11 miles. Shortly after you pass the intersection of CO 513 and School 16 Rd./ Caps 16 Ln., you'll see a prominent roadcut to your left on the east side of CO 513 (Figure 4). Towards the south end of the roadcut you'll see a sign for Lakewood Cemetery and the cemetery access road. You'll also see a blue and white sign with the address 5991 CO 513 T Rd. (Figure 5). On some maps the cemetery access road is called Hemlock Dr., although there's no sign there bear-



Figure 5: Entrance to Lakewood Cemetery on CO 513 T Road. Photo by Dave Adler.

ing that name. If you come to the intersection of CO 513 and Idlewood 15.5 Ln., you've gone just a little too far south.

### Geology

Park on the side of the road at the entrance to the cemetery. The roadcut is about 20 feet high and extends along the east side of CO 513 for approximately 600 feet or so. See Figures 6 and 7. The gray, soft and weathered shale and argillaceous limestone layers that comprise most of the roadcut at this location are the uppermost beds of the Bill's Creek Shale. The Bill's Creek beds weather easily forming a talus slope draping some of the roadcut. These rocks are rich in invertebrate marine fos-



Figure 6: Roadcut Along CO 513 Looking North. Note Gray Bill's Creek Shale Overlain by Tan Stonington Limestone. The Entrance to Lakewood Cemetery is in Middle Left of Photo. Photo by Dave Adler.



Figure 7: Roadcut Along CO 513 Looking East. Note Gray Bill's Creek Shale Overlain by Tan Stonington Limestone. Photo by Dave Adler.



Figure 8: Hand Size Specimen of Fossiliferous Bill's Creek Shale. Photo by Dave Adler.

sils that are easily collected by hand.

A good example of a hand size specimen with some

well-preserved fossils is shown in Figure 8. The well-formed Pelecypods that can be seen in this specimen have been identified by Hussey (1952) as Cleidophorus noquettensis. According to Hussey (1952) when referring to the uppermost beds of the Bill's Creek Shale on the west side of the Stonington Peninsula: "Great numbers of small pelecypods belonging to the genus Clidophorus occur in the limestone layers and in the shaly partings between the layers". Hand size and larger specimens that are laden with fossils can be easily found and collected here.

As you look towards the uppermost portion of the roadcut, you'll see the rock layers change color from gray to light tan and become more competent and less weathered. These tan beds are the basal portion of the Bay De Noc member of the Stonington Formation that overlies the Bill's Creek Shale.

## Stop 2: Fossil Beach at CO 513 and the End of Thorsen 14.5 Road

Latitude: 45°44'42"N; Longitude: 86°58'28"W

Section 25, T39N, R22W, Delta County

FIGURE 9 | STOP 2 - FOSSIL BEACH AT END OF THORSEN 14.5 RD



### **Directions**



Figure 10: Landmark at the End of Thorsen 14.5 Rd. (Intersection of CO 513 and Thorsen 14.5 Rd.). View West towards Escanaba with Little Bay De Noc in the Background. Photo by Dave Adler.

From Stop 1 on CO 513, continue south on CO 513 for approximately 1.3 miles to the intersection of CO 513 and Thorsen 14.5 Rd. You'll see a green road sign that says "CO RD 513T Rd" on one side and "Thorsen 14.5 Rd (CRK-17)" on the other side. There will be a short dirt road extension of Thorsen 14.5 Rd. leading into a field to your right, to the west towards Little Bay De Noc (see Figures 9 and 10). Pull in to this dirt road. You can park in the field and continue walking down the short dirt road to a beach on Little Bay De Noc. It's a short and relatively easy walk down the dirt road to the beach. Alternatively, you may be able to drive down to the beach and park there, depending on local conditions at the time of your visit. Four-wheel drive is recommended if you drive down to the beach.

### Geology



Figure 11: Fossil Beach Looking South Towards Stop 3. Note the Rock Cliffs Rising Above Little Bay De Noc in the Background. Photo by Dave Adler.

