

TPG is a publication of the American Institute of Professional Geologists

THE PROFESSIONAL GEOLOGIST

VOLUME 61 NUMBER 1

JAN.FEB.MAR 2024

The Hidden Geology of Walt Disney World
Minimizing Risk and Uncertainty in Humanitarian Efforts
Stormwater Infiltration System Design

Peer-Reviewed
Mexico: Gold and Silver Vein Deposits



AIPG 61st Annual National Conference Fort Lewis College



AIPG 2024
DURANGO, CO
RESOURCES OF THE WEST
August 10-13

- Glacial Geology
- Volcanic Calderas
- Paleozoic & Mesozoic Sedimentary Complexes
- Precambrian Basement Complexes
- Mining and Resource Development
- Ancient Native American History
- Technical Presentations
- Field Trips and more!

GEOLOGY, MESOZOIC & PALEOZOIC DRY-ERASE GLOBES & HEMISPHERES



18" & 30"
SIZES



WWW.REALWORLDGLOBES.COM

AIPG Member Photo Challenge

Challenge categories:

1. **Off the Beaten Path - Unique feature/formation.**
2. **Ancient Life - Fossil hunting finds.**
3. **Geologists in the Field - People at work/field trips.**
4. **Micro-Geology - Under the microscope.**

Entries must be original and taken by a member. Entry authorizes publication of the image in *The Professional Geologist* by AIPG with credit given to the photographer.

Challenge Rules:

Image requirements: digital, 300 dpi, 8.5"x11," portrait orientation full color.

Members are allowed one entry per category with up to four submissions (one per category).

All images must be original and taken by the member.

Submit entries via email to aipg@aipg.org.

Entries must include:

- Name
- Member number
- Section
- Title of image
- Less than 200 word description of the image
- Names of any identifiable persons in the image and permission to publish their photo
- Year photo taken

Entry deadline: **November 1, 2024.**

Awards:

First place in each category:

Image published on the cover of *TPG* in 2025. Winners will receive a personalized Estwing rock hammer engraved with their name and member number or AIPG Gear of choice up to \$50.

Runners Up in each category:

Images will be published in the *TPG* in a special feature album. Runners up will receive AIPG gear of choice up to \$30.



The Professional Geologist

Volume 61 Number 1

JAN.FEB.MAR 2024

INSIDE THIS ISSUE

FEATURES

- 5** **The Hidden Geology of Walt Disney World**
Robert P. Blauvelt, CPG-6508
- 10** **Peer-Reviewed Gold and Silver Vein Deposits in the Sierra Madre Occidental, Mexico**
Francisco Pedro Cruz Frisby, CPG-11977
- 16** **AIPG Wants Your Unwanted Geology Textbooks, Geology Maps and Other Books About Science and Nature**
Dawn H. Garcia, CPG-8313
- 17** **Minimizing Risk and Uncertainty in Humanitarian Efforts**
Robert K. Merrill, CPG-4984
- 22** **Stormwater Infiltration System Design Regulation Flaws Due to Simplistic Assumptions Regarding Site Hydrogeology**
Andrew M. Koenigsberg, CPG-7973
- 38** **The Perseverance Rover: An Exciting Camp Towards Summiting the Red Planet**
Isaac Pope, SA-9950
- 47** **New York State Education Department Approves AIPG as a Continuing Education Provider for Licensed State Geologists**
John M. Nadeau, PG, CPG-11181

On the Cover: 2023 Photo Contest Winner Micro Geology: Under the Microscope.

Description: The reflected light image under crossed polars with 1 second exposure illustrates four minerals. Pyrite, FeS_2 , is dark gray, Gold, Au, as four massive yellow grains is enclosed by Hessite, Ag_2Te , in multiple hues of light gray, blues, browns and orange red. A late second gold (silver-rich) stage is lighter yellow with dendrites replacing hessite. Coarse red hessite contains pseudomorphic isometric twin structures in light gray and other hues. This was a consequence of ore cooling below $\sim 150^\circ\text{C}$ resulting in the dimorphic change to the monoclinic crystal system with many anisotropic hues.

The ore sample was mined by Matt Collins, Mine Manager, and Jim Smith, Mine Foreman, in 2007 on the 3rd level sill at the C-2 stope in the Cash vein, Cash Mine, Gold Hill, Boulder County, Colorado, USA. One 6-inch wide vein assay returned 366 ounces per ton silver and 27 ounces per ton gold. The ore was analyzed in 2007 and photographed in polished section by Jim A. Paschis, Senior Mine Geologist. 2023 Photo Contest: Micro Geology - Under the Microscope. Runner Up on page 51.

AIPG National Executive Committee

PRESIDENT - Shanna Schmitt, CPG
Minnesota Pollution Control Agency
O: (651) 757-2697, Minnesota Section
shanna.schmitt@state.mn.us

PRESIDENT-ELECT - Sara Pearson, CPG
Michigan Department of Environment, Great Lakes, and Energy
O: (517) 420-3219, Michigan Section
pearsons@michigan.gov

PAST PRESIDENT - Dawn Garcia, CPG
Stantec
O: (520) 545-7603, Arizona Section
dawnhgarcia@gmail.com

VICE PRESIDENT - J. Todd McFarland, CPG
WSP
O: (615) 577-7157, Tennessee Section
todd.mcfarland@wsp.com

SECRETARY - Robert Andrews, CPG
City of Columbus - Department of Public Works
O: (614) 861-1690, Ohio Section
reandrews@earthlink.net

TREASURER - Mark Schaaf, CPG
Kleinfelder
O: (410) 850-0785, Capitol Section
mschaaf@kleinfelder.com

EDITOR - Adam W. Heft, CPG
WSP
O: (517) 886-7400, Michigan Section
adam.heft@wsp.com

EARLY CAREER PROFESSIONAL - Brigitte Petras, ECP
Battelle Memorial Institute
O: (330) 559-1812, Ohio Section
petras@battelle.org

ADVISORY BOARD REPRESENTATIVES

Mark J. Howell, CPG
Xenon Geosciences
O: 317-745-0002, Illinois-Indiana Section
mhowell@xenongeosci.com

Paula Leier-Engelhardt, CPG
HydroGeo Solutions LLC
(920) 737-9811, Wisconsin Section
pjeier@gmail.com

Andrew Jones, MEM
Plexus Scientific Group
O: (502) 471-7553, Colorado Section
andrew.jones.geo@gmail.com

Clint Noble, MEM
CDM Smith
O: (904) 527-6715, Florida Section
noblecc@cdmsmith.com

NATIONAL HEADQUARTERS
1333 W. 120th Avenue, Suite 211
Westminster, CO 80234
7:30 AM - 4:30 PM MDT; M-F
(303) 412-6205 • Fax (303) 253-9220
aipg@aipg.org • www.aipg.org

EXECUTIVE DIRECTOR - Aaron W. Johnson, MEM - awj@aipg.org
ASSISTANT DIRECTOR - Wendy J. Davidson - wjd@aipg.org
PROFESSIONAL SERVICES MGR - Cathy L. Duran - cld@aipg.org
MEMBERSHIP SERVICES MGR - Dorothy K. Combs - dkc@aipg.org
BOOKKEEPER/OFFICE ASSISTANT - Cristie J. Valero - cjv@aipg.org
OFFICE ASSISTANT - Kathy Glivar - officeadmin2@aipg.org
AWG ADVANCEGeo Program Manager - Hannah Horinek - advancegeo@awg.org
AWG ADMIN ASSISTANT - Mona Scott - office@awg.org
AASG ADMIN ASSISTANT - Karen Keeley - office.aasg@gmail.com

MEDICAL, AUTO, HOME, LIFE AND SUPPLEMENTAL INSURANCE
GeoCare Benefits Insurance Plan
Phone: 800-337-3140 or 602-870-4121
http://www.geocarebenefits.com/member.asp
E-mail: geocarebenefits@agia.com

PROFESSIONAL & GENERAL LIABILITY INSURANCE
AssuredPartners of Colorado
Phone (800) 322-9773 (303) 863-7788
http://www.assuredpartnerscolorado.com

ALAMO RENTAL CAR -
(800) 354-2322 - Member #BY-706768

AVIS RENTAL CAR -
(800) 698-5685 - Member AWD #T003300

UPS Savings Program
www.aipg.org or www.sawewithups.com/aipg
Use promo code WES462

DEPARTMENTS

3	Editor's Corner
4	Letters to the Editor
29	The Foundation of the AIPG
30	Executive Director's Message
31	President's Message
32	Test Your Knowledge
33	Professional Ethics and Practices
36	AIPG Moment
37	New 2023 Certified Professional Geologists
40	Educator's Corner
45	Early Career Professional Point of View
48	2023 National Conference Photos
50	In Memoriam
51	Celebrating Member Achievements
52	AIPG Membership Totals
52	Professional Services Directory

AIPG Publication Policy, October 4, 2010. AIPG encourages submission of articles and editorials for publication in *TPG* on topics related to the science and profession of geology. Submittals shall be of interest to the members of AIPG, other professional geologists, and others interested in the earth sciences. Articles and editorials may be noted as follows at the discretion of the Editor, "The opinions, positions and conclusions presented herein are those of the author and do not necessarily reflect the opinions, positions or conclusions of the American Institute of Professional Geologists." All materials submitted for publication, including author opinions contained therein, shall include accurate and appropriate references. The Editor has the authority to solicit, edit, accept, or reject articles and editorials and other written material for publication. The Executive Committee has the authority if it so chooses to act on any particular case to support or overrule actions of the Editor regarding the solicitation, editing, acceptance, or rejection of any particular article, editorial, or other written material for publication.

American Institute of Professional Geologists (AIPG) is the only national organization that certifies the competence and ethical conduct of geological scientists in all branches of the science. It adheres to the principles of professional responsibility and public service, and is the ombudsman for the geological profession. It was founded in 1963 to promote the profession of geology and to provide certification for geologists to establish a standard of excellence for the profession. Since then, more than 12,000 individuals have demonstrated their commitment to the highest levels of competence and ethical conduct and been certified by AIPG.

The mission of the American Institute of Professional Geologists (AIPG) is to effectively advocate for the profession of geology and support members through activities and programs that advance professional growth and promote high standards of ethical conduct.



The Professional Geologist (USPS 590-810 and ISSN 0279-0521) is published quarterly by the American Institute of Professional Geologists, 1333 W. 120th Avenue, Suite 211, Westminster, CO 80234-2710. Periodicals Postage Paid at Denver, Colorado and additional mailing offices.

POSTMASTER: Send address changes to *The Professional Geologist*, AIPG, 1333 W. 120th Avenue, Suite 120, Westminster, CO 80234-2710

Subscriptions for all Members and Adjuncts in good standing are included in annual membership dues. Subscription prices are \$20.00 a year for Members' additional subscriptions and \$30.00 a year for non-members for 4 issues (for postage outside of the U.S. add \$10.00). Single copy price is \$5.00 for Members and \$8.00 for non-members. Claims for nonreceipt or for damaged copies are honored for three months.

Entire contents copyright 2024 by *The Professional Geologist*. Original material may be reprinted with permission. Deadline for articles and advertisements is eight weeks preceding publication. Advertising rates available upon request. Opinions and views expressed by the authors are their own and do not necessarily reflect those of the American Institute of Professional Geologists, its staff, or its advertisers.

Printed in U.S.A. by Modern Litho-Print Company in Jefferson City, Missouri.

For AIPG news and activities go to www.aipg.org.



Civility... Make it Personal

Adam W. Heft, CPG-10265

Happy New Year, everyone! I hope that 2023 was a good year and that you're enjoying (or have recently finished enjoying) the Holiday season. For me, 2023 was a very busy year, packed with personal and professional activities; from work, to AIPG events and preparation of your favorite quarterly professional publication, *TPG* (and for those in the Michigan Section, *Geologically Speaking*), to projects around the house. Fortunately, Sara and I no longer have both our houses, and are down to one, but there is still a lot to accomplish and the list of home improvements waiting to be finished is long.

If you've been paying attention to the editions of *TPG* since I became your Editor, you will have noticed subtle changes each year. Typically, the biggest change occurs with the first edition of the year. 2024 will be no different. One of the noticeable changes is with the font. You may recall that font readability was a subject that **David Abbott** (CPG-04570) touched on in a couple of his recent Professional Ethics & Practices columns. Beginning with this issue, we have changed from a serif font to a sans serif font. I think you will notice that the articles are more easily readable, and the words are less likely to "swim" before your eyes. I'll note that the font in figures may or may not follow this same format (at least for the time being) as it will depend on the source of the figures and whether the author selected a sans serif font. The use of this kind of font in figures will phase in as it becomes a requirement for new articles; only figures that are excerpted (with permission) from previous publications may be exempt.

Another change that we have made is in regard to the advertising rates for *TPG*. Previously, the rates were high enough that we had few, if any advertisers in a given edition. The new rate structure is significantly lower, and now includes package deals for national conference sponsors and exhibitors. The new rate structure may be found at: cdn.ymaws.com/aipg.org/resources/resmgr/documents/publications/2024_tpg_advertising_rates.pdf. Does this mean that *TPG* will become a publication of advertisements with no other technical content? Absolutely not. While I hope to entice many companies to support our organization, our focus remains on providing the articles and content that you have come to expect from AIPG. There is a limit on the number of ads contained in *TPG*.

I'd like to hear from you, our readers to learn what you think of the new and ongoing appearance of our publication. We want to provide a modern looking publication that our readers look forward to receiving and contributing content. What do you think of the overall layout and appearance? Please share with me your feedback on these and any other aspects of *TPG* that interest or concern you. Thank you.

This edition of *TPG* has a nice mix of articles that I hope you will enjoy. **Andrew Koenigsberg** (CPG-07973) discusses how oversimplification of hydrogeology with regards to stormwater detention systems can result in failure. A peer-review article by **Pedro Frisby** (CPG-11977) on gold and silver veins in the Sierra Madre is a more traditional hard rock discussion. And **Robert Blauvelt** (CPG-06508) wrote a fun article on the geology of Walt Disney World. Besides a couple of Letters to the Editor, we are honoring members who have passed; we sadly receive more notices with the dues renewal.

Last year, I wrote about the subject of what makes a professional. There were eight characteristics of professionalism that I listed from sources I referenced. One of the eight characteristics was "respect." I'll add another that I think goes hand in hand with respect; it is civility. Webster's Dictionary defines civility as "formal politeness and courtesy in behavior or speech." This is something that we should all practice and exercise in our professional and personal interactions. I've seen and experienced instances of a lack of civility in communication and discussion. It leads to ill feeling, a lack of respect, and worse. Civility is something that seems to have disappeared from public view over the years.

One of the main culprits for the erosion of civility, at least in the U.S., is the right to free speech. While this is a fundamental right of all people here in the U.S., it can be (and often has been) selfishly taken too far. Many believe that they can say anything they choose. For example, it is far too easy to post hurtful or hateful speech on social media with little to no accountability. Should we accept or condone this behavior as professionals and individuals who believe in doing the right thing and achieving the highest standards of professionalism? What do we achieve when we resort to senseless name calling? Disagreements happen. There are productive ways to work through them while maintaining the dignity of the parties involved. One only needs to listen to the news to get a cross-section of how the lack of civility is sensationalized and presented as the popular opinion and behavior of the masses. It is becoming normalized in society. We value doing the right thing as professionals with competence, integrity, and ethics. Shouldn't we set the standard among our peers in our personal and professional lives and pass it on.

The next edition of *TPG* will be the Student Edition. Please submit your articles, informational or opinion pieces that will be of interest to students to me as soon as possible. The deadline is February 1, 2024 for articles; however, early submissions are more than welcome.

Comments Regarding Place-Based Education in Geoscience

The article “Place-Based Education in Geoscience” in the July-August-September issue of *The Professional Geologist* concerns a new (or relatively new) theory. Place-based education (PBE), as described by Dr. Rasoul Sorkhabi, involves conducting scientific observations and investigations in relation to the location (place) of concern. This sounds reasonable, but, having read Dr. Sorkhabi’s article, I have some concerns and objections to this practice.

Dr. Sorkhabi defines “place” as a spatial, special and social construct by humans. Alright, but here one is moving away from a scientific discipline with specific methods and procedures to one of political science and sociology where the basis of practice is nebulous and highly changeable. Attempts at mixing science and non-scientific methods and thoughts invites trouble. Diluting scientific content and thinking takes place. The science is perverted as true scientific thought is debased or even pushed aside to make way for woke thinking.

Reading further into the article, Dr. Sorkhabi states that there is an enormous amount of research and literature regarding measuring the sense of place, psychological attachments and physical dependence people have to their habitats. Fine, these are actual subjects of study, but they are not science! One can take separate courses in these subjects. I learned about the relationship citizens have with their community and their “place” when I interacted with them at various public meetings as part of my professional work. The citizens I met were always the most vocal members of the community. Often, by their actions and words, I could tell I was not dealing with average citizens, but with a vocal minority who, at times, were really present to fulfill their agenda – for better or worse. So, trying to conduct your studies or work using the theory of “place” would not always succeed.

In the article, David Gruenewald of Washington State University is quoted as stating that “place-conscious education aims to work against the isolation of schooling’s discourse...” Yes, college can be a cloistered, rarified environment, but the larger the university, the greater the influence of various theories. Some of these theories are of a dubious nature or value or are even destructive to society. Isolation has its place when one needs to concentrate on studying a subject, as in college or an educational organization – or a cult.

Place-based geology education at Dine College sounds like a good fit. Native American tribes have lived on their respective lands as close-knit communities. However, I wonder whether the place-based geology course meets the scientific standards or is as rigorous as a geology course at a public college or university.

Dr. Sorkhabi describes in his article how Anthony Deringer of Texas discussed how PBE “helps to strengthen mindfulness and attentiveness in students by promoting environmental justice and social justice.” What? The inclusion of justice goals is inappropriate in a science curriculum. Teaching what is justice is politics mixed with sociology. Mr. Deringer intends to conduct indoctrination, not education. With that in mind, I would never teach PBE in a geoscience course. Various civil service agencies, corporations and institutions have their own staff who teach this nonsense. In fact, PBE is probably taught as a one semester course in various political science, environmental science, sociology, and psychology departments across the country.

In the last paragraph in Dr. Sorkhabi’s article, it is written that there is a “huge (and growing) volume of literature available on the theory of PBE.” He mentions The Orion Society as a supporter of PBE. However, if one were to look up The Orion Society on the internet, then you will find that they are interested in more than the natural environment. If one goes deeper into the site’s web pages, you will find a list of their goals. Topping the list is racial

justice community outreach. As such, I would assume that racial justice influences their teaching and research regarding PBE. Then again, why did Dr. Sorkhabi include this information in his article? I have the impression that he is an advocate of social justice and is trying to have this subject installed in the geology curriculum.

Every science student needs to have the opportunity to learn the information that forms the basis of their respective subject of study. Without this, the student cannot be a scientist. Scientists must have a strong background of information, but they must also be trained in the skills of observation, testing and objective reasoning. One cannot acquire the necessary information base when the scientific teaching is diluted by PBE. It is better to wait until the student is in his or her senior year, or even graduate school, when the knowledge base is well-formed and the necessary scientific skills are in place.

I don’t believe PBE should be a required course. Science students have enough on their plates during this era of information overload. Also, if they don’t pick it up while in college, then they can usually obtain the information “in house” at most government agencies and corporations.

In summation, the incorporation of PBE in a geoscience course poses a very real danger to the integrity of geology as a science. It is not certain that staff who teach PBE will limit the amount of information or time they will incorporate into the course. These staff are most likely not just advocates of PBE, but are probably also anti-fossil fuel and anti-geology. One can expect geological information to be increasingly pushed aside until what you have is indoctrination that is politically-socially based. This is what happened to climate science. It has turned into a WOKE religion, an infection, that is very hard to correct and which has almost destroyed the science. It is easier to stop an infection that has just entered the body of geoscience, then to treat and remove the disease once it has had a chance to spread widely!

Sincerely,

Raphael Ketani, CPG-9003
Sunnyside, New York

Adam,

As an observer on the side, I just wanted to tell you that you have done a great job as AIPG Editor! Halfway through your second term - according to your recent piece in the Oct-Nov-Dec 2023 *TPG*.

TPG looks great. Thank you for your terrific skills on editing and all your long hours of volunteer work getting *TPG* into shape!

Well done!

Jim Jacobs, CPG-07760

Editor’s response:

Thank you, Jim; your note is appreciated. I should clarify that the great appearance of the layout of *TPG* is a result of Sara Pearson’s efforts – she is the Design Editor and deserves at least as much credit as I receive.

Adam Heft, CPG-10265

The Hidden Geology of *Walt Disney World*

Robert P. Blauvelt, CPG-6508 (retired)

Geology is where you find it. While at Rutgers University in Newark, New Jersey it was along noisy, litter strewn road cuts on Route 15 in the Hudson Highlands, or on a frozen beach in February at Sandy Hook National Seashore, or at the base of the Palisades Sill on Frank Sinatra Drive in Hoboken. Recently, and to my surprise, I found it near Orlando, Florida at Walt Disney World.

We had taken the kids to the House of Mouse two or three times over the years and these excursions were frenetic, exhausting, and expensive. But in early December 2022 we went to Disneyworld for a few days with good friends (and no children) to try and capture a little more summer and enjoy some down time before the holiday season. Boarding the Magical Express bus at the airport, I realized I knew very little about Florida geology and nothing at all with regards to Disneyworld's lithologic setting. On this visit, I resolved to find out where I was geologically and to pay special attention to the way earth science may have been incorporated into the resort experience.

A Brief Tectonic History of Florida

At about 1.2 Ga, a mostly ice-covered supercontinent that had sprawled across the South Pole for over 300 million years, began to fragment. This landmass – Rodinia – may have been assembled from pieces of another earlier supercontinent – Columbia – that had been cleaved apart by embryonic tectonic activity about a billion years earlier (Zhao et al., 2004). Rodinia's leisurely demise, it would take about 500 million years or until very early Cambrian time or around 700 Ma for the process to be completed, resulted in the formation of four primary landmasses: Siberia, Laurentia (North America), Baltica (northern Europe), and Gondwana (Africa and South America) as well as a host of smaller islands and landforms (Carwood & Pisarevsky, 2017).

Over the next 240 Ma, these four continents would bounce around the globe, but eventually they came together once again to create Pangea, another supercontinent. As part of this process, Laurentia would move towards Gondwana during the Cambrian and form Florida's igneous basement. By the Ordovician, Florida is at latitude 50° south and its igneous bedrock is covered by an assortment of sandstone and shale. During Carboniferous time, Gondwana and Laurentia are joined to fashion the Appalachian Mountains. This process welds Florida to Laurentia (North America) and the Sunshine State's igneous basement rocks were uplifted,

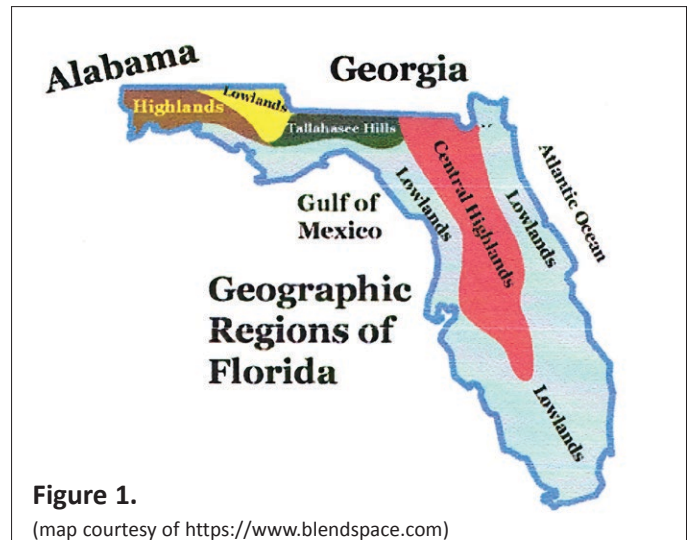


Figure 1.

(map courtesy of <https://www.blendspace.com>)

eroded, and eventually unconformably overlain by continental sandstone and shale mixed in with the occasional basalt flow (Applin, 1951).

By the end of the early Jurassic (circa 200 Ma) Pangea begins to rift and Laurentia separates from northwestern Africa (Gondwana) and moves northward. Through the Mesozoic until Jurassic time, Pangea continues to disassemble and evaporites and carbonates come to dominate Florida's geologic column eventually forming the 10,000 foot (3,050 meter) thick Florida Platform. By the Cretaceous, Florida is about 25° north of the equator. During the Cenozoic, the Florida Platform would be inundated and desiccated by various glacially motivated sea level rises and falls, with each event resulting in further deposition of clastic or evaporite/carbonate rocks.

Condensed Physiographic Description

Today, the results of all this tectonic pushing and shoving are reflected in Florida's three major physiographic provinces: the Northern and Central Highlands, the Gulf Coastal Plain, and the Atlantic Coastal Plain or Lowlands (Figure 1). These provinces rest on a clastic and evaporite/carbonate platform which, in turn, has been built on late Proterozoic to early Paleozoic granites and gneisses.

The Northern and Central Highlands emerged as Pleistocene glaciation lowered sea levels and waves, currents, and other subaerial processes sculpted previously formed relict landscapes. This largely erosive episode is preserved as a series of discontinuous, gently sloping, sub-parallel ridges separated by broad lowland valleys. Walt Disney World (WDW) was built on the Central Highlands. This region is about 400 to 500 miles (640 to 800 km) long, extending from Alabama eastward to Georgia and then southward through the center of Florida. Elevations run about 200 to 300 feet (60 to 90 m) above mean sea level.

The geology of Florida's Central and Northern Highlands is characterized by limestone and dolomite, sandy ridges, and a karst topography that gives rise to lakes, sinkholes, and springs. Two prominent features which form the geologic backbone of this province are the Brooksville or Central Florida Ridge, which runs from Hernando County in the west to Lake Wales Ridge in the east. This ridge is composed of Ocala and Suwannee group limestones and dolomites. The Lake Wales Ridge stretches from Lake County to Highlands County and was an ancient shoreline. It is sandstone and limestone and is home to a unique ecosystem, featuring sandhills, scrub vegetation, and rare plant species adapted to its well-drained, sandy soils (Miller, 1986).

While the Highlands were being eroded, declining sea levels and associated depositional processes such as longshore and riverine currents, spread sand and gravel from the Appalachians and its piedmont to form the Gulf and Atlantic Coastal Plains (Bostick et al., 2018). The Gulf Coastal Plain, on the western side of the state, is dominated by unconsolidated sediments and marine deposits. The western portion of the plain is made up of an extensive series of sand dunes and barrier islands, which serve as natural protection against the open Gulf waters. These barrier islands, such as Sanibel Island and Captiva Island, are composed of sand, silt, and significant amounts of organic material (e.g., shell fragments).

Moving eastward, the Gulf Coastal Plain transitions into the Atlantic Coastal Plain, which is characterized by a combination of marine, estuarine, and terrestrial deposits. Coastal Plain sediments comprised of sand and silt sediments, and surface features such as

marshes, swamps, and lagoons testify to a shallow, productive water table. Barrier islands, such as Amelia Island and Anastasia Island, also are present along the Atlantic coast.

The underlying geology of the coastal plains includes formations such as the Hawthorn Group, which consists of clay, sand, limestone, and exploitable phosphate deposits (Lane, 1994). These formations contribute to the mix of soils found in the region, ranging from sand near the coast to more fertile and clay-rich loams further inland.

In summary, Florida's geology was formed by slow-motion collisions and breakups of supercontinent landmasses interspersed with long, quiescent, erosional, and depositional stages. The final act of this geologic ballet would be the burial of the Florida Platform by clastics eroded from the nearby Appalachian Mountains which in turn would be smothered by sand and silt pushed down the Atlantic and Gulf coastlines by longshore currents and related upland fluvial processes. The geology along Florida's Gulf and Atlantic Coastal Plains is characterized by extensive sedimentary deposits, including sand, clay, and limestone. These form a seaward thickening wedge of poorly consolidated clay, silt, and sand which is subject to ongoing erosion and deposition processes, resulting in the formation of barrier islands, beaches, and estuaries. These two low-relief, coastal plain provinces nestle around the Central Highlands and form a close-fitting sedimentary collar across much of the Florida Peninsula.

