TPG is a publication of the American Institute of Professional Geologists

THE PROFESSIONAL GEOLOGIST

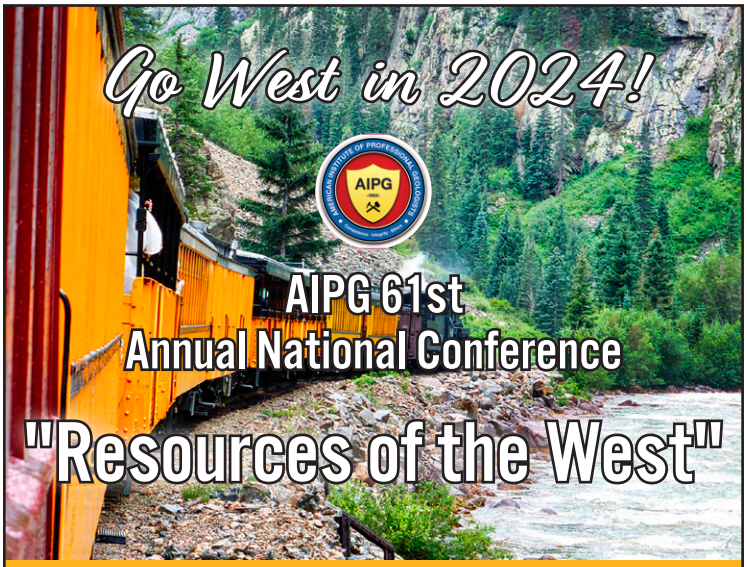
VOLUME 60 NUMBER 4 OCT.NOV.DEC 2023



Annual Honors and Awards

A Taste of Caribbean Geology

Experiencing the White Mountains



Make your travel plans!
August 10-13, 2024
Ft. Lewis College
Durango, Colorado

Highlights

7 Field Trips - Explore and experience the complex geologic history first hand from the local beauty of Durangp to hiking the heights of the Molas Pass at 11,000 feet.
Technical presentations from experts in the field.
And much more...

Geology, Mesozoic & Paleozoic Dry-Erase Globes & Hemispheres



18" & 30" SIZES



REAL WORLD GLOBES

WWW.REALWORLDGLOBES.COM

AIPG Member Photo Challenge



Challenge categories:

1. **Scenic Wonder - Grand scale landscape.**
2. **Off the Beaten Path - Unique feature/formation.**
3. **Geologists in Action - 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, 2023**.

Awards:

First place in each category:
Image published on the cover of *TPG* in 2024. 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 60 Number 4 OCT.NOV.DEC 2023

INSIDE THIS ISSUE

FEATURES

17 **Geology of the White Mountains: An Overview**
Julia Rudlaff, SA-11675

21 **Re-Establishment of Deregulated P.G. Licensing Board in Puerto Rico**
Yomari Soto-Lopez, P.G.

22 **Caribbean Geology: A Taste**
Robert G. Font, PhD, CPG-3953

39 **Arizona and New Mexico Section Members Visit the Hillsboro Mining District and National Radio Astronomy Observatory (NRAO) Very Large Array (VLA)**
Sally Clement CPG-10347 and Dawn Garcia, CPG-8313

56 **National Mining Hall of Fame Inductees**
Media Release

On the Cover: 2022 Photo Contest Geologists in Action Winner: Training the Next Generation of Geologists

Description: Training the Next Generation in Field Geology. This is Albert with his daughter Meaghan when she was three-years old teaching her how to study rocks in the field. She was very interested! This photo was taken outside of Missoula, Montana in 1983.

Photo submitted by: Albert LaMarre CPG-06798, California Section.

2022 Photo Contest: Geologists in Action Runner Up on page 4.

AIPG National Executive Committee

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

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

PAST PRESIDENT - Matthew J. Rhoades, CPG
AlterEcho
O: (303) 359-1165, Missouri Section
rhoadesgeo1@gmail.com

VICE PRESIDENT - Dennis Pennington, CPG
O: (215) 542-2308, Pennsylvania Section
Feldspar18@gmail.com

SECRETARY - John Sorrell, CPG
Sorrell Consulting, LLC
O: (312) 288-3823, New Mexico Section
geodejohn@gmail.com

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

Robert Andrews, CPG
City of Columbus - Department of Public Utilities
O: (614) 645-3227, Ohio Section
reandrews@earthlink.net

William Brab, CPG
AST Environmental, Inc.
O: (859) 846-4900, Kentucky Section
billbrab@gmail.com

Andrew Jones, MEM
Midnight Sun Global Services
O: (502) 471-7553, Colorado Section
andrew.jones.geo@gmail.com

Mehmet Pehlivan, MEM
Delta Group
O: (714) 719-6854, California Section
mpehlivan@yahoo.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.savewithups.com/aipg
Use promo code WES462

DEPARTMENTS

3	Editor's Corner
4	Letters to the Editor
5	2023 Honors and Awards
13	The Foundation of the AIPG
16	2024 Election National Officer Results
34	Executive Director's Message
35	President's Message
36	Test Your Knowledge
37	Professional Ethics and Practices
44	Educator's Corner
46	AIPG Moment
47	Early Career Professional Point of View
57	In Memoriam
60	AIPG Membership Totals
60	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 2023 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.



Change is in the Wind...

Adam W. Heft, CPG-10265

This edition of *TPG* marks the last edition of 2023, and the midpoint of my second term as Editor. I can't believe how quickly this year has passed by. As I write this, the Annual Meeting is still almost three weeks away, but will have come and gone by the time you are reading this. Look for highlights of the meeting in the Jan/Feb/Mar 2024 edition! For those who attend, I'd like to get your perspectives on the meeting to share in with our readers and Executive Committee – and yes, you can request to remain anonymous if you so choose. But your feedback, either what you enjoyed most or opportunities for improvement, can help future committees plan upcoming Annual Meetings. I would like to publish this feedback in the "Letters to the Editor" section with your permission.

In this edition, we are featuring a big article on the Caribbean. **Robert Font's** (CPG-03953) Caribbean Geology – A Taste shares his knowledge of the region and the islands he has visited. I visited Puerto Rico once about 15 years ago for a project, and at the time, I unfortunately didn't know much about the island's geology. After reading Robert's article, I see how much I missed, and now, I want to go back. I hope maybe some of you will catch the bug to go island-hopping! I think you will enjoy reading it as much as I did.

Julia Rudlaff (SA-11675) is one of our 2023 student scholarship recipients. She is very enthusiastic about becoming a geologist and embraces the opportunity to teach others. She immediately wrote an article on the Geology of the White Mountains based on her experiences working there over two summers. Her enthusiasm is contagious. I am also reprinting an article on licensure from the Florida Section's newsletter and how devastating the loss of licensure is when people do not understand our role as professionals in society. Their story could happen anywhere. Let's take Florida's example and keep advocating for our profession.

I've also included a new feature called *AIPG Moments*. An AIPG Moment is a short (150 to 250 words) informal summary around a specific topic that promote a safe, welcoming, and supportive workplace. Each moment featured will be an experience or a discussion of a topic that positively impacts the social, mental, and physical wellbeing of geologists. I invite you to share a personal story of support from another AIPG member, a safety share from a field trip, or an event that was impactful.

This edition includes the 2023 election results for our next slate of National officers. For those who have long histories with AIPG, you will note that the results will mark a historic "first" for the organization. Next year's Executive Committee will have for the first time ever, all three "Presidential" positions – President Elect, President, and Past President – occupied by women at the same time!

This is a sign that AIPG is changing. I recall that when I first became a CPG (back in 1998), there had been only one female President in the first 35 years (in case you were wondering, it was Susan Landon in 1990). Counting this year there have been five more, with two more elected and waiting to serve.

Speaking of change, there have been changes to *TPG* over the years. The most significant changes included the frequency of publication and the appearance of the issues. Most recently, we made the switch to full color from what had been largely black and white. The feedback we've had on this change has been overwhelmingly positive. More changes are coming in 2024. I've already indicated that the Student Edition, which in the past had been the Jan/Feb/Mar issue, was moved to the Apr/May/Jun issue this year. I feel this change is appropriate because the issue is published in April near the end of the academic year giving students more time to write content and also benefit from the advice often given by professionals as students make the transition from academia to career. We are constantly striving to improve *TPG* and publish content that our readers want. Share your ideas with us.

Our readers are not just our members. Keep this in mind and note that an annual subscription is $20. The content that we provide may be of interest to your colleagues. How about purchasing a subscription to share at the office with colleagues and clients? One of the more common things we see is the purchase of extra copies of the student edition to share with the colleges and universities in the sections. How about purchasing some for the colleges and universities that are not active participants in the section or even for the science department at the local high school. Wouldn't it be great if a student found their way to our profession after reading our publication? Some of our friends are geology enthusiasts even though it is not their "day" job. Wouldn't a subscription make a unique gift for them? How about your family? Wouldn't it be fun to purchase copies of an edition in which you have a published article to share with your family? Or how about sending a subscription to your legislators? Most legislators have no idea what a professional geologist does; this would be a great way to educate them!

I have purchased an additional subscription that goes to my family, and I plan to suggest to my Section Executive Committee to consider providing subscriptions to each of the geoscience departments in our state; with roughly a dozen geoscience departments in the state, the cost is not that great. I hope you will consider doing the same – getting the word out there will pay dividends for AIPG!



The response to the solicitation for unused geology textbooks, geology maps and other books about science and nature (published in the last edition of *TPG*) has been very gratifying. I think that AIPG headquarters started receiving inquiries on how to donate as soon as *TPG* arrived at members' mailboxes. I've had the opportunity to talk to some of our members who are donating, and they were very pleased to find a way to re-home their materials that are no longer used in retirement or when office spaces are reduced. The consensus is that it's a shame to throw away textbooks, so this effort is a win-win situation for AIPG members and the State University of Sonora. A big THANK YOU for those donations!

I hope that others will keep this opportunity in mind when wanting to clean out their bookcases, and that members will contact the national headquarters to donate their unneeded books and maps.

Sincerely,

Dawn Garcia, CPG-8313
Tucson, Arizona

To the Editor -

I am a retired CPG, but I still enjoy reading The Professional Geologist. In the last few issues, I have noticed that some of the photos of columnists have changed from issue to issue, and that is a good idea. Geologists in action! Also, the addition of more color throughout the whole magazine makes it much more appealing and professional. Just wanted to say Thank You and keep up the good work!

Richard Allen, CPG-06610
Scottsdale, Arizona



2022 Photo Contest Runner Up Geologists in Action Category

Here at the Giant's Causeway in Northern Ireland these pillars formed approximately 50 to 60 million years ago. The region consisted of chalk sedimentary beds which were then subjected to volcanic activity, forming a lake of lava that cooled relatively rapidly, forming the hexagonal columns we see now. Pictured: Molly Gardner.

Photo by: **Molly Gardner, CPG-12105**, Wisconsin Section

2023 Honors and Awards

The American Institute of Professional Geologists (AIPG) has a history of effective and outstanding service to the profession of geology. From its beginning in 1963, the Institute has emphasized the role that professional geologists play in this fascinating, changing, and highly complex world in which we live.

In an Institute such as this, there are so many highly motivated geologists contributing to the profession, the Institute, the public, and the nations in which we live and work that the identification of a select few for particular awards is a monumental task. The continued success of the Honors and Awards Program is dependent on an accessible nominating process and a diligent screening of those nominated. This is done by the Honors and Awards Committee.

Currently, there are seven honors bestowed by the Institute: Ben H. Parker Memorial Distinguished Service Medal, Martin Van Couvering Memorial Service to the Institute Award, John T. Galey, Sr., Memorial Public Service Medal, Award of Honorary Membership, Outstanding Achievement Award, John Stewart Memorial Early Career Professional Award, and Presidential Certificate of Merit.

Descriptions of the awards, past recipients, and the nomination forms can be found on the AIPG National website or contact the AIPG National Headquarters office.

This year the Honors and Awards Committee selected a group of outstanding leaders who have committed to contributing to the organization and advancing the geosciences. We congratulate the honorees on the following pages.

Nominations for 2024 are being accepted online or via mail now through January 15, 2024. Information on how to submit your nominations for a national or section leadership award is available on pages 14 and 15 of this edition of *TPG*.

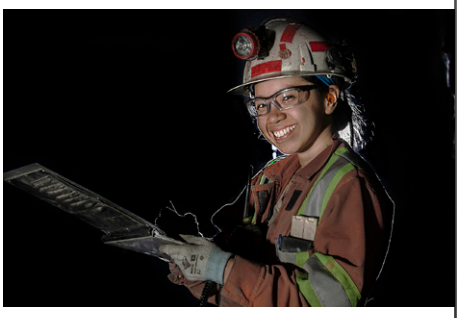
When you pay your dues this year, please consider submitting a nomination recognizing a colleague for their contributions to the organization and the geoscience profession. Professionals in the geosciences are making a difference every day in the lives of people across the world, further advancing our knowledge of the earth and it's processes, and finding better solutions to managing our environment. We look forward to seeing them nominated in 2024.

Mentoring Matters

https://aipg.org/page/MentoringProgram







Find your mentor at AIPG!

AIPG has members across all geoscience specialties who are willing to share their geoscience experiences, expertise and career choices and paths.

Members, Sign up to be a mentor today!

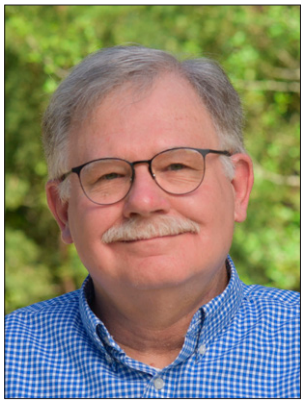
Scan QR code to learn more.

BEN H. PARKER MEMORIAL DISTINGUISHED SERVICE MEDAL

Vincent S. Cronin

CPG-11830

Texas Section



The Ben H. Parker Memorial Distinguished Service Medal is the Institute's most distinguished award. It was established by the Executive Committee in 1969 in posthumous honor of a truly great leader, who devoted much of his life to improve the quality of geology and geologists and the services they provide. The medal is awarded to individuals who have long records of distinguished and outstanding service to the profession.

It is a sign of a gracious community that it occasionally pauses to thank its members for their work. I am profoundly grateful and humbled to have been chosen by AIPG to receive its Ben H. Parker Memorial Distinguished Service Medal this year. I thank everyone involved in the nomination and selection process.

Credit for whatever good work I have accomplished as a geologist is also due to my family, my students, and a supportive geoscience community. My life has been wonderfully stabilized during the past 38 years by Cindy Cronin: my life partner, wife, best friend, and holder of BS and MS degrees in Geology. We have two fine descendants — Kelly and Connor. Their patience, understanding, support, and loving criticisms have made my geological career possible.

If my parents were here, they would take me aside and quietly say something like this: "We're very proud of you, but don't let this go to your head. Take a few minutes to enjoy it, but then move on. You have a lot more work to do. You can still do better."

I have taken advantage of opportunities to teach geoscience to undergraduate and graduate students, emphasizing knowledge and skills that are useful in applied geology. I trained and encouraged geoscience educators to include complex topics like active tectonics, earthquake seismology, and geodesy in their courses. As Editor and principal revision author of the **AGI/NAGT Laboratory Manual in Physical Geology**, I have helped countless students learn about Earth through data-driven activities and hands-on experiences.

My curiosity has led me in many directions. In recent years, my students and I have used new technologies and datasets to identify the ground-surface trace of active faults. We have used GPS velocity data to measure how the crust has been changing shape during the past decade or two. And I still work on quantitative plate kinematics.

I have been fortunate to have enjoyed a varied career in geoscience, including the chance to contribute to the field of geoethics during a time of significant international growth. I am mindful of the emphasis that the founders of AIPG placed on professional ethics. Ethics is still a fundamental concern within our profession.

If you are interested in any of this educational or research work, I created a web page that contains related information. Visit https://Cronin-Projects.org/AIPG/

My life is happier to the extent that I spend more time concerned with the needs of others than with my own issues. The more professional geologists can get out of their own stew pots and help others, the happier they will be and the stronger the geoscience community will become.

I understand that time is not elastic, and our energy is limited. We are all busy people. Still, I have a suggestion for you. In your capacity as a professional geologist, see if you can find one volunteer activity that you can do well in service to society or your profession. Then commit to making that voluntary contribution persistently.

Society's need for reliable geoscience information supplied by well-informed professional geoscientists is profound, especially in a warming world. Society wants our best scientific understanding, described clearly, so we can confront environmental issues honestly and effectively together. No malarkey. Richard Feynman reminds us, "...reality must take precedence over public relations, for nature cannot be fooled." The web page I created to accompany these remarks includes suggestions for enhancing your knowledge of the causes and effects of climate change.

Being chosen to receive the Ben Parker Medal is an unexpected gift. I sincerely appreciate this recognition. It energizes me as I look forward to the tasks I plan to accomplish in service to geoscience and society in the coming years. Thank you.



J. Todd McFarland
CPG-11348
Tennessee Section

The Martin Van Couvering Memorial Service to the Institute Award was established by the Executive Committee in 1979 in posthumous honor of the first president of the Institute. Martin Van Couvering made the presidency a full-time occupation for the first two years of the Institute's history. His dynamic leadership, diplomacy, and organizational abilities established the solid foundation from which the Institute has grown. Few, if any, have given so much to the Institute.

It is humbling to see the list of past award winners, and I am honored to receive the Martin Van Couvering Memorial Award for service to AIPG. I have witnessed the hard work that many of the past recipients have put into this organization and know that I still have contributions to make to AIPG. My career as a geologist was not a traditional path. As I prepared for my last two semesters as an undergraduate in chemistry, I was unsure of what career path to take. After spending many years exploring the caves of south-central Kentucky, I had a desire to mix my working days inside with some adventure. When I chose an environmental geology class as an elective course, my uncertainty disappeared. My future was defined after the first day of that class. I spent the next year immersed in a typical undergraduate geology curriculum, although at a somewhat accelerated pace. After I finished the undergraduate level geology classes, I wanted to continue to learn more about environmental geology and entered a master's program. I was then admitted to the geology program and completed my graduate degree.

After receiving my M.S. in Geology, I spent a few years behind a drill rig, logged soil throughout the southeast, sampled too many wells to count, and quickly learned what it meant to be a field geologist. However, I still had a lot to learn about what it meant to be a professional geologist and then I found AIPG. I joined AIPG in 2008 and upgraded to a CPG in 2010. Although field work consumed most of my time during my initial years as an AIPG member, I remained involved with the organization at the Section level and became the Tennessee Section President in 2013. My first trip to the annual AIPG meeting was the 2013 meeting in Colorado where I was subsequently elected to the 2014 Advisory Committee thanks to some wonderful conversation with Larry Weber and Bill Siok. I was very new to the organization on the National level but was excited to get involved after attending that first National meeting and interacting with members from across the country. I served as Vice President in 2015 following my year on the Advisory Committee. I was the Tennessee Section President in 2017 as well as the general chairman for the 2017 National Meeting. I served as AIPG President in 2020 as AIPG navigated through the Covid pandemic. Although far from a traditional presidential tenure, it was a great experience to see how we all adapted to the constant changes. The staff members of this organization and the members we serve are two of the reasons why I will continue to serve this organization.

Many of us have busy professional lives and hectic personal lives, but we still choose to volunteer our time to this organization. Why? Because AIPG has the resources to advance our profession, which gives geologists the opportunity to make a difference in this world every day. As noted by Victor Frankl, it does not matter what we expect from life, but rather what life expected of us. We take the responsibility to find the right answer to its problems and to fulfill the tasks which it constantly sets for each individual. Geologists are continuing to work to answer questions and solve problems related to energy resources, mineral resources, water quality and supply, natural hazards, and sustainability – just to name a few. I focus on remediating impacted sites across the country, and this allows me to make a difference in an area that doesn't directly impact my life. However, addressing soil and groundwater impacts at an abandoned facility so that it can be repurposed for beneficial

"The staff members of this organization and the members we serve are two of the reasons why I will continue to serve this organization. "

use to a community is a win for that community. Get involved with AIPG and stay involved so we can continue to advance our profession.

We should also make sure this profession continues to thrive for the students and early career professionals. AIPG provides opportunities to be involved through mentoring, through assisting with organizing student chapters, or through working with State Sections. AIPG promotes advancing the profession of geology and advocates for the profession before government and the general public. But the organization needs your help to continue to grow so we can continue to support those initiatives. Engaging student members and early career professionals as soon as possible in their careers will foster growth and participation in the organization on National, Section, and student chapter levels. This can include promoting AIPG to university geology departments with student members and to employers of early career professionals, and this is most easily accomplished with members at the local level volunteering their time. This is what motivates me to stay involved and I am ready to be back on the board in 2024 to serve as Vice President.

AWARD OF HONORARY MEMBERSHIP



Kelvin J. Buchanan

CPG-6058

Nevada Section

Since 1984, AIPG has conferred Honorary Membership to those who have an exemplary record of distinguished service to the profession and to the Institute.

I was very surprised on being notified in April by Dawn Garcia that I would be receiving the award of Honorary Membership in AIPG, in part because secrets are hard to keep, and I have many friends in the Institute. I couldn't be more honored.

I joined AIPG in 1982, at the suggestion of the management of the Houston company I was employed by at the time, even though I wasn't familiar with the AIPG organization. My three sponsors were all from the firm I worked for, but only one was from Texas. When my luncheon interview with the vetting committee commenced (yes, there was a vetting committee), the two petroleum geologists looked at my Alaska and Toronto sponsors with raised eyebrows, wondering why any hard-rock geologist would want to join what was then a primarily energy-based organization. However, they were very polite, and I was approved for membership and became a CPG.

I returned to Reno in 1983, found that there were eleven AIPG members in Nevada, and made new friends as a result. As a state chapter with no money, we had to creatively find ways to purchase postage stamps, but field trips provided an answer. The Nevada section had a nominal president at the time, but no organization. The only way to grow was to recruit new members, so it was decided by the section that as the newest Nevada AIPG member, I would be "selected" as the new Screening Board Chairman. At the time, Nevada geologists were primarily employed by mining companies domiciled in Canada. Getting Nevada geologists to apply for AIPG membership was difficult for a few years, but a change in Canadian security laws, and the QP designation, gave our recruiting efforts a real boost.

In 1990, I attended my first AIPG National Meeting in Long Beach. The geologists I met at that event exhibited a high degree of professionalism, were a lot of fun to be with, and they inspired me to take a more active role in the national organization. I found that having events, such as the Washington fly-in, that allowed access to personal interaction with agencies and Congress, were only possible through membership in a nation-wide organization. I became interested in AIPG policy issues. After chairing the Continuing Education Committee, I served on the Executive Committee over the next few years, and was elected AIPG president in 2007.

Keeping a professional organization like AIPG going for sixty years is no mean feat, and I'm glad I was given the opportunity to participate with, and help out where I could, the individuals who form the backbone of our Institute.

Thank you for this honor.

Outstanding Achievement Award

MAJOR CONTRIBUTION TO THE PROFESSION



Donald Prothero, Ph,D.

Professor teaching geology and paleontology at Caltech, Columbia, and Occidental, Knox, Vassar, Glendale, Mt. St. Antonio, and Pierce Colleges and author of more than 40 books including 6 textbooks and more than 300 scientific papers.

The Outstanding Achievement Award Major Contribution to the Profession was established by the 1989 Executive Committee to honor a non-member of AIPG who is widely recognized as a major contributor to the profession of geology. The award is not necessarily given annually, but only when the Awards Committee recommends an outstanding candidate to the Executive Committee for their consideration.