The beach along Little Bay De Noc in this area is a fossil hunter's paradise. The combined forces of gravity, erosion, and wave action have broken down the Bill's Creek Shale into gravel, cobble and small boulder sized pieces (see Figure 11). Wave action has partially polished many of the fossiliferous beach rocks, thereby en-



Figure 12: Brachiopods and Rugose Corrals Collected at Stop 2. Photo by Dave Adler.

hancing their appearance. Many cobble and small boulder sized pieces suitable for cutting, slabbing, and making bookends or similar aesthetically pleasing objects can be found here. Individual fossil specimens from the Bill's Creek Shale can also be found here. Whole brachiopods and rugose corals that have been released from the shale and polished by wave action are especially abundant at Stop 2 and make nice collector's items (see Figure 12).

As you stand on the beach looking out to the west into Little Bay De Noc, turn to your left and look south down the coastline of the Stonington Peninsula. You'll see cliffs rising along the coastline to the south towards Stop 3. As shown on Figure 13, these cliffs offer excellent exposures of the gray Bill's Creek Shale and the overlying tan Stonington Limestone (Bay De Noc Member). You may be able to access the cliffs by walking south along the beach from Stop 2, depending on beach conditions and water levels in Little Bay De Noc at the time of your visit. Keep



Figure 13: Beach Cliffs along Little Bay De Noc South of Stop 2. Note Gray Bill's Creek Shale and Talus Piles Overlain by Overhanging Tan Stonington Limestone. View South Towards Stop 3. Photo by Dave Adler

an eye out for fossils as you walk the beach. The cliffs can also be accessed by watercraft. It's an easy paddle from the beach at Stop 2 when wave and wind conditions are appropriate.

## Stop 3: Public Boat Launch at Co 513 and Swede 13 Road

FIGURE 14 | STOP 3 - PUBLIC BOAT LAUNCH AT END OF SWEDE 13 RD



Latitude: 45°43'25"N; Longitude: 86°58'50"W

Section 35, T39N, R22W, Delta County

### **Directions**

Stop 3 is a public boat launch at the intersection of CO 513 and Swede 13 Rd. There is a beach with outcrops and more great fossil hunting at this location. This is also an excellent place to observe the shoreline cliffs along the east side of Little Bay De Noc. From Stop 2, proceed south on CO 513 for approximately 1.6 miles to the inter-



Figure 15: View south of the Low-Lying Outcrops of the Gray Bay De Noc Member of the Stonington Limestone and the Cobble Beach at the Stop 3 Public Boat Launch. Photo by Dave Adler.

section of CO 513 and Swede 13 Rd. (see Figure 14). Turn right (west) into the boat launch area where there's free parking and a free public boat launch. You will see a circular drive area. Walk along the circular drive to a cobble beach on Little Bay De Noc where there are low lying outcrops of gray limestone (see Figure 15).

### Geology

The gray limestone here is much harder, less weathered, and more massively bedded than the rocks exposed at Stop 2. Hussey (1926) attributed these gray limestone beds to the Bay De Noc Member of the Stonington beds of the Richmond Formation (equivalent to what is now considered the Bay De Noc Member of the Stonington Formation). He described the rock as gray, very fine-grained argillaceous limestone, non-crystalline and moderately hard that yields numerous fossilized specimens of the Ordovician pelecypods Whiteavesia (Pholadimorpha) pholadiformis and Modiolopsis vailda. Hussey (1926) gives a total thickness of the abundantly fossil bearing Bay De Noc Member in this area of about 28 feet.

The cobble beach just below the above noted low lying gray limestone outcrops is relatively small in area but yields what seems like an endless supply of cobble and boulder size specimens of hard, gray to tan limestone that has abundant and very well-defined fossilized bryozoan colonies, a striking example of which is shown on Figure 16. This is a great place for collecting fossils. The access is easy, you can park your vehicle nearby on the circular



Figure 16: Tan Limestone Cobble with Bryozoans at the Stop 3 Cobble Beach. Photo by Dave Adler.

drive, and you don't have to carry your specimens very far.