Geology "on Property"

Walt Disney World Resort, also known as Disney World or Walt Disney World (WDW) sits on approximately 27,000 acres (43 square miles or 110 square km) in Florida's Central Highlands. It is southwest of Downtown Orlando cutting across southwestern Orange and Osceola Counties. The property includes the municipalities of Lake Buena Vista and Bay Lake.

WDW is anchored by four theme parks which support two dozen hotels, water parks, golf courses, a campground, and almost every other type of family entertainment venue imaginable. All of this is connected via a complex infrastructure of access roads, buses,

TPG Student Edition



Research projects
Student experiences
Field Camp
Advice to Students

April-May-June
2024 Issue

Submission Deadline
February 1, 2024

Articles
Wanted

email articles to:
aipg@aipg.org

a monorail, and an aerial tramway. If you are “on Property” that means you are in one of the theme parks or staying at one of the hotels or traveling on one of the resort’s transportation systems. Almost 80,000 people work at WDW, which has an annual payroll and benefit spend of about \$1.7 billion. It is the largest single-site employer in the United States (Richwine, 2020).

Geology at Walt Disney World is simultaneously obvious and concealed. Many of the park’s rides and attractions have an unapologetic geology-related theme, while others often incorporate, unknowingly in a few cases, less obvious geologic features that still can be picked out if you look for them. The descriptions below provide several examples.

Magic Kingdom – The first of the four theme parks constructed at the resort, the Magic Kingdom covers 107 acres (43 ha), and its rides are based primarily on fairy tales, Disney movies, and Disney characters. Two attractions are geologically noteworthy inside the Magic Kingdom. *The Seven Dwarfs Mine Train* is an approximately 3.5 minute, mini-roller coaster which travels through underground workings where Snow White’s diminutive singing companions are extracting a variety of fluorescent minerals using techniques that violate numerous Mine Safety and Health Administration (MSHA) regulations. The degree of apparently natural occurring mineral fluorescence visible in this mine’s ores makes the Franklinite deposits in New Jersey look like fog obscured streetlights. Outside the underground workings, the coaster careens through massive sandstone. No bedding planes are visible within the sandstone, although a handful of fractures have been infilled (calcite?), and the faces of scattered outcrops are lightly oxidized.

Big Thunder Mountain Railroad, the most geologically interesting attraction in the Magic Kingdom, is an approximately four-minute roller coaster ride roughly based on the geology of Monument Valley. The back story of the ride describes how the mine opened but was later abandoned after an earthquake. Now the ore cars run unattended (Surrell, 2007). The variegated bedding of the sandstone and shale so recognizable to the rocks of the Colorado Plateau has been faithfully copied; however, MSHA likely would have a problem with the slipshod shoring and bracing visible throughout the underground workings. The interior portion of the ride gives the guest a quick view of a limestone cavern with stalactites and stalagmites and once again we see a startling array of fluorescent minerals. As an added geologic bonus, the coaster passes through the vertebrae of a fossilized dinosaur, complete with nearby cracked eggshell.

Hollywood Studios - Spanning 135 acres (55 ha), the Hollywood Studios theme park is focused on rides and attractions associated with movies, television, music, and theater. The not-so-hidden geology at Hollywood Studios is most prominently on display in the area known as Star Wars: Galaxy Edge. Guests entering this 14-acre portion of the park, which hosts two very popular rides (*Rise of the Resistance* and *Millennium Falcon: Smugglers Run*) pass through and underneath an impressively varved sequence of siltstone and mudstone. In other places within the Galaxy Edge area, these varved deposits are overlain and interbedded with massive, undifferentiated sandstone. Dominating the Galaxy Edge horizon, and occasionally forming protective concaves around the gift stands and spaceship displays, are vertically fractured metavolcanic spires which have punched up through the sandstone country rock (Figure 2). In places the extraterrestrial limestone and sandstone have been incorporated as building materials into foundations and walls of these structures.

Animal Kingdom – This part of WDW opened on Earth Day, April 22, 1998. Its 580 acres (230 ha) makes it the largest theme park in the world, and it is dedicated to and engaged with the natural environment and animal conservation. Virtual geology is



Figure 2. Volcanic spires penetrating sandstone country rock at Star Wars: Galaxy Edge in Hollywood Studios, Walt Disney World, Florida.

encountered in the Animal Kingdom via the *Avatar, Flight of Passage* ride. The key geologic features of this vertigo inducing five-minute ride include views of limestone sea stacks along a basaltic coastline. You then fly across riverine valleys connected by sandstone arches. Occasionally the sea stacks are pried loose via gravitational forces within the planetary system and can be seen as bunched, floating remnants. These hovering inselbergs are based on the Hanshan Mountain range in eastern China (Porges, 2017). The Hanshan Mountains, a World Heritage site, are granite massifs uplifted during Early Cretaceous and later Miocene orogenies that have been acted on by weathering and fluvial erosion to produce a spectacular, deeply incised morphology (Huang, et al., 2002).

For a non-virtual geologic experience, the approximately 10-acre Dinoland USA is clearly one of the best science-oriented attractions at WDW. The entrance to Dinoland USA has a museum-like feel to it with dinosaur skeletons presented in a variety of poses. These are accompanied by explanatory panels on each creature’s morphology and habitat. Within the indoor waiting area there are very professional displays of numerous fossils, big and small, cross sections of sedimentary rocks containing fossils, and a pre-show introduction proposing explanations for mass extinction events.

The main ride in Dinoland USA is *Dinosaur*, a time travel mission to the Cretaceous to save an iguanodon from extinction. Adjacent to the ride’s exit is Cretaceous Trail, a walking path/garden and character meet and greet venue that displays Late Mesozoic plant life. It also contains an example of a paleontological dig. A small playground (The Boneyard) is nearby which offers young children a chance to dig for fossils and burn off a bit of energy. Unfortunately, this geologically focused area will be closing. In May 2023, WDW announced that Dinoland USA will be repurposed to allow for the expansion of other Animal Kingdom experiences.

Wildness Lodge - No geologic tour of WDW would be complete without a visit to Wilderness Lodge, a hotel patterned after many of those at the U.S. National Parks. The main hall is dominated by the 82-foot (25 m) tall fireplace whose façade is made up of a geologically accurate cross-section of Grand Canyon lithology. The adjacent display case provides a brief description of each formation, including one or two lines about associated fossils assemblages. At the end of a short outdoor walkway, you can also look for the 120-foot (36 m) Fire Rock “Geyser”, which conveniently spouts on the hour.

Disney Springs – Two geologic venues are present at Disney Springs, the 120-acre (49 ha) shopping and entertainment center approximately five miles (eight km) southeast of the Magic



Figure 3. “Eruption” of composite cone volcano, Rain Forest Café at Disney Springs, Walt Disney World, Florida.

Kingdom. T Rex is a 600-seat restaurant that features interactions with animatronic dinosaurs and other early Cenozoic fauna in six specialty rooms (Ice Age Room, Jungle Room, etc.). A meteor shower occurs along the ceiling about every 20-minutes, parts of the bar in the lounge area occasionally burst into flame, and a 5,000-gallon (19,000 L) shark tank runs the length of the main dining hall. Eating there is an enjoyable, over-the-top, in-your-face, geologic experience. The entrance to the restaurant is guarded incongruously by a 70 foot (21 m) long replica of Apatosaurus, itself likely a favorite meal of the eatery’s ferocious namesake.

The other striking geologic feature at Disney Springs is the composite cone style volcano behind the Rainforest Café. After dusk, it catches your attention with a two-minute eruption every 30-minutes, with flames shooting tens of feet (meters) into the air and its numerous side fissures glowing a bright red (Figure 3). You can safely sit out the eruption in the restaurant’s lounge, which is a fairly accurate representation of a lava tube.

Discussion

Between 1955 and 1957, Disney produced four animated television documentaries focused on science and technology. The first three were about space travel: *Man in Space*, *Man in the Moon*, and *Mars and Beyond*, and included technical discussions with Wernher von Braun as well as other credible scientists about the physics and technological challenges of space travel. The fourth, which premiered in January 1957, *Our Friend the Atom* is widely credited with allaying public fears about nuclear power and helping to legitimize its use (Mechling & Mechling, 1995). All four shorts are available for viewing on YouTube and provide a unique glimpse into the public perception of science within the context of the Cold War and, with the launch of Sputnik in late 1957, the nascent Space Race.

These films evidenced Walt Disney’s strong commitment to ensuring that the entertainment products being created by his company were based on science fact, not science fiction (Telotte, 2005). This commitment continued through the development of

the Disneyland and Disney World theme parks, with such science-based attractions at EPCOT as *Awesome Planet* and *Mission Space*. Disney also integrates into its rides environmental themes including protection of endangered species (*Kilimanjaro Safaris* at Animal Kingdom), integrated pest management (*Living with the Land* at EPCOT), and the impacts of climate change (*Coral Reefs* also at EPCOT).

Lest we forget, Disney is an international, multibillion-dollar media and travel destination company, not an educational institution; although, as described in this article, it has taken the time and spent the money to effectively merge the two subjects across several of its entertainment platforms. While certain aspects of geology, especially vertebrate paleontology and volcanology, are well represented at the Florida theme parks, I feel that Disney has missed an opportunity to creatively incorporate into its guest experience more classical elements of the science.

The faux rock exposures inside the Galaxy Edge region of Hollywood Studios would be much more interesting if cross bedding, graded bedding, or other types of basic sedimentary features had been incorporated into their outcrops. Beast’s Castle (Magic Kingdom, Figure 4) sits atop what appears to be a uniform

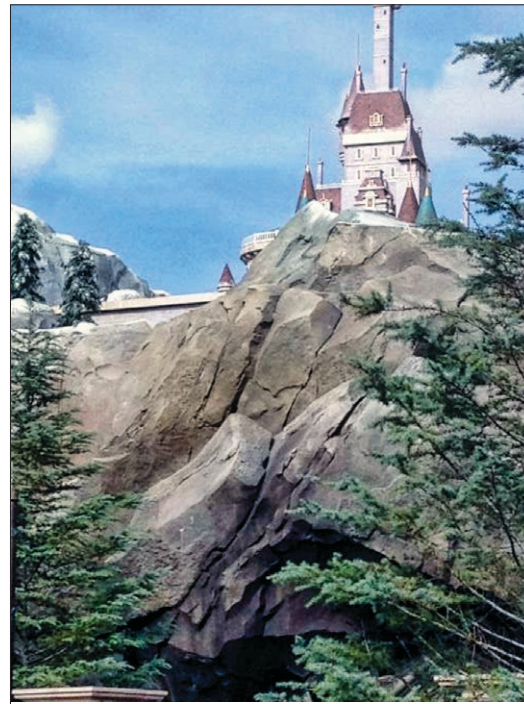


Figure 4. Beast’s Castle atop a rather bland fractured siltstone. Magic Kingdom, Walt Disney World, Florida.

and non-descript, fractured siltstone. To liven up this cliff-forming geologic setting (which is a key part of the movie’s final scene) Disney’s “Imagineers” could have added appropriate colors, converting the rather plain-looking siltstone to a livelier granite or basalt and even added a reverse fault, pegmatites, or columnar jointing. To be fair, at a few locations Disney has tried to spice up its geology – see description above for *Big Thunder Mountain Railroad* – including the sandstone outcrop which surrounds most of this ride and contains clasts and pseudo-bedding planes (Figure 5) on the following page.

Metamorphic rocks at Disney World are significantly underrepresented. Figure 6 (Tomorrowland, Magic Kingdom) shows a series of angular, overturned or upthrust slabs of perhaps



Figure 5. A bold geologic outcrop surrounds the *Big Thunder Railroad* roller coaster ride. Magic Kingdom, Walt Disney World, Florida.



Figure 6. Oddly colored metamorphic rocks at the entrance to Tomorrowland, Magic Kingdom, Walt Disney World, Orlando, Florida.

schist or gneiss, although for some strange reason they have been painted purple. A rock mass with anticlinal or recumbent folds, boudinage, or angular unconformities would certainly catch the eye and present a more dramatic sense of the forces at play within the planetary crust.

Looking at and pondering how the geology on display at Disney World could be enhanced or re-presented in a more dramatic fashion is not a bad way to spend queuing time. Many of the resort's attractions could be enriched by the inclusion of common geologic characteristics illustrating earth processes and these would be complementary to the guest experience. Costs for adding these features probably are incremental during construction but likely prohibitive to retro fit. Consultation with any established geologic organization at the planning stage would yield a variety of useful suggestions and concepts. Indeed, the Florida Geological Survey has a robust and in-depth understanding of local and regional geology that could be productively accessed by Disney; granting that any near-term, pre-election interactions between the two organizations might be awkward.

References

- Applin, Paul L., 1951. *Preliminary Report on Buried Pre-Mesozoic Rocks in Florida and Adjacent States*. United States Geological Survey, Geological Survey Circular 91. <https://pubs.usgs.gov/circ/1951/0091/report.pdf> (accessed July 2023).
- Bostick, Kyle W., Shelly A. Johnson, and Martin B. Main. 2018. Florida's Geologic History: WEC189/UW208, Rev. 11/2018. EDIS 2018 (6). <https://doi.org/10.32473/edis-uw208-2018>. Accessed July 2023.
- Cawood, P.A., and Pisarevsky, S.A. 2017. *Laurentia-Baltica-Amaozonia relations during Rodinia assembly*. *Precambrian Research*, 292, 386-397. <https://doi.org/10.1016/j.precamres.2017.01.031> (accessed July 2023).
- Huang, Pei-Hua; Diffendal, Robert F.; and Yang, Ming-Qing. 2002. *Structural and Geomorphological Evolution of Huangshan (Yellow Mountain), Anhui Province, China*. *Papers in Natural Resources*. 120. <https://digitalcommons.unl.edu/natrespapers/120> (accessed July 2023).
- Lane E., (ed.) 1994. *Florida's Geologic History and Geologic Resources*. Florida Geological Survey Special Publication, V 35, p. 64.
- Mechling, Elizabeth Walker and Jay Mechling. 1995. *The atom according to Disney*, *Quarterly Journal of Speech*, 81:4, 436-453, DOI: 10.1080/00335639509384128 (accessed July 2023).
- Miller, J.A., 1986. *Hydrogeologic Framework of the Floridan Aquifer System in Florida and in parts of Georgia, Alabama, and South Carolina*: United States Geological Survey Professional Paper 1403-B, 91 p.
- Porges, Seth. April 26, 2017. "Everything You Need to Know About Disney's New 'Avatar'-Themed Land". *Forbes*. Retrieved April 27, 2017.
- Richwine, Lisa (July 12, 2020). *Mandatory masks, Mickey at a distance as Walt Disney World reopens*. REUTERS.
- Surrell, Jason. (2007). *The Disney Mountains: Imagineering at Its Peak*, pub. Disney Editions, New York, 2007. pp. 60-75.
- Telotte, J.P. 2005. *Disney in Science Fiction Land*, *Journal of Popular Film and Television*, 33:1, 12-21, DOI: 10.3200/JPFT.33.1.12-21 (accessed July 2023).
- Zhao, G.C., Sun, M., Wilde, S.A., and Li, S.Z., 2004. *A Paleo-Mesoproterozoic supercontinent: assembly, growth and breakup*. *Earth Science Review*. 67, 91-123. <https://doi.org/10.1016/j.earscirev.2004.02.003> (accessed July 2023).

Gold and Silver Vein Deposits in the Sierra Madre Occidental, Mexico

Francisco Pedro Cruz Frisby, CPG-11977

Abstract

I remember a movie called "Treasure of the Sierra Madre" and that gave me the idea to use my 15 years' experience working for several companies in different places in the states of Sonora, Chihuahua, Durango, and Nayarit to write a paper about the many gold & silver veins, that have been discovered in the western Sierra Madre of Mexico since the arrival of the Spaniards in the 16th century.

These gold & silver veins are almost exclusively hosted by intermediate volcanic rocks of the Lower Volcanic Complex (LVC). These host rocks are mainly andesite flows, andesite tuff, dacite tuff, volcanic breccias and andesite agglomerates; also, lithic tuff forms part of the complex.

The Sierra Madre is one of the biggest fields of felsic volcanic rocks in the world, it is more than 1,200 km long north to south and 150 to 200 km wide west to east. The Sierra Madre Occidental is composed of two major packages of volcanic rocks. The rocks of the LVC formed in a magmatic arc related to a subduction zone on the Pacific side that slowly migrated eastward and is considered to be of late Cretaceous to early Tertiary age. This calc-alkaline package can have a thickness of more than one km and has been intruded by granodiorite stocks and granitic batholiths of Laramide to early Tertiary age.

In Oligocene time the tectonic stresses reversed from compression to extension and provoked the eruptions of the Upper Volcanic Series (UVS). The UVS was formed in mid Tertiary time by the eruption of hundreds of calderas of various sizes, but all composed mainly of ash flows, ignimbrites, rhyolite tuffs and sub-volcanic domes (Swanson & McDowell, 1984).

Mineralized structures are normally tabular fissure-veins deposits with typical mineralization of quartz, calcite, sulfides, and oxides near surface. Veins are commonly formed in association with normal faults with some lateral displacement. Mineralization in the Sierra Madre occurs as polymetallic epithermal low sulfidation veins bearing Au-Ag-Zn-Pb-Cu.

Veins have widths of 0.5 to over 10 meters (occasionally they can be tens of meters in the intersection of structures) and their lengths range from one to five km. Some mine operations report depths of more than 500 meters in vertical extent of the veins. Nearly all veins have underground (UG) mining operations.

Throughout the Sierra Madre, especially in the state of Chihuahua, there are mines with multiple veins or vein arrays located near- surface: these have been mined by open pit methods as well as underground methods.

Gold & Silver veins in the Sierra Madre Occidental

Some features of the Sierra Madre Occidental.

Elevation ranges from 2,000 to 3,000 meters above sea level on average. The Sierra has the morphology of a tableland that has been cut by deep canyons to expose older rocks of the lithology column.

These older rocks are the host for mineralization emplaced as fissure veins. It is important to note that we have mineralization in other types of deposits like skarn, high sulfidation and flat veins in intrusive rock, but those types are just a few in comparison with the abundant epithermal veins.

Epithermal low sulfidation Au-Ag veins with base metal credits are being successfully, responsibly, and profitable mined by Mexican, Canadian, and American companies.

In the Sierra Madre Province, we have mines with long periods of operation and large quantities of mineral production. For example, the Tayoltita mine in southwest Durango is reported to be one of

the major gold and silver producers with over 745 million ounces of Ag and 11 million ounces of Au. Tayoltita mine was operated for a long time by San Luis Mines, then by Goldcorp for approximately a decade and is now operated by First Majestic Silver.

Of course, there are other mines with more than a million ounces of gold in this province; including Cienega de Nuestra Senora in the state of Durango operated by Fresnillo PLC in an operation started in 1994. Another good example is Batopilas mining district in Chihuahua, with historic production of 300 million ounces of silver in the last century and is now being explored by a Canadian junior company.

The study area is divided into three parts to facilitate deposit locations (Fig. 1), and the characterizations of each area are given below.

North part of the Sierra Madre:

The low sulfidation deposits in this northern area of study are in Chihuahua state. (Figure 2 on page 12)

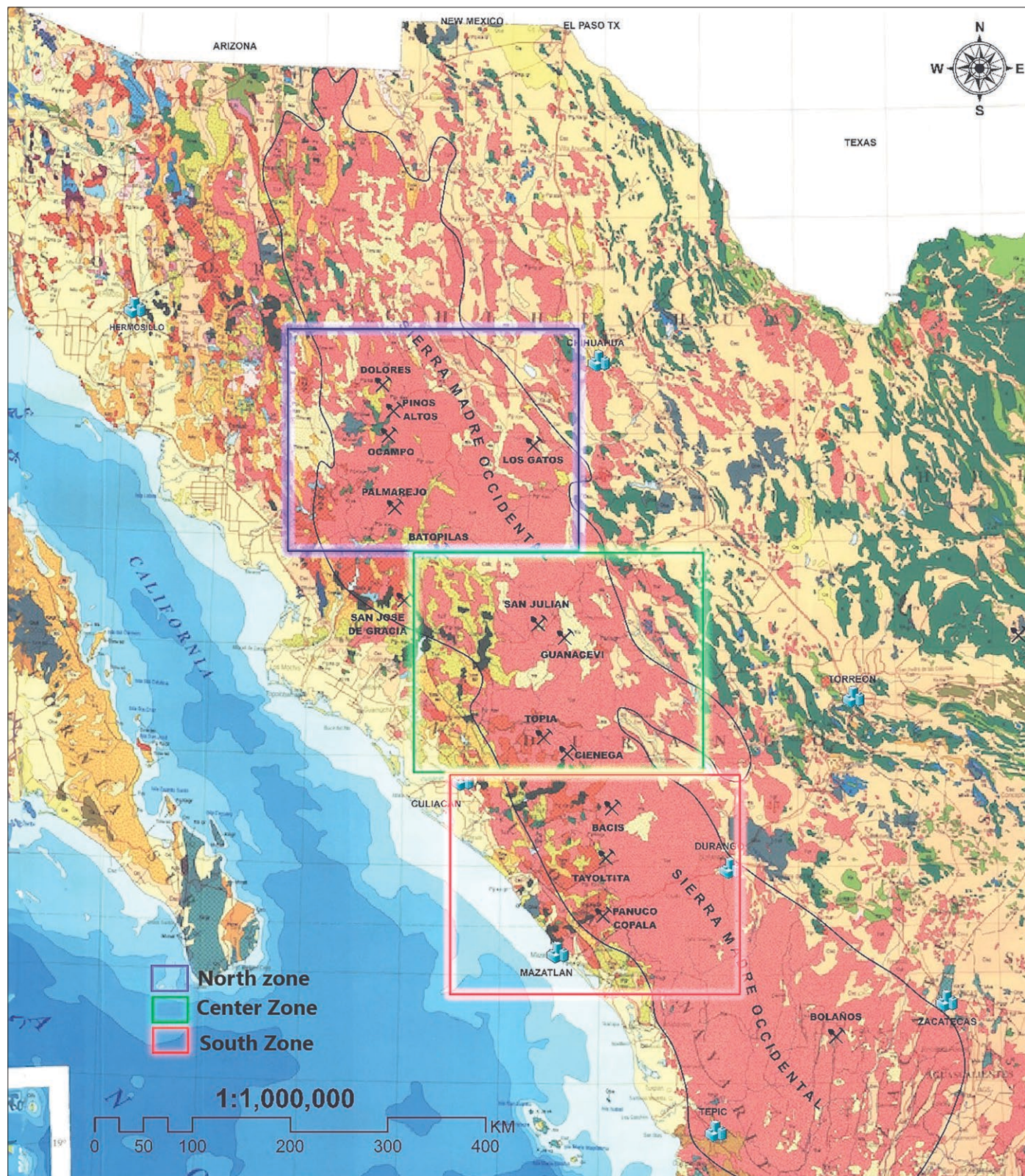


Figure 1. Geology map of the NW of Mexico (Servicio Geologico Mexicano). The study area is outlined in black, and deposits mentioned in the text are labeled with a mine symbol and their name in black upper-case letters.

A. Dolores Mine

This deposit is the northmost operation in Chihuahua and it is being mined by the company Panamerican Silver. It was developed by the company Minefinders in the 90s. By 2001, Minefinders reported reserves and resources of 101 Mt at 0.84 g/t Au and 40.8 g/t Ag.

The host rocks of the mineralization are andesite and latite flows of Eocene age. Quartz veins, stockworks and hydrothermal breccias carry gold and silver plus pyrite, sphalerite, and galena. The average grade for gold is 0.5 ppm and silver grades 50 ppm. (Apodaca V. Jorge, University of Sonora 2016).

The principal veins, faults and dikes are oriented to the northwest. At the time of the Apodacas report, Dolores mine was mining 18,000 tons per day (t/d) of mineral and 82,000 t/d of waste in an open pit operation.

B. Pinos Altos Mine

This property was a combined open pit and UG operation when mining operations were begun in 2009, by Agnico Eagle. It was this company's first operation in Mexico. In 2007 they reported 20 Mt at 3.47 g/t Au and 102.3 g/t Ag (Agnico Eagle web page).

Presently, the mine has only UG operation in the deep portion of the rich set of veins of the Santo Nino system, which is up to 40 meters thick and 2.5 kilometers long, striking northwest. At the present time the gold grade is 2.05 g/t and silver grades 50 ppm, but grades were higher at the beginning of operation.

One characteristic of this deposit was the presence of greenish quartz associated with high grade ore. Mineral production of mineral is 4,500 t/d and the mine has proven reserves of 750,000 ounces of gold.

C. Ocampo Mine

The mineralization in Ocampo was discovered in the mid-18th century, and it became an American-populated town for more than 30 years, until the Mexican revolution stopped all activity in 1910. The locality was abandoned for many years but in 1995 an Australian company, Mogul Mining PLC began exploration that was taken over by the Canadian company Gammon Lake Resources Inc. who built an UG and open pit mine in 2005 with proven reserves of more than 2 M ounces of equivalent gold, that is 39.3 Mt at 1.46 g/t Au and 61 g/t Ag (Oscar Gonzalez, Thesis University of Sonora 2010).

The Mexican company Minera Frisco acquired the property in 2013, and one of its reports in 2018 says the underground production was 1,500 t/d with grades of 3.5 g/t Au and 230 g/t Ag. All veins (quartz breccias, stockwork and fault veins) trend northwest and are hosted by LVC andesites.

In 2012, Minera Frisco opened another mine named Concheno located 20 km northeast of Ocampo. This property was an open pit operation of 20,000 t/d at the beginning. In the last couple of years, they have started UG operations, mining 6,000 t/d with average grade of 1.7 g/t Au. Mineralization is in a fault zone and quartz breccias trend northwest and are hosted by the same LVC andesites.

D. Palmarejo Mine

The deposit was discovered by Spanish miners in the 17th century with small old workings. In the late 19th century, minor scale underground mining was conducted by various companies. Many companies have since conducted exploration on this site including, Luismin SA, Mexican Gold Fields, Kalahari Resources, SSR, Alaska J Mining Co., ASARCO, Industrias Penoles, Noranda, Kennecott, etc. The modern discovery was made by Palmarejo Silver and Gold Corp in 2003.

Historic principal veins were La Blanca and La Prieta. Both veins were rich in silver (acanthite, native silver, and electrum) with base metal mineralization going deeper in the veins (galena, sphalerite, pyrite). All veins were striking to the northwest and were hosted by LVC andesites.

Coeur Mining acquired the property in 2008 and opened an UG and open pit mine in 2009, with estimated reserves of 14 Mt at 2.1 g/t Au and 190 g/t Ag (Oscar Gonzalez, Thesis University of Sonora 2010).

Open pit mining operations ceased in 2016 and the company opened three UG mines near the Palmarejo mine. These operations include the Guadalupe mine in 2014, Independencia mine in 2016 and La Nacion mine in 2019.

In 2021, Coeur reported Measured and Indicated (M&I) resources of 19.1 Mt at 1.70 g/t Au and 120 g/t Ag (Palmarejo Operations Technical Report Summary 2021). Current production is 5,500 t/d.

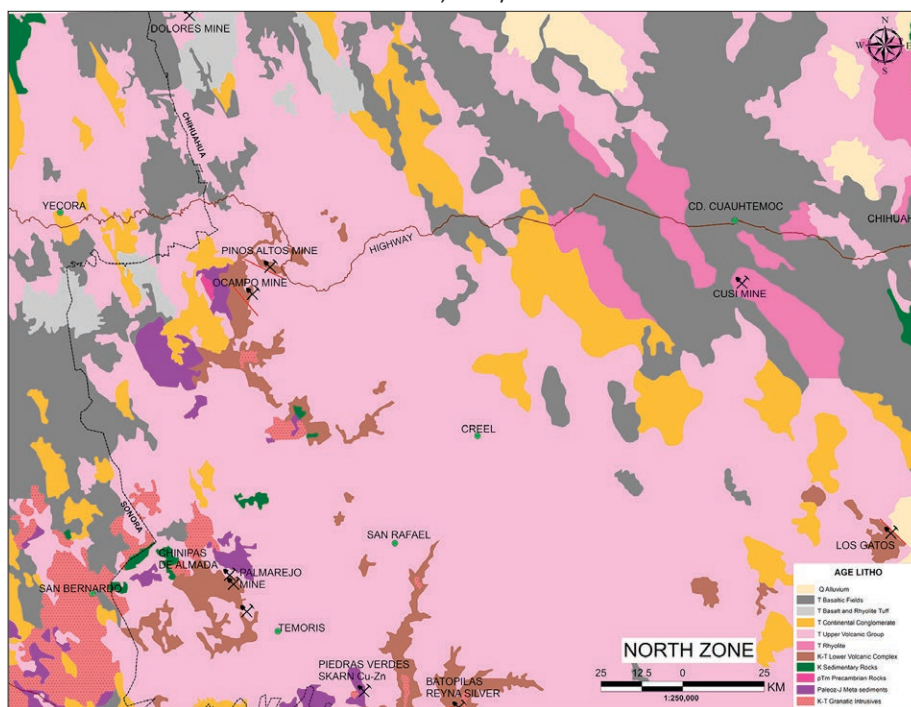


Figure 2. Simplified geology of the Northern Sierra Madre Occidental (Cartas Geológicas 1:250,000 of the Servicio Geológico Mexicano).