I am very humbled and flattered to be honored by your society. I want to thank the AIPG and all of its members for this wonderful award. I must confess—I'm not really a professional geologist. I've done a handful of small consulting jobs for environmental firms, but I'm mostly a paleontologist and stratigrapher who teaches college students, so it is an even greater surprise to be receiving an award from you who make geology your profession, and are not my academic colleagues. I can only surmise that this reward reflects how many of you probably used my textbooks when you went through college, and learned some aspect of geology from my writings. In that regard, I feel very lucky that I have students all over the world who never took a class from me, but that were influenced by me and learned about geology through my eyes. In turn, I learned through the perspectives of my professors at University of California Riverside and Columbia University, and the textbook authors of my college textbooks, who trained and influenced me. It is just so gratifying that so many people learned about geology through my books, and that influence just keeps spreading as those who were students using my textbooks are now teaching the next generation of geologists with my textbooks.

I am so sorry that I cannot be there to accept this award in person. I am now semi-retired, so I don't have grant funds and can only afford to pay for limited travel out of pocket. I thank James Jacobs for nominating me, and the leadership of the AIPG for deciding to make me the recipient of this award.

I wish you all continued success in your professions, and have a wonderful convention!

TPG Student Edition



April-May-June 2024 Issue

Submission Deadline
February 1, 2024

Articles *Wanted*

email articles to:
aipg@aipg.org

JOHN STEWART
MEMORIAL EARLY CAREER PROFESSIONAL AWARD



Andrew Jones
MEM-3347
Colorado Section

The John Stewart Memorial Early Career Professional Award was established by the Executive Committee in 2019 in posthumous honor of John Stewart, who graciously gave his time and experience to AIPG and in encouraging geologists in their early careers and professional growth. This award is to honor an Early Career Professional member who has demonstrated an ongoing commitment to the geologic profession and AIPG at the section and/or national level, and in particular, to mentoring and aiding in the advancement of Early Career Professional members in their early careers and within AIPG.

I am humbled and honored to receive this award from AIPG National. AIPG is an important organization, and one that has helped shape my career. The connections and friendships that I have made through this organization have been instrumental in my journey as a Geologist. My good friend Bill Brab helped push me to sit for my FG, which helped me get my first job; I was hired over two engineers for a geotech position, by an engineer. The GIT was a big check mark.

That mentorship and friendship is so critical. This award is for Early Career Professional; I encourage each of you to connect with both students and ECPs to give them a hand up. Our profession is important, and we must engage with and help develop the next generation of geologists. We will undoubtedly face more opposition to our discipline in the coming years and decades, through attempts to erode licensure. Engagement and growth of our organization and profession will help us resist these forces. AIPG can remain a strong, vibrant, diverse organization, but only through our efforts.

SECTION LEADERSHIP AWARDS

The AIPG Section Leadership Award was established by the Executive Committee in 2013 to recognize one or more of our members who have demonstrated a long-term commitment and have been long-term contributors to AIPG at the section level.



Paula Berger, MEM-0665, *Minnesota Section*

Paula has been a mentor to many young geoscientists; through her employer, WSP, and through her volunteer work with the Minnesota Section of the AIPG. She is a tireless volunteer and has held almost every position within the Section. As of 2023, she volunteers as the Chair of the Membership Committee and the Sponsorship Sub-Committee. In her various roles, Paula has helped organize and promote our monthly technical talks, our annual Spring Social events, our golf fundraising events, and numerous field trips.

Nominated by: Shanna Schmitt, CPG-11781

Paula Leier-Englehardt, CPG-8798, *Wisconsin Section*



Paula has been active since 2016 in presenting "So, you want to be a Geologist" presentations to our northern University Geology Departments and most recently to a March 17, 2022, University of Wisconsin – Milwaukee Department of Geosciences Colloquium presentation. Twenty-three students and faculty attended this live presentation, with more taking advantage of the presentation recording. The presentation was titled: "Professional Geologist. . . Certified Professional Geologist Pros and Cons of Registration Are all these initials worth the effort?" and it was very well received. She also continues giving support and suggesting resources to personnel from University of Wisconsin – Milwaukee Geology Department programs that increase interest and recruit from under-represented groups. One program is called Go FORWARD, a summer educational experience in the geosciences and newly funded by a National Science Foundation grant. The second program is called Let's Geo, and helps undergrads explore careers in the geosciences and develop necessary skills. We appreciate being connected to both these programs through Paula. Inspired by the work Go Forward and Let's Geo programs have been accomplishing, Paula recommended the Wisconsin Section work with the Wisconsin Geologic and Natural History Survey (WGNHS) to fund an AIPG- sponsored summer internship at WGNHS. One of the goals of this internship is to promote geology as a career and recruit from under-represented groups. The first intern was hired and completed their mapping project in the summer of 2022. Last, but not least, we want to give Paula kudos for her research and then visiting geology features in each Wisconsin county. Since 2016, Paula has been writing an article for WI AIPG's new letters featuring the geology of each Wisconsin county! Each article starts the same by saying: "Far from Boring, And Not Even Thinking About Staying Close to Home by Paula Leier-Engelhardt, P.G., C.P.G. After 40 years of marriage to a geologist and unwittingly becoming the best sample Sherpa ever, my husband knows there is no hope in dissuading me from any geology-related project I cook up. So, when I announced that as a long-term goal, I was going to collect a rock from each Wisconsin county (there are 72, in case you were wondering), he put his head in his hands and said, "When do you want to start?" What neither of us counted on was finding hidden treasures that the average Wisconsinite may not realize exist in the state. So, allow me to introduce you to some of the places we have discovered, and some of the people we have met along the way. Paula has quite a fan club of these articles from Wisconsin and other States!

Nominated by: Christine Lilek, CPG-10195



Craig McCammack, CPG-11731, *Illinois-Indiana Section*

Craig has served the Illinois-Indiana Section as its President for the past six years (2017 through 2022). He held the Section together during the pandemic and always remained a caring, steadfast, cheerful, and positive influence on us all. Craig has introduced many members to this organization as a platform for finding great geologists to meet and synergize with. He has that kind of spirit and leadership in and outside AIPG that is infectious and makes people want to join and support us. Craig's welcoming and encouraging nature has ensured that all members, new and seasoned, feel heard when speaking up with recommendations and ideas for our section. In every situation and conversation, he has found ways to promote AIPG that is not pushy but makes people want to ask more about it. Although things moved slower over the last two years for the section, Craig's leadership sustaining a core group of volunteers while adding half a dozen dedicated board members over the previous few years is already paying dividends as we are going into 2023 with energy and momentum. Craig continues to contribute to AIPG by working to organize the 2023 National Conference with the Kentucky and Ohio Sections and National Conference committee, as well as continuing to advise and support the Illinois-Indiana Section on various committees. Craig is an exemplary member of AIPG and has been indispensable to the Illinois-Indiana Section, both functionally and personally.

Nominated by: Anna Sutton, MEM-2528; Jennifer Goshorn Stepina, MEM-3262; Peggy Straub, Tim Norris, CPG-12134; David Heidlauf, CPG-09365; Michael Monteith, CPG-10238; James Adamson, MEM-1532

Ian Wynn, SA-8150, *Georgia Section*



Ian has been the best partner to go through my program. He has pushed me academically, professionally, and personally. He is one of the best tutors at my school. His passion is infectious.

Ian was one of two undergraduates to represent our chapter at the North West GSA conference this past spring for his research in China's ceramic glaze industry.

Last year he served as our Geology Club President and is currently the Vice President. Our program was unfortunately cancelled. Current students were given an opportunity to finish their degrees. In these trying times, Ian went above and beyond as our club president to maintain our stamina to finish strong to make our professors proud.

Nominated by: Ashley Davis, SA-11068

Congratulations!

Student Chapter of the Year



2022-2023 Western Michigan University Student Chapter Officers (from left): Moira Burns, SA-11403 (Vice President); Avianna Jackson, SA-11162; (President), Mary Howe, SA-11407 (Secretary), Will Roosien, SA-11409 (1st Semester WSA Representative), Garrett Link SA-10752 (Treasurer).



WESTERN MICHIGAN UNIVERSITY



WMU Student Chapter holding the popular rock sale.

Pictured Left: Students attending the Michigan Section Annual Meeting and successfully competing for the top spots in the poster contest (from left): Luke Singer, SA-11610; Garrett Link, SA-10752; Donovan Vitale, SA-11158; Lauren Jaskot, SA-11123; Ashley Scott, SA-11678; Moira Burns, SA-11403; Ariel Martin, SA-11557; Faculty Advisor - Tom Howe, SA-5050; Avianna Jackson, SA-11162.

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. This year the Foundation has 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



Honors and Awards

2024 Call for Nominations

The 2024 AIPG Awards Committee is seeking nominations for future honorees who exemplify the qualities of leadership and dedication to service upheld as the highest standards and values of the Institute. The qualifications for these awards can be found below. Nominations are due January 15, 2024. Submit online at https://aipg.org/page/Awards or scan the QR code on page 15.

Leadership

Ben H. Parker Memorial Medal

The Institute's most distinguished award was established by the Executive Committee in 1969 in posthumous honor of a truly great leader, who devoted much of his life to improve the quality of geology and geologists and the services they provide. The medal is awarded to individuals who have long records of distinguished and outstanding service to the profession.

The most important criterion is a continual record of contribution to the profession of geology. A wide variety of contributions can be considered, such as (a) the education and training of geologists, (b) professional development of geologists, (c) services to the Institute, (d) leadership in the surveillance of laws, rules, and regulations affecting geology, geologists, and the public, and (e) activity in local and regional affairs of geologists.

Service to the Institute

Martin Van Couvering Memorial Award

Established in 1979 by the Executive Committee in posthumous honor of the first president of the Institute. Martin Van Couvering made the presidency a full-time occupation for the first two years of the Institute's history. His dynamic leadership, diplomacy, and organizational abilities established the solid foundation from which the Institute has grown. Few, if any, have given so much to the Institute.

The most important criterion for the Martin Van Couvering Memorial Award is service to the Institute. A wide-variety of contributions to the Institute may be considered. By far the most important contribution a geologist can make to the Institute is that of time. It is the contributions by individuals to the Section, the committees, and special projects that enable the Institute to enhance the practice of geology.

Service to the Public

John T. Galey, Sr. Memorial Public Service Award

AIPG's Public Service Award was established in 1982 in recognition of one of its primary purposes: service to the public. In 1992, it was renamed after John T. Galey, Sr., in posthumous honor of our fourth President, whose long professional career was a continuum of service to both the geological profession and the general public.

Recognition of public service is important because so many Members have distinguished themselves as experts in the field to governmental agencies and the serving the needs of the public.

The application of geology to the needs of the general public may be in many different forms. Recipients of this award have outstanding records of public service.

Honorary Membership

Honorary Membership

Since 1984, AIPG has conferred Honorary Membership to those who have an exemplary record of distinguished service to the profession and to the Institute.

John Stewart Memorial Early Career Professional Award

The John Stewart Memorial Early Career Professional Award was established by the Executive Committee in 2019 in posthumous honor of John Stewart, who graciously gave his time and experience to AIPG and in encouraging geologists in their early careers and professional growth. This award is to honor an Early Career Professional member who has demonstrated an ongoing commitment to the geologic profession and AIPG at the section and/or national level, and in particular, to mentoring and aiding in the advancement of Early Career Professional members in their early careers and within AIPG.

This award is to assure that active and ambitious Early Career Professional member geologists are honored as the future of AIPG.

Emerging Leaders

Advancing Geosciences

Outstanding Achievement Award Major Contribution to the Profession

The Outstanding Achievement Award Major Contribution to the Profession was established by the 1989 Executive Committee to honor a non-member of AIPG who is widely recognized as a major contributor to the profession of geology. The award is not necessarily given annually, but only when the Awards Committee recommends an outstanding candidate to the Executive Committee for their consideration.

In 2013, the Executive Committee voted to expand the scope of the award to include candidates engaged in all types of media that inform or enlighten the public on the roles of professional geologists and the geosciences in society. This award may be for work in any media that inform or enlighten the public on the roles of professional geologists and geosciences in society. This award may be for work in any media such as visual (television, film, webcasts), auditory (radio, pod casts) or printed (books, articles, websites). The work must have been completed within five years preceding the award nomination and the nominee may be an individual, a group, or a company.

AIPG Section Leadership Award

The AIPG Section Leadership Award was established by the Executive Committee in 2013 to recognize one or more of our members who have demonstrated a long-term commitment and have been long-term contributors to AIPG at the section level. AIPG has many sections where one or more individuals have demonstrated exceptional leadership for their section and in many instances kept the section together and moving forward. These individuals are commonly not known at the National level or by AIPG members outside of their sections; however, their contributions have been vital to their sections and they perform this work because of their commitment to our profession and AIPG. All active section members are eligible. It is not required to be a current or past section officer. The award will consist of a plaque (or similar) that will be presented to the awardees at the annual meeting of AIPG.

Based on the above criteria the Awards Committee may select multiple nominees for the award.

Section Leaders

Nominations due January 15, 2024

https://aipg.org/page/Awards

2024 National AIPG Executive Officer Election Results



2024 National President-Elect
Sara Pearson, CPG-10650
Portland, Michigan

2024 National Vice President
Todd McFarland, CPG-11348
Nashville, Tennessee





2023-2024 National Secretary
Robert Andrews, CPG-11975
Lockbourne, Ohio

2023 National Early Career Professional
Brigitte Petras, ECP-0851
Campbell, Ohio



Geology of the White Mountains

An Overview

Julia Rudlaff, SA-11675

Background

The White Mountains is a mountainous region extending from north-central New Hampshire to western Maine that includes some of the most notable and highest peaks on the East Coast like Mt. Washington in the Presidential Range. Other mountain ranges in the White Mountains include the Franconia Mountains, the Carter-Moriah range, and the Sandwich range. These areas are known for their stunning, glacier-carved notches, rocky peaks, and forested wilderness areas.

My introduction to the White Mountains came with a summer job working for a trail crew in the White Mountain National Forest. Within a few weeks of starting the job, I was fully immersed in the geologic, ecologic, and biologic environment surrounding me. I spent my workdays in the woods doing trail maintenance and construction, and my weekends in the woods hiking, rock hunting, and waterfall chasing. I spent weeks working in the alpine zone and weeks in the forested valley and returned this summer for another season. Over the course of these two summers, I have become increasingly familiar with the region and sought to understand its geologic history as much as I understand its current forest and mountainous features.

Tectonic History

The White Mountains initially formed from a series of collision events that sutured land masses onto the continent of Laurentia. These collisions, the Taconic orogeny, Salinic orogeny, and Acadian orogeny, occurred from 485 million years ago to 400 million years ago. The earliest, the Taconic orogeny, shown in Figure 1, is characterized by a series of collisions, most notably of two island arcs called the Shelburne Falls arc and the Bronson Hill Arc. These arcs added landmass to Laurentia, pushed the coast of the continent eastward, and created the Vermont and some of the New Hampshire mountains. There are few exposures standing as a testament to this orogeny, and all are concentrated in the town of Randolph, New Hampshire, most notably along Cold Brook and Snyder Brook.

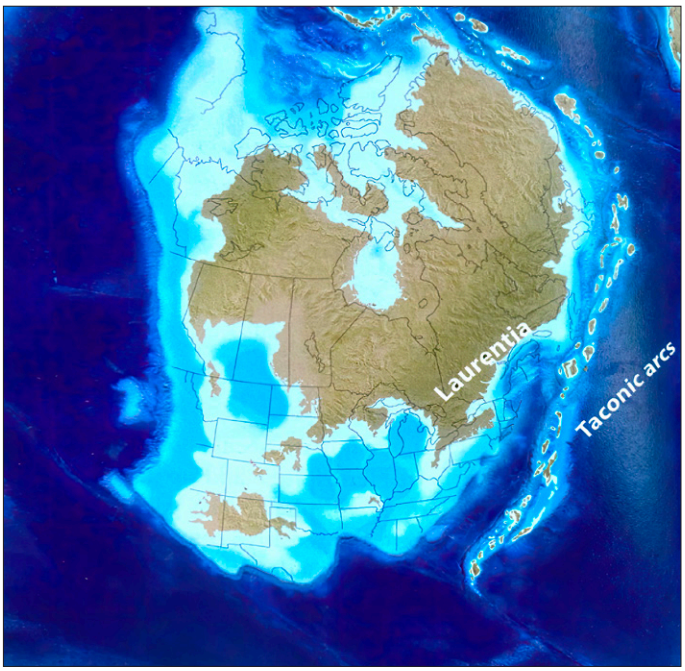


Figure 1. The Taconic Orogeny (450-485 Ma), where at least two volcanic arcs collided with Laurentia. Image source: Ron Blakey (*The Geology of New Hampshire's White Mountains).*

• • •

On my third day of work for the Randolph Mountain Club trail crew, we went on patrol. Patrolling is what many trail crews do at the beginning of the season, and it involves hiking every trail in the network and doing yearly maintenance and clearing. Our primary goal included clearing drainages to facilitate water flow off the trail and clearing blowdowns – trees that have fallen across the trails. Five minutes into the patrol, the crew crossed a bridge over Cold Brook. From the bridge, you can see a stunning, four-tiered waterfall called Cold Brook Fall. The magnificence of the fall stopped me in my tracks.

Where I'm from in Michigan, there aren't many waterfalls hiding out in the forest. Here, however, they are abundant.

I continued work that day buoyed by the beauty of my environment. I could not believe I was being paid to hike on some of the most beautiful trails in the country and see waterfalls at work. Little did I know that when I stopped to admire that waterfall, I was not only admiring the beauty of water cascading across rock ledges, but I was also likely standing witness to a geologic monument, an outcrop preserving 450 million years of geologic history and telling the pre-history of the White Mountains.

• • •

The most significant orogenic event in building the White Mountains was the Acadian orogeny, shown in Figure 2, a major tectonic event in which an intense collision between the continental plate of Avalon, a landmass roughly the size of New Zealand, and Laurentia. The Presidential Range of the White Mountains was created from this collision. When Avalon collided with Laurentia, the oceanic sediments caught between the two plates were metamorphosed, forming the Presidential Range. Geologists are still unsure exactly how tall these mountains once were, but estimates have settled around 15,000 feet.

• • •

The first time I hiked in the White Mountains, I was wildly unprepared for how physically demanding it would be. I knew the mountains were tall and the trail grades steep, but I thought my previous hiking experience in Maine, Virginia, and Michigan would help. It did, but it was not enough. Many of the trails here, the older ones especially, climb straight up the mountain, scorning switchbacks. The terrain also becomes increasingly unforgiving as you ascend, transforming from a forest, into a transitional alpine zone, then into a full alpine zone. It is a beautiful experience to watch the trees shrink in height and rocks expand in number, but also strenuous. Gaining 4,000+ feet of elevation in just over four miles is standard for many White Mountain trails. Regardless, the view from the peaks is worth the immense effort.

The first mountain I summited here was Mt. Adams, via the Randolph Mountain Club trails Amphibrach, Spur, and Upper Spur. From the peak, Mt. Washington, Mt. Jefferson, and their thick-shouldered ravines fanned out majestically. I imagined these mountains towering three times or more their current size. They may have been as tall as or taller than the Rockies, but they are still glorious mountains today. They still tower over the northeast, with alpine zone-dipped, periglacial peaks, steep and circular ravines, and remarkable wildlife.

• • •

The formation of Pangea, ushered in by the Alleghanian orogeny, marks the final tectonic collision in the history of the Appalachian Mountains. Though geologically significant, this collision did not have a significant impact on the White Mountains specifically and is evident only in small amounts of granitic magmatism and strike slip-faulting in limited areas within the northeast.

In short, the tectonic history of the White Mountains is marked by collisions. Island chains that formed from island arcs in what we would now call the Atlantic Ocean, were pushed up and onto the existing landmass of Laurentia,

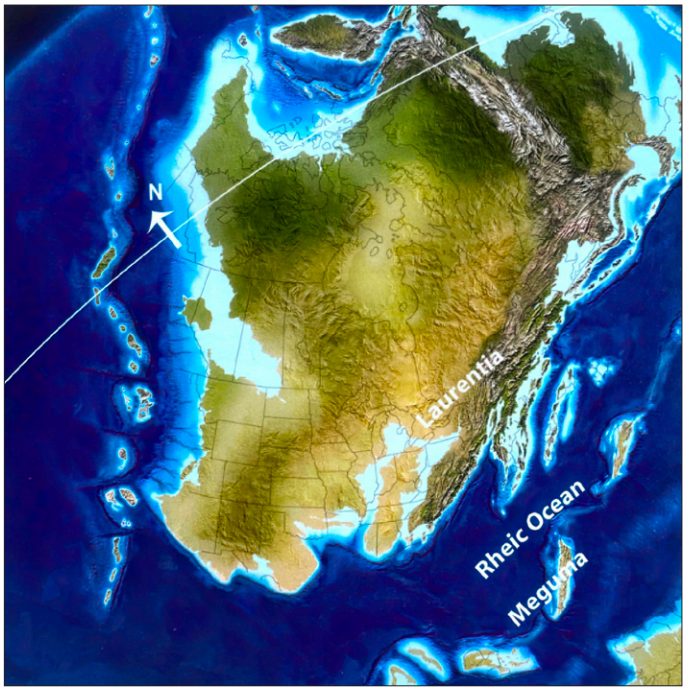


Figure 2. The Acadian Orogeny (400 Ma) after Gander and Avalon collided with Laurentia. Image source: Ron Blakey (*The Geology of New Hampshire's White Mountains*).

forming the Appalachian mountain chain which includes the White Mountains of New Hampshire, the Green Mountains in Vermont, and other mountain belts along the east coast and in the northeast.

Deformation and Metamorphism

The orogenic events that built the White Mountains – the Taconic, Salinic, and Acadian orogenies, folded, faulted, and otherwise deformed the underlying rock structures. Most of these deformation events were concentrated in the Acadian orogeny during the Devonian period, which may have obscured older deformation events.

Folding is the most prominent and easily visible feature resulting from Acadian orogeny deformation. The Presidential Range preserves two main episodes of folding that are evident throughout the range, and two other folding events that are visible only in certain regions. The folding is so extensive that it overturned the entire stratigraphy, such that Mt. Washington has upside down stratigraphy and Pinkham Notch has right-side up stratigraphy.

These deformation events were accompanied by metamorphism, and the highest temperatures and pressures occurred during the Acadian orogeny. There were metamorphic events associated with the Taconic and Salinic orogenies, but, like the folding and faulting events, these were likely overprinted by the impact of the Acadian metamorphism.

Acadian metamorphism (400-380 Ma) transformed the existing muddy shales into crystal-rich schists. Index minerals that have been found in these schists, like staurolite, andalusite, and sillimanite, provide insight into the temperature and pressure conditions that formed them. Geologists estimate that the original sedimentary deposits were emplaced in temperatures around 25°C and one to two bars of pressure.

As the Acadian collision occurred, pressures and temperatures increased to 500-600°C and three to four kbars of pressure. These pressure and temperature increases were caused by compression during folding and collisions, burial of rocks, and upwellings of magma within the collisional belt. To reach pressures that high from burial requires the rocks we see today to have been six to nine miles below the surface. Only about one third of this height contributed to the elevation of the mountains because the accumulated mass pushed the crust deeper into Earth's mantle. Therefore, at their tallest, these mountains are estimated to have been 15,000 feet tall.

• • •

Many of the rocks on the exposed peaks of the Northern Presidentials, including Mt. Madison, Mt. Adams, and Mt. Jefferson, are schists resulting from Acadian metamorphism. These schists contain visible minerals like muscovite, biotite, quartz, feldspar, garnet, and in some places, kyanite.