If you walk clockwise around the circular drive from the cobble beach towards the boat launch and a wooden pier that sticks out into the water, look along the coastline to the north (back towards Stop 2). This is one of the best vantage points to observe the bedrock cliffs along the west side of the Stonington Peninsula. The cliffs in this area show some of the best exposures of the gray Bill's Creek Shale in the lower half of the cliff face, overlain by the tan beds of the Stonington Limestone in the upper half of the cliff face (see Figure 17). The Bill's Creek



Figure 17: The Bedrock Cliffs Along the West Side of the Stonington Peninsula. View North from Stop 3. Photo by Dave Adler.

Shale is noticeably more weathered, softer, and more friable than the overlying Stonington Limestone. It's only a short walk along the shoreline from the boat launch to the cliffs, but you may have to traverse private property. The cliffs can also be accessed by watercraft, again depending on local wind and wave conditions at the time of your visit.

An often-observed feature of cliff faces and high angle rock cuts where softer, more friable rocks underlie harder,

more competent rocks is slope instability caused by undercutting of the overlying rocks leading to collapse. This type of rock slope failure was observed in the bedrock cliffs near the area shown on Figure 17 from the vantage point at Stop 3. As shown on Figure 18, the overhanging tan Stonington Limestone beds in the upper portion of the cliff face have collapsed due to undercutting caused by weathering and wave erosion of the underlying softer shale beds. The resulting slope instability, though localized, is rather striking and dramatic in appearance.



Figure 18: Bedrock Cliff Collapse where the Bill's Creek Shale has undercut the Overhanging Stonington Limestone North of Stop 3. Photo by Dave Adler.

### Stop 4: Peninsula Point Lighthouse and Picnic Grounds

Latitude: 45°40'07"N; Longitude: 86°58'00"W

Section 24, T38N, R22W, Delta County

### **Directions**

Stop 4 is the Peninsula Point Lighthouse and Picnic Grounds, also known as Peninsula Point Park, located at the southern tip of the Stonington Peninsula. The park is operated by the US Forest Service and offers opportunities for fishing, picnicking, beachcombing and hiking along the shoreline, observing rock outcrops, and collect-



Figure 19: Aerial View of Peninsula Point Lighthouse and Picnic Grounds. Photo by Bing.com.

ing rocks and fossils. There are picnic tables, outdoor grills, drinking water, outhouse style restroom facilities, and a historic lighthouse tower (see Figure 19). You can climb the 40-foot high lighthouse tower and view the surrounding countryside and the horizon as it extends over Green Bay, Little Bay De Noc, and Lake Michigan from the deck at the top of the tower. Peninsula Point is also a well-known place to observe a multitude of migrating bird species as well as monarch butterflies. It's a very nice venue for a gathering of friends or a family reunion.

When you exit the public boat launch at Stop 3, turn right onto CO 513 and proceed south for approximately four miles. CO 513 ends at Peninsula Point Park. The last mile or so is a somewhat narrow dirt road through the woods that necessitates slowing down a bit, but four-wheel drive isn't needed to get to Peninsula Point. However, the dirt portion of the road is not considered suitable for recreational vehicles or trailers greater than 16 feet long or eight feet high.

### Geology

The glacial cover at Peninsula Point is very thin. As shown on Figure 20, bedrock occurs directly underneath the surficial topsoil and vegetation. The bedrock is well exposed along the shoreline at Peninsula Point. It has been identified by Hussey (1926) as belonging to the Ogontz Member of the Stonington beds (Stonington Formation). According to Hussey (1926), the Ogontz member is comprised mostly of cherty limestone that conformably overlies the Bay De Noc Member of the Stonington Formation. The Ogontz consists of 3-20 feet of light gray to yellowish-brown to dark brown massive and irregularly bedded limestone varying from soft and argillaceous to hard and cherty, with fossiliferous cherty beds being predominant. The base of the Ogontz is typically argillaceous. The fossils in the cherty layers, including gastropods and trilobites, are often well preserved, but the cherty nature of the rock matrix makes good specimens hard to obtain.