E. Monterde Project

Located 35 kilometers northeast of Palmarejo, this low sulfidation gold/silver project was explored for around 15 years by the junior company Kimber Resources. The property has old workings, levels, and stopes mined out by small companies during World War II.

Structurally controlled veins and breccias striking to the northwest are hosted in volcanic rocks of intermediate composition, more commonly with crystal lithic tuffs and tuff breccia. Mineralization consists of acanthite and electrum in the upper portion of the veins; galena and sphalerite are observed at depth.

F. Batopilas Project

Discovered in the 17th century, Batopilas is a unique silver deposit in the Sierra Madre. It is in the bottom of a canyon near the town of Satevo, Chihuahua. In spite of the fact that the deposit is close to a reported porphyry system, some geologists link the mineralization to an epithermal system. Silver mineralization is pure native silver emplaced in calcite veins that are trending to the northeast; veins are hosted by intrusive and LVC volcanic rocks with an uncommon chlorite/actinolite alteration in the wall rock (Wilkerson et al. 1988, Batopilas Mining District, Chihuahua, Mexico. Economic Geology Vol 83).

Phelps Dodge drilled the property in the mid-1990s especially on the west side of the property, in a zone called Corralitos over strong oxidized intrusive rocks related to a copper porphyry system. Batopilas produced 300 M oz of silver in Spanish colonial times and in the late 19th century. Today, one junior company is exploring the mining zone.

G. Los Gatos Mine

A new underground mining operation has started in Los Gatos in the last few years: it is located 120 kilometers south of the city of Chihuahua. This epithermal deposit is composed of several polymetallic veins with silver grading about 244 g/t with base metal values of 4.5% Zn and 2.14% Pb. Gold is grading 0.27 g/t. Mineralized structures trend to the northwest and are hosted by LVC andesites and dacites.

Last year production was 17.1 M oz of silver equivalent and mill throughput of 2,850 t/d. (Gatos Silver Inc. BMO Global Metals, Mining & Critical Mining Conference. February 2023).

H. Cusi Mine

The deposit was discovered in 1687 by Spanish miners and is located 15 kilometers south of Ciudad Cuauhtemoc, Chihuahua. Production data since Spanish time to 1910 was of 35.3 M oz of silver (Cortes M.R. 1971. Posibilidades minerales del área Cusi-huirachi, Chih. Thesis National Autonomous University of Mexico UNAM).

Modern mining was carried out for about 20 years by the Cusi Mining Company from 1924 to 1942, the report says the production was 7 M oz of silver during this time.

The Cusi mine zone consists of several silver veins oriented to the northeast that intersect with a single large regional fault oriented to the northwest named the Cusi fault. Originally, almost all mining activities were developed in the northeast oriented veins (Promontorio, Sta Eduwiges, Minerva, etc.) hosted in the lower volcanic complex. But, in recent years one new vein was found at depth parallel to the Cusi fault. It

is called Santa Rosa de Lima; this vein provides the present production.

The Cusi mine is operated by a company named Sierra Metals by underground methods and they produce 1,200 t/d with grades of 180 g/t Ag, 0.5% Pb and 0.6% Zn. (Sierra Metals Inc. web page).

Central part of the Sierra Madre:

The low sulfidation deposits in this central area of study are in Durango state, Chihuahua state and a few in the eastmost side of Sinaloa. (Figure 3 on page 14)

A. San Jose de Gracia

Located about 100 kilometers east-northeast of the city of Los Mochis, Sinaloa. This gold mine has several quartz breccia veins striking to the northeast and hosted by andesites of LVC in a very close contact with thin bedded deformed meta-sediments (Paleozoic age?). The veins can have widths of 0.5 to 1.5 meters and extend for hundreds of meters. Mineralogy is described as native gold on fresh pyrite on quartz-calcite gangue. Other minerals include chalcopyrite, galena, and sphalerite.

One company, Dyna Resources, has been operating the property for 20 years; in 2018 they were milling 200 t/d with grades of 7.0 g/t Au and 10.0 g/t Ag. Apparently, they recently increased production to 500 t/d. San Jose de Gracia reported historical production of more than one million ounces of gold before the Mexican revolution in 1910.

B. San Julian

Located exactly on the border line between the states of Chihuahua and Durango, it is in the middle of the Sierra Madre Mountain Range. Mineralization is exposed in a small window of LVC andesites and dacites that are hosting northeast trending quartz veins; the old mine was worked by miners like Mr. John Marshall in the middle 1800s and this mineral district was explored in the last century by the Consejo de Recursos Minerales, who sold the property to Fresnillo PLC.

Fresnillo continued exploring and discovered a huge gold-silver epithermal deposit. The preparation and development of this was carried out in the following years and production began in 2012. Today, the mineralization is split in two systems: one is the vein system itself, which produces 3,500 t/d with grades of 1.5 g/t Au and 120 g/t Ag. The second system comprises a disseminated quartz stockwork deposit which produces 6,000 t/d with grade of 0.1 g/t Au, 250 g/t Ag, 0.5 % Pb and 1.3 % Zn. All production is mined by underground methods.

C. Guadalupe y Calvo

This is a historic mining district located 50 kilometers west of San Julian and it is the biggest town in this part of the Sierra Madre. The past production reported is 2.0 million ounces of gold and 28.0 million ounces of silver (Ridgestone mining web page). Several junior mining companies have explored in this area in the last 25 years: Glamis Gold, Gammon Lake Resources and Endeavour Silver. Their drilling totals more than 50,000 meters.

The quartz breccia veins are trending to northwest inside the Rosario fault complex, where LVC andesites exposed in a small window are the mineralized host rock.

D. Topia

This is a very old mining district worked since Spanish times, it is in the heart of the mountains of Durango state. Mineralization consists of many quartz veins striking north-east with some lengths up to 2.4 kilometers and depths of 480 meters below surface. The veins are hosted by LVC andesites and one intrusive body of granodiorite. Narrow veins are rich in base metals and silver and have widths of 0.3 to 1.5 meters.

In the 1950's Peñoles Company operated the mines Saltaranas, Argentina y Veta Madre for several decades; but beginning in this century the property was worked by the Canadian junior company Great Panther that exploited about 300 t/d grading almost half a kilogram of silver. Recently there is a new owner, Guanajuato Silver who is producing 260 t/d at 600 g/t Ag and 1.3 g/t Au.

(Fco. Jose Abril M., Geología regional y yacimientos minerales del área Topia-Canelas en el estado de Durango Mexico. Thesis University of Sonora 2001.)

The last information provided by the company web page, shows a production of 4,000 t/d with grades of 150 g/t Ag, 1.2 g/t Au, 0.5% Pb and 1.0% Zn.

The initial gold grades on this property were better than those available today, with average grades up to 3.0 g/t, but silver values have been very consistent.

F. Guanacevi

Located in the east flank of the Sierra Madre in Durango state, this historic mining district was discovered by the Spanish in 1525 and was the main silver producer in Nueva España for the entire 16th century. The supply of mercury necessary for the refining process ran out and mining activity thus had many up and downs in the 17th and 18th centuries. Mining of high silver grades continued sporadically until the revolution in 1910, and for the last century Guanacevi was worked by small Mexican mining companies. Historical production is reported to be 500 million ounces of silver.

In 2004, Endeavour Silver purchased the property and started mining the principal vein in the district called Veta Santa Cruz which extends for more than 5 km and has an average width of 3 meters. The vein is hosted in LVC andesites and strikes to the northwest. At the present time, the company produces 1,200 t/d at 465 g/t Ag and 1.3 g/t Au. Source: Endeavour Silver web page, edsilver.com/portafolio/operations/Guanacevi 2023.

G. Tahuehueto

This advanced project is in the mine construction stage. It is located 25 kilometers north of Topia in an area of deep canyons and steep mountains within the Sierra Madre.

Mineralization consists of several polymetallic epithermal quartz-calcite veins hosted by LVC andesites. Brecciated ore structures show multiple mineralizing events with strong oxidation in the upper portion of the veins producing malachite, azurite, limonite, and hematite. Sulfide mineralization in the lower portion of the veins consists of sphalerite, galena, chalcocite, and tetrahedrite (Luca Mining Corp web page, former Altaley Mining).

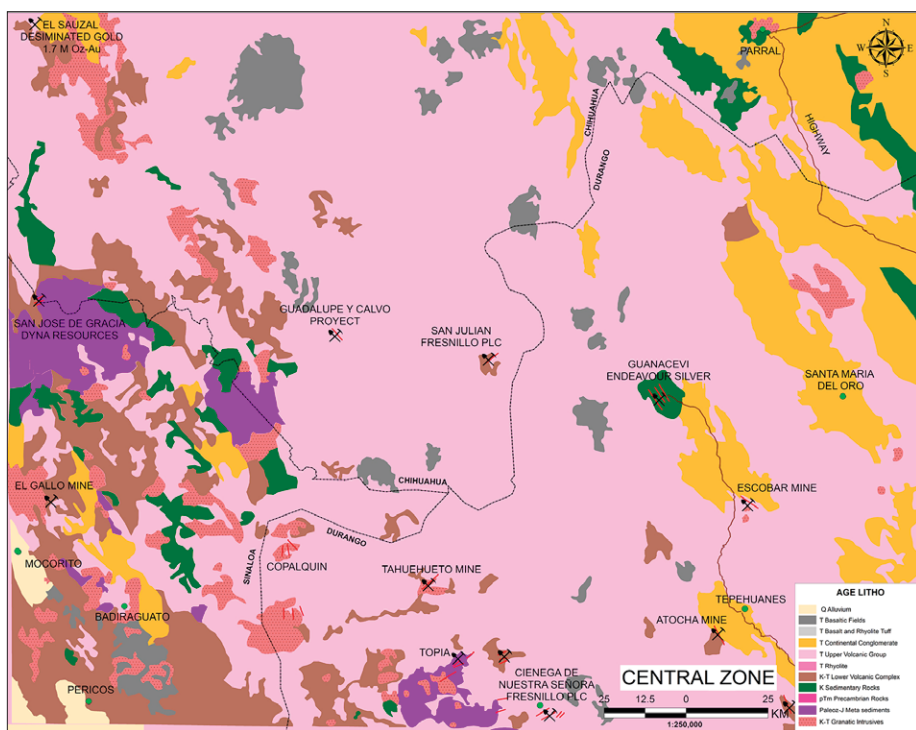


Figure 3. Simplified geology of the central part Sierra Madre Occidental (Cartas Geologicas 1:250,000 of the Servicio Geologico Mexicano).

E. Cienega de Nuestra Señora

This large gold-silver mine is situated about 25 km east of Topia. It was discovered by Peñoles company in the 1980s (now Fresnillo PLC) and production started in 1994. Mineralization is comprised of several quartz veins trending to the northwest and northeast and hosted by LVC andesites exposed in a small window. Polymetallic ore is also present and recovered. The main vein called La Cienega is 3.6 km in length, and it has width of 4.0 meters; mineralogy mainly includes quartz, pyrite, sphalerite, galena, acanthite and tetrahedrite.

The owner of Tahuehueto is the Luca Mining Corp. and last table of M&I Resources shows 6.3 million tons of mineralization averaging 2.11 g/t Au, 46.9 g/t Ag, 0.27% Cu, 0.90% Pb, and 1.98% Zn.

The company is currently nearing completion of construction of a 1,000 t/d mill for UG operation, they are building all facilities and have all the financing necessary to start a new mine very soon.

H. La Sorpresa

Located less than 20 kilometers south of Cienega de Nuestra Señora, la Sorpresa mine is an UG operation working several quartz fissure veins bearing gold and lesser amounts of

silver. Mineral structures are hosted in typical LVC andesites and volcanics.

The mine belongs to a private Mexican company, and it is now in care and maintenance. No public information is available.

Southern part of the Sierra Madre:

Very important epithermal deposits are in this area of study, and the principal gold-silver mine is Tayoltita in Durango state. (Figure 4)

A. Tayoltita

Tayoltita has produced 745 million ounces of Ag and 11 million ounces of Au since mining began (Erme Enriquez et al. 2018: Tayoltita low-sulfidation epithermal Au-Ag district, Durango and Sinaloa.). The mining district is located around 120 kilometers westward from Durango City. Tayoltita mine has more than 100 km of underground mine workings.

This gold and silver mining district has a large number of quartz veins trending mainly north-east. They are hosted principally by LVC andesites, but some veins are hosted in the granodiorite intrusive that outcrops along the Piaxtla river. Normal faulting is very strong with clear orientation to the north and northwest and forms several horsts and grabens. The veins predate the faulting.

Mineralization in this very rich deposit contains native gold, electrum, acanthite, and native silver. Minerals like chalcopyrite and galena are present but rarer. Sphalerite is less rare. Gangue minerals in the vein include calcite, barite, rhodonite, adularia and three types of quartz.

First Majestic Silver is currently operating the mine. Production is 2,500 t/d, with average grades of 3.5 g/t Au and 300 g/t Ag.

B. Bacis

Another old mine discovered by Spanish in the 17th century, it was also owned by English miners from 1900 to 1938. Since 1943 the mine has belonged to a private Mexican company.

Mineralized structures strike northwest and are hosted by LVC andesites in close proximity to an underlying deformed thinly bedded meta sedimentary rock unit.

Current production is 2,000 t/d with grades of 2.5 g/t Au and 350 g/t Ag. Very little information is available on this mine because of the private ownership.

C. Panuco- Copala

Another mining district of epithermal gold and silver mineralization is in Sinaloa State, very close to the highway between Mazatlan and Durango city.

Viszla Silver Corp has been executing a strong drilling campaign for the last three years and has completed over

250,000 meters of drilling. They report 105 M oz Ag eq (Silver equivalent) of M&I resources and 114 M oz of inferred resources. The long extension of quartz veins (tens of kilometers) is hosted by LVC andesites.

Conclusions

The mines in the Sierra Madre Occidental in Mexico have produced more than 24 million ounces of gold, plus 2,000 million ounces of silver. This mineralization is epithermal of low-intermediate sulfidation and emplaced as veins hosted by andesites and dacites of the Lower Volcanic Complex.

The potential still is very favorable and new discoveries wait in future years.

References

Apodaca V. Jorge, *Actividades en el area de produccion y exploración Compañía Minera Dolores SA de CV*. Thesis University of Sonora 2016.

Agnico Eagle web page.

Cortes M.R. 1971. *Posibilidades minerales del área Cusihuiriachic, Chih.* Thesis National Autonomous University of Mexico UNAM.

Endeavour Silver web page, www.edrsilver.com/portafolio/operaciones/Guanaceví 2023.

Fco. Jose Abril M., *Geología regional y yacimientos minerales del área Topia- Canelas en el estado de Durango Mexico*. Thesis University of Sonora 2001.

Fresnillo PLC web page.

Gatos Silver Inc. BMO Global Metals, Mining & Critical Mining Conference. February 2023.

<https://atlasmateriaprima.net/Carta-Geologica-de-Mexico>.

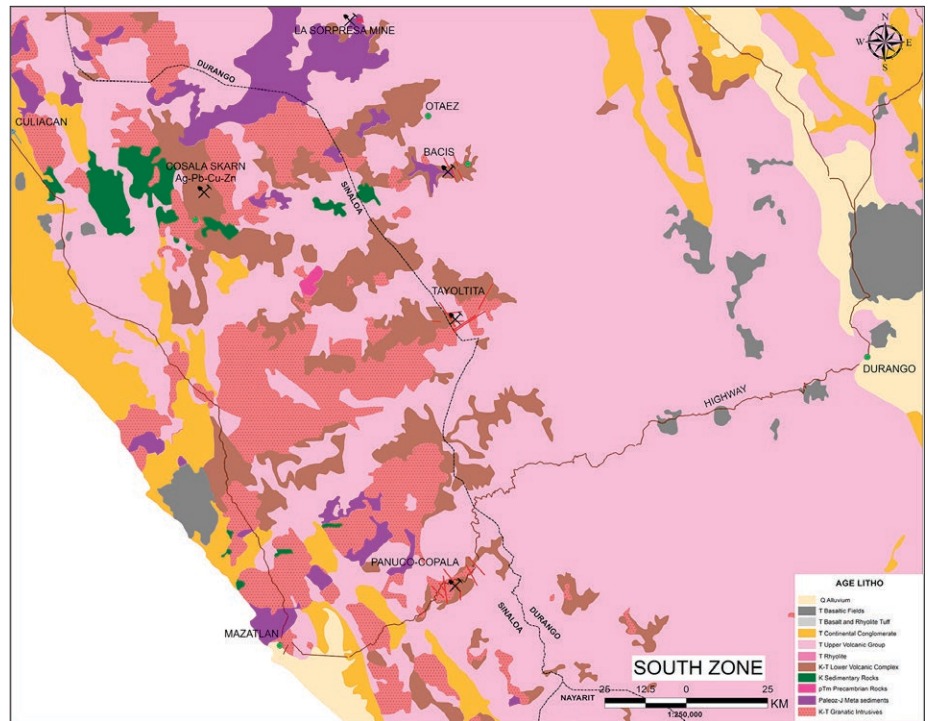


Figure 4- Simplified geology of the southern Sierra Madre Occidental (Cartas Geológicas 1:250,000 of the Servicio Geológico Mexicano).

https://mapserver.sgm.gob.mx/Cartas_Online/geologia.

Luca Mining Corp web page/projects/Tahuehueto 2022.

Oscar A. Gonzalez Peña, *Características principales de los depósitos epitermales en el NW de Mexico, un análisis y comparación*. Thesis University of Sonora 2010.

Palmarejo Operations Technical Report Summary 2021.

Ridgestone mining web page.

Sierra Metals Inc. web page.

Tayoltita low-sulfidation epithermal Au-Ag district, Durango and Sinaloa. Erme Enriquez et al. 2018.

Viszla Silver Corp web page.

Wilkerson et al. 1988, Batopilas Mining District, Chihuahua, Mexico. *Economic Geology* Vol 83.



AIPG Wants Your Unwanted Geology Textbooks, Geology Maps and Other Books About Science and Nature

Do you have overflowing bookcases?

Piles of geologic maps?

Feel like doing some spring cleaning or looking for a good home for your unwanted textbooks and coffee table books?

AIPG wants to help you reduce, reuse, and recycle!

AIPG has a long history of partnering with a public university in Hermosillo, Sonora (Mexico) to help them populate a library for their geology students. Books on any discipline related to geology, chemistry, hydrogeology, engineering geology, environment... you name it and if it's related to natural sciences, it can be useful. The department would also be very appreciative of maps and field guides. The books can be in English (and of course books in Spanish are also useful!). The geology students are encouraged to have a working knowledge of English, which is a big boost in their future careers.

What are the logistics of donating books and maps? You would need to ship materials to Tucson, Arizona. The US Postal Service has a special book rate called "Media Mail". The cost is based on weight and the cost can be calculated at postcalc.usps.com. For example, a 12-inch square box weighing 10 pounds costs about \$10 to ship from Illinois to Arizona. AIPG will sort, organize, and arrange transport to Mexico.

To make a donation of materials, please contact the AIPG headquarters (email aipg@aipg.org or call 303-412-6205).

"A mind needs books as a sword needs a whetstone, if it is to keep its edge."

George R.R. Martin

Thank You!

A big thank you to the individuals who have generously donated books and maps already listed below. These contributions will be very appreciated by the geology students and professors at UES! I hope we caught the names of all who have donated and apologize for any errors or omissions.

Bob McCusker, CPG-11684
Robert Blauvelt, CPG-06508
William Toomey, CPG-10651
Stephanie Earls

Tom Timmermans, CPG-11757
Marty Evans, CPG-08164
Al Kampmeyer, CPG-08140
David Brown, CPG-07130

-Dawn H. Garcia, CPG-08313

Minimizing Risk and Uncertainty in Humanitarian Efforts

Robert K. Merrill, CPG-4984

Abstract

When environmental hardships and natural hazards confront communities, geoscientists create solutions, including: managing groundwater; securing sustainable food sources; preparing for earthquakes, volcanic eruptions, landslides, and tsunamis; reducing pollution; and saving unique, irreplaceable, and culturally valuable archaeological sites. Geoscientists' knowledge and technology allow them to deliver vital humanitarian relief to communities coping with global environmental crises. Scientists and their teams come together to solve critical challenges, collaborating with multidisciplinary experts, community leaders, and local partners, applying geoscience skills where most needed to build sustainability.

Geoscientists *without Borders*[®]

A 2008 visit to Bangladesh inspired me to consider how a geosciences background can help solve global humanitarian crises. Visiting several villages, the critical need for access to potable water in local communities was apparent. This experience reinforced the necessity of engaging local communities as part of the solution to humanitarian challenges. About five years later, I became aware of the Society of Exploration Geophysicists (SEG), Geoscientists *without Borders*[®] (GWB) program and immediately recognized that a global humanitarian program like GWB would provide a pathway for geoscientists to apply their skills and provide humanitarian relief for communities in need. In 2015 I joined the SEG GWB Steering Committee to evaluate humanitarian project proposals for funding.

History of GWB: GWB emerged from the December 26, 2004, magnitude 9.3 earthquake and the subsequent tsunami in the Indian Ocean. The disaster claimed 227,000 lives in 14 countries. Several SEG members asked themselves how to use their knowledge and skills to aid communities facing such dangers. In 2008 Schlumberger donated an initial \$1 million USD to the Society of Exploration Geophysicists Foundation (SEGF), a 501(c)3 not-for-profit charitable organization, which was combined with additional corporate and individual donations¹, and the Geoscientists *without Borders*[®] humanitarian program was launched.

GWB's initial grants, in 2008, advanced projects addressing water management decisions in India, tsunami destruction in Sumatra,

locating sustainable water sources in Honduras, and surveying archaeological sites in Thailand. Each year since then, GWB has continued to support humanitarian efforts and build sustainable communities confronted with challenges in water management, pollution mitigation, archaeology, and natural hazard preparedness in some of the remotest locations, like Timor Leste.

GWB Projects: a Collaborative Effort

Each GWB-sponsored project identifies its participants and partners before submitting a funding request. GWB requires that each project include local partners to be eligible for funding. This becomes a collaborative effort through contact and negotiation with local communities, nonprofit organizations, higher education institutions (colleges and universities), and local, regional, and national governments. For example, GWB's past Uganda Water, Sanitation, and Hygiene (WASH) project partners included the University of Calgary, IsraAID, Worley Parsons, and the Kenyan Water Institute (https://seg.org/gwb_projects/uganda/). In Peru, a GWB-sponsored project involved the community of Zurite in Cusco, Peru, Humboldt State University, Rutgers University, Engineers without Borders in the USA, and Universidad Nacional de San Antonio Abad de Cusco (https://seg.org/gwb_projects/peru-2). Figure 1 is a photo of the Ramuschaka watershed in Zurite, Peru, where the team is preparing a geophysical survey.

An excellent example of collaboration in a GWB-sponsored project is the "WAVES Java Project" (https://seg.org/gwb_projects/java-

1. Other corporate supporters have joined this contribution, including CGG SA (La Compagnie Générale de Géophysique), Baker Hughes ConocoPhillips, Geophysical Pursuit Inc., Global Geophysical Services Inc., KiwiEnergy Ltd, Petroleum Geo-Services, Santos, and hundreds of individual donors. Partnerships and supporting societies include the American Association of Petroleum Geologists Foundation, the American Geosciences Institute, the Environmental and Engineering Geophysical Society, and The Geological Society of America.



Figure 1. Preparing a geophysical survey in the Ramuschaka watershed, Zurite, Peru.



Figure 2. Tsunami project team mapping beach rock slabs deposited by a tsunami (photo by Ron Harris).

[indonesia-tsunami/](#)) Collaborators in this project include Brigham Young University, Utah Valley University, Universitas Pembangunan Nasional, APMD Indonesian Institute of Community Development, BPBD – Indonesian Government Disaster Mitigation Agency, Lembaga Ilmu Pengetahuan Indonesia, and the Indonesian Institute of Science. The project aims to ensure that a similar scenario to the 2004 Indian Ocean disaster does not reoccur in Java. Figure 2 shows a beach with imbricated beach rock slabs deposited by a tsunami on the south coast of Java. The project focuses on three questions:

1. What evidence is preserved in the geological record for past mega-tsunami events along the Java coast?
2. Are those in harm's way of tsunami aware of the hazards they face, and do they know how to respond?
3. What is the most effective way to increase resilience to tsunami hazards in Indonesia?

The approach to these questions involved interweaving technical and social sciences to close the communication gap that cost lives in the 2004 Indian Ocean Tsunami. Sharing the research and subsequent discussions with the community resulted in a project that has laid standards for response to tsunami preparation in Indonesia. One key engagement pathway is providing community members with practical, meaningful, and appropriate training.

Figure 3 summarizes the GWB approach to community-based disaster mitigation designed to close the gap between what science can demonstrate is a significant risk to tsunami hazards and preparing those in harm's way. For example, the 20-20-20 program designed with community collaboration states, "If you feel the ground shake for 20 seconds, you have 20 minutes to get 20 meters above sea level. The key to the success of this project and any successful GWB-sponsored projects is understanding and addressing tsunami risk as lived by those affected. An applied geosciences approach and community involvement led

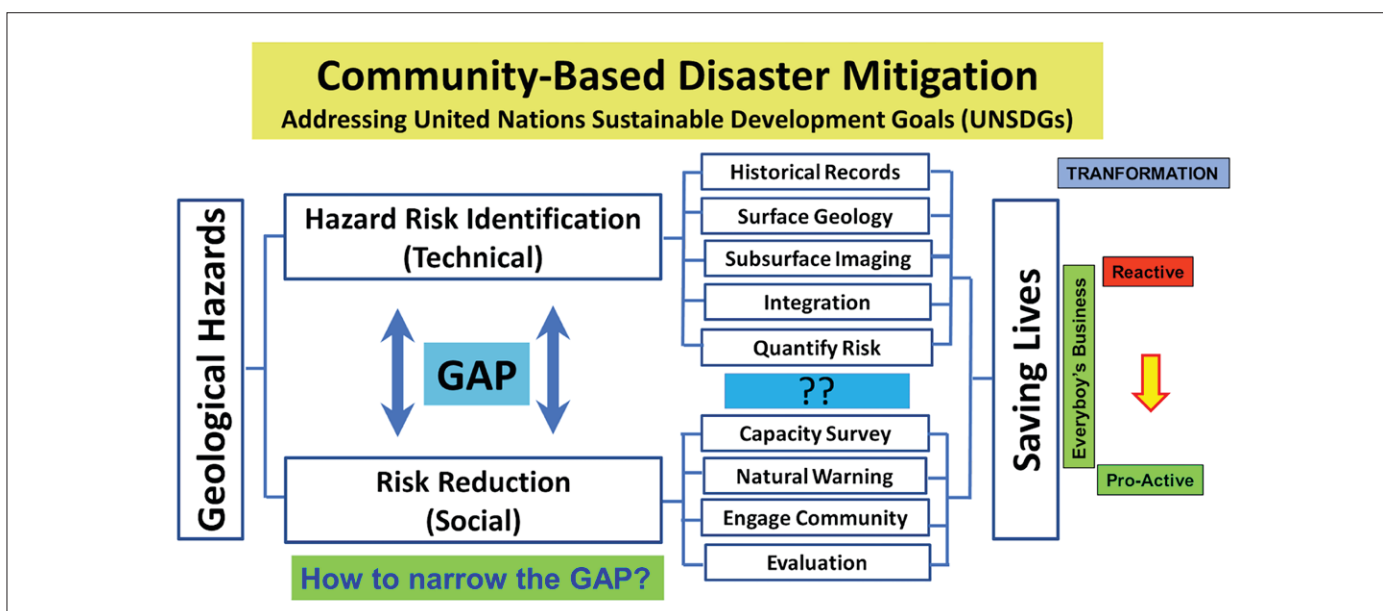


Figure 3. Geoscientists *without* Borders® flow chart for addressing Community-based Disaster Mitigation projects.