There's a mountain hut a mile below the summit of Adams called Gray Knob, and the trail crew sometimes spends the night there to be closer to a worksite or trail. Outside of the shelter, there are exposed rock faces of schists with well-defined foliations and index minerals like biotite, garnet, and what appears to be black kyanite. The rocks are mostly white, with small, circular to dodecahedral ruby-red garnets, black, fibrous kyanite, and clear to smoky colored quartz, each mineral providing evidence for the temperature and pressure conditions in which it grew. The geology of the White Mountains is evident in many places, if you know where and how to look.

• • •

Magma Intrusions, Volcanism, and Mineral Collecting

The breakup of Pangea ushered in a period of volcanism and magmatism in the White Mountains. Over 200 million years, Pangea split apart, creating the Atlantic Ocean and separating the supercontinent into the smaller landmasses we recognize today. The breakup of Pangea began 240 million years ago with the initiation of the mid-ocean ridge, which is still spreading and creating new oceanic crust today.

There were two periods of igneous activity that impacted the White Mountains, one in the Jurassic 200-155 Ma and one in the Early Cretaceous 130-110 Ma. The White Mountains batholith was formed in the Jurassic and covers a large swatch of the White Mountains. This batholith is characterized by overlapping centers of felsic magmatism with centers comprised of ring dikes and porphyritic quartz syenite. The Conway and Mt. Osceola granites are two main rock units within the Batholith. The Conway Granite is a subalkaline biotite granite, and the Mt. Osceola Granite is a subalkaline amphibole granite. The younger complex, the Ossipee Complex, comprises a smaller portion of the igneous activity in the White Mountains and is unique for preserving some of the only basaltic rocks in the region.

• • •

The igneous activity in the White Mountains provided some of the most beautiful mineralogical features of the region. The Moat Mountain mineral collection site in North Conway, New Hampshire is a must-visit destination for mineral collectors and rock lovers of all kinds. Here, the Moat Mountain Volcanics held hollow pockets that facilitated impressive mineral growth. Collectible minerals such as richly colored smoky quartz, blue-green amazonite (microcline), and teal and lilac fluorite are abundant and easily accessible on the surface or through digging small pits in the mineral collection area. Other valuable and beautiful specimens such as garnet, amethyst, and apatite can be found at Lord Hill and Deer Hill mineral collection sites in Western Maine. There is no fee to collect minerals at any of these publicly accessible sites, but a day-use permit must be filled out at the trailheads. More information on collecting at these sites can be found here: https://www.fs.usda.gov/activity/whitemountain/recreation/rocks-minerals.

Erosion

Erosion and gradual uplift are the defining geologic processes of the Tertiary period in the White Mountains, with significant erosion occurring 120 million - 60 million years ago. There are no exposed rocks in this region younger than the 100 million- to 130-million- year-old Early and Middle Cretaceous intrusions. Apatite fission tracks have been a recent age dating technique used to measure the rate of erosion and the areas impacted and found a consistent rate of erosion of 0.024 millimeters per year, which results in one kilometer of erosion over 50 million years. The exact cause of this erosion is unclear, but the two primary theories suggest it was triggered by ancestral river drainages cutting into the landscape or motion along faults.

Erosion occurs at different rates based on the type of rock. For example, the metamorphic schists that comprise the peaks of the Presidential Range do not weather as easily as some of the granitic rocks more common in Conway, New Hampshire. These different rates of erosion contribute to the height of the peaks we see today, with the Presidential Range towering above the lower slopes of the granite peaks. Estimates from different geologists agree that the relative heights of the peaks within the White Mountains were established about 60 million years ago, and since then have been eroding at a near constant rate across the region, as shown in Figure 3 on the following page.

• • •

One of the primary goals of trail crews in the White Mountains is erosion prevention. At the beginning of the season, we clear drainages which usher water off the trails and prevent the tread from wearing down. Throughout the rest of the season, we build erosion resisting structures like rock water bars, retaining walls, and rock staircases that direct water flow, uphold existing stream banks, and provide structure to trails that keep hikers on the existing path. Our primary goal in this work is conservation of land while providing a safe and low-impact way for people to enjoy recreating in the outdoors.

Watching a thin stream of water carve through mineral soil over the course of a few weeks makes it easy to imagine how significantly larger bodies of running water can transform an entire landscape. Water is a powerful erosional force, and its impacts cannot be understated. It is awe-inducing to imagine a time-lapse of these mountains being eroded, millimeter by millimeter, with the aid of no construction equipment, no excavators or skid steers or cranes, just water moving sediment, transporting the Earth grain by grain.

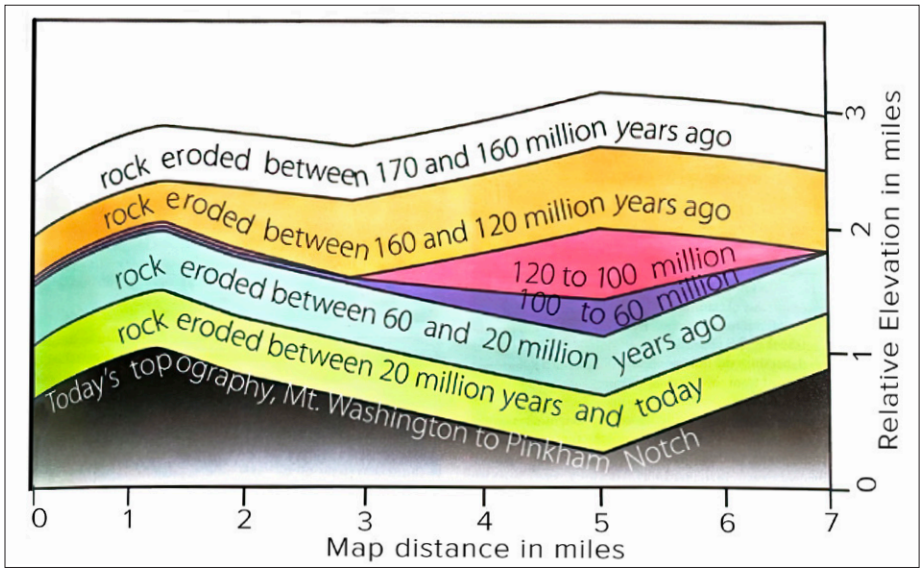


Figure 3. Estimated erosional rates across the Presidential Range from Mt. Washington to Pinkham Notch. Erosion rates were determined using apatite fission track length modeling and shows how the rate of erosion is varied from 170 to 60 Ma, and then follows a consistent pattern across the range from 60 Ma – present. Image source: *The Geology of New Hampshire's White Mountains.*

A Glacial Landscape

The Pleistocene age of glaciation dramatically changed the White Mountain landscape. Many of the region's notable features, including cirques and notches, rocky peaks, and clear streams and lakes, are the result of glacial activity. Glaciers primarily impact landscapes via erosion. The erosive power of glaciers can be seen on smooth summits like Mt. Eisenhower in the southern Presidential Range. Microscale erosive features like glacial striations are also visible on some exposed surfaces, and stoss and lee topography, which are features with one very steep and one shallow side like the peak of Mt. Monroe, provide clues as to the direction of ice flow.

As each continental ice sheet in this glacial cycle pushed southward from the north, it would have traversed the valleys, following the path of least resistance. These pathways carved out steep notches that represent some of the most beautiful terrain in the region, including Kinsman, Franconia, Zealand, Carrigain, Crawford, and Pinkham Notches.

Glacial cirques are other abundant and notable features in the White Mountains. Cirques are bowl-shaped depressions carved out of mountain landscapes by glacial movement. The cirques in the White Mountains were likely created by alpine glaciers that formed during glacial episodes in which snow was consistently deposited into the existing stream valleys. The weight of these alpine glaciers depressed the ground beneath them, leaving circular carvings in their wake. Figure 4 shows King Ravine, a beautiful glacial cirque near Mt. Adams.

The Laurentide ice sheet had the most significant impact on the glacial geology of the White Mountains. It covered the region from 30,000-13,0000 years ago, and reached as much as a mile high. Evidence for the ice sheet's coverage of the White Mountains comes from glacial till, glacial erratics, and glacial lakes that dot the region.

Today, the high peaks of the White Mountains are considered periglacial environments, where freeze-thaw cycles are the preeminent force shaping the landscape. Evidence for this can be seen in the jagged rock surfaces blanketing the higher summits as shown in 5, the limited and hardy vegetation, and periglacial features like patterned ground on Mt. Washington. The valleys and lower summits are post glacial environments, distinguished by the features carved from them by ice, like waterfalls, potholes, and stray boulders.

• • •

Last summer, the trail crew worked just below the summit of Mt. Adams, and our jobsite was on the large rock pile characteristic of the Northern Presidential peaks. We spent most days there carrying jagged, lichen-covered rocks from one spot on the mountain to another. These rocks were used to build scree walls that line the boundaries of the trail, keeping hikers off the fragile alpine vegetation.

The work was difficult, and the terrain was harsh, but we were constantly surrounded by beauty. When the clouds disappeared, Tuckerman ravine opened up before us, revealing a panoramic view of Mt. Jefferson, Mt. Clay, and Mt. Washington. Other days, it hailed in July and our wet gloves froze to our fingertips. The environment was constantly changing, and we saw evidence of the region's glacial history all around, in the large rock piles we used for construction, in the mountain avens flowers, and in the snow that still stuck to the sidehills of the summits well into June.

• • •



Figure 4. The glacial cirque of King Ravine as seen from the King Ravine Trail.

Recreation and Other Notes

The White Mountains may be most notable for their recreational possibilities, and that is how I came to love and appreciate them. The White Mountains are home to hundreds of hiking and mountain biking trails, beautiful backcountry campsites and alpine huts, and stunning lakes and rivers accessible for fishing, boating, and swimming. Learning about a place in textbooks and through scientific papers is one aspect of immersion with a subject and region, but it is an entirely different and equally fulfilling experience to explore something first-hand, with boots on the ground and hands on the rocks.

References

Eusden, J. D., Thompson, W., Fowler, B., Davis, P., Bothner, W., Boisvert, R., Creasy, J. (2013). *The Geology of New Hampshire's White Mountains*. Durand Press.

Eusden, J. D. (2010). *The Presidential Range: Its Geologic History and Plate Tectonics*. Durand Press.

Series, W. M. M. (1995). Third Hutton Symposium on Granites and Related Rocks.



Figure 5. The rock pile extending down from the summit of Mt. Adams and the panoramic view of Mt. Jefferson, Mt. Washington, and Tuckerman Ravine.

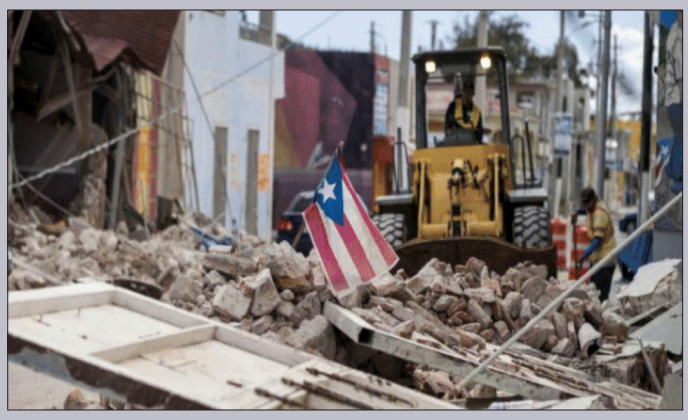
Editors note: This article is a reprint of the original article featured in the Summer 2023 Florida Section AIPG and Florida Association of Professional Geologists newsletter.

Re-Establishment of Deregulated P.G. Licensing Board in Puerto Rico

Yomari Soto-Lopez, P.G.

The Puerto Rico Board of Examiners of Geologists (the Board) was created under law No. 163 of August 26, 1996 (Ley de la Junta Examinadora de Geólogos de Puerto Rico). The Board was created for granting licenses to professionals who have the knowledge and skills to practice geology. Professional geologist licenses were issued for approximately 20 years and these licensed professionals provided, with great success and value, their expertise to private industry as well as Government agencies. Unfortunately, a newer Puerto Rican governor and his legislature failed to realize the importance of Geologists and neglected to re-appoint the Puerto Rico Geology Board. As a result, the Board became inactive in 2018 due to political instability and administrative interruptions which resulted in professional geologists of Puerto Rico not being able to renew their licenses and younger geologists not taking the National Association of State Boards of Geology (ASBOG) Fundamentals of Geology and Practice of Geology exams to obtain their licenses.

By 2022 all professional geologists' licenses had expired in Puerto Rico, yet the current administration of the government of Puerto Rico recognized the importance of professional geologists following continual lobbying and communication by local geologists and several recent natural disasters with extensive recovery efforts requiring Professional Geologists. Administrative project No. 1464 authorized the Boards' reinstatement. This administrative project was necessary for the Puerto Rico government to appoint new Board members because according to law No.163, the Board requires three geologists with a current license to be members, however all previous licenses had lapsed due to the inactive Board. The new Board was finally reinstated by the government of Puerto Rico in May 2023. Once it reorganizes, and the expired licenses are



Earthquake rubble. Guánica, Puerto Rico

Continued on p. 55

Caribbean Geology

A Taste

Robert G. Font, PhD, CPG-3953

Introduction

The Caribbean area was my playground during my youth and early teenage years. I grew up in Cuba enjoying various water sports and, of course, playing baseball. Many years later, as a man living at the time in Midland, Texas, I became a certified open-water scuba diver and for the following twenty years I savored annual diving trips to various portions of the region. Among these dive sites are Cozumel Island in Yucatan, Mexico, the Cayman Islands, St. Thomas (U.S. Virgin Islands), Bimini (Bahamas), Belize, and Roatan (Honduras). I can claim to have explored the Caribbean from the bottom up (Fig. 1). Through work and pleasure, I have visited many of the islands in this tropical paradise.

The Caribbean Sea – General Geological Setting

The Caribbean Sea area is geologically very complex. The Caribbean region (Fig. 2) includes waters south of the Greater Antilles, west of the Lesser Antilles and north of Colombia and Venezuela. It is also bordered on the west by Central America.

The main islands of the Caribbean (Fig. 3, p. 23) comprise those belonging to the Greater Antilles and the Lesser Antilles.



Figure 2. Caribbean Sea area sketch location map.



Figure 1. The author holds a sea cucumber near Roatan, Honduras (left) and swims into a short tunnel off the island of Cozumel, Yucatán, Mexico (right).

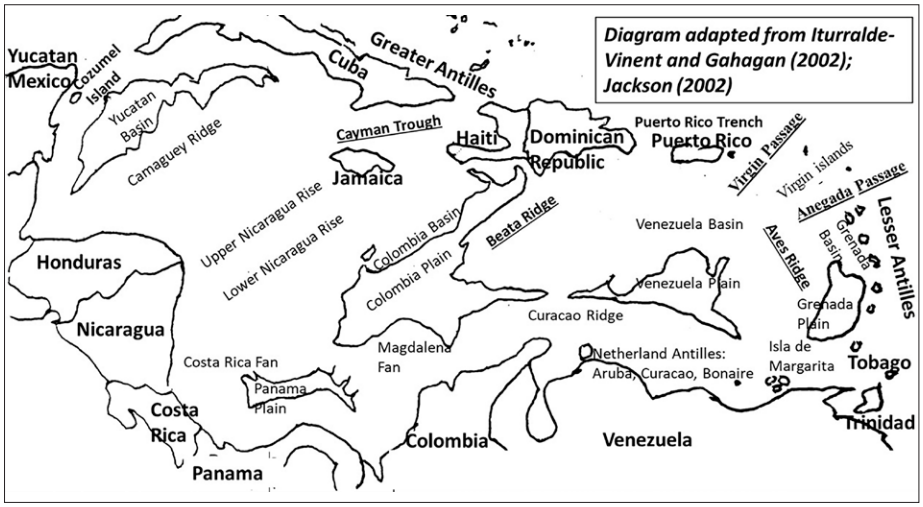


Figure 3. Physical features of the Caribbean Sketch Map.

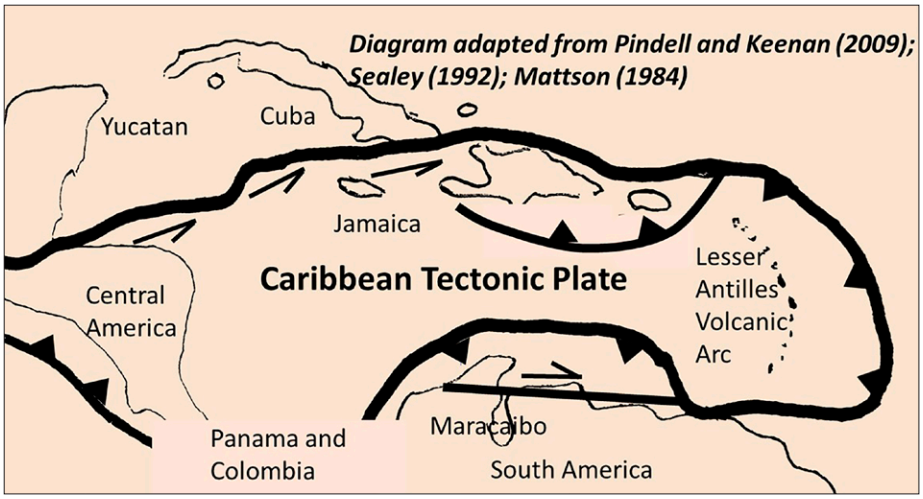


Figure 4. Caribbean Plate Sketch Map.

The Greater Antilles include the major islands of Cuba, Jamaica, Hispaniola (Haiti and the Dominican Republic), and Puerto Rico. The Virgin Islands, and the Bahamas lie east of the Greater Antilles and north of the Lesser Antilles. The Virgin Passage separates Puerto Rico from the Virgin Islands. The Anegada Passage separates the Virgin Islands from the Lesser Antilles. The Lesser Antilles form the volcanic island arc that lies south of the Anegada Passage.

The main oceanic basin of the Caribbean Sea lies south of the shallow banks that stretch from Honduras and Nicaragua to Jamaica and to Hispaniola. The Beata Ridge divides the Caribbean into a western and eastern part. The average depth of the Caribbean Sea is approximately 7,220 feet. West of the Aves Ridge lies the Venezuela Basin with a depth of about 16,800 feet. East of the Aves Ridge is the Grenada Plain and Grenada Basin. East of the Grenada basin one finds the Lesser Antilles and their supporting ridge. The Cayman Trench (Bartlett Trough) lies between Jamaica and the south-eastern tip of Cuba. The trough has a maximum depth of 25,216 feet.

Suggested references providing valuable information on this topic include the works of Pindell and Keenan (2009); James (2005); Jackson (2002); Donovan, and Jackson (1994); Draper, and Jackson (1994); Pindell (1994); Sealey (1992); Dengo, and Case (1991); Pindell, and Barret (1990); Bally, and Palmer (1989).

The Caribbean Tectonic Plate and Main Geological Events

The plate tectonic and structural development of the Caribbean area has been discussed by various authors, including the works of García-Casco, Proenza and Iturralde-Vinent (2011); James, Lorente and Pindell (2009); Pindell and Keenan (2009); Iturralde-Vinent and Gahagan (2002); Sealey ()1992; and Mattson (1984). Key points are summarized below.

The Caribbean Tectonic Plate is an oceanic plate underlying Central America and the Caribbean Sea, lying on the north coast of South America (Fig. 4). With an area of about 1.2 million square miles, the Caribbean Plate borders the North American Plate, the South American Plate, the Nazca Plate, and the Cocos Plate.

The plate boundaries are regions of seismic activity and volcanic eruptions:

- The northern plate boundary with the North American plate is a transform boundary or strike-slip fault which runs from the border area of Belize, Guatemala, and Honduras in Central America, eastward through the Cayman trough. Part of the Puerto Rico Trench (the deepest part of the Atlantic Ocean and about 27,500 feet deep) lies along this border.
- The eastern plate boundary is a subduction zone where oceanic crust dives beneath the Caribbean tectonic plate. Subduction at this convergent boundary forms the islands of the Lesser Antilles Volcanic Arc, from the Virgin Islands on the north to the islands north of the Venezuelan coast on the south. Seventeen key active volcanoes form part of this arc. The most notable of these are Soufriere Hills on the island of Montserrat, Mount Pelée on Martinique, La Grande Soufrière on Guadeloupe, Soufrière Saint Vincent on Saint Vincent, and the submarine volcano Kick 'em Jenny about ten kilometers north of Grenada.
- The southern plate boundary is geologically complex, where the Caribbean Plate interacts with the South American Plate forming Barbados, Trinidad and

Tobago, and the islands off the coast of Venezuela and Colombia. This boundary is a combination of transform faulting along with thrust faulting and some subduction.

- The western portion of the Caribbean plate contains Central America. The Cocos Plate in the Pacific Ocean plunges beneath the Caribbean Plate, along the western coast of Central America. This subduction zone forms the Central America Volcanic Arc and accounts for the volcanoes of Guatemala, El Salvador, Nicaragua, and Costa Rica.

The Atlantic Ocean opened at the end of the Triassic Period as the North American Tectonic Plate rotated away from South America and Africa. In turn, the Yucatán area moved into the Caribbean region creating the Gulf of Mexico. Closer to the Atlantic Ocean a long and tapering sedimentary wedge was deposited in a shallow sea essentially forming the Florida-Bahamas-Cuba platform. These movements continued until Cretaceous time. At this point Central America, as far as Guatemala, looked like its current configuration. In addition, South America had started to move westward opening the south Atlantic. Both the North American and South American plates were diverging and drifting westward creating an increasing gap between them. A section of the Pacific Tectonic Plate moved in to fill the gap. In doing so, the Caribbean Tectonic Plate came into existence forming the Caribbean region. A convergent boundary and its related subduction zone developed resulting in volcanic activity and the creation of the Greater Antilles. Initially, the Caribbean Tectonic Plate moved eastward and northward, pushing towards Cuba and the Bahamas. By the end of Cretaceous time, subduction activity stopped in the Greater Antilles and by Eocene time subduction began in the Lesser Antilles.

At present the Caribbean plate is moving eastward about 22 millimeters per year relative to the South American Plate. Relative to the North American Plate, the Caribbean Plate moves east-northeast at approximately 20 millimeters per year. Sealey (1992, p. 9) points out that the Caribbean Plate now moves very slowly to the southwest, but it is overtaken by the motion of both the North American and South American plates; thus, relative to these, the Caribbean Plate moves in an eastwardly direction. Plate migration started in the Late Cretaceous.

Table 1. Main Events in the Caribbean Region.

Geologic Time Unit	Geological Events
Pleistocene to Holocene	The islands of the Bahamas were formed, while Barbados and the limestone bank islands took their current configuration.
Pliocene	The margins of the Caribbean Plate were underthrusted and uplifted. The western leeward islands of the Lesser Antilles were formed via volcanism.
Miocene	Jamaica and Trinidad rose above sea level.
Oligocene	The Bahamas, Belize, and much of the Greater Antilles became shallow-water banks fringed by coral reefs.
Eocene	Subduction and its related volcanism came to an end in the Greater Antilles and began along the western belt of the Lesser Antilles and Winward Islands. Jamaica was submerged.
Paleocene	The Caribbean Plate started to move eastward resulting in orogenic activity in the Greater Antilles, Trinidad, and Venezuela.
Cretaceous	The Caribbean Plate broke away from the Pacific Plate. The islands of the Greater Antilles formed as a volcanic chain resulting from lithospheric subduction.

Adapted from Sealey (1992).

Pertinent to its genesis, there are two theories that account for the development of the Caribbean Tectonic Plate. The first theory sees the Caribbean large igneous province originally forming in the Pacific Ocean. A second theory describes the Caribbean Plate as developing from an Atlantic hotspot no longer in existence.