As shown on Figure 20, the bedrock observed at the coastal exposure at Peninsula Point is light gray, relative-



Figure 20: Coastline Outcrops of the Ogontz Member of the Stonington Limestone at Peninsula Point. Photo by Dave Adler.

ly flat lying limestone with fairly well-defined bedding. It does not appear to be particularly cherty. The exposed beds of the Ogontz here are fossiliferous, although fossils are not as abundant as in the Bill's Creek Shale. If you look closely at Figure 20, you can see the limestone beds extending under the water and out into Green Bay, giving one a feel for the reefs that are known to occur nearby that have historically been a hazard to shipping.

### **Peninsula Point Lighthouse**

During the 1860s, the town of Escanaba and other nearby ports were teeming with sailing ships hauling iron ore, lumber, fish and other commercial goods. When iron ore docks were constructed in Escanaba in 1864, Congress appropriated \$15,000 for a lighthouse at the tip of the Stonington Peninsula at Peninsula Point (Stop 4) to assist ships in navigating around shoals and reefs in the local waters of Lake Michigan/Green Bay. The Peninsula Point Lighthouse was completed in 1865 with a square, 40-foot tall brick tower attached to a 1.5 story brick light keeper's dwelling. The lighthouse was equipped with an oil-fired fourth order Fresnel lens inside the decagonal shaped lantern room atop the lighthouse tower. A photo of the lighthouse and keeper's dwelling circa 1914 is shown in Figure 21.

In 1922, the fuel for the light was changed from oil to acetylene gas, allowing the lighthouse to be automated and unattended. The acetylene fueled light produced a white flash every ten seconds. In 1936, a new lighthouse was constructed at Minneapolis Shoal located approximately seven miles southwest of Peninsula Point. As



Figure 21: Peninsula Point Lighthouse Circa 1914 Showing the Keeper's Dwelling and Associated Outbuildings. Photo source: https://www.lighthousefriends.com/PeninsulaPoint1\_1914\_cg.jpg.

most shipping in the area now passed to the south of Minneapolis Shoal, the lighthouse at Peninsula Point was no longer needed and was decommissioned. Ownership of the Peninsula Point lighthouse and surrounding 47 acres was transferred to the U.S. Forest Service in November of 1936. The Civilian Conservation Corps was granted custodianship in 1937 and subsequently repaired the lighthouse buildings and created a campground and picnic area on the grounds.

The light keeper's quarters burned in 1959 and the remains of the building were removed. Today, only the 40 -foot tall lighthouse tower remains, surrounded by a day use picnic area with picnic tables, outdoor grills, and primitive restroom facilities. There is an interpretive trail along the coastline where outcrops of the exposed fossiliferous Ordovician carbonate rocks can be observed. The lighthouse tower is listed on the National Register of Historic Places. Visitors can climb the lighthouse tower for spectacular panorama views of Lake Michigan and the surrounding coastline. The tower also serves as an elevated vantage point for watching migrating birds and butterflies.

### Closing

The west side of the Stonington Peninsula offers a number of excellent opportunities to observe and examine the Ordovician rocks of the Michigan Basin and collect specimens of the abundant fossil assemblages found in these rocks. It's also a secluded place of quiet solitude where one can breathe fresh clean air, enjoy the wildlife, comb the beaches, fish, and paddle the blue waters of Lake Michigan. It's a place that has much of the appeal that Michigan's Upper Peninsula is known for.

This field guide is intended to assist those who may be interested in fossil collecting and experiencing some of the geology of Michigan in an up close and personal way. The fossils of the Ordovician rocks on the west side of the Stonington Peninsula have been presented in this field guide in a general manner. Those wishing to take a deeper dive into the paleontology of this area are encouraged to consult the references below, where additional and considerably more detailed information can be obtained.