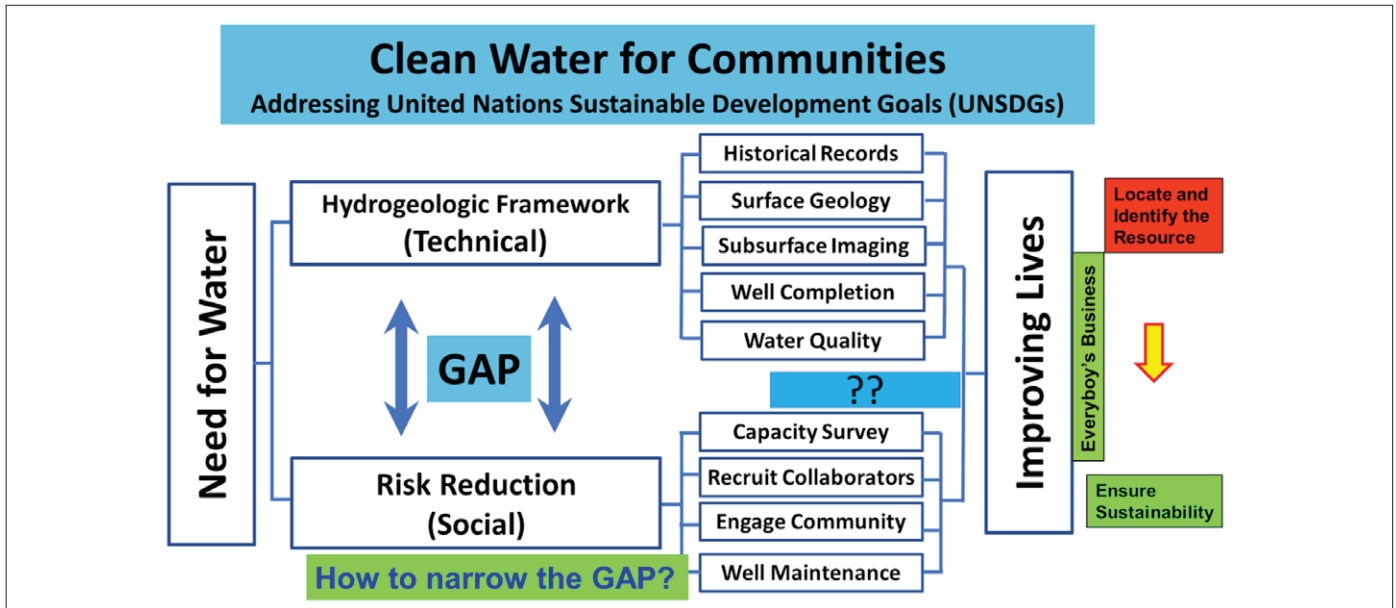


Figure 4. Geoscientists without Borders® flow chart for addressing Clean Water for Communities projects.

to a successful project for saving lives and ameliorating potential humanitarian challenges like tsunami hazards.

Figure 4 outlines GWB’s approach to community-based interventions for successful WASH projects. For example, in Perú, Zurite, a 100-family farming community, needed reliable, year-round irrigation for their crops, livestock, and livelihood. The GWB project team used geological and geophysical mapping to survey and map the puna grasslands of the upper Ramuschaka River basin above Zurite. The scientific work identified the “bofedales,” or peat-forming wetlands, of the nearby mountain valleys as important hydrologic features that store large amounts of water, sustain dry season runoff in streams, and are vital to the downstream irrigation supply. Using this knowledge, undergraduate and graduate geology students and community members from Zurite designed and

constructed 1.3 km (0.8 mi) of irrigation canals. The Municipality of Zurite, the Farmer’s Union, local water users, and GWB combined to finance the 1.3 km irrigation canal project. Twenty-nine student participants guided research, interacted with the community, and performed fieldwork and data analysis, successfully merging their learning objectives with cultural exchange and scientific research.

Critical Needs Geoscientists without Borders® Is Designed to Address

Since 2008 GWB has funded more than 58 projects in 41 countries (Figure 5) and awarded about \$4.25 million USD to humanitarian projects. Over the last four years, there have been eight to 10 current projects. GWB advances projects in four primary areas: Water, Sanitation, and Hygiene (WASH); Food Security; Disaster Risk Reduction (DRR); and Environmental and Cultural Conservation. Projects are funded to a maximum of \$50,000 annually for up to two years. These projects target communities in need and provide direct human benefit by applying geoscience, which can make a critical difference and educate the next generation of geoscientists. The project teams help protect the environment by using scientifically appropriate and effective methods to ensure long-term sustainability. Finally, many GWB projects empower women by alleviating poverty, improving work conditions, and directly involving students, local leaders, and community members in the solutions.

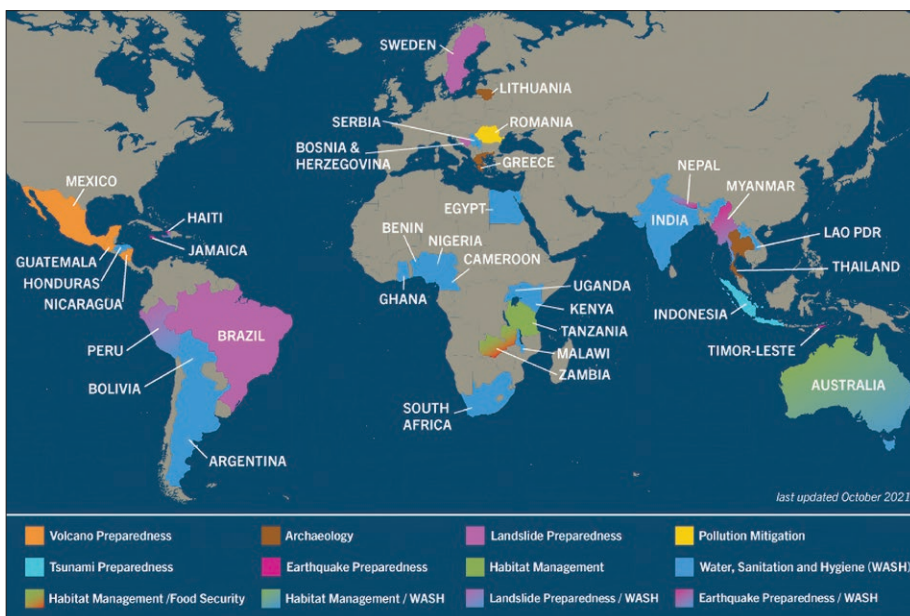


Figure 5. Location of historical Geoscientists without Borders® Projects.

merit and feasibility, project sustainability, and student engagement. Additionally, projects must include student involvement to meet GWB's mission to educate and train the next generation of geoscientists. GWB-sponsored projects have included over 675 students, 80 university partners, 65 community partners, and 25 industry partners. Many GWB projects address one or more United Nations sustainable development goals (UNSDGs) at the same time. To learn more about UNSDGs, please visit <https://www.un.org/sdgs>.

WASH projects generally use electrical and seismic technology and methods to systematically explore for and identify groundwater aquifers and optimum locations to drill water wells that the communities need. The project teams have also examined natural and anthropogenic influences on groundwater quality and evaluated aquifer recharge from surface waters to develop sustainable water management programs with communities. GWB-sponsored WASH projects include using geophysical technology to locate water wells in refugee camps in Kenya and Uganda. Other completed WASH projects were in Argentina, Nigeria, Ghana, Cameroon, Laos PDR, and Peru.

Food Security: Geophysical tools, combined with soil analyses and satellite imagery, help communities focus on sustainable management of agricultural practices while ensuring water is available for these activities year-long. GWB programs have focused on improving groundwater management and agricultural productivity, working with Engineers without Borders, and designing irrigation systems to bring water to communities. GWB-sponsored food security projects improved agriculture through targeted irrigation in Ghana, Peru, and Laos and defined fishery habitats in Lake Tanganyika in Tanzania and Zambia.

Disaster Preparedness: Projects have included mapping faults and developing earthquake monitoring systems where seismic networks are inadequate; mapping tsunami deposits and developing disaster plans for communities; mapping landslide deposits and monitoring land-slip movements; developing volcano monitoring systems so communities in danger recognize the risks and develop evacuation and emergency response programs, including Early Warning Systems (EWS). GWB-sponsored projects in Indonesia developed programs to mitigate tsunami risk and identified substrates where earthquakes are most likely to result in structural damage in Indonesia. Other earthquake mitigation projects took place in Haiti, Jamaica, Nepal, and Peru and addressed volcanic hazards in Mexico, Guatemala, Nicaragua, and Honduras.

Environmental and Cultural Conservation programs have included mapping habitats and developing wildlife management programs. Pollution mitigation projects to develop mitigation plans have mapped the distribution of pollutants that affect the human body, animals, and plants. In addition, archeology projects

Table 1. Attributes of successful GWB humanitarian proposals..

Human Benefit	The GWB charter specifies that projects should benefit communities in need, where applying geoscience is critical to improving conditions of poverty or where dangerous conditions and hazards can be mitigated or removed through applied geosciences technology. How the project addresses community involvement is a critical criterion.
Scientific merit	It must be clear that the methods selected are appropriate choices for addressing the problem. The proposers can demonstrate an ability to execute the work. However, proposals for developing new methodologies will not likely find strong support among reviewers. However, recently developed technologies should effectively meet the target community's needs directly.
Teaming	Teams that include in-country participants are viewed very positively by the GWB Committee. If the appropriate expertise exists in-country, the team does not need to include members from outside the country. Where in-country expertise is not strong, international partnerships composed of foreign and domestic participants are viewed favorably. Foreign participation can be as simple as playing an advisory role or involve joint execution in all phases of the project (data acquisition, analysis, interpretation, etc.).
Sustainability	The GWB program's primary goal is that every project has a sustainable, lasting impact. The best projects demonstrate a complete plan for meeting a need (even if some components are conducted outside of the GWB project) and train persons in-country who can replicate the success at other sites in the country or region where similar needs exist.
Student Involvement	GWB has a clear goal of providing educational opportunities for students. When students participate in GWB projects, they develop a deeper awareness of the world around them and become better citizens and better scientists. In addition, student involvement can enable more work with the limited funding GWB can offer. In addition, the Committee favors proposals encouraging local in-country students to participate in the projects.
Financial Transparency	Budgets need to be readily understood and consistent. Equipment purchase is allowed. A long-term benefit can consist of leaving the equipment with trained in-country users. Many equipment manufacturers or leasing firms are willing to loan equipment to GWB projects at little or no cost; some may even provide shipping costs.

utilize non-destructive geophysical methods to assist archeological site investigation. GWB-sponsored environmental and cultural conservation projects have occurred in Lithuania, Greece, Australia, Thailand, and Romania.

Measures of Success

GWB has strict guidelines and criteria that applicants must meet to ensure maximum success for project implementation. Table 1 lists the attributes considered in evaluating a humanitarian project proposal.

Overall, GWB projects are most effective when they demonstrate the following:

- Humanitarian benefits that influence positive change in communities facing environmental hardship and natural hazards to create sustainable support for the community's future needs.

- Student involvement, program diversity, and partner relationships are integral to a project.
- Geophysics and other geosciences provide a knowledge base from which communities can draw for years afterward.

Summary

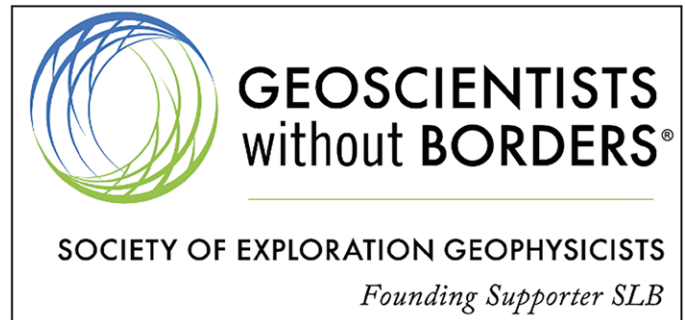
A visit to villages in Bangladesh was the impetus for me to apply my geoscience background to humanitarian crises. Geoscientists without Borders® (GWB), SEG’s humanitarian program, whose goal is to support geoscience applications to support communities in need, helps achieve that mission. GWB recognizes that geoscientists, geologists, and geophysicists have the tools to influence positive change in communities facing environmental hardship. These humanitarian challenges include natural hazards like volcanic activity, flooding, earthquakes, tsunamis, water shortages, drought, and compromised water quality due to various natural and anthropogenic impacts. Through individual and corporate donors, GWB helps geoscientists work worldwide, applying their specialized knowledge and technical skills to mitigate the adverse effects of natural hazards in some of the neediest communities.

In summary, GWB provides funding to projects that will benefit communities in need, where applying geoscience and technical knowledge is critical to improving poor conditions or mitigating or alleviating dangerous conditions and hazards. Using geoscientific data and technology in humanitarian efforts provides the foundation to ensure sustainable solutions are provided to make communities resilient in the face of a disaster. Finally, the GWB program aims to strengthen the global geoscience community

through beneficial multidisciplinary partnerships and cooperation with other organizations, as well as to encourage and train students in a broad range of geoscience careers and strengthen university programs in geophysics and geosciences.

Acknowledgements

I would like to thank the SEG staff, SEG Foundation, and GWB Committee members for their help during my time with GWB. Additionally, I would like to recognize Ron Harris, BYU, for developing the Community Basis Disaster Mitigation diagram (Figure 2) and his team for their WAVES project in Indonesia. Additionally, I want to recognize Jasper Oshun, Humbolt University, and his teams for their Zurite, Peru, project. Finally, I wish to thank all GWB projects’ Principal Investigators (PIs) and their teams for applying geoscience and technology to a diverse world of humanitarian projects.



1894-2024:
130 Years
as the
Gold Standard
of Geological
Compasses

AIPG Members
save 15% off all
Brunton products

Use discount code
AIPGmember
 at checkout

www.brunton.com | sales@brunton.com

Stormwater Infiltration System Design Regulation Flaws Due to Simplistic Assumptions Regarding Site Hydrogeology

Andrew M. Koenigsberg, CPG-7973

Introduction

Land development alters surface hydrologic characteristics via replacement of pervious natural landscape with impervious surfaces such as roads, parking areas, and buildings. Resulting impacts include increased rates of runoff, pollution of adjacent wetlands and surface waterbodies, erosion, flooding, and reduced aquifer recharge.

Federal and state agencies created regulations and standards to address these impacts using a wide range of best management practices (BMPs). Surface and subsurface stormwater detention systems (SDS) are the most widely and least expensive BMPs used to decrease runoff rates to pre-development levels, replace lost aquifer recharge, and treat runoff by trapping sediment prior to discharge to resource areas (USDA, 1986).

Although aquifer recharge is a primary goal of stormwater management (MADEP, 2008a), regulations that provide the methodology used to design detention systems in many states do not require rigorous evaluation of site hydrogeology.

Using Massachusetts as an example, this article will present a brief description of the stormwater management standards specifically related to detention basin design and the gaps in those standards relative to hydrogeology which can lead to SDS designs that do not function effectively. A case study will illustrate these issues.

Stormwater Management Systems (SMS)

The SMS design process involves calculating pre-and post-development surface hydrology conditions, the goal being to have the same rate of runoff discharge to resource areas in both conditions and to treat discharge to resource areas to remove pollutants for a given design storm.

A design storm is the amount of precipitation from a storm event of 24 hours duration with a specified recurrence interval. Typically, the recurrence interval used in SMS designs are two, 10, 25, and 100-year storms. Note that the definition of storm event represents the chance of recurrence in a given year. A two-year 24-hour storm has a 50% chance of recurrence (100/2) in a given year, not recurrence every two years.

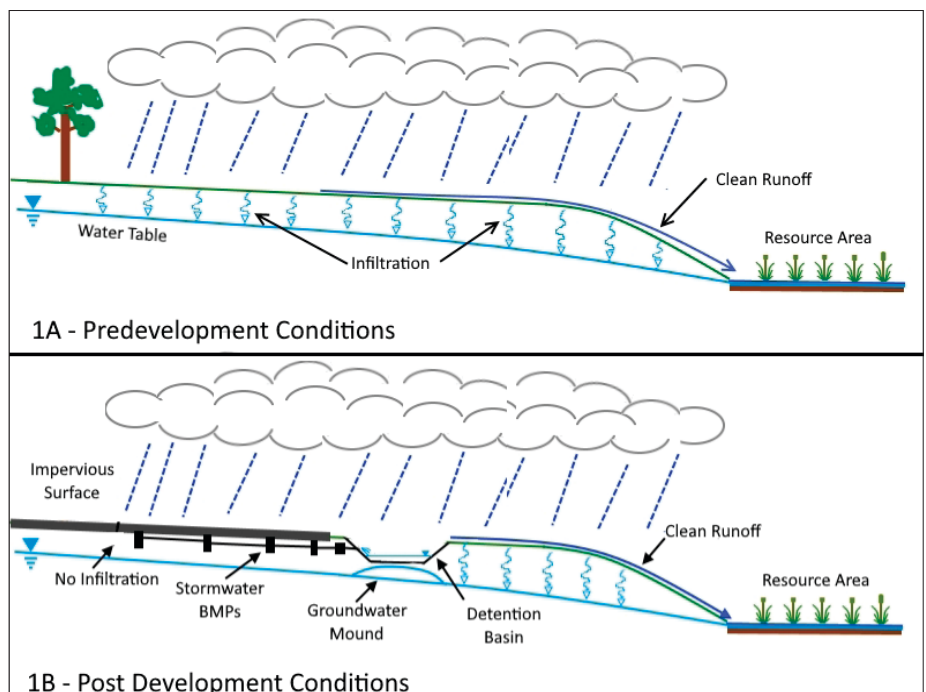


Figure 1. Pre and Post Stormwater Runoff Scenarios. 1A. pre-development conditions. 1B. post-development conditions with BMPs.

A two-year storm can occur several times in a given year.

Figure 1 is a schematic cross section illustrating the above concepts. Figure 1A shows pre-development conditions, where infiltration starts early in the storm event and runoff develops as the surface layer of the soil becomes saturated. Forests, meadows, and other vegetated landscape features slow the runoff rate to resource areas.

Figure 1B shows post-development conditions, where runoff from impervious surfaces is diverted via storm sewer networks or surface channels to BMPs such as hooded deep-sump catch basins or other pollution removal systems and finally, detention basins.

Stormwater Detention Basins

Detention basins have two functions: storing and releasing runoff to resource areas at a rate equivalent to natural conditions via an outlet pipe or weir as shown in Figure 2 and infiltrating runoff to groundwater.

Figure 2 shows the initial basin water levels at the end of various storms. In Massachusetts, the standard is that detained runoff will exfiltrate the basin within 72 hours post-storm. 10-year or greater storms will both exfiltrate to the underlying soil and discharge from the basin outlet.

Simplifications of Hydrogeology

During and after a recharge event, water infiltrating into the aquifer will form a mound underneath the stormwater basin (Figure 3). The buildup and decay of a groundwater mound is a dynamic process. This mound will dissipate over time, but the dissipation rate depends on the several hydrogeological characteristics. Typically, the mound decay rate is lower than the rate at which the mound builds up.

Because Massachusetts SMS design standards are focused on surface water hydrology, important groundwater hydrologic soil characteristics are excluded. These characteristics include:

- Hydraulic Conductivity (K)
- Saturated Thickness (H)
- Drainable Porosity (Sy)

If site conditions are marginal, for example: shallow bedrock, shallow water table, dense soils such as basal glacial till, and soils with high percentages of fines,

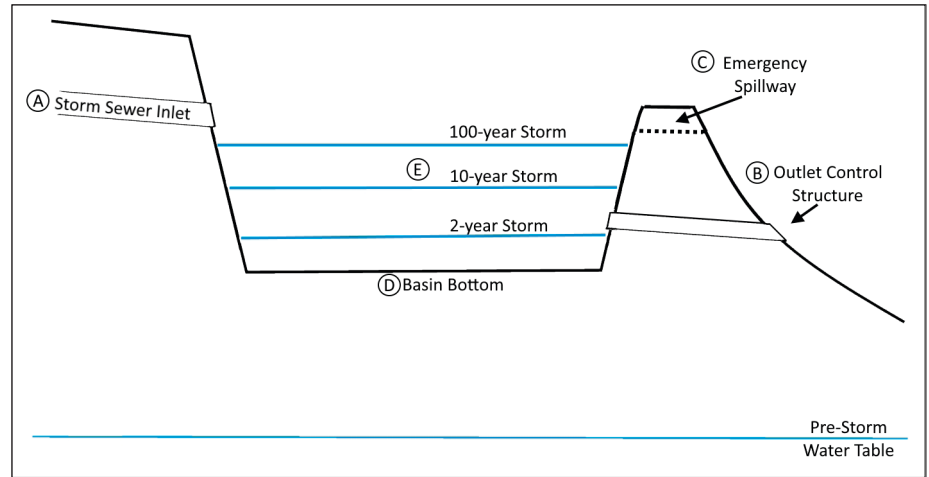


Figure 2. Schematic Detention Basin Cross Section showing components. A) Inlet pipe from stormwater sewer system. B) Outlet Control Structure which causes restricted flow from the basin. C) Emergency spillway for storms that exceed capacity of basin storage. D) Basin bottom through which Infiltration to the aquifer occurs. E) Initial water levels after the end of two, 10 and 100-year storms.

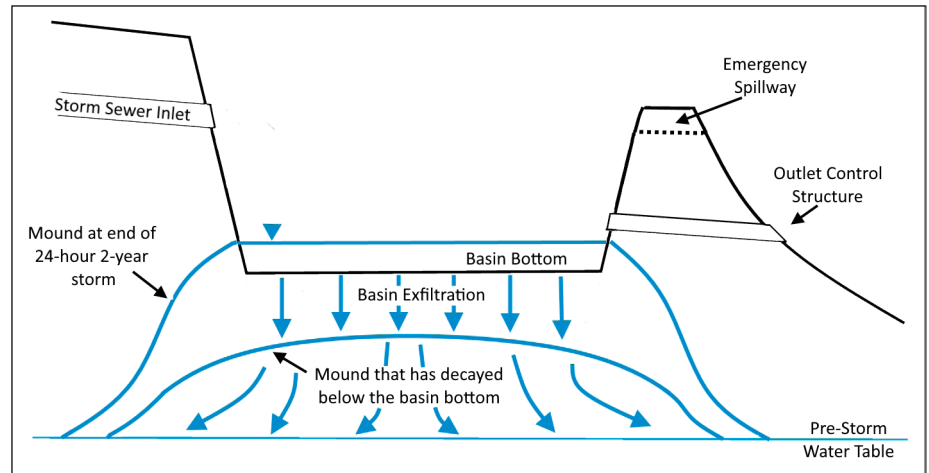


Figure 3. Schematic Detention Basin Showing Groundwater Mound. The mound can initially extend above the basin bottom when soil is fully saturated, and infiltration slows.

detention systems are more likely to not meet the Massachusetts 72-hour drainage requirement, even if they meet regulatory design criteria.

The issues are discussed below.

Hydraulic Conductivity

Hydraulic conductivity (K) as a measure of the ability of a porous medium to transmit water under saturated conditions, also referred to as K_{sat} (Fetter 2001). Normally, this value is determined using field tests.

The Massachusetts SMS design standards rely on a qualitative soil description as the basis for estimating infiltration rates, relying solely on the “Rawls Rate.” The “Rawls Rate” is not a rate. It is the K_{sat} for a given soil texture, based on research published by Rawls et al (1982), where the

authors performed statistical analysis of K_{sat} estimates from over 1,300 soil samples with the goal of assigning a specific K_{sat} to each texture. Table 1 on the following page summarizes these values.

The “Rawls Rate” method excludes the geologic context and in-situ soil properties such as bulk density, which can change K_{sat} by orders of magnitude. Table 2 shows variations in estimate K_{sat} based on bulk density for Sandy Loam NRCS 2019).

The K_{sat} range for high bulk density sandy loam is typical of unweathered basal glacial tills found in Southern New England (Melvin et al, 1991). The “Rawls Rate” of 2.04 ft/d is skewed towards the higher K_{sat} value for low bulk density soil.

This comparison illustrates that evaluating and testing the hydrologic

Table 1. Hydraulic Conductivity Based on Soil Textures (Rawls et al, 1982).

Texture Class	K _{sat} (ft/day)
Sand	16.54
Loamy Sand	4.81
Sandy Loam	2.04
Loam	1.04
Silt Loam	0.54
Sandy Clay Loam	0.34

properties of soils in their geological context should be a necessary component of SDS design. Geohydrologic properties cannot depend solely on standardized values.

Saturated Thickness

Massachusetts SMS design standards do not account for the saturated thickness of the soil below the SDS or the presence of any limiting layer that would impede vertical flow. As long as the difference between the estimated seasonal high groundwater (ESHGW) elevation and the base of the SDS is four feet or greater, the base of the aquifer could be a foot below ESHGW and still meet design standards.

Drainable Porosity (Sy)

Drainable porosity, also known as Specific Yield, is the percentage of water that can drain from a fully saturated volume of soil due to gravity. Because water is a polar molecule, some percentage of water will remain in the soil due to surface tension (capillarity) and direct adherence of water on soil particles. Soil void space interconnection, particle sorting and grain size influence capillarity and water adherence.

As long as water flow through an aquifer is considered steady state, soil porosity is not a factor. It only becomes one during a transient event such as a rainstorm, where water enters the unsaturated zone then flows down to the underlying aquifer.

Basin Drainage Time

To determine whether a SDS will drain within 72 hours, Massachusetts SMS design standards use the following formula:

Equation 1: $Td = \frac{Rv}{(K)*(A)}$

Table 2 – Sandy Loam K_{sat} Variation based on Bulk Density (NRCS, 2019).

Bulk Density	Low K _{sat}	High K _{sat}
High	1 μm/s (0.03 ft/d)	10 μm/s (3.0 ft/d)
Low	10 μm/s (0.3 ft/d)	100 μm/s (0.3 ft/d)

Where:

Td = Drawdown Time: Time required for detained runoff to exfiltrate through the basin bottom

Rv = Required Recharge Volume: a depth of runoff corresponding to the soil type multiplied by the impervious areas covering that soil type at the post-development site.

K = “Rawls Rate”: K derived from soil texture analysis (Table 1)

A = Bottom area of SDS

The above equation is derived from the Darcy equation, which assumes steady state flow:

Equation 2: $Q = KA \left(\frac{dh}{dl} \right)$

Where:

K = Hydraulic Conductivity

A = Area: Cross-sectional area through which flow is occurring

Q = Discharge Rate: Total volume (V) divided by time (t) through a given cross-sectional area (A).

(dh/dl) = Hydraulic Gradient: Change in the height of the water column over a specific length

Assuming vertical flow, then dh/dl = 1, reducing the Darcy equation to:

Equation 3: $Q = KA$

Since discharge Q can be written as V/t, the equation can be written as:

Equation 4: $KA = \frac{V}{t}$

or:

Equation 5: $t = \frac{V}{KA}$

Equation 5 is equivalent to Equation 1.

Once a mound forms, the basin exfiltration process is more complex because mound decay is a transient process. Mound decay is dependent on changes in storage, the rate of horizontal radial dispersion of water from the SDS, and the thickness of the aquifer; therefore, the steady state flow assumption is not valid. It will lead to

an underestimate of the time it takes for exfiltration to occur.

HydroCAD and Aquifer Recharge Simplifications

HydroCAD (HydroCAD 2023) is a widely-used tool for stormwater management system design; however, it is not a groundwater flow model and thus tends to overestimate the ability of aquifer to accept recharge as it uses the same steady state equation (Equation 5) to calculate the time it takes for the basin to exfiltrate stormwater into the ground.

Case Study

This case study illustrates how the simplifications of site hydrogeologic conditions inherent in current Massachusetts SMS design standards can lead to stormwater detention systems that will not completely drain 72 hours after the end of the storm, even though the design uses methodology required in those standards. The case study is based on publicly available information from a stormwater management plan submitted as part of a permit application for a site in Massachusetts.