The main geological events in the Caribbean as shown in Table 1.

The Greater Antilles

Informative publications concerning the geology of the Greater Antilles are the products of the research by Iturralde-Vinent, García-Casco, Rojas-Agramonte, Proenza, Murphy, and Stern (2016); Pardo (2009); James (2005); Cobiella-Reguera (2002); Jackson (2002); Jackson and Scott (2002); Draper, Gutierrez, and Lewis (1996); Donovan, and Jackson (1994); Draper, Mann, and Lewis (1994); Draper, and Jackson (1994); Robinson (1994); Sealey (1992); Mann, Draper, and Lewis (1991); Dengo, and Case (1991); Bally, and Palmer (1989); Potter (1982); Walper (1982); Nagle, Palmer, and Antonini (1979); King (1977); Bowin (1975); Kaye (1975); Nairn, and Stehli (1975); Khudoley, and Meyerhoff (1971); Beinroth (1969); Howard (1962); Kaye (1957); Eardley (1951); and Palmer (1945).

With a surface area of approximately 80,000 square miles, the Greater Antilles account for about 90% of the landmass of the West Indies. Following is a synopsis of the geology of the main islands that comprise the Greater Antilles.

Cuba

Physiography:

Cuba has an area of about 42,800 square miles with a length and width of approximately 777 miles and 119 miles, respectively. The main physiographic provinces (Fig. 5, p. 25) are summarized as described by Palmer (1945). The three main mountain belts of Cuba include the Organos Mountains in the west, the Trinidad Mountains in the central portion of the island, and the Sierra Maestra Mountains in the east. The highest elevation is Pico Turquino at 6,476 feet above sea level in the Sierra Maestra. The famous Cuban "mogotes" or limestone mounds in a karstic depression in the Organos Mountains of western Cuba are a unique physiographic attraction (Fig. 6, p. 25). As a youngster, I remember climbing one of these "mogotes."

Geological summary:

The western and central regions of Cuba are a deformed orogenic belt that formed from the collision of an island

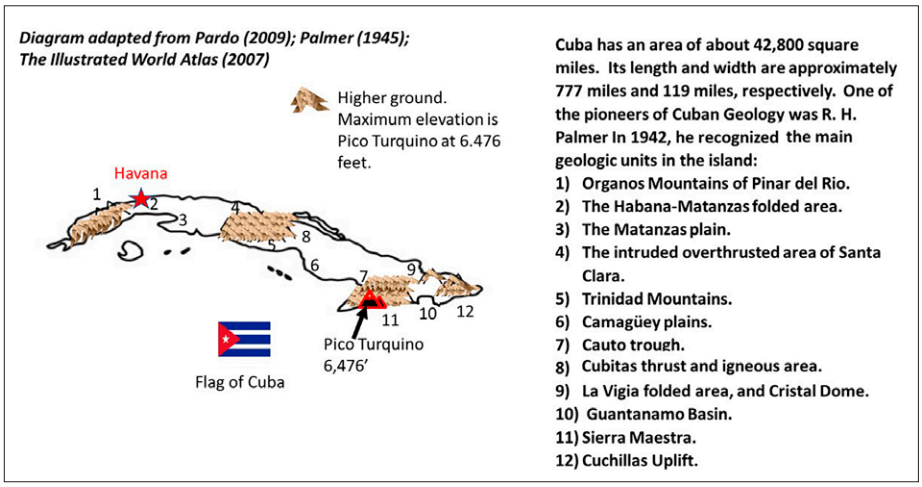


Figure 5. Cuba's Physiographic Provinces Sketch Map.



Figure 6. A "mogote" or limestone mound in the Viñales Valley (karstic depression) in the Organos Mountains of Western Cuba. Photos by Tony Nojman.

arc in the Cretaceous with the Florida-Bahamas platform. Because of this collision an ophiolite zone on the island became obducted creating a northward leaning fold and thrust belt. Central Cuba has a zone of Proterozoic metamorphic rocks. Jurassic and Cretaceous outcrops are plentiful throughout the island.

Various orogenic episodes are recognized in Cuba:

- The first and oldest tectonic episode is of Jurassic age and consists of folded metamorphic rocks.
- A second and subsequent pre-Cretaceous orogenic episode was responsible for the folding of some of the carbonates found on the island.
- A third, intensive orogeny, characterized by folding and low angle thrust faulting, occurred in the Eocene.
- A fourth orogenic episode took place in the Oligocene.
- A fifth orogeny occurred in Miocene time. Although not as intense in its degree of deformation, it raised the island into a single mass rather than the previous system of scattered islands.
- High-angle block faulting occurred after the five orogenic episodes. In eastern Cuba, this deformation is represented by

Table 2. Cuba - Age of rocks and lithologic descriptions.

Time Frame	Description of the Strata
Pleistocene	Pleistocene rocks are represented by terraces found in several parts of the island.
Miocene	In the Miocene, most of Cuba was submerged. Carbonate deposition became widespread, unconformably overlying older lithostratigraphic units. Miocene rocks are also found in a few of the island's estuaries.
Oligocene	Oligocene rocks are marly shale, limestone, and coral reef units.
Eocene	Eocene strata consist of shale and quartz sandstone in the western portion of the island. Eocene carbonate and clastic rocks are found throughout Cuba. The sea deepened throughout the Eocene. Conglomerate and sandstone are overlain by other coarse-grained clastic sediments, fine-grained shale, and deep-water chalk.
Cretaceous	Only upper Cretaceous rocks are found in Cuba. The highly folded Cretaceous strata consist of a clastic facies composed of coarse-grained calcareous sandstone and marl capped by sandstone, shale, and a conglomerate with lithologic components not indigenous to the island, and a carbonate facies comprised of limestone along the northern side of the central portion of the island.
Jurassic	The Jurassic strata include an older sequence of about 35,000 feet of folded shales, slate, phyllite and schist, and a younger series of unmetamorphosed dark-colored limestone, shale, and chert with thicknesses ranging from 1,000 to 5,000 feet.
"Basement"	Eastern Cuba has a Cenozoic volcanic arc composite with ophiolites occurring north and east of the Sierra Maestra. The oldest rocks on the island are metamorphic and of Proterozoic age. Other basement rocks are Jurassic to Cretaceous units. An ultramafic composite of serpentinized peridotite intrudes the older metamorphic strata. In turn, the ultramafics are unconformably overlain by Cretaceous volcanic tuff.

a north-tilted fault block; the Sierra Maestra.

As a point of interest, Cuba's Cretaceous to Tertiary marine fauna consists of marine foraminifera, radiolarian, corals, echinoids, and mollusks. The fauna is not considered characteristic of North America, but that which is closer to that found in Iran and Egypt.

Cuba's igneous rocks are divided into intrusive and extrusive lithologies:

- Intrusive rocks are both felsic and mafic. Felsic plutons are found in the southern part of Cuba, along the Trinidad Mountains and in the Sierra Maestra Mountains (e.g., central, and eastern Cuba, respectively). Mafic plutons are more predominant along the northern part of the island.
- Extrusive rocks include about 6,000 feet of lava flows, volcanic tuff, and breccia. Basalt is the main component of the Sierra Maestra Mountains with thicknesses of 13,550 to more than 18,000 feet. Basalt is found in the eastern side of the island and pumice in central Cuba.

A synopsis of key lithologic units found on the island is shown in table 2.

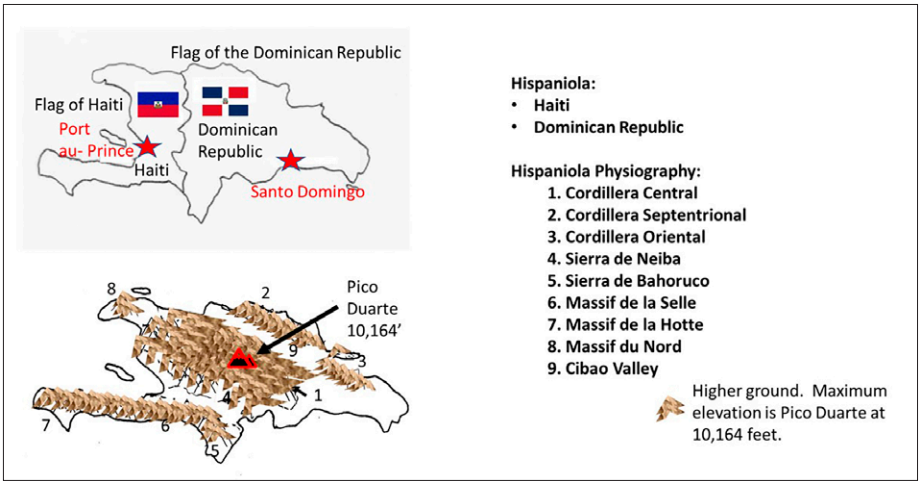


Figure 7. Hispaniola's Political and Physiographic Sketch Maps.



Figure 8. The rugged coastline of northern Haiti around Labadee (left and topography in the San Cristóbal Province in the southern part of the Dominican Republic, at the foothills of the Cordillera Central (right). Dominican Republic photo by Cesar Done.

Hispaniola

Physiography:

Hispaniola is the second largest island of the Greater Antilles consisting of Haiti and The Dominican Republic (Fig. 7). The island is 400 miles long by 160 miles wide. Several northwesterly-oriented mountain ranges cross the island. The Central Cordillera (Fig. 8) reaches heights of over 9,500 feet. The highest elevation is that of Pico Duarte at 10,164 feet. North of the island lies a narrow submarine trough 12,000 feet deep. The trough deepens to the east into the Brownson Trough. North of the trough sits the shallow platform of the Bahamas. South of the island, a narrow shelf area drops into deep water. The southern peninsula passes into the submarine Beata Ridge.

Geological summary:

Hispaniola began forming during Cretaceous time through island arc-related plutonic activity. The island is interpreted as being formed from various small and separate island arcs. Plutonic intrusions, metamorphism and volcanism began concurrently on the largely submerged landmass. The Cordillera Central has obducted peridotite overlying a metamorphosed schist and mylonite shear zone. The basal metamorphic lithologies in Hispaniola are of Jurassic to Cretaceous age. They

Table 3. Hispaniola - Age of rocks and lithologic descriptions.

Time Frame	Description of the Strata
Cenozoic	The Cenozoic strata consists of thick sedimentary rocks of Eocene, Oligocene, and Miocene age. Pliocene strata are found to the south and Pleistocene rocks are scarce.
Pre-Cenozoic	Pre-Cenozoic strata consist of argillite in the north and limestone in the south. Older volcanic rocks occur in the Massif du Nord (Haiti) which are overlain unconformably by marine and non-marine sedimentary strata and radiolarian chert. Cretaceous rudists reefs unconformably overlie sedimentary lithologies.
"Basement"	The oldest rock units include igneous rocks (granite, quartz diorite, andesite, basalt, and tuff), sedimentary rocks (mainly carbonates), and metamorphic rocks (schist, and serpentine). These make up the axis of the Cordillera Central. Greenstone and amphibolite occur in the northern part of the island.

are exposed along the Cordillera Central of The Dominican Republic and the northern range of Haiti.

The early orogenic episodes described for Cuba are combined into Hispaniola's basal complex. The time of great thrusting in Cuba was an interval of deposition in Hispaniola. Compressional features (thrust faults and folds) constitute the main form of structural deformation. The current physiographic landscapes result from a thrusting phase of Miocene to Pliocene age.

A summary of some key lithologic units found on the island is given in table 3.

Puerto Rico

Physiography:

The island of Puerto Rico (Fig. 9) is about 105 miles long by 35 miles wide. The Brownson Trough or Puerto Rico Trench lies just north of the island dropping down to a depth of 27,552 feet. The island sits on a plateau-like ridge that also holds the Virgin Islands to the east. South of Puerto Rico the sea drops to a depth of 17,000 feet. The Anegada Passage separates Puerto Rico from the Lesser Antilles. On the west side, the Mona Passage (with water depths of 1,200 to 3,760 feet) separates Puerto Rico from Hispaniola. The central part of Puerto Rico is comprised by a rugged mountain range (Cordillera Central) that runs in an east to west direction. A composite of basement rocks makes up the central ridge. The average elevation in this range is approximately 2,000 feet above sea level. The highest peak is Cerro de Punta at about 4,356 feet. The Sierra de Luquillo and the Rio Grande scenic area (Fig. 10) occupy the eastern edge of the island.

Geological summary:

The island of Puerto Rico consists of an extinct volcanic island-arc terrane which started to form in Mesozoic time. The island began as an active volcanic area related to the subduction of the Pacific Tectonic Plate beneath the western coast of South America. During Cretaceous time, the island-arc was propelled northward and eastward as the North and South American plates pushed westward around the newly created Caribbean Tectonic Plate. An older series of tilted, folded, and overturned strata is found in the northeast. Folds strike northwest to southeast and are interrupted by flexures that extend in a north-to-south direction. A younger series of structures is found on the north side of the island. The area is elevated but not strongly deformed. The south side of the island is gently folded and faulted. The Mesozoic to Eocene orogenic episodes recognized in Cuba are imprinted in the older system of bedrock found in Puerto Rico, but only one post-Cretaceous/Eocene orogenic episode is distinguishable on the island. Cenozoic

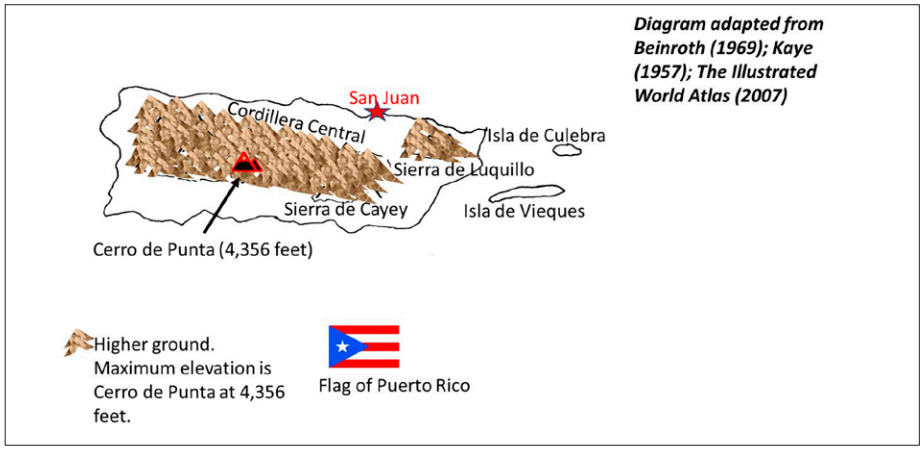


Figure 9. Sketch Physiographic Map of Puerto Rico.



Figure 10. Topography in the Rio Grande area of Puerto Rico, located on the eastern edge of the island, north of the Sierra de Luquillo. Photo by Molly Champion.

history, in general, appears to have been one of little structural deformation.

Critical lithologies in Puerto Rico are outlined in table 4.

Table 4. Puerto Rico - Age of rocks and lithologic descriptions.

Time Frame	Description of the Strata
Cenozoic	A younger system of Oligocene and Miocene shales, sandstone, and reef limestone rests unconformably on the older bedrock. The younger sedimentary strata are found as marginal deposits on the north and south sides of the island.
Mesozoic	An older volcanic system of Cretaceous age contains deformed and faulted volcanic tuff, volcanic ash, and intrusive igneous rocks, as well as some sedimentary strata such as limestone, shale, and conglomerate. This system is found in the central and southern parts of the island.

Jamaica

Physiography:

The highest area of Jamaica (Fig. 11) is the Blue Mountains Range on the eastern part of the island. The Blue Mountains have a central ridge of metamorphic rocks surrounded by limestone. This central ridge is oriented in a northwest to southeast direction with extensions projecting to the north and south. The highest peak is the Blue Mountain Peak at 7,402 feet above sea level. The Blue Mountains rise quickly from the coastline in about 10 miles of horizontal distance, giving rise to very steep gradients and impressive landscapes (Fig. 12). The John Crow Mountains lie to the north of the Blue Mountains. The John Crow range is a tilted limestone plateau with elevations of about 3,300 feet. The limestone plateau which covers about two-thirds of the country lies to the west of the Blue Mountains in the central region. The high rolling plateau on the north forms the Dry Harbour Mountains. Other high areas include the Nassau, Santa Cruz, Carpenters, Mocho, and Don Figuerero mountains. Karst topography is pervasive within the limestone plateau area. From the northern shore, the land rises in the form of gentle hills and continues into the high country. High cliffs are found along the southern shore. Jamaica lies 90 miles from Cuba, separated by the deep water of the Bartlett Trough. Water depth in the trough exceeds 15,000 feet and reach 21,000 just south of Cuba. The long and narrow peninsula of Haiti is about 90 miles from Jamaica where water depths are over 4,000 feet. South of Jamaica, water depths drop to 13,800 feet. Jamaica and Honduras are 900 miles apart.

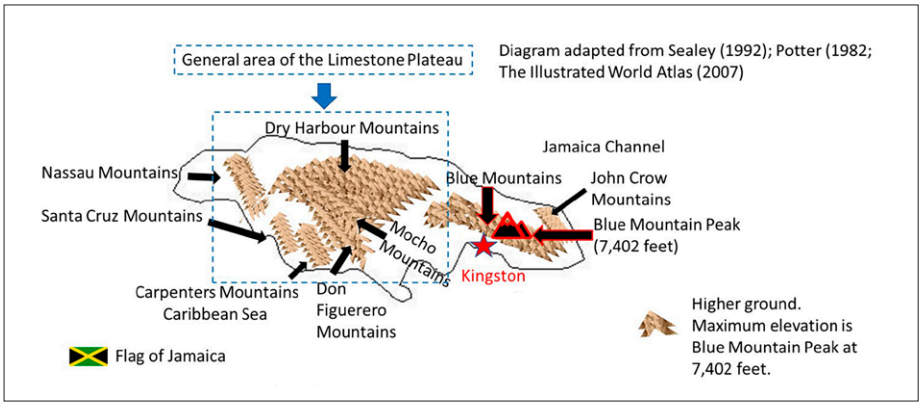


Figure 11. Sketch Physiographic Map of Jamaica.

Geological summary:

The basement rocks of Jamaica consist of island arc and back-arc basin sequences of Cretaceous age that formed above a convergent plate boundary and its related subduction zone. The overlying strata are mainly shallow water carbonates that have



Figure 12. Dunn's River Falls at the foot of Dry Harbour Mountains and landscape near Spanish Town along Rio Cobre, about 13 miles west of Kingston. Rio Cobre photo by Sean Witter

Table 5. Jamaica - Age of rocks and lithologic descriptions.

Time Frame	Description of the Strata
Cenozoic	Clastic sedimentary rocks of the Eocene age also overlie the Cretaceous. Eocene strata, as well as Oligocene rocks are essentially limestone with thicknesses of more than 1,500 feet. These carbonates contain thick-shelled foraminifera that are indicative of water depths more than 1,000 feet.
Mesozoic	Basement rocks are covered by about 3,000 feet of volcanic material. Some Cretaceous fossiliferous marl and limestone are also present.

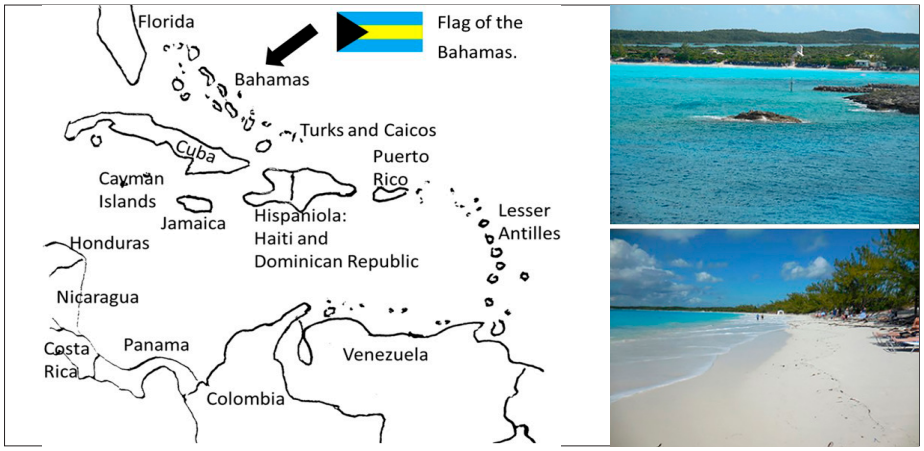


Figure 13. Sketch Location Map and views of the Bahamas.

Table 6. Bahamas - Age of rocks and lithologic descriptions.

Time Frame & Depth	Description of the Strata
Miocene to Holocene (0 to 2,200 feet)	Coquina, limestone, and some dolomite.
Eocene (2,200 to 4,640 feet)	Alternating limestone and dolomite with some coquina.
Paleocene (4,640 to 8,760 feet)	Dolomite with some chalky limestone.
Cretaceous (8,760 to 14,587 feet)	Dolomite with some limestone.

Adapted from Eardley (1951).

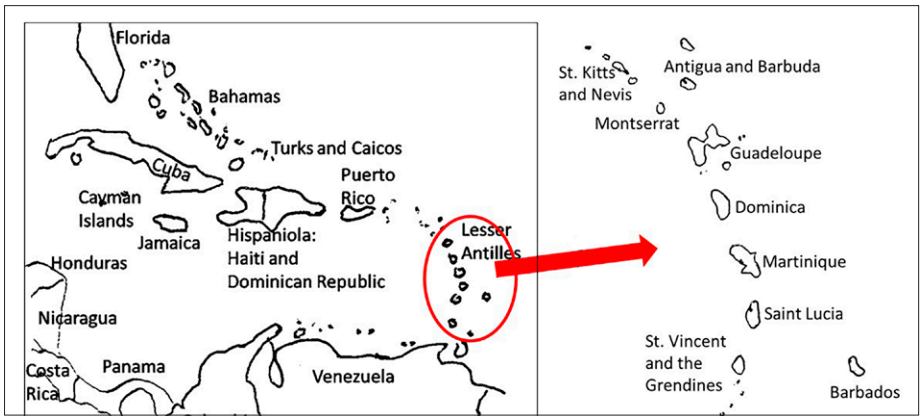


Figure 14. Sketch Maps showing Lesser Antilles.

been subsequently uplifted. A late Cretaceous to Eocene orogeny affected the island. Cretaceous rocks are tightly folded and oriented in a northwesterly direction. In the Oligocene about 80% of the island was submerged. During this time, extensive limestone units were deposited. The east-to-west elongation of the island is related to late Miocene epeirogeny and faulting. Land rose in the Miocene along with intrusions of diorite and granite. Cross faulting occurred in the Pleistocene.

Critical lithologies found in Jamaica are given in table 5.

Bahamas

Physiography:

Technically, the Bahamas are in the Atlantic Ocean and not in the Caribbean Sea. However, these islands are in the Lucayan archipelago (along with the Turks and Caicos) and are generally associated with the Caribbean region. They form part of the West Indies.

The islands of the Bahamas (Fig. 13) comprise about 700 islands and keys and 2,400 rocky mounds. The islands are flat and low, resembling the Florida coast and keys. On a personal note, immediately after being certified as an open-water scuba diver, my first diving destination was the island of Bimini in the Bahamian chain.

The Bahamas region is separated from Florida by the Florida Channel and from Cuba by the Bahama Channel. On the east side, the Bahama's platform drops sharply into the depths of the Atlantic Ocean (15,600 feet). The greater part of the platform is covered by very shallow water (18 to 25 feet deep). Submarine channels and canyons cut through the platform.