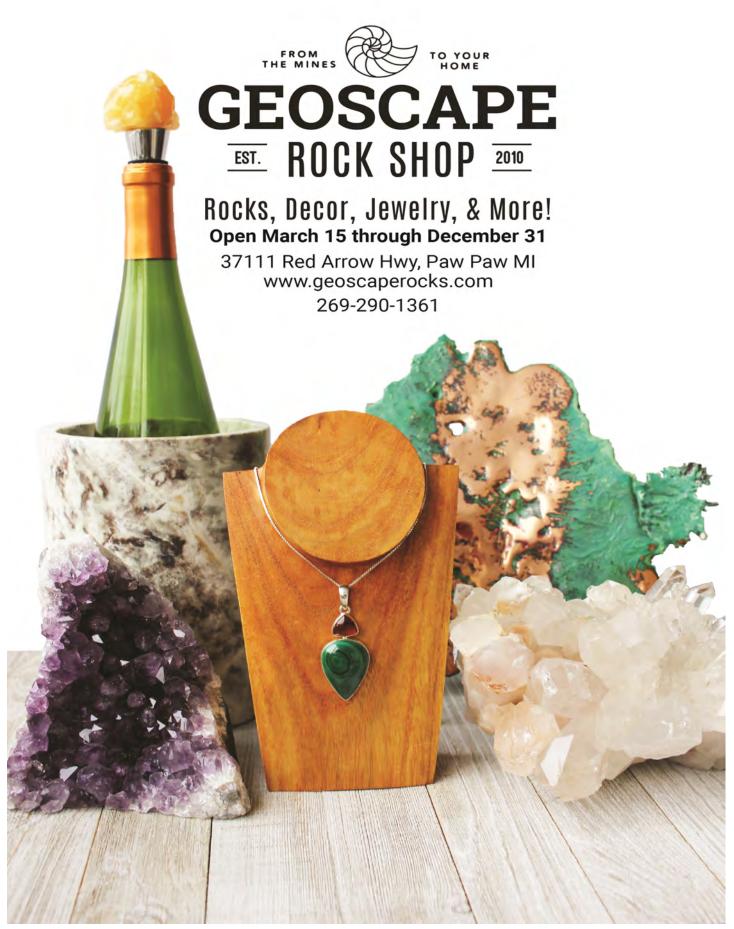
### **Acknowledgments**

Ms. Jenny Hamel was instrumental in preparing the figures for this field guide. Special gratitude is also extended to Eric Wallis, CPG, who first told the author about the excellent fossil hunting on the west side of the Stonington Peninsula many years ago.

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# **Scholarship Awards!**

Each year, the National AIPG Scholarship Committee awards multiple scholarships to student members. The purpose of these scholarships is to assist students with college education costs and to promote student participation in AIPG. Typically, up to 10 scholarships are awarded to declared undergraduate geological science majors each year. In addition, one graduate scholarship, the William J. Siok Scholarship is awarded annually.

The requirements of the scholarships is detailed on AIPG's website, and was also summarized on Page 11 of the Jan/Feb/Mar 2021 edition of *The Professional Geologist*.

The Scholarship Committee judges all of the scholarship applications; this year, there were 36 undergraduate applicants from around the country that met the requirements of the

scholarship. A total of 16 students were scholarship recipients; some were sponsored by AIPG Sections.

While each of the undergraduate recipients were identified in the Jul/Aug/Sep 2021 edition of TPG, the Michigan Section Executive Committee would like to give special recognition to the TWO Michigan students that received the scholarship this year: **Breauna Murray** of Wayne State University, and **Grace Ojala** of Michigan Technological University. Congratulations to both of you!

As many of you know, the Michigan Section also has a scholarship it awards each year: the Andrew Mozola Memorial Scholarship. This scholarship was named in honor of the Michigan Section's first President, Andrew Mozola.

The purpose of the Mozola scholarship is to support undergraduate students majoring in geology at a Michigan college or university with their education costs, and to encourage student participation in AIPG. The value of the scholarship is \$4,000.