Site Development Plan

The site is located on a 19-acre parcel, with a wetland resource area on the west side, with a planned 193,000 ft² industrial building (Figure 4) on the following page. The breakdown of impervious to pervious surfaces is summarized in Table 3.

SDS Design Calculation Summary

The site development stormwater management plan calls for five subsurface stormwater detention systems. Based on soil textural analysis, the infiltration rate used in HydroCAD was set to a “Rawls Rate” of 2.04 ft/day. Table 4 breaks down the stormwater calculations used in the stormwater management report. A 10-year storm was used to confirm the design 72-hour post storm drainage time.

Site Geology

USGS Surficial Geology and Natural Resources Conservation Service (NRCS) soils data were obtained from the Massachusetts

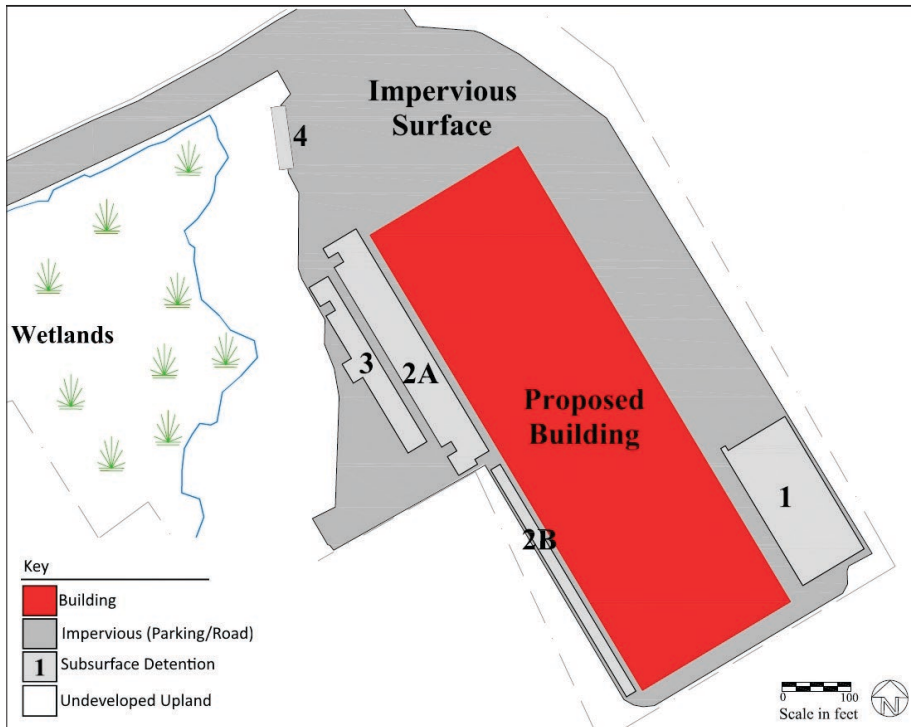


Figure 4. Case Study Site Layout. Total impervious upland (building, parking, road) is 10.65 acres. Pervious upland is 2.11 acres. Wetland area is 6.18 acres.

Table 3 – Developed Site Surface Areas.

Surface Type	ft ²	Acres
Upland Impervious Surface	464,090	10.7
Upland Pervious Surface	91,776	2.1
Wetlands	26,160	6.2

Table 4 - Stormwater Management Report Calculations Summary.

System	Bottom Area (ft ²)	Exfiltrated Volume (ft ³)	System ESHGW Separation (ft)	Basin Drainage Time (days)
1	23,350	42,266	2.0	0.89
2A	20,806	78,843	2.0	1.85
2B	6,144	23,282	2.0	1.85
3	9,475	24,933	2.0	1.25
4	2,000	2,172	2.0	0.67

GIS MassMapper system as part of this case study.

The USGS and NRCS describe the soils as lodgment glacial till overlying bedrock, which is consistent with logs from site subsurface investigations. The logs described the soils below the subsoil as “natural till soils”

consisting of “medium dense to very dense, beige/beige-tan/beige-gray/gray, fine to coarse sand with about 20 to 50 percent fine to coarse gravel, about four to 35 percent silt, and up to about 20 percent cobbles/boulders” starting at 1.3 to four feet below grade.

Site Hydrogeologic Evaluation

The following hydrogeologic parameters were obtained from site investigation results:

- Horizontal hydraulic conductivity (Kh) from slug test analyses which ranged from 8.6 to 17.3 ft/day. The geometric mean was 11.1 ft/day.
- Specific yield (Sy) of 0.25 based on grain-size analysis of soil samples from borings and test pits in the unweathered till soil horizon obtained by plotting sand, silt, and clay particle-size fractions on Figure 1 from Johnson (1967).
- Saturated thickness (h) of 16.2 feet based on test pit and soil boring data.

Mounding Analysis Requirement

The Massachusetts standards require a mounding analysis of the proposed SMS if the separation between the SDS bottom and ESHGW is less than four feet, which is the case at this site, where separation is two feet (Table 4). The standards recommend the Hantush method (Hantush, 1967).

The Hantush method is an analytical model which is limited to modeling a single system at a time in two dimensions. Figure 4 shows systems 2A, 2B, 3, and 4 in close proximity, making interference between each mound an issue; therefore, a numerical model of the entire site was better suited to performing the mounding analysis. MODFLOW (USGS, 2023) was chosen for this purpose because it could model the impact of multiple recharge systems simultaneously.

Groundwater Model Description

Figure 5 shows the layout of the MODFLOW numerical model, including grid, recharge areas and boundary conditions. The conceptual model design included the following assumptions:

- The aquifer beneath the Site can be modeled as a single, unconfined layer with the water table as the upper surface;
- The saturated thickness is uniform over the entire model grid based on the difference between redox and boring refusal depths;
- The wetlands on the southwest side of the property can be modeled as a local groundwater discharge area

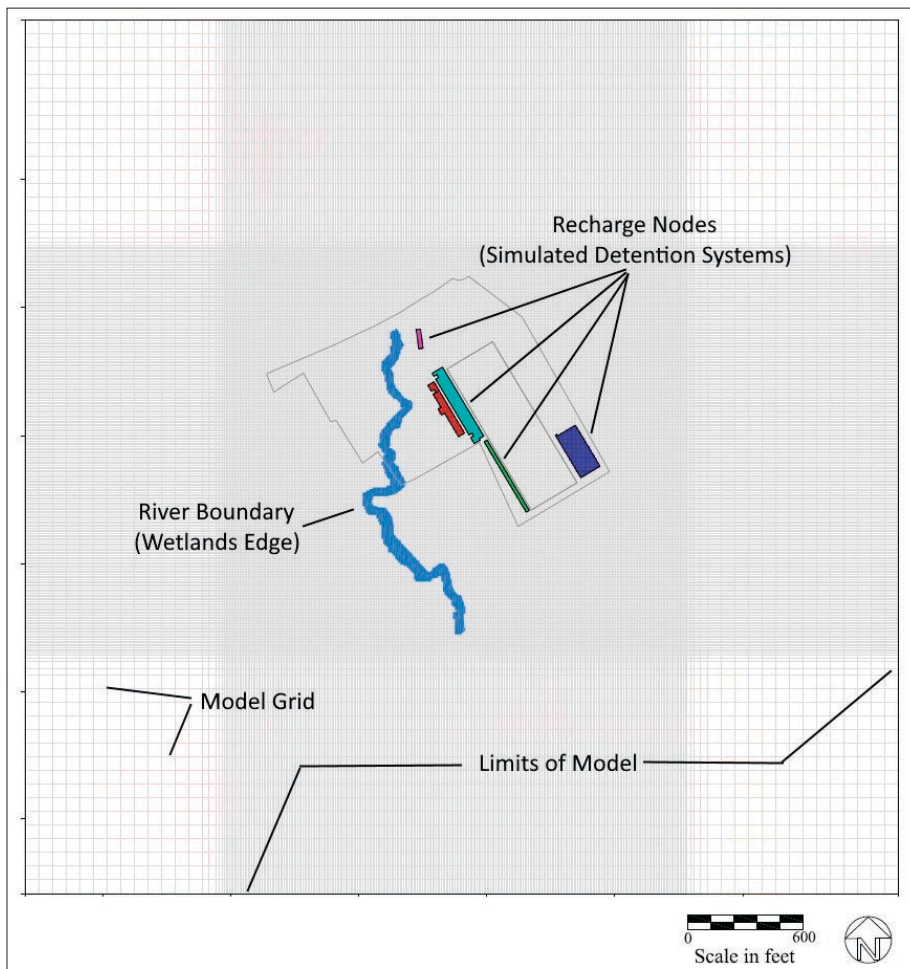


Figure 5. MODFLOW model Layout. Model dimensions are 4096 x 4096 feet. Model node dimensions telescope from 64 to eight feet.

using a MODFLOW (RIV) specified head boundary;

- Aquifer hydraulic conductivity can be estimated using an average hydraulic conductivity based on aquifer slug test results;
- Specific yield can be estimated using the results of particle-size analysis compared to standard references.

Based on the results of the site hydrogeological evaluation, model parameters are summarized in Table 5.

Model Grid: The MODFLOW model represented the water table aquifer beneath the site as described above using a 4,096 foot by 4,096-foot grid as a single unconfined layer. The model grid used a variable node spacing starting at 64 by 64 feet at the edges of the model, telescoping to eight-by-eight feet in the vicinity of the site, encompassing each SDS and the adjacent wetland. The smaller grid spacing in the area around the each SDS, where groundwater recharge causes steeper

groundwater gradients, provided higher resolution and thus a more accurate model prediction of groundwater flow around each SDS.

Recharge Rate: To simulate each SDS in the model, specific recharge nodes were assigned to each SDS. Because the model grid orientation did not exactly match the design footprint of the systems, recharge rates per model node for each SDS were adjusted to ensure that the modeled recharge accurately simulated the design recharge rate of each SDS, so that the modeled and design recharge volumes were

the same as the design recharge rates. Table 6 shows the adjusted rates.

Wetland Boundary: Wetlands were simulated using the MODFLOW RIV Specified Head Boundary. This model feature allows groundwater to discharge to the wetland when the water table elevation is higher than the wetland surface elevation and to receive water from wetland when groundwater elevation when is lower than the wetland surface.

Model Results

The model was run using transient flow with four recharge periods of one, four, 15 and 30 days. Recharge was limited to the first period, as would be the case during a design storm of 24 hours duration. Figure 6 shows the mounding for the entire site at the end of the second period of four days (72 hours after the end of the design storm).

With the exception of the systems SDS 2B and 4, the mound heights exceed the two-foot separation distance between the water table and the base of each system more than 72 hours post storm. Figure 6 highlights the two-foot contour in red, which represents where the mound height exceeds the basin bottom height above the water table. Figure 6 also shows that the modeled mounds did overlap each other.

The MODFLOW observation well option was used to simulate monitoring wells located in the center of each SDS. Hydrographs of water levels in each well during the model run were generated from these data. Table 7 summarizes the results of each hydrograph. Figure 7 shows the hydrograph from SDS-1 as an example, which shows the mound height intersecting the basin bottom at 6.15 days post storm. Table 7 shows basin drainage time was underestimated by an order of magnitude in three of the five detention systems.

Conclusions

Groundwater models of any type, whether analytical or numerical, are mathematical approximations which can be used to better

Table 5 – MODFLOW Model Input Parameters.

Parameter	Value
Horizontal Hydraulic Conductivity (K_h)	11.1 ft/d
Vertical Hydraulic Conductivity (K_v)	11.1 ft/d
Specific Yield (S_y)	0.25
Saturated Thickness (H)	16.2

understand how a groundwater system functions, but have limitations based on the model's underlying assumptions and the quality of data input.

The case study presented in this article shows that when hydrogeological factors such as storage, saturated thickness, quantitative measure of hydraulic conductivity, and the transient nature of the drainage process are taken into account, the estimated SDS drainage time may be substantially greater than time estimates derived from more simplistic methodologies found in state stormwater design regulations.

The stormwater management SDS design regulations in Massachusetts are not unique. Other states (Rhode Island and Minnesota, for example) use similar detention system design standards, although the drawdown requirements are shorter than Massachusetts. Minnesota uses 36 hours (MPCA, 2008).

Recent studies, such as Douglas and Fairbank (2011) and information on public websites (EPA, 2021) have demonstrated that the frequency of storm events is increasing in many regions of the country. It is not unreasonable to expect back-to-back major storms occurring within days of each other. In this scenario, an SDS will fail, even if it meets regulatory design standards, if those standards are not based on a rigorous understanding of site hydrogeology.

About the Author

Andrew Koenigsberg, PG, CPG 7973, practices hydrogeology in Massachusetts. He holds a BA in Geological Sciences from Cornell University and an MS in Geological Sciences from the University of New Orleans. He works for a small consultancy which specializes in groundwater hydrology.

References

Douglas, E.M. and C.A. Fairbank, 2011, *Is Precipitation in Northern New England Becoming More Extreme? Statistical Analysis of Extreme Rainfall in Massachusetts, New Hampshire, and Maine and Updated Estimates of the 100-Year Storm*, Journal of Hydrologic Engineering, March 2011.

Fetter, C.W., 2001, *Applied Hydrogeology*, Fourth Edition.

Johnson, A.I., 1967, *Specific Yield--Compilation of Specific Yields for Various Materials*, USGS WSP 1662-D, <https://pubs.usgs.gov/wsp/1662d/report.pdf>.

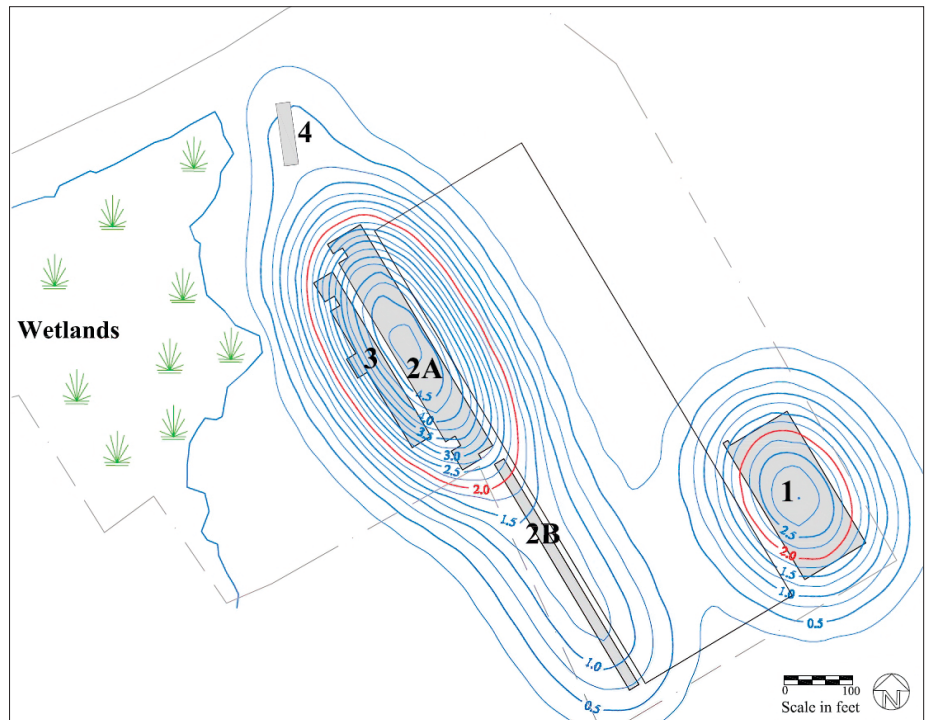


Figure 6. 10-year Storm Mound at 72 hours post storm. Red contour represents where the modeled mound exceeds the two-foot required separation between the basin bottom and mounded water table.

Table 6 – Model Recharge Rate Summary per ft²

SDS	Basin Rate Recharge (ft/d)	Adjusted Model Recharge Rate (ft/d)
1	1.810	1.775
2A	3.789	3.838
2B	3.789	3.675
3	2.631	2.580
4	1.357	1.368

Hantush, M.S., 1967, *Growth and Decay of Ground-Water Mounds in Response to Uniform Percolation*, Water Resources Research, 3: 227-34.

HydroCAD, 2023. *HydroCAD Stormwater Modeling version 10.2-3*. HydroCAD Software Solutions LLC., Tamworth, New Hampshire. <https://www.hydrocad.net>.

Massachusetts Department of Environmental Protection (MADEP), 2008a, *Massachusetts Stormwater Handbook Volume 1 Chapter 1: Stormwater Management Standards*. <https://www.mass.gov/doc/massachusetts-stormwater-handbook-vol-1-ch-1-stormwater-management-standards/download>.

Massachusetts Department of Environmental Protection (MADEP), 2008b, *Massachusetts Stormwater*

Handbook Vol 3, Ch 1, Documenting Compliance, <https://www.mass.gov/doc/massachusetts-stormwater-handbook-vol-3-ch-1-documenting-compliance/download>.

Melvin, R.L., V. de Lima, B.D. Stone, 1991, *The Till Stratigraphy and Hydraulic Properties of Tills in Southern New England*, U.S. Geological Survey OFR 91-481.

Minnesota Pollution Control Agency (MPCA), 2008, *Minnesota Stormwater Manual v2*, Lafayette, MN.

Natural Resources Conservation Service (NRCS), 2019, *National Soil Survey Handbook, Part 618, Subpart B Exhibit 618.88-Guide for Estimating K_{sat} from Soil Properties*, <https://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=46752.wba>.

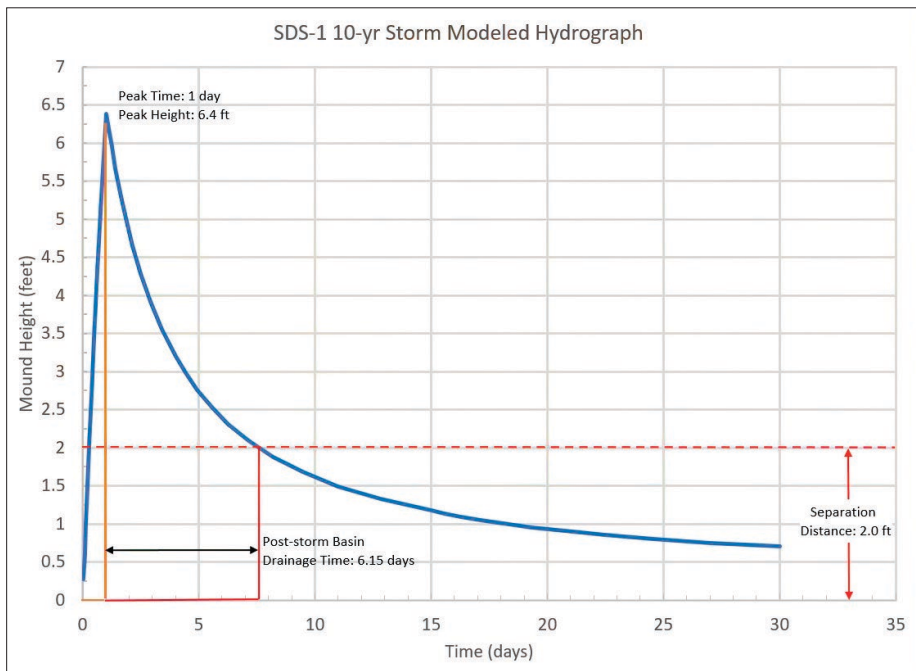


Figure 7. Height versus Time Hydrograph for SDS-1 based on MODFLOW results. Mound does not decline below basin bottom until 6.15 days post storm. Note that the hydrograph does not represent the actual height of the mound in the basin.

Table 7 - Model Mounding versus Design Standards Drawdown Time Comparison

SDS	Separation Distance (ft ²)	Peak Time (days)	Modeled post-Storm Basin Drainage Time (days)	Design Standards Drawdown Time (days)
1	2.0	1.0	6.15	0.89
2A	2.0	1.0	14.58	1.85
2B	2.0	1.0	1.15	1.85
3	2.0	1.4	14.95	1.25
4	2.0	1.0	0.42	0.67

Rawls, Brakensiek, and Saxton, 1982, *Estimation of Soil Water Properties*, Transactions American Society of Agricultural Engineers 25(5): 1316-1320, 1328.

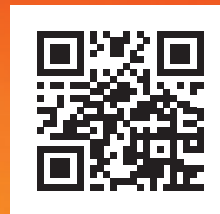
USGS, *MODFLOW and Related Programs*, March 3, 2022. (<https://www.usgs.gov/mission-areas/water-resources/>

[science/modflow-and-related-program](https://www.usgs.gov/mission-areas/water-resources/science/modflow-and-related-program)).

Championing the Geosciences Profession Together

Membership Renewals Due January 1, 2024

Payments after February 15, 2024 - \$40 late fee.



Scan to renew today!

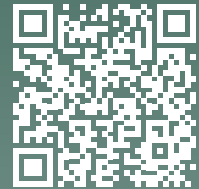
Building the Future of Geology

Support the Foundation of the AIPG

The Foundation of the AIPG supports a variety of programs including student scholarships, student and young professional workshops, educational programs aimed at practitioners, the public, and policy makers, and some special needs requested by AIPG or other professional organizations. In 2023, the Foundation provided grants to AIPG for preparing a virtual field trip in conjunction with the 2023 National Meeting and in support of the undergraduate scholarships awarded by AIPG. Additionally, the Foundation has awarded its own William J. Siok Graduate Student Scholarship. The Foundation is proud to be able to serve AIPG and the geosciences by providing financial support for these programs. Every donation helps the Foundation to contribute toward building the future of geology. If you have any questions or comments about the Foundation, please contact me or any of the other Trustees of the Foundation for additional details and check the AIPG web site for more information about the Foundation. Your continued support is greatly appreciated. Thank you.

Mike Lawless

Michael D. Lawless, CPG, PG
Chairperson, Foundation of the AIPG
540-557-1319 office phone; mlawless@trccompanies.com



Give today!

*The Foundation of the American Institute of Professional Geologists is a 501(c)(3) organization.
Contributions are tax deductible. EIN 45-2870397*



Using, Making, and Sharing Maps

In this webinar, Madeline Kelley, a geographer and geomorphologist with the University of New Orleans, discusses her education and career involving many different jobs that involve maps.

AGI's Early Career Professionals in Mapping Webinar Series features early career geoscience professionals who share their work related to mapping, especially geologic mapping, and experiences entering the geoscience community. This webinar series is geared towards high school students and the general public.

There will be time for live questions from the audience. The webinars will be recorded and posted on AGI's website and YouTube channel.

This webinar series is generously supported by the USGS National Cooperative Geologic Mapping Program.

www.aipg.org

**Free Webinar
Series
February 8, 2024
1-2 pm EST**



Scan to register.

Jan.Feb.Mar 2024 • TPG 29



Transforming the Perception of Geosciences for a Sustainable Future

Aaron W. Johnson, MEM-2783
awj@aipg.org

“ We must attract talent and we must do so with a message that geologists are part of the solution, rather than part of the problem. ”

I recently had a long discussion with Vitor Correia, the Secretary General of the International Raw Materials Observatory and a past president of the European Federation of Geologists. As it always seems to, our conversation covered a lot of ground, mostly focused on topics that both of us feel are becoming ever more important to geologists and to the profession. The first, and in many ways most pressing, topic is the global decrease in geology enrollments. The numbers are stark, with net enrollments dropping by around 20%, leading to the closure of some departments that were already under stress due to financial constraints on colleges and universities. According to a recent article in *Nature Reviews Earth and Environment*, Macquarie University in Australia shuttered its entire Geology Department. Not to be outdone, Laurentian University in Canada closed its entire School of Environment and discontinued undergraduate courses in a wide variety of earth science-related disciplines. In the UK, the University of London plans to reduce staffing in some Earth science courses it deems “less popular,” and right here in the USA, the University of Vermont did away with their Department of Geology.

These actions come at a time when Geology and Earth science are more critical than ever to a sustainable future. The current transition from a carbon-intensive energy grid to one that relies more on renewable energy will require an increase in raw materials production. Geologists will play a critical role in not only finding those resources but ensuring that resources are utilized with minimum impact on the environment and the people that live in communities nearby. When production of resources ends, geologists will play a critical role in closure and remediation. As demand for raw materials increases, demand for geologists will increase as well.

What is driving the decrease in geology enrollments? No one knows for sure. However, there is some preliminary and, as yet unpublished, data that suggests that this generation of students sees geology as a ‘dirty’ profession that does not contribute to the green transition. According to some of this anecdotal evidence our profession engages mostly in the exploitation of resources with little regard for the environmental consequences. While those of us in the profession know that this does not accurately describe our profession, one thing is abundantly clear: we must change this perception to more accurately reflect what we do.

The second, and in many ways most sobering, topic of our discussion was the current trend toward increased protectionism and nationalism in the raw materials sector. At a recent international meeting, I learned that the EU has signed international partnership agreements with eight different countries to work together to provide access to critical and strategic raw materials. Those countries include Argentina, Canada, Chile, The Democratic Republic of Congo, Kazakhstan, Namibia, Ukraine, and Zambia. It is telling that the United States is not one of those eight. In fact, according to some members of the European Commission, the United States is “an old ally” and “during a raw materials meeting with the United States, nothing was accomplished.” While there was talk of a free trade agreement with the United States that would include some sort of resource partnership, at this time there is no such agreement. I don’t mention this to be critical of the US or our allies. It’s simply an example of the increasing global competition for raw materials.

The fact that China is among the worlds leading producers and processors of critical raw materials only exacerbates the situation. China produces 100% of processed heavy rare earth elements and 97% of magnesium. In addition, China is among the leading producers of processed graphite (critical for batteries), germanium, and gallium. Recently, China announced additional export restrictions on these three critical materials, placing increased pressure on global supply chains.

These two facts, decreasing geoscience enrollments and increased demand for raw materials, place society at a crossroads. Jan Mostrom, CEO of LKAB (the largest iron producer in Europe) recently stated, “the green transition begins in the mine.” While this is true, without competent qualified geologists to locate and extract raw materials and to complete post-mine remediation this transition will, at best, be delayed. In a recent talk to the Global Geoscience Professionalism Group, the presenter stated that simply waving a cell phone and saying “if you want one of these, you have to have mining” does not resonate with the current generation of students. We must attract talent and we must do so with a message that geologists are part of the solution, rather than part of the problem.

Best Regards,

Aaron



Looking Forward to 2024!

Shanna Schmitt, CPG-11781
shanna.schmitt@state.mn.us

Welcome to 2024! I'm pleased and excited to serve as President of AIPG. I'm a lifelong Minnesotan, and the Minnesota Section is looking forward to seeing you at the 2026 Annual Conference in the spectacular Duluth/Superior area in a few years. By way of introduction, I was drawn to geology during my eighth grade Earth Sciences class, where one of the highlights was constructing a papier-mâché brachiosaurus, scaled to about five feet tall and supported with a chicken wire frame. I started learning that geology is everywhere and it's the story of Earth. While at the University of Minnesota – Twin Cities, I took advantage of every field trip offered, but still had no idea what I was going to do after graduating! When I was looking for a job in spring 2003, the market wasn't great, so I took the first job I was offered and began earning a living in the geosciences. Starting off in consulting provided a great opportunity to work on a variety of sites. While in consulting, I also worked for several project managers, including my first mentor, **Paul Wiese**, CPG-09477.

Most of my work in consulting was at state-funded petroleum and chlorinated solvent sites, with some private agricultural and commercial sites thrown in the mix. I worked for a national consulting company, but the Minnesota location was small, so when I made the move to the government sector after several years, it was a way to get a promotion while remaining in the remediation sector. I now work as a hydrogeologist, focusing on Brownfield and Superfund sites for the Minnesota Pollution Control Agency. Although I've stayed in the remediation realm, I believe my involvement with AIPG, including monthly technical talks and networking with the Minnesota Section, and obtaining my CPG membership status, have helped me grow as a geologist, expanded my network, and kept my career options open. Minnesota offers professional licensure, but I'm still a CPG member as I believe it gives me more flexibility for future job changes and career moves. It also adds another layer of ethics adherence and peer-recognized competency. You never know where you'll end up or when a great career move will happen, and I believe that being prepared is prudent.