Geological summary:

The region that encompasses the Bahamas may have been emergent to begin with and the submarine canyons cut by subaerial streams. The area underwent subsidence, as much as 10,000 feet during Mesozoic and Tertiary time. Reefs began to build up as subsidence continued, during which time the reefs grew vertically and somewhat laterally. Reef buildup has been prominent in the history of this region. The emergence of the platform and current island configuration began in Pliocene time. Whether or not the present-day submarine canyons are

of subaerial erosion origin or cut by submarine turbidity currents is still a debatable topic.

Carbonate sediments are dominant in the Bahamas. The lithologies encountered in a deep well in Andros Island are illustrated in table 6 (p. 29).

The Lesser Antilles:

The Lesser Antilles is the island arc south of the Virgin Islands. The arc lies between the Greater Antilles to the north and west, and the continent of South America to the south. The islands form the eastern boundary of the Caribbean Sea with the Atlantic Ocean. Together, the Lesser Antilles and the Greater Antilles compose what we know as the "Antilles." The combination of the Antilles and Bahamas form what we know as the West Indies.

The Lesser Antilles coincide with the eastern boundary of the Caribbean tectonic plate. Many of the islands were formed because of the subduction of oceanic crust of the South American Plate under the Caribbean Plate. This process is ongoing and is responsible for the volcanic and earthquake activity in the region. The islands along the South American coast are the result of the interaction of the South American Plate and the Caribbean Plate. This southern boundary is complex with strike-slip motion and a compressional component.

The geologic history of the Lesser Antilles is complicated as reflected in the structure and rock composition of various islands. North of the island of Dominica, the arc is divided into two island chains (Fig. 14, p. 29). The eastern chain is an older extinct island-arc and is covered by thick carbonate platforms. The western chain has been the site of active volcanism since approximately Late Miocene. South of Dominica, the older and recent arcs are superimposed, forming one chain of islands.

Important contributions to our understanding of the geology of the Lesser Antilles have been made by Allen (2017); Fielding (2017); Edward, and Robertson (2017); Garmin, Allen, and Groom (2017); Potter, Chenoweth, and Day (2017); Modlin Jr, and Allen (2017); Slinger-Friedman, Diller, and Parkinson (2017); Day, and Day (2017); Arkle, Owen, and Weber (2017); Schumtz, Potter, and Modlin Jr (2017); Humphrey (1997); Draper, and Jackson (1994); Bally, and Palmer (1989); King

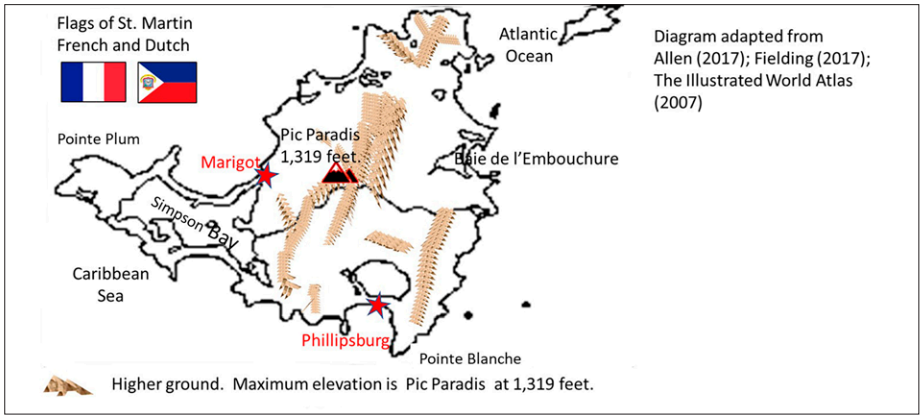


Figure 15. Sketch Physiographic Map of Jamaica.

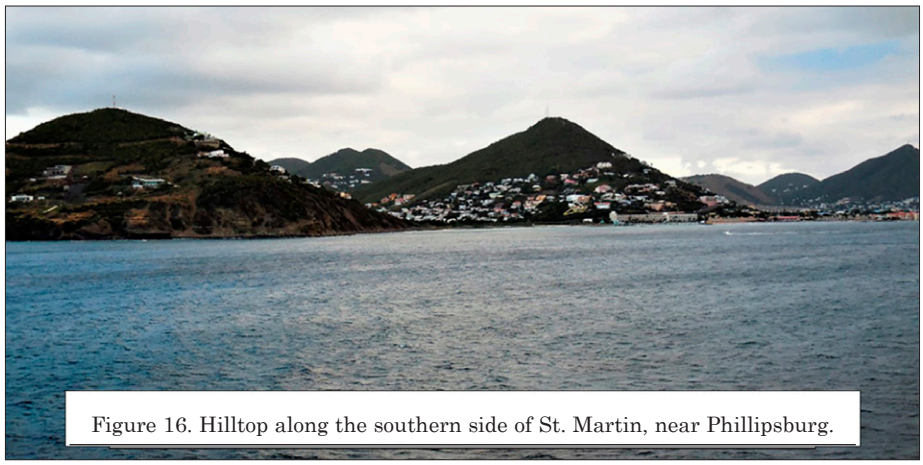


Figure 16. Hilltop along the southern side of St. Martin, near Phillipsburg.



Figure 17. Sea stacks and sand beaches in St. Martin.



Figure 18. Tilted strata in St. Martin.

Table 7. St. Martin - Age of rocks and lithologic descriptions.

Time Frame & Depth	Description of the Strata
Quaternary	Quaternary rocks include coral limestones and alluvial sands. These are found mainly on the westernmost area, around Simpson Bay, and near Phillipsburg.
Miocene	In the Miocene, a marine transgression occurred resulting in the deposition of limestone and marl. These lithologies are found from the westernmost point of the island trending southeast to the end of Simpson Bay, along the southern coast.
Oligocene	In the Oligocene, existing strata were intruded by a diorite batholith. Quartz diorites are found on the north and east-central regions. Oligocene porphyrites and dolerites are present on the western side of St. Martin and around the diorite intrusions.
Eocene	Eocene basement rocks consist of silicified volcanic tuff. These tuffs are found along the center of the island, along the eastern coast, and scattered on the north and west.

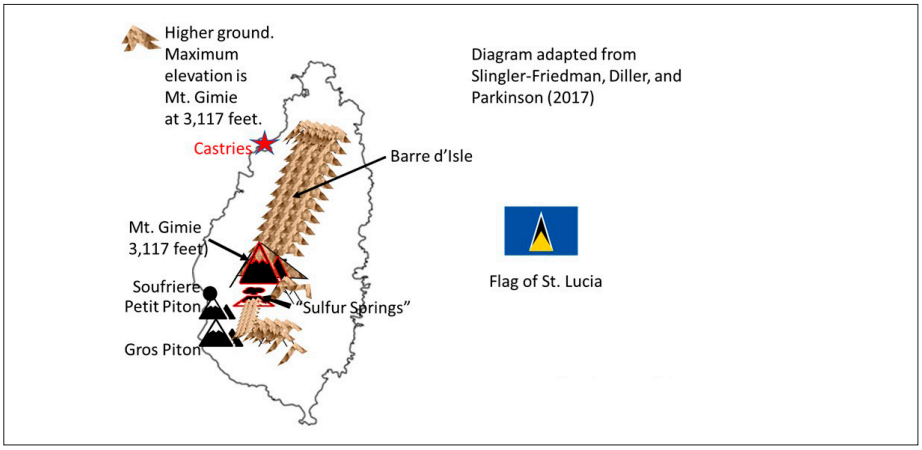


Figure 19. Sketch Physiographic Map of St. Lucia.



Figure 20. "Petit Piton" (dacite peak) in St. Lucia.

(1977); Martin-Kaye (1969); Christman (1953); and Eardley (1951).

Following is a summary of the physiography and geology of some of the islands of the Lesser Antilles, specifically St. Martin, St. Lucia, Barbados, Martinique, St. Kitts and Nevis, Antigua and Barbuda, the Dutch Leeward Islands (Aruba, Curaçao, and Bonaire), and Trinidad and Tobago. I have had the good fortune of having visited most of these.

Sint. Marteen/St. Martin

Physiography:

Saint Martin is under the sovereignty of France and of the Kingdom of the Netherlands (Fig. 15, p. 30). The main cities are Philipsburg (Dutch side) and Marigot (French side). The highest topographic feature is Pic Paradis (1,391 feet)) in the center of a chain of hills on the French side, but both sides are hilly with mountain peaks (Fig. 16, p. 30). There are no rivers on the island. Sea stacks and sandy beaches occur throughout the coastline (Fig. 17, p. 30). Tilted and folded strata are present on the island (Fig. 18, p. 30).

Two distinct mountain chains occupy the central region, and the eastern coast, from Point Blanche to Baie de l'Embourchure.

Geological summary:

Three volcanic phases are recognized on St. Martin, the first two having occurred below sea level.

Distinct lithologies in St. Martin consist of Eocene andesite, tuff and volcanic breccia which have been intruded by quartz diorite, basalt, and younger andesite. Volcanic activity led to metamorphism and the tilting and folding of the volcanic tuff and other rocks. Marl and limestone were subsequently unconformably deposited over the eroded volcanic rocks as volcanic activity shifted away from the area.

The presence of large boulder ridges and solitary boulders on high cliffs may be indicative of storm and tsunami deposits.

Sandy beaches alternate with rocky coastlines of basalt, limestone, and marl. Caves are found in the limestone regions.

The oldest rocks in St. Martin are Eocene to Oligocene volcanics overlain by Miocene sedimentary strata. Rock units



Figure 21. "Soufriére" (Sulfur Springs) Volcano in St. Lucia.

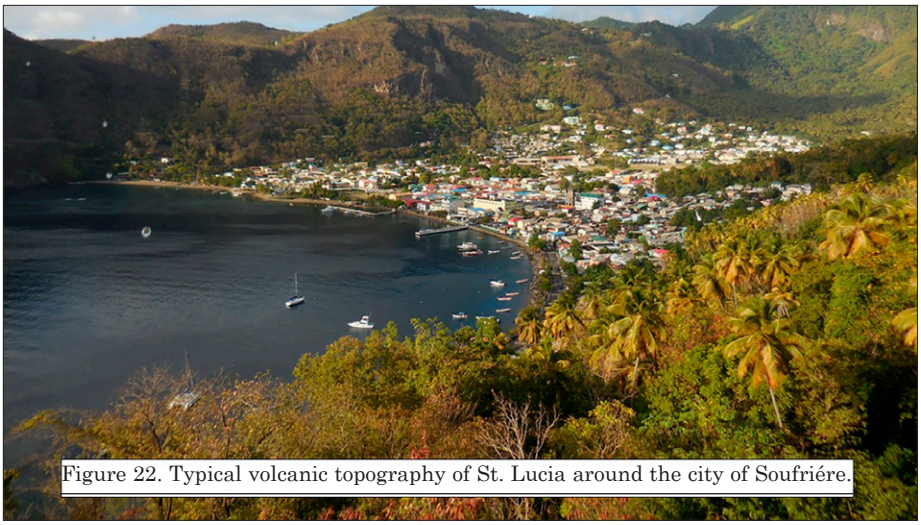


Figure 22. Typical volcanic topography of St. Lucia around the city of Soufriére.

Table 8. St. Lucia - Age of rocks and lithologic descriptions.

Volcanic rock type	Location and distribution
Basalt	Eroded basalts are found in the northern part of the island.
Andesite, pyroclastic material, and dacite	Andesite and pyroclastic aprons are found on the eastern side of St. Lucia and along an east-west band in the north-central section. Dacite domes and peaks are in the southwestern zone of the Soufriere volcanic complex.
Pumice	Pumice deposits are seen north of the City of Soufriere, in the southwest zone directly south of the Soufriere volcanic complex and mixed with eroded basalt and andesite in the southernmost region.

and their distribution are summarized in table 7 (p. 31).

St. Lucia

Physiography:

The volcanic island of Saint Lucia is more mountainous than most Caribbean islands (Fig. 19, p. 31). The highest point being Mount Gimie, at 3,120 feet above sea level. Two other mountains, the "Gros Piton" at 2,526 feet, and "Petit Piton" at 2,437 feet (Fig. 20, p. 31) form the island's most famous landmarks. They are located on the western side of the island. The "Pitons" are remnants of lava domes composed of dacite. The "Pitons" were formed 300,000 to 200,000 years ago. St. Lucia has a north-south running backbone ridge (Barre d'Isle) with mountains increasing in size along the spine towards the south. "Sulfur Springs" is a landmark on the island (Fig. 21).

Geological summary:

Rocks in St. Lucia are mainly of volcanic origin and of Miocene to Pliocene age. Three periods of island building have been described during this time frame. The youngest volcanic event, around Mt. Gimie, connected portions of St. Lucia into a single island mass.

The Soufriere volcanic complex occupies the southwestern portion of the island just south of the city of Soufriere. The area contains dacite lava domes, andesitic cones, ash flows, pumice deposits and basaltic rocks. Mt. Gimie, the Gros Piton, and the Petit Piton are part of the complex.

St. Lucia also claims an actual drive-in volcano. La "Soufrière Volcano" or "Sulfur Springs" is located to the south of Mt. Gimie and neighboring mountains. Hot water pools and associated gasses are found at temperatures of about 340º F and downstream at 110º F. Sulfur gas in the form of H_2S emanates from this area. The associated spring water is blackened by the chemical reactions between sulfur and iron. Other mineral deposits include iron oxide, copper, alkaline lead, and calcium oxide. The Sulfur Springs area lies within the Qualibou Caldera and Qualibou Depression, a zone of structural collapse.

Spectacular landscapes are seen throughout the island (Fig. 22).

The oldest rocks in St. Lucia are found in the north dating back to Early Miocene time. Types of volcanic material and their location and distribution in St. Lucia are summarized in table 8.

Barbados

Physiography:

Barbados is in the Atlantic Ocean, east of the other island of the West Indies. Barbados is the easternmost island in the Lesser Antilles (Fig. 23, p. 33). The terrain is flat in comparison to the neighboring islands to the west. The island rises gently to the central highland region, with the high point being Mount Hillaby (1,115 feet above sea level) in the geological Scotland District (Fig. 24, p. 33). A large portion of the island is circled by coral reefs. Caves and gullies are found in the limestone

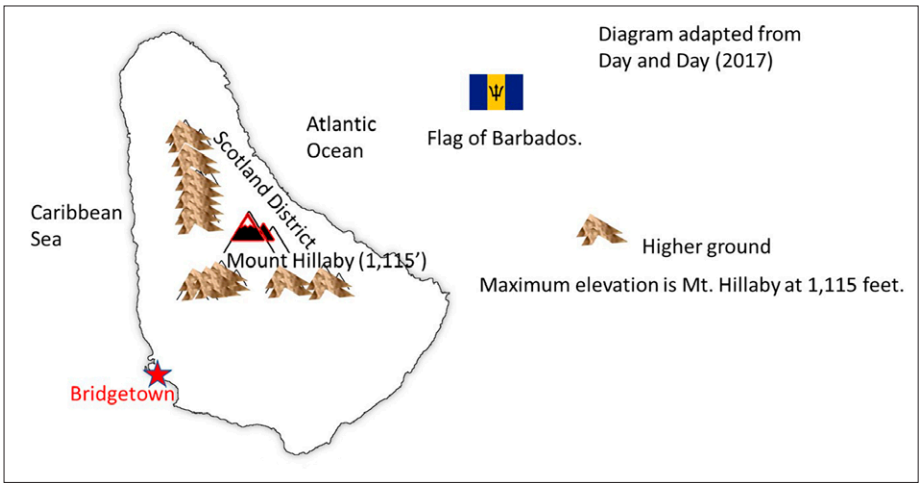


Figure 23. Sketch Physiographic Map of Barbados..



Figure 24. Scotland District, Barbados.

Table 9. Barbados – Age of rocks and lithologic descriptions.

Time Frame & Depth	Description of the Strata
Miocene, Pliocene, and Pleistocene	Barbados is covered with Pleistocene limestone formations. Miocene to Pliocene folding and post Pleistocene uplift and fracturing are observed. The coalescence of discontinuous coral reefs and ongoing tectonic movements during eustatic low stands formed a series of terraces consisting of back-reef, reef crest, and fore-reef deposits.
Eocene, Oligocene, and Miocene	Eocene turbidites and radiolarites are covered by Miocene nappes in thrust contact with younger pelagic strata and volcanic ash. These rocks are intruded by diapirs with an organic mud matrix. Oceanic strata were deposited over the basement complex. Older limestones occur in the central portions of the island. Biomicrites, chalk, radiolarian earth and volcanic tuff were folded, uplifted, eroded, submerged, and covered with Oligocene to Miocene marl.
Eocene basement rocks	The basement beneath the limestone cover is an allochthonous sequence of marine sediments. The oldest beds are clastic sedimentary rocks which were folded, thrusted, and covered by mud flows.



Figure 25. Erosional boulders and sea stacks along the coastline of Barbados.



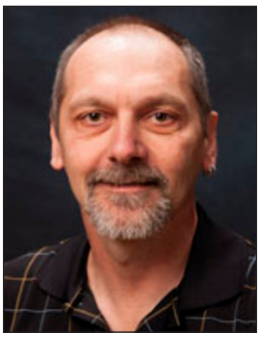
Figure 26. Steeply-tilted strata is found in Barbados.

terrain of the Scotland District. Along the eastern coast, sea stacks can be seen (Fig. 25). Impressive outcrops showing steeply tilted strata are present on the island (Fig. 26).

Geological summary:

Barbados lies on the boundary of the South American and the Caribbean

Continued on p. 48



Advantages of AIPG Membership

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

Fall is nearly upon us. Summer in Denver this year has been an alternating pattern of heavy rain interspersed with extremely high temperatures. It seems that we've had more extremes in our weather this year than in years past. Of course, that could also be what the psychologists call 'recency bias.' I could simply be emphasizing the variation this summer over that of summers past.

This fall also marks the start of the dues and membership renewal process for 2024. This year, AIPG will see a dues increase, our first since 2020, and only our second dues increase since 2016. The Executive Committee and National Office staff thought very carefully about this increase. We know that you entrust to us your hard-earned money and we do our very best to squeeze every bit of value out of those dollars. We came to the decision to raise dues at a rate that mirrors the increase in the US Consumer Price Index over the past four years. Our goal is simply to keep pace with increases in the costs of doing business.

Your dues support AIPG programs and help us to provide the best quality services that we can. Over the past four years, your membership dues, combined with funding from The Foundation of the American Institute of Professional Geologists, have provided more than $80,000 in scholarships for AIPG Students. We've used your dollars to build high quality online continuing education opportunities, such as the AIPG Lunch and Earn series, and we've offered those webinars to members at a rock-bottom price. We continue to advocate for professional registration in the United States, and we work directly with ASBOG and with state boards to support registration during mandated program reviews.

We've broadened the reach of the CPG credential, building a new reciprocal agreement with the Institute of Geologists of Ireland, and we've maintained the recognition of the AIPG CPG for CP/QP qualification under the Securities and Exchange Commission's SK-1300 regulation, for the purposes of completing NI 43-101 reports in Canada, and under the CRIRSCO family of reporting codes. We continue to be a national and global leader, working with our partners at Geoscientists Canada, The European Federation of Geologists, The Geological Society of London, The Global Geoscience Professionalism Group, and The International Raw Materials Observatory, among many others, to advocate on behalf of geologists in the United States and those working for companies with a large, global footprint.

Our National Office staff provide outstanding service to our members. We ensure that our reporting, code of ethics, and membership requirements meet or exceed the criteria that have been set by regulatory agencies. We regularly verify the CPG credentials of our members for purposes of regulation and reporting. We've worked extremely hard to bring the CPG application process into the digital age and we now have a fully online application process for certification. We have renegotiated contracts for office services to squeeze every bit of value that we can out of the dollars that you entrust to us. Most of all, we strive to meet your needs as efficiently and effectively as is possible. We strongly believe that AIPG is simply the very best value of any geoscience professional organization that focuses on the professional practice of geology and the certification of geologists.

As we mark our 60th year, I want to thank each of you for your continued support of AIPG. Working together, I believe that we can position AIPG to advocate for our profession for another 60 years.

Best Regards,

Aaron

"We came to the decision to raise dues at a rate that mirrors the increase in the US Consumer Price Index over the past four years. "



THINK BIG, TAKE RISKS

Dawn Garcia, CPG-8313
dawnhgarciacpg@gmail.com

Whoosh – 2023 is moving quickly to the end of the calendar year and it's time for me to a look back at my year as president. Being president is a personal and professional growth opportunity, and it has been a wonderful, career-enhancing experience. I encourage each member to take advantage of the opportunities offered by involvement in AIPG to enhance your own professional development, create a national network of colleagues and build life-long relationships and friendships. I know from my personal experience, that my career would have been very different if I hadn't gotten involved with AIPG early on. Highlights include finding a job **three times** through AIPG connections; learning from senior geologists how to manage a meeting when I was still a junior geologist and didn't have those opportunities at work; and traveling to locations with great geology with enjoyable, interesting people.

I am fortunate to be part of a team of AIPG leadership that has taken a long-term approach to Institute business. AIPG has been able to make advances on multiple fronts because the planning and activities started last year with the intention of implementation through a multi-year approach. Following a long-term plan allows us to **THINK BIG** and tackle the big-vision questions of *what is the vision and mission of the organization, are we providing value to our members and where do we see ourselves in five years, 10 years, and beyond?* Discussions of vision, mission, and value to our members were integral to the update of our strategic plan. AIPG leadership started taking a hard look at the strategic plan in late 2022 and found that we needed to refresh our vision and mission since its last major overhaul in 2009. AIPG's founding principles of competency, integrity, and ethics abide, but it was recognized that the profession of geosciences has evolved with the introduction of new technology, additional fields of study, and the importance of sustainable and responsible stewardship of natural resources. The strategic plan includes appendices that provide information and outline actions to increase membership, diversify sources of revenue, strengthen sections, provide advocacy for the profession and support public education. The strategic plan is available to all AIPG members on the AIPG website on the Member Resource Page.

It was my personal goal to make sure that AIPG provided value to our members and to communicate AIPG's opportunities for members through multiple media. AIPG has been very busy this year adapting activities to changes in members' habits. For example, the online webinars are very popular, particularly in some sections that have little appetite for in-person events. There have been fantastic technical and professional development events offered nationally and by sections, plus changes that were made to support the sections and make the business of the Institute more efficient. Here's a taste of what we've been doing:

- The CPG program has been converted to an online process for the application, employment verification, and sponsors. Supplemental documentation such as transcripts can also be uploaded by the respective entities. Aspects of the process remain the same with verification and sponsorship documents being hidden from the applicant. In addition, after consultation with legal counsel, the need for a notarized application has been changed to submittal of a copy of government-issued identification with a statement from the candidate. The change to an online process will speed up the submittals and screening committee reviews considerably, and the removal of the notarization will make the process much easier, especially for foreign candidates who don't have access to notary services.
- AIPG continues to be an advocate for the profession and submitted a position statement to the US Bureau of Land Management (BLM) on land use definitions.
- The AIPG officer's manual has been updated and expanded to make it easier for elected officers and appointed committee members to integrate into the Institute leadership.
- Section officer training was provided during a webinar and quarterly follow up meetings set to support the section leadership.
- The Diversity, Equity, and Inclusion (DEI) committee organized multiple webinars and coordinated DEI activities and sessions as part of the annual meeting. The DEI discussions consider practical applications for the workplace and home.
- High-quality technical webinars were offered with an initial series that focused on economic geology followed by a series on water issues. These webinars are an excellent bargain for CEU credit starting at $10 for CPGs, whereas some organizations charge $50.
- Webinars on professional development that focused on students and early career professionals were presented. It was enlightening for students to learn about licensure and certification, plus hear about what a diverse group of geologists do as part of their jobs.
- The National Executive Committee, which holds quarterly all-day business meetings, has also met monthly for a shorter meeting to keep momentum going and to track progress. The monthly meetings have been very helpful in moving business items forward faster. When business items are taken care of during a monthly

Continued on p. 42

Answers on Page 38



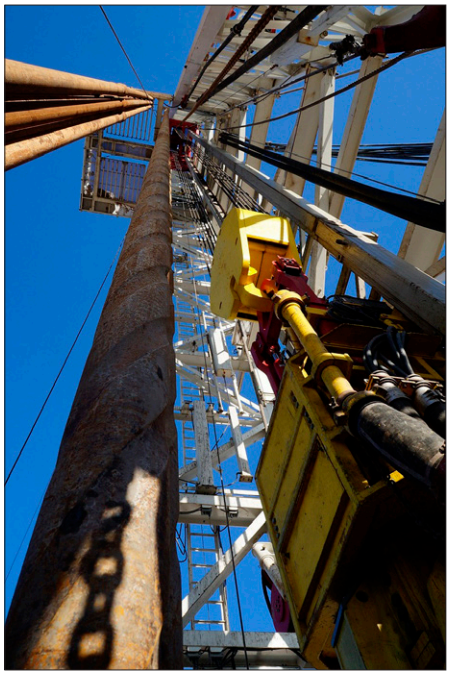
Robert G. Font, CPG-03953
robertfontphd@gmail.com

1. When do gymnosperms first appear in the geologic record?

a) Around the Devonian to Carboniferous Periods.
b) Around the Cretaceous Period.
c) Around the Ordovician to Silurian Periods.
d) Around the Cambrian Period.
e) Dude, I don't like this question! Period!