In 2021, the Michigan Scholarship Committee judged the applications, and decided to award the 2021 Andrew Mozola Memorial Scholarship to Central Michigan University student **Emily Yoder** for her outstanding application and credentials. In case you missed it, Emily submitted an article titled "The Pegmatite Puzzle: Insights from Mineral Intergrowth Textures" that was published in the Jan/Feb/Mar edition of *The Professional Geologist* as well as *Geologically Speaking*. Please join the Michigan Section Executive Committee in congratulating Emily!





National Scholarship Winners: **Breauna Murray**, SA-9764, Wayne State University (top left); **Grace Ojala**, SA-9664, Michigan Technological University (top right).



Michigan Section's Andrew Mozola Scholarship Winner: **Emily Yoder**, SA-9933, Central Michigan University.

### Welcome New Members

The Michigan Section is continuing to grow. Please welcome the following new CPGs, Professional Members, Early Career Professionals, Associate Members, and Students:

Joshua Boren, MEM-3296; Mariah Burnett, MEM-3298; Paul Glasser, CPG-12106; Goran Kovacevic, AS-0184; Brian Meisel,

CPG-12108; and Brandon Schultz, SA-11064.

To each of our new members, welcome to our Section. We encourage you to attend Section meetings and other events. You are also invited to provide information for the Member's Corner articles.

## **Coming Events**

October 23-26, 2021: Rescheduled 57th Annual AIPG Meeting to be held in Sacramento, California. The Role of Geoscientists for Resiliency, Sustainability and Opportunities in a Changing Environment. The meeting venue will be the Hilton Sacramento Arden West.

October 28, 2021: Why Your Vapor Mitigation System Doesn't Have to Suck. <a href="https://www.michigan.gov/egle/0,9429,7-135-3308">https://www.michigan.gov/egle/0,9429,7-135-3308</a> 3333-549843--,00.html.

**June 21-22, 2022:** Environmental Risk Management Workshop at the Ralph A. MacMullan Conference Center, Roscommon, Michigan.

**August 6-9, 2022:** 58th Annual AIPG Meeting to be held in Marquette, Michigan. See article in this edition of *Geologically Speaking* regarding meeting planning.

# Interesting Geology Links

The Editor has received links to various interesting geology-related sites. Some of the more interesting links are included here. If you have any links to geology-related sites that you would like to share, please forward them (with a citation, if applicable) to the Editor.

Thanks to Mark Francek of Central Michigan University for sharing via the "Earth Science Site of the Week" emails. This edition features a few "fun" links.

A collapse of a part of Pictured Rocks: <a href="https://www.uppermichiganssource.com/2021/06/28/watch-200-foot-pictured-rocks-cliff-face-plummets-into-lake-superior/">https://www.uppermichiganssource.com/2021/06/28/watch-200-foot-pictured-rocks-cliff-face-plummets-into-lake-superior/</a>. This link provided by Allan Blaske.

Landslide in Japan: <a href="https://www.youtube.com/watch?">https://www.youtube.com/watch?</a>
<a href="yeeR77MhKwAew">yeeR77MhKwAew</a>.

Rare Geological Clay Swelling: <a href="https://www.youtube.com/">https://www.youtube.com/</a> watch?v=T8akki50rvg.

# Member's Corner

The Member's Corner includes information about the Section's membership. This is your chance to provide information on where you are and what you are doing. Simply send the information to the Editor for inclusion in this section.

No Member's Corner articles were received for this edition of *Geologically Speaking*.

# **Annual Meeting Planning**

The Michigan Section AIPG will be hosting the 2022 Annual Meeting in Marquette on August 6-9, 2022. The planning committee is growing but needs your help! The committee is co-chaired by Adam Heft and Sara Pearson. If you are interested in helping with the 2022 Annual Meeting or would like to be on the planning committee, please email either Adam or Sara at adam.heft@wsp.com or pearsons@michigan.gov.

As one of the most active AIPG Sections, Michigan wants to have an exciting program and a highly successful Annual Meeting with many attendees. If you have any suggestions or ideas that will make the 2022 Annual Meeting one to remember, please pass them along.