As we enter the new year, I've been reflecting on 2023. Thank you for celebrating our 60th anniversary with us! The past year saw us continue to offer educational content online, including technical talks (our Lunch & Earn series), webinars specifically for students and early career professionals, general information webinars, opportunities for input via our town hall events, and several educational webinars through the Geosciences Online Learning Initiative (GOLI) platform provided through our partnership with the American Geosciences Institute (AGI). We had a wonderfully successful Annual Conference in Covington, Kentucky in September, where we had a fabulous array of field trips, technical talks, panels, workshops, forums, keynote speakers, and more. Thanks to everyone who planned, provided content, and/or participated in AIPG during the year.

AIPG, like most professional organizations, is struggling to find volunteers and grow membership. I began chairing our Membership

Committee in 2023, and we have been reimagining the way we describe the many benefits of AIPG membership. The Institute has a lot to offer our community and an extensive network in place, at both the Section and National levels. In 2024, the National Executive Committee will continue to meet monthly, and our focus will be directed by our recently finalized AIPG Strategic Plan: demonstrating the benefits of membership and providing value to members. The Membership Committee will continue to receive direction from the Executive Committee, and the committee welcomes additional members!

AIPG is an organization that runs on the power of volunteers. Although we have national staff who are wonderful and consistently do great work for us, the volunteers are the bedrock. All the people at the National and Section levels who run our committees, act as liaisons with external organizations, and provide input and feedback, are volunteers. As you map out the months and years ahead, please consider volunteering with AIPG in some way. Reach out to me if you'd like to discuss ideas. To the 2023 volunteers on

“AIPG is an organization that runs on the power of volunteers.”

the National and Section levels, we acknowledge your gift of time and energy, and we're very grateful for your efforts!

In June 2023, national leadership finished a multi-year effort to update AIPG's strategic plan. We have updated guidelines for moving forward! We'll continue working on dozens of other initiatives and committees from ethics to membership and everything in between. We'll continue working on the Exploratory Committee, which is exploring ways to partner with other geoscience organizations. We'll continue offering opportunities for member engagement through our Town Hall events – one of the easiest ways to be involved.

Our most visible event in 2024 is our National Conference that will take place in Durango, Colorado. Not too far from the Four Corners area, this is an area where geology is definitely on display. You'll see the save-the-date reminders in this issue of *TPG*, and you'll get the exciting field trip descriptions in the next issue. Please join us!

As we move through 2024, reach out if you have questions or comments! I'm looking forward to working for you, and with you, this year!

Shanna

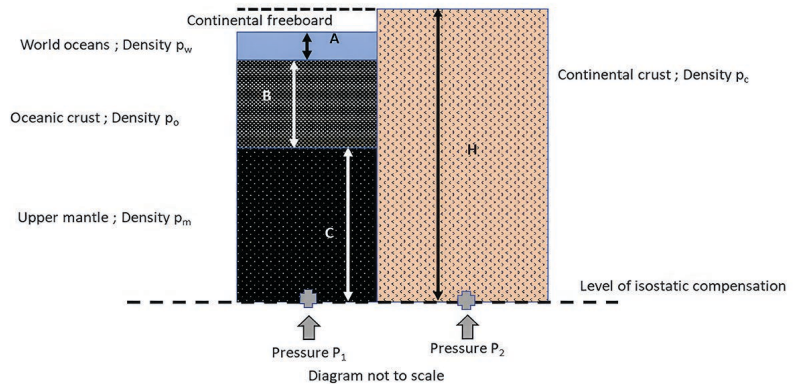


Robert G. Font, CPG-03953
 robertfontphd@gmail.com

1. "Bornite" is a sulfide mineral and an ore of:
 - a) Tin
 - b) Copper
 - c) Molybdenum
 - d) Mercury
 - e) Lizzen mann, ay was born att nite, nd mi naim is Bornite, nd ay R nut a mineral, ore a sulfide huateverr....!

2. "Deinonychus" refers to the genus of a type of:
 - a) Crinoid
 - b) Brachiopod
 - c) Theropod
 - d) Placoderm
 - e) Sticky, slimy, gummy, disgustingly ugly, soft-bodied critter that you can deep-fry and eat with horseradish cocktail sauce and a pitcher of sangria...

3. Given the level of isostatic compensation illustrated in the diagram to the right, what is the value of "C" or depth to which the continental column projects into the mantle?
 - a) $C = (Hp_c g + Ap_w + Bp_o) / p_m$
 - b) $C = (Hp_c - Ap_w - Bp_o) / p_m$
 - c) $C = (Hp_c - Ap_w) / p_m + Bp_o$
 - d) $C = (Hp_c + Ap_w) / p_m - Bp_o$
 - e) Dude, I know a lot about the "level of static compensation." I had a job and my boss would not raise my salary and it made me so maaaaadddd....



4. Which of the following combines with oxygen to yield the mineral that we know as "corundum?"
 - a) Calcium
 - b) Magnesium
 - c) Zinc
 - d) Aluminum
 - e) Dude, on this one I am going to have to consult with my friend, Ruby.

5. (Question submitted by David M. Abbott, Jr., CPG-04570). A bumper sticker is available reading "Tuff Schist." Aside from the sophomoric humor, if a dacitic tuff containing prominent biotite phenocrysts has been subjected to greenschist grade metamorphism, what would the metamorphic rock be described as:
 - a) Granite gneiss
 - b) Granulite
 - c) Gneiss
 - d) Gneissic granite
 - e) Leucocratic schist



Compiled by David M. Abbott, Jr., CPG-04570
 5055 Tamarac Street, Denver, CO 80238
 303-346-6112, dmageol@msn.com

Topical Index-Table of Contents to the Professional Ethics and Practices Columns

A topically based Index-Table of Contents, "pe&p index.xls" covering columns, articles, and letters to the editor that have been referred to in the PE&P columns in Excel format is on the AIPG web site in the Ethics section. This Index-Table of Contents is updated as each issue of the TPG is published. You can use it to find those items addressing a particular area of concern. Suggestions for improvements should be sent to David Abbott, dmageol@msn.com

Donating your personal files

Dr. Jon Thorson, CPG-10994, wrote asking me about the ethics of donating one's old files to a state geological survey or other suitable repository. Creating and maintaining such data repositories would help prevent having to re-acquire the same data. Unfortunately, this is a topic without a simple answer. The answer involves who owns what. Your interpretations are yours but even so, you may not be free to share them. The company for whom you worked owns the data on which your interpretations are based. If your report was publicly filed with a regulatory agency like a 43-101 report that was filed with a Canadian securities authority, then the report is public, and you can distribute copies. Otherwise, the question is complex.

Discussions related to this topic have appeared in numerous previous columns. "Conflicts of interest: data ownership and personal files" was addressed in Column 33 (Aug '98) and amplified in column 36 (Nov '98). Do we have the right to (1) keep a copy of the information, or (2) use it at some later time to develop exploration targets. I would say that if the work was paid for by a client, the client's permission would be required before the data could be used for another purpose. What if the client is no longer in business? Or, more fundamentally, do we even have the right to keep copies of reports that we generate? This question was addressed in connection with subpoenas for our reports in Column 83 (Apr '03) that addressed the issue that our reports are professional services rather than work product in Column 85 (Jul '03) and therefore we should keep copies of reports in case we have to defend them. This does not mean that we can make them public. This position was discussed extensively in

Column 136 (Nov '11). In Column 154 (Apr '15), the question was raised regarding a client firm that no longer existed and there was no evidence of merger, acquisition of the property interest, etc. The question was raised regarding uranium exploration projects in the 1970s that were abandoned but which were the subject of renewed interest in 2007 (Column 109, May '07). This column contained an extensive review

entists by M.A. Chan and D.H. Mogk was published in the August 2023 issue of GSA Today (<https://doi.org/10.1130/GDA-TG559GW.1>). The article reports on the results of a 46-question survey to which 810 responses were received from a broad range of respondents in the US and foreign countries. The issues addressed were obtaining permission for collecting samples, the degree to which oversampling may have occurred, the fate of the samples collected (stored or tossed out), and the degree of training on sampling ethics. One of the areas requiring far more attention by students and others is the concept of "leave no trace" when sampling. The topic, "Ban indiscriminate hammering and other outcrop destruction" appeared in Column 155 (Aug '15). Various aspects of sampling have been discussed in this column (see the PE&P index.xlsx file <https://aipg.org/page/EthicsIndex>). The Geological Society of America has established a field ethics and sampling website (www.geosociety.org/fieldethics) that includes the attached Figure 1, a field ethics and sampling checklist. This is a useful tool to guide the planning and implementation of your sampling programs.



Figure 1. GSA sampling ethics chart.

of the issues. In summary, there is no clear answer, particularly if a current holder of the property interest can be identified.

Sampling Ethics

An article, *Establishing an Ethic of Sampling for Future Generations of Geosci-*

entists by M.A. Chan and D.H. Mogk was published in the August 2023 issue of GSA Today (<https://doi.org/10.1130/GDA-TG559GW.1>). The article reports on the results of a 46-question survey to which 810 responses were received from a broad range of respondents in the US and foreign countries. The issues addressed were obtaining permission for collecting samples, the degree to which oversampling may have occurred, the fate of the samples collected (stored or tossed out), and the degree of training on sampling ethics. One of the areas requiring far more attention by students and others is the concept of "leave no trace" when sampling. The topic, "Ban indiscriminate hammering and other outcrop destruction" appeared in Column 155 (Aug '15). Various aspects of sampling have been discussed in this column (see the PE&P index.xlsx file <https://aipg.org/page/EthicsIndex>). The Geological Society of America has established a field ethics and sampling website (www.geosociety.org/fieldethics) that includes the attached Figure 1, a field ethics and sampling checklist. This is a useful tool to guide the planning and implementation of your sampling programs.

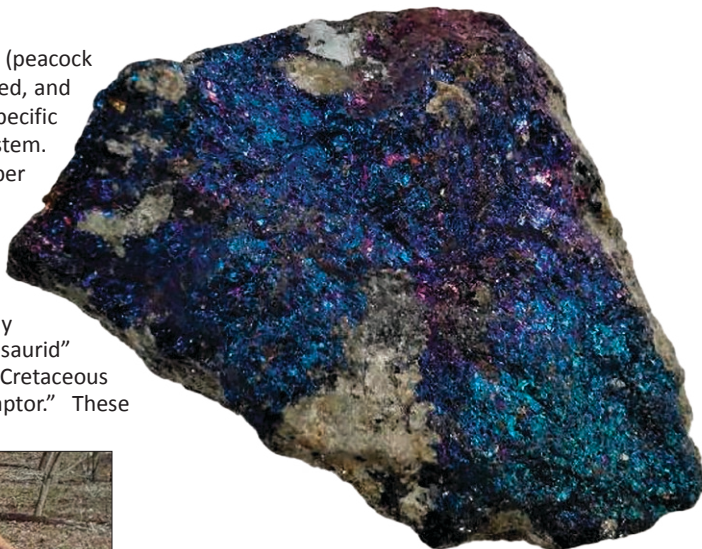
AI, ChatGPT, Bing Chat, etc. — Discussions Continued

Column 187's discussion of AI and ChatGPT covered a variety of aspects of the evolution of AI programs, both the good and the bad. Discussions of the issues continue. Bing Chat, Microsoft's version that is incorporated in Microsoft Edge, is an easy-to-use method of getting answers to questions using AI rather than the web-search-based meth-

Continued on p. 35

Answers:

1. The answer is choice “b” or “Copper.” “Bornite” or Cu_5FeS_4 (peacock ore) has a metallic luster with iridescent purple, blue, copper-red, and bronze-brown shades. The mineral has a hardness of 3, a specific gravity of 5.06 to 5.09, and crystallizes in the orthorhombic system. It is mined and smelted to produce copper electrical wires, copper tubing and plumbing pipes, as well as coins, etc.
2. The answer is choice “c” or “Theropod.” “Deinonychus” is a genus of a dromaeosaurid theropod dinosaur. It has one described species, “Deinonychus antirrhopus.” The animal could grow up to 11 feet in length and lived during the early Cretaceous Period (about 115–108 million years ago). “Dromaeosaurid” dinosaurs were carnivorous and bipedal specimens of a late Cretaceous family which included “deinonychus” as well as “velociraptor.” These predators had a large slashing claw on each hind foot.



“Deinonychus.” Outdoor exhibit at the Heard Natural Science Museum and Wildlife Sanctuary, McKinney, Texas.

3. The answer is choice “b” or “ $C = (\text{Hp}_c - \text{Ap}_w - \text{Bp}_o) / \rho_m$ ”; the proof follows. Please refer to the diagram in the question and note that “g” is the acceleration of gravity. Also note that P_1 and P_2 are pressures at the respective points shown and that they must be equal at the level of isostatic compensation. Thus:

$$P_1 = \text{Agp}_w + \text{Bgp}_o + \text{Cgp}_m \quad (1)$$

$$P_2 = \text{Hgp}_c \quad (2)$$

$$P_1 = P_2 \quad (3)$$

$$\text{Agp}_w + \text{Bgp}_o + \text{Cgp}_m = \text{Hgp}_c \quad (4)$$

$$\text{Ap}_w + \text{Bp}_o + \text{Cp}_m = \text{Hp}_c \quad (5)$$

$$\text{Cp}_m = \text{Hp}_c - \text{Ap}_w - \text{Bp}_o \quad (6)$$

$$C = (\text{Hp}_c - \text{Ap}_w - \text{Bp}_o) / \rho_m \quad (7)$$

Equation (7) is the answer to the question. If we assume that the average thickness of oceanic and continental crusts are 5 km and 23 km, respectively, the “C” value approximates 13 km. As may be expected, under mountain chains with deep roots the “C” value increases accordingly.

4. The answer is choice “d” or “aluminum.” Corundum is aluminum oxide (Al_2O_3). Calcium, magnesium and zinc are divalent cations (Ca^{++} , Mg^{++} , Zn^{++}), whereas aluminum is a trivalent cation (Al^{+++}). Two Al^{+3} combine with three O^{-2} to balance out the formula for corundum. As we know, varieties of corundum include the gemstones zaphire and ruby.
5. (Answer submitted by David M. Abbott, Jr., CPG-04570).

The answer is choice “d” or “Gneissic granite.” Gneissic granite would be the most likely given chemical equivalence. While the biotite and other minerals provide a foliated fabric justifying the “gneissic” adjective, the basic rock is granitic.

A granulite is a much higher grade, dehydrated metamorphic rock that wouldn’t contain biotite.

Gneiss contains a greater percentage of biotite and other mafic minerals than would be present in a gneissic granite and more typical of a metamorphosed greywacke.

Leucocratic schist describes a light-colored rock with a schistose fabric like a muscovite-rich schist.

The answer depends on whether the original minerals remain or are changed into new minerals like muscovite from K-spar.

Professional Ethics, continued from p. 33

odology we've been using for several years now. Bing Chat can also generate new images, essays, computer code, text, and more. AI programs increasingly evolve and improve. It is a technology that we all must learn to use and to be aware of abuses and potential for misinformation.

Vision for an Ethical Professional Organization

Contributed by Sara Pearson (CPG-10650).

The vision of AIPG's founding steering committee was to establish a national organization of individuals, not of scientific societies.¹ According to the *History of AIPG 1963-2003*, the steering committee unanimously adopted the following Statement of Purpose:

WHEREAS, the geological profession has no nationwide structure dedicated to the establishment and maintenance of professional standards, and

WHEREAS, the public has an uncertain concept of the identity of this profession, and

WHEREAS, both the public and profession have insufficient protection against unethical and inadequate standards as related to the geological profession, and

WHEREAS, the profession lacks proper legal status in the eyes of its members, the public and the courts.

A professional organization herein designated as the American Institute of Professional Geologists be established to take the action necessary to strengthen the profession by the establishment and constant evaluation of its qualifications and thereby to enhance and preserve the standing of the geological profession in the public community. And that standards be established which will insure the protection of both the public community and the profession from non-professional practices.

The committee also established a set of professional, not scientific, responsibilities for AIPG and its members including defining who is a professional geologist, protecting reputable geologists from those who would engage in unethical practices in the name of the profession, protect the public from incompetent persons purported to be geologists and establish a system of certification.

This was 60 years ago when 11 prominent geologists felt so strongly about the

“ **Arguably, the public's misconceptions or misunderstanding of the geosciences is just as relevant today as it was 60 years ago, if not more so.** ”

need to establish national standards for certified professional geologists to separate themselves and others who value the profession from individuals professing to be experts and acting unethically. They saw how individuals acting unethically harmed the profession and threatened the public's safety, health, and welfare. They strategically selected our guiding principles of competence, integrity, and ethics. The Code of Ethics was among the first items of business at the first steering committee meeting.

Fast forward to 2023, the guiding principles are just as relevant today. As professionals in the geosciences, how many can say that they have not experienced or heard of unethical behaviors by those working in the geosciences? In recent years, ethics has received more time in the spotlight being referenced more and more in the news media, as an example, regarding a multitude of professions, not just geosciences. Is this an indicator that more people are acting unethically today? Is this an indicator of the “instant” information age that we live in thanks to social media? Is this an indicator of changing ethics standards in society? Something else? What do you think?

More interestingly is the second item in the original Statement of Purpose, which is that our founders felt that the public had an uncertain concept of the identity of our profession. This is often a topic of discussion that the Executive Committee and professionals in other circles have had in recent years. For example, how many of us who majored in the geosciences in college went to school with the intent of becoming a geoscientist? How many of us discovered the geosciences along the way taking an elective class and fell in love with the science? Arguably, the public's misconceptions or misunderstanding of the geosciences is just as relevant today as it was 60 years ago, if not more so. Do the movements that we have experienced in recent years dismissing science affect how the public views us? Could this be because

of unethical behaviors, incompetence, or lack of integrity by those professing to be expert geoscientists?

The founding members also felt that the public and the profession needed to be protected from unethical behaviors. Should we feel the same way today as they did back then? Considering the significant natural disasters that appear to be of greater intensity, larger magnitude, and are more costly than ever before, it could be debated that protection of public health, safety, and welfare is more imperative today than in the past.

AIPG was given the responsibility of being the voice of the profession to the public, to the regulatory authorities, to the legal system, and the policy makers. Can AIPG make an impact on how the public views our profession through the promotion of professional ethics, integrity, and competence? Can the guiding principles of competence, integrity, and ethics be incorporated into actions that will improve the public's perception of the profession or protecting the public health, welfare, and safety?

Public Perception of the Profession

Contributed by Sara Pearson (CPG-10650).

Under Canon 2 of the AIPG Code of Ethics, members are expected to promote public awareness of the effects of geology and geological processes on the quality of life. Scrolling through YouTube in November 2023 looking for updates on the volcanic activity in Iceland and potential for a new eruption, I found an excellent example of a geologist explaining the seismic activity happening in Iceland, which instantly reminded me of Canon 2. Geology Professor Shawn Willsey at the College of Southern Idaho was sharing facts and data from the Icelandic Meteorological Office and other sources, providing interpretations of data, and answering followers' questions. He was candid with what he knew, what was

1. Proctor, Richard J. 2004. *A History of AIPG 1963-2003*.

opinion, and more impressively, what he did not know lending to his transparency and honesty in his explanations. His approach is conversational, he uses geologic terms mixed with relatable examples for the public, and he speaks with empathy for the people whose homes and lives are in upheaval. The comments by many of his followers/subscribers validate this impression showing they trust his explanations, enjoy his teaching, and overall building a positive impression of the profession. Willsey is also the author of *Geology Underfoot in Southern Idaho* and co-author of *Roadside Geology of Idaho*.

While it has been more common to talk about violations of the code, what about focusing on examples of what we are doing right? This example embodies the vision of the Code of Ethics and the purpose of our organization. Do you have an example to share? Please send your examples to the Editor.

Follow Up on Fonts

Contributed by *Sara Pearson (CPG-10650)*.

Columns 185 (Apr/May/June 2023) and 187 (Oct/Nov/Dec 2023) delved into the directive from the US State Department mandating the use of the Calibri font to enhance accessibility for individuals with dyslexia and visual challenges, as well as for Optical Character Recognition. The latter column also highlighted the utility of the typewriter-based monospaced Courier font, emphasizing its consistent spacing for each letter to enhance character recognition and readability.

AIPG's objective is to be inclusive and ensure that publications cater to a diverse audience, thereby enhancing the accessibility of *The Professional Geologist*. Transitioning to Calibri font represents a logical progression towards this goal. In the first issue of 2024, this font change not only aims to improve readability, it also seeks

to give the publication a fresh, modern appearance.

Contributions to this column are welcomed

As Dr. Jon Thorson's question about donation of old files to a data repository that begins this column is an example of the type of questions I love to receive from readers. Such questions may address topics I haven't thought of but that warrant discussion. Or, like Thorson's question, warrant renewed discussion. Sara Pearson also contributed to this column. Please send me any questions or discussions of ethical and practice issues that occur to you. Your contributions will be acknowledged and demonstrate that you have spent time considering ethical and practice issues if you are required to report such activities as part of a professional development program.



The Utility of Look-the-Part PPE:

Geologists often work in the field and sometimes encounter landowners and residents who were not informed that field work would be taking place on or near their property. In some cases, residents can get upset and even violent if they perceive someone as a trespasser. In my work in rural southern California, members of my project team have had firearms brandished at them multiple times, when residents thought the workers had no business being there. One measure that we use to mitigate this risk is the concept of Look-the-Part Personal Protective Equipment (PPE).

At times, our work can involve fairly few physical hazards. Perhaps we are completing a Phase I Environmental Site Assessment visit, just checking some instrument readings, or taking photographs. A review of the hazards may indicate that the usage of a hard hat, safety glasses, traffic safety vest, work gloves, long pants, or work boots are not required for the task.

However, donning our full Level D PPE not only protects us from unexpected hazards, but it also helps communicate to those around us that we are serious workers doing an important job, and are not trespassing for nefarious purposes. Like the saying goes, you can go anywhere if you carry a clipboard. Your highly visible Level D PPE can help to give the community an assurance that you are supposed to be there and are not attempting to hide your presence.

The addition of amber vehicle light bars, company vehicle placards, and a company ID displayed on your vest completes this look, allowing your name and company to be easily identified by interested parties. Always have the Project Manager's or client's contact information handy to provide to anyone with questions. Allow your PPE to perform double duty, not only protecting you from physical hazards, but security hazards as well!

Submitted by Anna Sutton, PG, MEM-2528



Congratulations

New

Certified Professional Geologists!

January 1, 2023 - November 17, 2023

Section	Name	AIPG Member Number
Alaska	Matthew W. Blakeslee	CPG-12178
Alaska	Bonnie N. Broman	CPG-12179
Alaska	Luke A. Hoffmann	CPG-12177
Alaska	Kyle A. Negri	CPG-12191
Alaska	Amanda L. Willingham	CPG-12194
Arizona	Miles C. Hearn	CPG-12159
Colorado	Jacob L. Anderson	CPG-12160
Colorado	William G. Cutler, PhD	CPG-12173
Colorado	Kyle D. Erdmann	CPG-12185
Colorado	Amanda C. Irons	CPG-12166
Colorado	Michele V. Kashouh	CPG-12167
Colorado	Sean Kosinski	CPG-12174
Colorado	Owen G. Nicholls	CPG-12163
Georgia	Simon K. Kline	CPG-12186
International	Vivekanand Acharya, PhD	CPG-12193
International	Shabeer Ahmed, PhD	CPG-12169
International	Henry Kim	CPG-12196
International	Castulo Molina Sotelo, PhD	CPG-12170
International	Olga Raventos Ortega	CPG-12190
International	Sarah L. Wootton	CPG-12188
Michigan	Joseph R. Bolin	CPG-12162
Michigan	Christopher D. Carew	CPG-12195
Michigan	Michael K. Cox	CPG-12161
Michigan	Zachary S. McCurley	CPG-12181
Michigan	Barrett M. Walquist	CPG-12184
Minnesota	Steven M. Pinta	CPG-12171
Nevada	David R. Boden, PhD	CPG-12164
Nevada	David A. Browning	CPG-12182
Nevada	Graeme Davis	CPG-12189
Nevada	Anthony M. Gesualdo	CPG-12187
Nevada	Curtis P. Kortemeier	CPG-12180
Northeast	Kristen M. Amodeo	CPG-12175
Northeast	Dylan E. Eberle, PhD	CPG-12165
Oregon-Washington	Andrew D. Nelson	CPG-12172
Texas	Gilbert Gabaldon	CPG-12192
Texas	Javier B. Rojas-Pochyla	CPG-12176
Texas	John M. Seeley, PhD	CPG-12155
Texas	Michelle K. Transier	CPG-12168
Texas	Brett R. Whiteley	CPG-12183
Texas	Robert E. Williams Jr.	CPG-12158
Virginias	William L. Lassetter Jr.	CPG-12197

COMPETENCE

INTEGRITY

ETHICS

Pioneering
Excellence

The
Gold
Standard
in
Geoscience
Professionalism.



The *Perseverance* Rover: An Exciting Camp Towards Summitting the Red Planet

Isaac Pope, SA-9950
Colorado School of Mines, Golden, Colorado

Like a distant peak just out of reach above the horizon, Mars has beckoned to humanity with its mysterious yet eerily familiar history. Among our closest solar system neighbors, the Red Planet represents an exciting undiscovered country at the edge of our scientific society. Reaching it has required many “camps” along the path towards reaching the Red Planet’s summit, yet in those camps are the intersection of intellectual discovery, scientific ingenuity, and untold adventure.

Launched on July 30, 2020, from Cape Canaveral, the Mars 2020 Mission represents the latest of these scientific quests. With a project budget of 2.75 billion dollars, the Jet Propulsion Laboratory crafted the car-sized *Perseverance* rover and accompanying

miniature helicopter *Ingenuity* to further survey and sample the Martian surface. Following nearly a decade of engineering since NASA unveiled the project at the 2012 American Geophysical Union Annual Meeting, the Jet Propulsion Laboratory crafted one of the most advanced survey teams yet sent to Mars (Wall, 2012). Several key features helped mark the *Perseverance* rover from its smaller predecessor *Curiosity* (see NASA, n.d.). Drawing from a radioisotope thermoelectric power generator fueled by the decay of Plutonium-238, the *Perseverance* rover contains a sophisticated suite of sampling technology for collecting 54 cores from various waypoints on the Martian surface and depositing them in small cylinders for later delivery to Earth (figure 1). To that end, the *Perseverance* rover was prepared with a variety of

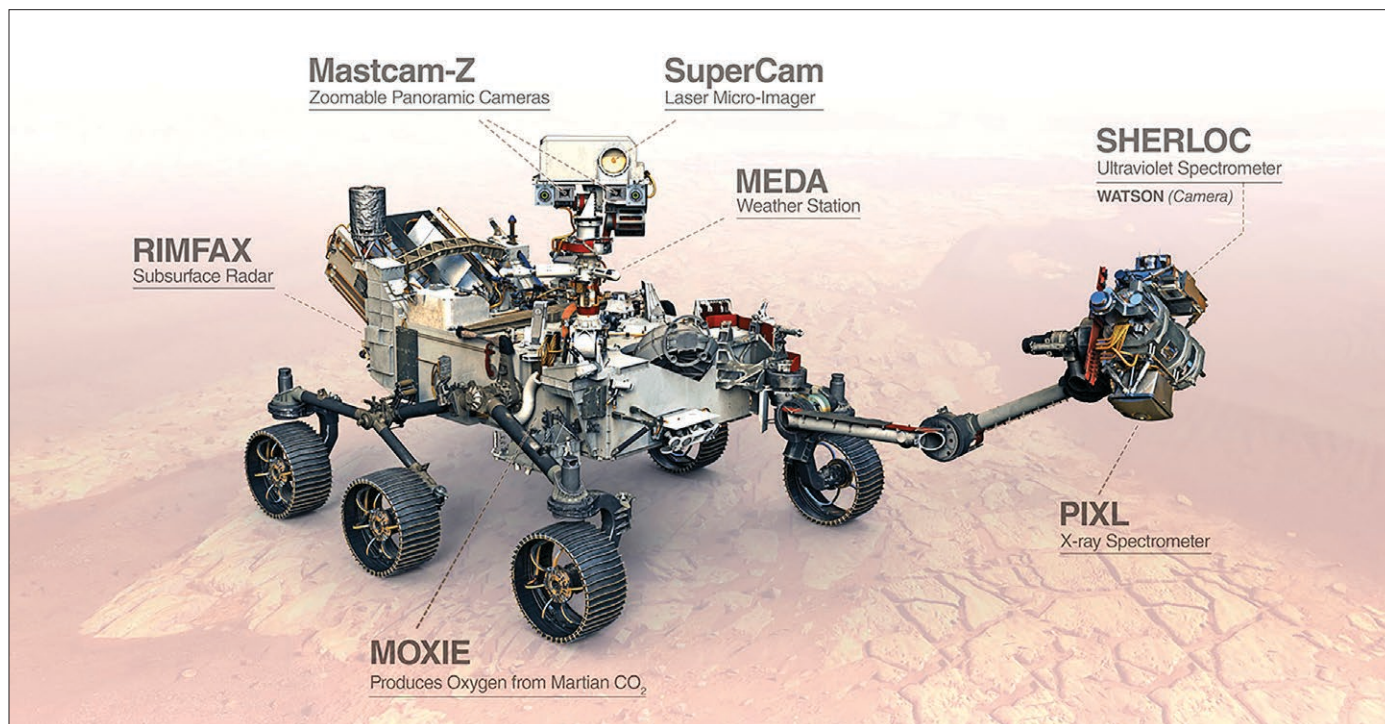


Figure 1. Drawing from a radioisotope thermoelectric power generator, the *Perseverance* rover is prepared with a variety of instruments. A Raman spectrometer enables the rover to ascertain the presence of organics in regolith, while a SuperCam visually identifies the mineralogy of encountered specimens. Image in the public domain.