2. A non-calcareous clay-shale in north-central Texas is well known for giving rise to engineering problems. A landslide in the clay-shale gave rise to a dam's failure. The formation has low shear strength, high Atterberg values and is known as a corrosive medium for metal pipes buried within it. Pyrite is present in the clay. In its chemical weathering which of the following compounds would be expected to form?

a) H_2CO_3.
b) H_4SiO_4.
c) HCl
d) H_2SO_4
e) Unhinged geochemist genius says: Dissolve the entire problematic formation and all rocks above and below it, replacing it with a chemical mixture with a molecular weight…



3. "Adularia" is composed of:

a) Sodium, aluminum, silicon, and oxygen.
b) Calcium, aluminum, silicon, and oxygen.
c) Iron, magnesium, silicon, and oxygen.
d) Potassium, aluminum, silicon, and oxygen.
e) Clusters of cemented coprolites.

4. In the oil industry, the term "tripping" is used to describe the following:

a) Calibrating the electrical circuitry of the computer network which houses the exploration and production software in order to avoid tripping a fuse.
b) Pulling the drill string out of the wellbore or relacing it in the hole.
c) Using tools and equipment to remove junk in the well bore.
d) Stumbling and falling off the derrick floor.
e) Travelling back and forth from well to well during drilling and/or producing operations.

5. The cross profiles of two glacial valleys are being compared. Glacial valley A has a cross profile that is represented by the function $y = 0.5 * x^2$ with a form ratio = 1.50. The cross profile of glacial valley B is approximated by the function $y = 0.02 * |x|^3$ with a form ratio = 0.36. Which of the following is a correct statement?

a) Glacial valley B is deep and narrow whereas Glacial Valley A is wider than it is deep.
b) The depth of glacial valley A is four times greater than it width.
c) Glacial valley A is deep and narrow whereas Glacial valley B is wider than it is deep.
d) The width of Glacial Valley B is five times greater than its depth.
e) Glacial valleys are cold, dude! To study them, one needs vast amounts of coffee, scotch, chips, gin, buffalo wings, vodka, jalapeños, tequila, tabasco…



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

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

Professor Discloses Inappropriate Information About a Student

Sara Pearson (CPG-10650) and **David Abbott** (CPG-4570) prepared this statement acting as the Ethics Committee. A senior geologist and a colleague were having coffee at a national conference when they met with a senior adjunct geology professor; all three had known each other for many years. During their conversation, the professor voluntarily described the inadequacies of a particular student. The professor's opinion was that the student would never be capable of practicing at a professional level and that the student would at most be a supporting technical assistant. There was no reason for this student's capabilities to be discussed by name or in detail. The senior geologist and colleague were shocked by the conversation regarding it as highly unethical.

> *"Members shall pursue honesty, integrity, loyalty, fairness, impartiality, candor, fidelity to trust, inviolability of confidence, and honorable conduct as a way of life.*

The applicable part of the AIPG Ethics Code is Standard 1.1: *Members shall pursue honesty, integrity, loyalty, fairness, impartiality, candor, fidelity to trust, inviolability of confidence, and honorable conduct as a way of life.* A professor's unsolicited and unnecessary specific description of a particular student's character violates a confidential student/teacher relationship. While we can understand that a professor may describe student failings generically, this should generally not include the identification of (a) specific student(s). If the professor is a student's advisor and feels that the student is not capable of working in the professor's specialty, the professor should advise the student to seek another advisor and/or specialization area. AIPG members who become involved in a similar discussion should interrupt the disclosure of inappropriate information and state their ethical concerns.

The senior geologist in this case informed the authors of this statement about the situation as part of an AIPG member's obligation to report unethical conduct (Standard 5.5). As noted above, Standard 1.1 is the applicable part of the AIPG Code of Ethics. Section 7.1 of AIPG's Disciplinary Procedures describes the various sanctions available for violations of the Code of Ethics. *These Disciplinary sanctions must be informed by the following principles in order of priority:*

- *The risk (perceived or otherwise) of damage to the community.*
- *The risk (perceived or otherwise) of damage to the profession.*
- *The general public's expectations of an AIPG member with regard to the allegation(s).*

The severity of the sanction will depend not only on the breach itself, but on the perceived risk, the actual damage caused, the experience and membership grade of the member responsible, and on the willingness of the member to acknowledge responsibility and hence lessen the likelihood of reoffending. Section 7.2.2 provides for issuing a Letter of Private Admonition as a sanction. A letter of private admonition shall be issued in cases where serious deception, fraud, misrepresentation, or professional misconduct is not alleged in the formal charges. A letter of private admonition may be accompanied by requirements for additional actions… A Private Letter of Admonition appears appropriate in this case.

AI and Chat GPT—More Uses and Abuses

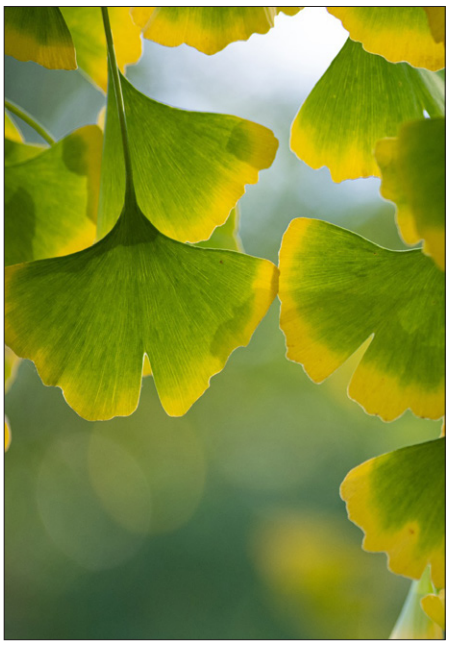
This discussion continues the topics contained in "ChatGPT and other AI Chatbots" and *The Battle for Your Brain* in column 186 (Jul/Aug/Sep '23). **Sara Pearson** (CPG-10650) has used the free version of ChatGPT to explore the potential use of the program. She and a colleague were working on a presentation, and ChatGPT generated an "8th-grade-level" outline for the talk in about five minutes. Clearly, additional work was needed on the outline, but it provided a good starting point. Pearson was having trouble coming up with an effective title and three-minutes or so of asking ChatGPT for suggested titles generated several potential titles.

While Pearson was arranging the scholarship winner's essays on *"Why I Want to be a Geologist"* for the Jul/Aug/Sep '23 *TPG* issue, she had ChatGPT write the following essay on this topic. *Title: Embracing the Earth's Secrets: My Aspiration to Become a Geologist.*

Introduction: From the soaring heights of majestic mountains to the depths of vast oceanic trenches, the Earth stands as an enigmatic realm,

Continued on p. 40

Answers:



1. The answer is choice "a" or "around the Devonian to Carboniferous Periods."

Gymnosperms have unenclosed seeds and produce no flowers or fruits. Conifers are the oldest, followed by the ginkgoes and cycads.

Seedless vascular plants first appeared (ferns) close to the end of the Silurian around the early Devonian.

Early seed plants around the late Devonian to early Carboniferous.

Flowering plants around the early Cretaceous.

2. The answer is choice "d" or "H_2SO_4" since sulfuric acid is a byproduct of the chemical weathering of pyrite.

Choices "a", "b" and "c" are carbonic acid, silicic acid, and hydrochloric acid, respectively.

3. The answer is choice "d" or "Potassium, aluminum, silicon, and oxygen." Adularia is a low-temperature variety of orthoclase. It is found in hydrothermal veins in mountain areas and is included in schists found in the Alps.

4. The answer is choice "b" or "Pulling the drill string out of the wellbore or replacing it in the hole."

Choice "c" describes the process of "fishing" or "fishing for junk."

5. The answer is choice "c" or "Glacial valley A is deep and narrow as compared to glacial valley B for which the width is greater than the depth."

The cross profile of glacial valleys has been studied for many years. A relatively recent PhD dissertation by Dr. Rebecca J. Coles (Sheffield, UK, 2014) has been instructive on this subject. Svensson (1959) described the cross profile of a glacial valley as being approximated by the power law:

$$y = a * x^b \qquad (1)$$

Subsequently, Pattyn and Van Heule (1998) proposed a better alternative as the general power law:

$$y - y_o = a * |x - x_o|^b \qquad (2)$$

In the latter, x_o and y_o define the coordinates of the origin of the cross profile, commonly taken as $(x_o, y_o) = (0,0)$. In such case, equation (2) simplifies to:

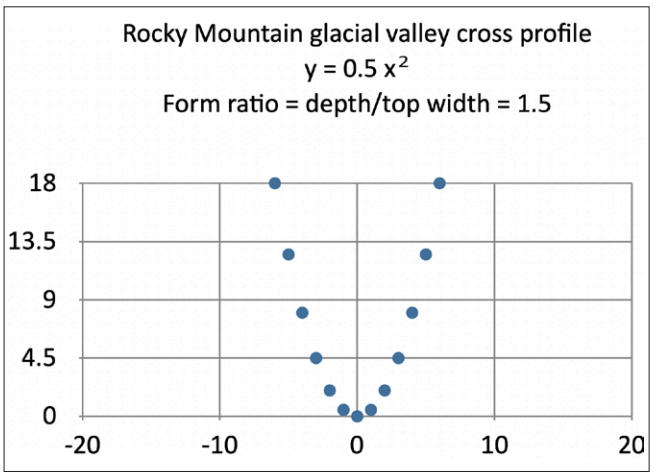
$$y = a * |x|^b \qquad (3)$$

From (3) we can see that "y" is dependent upon the product of a coefficient times the absolute value of "x" elevated to a given power. The values of "a" and "b" in the above equations dictate how wide the valley opens and how steep the sides rise, respectively. The "form ratio" is the ratio of depth to width at the valley's top.

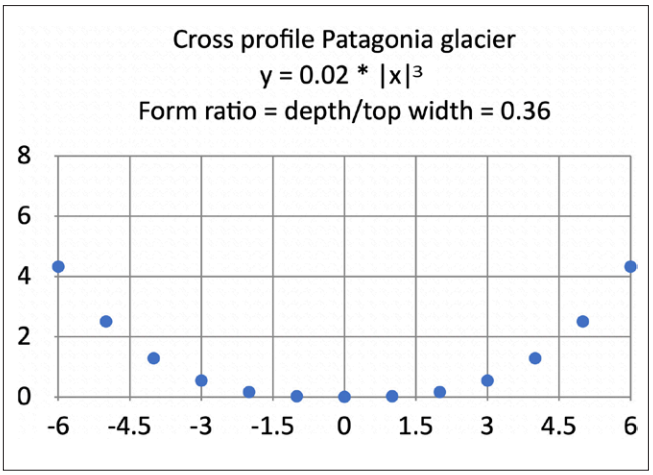
A "Rocky Mountain" glacial valley model (Coles, 2014) is approximated by the parabolic curve:

$$y = 0.5 * x^2 \qquad (4)$$

The form ratio of 1.5 indicates that the valley depth is 1.5 times the width. This describes glacial valley A as stated in this problem. The cross profile of this type of glacial valley is illustrated right:



Another glacial valley whose profile is approached by equation (4) is the Glen Rosa valley in Arran, Scotland (Coles, 2014).



In contrast to the Rocky Mountain model, the Patagonia and Antarctic model (Coles, 2014) is closer to our stated glacial valley B, where:

$$y = 0.02 * |x|^3 \qquad (5)$$

The form ratio of 0.36 describes a valley whose width is about 2.78 greater than its depth. The cross profile of this type of valley is shown to the left.

As it may be intuitively expected, Coles (2014) found a close relationship between form ratio and glacial valley floor slope. Steep valley floor slopes are associated with deep, narrow valleys. In contrast, gentle valley floor slopes are related to shallower and wider valleys. More mature glacial valleys have flatter longitudinal slopes.

Field Tripping

Arizona and New Mexico Section Members Visit the Hillsboro Mining District and National Radio Astronomy Observatory (NRAO) Very Large Array (VLA)

Sally Clement CPG-10347 and Dawn Garcia, CPG-8313

On Saturday June 10th and Sunday June 11th, 2023, members of the New Mexico and Arizona AIPG sections visited the Copper Flat historic mining and polymetallic project, located in the Hillsboro Mining District in New Mexico, west of Truth or Consequences (T or C), and then toured the National Radio Astronomy Observatory (NRAO) Very Large Array (VLA) observatory. Seventeen people, including AIPG members, guides, family, and friends, joined the field trip.



Group at the VLA (photo: Summer Ash, VLA tour guide)

The mine tour was led by William (Bill) Chavez, professor of geological engineering and economic geology at the New Mexico School of Mines at Socorro. At the mine the group saw exposed veinlets with pyrite, chalcopyrite and molybdate and their oxidation products, including blue ilsemmanite, a soluble molybdate characteristic of very low pH weathering. We also observed several rock types including dacite volcanics, and monzonite porphyries with cross cutting dikes. The cap of the porphyry at the mine has been removed by erosion, so sulfides are exposed at the surface. To explain the somewhat unusual geochemistry of the weathering products, Bill showed us how the pyrite in host rocks has oxidized to sulfuric acid producing very low pH weathering. Using pH paper, he demonstrated that some of the minerals produced by this low pH weathering had a pH of only three. He also showed how under these conditions, copper plated on a steel nail in a matter of seconds. Somewhat unusually, this mine has no carbonate weathering products, only sulfates.



Example of veinlets (photo: Dawn Garcia, CPG-08313)

Continued on p. 59

Professional Ethics, continued from p. 37

holding countless mysteries waiting to be unraveled. Fascinated by its intricate geological processes and hidden treasures, I have developed an insatiable curiosity about the world beneath our feet. Choosing to become a geologist is an exciting and rewarding path that allows me to explore and understand the Earth's geological marvels. This essay aims to delve into the reasons why I am passionately drawn towards the captivating field of geology.

Unraveling Earth's History: Geology offers a unique opportunity to unravel the Earth's captivating history. As a geologist, I will have the privilege of studying rocks, fossils, and other geological formations to decipher the story of our planet's past. Each layer of sediment, each geological structure is a testament to the Earth's dynamic evolution over billions of years. Being able to piece together the puzzle of Earth's history through geological investigations ignites a sense of adventure within me, urging me to explore further and uncover the secrets hidden in the geological archives.

Understanding Natural Disasters: Geological processes shape the Earth's surface, but they can also unleash catastrophic natural disasters. Volcanic eruptions, earthquakes, landslides, and tsunamis are all products of the Earth's inner workings. As a geologist, I aspire to contribute to society by studying these natural phenomena, understanding their causes, and developing strategies to mitigate their impact on human lives and infrastructure. The potential to make a positive difference in the world and safeguard communities from the devastation of such disasters is a driving force behind my desire to become a geologist.

Preserving Earth's Resources: Geology is intimately connected to the Earth's abundant resources. It enables us to locate and extract vital materials such as minerals, fossil fuels, and groundwater that sustain our modern way of life. However, the responsible management and sustainable use of these resources are of paramount importance to ensure the well-being of future generations. By becoming a geologist, I hope to contribute to the development of environmentally conscious practices in resource exploration, extraction, and management. It is my desire to strike a delicate balance between meeting our present needs and preserving the Earth's resources for the generations to come.

Exploring the Great Outdoors: One of the most captivating aspects of being a geologist is the opportunity to explore and immerse oneself in the great outdoors. Whether traversing rugged terrains, scaling mountains, or traversing vast deserts, geologists have the privilege of working in diverse and breathtaking landscapes. Such fieldwork not only provides a firsthand experience of the Earth's geological wonders but also fosters a profound appreciation for the beauty and resilience of our planet. The chance to combine scientific inquiry with outdoor adventure makes geology an enticing career choice for those seeking to escape the confines of a traditional office environment.

Conclusion: The allure of the Earth's mysteries, the desire to understand its history, and the opportunity to make a positive impact on society and the environment converge in my aspiration to become a geologist. Through this field, I aim to explore the Earth's depths, interpret its ancient tales, and contribute to the sustainable stewardship of its resources. The journey of a geologist is one of constant learning, discovery, and a deep-rooted connection with our planet. By embracing this career path, I endeavor to contribute to the rich tapestry of geological knowledge and inspire others to appreciate the extraordinary wonders that lie beneath our feet.

What a personally passionless essay! On the other hand, this essay does cover the topic although far more broadly than individually written essays published in the Jul/Aug/Sep '23 TPG issue.[1]

My friend **Jim Reed** of Rockware Inc. told me that he has found that ChatGPT provides better and quicker answers to questions rather than using internet search engines. He said he'd asked ChatGPT to search for information on digging fence posts in Golden, CO. ChatGPT responded in a few seconds with an outline of general guidelines with the following headings: checking for underground utilities, determining property boundaries, obtaining needed permits, getting needed tools and materials, choosing the appropriate hole depth and width, installing the post, and securing the post and backfilling the hole. ChatGPT reminds users that its database was built prior to 2021 and answers will reflect this limitation. Bill Gates was quoted as saying that AI programs will soon replace web search engines for questions of this type. Note, if you ask ChatGPT to respond to the same question four times, you will receive four similar, but different responses as a result of ChatGPT's use of randomized probabilities in generating its results.

I asked ChatGPT to rewrite the Gettysburg Address in Valley Girl speech. The first two paragraphs of the response were, *"Like, okay, peeps, listen up! So, back in the day, this really rad dude named Abe Lincoln stood up and was all like, 'Four score and seven years ago, our founding fathers were, like, totally doing their thing and bringing this awesome nation into the world.'*

"And now, we're all here, gathered at this super cool battlefield, to remember those who made the ultimate sacrifice. Seriously, they gave everything so we could have this totally awesome freedom and stuff. We can't forget that. It's, like, majorly important."

Such regeneration can be fun and silly, but demonstrates what ChatGPT can do, including translation to and from foreign languages.

Another friend reported that a colleague of his had submitted a paper for peer review and was surprised to receive three reviews a few days later. However, examination of the "peer reviews" showed they referred to the same articles, contained similar comments, and were generally written at a junior-high level. The author concluded that all three reviews had been generated by ChatGPT or a similar Chatbot program. He was dismayed that the peer-review publication had accepted the legitimacy of these three "reviews" and hoped this practice does not become a standard practice as it will not increase the quality of peer-reviewed publications. ChatGPT does not claim to be 100% ac-

1. As the ChatGPT essay on Why I want to be a geologist suggests, Sara Pearson and I have been having some fun with ChatGPT. The essay has been remixed into Shakespearean English, Valley Girl/influencer, and Dr. Seuss styles. If you'd like a copy, send a requesting email to dmageol@msn.com.



Original photo: Commonly experienced problem with photographs taken from a moving vehicle out the window shows glare and power lines that disrupt the view.



Same photo processed with Adobe Photoshop™ (Beta): The AI corrected the glare, removed the power lines, and regenerated the image creating a realistic new landscape.

curate. Indeed, it can and does generate fictitious quotations from fictitious technical papers.

Nita Farahanny, author of *The Battle for Your Brain* and a professor of law and philosophy at Duke Law School, is a leading scholar on the ethical, legal, and social implications of emerging technologies. She recently posted a YouTube chat, https://www.youtube.com/watch?v=inXSOnIU35s, in which she addresses the question of whether using ChatGPT in creating a college essay is cheating. A number of colleges and universities have banned the use of ChatGPT as cheating. Farahanny, however, takes the view that ChatGPT is a new tool that students and everyone else need to learn how to use, including recognition of ChatGPT's errors and other failures, in order to produce useful documents. One chapter in *The Battle for Your Brain* addresses the question of whether or not using brain-enhancing drugs prior to taking SAT or ACT tests is cheating. Farahanny is no ethical slouch and so her tack on the subject is worth thinking about. Reportedly, an English teacher asked her students to have ChatGPT prepare a 14-page essay and then examine the essay for errors, misstatements, and indicia that the essay had been created on ChatGPT. An interesting assignment.

Editing photos to remove such things as red eyes, enhancing color contrast, or increasing or decreasing overall lighting to improve a photo's quality and utility are things we've all done. However, inserting extra people, smoke, or other effects to produce artificial, fake pictures that have the potential for deceiving others is a real problem, particularly given the speed and widespread distribution that can occur within seconds on social media. The ability of Adobe Photoshop™ (Beta) to generate very realistic fake photographs has led Adobe to propose a general process of identifying artificially altered photographs from original photos and having this process adopted by all photo editing software.

Pearson has provided an example of simple editing using the Adobe program. The edits of an Icelandic landscape on this page took less than five minutes to make. The quick edits maintain the concept of the real image; however, the geomorphology has been changed. This photo could also be further edited to easily remove the stream or turn the stream into a significant river or lake. Software applications using powerful AI tools bring the power to alter images to everyday users of software in minutes rather than being limited to experienced professionals who took hours to complete.

DEI in AIPG—what it is and what it isn't

What DEI is for AIPG: DEI, diversity, equality, and inclusion, and what it means for AIPG has been discussed by a number of members for several years. "Diversity, Equality, and Inclusion" was the title of a topic in Professional Ethics & Practices column 154, in the Apr/May/Jun '15 *TPG* and addressed the number of women and ethnic minorities in the profession. Standard 4.4 of the AIPG Code of Ethics states, "A respectful and fruitful working environment is fundamental for maintaining a high level of professionalism. Therefore, discrimination or harassment, either sexual or of any other kind, is unacceptable because it offends the dignity of persons and seriously undermines the atmosphere of trust essential to the work of all geologists. Such actions should be denounced immediately to authorities. It is unprofessional and unethical to condone any kind of discrimination or harassment or to disregard complaints of harassment from colleagues or staff. AIPG's Events Code of Conduct policy provides more explicit examples of acceptable and unacceptable behavior." The percentage of women in the geosciences has increased dramatically in recent years. An AGI Currents Study in 2013 found that women made up 34% of the geoscience workforce and noted that "Among 23-30-year-olds, 49% were women compared to the 10% of women among 60 years old and older working individuals."[2] However other groups of individuals are woefully underrepresented in the geosciences.