Here is a preliminary list of potential field trips currently under consideration:

- Eagle Mine/Mill: Surface tour (underground tour if possible)
- Pictured Rocks: Miner's Castle, Miner's Falls, Munising Falls, and boat tour
- Tilden Mine/Mill, includes a visit to the main mine pit
- Historic Iron Mining: Michigan Iron Industry Museum, Jackson Mine Park, Cliffs Shaft Museum
- Republic Mine and Reclamation: Overlook, rock piles, tailings reclamation
- Keweenaw Stamp Sands: Lake Linden, Torch Lake, Historic Mills, Quincy Smelter, Gay, redevelopment

of stamp sands

Keweenaw Copper: Quincy Mine and Seaman Mineral Museum

Other possible trip locations could include:

- Champion Mine
- Back 40 Mine
- Iron Mountain Iron Mine
- Fayette/Big Spring
- Gulliver/Gould City Limestone Quarries
- Lake Ellen Kimberlite
- Wind Farm Power Production

Potential Guest Trips

- Pictured Rocks National Lakeshore
- Waterfall Tour
- Brewery Tour
- Lake Superior Fishing Charter

Field Trips are being evaluated by Allan Blaske and Dave Adler, with input from Mark Petrie.

Look for periodic updates on the status of the Annual Meeting planning in future editions of *Geologically Speaking!* 

### I Want To Publish Your Articles!



Hey everyone, I would like to encourage you to submit your articles for publication! As the Michigan Section Editor, and also the 2021-22 National Editor, I am working to put together two top-quality publications for our members. This is not a one person job. This is where you come in. I

welcome your technical articles, case studies, opinion pieces, mini field guides, and letters to the Editor.

The guidelines are pretty simple for articles for *Geologically Speaking*. All submissions must be professional and may not violate the AIPG code of ethics. They also may not have been submitted for publication elsewhere. While most submissions will be accepted, we do not accept articles that are a sales pitch for a product or company.

The deadline for submitting articles for TPG is two months before the start of the quarter for which the TPG edition is published. Thus, February 1 is the deadline for the Apr/May/Jun edition.

Please submit your articles of no more than 3,200 words in MS Word format directly to me or to Dorothy Combs at National Headquarters at <a href="mailto:aipg@aipg.org">aipg@aipg.org</a>. All graphics (photos, figures, or tables) should be submitted in .jpg, .tiff or other standard format at 300 dpi. Please ensure your graphics are clean and easy to read to make things easier for the editorial staff. Complete information on submitting an article may be found on National's website at: <a href="mailto:https://aipg.org/page/TPGInformation">https://aipg.org/page/TPGInformation</a>.

I'd like to encourage our members to consider submitting an article related to Michigan geology in advance of the Annual Meeting that will be held in Marquette in 2022.

# **ASBOG Exam Update**

Eleven individuals took the ASBOG FG exam at Central Michigan University on Friday, March 19th. Registration is now open for the next exam, which will be administered on October 1, 2021. Relevant dates for taking the exam this October are:

August 4 – apply to CMU

- · August 15 register with ASBOG
- October 1 FG exam at CMU

Additional details are available at: <a href="se.cmich.edu/asbog">se.cmich.edu/asbog</a> and will be provided in the next edition of *Geologically Speaking*.

# **Member Input Sought**

The Section Executive Committee is seeking input from members on a variety of topics. Do you have any suggestions regarding speakers/presentation topics that you would like to hear? What about field trips or other events? Some place you'd like to see us go, or something you think the membership would enjoy doing?

Then make your voice heard; please send your suggestions to one of the members of the Executive Committee; any of the six members would be glad to hear from you. AIPG is your organization. Please help keep it relevant and interesting for all by participating.

# **Support our Sponsors!**

The Section Executive Committee would like to remind its members to support the companies advertising in this publication. Consider working with these compa-

nies, and when you speak with their representatives, let them know that you saw their ad in the Michigan Section AIPG publication *Geologically Speaking*.