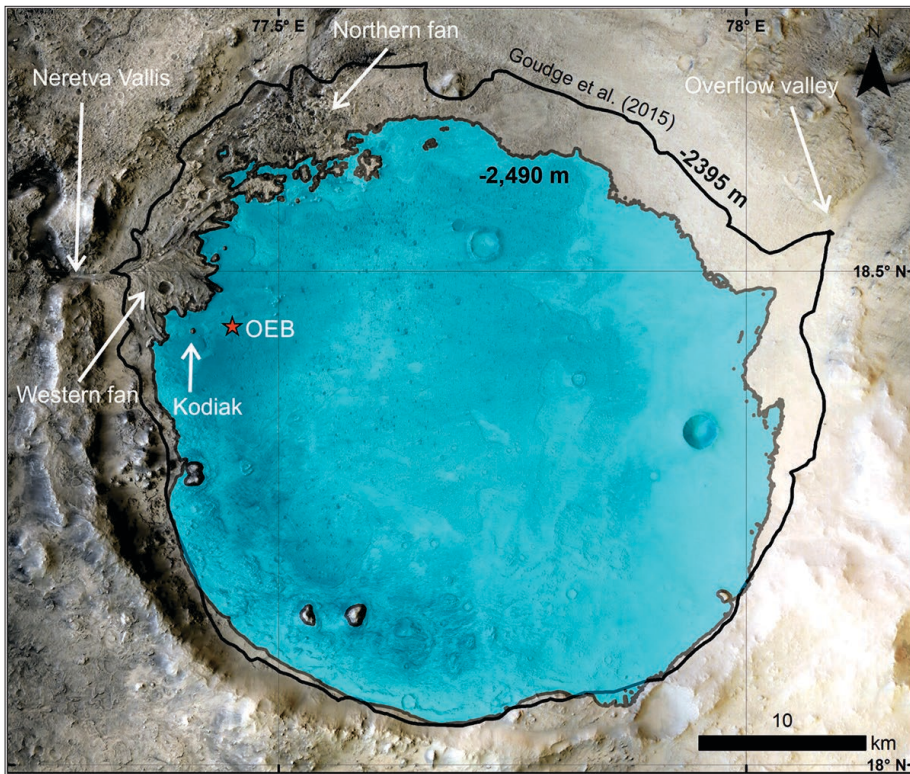


Figure 2. Boundaries of the inferred paleolake being investigated by the *Perseverance* rover. “OEB” is the Octavia E. Butler landing site where the rover’s journey began before it headed towards the Western fan. Image from figure 5 in Mangold et al. (2021).

instruments. A Raman spectrometer would allow the rover to ascertain the presence of organics in regolith, while a SuperCam would be employed to visually identify the mineralogy of the rocks encountered even if at a distance. All the while, the investigation would be heavily photographed. With its uniquely prepared system, the robotic team was sent as emissaries to the undiscovered country.

Landing February 18, 2021, after nearly seven months in transit, the *Perseverance* rover proceeded to arrive within five meters of the planned target, becoming the most accurate NASA landing on Mars (NASA, 2021). This was but the first of many superlatives attained by the mission while the heat shield and parachute landed within a few kilometers of the rover. Within eleven minutes after contact, NASA received news a successful mission had begun (NASA, 2021).

Since the beginning, the *Perseverance* rover and its helicopter had been sent to Mars for one mission: to peer into the chasm of time (Stack-Morgan, 2022). NASA scientists established three objectives. First, studying the prebiotic chemistry of early Mars could provide a proxy for early Earth, while absolute age dates could finally be assessed rather than the current reliance on relative cratering age. Even so, the primary mission has been the discovery of organic material on Mars. Potential organic signatures had been detected on Mars, yet nothing substantial had yet emerged. The *Perseverance* rover was tasked with investigating the ancient Martian surface to document whatever vestiges of life, if any, might exist.

Towards that end, the *Perseverance* rover landed in Jezero Crater. One of the largest craters on the Martian surface, Jezero Crater presents the only memory of a long lost paleolake on ancient Mars (Mangold et al., 2021). Well protected within the confines of the impact crater, the lake and delta deposits are some of the best

preserved on Mars, giving a window into planetary evolution hosting a variety of hospitable environments (Stack-Morgan, 2022).

The crater is characterized by several environs (Stack-Morgan, 2022). First, the hosting basement of igneous rocks that comprise the crater floor supported water-rock interactions and chemical gradients conducive to a hydrothermally fed habitat. Mudstones or chemical precipitates deposited in the lake adorned the adjoining delta deposits while coarse-grained rocks representing higher-energy river environments dominated the higher reaches. Upstream, the deltas above the crater rim are carbonates representing shallow lake margin deposition. It is in this complex web that the remains of life, should any exist, would most likely rest. Common in many paleolakes on Earth, perchlorates may too be present in the bottomset beds of the crater deposits where the hypothesized perchlorate-reducing microbial environments that feed upon them may be preserved (Lynch, 2015). It is in these deposits that *Perseverance* rover was tasked with discovering any Martian vestiges of life that may exist.

Since its landing, the rover and accompanying helicopter have been in continuous use for nearly 900 Earth days as it travels towards the delta (see Mangold et al., 2021, and Stack-Morgan, 2022, for summary of geologic discoveries). The first encountered scarps quickly revealed classic prograding delta deposits not unlike those documented on Earth. Some of these deposits hint at a high energy pulse late in deltaic formation resulting in several bouldery deposits. Some of these are similar to Keranitis deposits in Greece with matrix supported deposits bearing cobbles tens of centimeters across, suggesting a past hydroplaning debris flow. On the crater floor, the mafic composition of igneous Maaz Formation was quickly verified along with evidence of sulfate hydrothermal alteration. Some challenges were faced with sample collection of the hard igneous rock as the drill seemed to pulverize the core, leaving a few unsuccessful cores. Even so, one site was particularly rich in an olivine cumulate rock possibly from a ponding lava flow.

Heading higher upon the delta, siltstones were encountered that were rich with sulfates from diagenesis or lake precipitate. Graded laminations were found in the Enchanted Lake area. As often found on Earth, these tend to be highly efficient preservational sites for fossils, yet the *Perseverance* rover has yet to find such evidence.

Among the most recent investigations by the *Perseverance* rover has been of a scarp 70 to 80 meters in thickness, likely representing the youngest deposits of a delta nearly 200 meters thick. Unsurprisingly, sands are mostly locally derived from mafic and ultramafic silicates (e.g., olivines), yet no evidence of life had yet been revealed from those sands. Though within sight of the carbonate flats above the rim of the crater, the *Perseverance* rover has been redirected to return to the sample caches after following a wide transect along the northern rim of the crater. Like a beacon on the lighthouse to the ships, the Ingenuity miniature helicopter

Continued on p. 46



Geoscience Education, Research, and Careers: Towards New Roadmaps

Rasoul Sorkhabi, Ph.D., CPG-11981

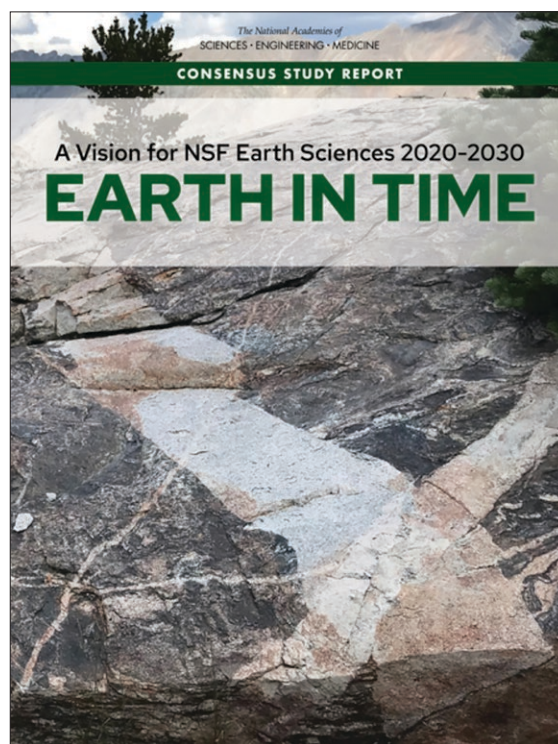
Dr. Rasoul Sorkhabi is a professor at the University of Utah's Energy & Geoscience Institute, Salt Lake City. Email: rsorkhabi@egi.utah.edu

When the field of geology emerged at the beginning of the 19th century, it grew rapidly. The philosopher and historian of science, William Whewell, who happened to live and witness this phenomenal emergence of geology and was actually the President of the Geological Society in London, called it (in his presidential address in 1839) the “the heroic age of geology.” Giants like Charles Lyell and Charles Darwin dominated and advanced the field throughout the 19th century; geology was a respected and reputed science; and field trips were led and attended by “gentlemen geologists” in their charming attires. It was, however, during the 20th century that geoscience made revolutionary discoveries, including plate tectonics, radiometric dating of rocks, subsurface seismic imaging, and so forth. Now in the early part of the 21st century, geoscience and its community are facing daunting challenges including (1) low college enrollments, (2) downsizing, merging or even slashing of geoscience departments, (3) decline in the oil and gas industry (historically a major employer of geology and geophysics graduates), and (4) public images of “dirty coal or oil finders” (energy), “dirt diggers – but no way in my backyard” (mining and field work), and “earthquake lovers” (natural hazards). Our century is neither the 19th nor the 20th century; we are living in a new era among new generations, facing new competitions, and perhaps even an “identity crisis.” We need new roadmaps for our education, research, mentoring, careers, employment, collaborations, publications, and outreach; we need new public images for our profession and renewed validations for the vital relevance of our work to society and science. (In the 2015 film *A Walk in the Woods*, based on Bill Bryson’s book of the same title, Bryson – played by Robert Redford – tries to explain geology and plate tectonics to an old friend who is accompanying him on the Appalachian walk, and the friend remarks, “Who gives a damn to the shifting tectonic plates.”).

With this statement of the problem, here I am reviewing four reports recently published by various reputed agencies that discuss how to reprogram and refresh geoscience in all its aspects, from education and research to employment and societal contributions.

A Vision for NSF Earth Sciences 2020-2030: Earth in Time¹

A Vision for NSF Earth Sciences 2020-2030: Earth in Time, published by the US National Academies of Sciences, Engineering, and Medicine in 2020, was prepared by the “Committee on Catalyzing



Opportunities for Research in the Earth Sciences (CORES): A Decadal Survey for NSF’s Division of Earth Sciences,” “Board on Earth Sciences and Resources,” and “Division on Earth and Life Studies” of the Academies. Dozens of geoscientists were involved in writing and reviewing the report. They have suggested 12 key problems as the focus of research projects sponsored by the NSF’s Division of Earth Science. They include the following:

1. How is Earth’s internal magnetic field generated?

“Understanding what has powered the geodynamo through time and what controls its rate of change is crucial for understanding interactions from Earth’s interior to the atmosphere, as well as the human activities that are impacted by the geomagnetic field.”

1. National Academies of Sciences, Engineering, and Medicine (2020) *A Vision for NSF Earth Sciences 2020-2030: Earth in Time*. The National Academies Press, Washington, DC. <https://doi.org/10.17226/25761>.

2. When, why, and how plate tectonic start?

“Plate tectonics produces and modifies the continents, oceans, and atmosphere, but there remains a lack of fundamental understanding of when plate tectonics developed on the Earth, why on the Earth and not on other planetary bodies, and how plate tectonics developed through time.”

3. How are critical elements distributed and cycled in the Earth?

“The cycling of critical elements essential for geologic processes creates suitable conditions for life and provides the ingredients for materials necessary for modern civilization, yet fundamental questions remain about how elements are transported within the Earth across a range of spatial and temporal scales.”

4. What is an earthquake?

“Earthquake rupture is complex, and the deformation of the Earth occurs over a spectrum of rates and in a variety of styles, leading Earth scientists to reconsider the very nature of earthquakes and the dynamics that drive them.”

5. What drives volcanism?

“Volcanic eruptions have major effects on people, the atmosphere, the hydrosphere, and the Earth itself, creating an urgent need for fundamental research on how magma forms, rises, and erupts in different settings around the world and how these systems have operated throughout geologic time.”

6. What are the causes and consequences of topographic change?

“New technology for measuring topography over geologic to human time scales now makes it possible to address scientific questions linking the deep and surface Earth and urgent societal challenges related to geologic hazards, resources, and climate change.”

7. How does the critical zone influence climate?

“The reactive skin of the terrestrial Earth influences moisture, groundwater, energy, and gas exchanges between the land and atmosphere, and its influence on climate is therefore a vital component of understanding the Earth system and how it has responded and will respond to global change.”

8. What does Earth's past reveal about the dynamics of the climate system?

“Evidence of both long-term and rapid environmental change in Earth's history provides key baselines for comparison to modern change, helps to elucidate Earth system dynamics, provides magnitudes and rates of change, and plays a critical role in predicting future change.”

9. How is Earth's water cycle changing?

“Understanding current and future changes to the water cycle requires fundamental knowledge of the hydro-terres-

trial system and how the water cycle interacts with other physical, biological, and chemical processes.”

10. How do biogeochemical cycles evolve?

“To quantify the role of biology through time in the formation and weathering of rocks and minerals, the cycling of carbon, and the composition of the very air we breathe requires a deeper understanding of biogeochemical cycles.”

11. How do geological processes influence biodiversity?

“The diversity of life on the Earth is a major characteristic of the planet and yet we do not fully know how it came to be. We need to understand how and why diversity has varied over time, environment, and geography, including major events like extinctions.”

12. How can Earth science research reduce the risk and toll of geohazards?

“A predictive and quantitative understanding of geohazards is essential to reduce risk and impacts and to save lives and infrastructure.”

The publication also discusses infrastructures, facilities, and partnerships within the US to address the above “scientific priority questions” for the NSF’s 2020-2030 decade.

This NSF report is actually a follow-up to a previous and similar effort entitled *Solid-Earth Science and Society* (1993)², which had suggested four objectives for the 1990s: (1) Understand the processes involved in the global earth system, with particular attention to the linkages and interactions between its parts (the geospheres); (2) Sustain a sufficient supply of natural resources; (3) Mitigate geological hazards; (4) Minimize and adjust to global and environmental change. The 1993 Report also selected five research areas for achieving the above-mentioned goals: (1) Global paleoenvironments and biological evolution; (2) Global geochemical and biogeochemical cycles; (3) Fluids in and on the Earth; (4) Dynamics of the crust (oceanic and continental); (5) Dynamics of the core and mantle. It would be very useful if the NSF or the National Academies would also publish a progress report on how these objectives and research areas were fulfilled during the decade 1990-2000.

AGI's 2020 Report on Critical Needs and the Geosciences³

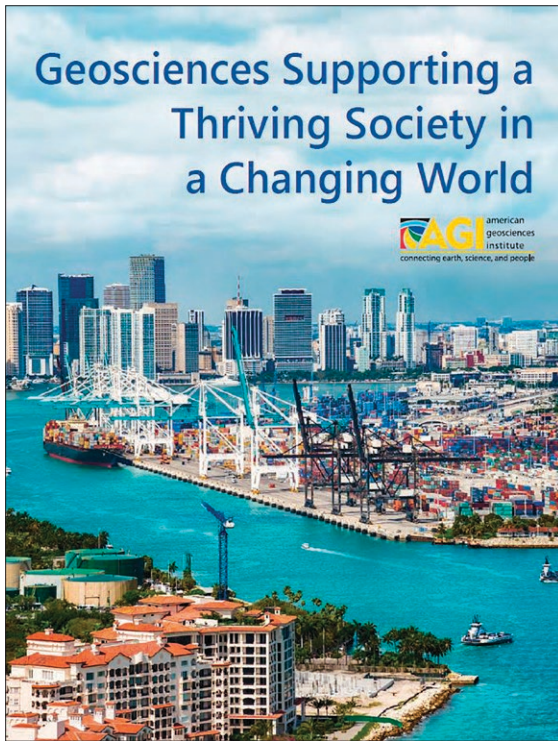
In 2020 the American Geoscience Institute published *Geosciences Supporting a Thriving Society in a Changing World* with a focus on the practical aspects of geoscience. It was prepared by the “Critical Needs Authoring Committee” with members from 13 professional societies in the USA. They suggested the following critical needs to which geoscience can significantly contribute:

1. Climate Change + Resilience, Adaptation, and Sustainability:

“Climate change mitigation involves taking actions to reduce the amount of carbon dioxide in the atmosphere, thus reducing risks associated with a changing climate. Adaptation helps society and natural systems to deal with consequences of climate change. Managing risks from cli-

2. National Research Council (1993) *Solid-Earth Sciences and Society*. Washington, DC: The National Academies Press. <https://doi.org/10.17226/1990>.

3. AGI (2021) *Geosciences Supporting a Thriving Society in a Changing World*. American Geosciences Institute, Alexandria, VA. <https://www.grow-geocareers.com/assets/files/CriticalNeeds2020.pdf>



mate impacts protects communities and ecosystems and strengthens the resilience of the economy.”

2. Water + High Quality Geospatial Data and Maps:

“Understanding the distribution of rock units and their geologic, chemical, and physical properties benefits the water resources community. Knowledge of which units have high, low, or no porosity; fracture vs. inter-granular porosity, etc., is essential in assessing groundwater hydrology.”

3. Energy + Technology & Engineering:

“Innovative technology and engineering is essential to understanding alternative exploration scenarios for energy resources.”

4. Natural Hazards + Infrastructure:

“Levee, floodwall and dam failures can be anticipated and avoided with proper assessments.”

5. Natural Hazards + High Quality Geospatial Data and Maps:

“High quality mapping of bedrock and surficial materials is essential to understanding processes that involve the potential for natural hazards. Examples include mapping active faults or the relative stability of slope materials that could lead to landslide or produce slow mass-movement hazards.”

6. Soils + Global Change:

“Global changes in temperature, precipitation, and nutrients will impact soils and agriculture in the United States.”

7. Mineral Resources + Technology & Engineering:

“Mineral resources provide critical components for items that society relies on every day such as cell phones, batteries, and cars. Technology and engineering help geoscientists understand the extent and accessibility of the nation’s mineral resources.”

8. Oceans & Coasts + Resilience, Adaptation, and Sustainability:

“Coastal cities across the U.S. are becoming more sustainable and resilient to disasters such as coastal flooding and hurricanes through adaptation informed by geoscience research.”

9. Oceans & Coasts + Infrastructure:

“Ports are an important economic driver in coastal areas that create American jobs and help transfer goods to communities across the nation. Ports also serve as significant resources for national defense and emergency preparedness.”

10. Waste Disposal + Public Health:

“Poor waste handling and disposal can lead to environmental pollution and cause diseases in animals and humans.”

11. Workforce + Thriving Economy:

“A strong geoscience workforce can help create a thriving society by sharing their knowledge with the public and helping people to understand Earth’s processes. A workforce made of people from diverse backgrounds is best positioned to respond to our Nation’s needs, including ensuring a society safe from changing hazards.”

It should be noted that the AGI has also published several “critical needs” reports in 2008, 2012, 2016. These are available on the AGI’s website.⁴

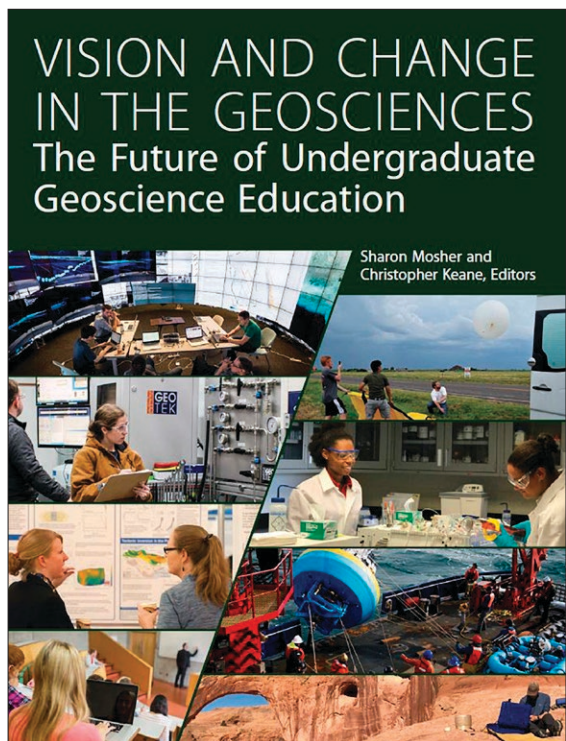
AGI/NSF 2021: Vision and Change in the Geosciences⁵

In 2021, the American Geoscience Institute published *Vision and Change in the Geosciences: The Future of Undergraduate Geoscience Education*, edited by Sharon Mosher (of the University of Texas at Austin) and Christopher Keane (of AGI). This study prepared by 10 geoscientists from various universities was supported by a five-year NSF research grant (2014-2019, “Future of Undergraduate Geoscience Education”). The NSF project involved several summits and gatherings of more than 1,000 geoscientists in total. Three critical questions were tackled:

- (1.) What concepts, skills, and competencies do undergraduates need to succeed in graduate school and/or the future workforce?
- (2.) What are the best teaching practices and most effective uses of technology to enhance student learning?
- (3.) How do we recruit, retain, and ensure success of a diverse and inclusive community of geoscience majors and support

4. <https://www.americangeosciences.org/policy/critical-needs/2016>

5. Sharon Mosher and Christopher Keane (Eds) (2021) *Vision and Change in the Geosciences: The Future of Undergraduate Geoscience Education*. American Geosciences Institute, Alexandria, VA. <https://www.americangeosciences.org/change/print-edition/>



K–12 science teachers to contribute to a well-informed public and dynamic geoscience workforce?

The final 2023 report published by the AGI aims to revitalize the undergraduate geoscience education. The authors suggest several “important skills and competencies” necessary for geoscience education and which were identified by employers. These skills are presented in the table below.

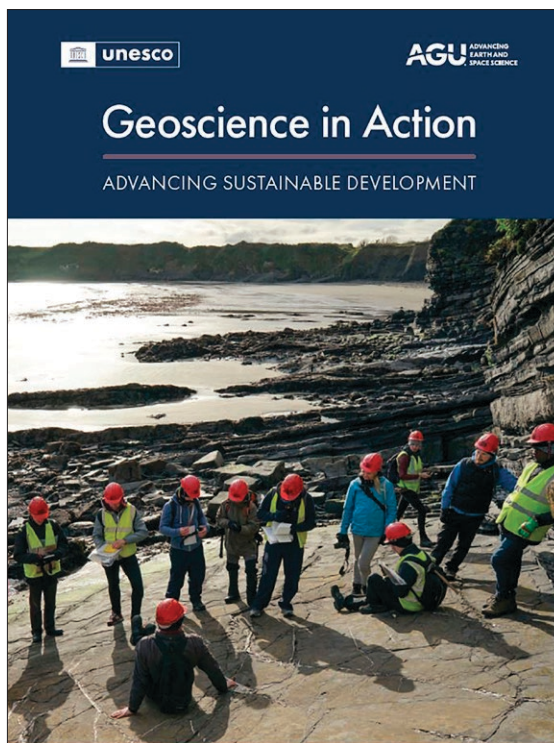
Skill	Level of Mastery
Critical thinking/problem solving	Proficient
Communicate effectively with scientists & non-scientists	Proficient
Readily solve problems, especially spatial and temporal	Mastery
Make inferences about Earth system from observations of natural world combined with experimentation and modeling	Mastery
Work with uncertainty, non-uniqueness, incompleteness, ambiguity, and indirect observations	Mastery
Ability to access and integrate information from different sources and to continue to learn	Mastery
Understand and use scientific research methods	Proficient
Have strong quantitative skills and ability to apply	Proficient

Skill	Level of Mastery
Integrate data from different disciplines and apply systems thinking	Proficient
Have strong field skills and working knowledge of GIS	Mastery/Proficient
Work in interdisciplinary teams and across cultures	Proficient
Have strong computational skills and the ability to manage and analyze large datasets	Proficient
Be technologically versatile (i.e., Google Earth®, tablets, smartphones)	Mastery

UNESCO and AGI: Geoscience in Action (2023)⁶

Geoscience in Action: Advancing Sustainable Development is written by 12 geoscientists, published by UNESCO and American Geophysical Union in 2023, and sponsored by 24 professional societies (including the AAPG, AGU, AGI, GSA, EAGE, and SEG). The publication aims to “to inspire geoscientists everywhere to give more focus to advancing sustainability by showcasing case studies of how geoscience is already addressing climate change and other global challenges.” It opens with the following statement:

“It is estimated that more than 400,000 people work globally as geoscientists. The profession is, nevertheless, going through an



identity crisis. University enrollment in geology courses is declining in many countries. There is a sense that the profession needs to find a new purpose that is more in tune with evolving societal

6. Maria Angela Capello, Emer Caslin, Iain S. Stewart, Denise M. Cox, Anna C. Shaughnessy, Estella A. Atekwana, Heather K. Handley, Ted Bakamjian, Ludivine Wouters, Miriam S. Winsten, Vimal Singh and Kombada Mhopjeni (2023) *Geoscience in Action: Advancing Sustainable Development*. UNESCO, Paris; AGU, Washington DC. <https://geoscienceinaction.org/>

needs and the expectations of budding scientists. Consequently, appointments to academic posts in sustainability geoscience are becoming more common, traditional petroleum geology courses are being rebranded as geo-energy courses and many mining geology courses are now encompassing natural resource management. In industry, fossil-fuel and mining companies are beginning to extend their renewable energy and new minerals portfolios and to reskill their staff in sustainability thinking.”

Geoscience in Action attempts to identify and emphasize geoscience disciplines and methods that contribute to 17 Sustainable Development Goals (SDGs) outlined by the United Nations in 2016.⁷ These include the following:

1. **No Poverty.** End poverty in all its forms everywhere.
2. **Zero Hunger.** End hunger, achieve food security and improved nutrition and promote sustainable agriculture.
3. **Good Health and Well Being.** Ensure healthy lives and promote well-being for all at all ages.
4. **Quality Education.** Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.
5. **Gender Equality.** Achieve gender equality and empower all women and girls.
6. **Clean Water and Sanitation.** Ensure availability and sustainable management of water and sanitation for all.
7. **Affordable and Clean Energy.** Ensure access to affordable, reliable, sustainable and modern energy for all.
8. **Decent Work and Economic Growth.** Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.
9. **Industry, Innovation and Infrastructure.** Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.

10. **Reduced Inequalities.** Reduce inequality within and among countries.
11. **Sustainable Cities and Communities.** Make cities and human settlements inclusive, safe, resilient and sustainable.
12. **Responsible Consumption and Production.** Ensure sustainable consumption and production patterns.
13. **Climate Action.** Take urgent action to combat climate change and its impacts.
14. **Life Below Water.** Conserve and sustainably use the oceans, seas and marine resources for sustainable development.
15. **Life on Land.** Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.
16. **Peace, Justice and Strong Institutions.** Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels.
17. **Partnerships for the Goals.** Strengthen the means of implementation and revitalize the global partnership for sustainable development.