The problem for AIPG is, as 2020 AIPG President **Todd McFarland**, CPG-11348, pointed out in his President's Column, earth science has a whiteness problem citing a *New York Times* December 2019 article that "indicated less than 10% of doctoral degrees in the geosciences go to recipients of color. In addition, people of color hold less than 4% of tenured or tenure-track positions in geoscience departments." As I pointed out in PE&P column 175 (Jul/Aug/Sep '20), "The established rock

2. AGI's "Representation of Women in the Geoscience Workforce" appeared on the inside cover page of the Oct/Nov/Dec '17 *TPG*.

hammer and field boots culture of geology is exclusive and marginalizing for those who cannot or do not go on hikes over rough terrain." On April 24, 2020, an AGU/AGI-sponsored webinar, Field Trips for All: Accessibility and Inclusivity for Students with Disabilities.[3] Given the title, I expected that the webinar would focus on the physically disabled. While the physically disabled were certainly discussed, a much broader array of disabilities were covered including color vision deficiency, blindness and low vision, learning disabilities, cognitive deficiencies, social and behavioral disorders, and hearing impairment. Specific issues with field trips and field camps include those with food restrictions due to allergies or religious obligations and those inexperienced in hiking, camping, and other basic field skills. These groups, along with non-white ethnic groups, are the types of individuals AIPG's DEI program focuses on.

What DEI is NOT for AIPG: The political far right has been attacking DEI and its alleged focus on LGBTQ+ issues. On June 6, 2023, the Human Rights Campaign declared a state of emergency for LGBTQ+ people citing more than 75 anti-LGBTQ+ bills signed into law in many states in 2023, more than double the number of such bills in 2022.[4] In May 2023 Florida Governor Ron DeSantis signed a bill banning Florida's public colleges and universities from spending money on DEI programs. According to DeSantis, DEI stands for "discrimination, exclusion, and indoctrination."[5] DeSantis believes DEI programs focus on such issues as critical race theory, gender identity, and sexual orientation. DeSantis' views are part of what has led to a focus on anti-LGBTQ+ issues. This specific focus on LGBTQ+ issues is a vehicle to divide and drive popular opinion in society, and is not the primary focus of AIPG and other geoscience organizations. AIPG and other geoscience organizations view DEI as incorporating a wide-ranging number of groups described above. Finally, the AIPG Code of Ethics implies with the statement, "discrimination or harassment, either sexual or of any other kind, is unacceptable."

Another Comment on Fonts

In the topic, "Switch to Calibri from Times New Roman," in column 185 (Apr/May/Jun 2023) I noted that the US State Department is now mandating the use of Calibri, a sans serif font, to improve accessibility for dyslexics and other individuals with visual challenges and Optical Character Recognition. A recent newsletter on the use of Microsoft Office™ noted that the `typewriter-based monospaced Courier font` is still useful noting, "Monospace or fixed fonts use the same horizontal space for each letter, just like manual typewriters. Fixed fonts are useful for code snippets and other situations where you want each character to be very clear and distinct – like passwords." (Office for Mere Mortals, 5/1/23). A tip to keep in your typography kit.

FBI Warning Against Using Public Phone Chargers

The FBI is warning against the use of public phone charging ports at airports, hotels, and shopping centers. Crooks have managed to hijack phone chargers to load malware and software providing access to your phone (https://www.cnbc.com/2023/04/10/fbi-says-you-shouldnt-use-public-phone-charging-stations.html). The recommended solution is to charge a personal battery pack or power bank at home and bring this device with you.

3. https://www.youtube.com/watch?v=2MxMg3aHscQ
4. https://www.hrc.org/press-releases/for-the-first-time-ever-human-rights-campaign-officially-declares-state-of-emergency-for-lgbtq-americans-issues-national-warning-and-guidebook-to-ensure-safety-for-lgbtq-residents-and-travelers
5. https://www.npr.org/2023/05/15/1176210007/florida-ron-desantis-dei-ban-diversity

President's Message continued from p.27

meeting that means more time available for discussions during the quarterly meetings. These business meetings are open to all members, so keep an eye out for meeting announcements if you would like to sit in on virtual meetings.

- The membership and financial committees have been revitalized. Please note that the membership committee meets monthly, and additional volunteers are both needed and welcome.
- A field trip guidance manual was prepared in response to some sections needing support in the "how to" aspects of identifying and organizing a field trip.
- A luncheon meeting for AIPG members and guests has been organized as part of the SME annual conference in February 2024 to be held in Phoenix, Arizona. The luncheon registration is available on the AIPG website (https://aipg.org/events/EventDetails.aspx?id=1764891&group=) and has also been advertised through SME. The luncheon will be held within walking distance of the Phoenix convention center and there is no need to attend the SME conference to attend the luncheon. Many thanks to the luncheon sponsors: the AIPG Arizona section, Clear Creek Associates and Stantec.
- A paper on licensure and certification of professional geologists and the role of AIPG was prepared. This paper was specifically addressed to Mexican geologists who may want to obtain a professional certification through AIPG. The paper will be available on the AIPG website after October 2023.
- AIPG staff and leadership have continued to attend conferences to represent AIPG, talk to members and promote the profession of geology. Conferences attended in 2023 included (or will include by the end of 2023) the SME Annual Conference; Prospectors and Developers Association of Canada; Joint Northeast/Southeast GSA Section Meeting; Women in Mining Annual Conference; North Central GSA Section Meeting; Battelle Bioremediation Conference; Rocky Mount Section GSA Meeting; Discoveries Conference; GSA Rocky Mountain Section Meeting; American

Association of State Geologists; AIPG Michigan 12th Annual Environmental Risk Management Workshop, National Council of State Legislatures Legislative Summit; Colorado Oil and Gas Association Energy Summit; Geological Society of America Annual Meeting; *Asociación de Ingenieros de Minas, Metalurgistas y Geólogos de México* International Conference; American Exploration and Mining Association Annual Meeting, and SME Arizona Conference. And, of course, the 60th anniversary conference of AIPG! I suspect that I have missed other conferences that are attended by section leadership and members, so please forgive any omissions.

- Most of these conferences are attended by AIPG volunteers who live near the conference location, and thus no costs are incurred by AIPG to send a representative from the national office. Many of the conferences will need members to volunteer to represent AIPG for the 2024 events. Please reach out to the AIPG national office (aipg@aipg.org) to volunteer to be a representative of the Institute if you plan to attend a conference in 2024.
- AIPG is currently providing accounting and other membership services for Association of American State Geologists (AASG) and Association for Women Geoscientists (AWG). The income received from those groups covers the hourly costs of the AIPG staff who provide the services plus provides additional non-dues revenue and supports the geologic community.
- AIPG has established a Memorandum of Understanding (MOU) with the Society of Mining Engineering, Metallurgy and Exploration (SME) to collaborate on programming at conferences. Many AIPG members who work in mining are also members of SME and attend the SME annual conference. Although this MOU is recent, the response has been very positive on both sides. SME was particularly interested in having more geology-based programming in the technical sessions at its annual conference, as well as to encourage more field trips be offered as part of the annual conference. AIPG is organizing two technical sessions and three field trips as part of the 2024 SME annual conference, as well as holding the AIPG luncheon mentioned earlier. AIPG members receive discounted membership registration fees for SME events, which is a benefit from the MOU.
- AIPG is in the process of establishing a MOU with the Mining and Metallurgical Society of America (MMSA). It is anticipated that webinars will be a strong part of the joint programming.
- AIPG has also started discussions with Women in Mining to establish a MOU. Women in Mining is particularly strong in DEI efforts and would be a valuable partner for the AIPG DEI committee.
- AIPG organized the collection of books and maps that can be donated to the state university of Sonora. This effort is in alignment with AIPG's objective to promote the geosciences, and it's just a good practice to pass along unused materials to someone else who will benefit.

I am pleased to be able to have a healthy list of items completed and feel that it shows the Institute is providing high value for its members, plus demonstrates the commitment and dedication of its members to the Institute and the profession of geology.

TAKE RISKS. For the long-term health of the Institute, your leadership has also been willing to look critically at the profession of geology and envision what an organization that serves the profession could be in the future. AIPG leadership has been actively looking for opportunities to collaborate with other geoscience societies. Many of our members are currently members of AIPG plus one or more technical organizations and local geology groups. The impact of member's resources of time and money has meant that members are stretched thin and need to choose between organizations. AIPG worked with the American Geosciences Institute (AGI) on a task force to investigate and facilitate collaboration among AGI Member Societies and other interested geoscience societies. AGI sent out a questionnaire to gauge the interest of collaboration.

The survey had questions about the degree of interest regarding joint meetings, conferences, field trips and other events; publishing; membership software and databases, including joint membership or universal membership; administration such as shared services, insurance, and office space; and potential mergers. The task force will review the survey results and then connect societies with similar interests through working groups.

AIPG has a high degree of interest in investigating possibilities of collaboration in all these areas. Any sort of collaborative effort for AIPG would be based on AIPG maintaining its name and the Certified Professional Geologist program, which is nationally and internationally recognized. For example, AIPG is listed in the Canadian NI 43-101 appendix as a recognized foreign professional organization that meets the definition of "professional association" for the purposes of the regulation, and it would be very difficult to affect a change in the regulation if AIPG changed its name. Finding ways to strengthen the Institute with adaptations that keep the profession of geology and AIPG's vision and mission vital for the long-term will be our focus.

The Vision is:

Advocate for the profession of geology and certify the competency, integrity, and ethics of professionals on domestic and international levels.

The Mission is:

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.

It has been my pleasure and honor to have served as the 2023 president of AIPG. I have been privileged to see the dedication of the many people who make the Institute thrive. Many thanks to the AIPG members and the national office personnel for the many hands that make things happen. I will be passing the gavel to a very competent incoming president, Shanna Schmitt. I look forward to continuing the long-term initiatives that are in motion and seeking opportunities for continuous improvement. I thank you, the AIPG members, for your confidence in electing me to serve as president.

Warm regards,
Dawn



How to Refresh Your Geology

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

In teaching geology, we use textbooks – whether print or nowadays mostly electronic copies. Textbooks, however, are one of the tools in teaching and learning. We often ignore the value of popular science books in our education. Technically called "trade" books, they are written for the general public and thus use a narrative, non-technical language. In the field of geology, there are a large number of interesting popular books that can teach or refresh our knowledge. In my introductory geology classes, I usually give a book reading assignment to students: If a student reads the book (from the list I provide) and writes a brief report of interesting things he or she has learned, I give extra points toward the student's final grade. Oftentimes, these extra points (usually equal to 5% of the total grade) are game changers. For instance, they may change the student's grade from C to B, or B+ to A-. Here is the list of 12 popular geology books that I have read over the years and thus recommend for geology students, instructors and even professionals who would like to refresh their basic knowledge of geology, after years of graduating from the college. Pick any of them and enjoy reading at your leisure time. (There are of course other equally good books that are not on this list.)

Reading the Rocks: The Autobiography of the Earth by Marcia Bjornerud (Basic Books, 2006) is a good start. Bjornerud is a professor of geology at Lawrence University in Wisconsin and winner of the Association of Women Geoscientists 2011 Outstanding Educator Award. The book is thus written by an experienced geology instructor. It sums up the vast expanse of geology in a succinct style, and is thus a great review of the subject. Chapters include: Prologue (Stone Crazy); (1) The Tao of Earth; (2) Reading Rocks: A Primer; (3) The Great and the Small; (4) Mixing and Sorting; (5) Innovation and Conservation; (6) Strength and Weakness; and Epilogue (The Once and Future Earth). The author's choice of titles for the chapters and sections as well as the opening epigrams and quotes give a flavor of poetry to the book; for example, the chapter "The Tao of Earth" begins with this phrase from the Roman writer Plutarch: "For water continually dropping will wear hard rocks hollow" (similar to a phrase in *The Tao Te Ching*). The book is full of both information and insight. Bjornerud's more recent book, *Timefulness: How Thinking Like a Geologist Can Help Save the World* (2020) is equally a gem, and should perhaps be read after *Reading the Rocks*.

Why Geology Matters: Decoding the Past, Anticipating the Future by Doug Macdougall (University of California Press, 2011) is another well-written book but covering selected key topics in geoscience, including the geologic time scale, the earth's interior, meteorite impacts, plate tectonics, earthquakes, mountain building processes, ice ages, climate warming, large volcanic eruptions, and so forth. Macdougall is an emeritus professor at Scripps Institution of Oceanography, University of California in San Diego and currently lives in Edinburgh. He has published three other informative geology books – *A Short History of Planet Earth: Mountains, Mammals, Fire, and Ice* (1998); *Nature's Clocks: How Scientists Measure the Age of Almost Everything* (2008); and *Frozen Earth: The Once and Future Story of Ice Ages* (2013).

A Brief History of Earth: Four Billion Years in Eight Chapters by Andrew Knoll, (Mariner Books, 2021). Stephen Hawking's bestseller book *A Brief History of Time* appears to be an inspiration for the title of Andrew Knoll's book on the geologic history of Earth. The 4.5-billion Earth history is squeezed into about 230 pages and eight chapters: Chemical Earth, Physical Earth, Biological Earth, Oxygen Earth, Animal Earth, Green Earth, Catastrophic Earth, and Human Earth. Andrew Knoll is a professor of Natural History at Harvard University. His previous book, *Life on a Young Planet* (2003), received the Phi Beta Kappa Book Award in Science.

The Story of Earth: The First 4.5 Billion Years, From Stardust to Living Planet by Robert M. Hazen (Viking, 2012) is a systematic discussion of Earth's history from its birth in the bosom of the solar system to the near-future scenarios of our ever-changing planet. Based on recent research, the book examines Earth's history through eleven chapters: Birth, The Big Thwack (formation of the Moon), Black Earth (the first basaltic crust), Blue Earth (the oceans), Gray Earth (the first granitic crust), Living Earth (the origin of life), Red Earth (the great oxidation and photosynthesis), Boring Earth (mineral evolution), White Earth (the snowball-hothouse cycle), Green Earth (terrestrial biosphere), and the Future. Historical geology books often focus on the Phanerozoic history (the past 550 million years), but the Precambrian history covered in Hazen's book is very detailed and appropriate. Coming from the pen of a master science writer, this is another must-read book. Hazen is a professor at George Mason University and a researcher in mineralogy at Carnegie Institution's Geophysical Laboratory. Closely related to this book are his recordings (48 lectures, each 30 minutes), *The Origin and Evolution of the Earth: From the Big Bang to the*

Future of Human Existence (The Great Courses, 2013). After reading Knoll's book mentioned above, if you have a taste for a more detailed geologic history, Hazen's book is an excellent choice.

A (Very) Short History of Life on Earth: 4.6 Billion Years in 12 Pithy Chapters by Henry Gee (St. Martin's Press, 2021)

Moving to the history of life, Henry Gee's book is a good one to start. You cannot probably simplify the complex evolution of life on Earth more than what Gee has accomplished in this book. Gee is a British science journalist, an editor at *Nature*, author of several science books, and has appeared on BBC and NPR. His prose is entertaining and easy to read.

Life: A Natural History of the First Four Billion Years of Life on Earth by Richard Fortey (Knopf, 1998) is written by a renowned paleontologist and natural historian. Fortey, born in 1946 and studied at King's College and Cambridge, has had a long career at the Natural History Museum in London. His book *Trilobites* published in 2000 was a true labor of love. In his book *Life*, Fortey masterfully describes the history of life based on fossil record and in the context of plate tectonics (moving continents) as well as the history of geology – how scientists pieced together the story of evolution. The subtitle of his book ("A natural history of the first four billion years of life on Earth") refers to the idea that life appeared on Earth at about 4 billion years ago (some 500 million years after the formation of Earth) and that life on Earth will probably continue for a long time. Can't wait to see how long.

Earth: An Intimate History by Richard Fortey (Knopf, 2004) is another acclaimed work from the same scholarly writer that offers a geological exploration of Earth through a tour of 20 fascinating places around the world – places that Fortey himself visited, including the Alps, Iceland, Newfoundland, Hawaiian Islands, Oman, Mount Vesuvius, San Andreas fault, and so forth. The book is a vivid and scholarly description of geology in a regional context. Moreover, the reader gains a deep understanding of how human life and societies are rooted in Earth's history and processes. Fortey served as president of the Geological Society of London in 2007 and has presented several BBC natural history films during 2012-2016.

How the Mountains Grew: A New Geological History of North America by John Dvorak (Pegasus Books, 2021) is a fascinating book that combines the science of geology with the geography and story of a region – North America. When I first saw the title *How the Mountains Grew*, I thought the book was only about the tectonic formation of mountains, but its subtitle broadens the book's narrative to cover the tectonic history of North America. Nevertheless, as the book shows, geology is closely related to mountains where outcrops and rock record are accessible to the geologist. Dvorak's book offers a detailed regional evolution of North America chronologically (each chapter deals with a certain geologic time interval) from the Hadean (chapter 1, from 4.58 to 4.030 billion years ago, to precisely quote the book) to the Anthropocene (chapter 16, the Industrial Age). *How the Mountains Grew* takes the reader on a tour of deep time and vast geography. It integrates the geology of North America with that of Earth as a whole. The 36-page list of books and articles (amounting to almost ten percent of the book) not only shows the vast amount of reading the authors has done to write this book, but also offers, in its own right, a valuable bibliography for further reading and research. John Dvorak worked for the US Geological Survey studying volcanoes and earthquakes from Hawaii to Alaska. He has also written a few other books, including *Earthquake Storms* (2021) on the San Andreas Fault.

Here on Earth: A Natural History of the Planet by Tim Flannery (Grove Press/Atlantic Monthly, 2010) is a lucid narrative of planet Earth and earth science from an ecological perspective. It contains 23 chapters on various topics categorized into five sections: (1) Mother Earth or Monster Earth?; (2) A Turbulent Earth; Ever Since Agriculture; (3) Toxic Climax?; (4) Our Present State; and (5) An Intelligent Earth?. The book builds a solid bridge between geology and the history of humans including their role in the environmental issues of our time. Flannery, an Australian paleontologist, has also published a number of books on the ecological history of mammals and climate change such as *The Eternal Frontier: An Ecological History of North America and Its People* (2001), *Among the Islanders: Adventures in the Pacific* (2012) and *Europe: A Natural History* (2019). He is also an outspoken educator and advocator of environmental conservation.

Breaking Boundaries: The Science of Our Planet by Owen Gaffney and Johan Rockström (DK Penguin Random House, 2021) elaborates the concept that there are "planetary boundaries" beyond which Earth loses its habitability and sustainability, at least for humans, and that human activities are moving in this catastrophic direction. These planetary boundaries, according to the authors, are the following: (1) climate change, (2) ocean acidification, (3) stratospheric ozone depletion, (4) biogeochemical flow (for instance of nitrogen), (5) global freshwater use, (6) land system change (ice-free land surface and croplands), (7) biosphere integrity (genetic diversity), (8) chemical pollution, and (9) atmospheric aerosol loading. The authors tend to like numbering and system thinking. They describe Earth's 4.5-billion history in terms of four revolutionary Earths: Earth 1 (Hadean era: shaping of Earth); Earth 2 (Archean era: appearance of living cells); Earth 3 (Proterozoic era: photosynthesis and atmospheric oxygenation); Earth 4 (Phanerozoic era: complex life forms); and Earth 5 ("Wise Earth" which means humans awakening to realities and responsibilities). They talk of six societal systems that have transformative impacts on Earth: energy, food, poverty, cities, human's population and health, and technology. The book is divided into three parts. Act 1 is the story of Earth's life-supporting systems. Act II is the remarkable story of science and technology; and Act III is the story of good stewardship and how not to destroy Earth's life-supporting systems, for our own sake. The references at the end point to original articles and sources for in-depth reading. It is a thought-provoking book and also contains color plates that artistically depict the authors' message and perspective. A Netflix documentary film of the same title has also been produced and broadcast, which is worth watching and which enhances the reading of the book. Johan Rockström, who first conceived the idea of planetary boundaries in a 2009 article in *Nature*, is a professor of earth science at the University of Potsdam. Owen Gaffney is a British science journalist. They were born (according to their own admission in the book) when the atmospheric carbon dioxide was 320-324 ppm (in contrast to today's level of 421 ppm).

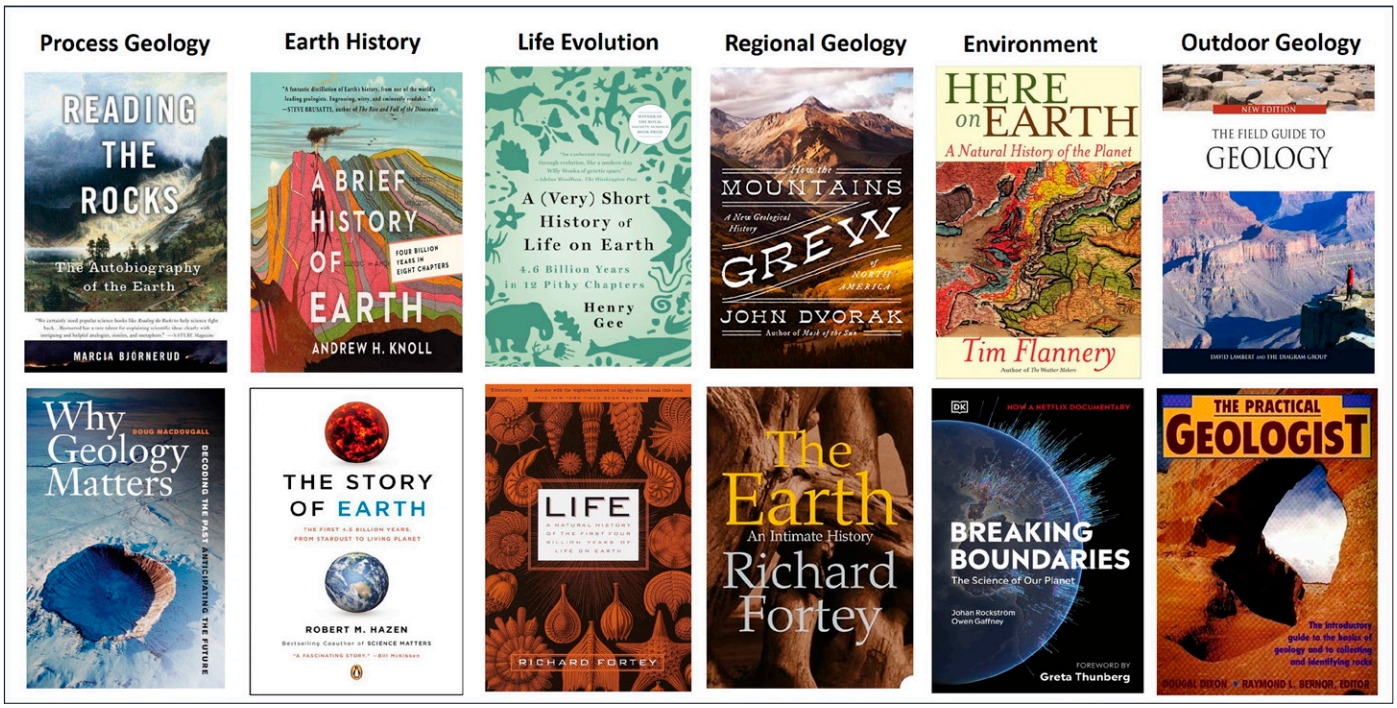


Figure 1. Twelve books described in this article in thematic order.

The Field Guide to Geology by David Lambert and Diagram Group (Checkmar Books, 2nd edition, 2006). If I want to recommend only one geology book to a freshman student it would be this one. *The Field Guide to Geology* is an easy-to-read and profusely illustrated book (with over 750 figures, maps, and charts). Through 14 chapters, the book covers lots of ground, including Earth's size and position in space, plate tectonics, three groups of rocks (igneous, sedimentary and metamorphic), the erosional and landscape shaping works of rivers, glaciers, wind and coastal waves, faults and earthquakes, Earth's stratigraphy, mineral resources, and mapping. The book ends with brief biographies of great geologists, and a list of geology-related museums, societies and websites.