# Why Your Vapor Mitigation System Doesn't Have to Suck

Vapor mitigation systems are commonly designed to create a measurable vacuum below the slab of a building that meets or exceeds a value specified by a standard or guidance document. That is, they are designed to suck the gas out from under a building. The generation of this vacuum also imparts some level of ventilation of the subslab soils beneath the slab, which reduces vapor concentrations and achieves some level of mass removal. While current industry practices most often specify the level of static vacuum required, the amount of ventilation required is often not specified or evaluated. This presentation will focus on new lines of evidence that warrant changes in the standard of practice for the design of vapor mitigation systems. The presentation will show how the permeability of the sub-slab material and the transmissivity will impact the vacuum and ventilation beneath a building during sub-slab depressurization. New evidence will be provided to support this approach. Tools will also be discussed for measuring these factors and evaluating the performance of a mitigation system not solely based on an ap-

plied vacuum metric.

Speaker Biography: Paul Nicholson is an engineer and senior member of Geosyntec's vapor intrusion practice. He has over 15 years of experience in environmental consulting, vapor intrusion assessment, vapor intrusion mitigation design and construction. As one of the developers of the High Volume Sampling methods, Paul's current focus is on the design and optimization of sub-slab mitigation systems based on over a decade of research in this area.

#### How to attend the Online Webinar:

To attend the online webinar register at https://
register.gotowebinar.com/
regis-



ter/6749964970517931788

After registering, you will receive a confirmation email containing information about joining the webinar.

# Michigan Section's 10th Annual Environmental Risk Management Workshop

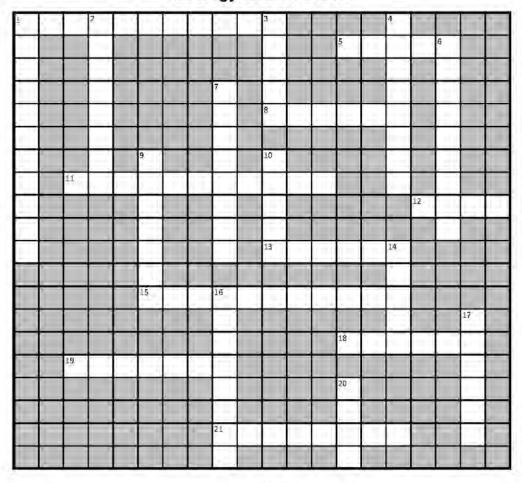
The Michigan Section hosted its 10th Annual Environmental Risk Management Workshop on June 15-17 2021. This year's event was held virtually via Whova and the theme was "The Data Tell the Story."

Although this year was not the in-person event that we were hoping for, we were still able to deliver high-quality technical presentations for our participants. Many of the technical presentations were recorded so that individuals can go back and listen in again. Page 33 of this edition of *Geologically Speaking* lists those talks with links to the recorded presentations.

Sara, Tammy and Adam would like to extend our thanks for participants and their patience for those talks that experienced minor technical difficulties, and a big thank you for our sponsors ,who are also identified on page 34. Also thanks to our session moderators, Chris Gellasch, Gail Carr, and Matt Germane.

Next year's Workshop will be held on June 21-22, 2022 at the Ralph A. MacMullan Conference Center in Higgins Lake! Please save the date; Sara and the rest of the Workshop planning committee are looking forward to welcoming you back to an in-person event next year!

### Geology Crossword #6



### Across

- 1. Squeeze
- 5. Lowest grade
- 8. "Oh \_\_\_\_!"
- 11. To alter the original form
- 12. To bend
- 13. Many people feel this
- 15. The potential for heat transfer
- 18. Change in shape or size of a body
- 19. German word for sausage
- 21. Large area

### Down

- 1. Castle walls have them
- 2. Intermediate grade
- 3. Republic is one example
- 4. A surface evidencing rock movement
- 6. Stretching
- 7. Planar arrangement of features
- 9. Old aviator term
- 10. Something stretching works out
- 14. Something done to sheep
- 16. Force exerted across a surface
- 17. Highest grade
- 20. Scoring; in the end

<sup>\*</sup>The solution to this geology crossword will be included in the next edition of *Geologically Speaking*.