Earth science as a scientific discipline, as an academic field, and as a profession requires new roadmaps in order to grow, explore, train and serve. Each of the four reports mentioned above focuses on one particular area: Research (*A Vision for NSF Earth Sciences*); Applied Geoscience (*AGI Critical Needs*); Education (*Vision and Change in the Geosciences*); and Sustainability (*Geoscience in Action*). It is high time for universities and research institutes as well as geoscience teachers and professionals to evolve and adapt to the new needs and conditions.

7. United Nations Development Program, World Economic Forum, Columbia Center for Sustainable Development and UN Sustainable Development Solutions Network. 2016. *Mapping Mining to the Sustainable Development Goals: An Atlas*. Geneva, Switzerland, World Economic Forum. <https://www.undp.org/content/undp/en/home/librarypage/poverty-reduction/mapping-mining-to-the-sdgs--an-atlas.html>

Visit the land of fire and ice with enthusiastic geologists through active exploration!



**ADVENTURE
GEOLOGY TOURS
ICELAND**

July 25-August 6, 2024

info@adventuregeologytours.com

Registration closes when trip fills



**Book
Now!**





www.adventuregeologytours.com





A Seaside View of the Emerging Energy Landscape

Brigitte Petras, ECP-0851

This fall I was honored to give a talk at the 6th International Workshop on Offshore Geologic CO₂ Storage which was hosted by the IEAGHG Greenhouse Gas R&D Programme (IEAGHG) at Aberdeen, Scotland. The IEAGHG is a non-profit established in 1991 that researches and deploys technologies which reduce carbon emissions. My talk was titled Qualitative Well Integrity Risk Assessment for Carbon Storage in the Gulf of Mexico Depleted Fields, funded through two of the six regionally funded carbon initiatives in the US (Figure 1). This work was possible through the Southeast Regional Carbon Sequestration Partnership (SECARB) Offshore regional carbon initiative which covers approximately half of the Gulf of Mexico and led by the Southern States Energy Board, and the Midwest Regional Carbon Initiative (MRCI) which covers a 20-state region and is led by Battelle and the Illinois State Geological Survey. These regional carbon initiatives are funded through the Department of Energy by project number DE-FE0031557 and DE-FE0031836, respectively.

At the IEAGHG workshop, individuals from 35 countries attended to share years of technical expertise on offshore carbon capture and storage (CCS). After all, Norway's first CCS project began in the offshore North Sea waters more than 27 years ago. This knowledge transfer is essential for safely and effectively storing carbon dioxide long-term in offshore geologic formations. For those interested in learning more about this workshop, read the IEAGHG report: <https://ieaghg.org/ccs-resources/blog/6th-international-workshop-on-offshore-geologic-co2-storage>.

Thanks to multidisciplinary groups such as but certainly not exclusive to IEAGHG and the US regional initiatives, the progress and evolution of CCS and other clean energy technologies has come far. In the U.S., CCS deployment has ramped up especially since the 45Q tax credit incentive which was originally introduced by the



Figure 2. Eastward view of the oil tankers and offshore wind turbines on the eastern coast of the North Sea in Aberdeen, Scotland.

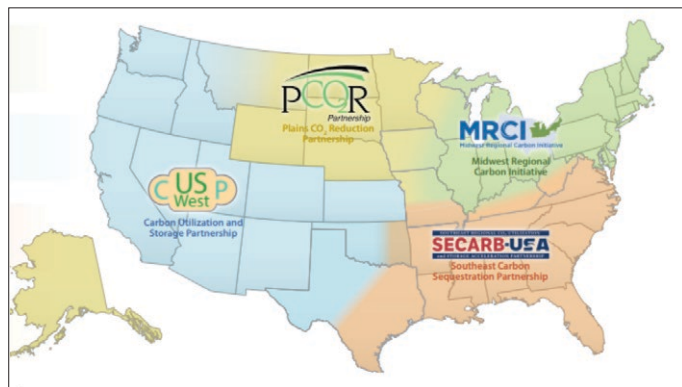


Figure 1. Map of the onshore regional carbon initiatives (NETL, 2022).

Internal Revenue Service (IRS) in 2008, which provides a monetary credit for each ton of carbon oxide stored permanently. This tax incentive is the main economic driver for CCS in the U.S. Currently, this incentive is at \$85 per ton of carbon dioxide permanently stored for CCS projects since the 2022 Inflation Reduction Act. Over 100 CCS permits have been submitted for onshore deep geologic carbon storage in the US.

“ At the IEAGHG workshop, individuals from 35 countries attended to share years of technical expertise on offshore carbon capture and storage (CCS). ”

Although the various countries have or are in the process of establishing their own carbon taxes or incentives, Europe has been very successful in developing CCS projects (see link above). The workshops also included talks on other clean energy technologies, such as wind turbines. As the workshop progressed, breaks were spent looking at the interesting offshore landscape outside the windows of the Sir Duncan Rice Library Building of Aberdeen to the east coast of Scotland (Figure 2).

Following the discovery of oil in the North Sea in 1969, Aberdeen was chosen as an oil and gas port, and today is commonly known to

EARLY CAREER PROFESSIONAL POINT OF VIEW

be the oil capital of Europe. Recently, the red oil tankers which are so characteristic of Aberdeen now have an addition to their coast—offshore wind turbines. The Aberdeen Offshore Wind Farm has been producing electricity since July 2018, and can power approximately 80,000 homes. Additionally, to the south of this offshore wind farm and 15 km off the coast is the Kincardine Offshore Floating Wind Farm, which has novel 'WindFloat' foundations created by California company, Principle Power. Soon, CCS will be in this same landscape, as the main agency reviewing CCS licenses, the North Sea Transition Authority (NSTA) recently announced 21 CCS licenses were approved from 14 different companies. One of these projects includes the Acorn CCS project from Shell Limited, which will operate offshore CCS to the north of Aberdeen. Up to 30 million tonnes of CO₂ per year could be stored by these projects by 2030, which is 10% of UK annual emissions from 2021.

The internal discussions and the new additions to Aberdeen's busy coast represented perhaps more than a diverse and emerging

energy landscape, but perhaps an energy landscape that has been developing for quite some time. As a result, many new career opportunities exist for students and early career professionals in this diverse space, and some experts who helped to establish these clean energy technologies can provide mentorship. If interested in these career opportunities, follow the latest on the regional initiatives (www.midwestccus.org), listen to podcasts such as EGeos (<https://www.midwestccus.org/podcast/>), attend other CCS webinars, and engage at CCS talks and workshops at other professional meetings.

Reference

National Energy Technology Laboratory (NETL), (2022). Regional Initiatives to Accelerate CCUS Deployment. Retrieved November 20, 2023, from <https://netl.doe.gov/carbon-management/carbon-storage/regional-initiative-to-accelerate-ccus-deployment>.

Perseverance Rover, continued from p.39

will assist in reconnaissance of the path ahead for the homeward bound journey.

Even though the primary object of discovering direct evidence of past life has not been successful, the *Perseverance* rover represents an exciting step closer to understanding the Red Planet. To date, 19 rock and regolith samples have been collected awaiting their transit back to laboratories on Earth (Fox & Johnson, 2023). Within those caches, fragments of Mars' history may be tediously reconstructed. Already, the many photographs from the rover mission have provided an unparalleled glimpse into an ancient sedimentary repository on Mars. As these details are placed into context, later missions will become better informed on how to best query this undiscovered country on its untold story and what it may reveal about our own planet.

References

Fox, K., and Johnson, A., 2023, April 1, Perseverance rover collects first Mars sample of New Science Campaign: <https://phys.org/news/2023-04-perseverance-rover-mars-sample-science.html> (accessed July 2023).

Mangold, N., Gupta, S., Gasnault, O., Dromart, G., Tarnas, J. D., Sholes, S. F., Horgan, B., Quantin-Nataf, C., Brown, A. J., ..., and

Williford, K.H., 2021, Perseverance rover reveals an ancient delta-lake system and flood deposits at Jezero crater, Mars: *Science*, v. 374, pp. 11-717, doi:10.1126/science.abl4051.

NASA, 2021, September 23, Touchdown! NASA's Mars Perseverance Rover safely lands on Red Planet – NASA mars exploration: <https://mars.nasa.gov/news/8865/touchdown-nasas-mars-perseverance-rover-safely-lands-on-red-planet/> (accessed July 2023).

NASA, n.d., Learn about the Rover: <https://mars.nasa.gov/mars2020/spacecraft/rover/> (accessed July 2023).

Stack-Morgan, K. M., 2022, October, The Perseverance Rover in Jezero Crater: Van Tuyle Lecture Series, Golden, Colorado, Colorado School of Mines.

Wall, M., 2012, December 4, NASA to launch new Mars Rover in 2020: <https://www.space.com/18763-nasa-new-mars-rover-2020.html> (accessed July 2023).

Lynch, K. L., 2015, A Geobiological Investigation Of The Hypersaline Sediments Of Pilot Valley, Utah: A Terrestrial Analog To Ancient Lake Basins On Mars [Ph.D. thesis]: Colorado School of Mines, 131 p.

AIPG SCHOLARSHIPS

Undergraduate
Graduate

APPLY ONLINE

Applications due: February 1, 2024

<https://aipg.org/page/UndergraduateScholarship>

<https://aipg.org/page/GraduateScholarship>



New York State Education Department Approves AIPG as a Continuing Education Provider for Licensed State Geologists

“AIPG has been providing high-quality continuing education across the United States and in other countries for decades. Getting approval to provide Continuing Professional Development in New York State was critical for AIPG and for our members. As result, not only can we provide access to continuing education, but through our CEU (continuing education unit) approval process, we can vet continuing education opportunities provided by third parties for use as continuing education for geologists registered with the state of New York. This means that courses offered through our partner organizations, such as the Geoscience Online Learning Initiative (GOLI) may be approved pending an application process. It’s another great reason to be a member of the Institute.”

- Aaron Johnson, AIPG Executive Director

John M. Nadeau, PG, CPG-11181, NYSCPG Executive Director

From the NE Section Holidays 2023 Newsletter, p. 69...

This article contains information that was shared in the New York State Council of Professional Geologists (NYSCPG) newsletter in May and is devoted to reviewing a critical aspect of your business and practicing geology within the confines of the law.

The law and regulations are clear regarding the structure of all company entities offering geologic services. To provide any services defined as geology, a company must hold a valid Certificate of Authorization (C of A) specifically for geology. If your company does not hold a C of A, you must obtain one immediately or risk receiving a cease-and-desist letter from the State Education Department (SED). A cease-and-desist order will prevent your company from providing geological services until the error is corrected - this means both you and your employer cannot practice geology in that company. Working without a C of A is unauthorized practice; regardless of your own P.G. registration, you also may be practicing unlawfully and violating rules of professional conduct if you are practicing geology in an unauthorized entity.

The process to acquire a C of A for your company is:

You must ensure that qualified person(s) within your organization received their individual license(s) to practice geology.

Your company must apply for a C of A from SED:

Your company structure must be a registered professional entity. General business corporations (Inc., Ltd, Corp, etc.) are not allowed and must convert to a lawful professional structure. Information regarding the permissible professional business structures in NYS can be found at <https://www.op.nysed.gov/corporate/introduction>.

Existing professional corporations (engineering, land surveying, etc.) must:

- Add a licensed professional geologist as an owner, and,
- Amend the company certificate to include geologic services

Your company must amend the certificate of incorporation with Department of State. Once approved, the documents return to SED for final approval.

More details of this process can be found at <https://www.op.nysed.gov/corporate/disclaimer/section-xii>.

Similar to other Design Professionals, geologists may not practice within a company that does not have the proper C of A for the specific professional license they hold. As a licensed professional, you are expected to understand and follow all the laws and regulations. If you are unsure, check the verification page at <https://www.op.nysed.gov/verification-search>. If your company is not listed as approved to practice geology, please confer with your organization about whether you need to apply for a C of A.

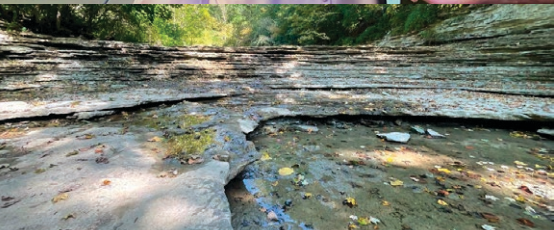
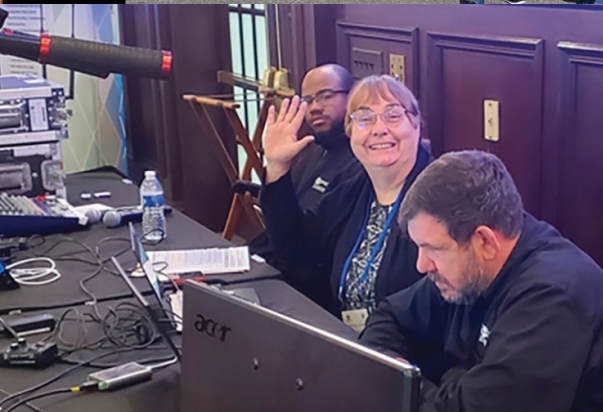
Please note a C of A does not currently apply to the grandfathered engineering firms as they work to pass legislation to offer geologic services.

For specific questions on permissible professional entities and NYS authorization for your company to practice geology, feel free to contact geology@nysed.gov or myself at jnadeau@nyscpge.com.

AIPG NATIONAL ANNUAL CONFERENCE 2023 - COVINGTON, KENTUCKY



AIPG NATIONAL ANNUAL CONFERENCE 2023 - COVINGTON, KENTUCKY



In Memoriam

Frank H. Jacobeen Jr., CPG-00178

*Herndon, Virginia
April 10, 1926 - August 24, 2022*

Member Since 1964

Obituary and photo excerpted from the Fairfax Memorial Funeral Home...

Frank Henry Jacobeen Jr., of Herndon, passed peacefully in his home with his son at his side; he was 96 years old.



Frank was born on April 10, 1926 in Hillsdale, New Jersey, where he spent the majority of his childhood. In 1943, Frank graduated from Westwood High and volunteered to join the Naval Air Force, but due to injury, he was unable to fly. Thus, he served on a munitions ship in the Atlantic. After proudly serving in the military during World War II, Frank attended Princeton University where he discovered his love and passion for geology. Frank began his lifetime career as a geologist working with the U.S. Navy Hydrographic Survey aboard the U.S.S. Maury where he surveyed the ocean floor in the North Atlantic Ocean and the Persian Gulf.

On April 14, 1951, Frank married Marion, his beloved wife. Together Frank and Marion moved to Kansas where Frank began work for Shell Oil Company. After 15 years of traveling across the United States with Shell, Frank settled into a job with Washington Gas Light Company in northern Virginia. During his time with Washington Gas, Frank received his master's and Ph.D. in Geology from the University of South Carolina. After almost 15 years with Washington Gas, Frank moved on to work for Puckeye Petroleum Company in New York City and then Republic Mineral Company. By 1985, Frank decided it was time to partially retire and spend time traveling with his beloved wife, Marion. Frank also took time in his retirement years to enjoy fishing, golfing, telling jokes, and acting as the resident "handy man."

Frank was a charter member of AIPG for 58 years, having joined the organization in October 1964. He was preceded in death by his wife Marion Therese Jacobeen, his parents Frank Henry Jacobeen and Gertrude Van der Wyden Jacobeen, and his sister Marjorie Limouze.

Harold W. Hanke, CPG-02660

*Oklahoma City, Oklahoma
June 13, 1937 - April 16, 2023*

Member Since 1974

Obituary excerpted from The Oklahoman website...

Harold Wayne Hanke passed on April 16, 2023. He was born June 13, 1937 in Dixon, IL to Oscar August Hanke and Gertrude Luella Menz. He was raised in Mt. Morris, IL and graduated from high school in 1955. Harold attended Carthage College where he met his future wife, Nancy Lu Ferguson. He later transferred to the



University of Oklahoma. They were married August 9th, 1958 at the First Presbyterian Church in Morris, IL and moved to Norman, OK where he continued studies in Geology and received his Bachelor Degree in 1960, later obtaining his Masters in Geology. After undergraduate school, he joined the Navy and went to Officers Candidate School in Newport, RI.

Harold was on active duty for four years and served 26 years in the Naval Reserve where he attained the rank of Captain. He helped establish the Oklahoma City Sea Cadets chapter.

He was heavily involved in Boy Scouts of America, especially Troop 201, The Village, OK and loved mentoring, inspiring and teaching adults and scouters until his death. He was extremely proud of his son and three grandsons, who are all Eagle Scouts. Harold also stayed an active member of several Geological Associations.

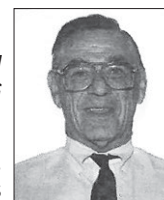
Travis H. Hughes, PhD, CPG-03529

*Erwin, Tennessee
October 1, 2023*

Member Since 1976

Obituary excerpted from the Valley Funeral Home website; photo from A History of AIPG 1963-2003 p. 147...

Dr. Travis Hubert Hughes, Sr., age 86, of Erwin, passed away on Sunday, October 1, 2023 at his home. Travis was born in Rapid City, SD, and is a son of the late Frank Lyon and Jane (Brown) Hughes. After graduation from Unicoi County High School, he departed Erwin to attend Vanderbilt University on a football scholarship. He obtained his BS and MS degrees there and moved to Boulder, Colorado and to the University of Colorado where he earned his PhD in Geochemistry in 1967. He was then employed in Tuscaloosa, AL as a college professor at The University of Alabama, ultimately becoming the head of the Geology and Geography Departments. In addition, he became the National President of the American Institute of Professional Geologist, the most prominent of Professional Geological Associations. After retirement from The University of Alabama he began a second career as a Geological Consultant traveling the entire seven continents of the world, from the polar ice of the arctic to the blazing deserts of the middle east. Travis held a steadfast and devout, but quiet, conviction of his spiritual salvation and generally preferred such with a Baptist flavor. He loved family, teaching, reading, thinking, scientific analysis, skiing, and rocky spaces (the more vertical, the better). In addition to his parents, Travis is preceded in death by his one brother, Frank W. Hughes.



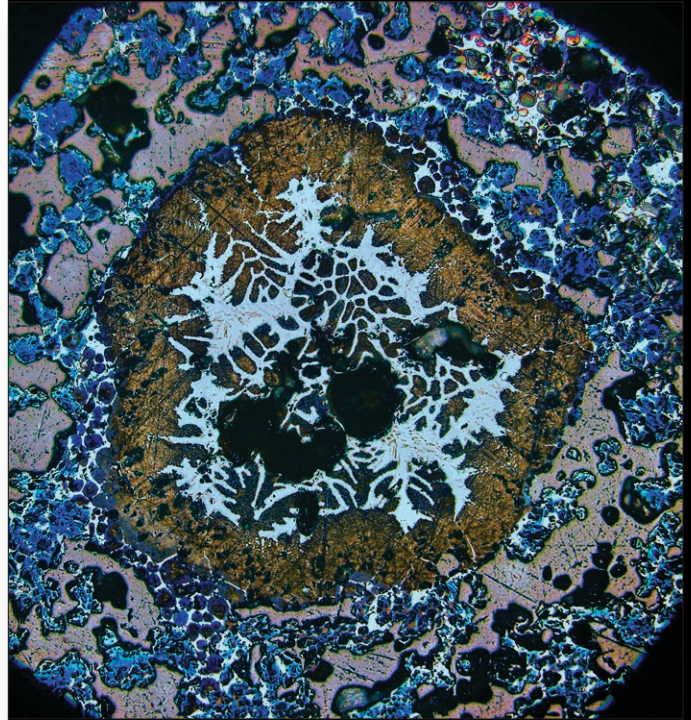
Travis was AIPG President in 1986. He received a Presidential Certificate of Merit in 1983 and 1999, and the Award of Honorary Membership in 2000. According to *A History of AIPG 1963-2003*, "Travis has earned the Waldemar Lindgren Citation for Excellence in Research (Society of Economic Geologists), a NASA Citation for innovative Research, an award for Distinguished Achievement in the Earth Sciences (Federation of Lapidary and Mineralogical Societies), and an award for Outstanding Service to the University of Alabama. He is one of 25 Founders of the AIPG Foundation (1981), and co-author of AIPG's 1991 publication "Education for Professional Practice."

Richard Beverlin, Jr., CPG-04477*Kemah, Texas**March 2, 1947 - February 26, 2023***Member Since 1979***Obituary and photo excerpted from the Crowder Funeral Home website...*

Richard Beverlin, Jr. passed away peacefully in Galveston County at the age of 75. He was born to Richard Beverlin, Sr. and Melba (Samora) Beverlin on March 2, 1947 in Houston, Texas. Richard was raised in Grafton, West Virginia following his father's wartime service with the U.S. Army Air Corps. He graduated from St. Augustin High School in 1965 where he excelled at basketball. He earned his B.S. in Geology from West Virginia University in 1969 where he graduated with honors and was a member of the Air Force ROTC. Upon graduation, Richard went to work in the oil and gas industry and established an independent exploration company, SOMAC. He transitioned to the aerospace community in the late 1980's and spent the duration of his career at the Johnson Space Center managing projects on both Shuttle and Space Station. During that period, Richard held leadership positions with Rockwell International, Dynacs, and ultimately retired from MDA Federal. Richard served as Group Commander for the Houston area Civil Air Patrol as a Lieutenant Colonel. Additionally, he volunteered on both the Air Force Association and the Selective Service boards.

William D. Robinson, CPG-06914*Fallon, Nevada**January 25, 1935 - July 22, 2023***Member Since 1985***Obituary excerpted from the Fallon Post website...*

William (Bill) was born on January 25, 1935, to Ruby and Miles Robison in Reno, Nevada. Bill was raised in Fallon, attended local schools, graduating from Churchill County High School in 1952. In 1953 he joined the Navy and was stationed at various places throughout the U.S., Japan, and Guam. After 20 years in the Navy, he retired in 1973 as a Chief Aviation Electronics Technician. Upon his retirement he attended Southwestern Junior College and San Diego State University, receiving a Bachelor of Science Degree in Geology. He then began a second career as a petroleum geologist with the U.S. Geological Survey in New Orleans, Louisiana. In 1981 he transferred to the Bureau of Land Management in Ely, Nevada, where he was an area geologist working in oil, gas, and hard rock mining. In 1993 he finished his career as a geologist, retiring for a second time.

Thomas E. Sparley, CPG-10807*Nine Mile Falls, Washington**September 13, 2023***Member Since 2004***No obituary available.***2023 Photo Contest Runner Up Micro Geology:
Under the Microscope.****Description:** *Dendritic Belite Nest in Portland Cement Clinker**Photomicrograph in reflected light of epoxy-encased portland cement clinker nodule showing dendritic belite nest formation. Photo taken in 2023 by Jeff Varga, CPG-10275 - Ohio Section.*

Celebrating **Member Achievements**

The Society for Mining, Metallurgy, and Exploration (SME) has selected **David Abbott** (CPG-04570) to receive the Harry Parker Excellence Award for 2024 "For his leadership and contributions to drafting the various editions of the SME Guide and the new SME Guidance about mineral deposit disclosures and for contributions to geoscience ethics."



Established in 2020 by SME, the Harry M. Parker Excellence Award is given to the individual who most exemplifies the effort and insight Harry Parker brought to improve the mining industry.

The award recognizes individuals who most exemplify the effort and insight Harry Parker brought to improve the mining industry. His work in resource/feasibility reporting and geostatistics has improved the investment community's perception of mining ventures.

ADVERTISE HERE!

AIPG MEMBERSHIP TOTALS

	As of 12/1/2022	12/1/2023
CPG/Active	2,285	2,177
CPG Emeritus Member	618	635
Honorary Member	19	20
Professional Member	762	797
Professional Member/Non-Practicing	48	46
Early Career Professional	283	270
Associate Member	52	53
Student Adjunct	1,131	1,131
TOTALS	5,198	5,129

Engineering solutions that work for your business



Civil/Structural Engineering
Aquatic/Ecological Services
Geotechnical Engineering
Environmental Services
Surveying
Construction Support

Adrian • Canton • Detroit • Grand Rapids • Houghton • Lansing • Monroe • Traverse City
Cincinnati • Cleveland • Columbus • North Canton • Toledo

AIPG Is On



Subscribe to AIPG's YouTube Channel

Send your geologists in action videos to
AIPG Headquarters

Scan QR code



*Comments on proposed rule:
Modernization of Property Disclosures
for Mining Registrants*

Comments on the U.S. Security and Exchange Commission's (SEC's) proposal are available at <https://www.sec.gov/comments/s7-10-16/s71016.htm>



AssuredPartners
COLORADO

AIPG Endorsed Professional Liability program exclusively for AIPG Members

We have 12 years of experience writing Professional Liability specifically for Geologists. Our program includes a Comprehensive Risk Analysis and a Contractual Insurance Review. In addition to Professional Liability programs, we can handle any of your other Property & Casualty Insurance needs.

We scour the market to make your insurance dollars go further.

Allan Crumbaker

allan.crumbaker@assuredpartners.com

Direct: (303) 228-2205 | Main: (303) 863-7788 | Toll Free: (800) 322-9773



Alpha Geoscience

679 Plank Road, Clifton Park, New York 12065

Independent Laboratory Data Validation

Emergent Contaminants

- PFOS, PFOA, and other PFAS

Quality Assurance/Quality Control

- Validation of soil, water, and air data
- Preparation of EDDs, SOPs, and QAPPs

Contact: Scott Hulseapple, PG, CPG

shulseapple@alphageoscience.com • (518) 348-6995

fishbeck

Engineers | Architects | Scientists | Constructors



800.456.3824
fishbeck.com

State Geological Surveys

AIPG advocates for the geosciences professions and the state geological surveys are among the key organizations focused on researching, mapping, and providing critical geological information for the state, regulators, consultants, and the public. This information is critical for resource development, protection, and management. Surveys produce data that should be relied upon for making sound, science-based policy decisions.

AIPG is seeking articles about the projects and programs that the state surveys are implementing, initiatives for the future and challenges featuring successes and lessons learned. Please send your article to me at aipg@aipg.org

Adam Heft, CPG-10265, Editor

Virtual Town Halls
Get Involved!
 Watch your email for upcoming dates and topics.

This service is open to AIPG Members as well as non-members. The Professional Services Directory is a one year listing offering experience and expertise in all phases of geology. Prepayment required. Advertising rates are based on a 3 3/8" x 1 3/4" space.

ONE YEAR LISTING FOR ONLY:

Member	\$100.00
Non-Member	\$300.00

Space can be increased vertically by doubling or tripling the size and also the rate.

CLEAR CREEK ASSOCIATES
 a Geo-Logic Company

Practical solutions in groundwater science

8777 N. Gainey Center Dr., Ste. 250
 Scottsdale, AZ 85258
 (480) 659-7131
 www.clearcreekassociates.com

221 N. Court Ave., Ste. 101
 Tucson, AZ 85701
 (520) 622-3222
 www.geo-logic.com

SUBMISSIONS DEADLINES

APR.MAY.JUN. - February 1, 2024
 JUL.AUG.SEP. - May 1, 2024
 OCT.NOV.DEC. - AUGUST 1, 2024

Technical writings including peer review, student writings, field experiences, career development, member news, and more accepted.

AIPG/AGI
 Geoscience Online Learning Initiative (GOLI)
Course Offering
 "Best Practices in Mineral Resource Estimation & Reporting"

Scan QR code to register.



TPG Advertising Rates

Full Color.

Ad Size	Single Issue	Annual (4 Issues)
Full Page	\$400	\$750
1/2 Page	\$200	\$400
1/4 Page	\$100	\$200
1/8 Page	\$50	\$100

Preferred Positions

Back Page available to full page advertisers only. \$600 for Single Issue, \$1,000 Annual (4 Issues).

Inside Front Cover (Subject to Availability)

1/2 Page	\$300 Single	\$600 Annual
1/4 Page	\$200 Single	\$400 Annual
1/8 Page	\$100 Single	\$200 Annual

(NEW!) AIPG National Conference Exhibitor/ Sponsor Marketing Boost Deals

See website for details!
<https://aipg.org/general/custom.asp?page=AdvertisingOpportunities>



LUNCH &

Earn!



Scan QR code
to learn more.

AIPG is an NYSED approved provider of continuing education credits for New York licensed professional geologists.

Geoscience webinars with continuing education credits for professionals hosted by AIPG.

Cost:
Members - \$15
Non-Members - \$30
AIPG Student Members - free
Earn 0.1 CEU / 1 PDH for attending!
Certificates will be emailed after the webinar.