Some students do not cherish abstract bookish knowledge but learn better through visual materials and applied exercises. This book and the one introduced below are for those who enjoy outdoor life, hiking, camping, and down-to-earth practical learning.

The Practical Geologist by Douglas Dixon and edited by Raymond Bernor (Simon and Schuster, 1992) is an "introductory guide to the basics of geology and to collecting and identifying rocks." Packed with more than 200 color illustrations, the book consists of ten chapters: What is a practical geologist?; The history of the Earth; The substance of the Earth; Earth movements; The Earth's storybook; Erosion and geomorphology; Field work techniques; Mapping; Geological sites; Geological time scale; and Glossary. A related book published by the same company is *The Practical Paleontologist* (1990) by Steve Parker, also edited by Raymond Bernor.

***

The twelve books mentioned above were introduced as supplementary teaching tools in geology classes and in the spirit of encouraging students to read popular books aside from the standard textbooks. I listed them in a thematic order of physical (process-based) geology, historical geology, paleontology (life evolutionary science), regional geology, environmental geology (planetary change), and practical (field geology) (see Figure 1). These popular books also benefit geology instructors and professional geologists. They not only refresh our knowledge of geology but also, being narrative prose, teach us how to explain complex scientific concepts of our science in a plain and entertaining language, which itself is an art. Pick a book that suits you and enjoy reading it. And of course, good books make great gifts as well.

AIPG Moments

The use of pronouns: Just before COVID, I went to GSA and I was confused by seeing pronouns on badges. It was the first time that I'd seen nametags with pronouns. Fast forward to 2023, and pronouns are common identifiers. I especially like using my pronouns in my email signature because I work internationally and many other cultures don't recognize my first name. I have been left waiting to be picked up at an airport because someone was looking for a man instead of a woman.

Pronouns are also a polite and inclusive way for someone to identify their gender. I like to make it easy for people to know my gender, and it makes it easier in written communications as well as for those pickups at the airport!

Submitted by Dawn Garcia, CPG-08313



How to Maximize your Potential at a Professional Conference

Brigitte Petras, ECP-0851

For many newcomers to conferences, it can be intimidating to enter into an overwhelmingly inspiring conference such as AIPG's annual meeting. How do folks successfully navigate this technical and networking atmosphere? Although there are many paths and goals for folks at conferences (such as presenting your work, searching for job prospects, looking to connect with other professionals, obtaining a certification, learning from technical talks, networking for future collaborations etc.), here are some tips to help you prepare for a future conference.

Plan ahead

This seems obvious if you've been to a conference before, but so much preparation can happen for a meeting. Here are some topics which you may want to consider before attending a conference:

- ✓ Will you submit an abstract or attend a field trip?
- ✓ What talks are most beneficial for you to attend?
- ✓ Who are you hoping to connect with and how will you connect with them (when are their talks/where are their exhibits, are they free to chat over lunch)?
- ✓ What other events can you attend (dinner, fundraisers, other evening networking events)?
- ✓ How will you subsidize your trip?
- ✓ Are there other offsite attractions you'll be visiting?

Ultimately, you need to figure out your goals and how you'll be achieving them. Additionally, if you are interested in getting more involved with conference planning (anyone can get involved and shows initiative, leadership, and planning skills at the very least), you can contact us (any AIPG staff members, Executive Committee members, or myself at petras@battelle.org).

Enjoy the Meeting

Enjoy all there is to learn at conferences and be aware that conference fatigue is normal. My advice is to go to that event, talk to someone you never met, sit down at a table where you don't know anyone, visit the exhibitors when you need a break from technical sessions, talk to speakers after their technical talk, and take notes and collect business cards. For young professionals and students, AIPG hosts a student and early career professional day with various activities that could include interviews, exam and resume/CV preparation, workshops, and evening networking opportunities. Please take advantage of such an opportunity. Below are some additional thoughts:

For students: Did you learn about the field of geology you're interested in through talks and connecting with individuals? Did you learn about other specialties? Did you get experience talking about your research? Did you get out of your comfort zone to talk to someone new?

For young professionals: Did you network with professionals from your company, and from outside your company? Is there a project at work that can be solved through the knowledge you learned or the people you connected with? Is there a new concept you learned that can be applied at work?

For other professionals: Have you connected with any students or young professionals at the meeting?

It's also a great idea to sign up for a particularly interesting field trip, as it is easy for geologists to bond over such an activity, and much can be learned by attending a field trip.

Follow Up

After a conference, properly archive what you've learned, and put any business cards and contacts in a database (whether it is a business card holder or in an app like Blinq). Using those notes, stay in touch with folks and act on post-conference follow-ups such as the following:

- Respond to requests and conversations from new and existing contacts, for instance,
  - Did you ask for information from another professional? Respond to a potential collaboration or job prospect?
  - Do you need to send a thank you to someone?
- Sign up for other opportunities you learned about, such as joining AIPG committees, executive roles, or programs like the AIPG Mentorship Program

Conferences are an opportunity to share scientific ideas and connect with a professional community without the boundaries of cubicles, offices, or company names. And again, a successful conference experience depends on your personal and professional goals. Conferences are a rewarding and worthwhile investment.

Caribbean Geology continued from p.33

tectonic plates. Subduction of the South American plate beneath the Caribbean plate scrapes sediment from the South American plate and deposits it above the subduction zone forming an accretionary prism. The island is rising about one inch per 1,000 years.

Pleistocene limestones cover a complex basement sequence of Eocene age consisting of a mixture of terrigenous and marine clastic sediments, and marine deposits. Lithologic units which make up the island are summarized in table 9 (p. 33).

Martinique

Physiography:

The total area of Martinique (Fig. 27) is 420 square miles. Martinique is the third largest island in The Lesser Antilles after Trinidad and Guadeloupe. It is 43 miles in length and 19 miles in width. The highest point is the volcano Mont Pelée at 4,583 feet above sea level (Fig. 28). The northern, central, and western areas of the island are mountainous. The south has gentler topography, though it still houses some impressive geographic landscapes.

As a point of interest, Martinique is home to the dangerous snake "fer-de-lance." The unofficial flag of Martinique is the "Drapeau aux serpents."

Geological summary:

Martinique is primarily a volcanic island. Volcanic action in the south and central portions of the island dates to Miocene time. The volcanic action in the northern section is Pleistocene to recent.

Mont Pelée formed about 400,000 BP. The volcano erupted in 1792, 1851, and twice in 1902. The May eruption of 1902 destroyed the city of Saint-Pierre and killed 29,000 people in about two minutes.

Volcanic rocks in Martinique include orthopyroxene andesite, hornblende andesite, quartz-hornblende andesite, quartz-biotite andesite, olivine basalt, and tridymite-rich dacite. Their age and distribution are shown in table 10.

St. Kitts and Nevis

Physiography:

St. Kitts (Fig. 29, p. 49) has the typical topography (Fig. 30, p. 49) and rock deformation (Fig. 31, p. 49) expected in the active part of the volcanic island arc.

St. Kitts has three distinct groups of volcanic peaks. These include the northwestern or Mount Misery Range, the central Verchilds Range, and the southeastern Olivees Range. The highest peak in St. Kitts is Mount Liamuiga (3,793 feet high).

The overlook at Timothy Hill (Fig. 32, p. 50) at the northern end of the Southeast Peninsula in St. Kitts is a landmark of the island, separating the Caribbean Sea from the Atlantic Ocean.

The island of Nevis has seven volcanic centers and is dominated by Nevis Peak (3,231 feet high).

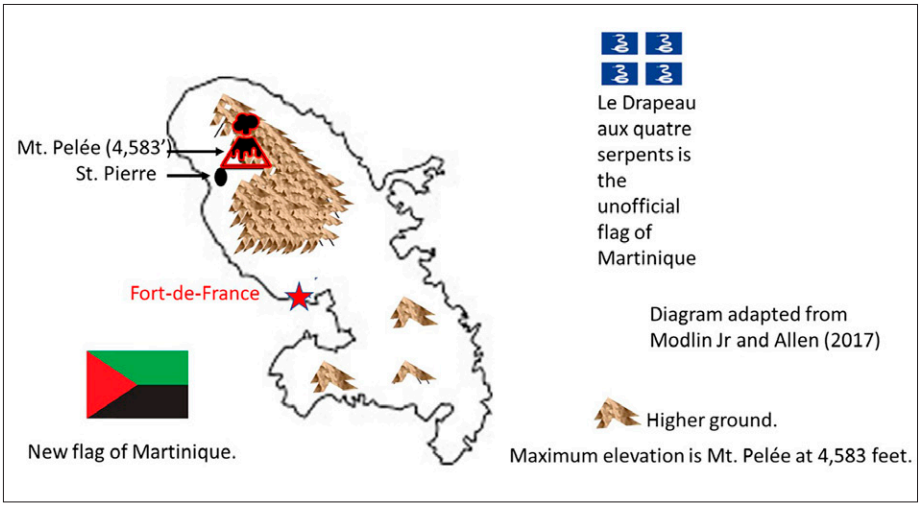


Figure 27. Sketch Physiographic Map of Martinique.

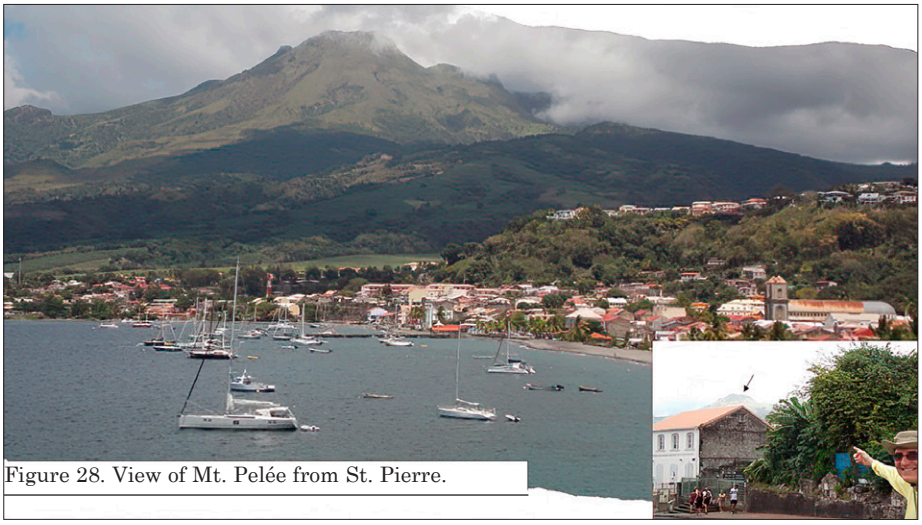


Figure 28. View of Mt. Pelée from St. Pierre.

Table 10. Martinique – Age of rocks and lithologic descriptions.

Time Frame	Volcanic units and their distribution
Pleistocene	Pleistocene volcanic strata are in the northern half of Martinique.
Miocene	Miocene volcanics are found in the southeastern region and middle to eastern portions of the island.
Late Oligocene to Early Miocene	The oldest rocks are andesitic lavas from the Late Oligocene to Early Miocene, mixed with those of basaltic composition. Martinique has a basal complex of Oligocene rocks in the southern part of the island.

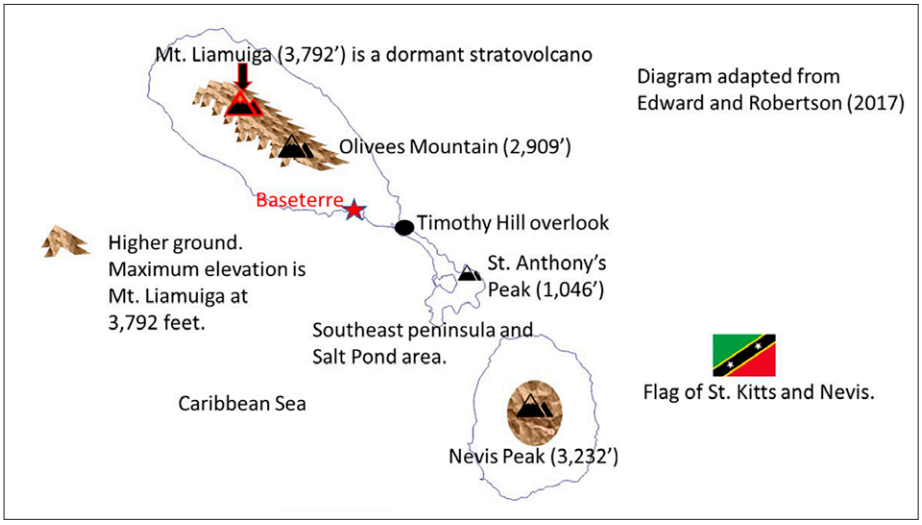


Figure 29. Sketch Physiographic Map of St. Kitts and Nevis.

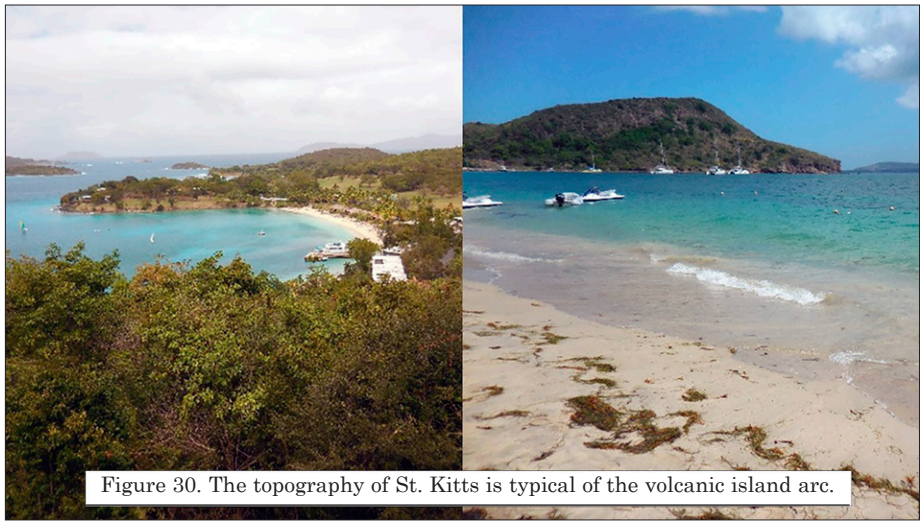


Figure 30. The topography of St. Kitts is typical of the volcanic island arc.

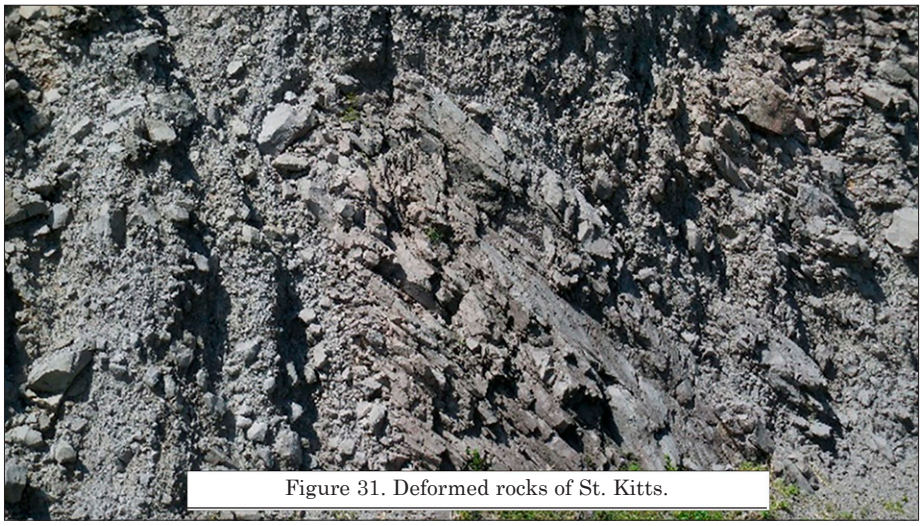


Figure 31. Deformed rocks of St. Kitts.

Geological summary:

Volcanic rocks including andesite, dacite, pyroclastic debris, and volcanic ash are dominant on the islands of St. Kitts and Nevis. Coarse-grained clastic rocks and agglomerates are also present.

The three volcanic centers in St. Kitts are Pliocene to Pleistocene in age and get progressively younger from southeast to northwest.

Mount Liamuiga is a stratovolcano consisting of alternating andesitic and basaltic lava flows and pyroclastic material which is in the north-central part of the island.

The volcanic centers in Nevis developed from Pliocene to Holocene time.

The island of St. Kitts may be divided into three distinct sections. A description of each area is summarized in table 11 (p. 50).

Antigua and Barbuda

Physiography:

Antigua and Barbuda (Fig. 33, p. 50) are located to the east of St. Kitts and Nevis and south of St. Martin. The two islands are 20 miles apart. Antigua and Barbuda have surface areas of 108 and 62 square miles, respectively. The highest elevation in Antigua is Boggy Peak (Mt. Obama) with an elevation of 1,319 feet above sea level. Topographic highs occur in Antigua in the southwestern regions. A famous landmark in Antigua is "Shirley Heights" separating English and Falmouth harbors (Fig. 34, p. 50). Barbuda is mainly flat, formed by coral reefs.

Geological summary:

Both Antigua and Barbuda have carbonate strata over volcanic rocks of the Eocene age. In Oligocene time, Antigua transitioned from volcanism to limestone deposition. Karst topography is present in the limestone regions. The three main sections of Antigua are described in table 12 (p. 50).

Other islands in the Lesser Antilles arc

Commentary:

Other islands along the Lesser Antilles volcanic chain include Montserrat, Guadeloupe, Dominica, St. Vincent, and Grenada. Montserrat, Guadeloupe, and Dominica lie between St. Kitts and Nevis



Figure 32. The Timothy Hill overview is a landmark of St. Kitts, separating Caribbean Sea from the Atlantic Ocean.

Table 11. St. Kitts – Sections of the island and associated geology.

Section of St. Kitts	Description
Main portion	A central chain of volcanic mountains is present. The core of the range is composed of Eocene, Miocene, and Pliocene volcanic lithologies. Pyroclastic fans and lahars are found at lower elevations.
Southeast peninsula	The southeast peninsula is the result of seven islands coalescing from previously existing tombolos. The highest peak on the peninsula is St. Anthony's Peak (1,046 feet high). The Timothy Hill Overlook is located at the northern end of the peninsula.
Salt Pond area	The Salt Pond area in the southeast contains lava dome strata, lahars, and pyroclastic deposits.

Table 12. Antigua – Sections of the island and associated geology.

Section of Antigua	Description
Southwestern highland area	Calc-alkaline andesite, dacite and quartz-basalt, as well as limestone lenses and tuff, are present in the southwestern highland area. Some of these lithologies are strongly metamorphosed. Agglomerates of pyroclastic tuff, lava flows and intrusive rocks are also found.
Central plains	The central plains are covered with shale, conglomerates, agglomerates, and tuff with chert beds and limestone lenses.
Northeastern section	The northeastern portion of the island is dominated by Oligocene age fossiliferous limestone and marl. Coral biostromes and patch reef material are overlain by fine-grained, deeper water limestone..

to the north and Martinique to the south. St. Vincent and Grenada are located south of St. Lucia (Fig. 35).

I have not had the opportunity to visit these islands and I am not familiar enough with their physiography and geology to comment on them in this work.

Allen (2017) is a key recent reference regarding these additional islands.

Dutch Leeward Islands (Aruba, Curaçao, Bonaire)

Physiography:

Aruba, Curaçao, and Bonaire have a distinct and unmistakably Dutch flavor (Fig. 36, p. 51). The islands originated via volcanic activity (Figs. 37 and 38, p. 51).

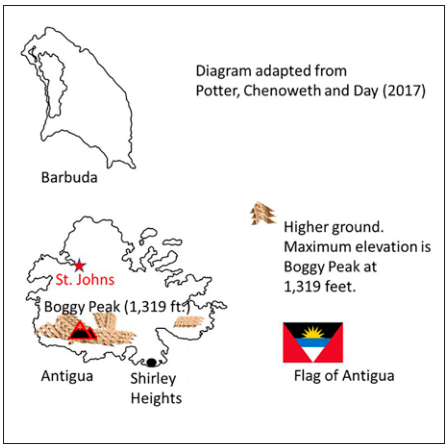


Figure 33. Sketch map of Antigua and Barbuda.

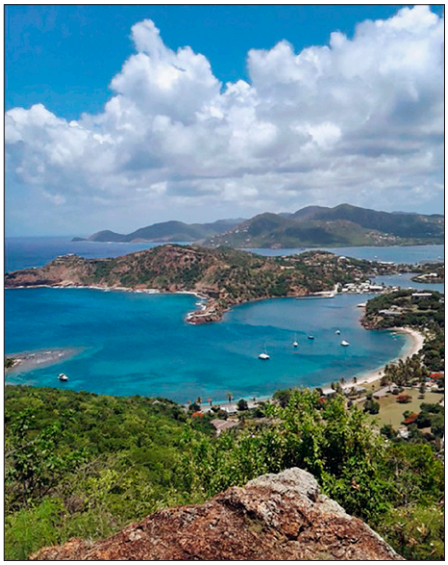


Figure 34. Shirley Heights in Antigua.

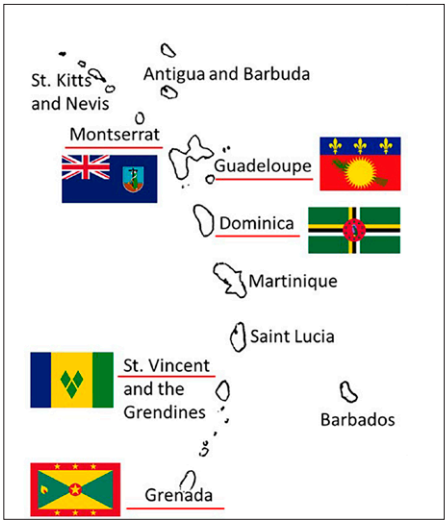


Figure 35. Other islands of the Lesser Antilles.



Figure 36. Views of Aruba and Curaçao with their unmistakably Dutch influence.

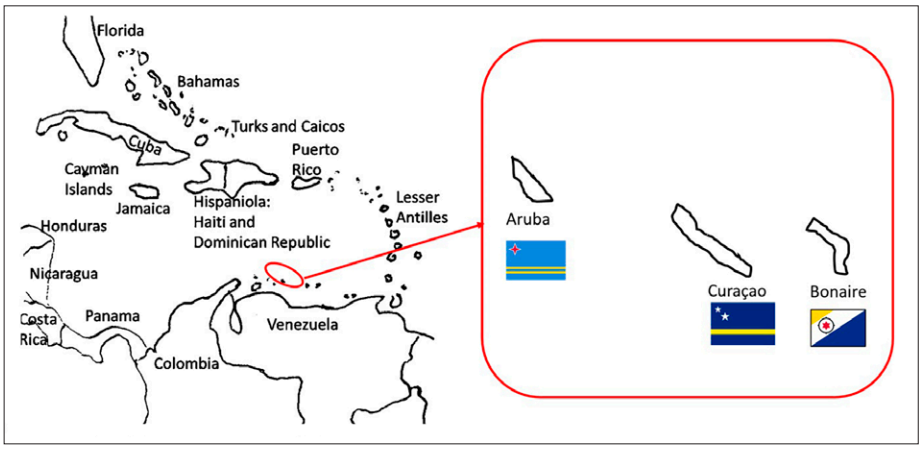


Figure 37. Sketch map of Aruba, Curaçao, and Bonaire.

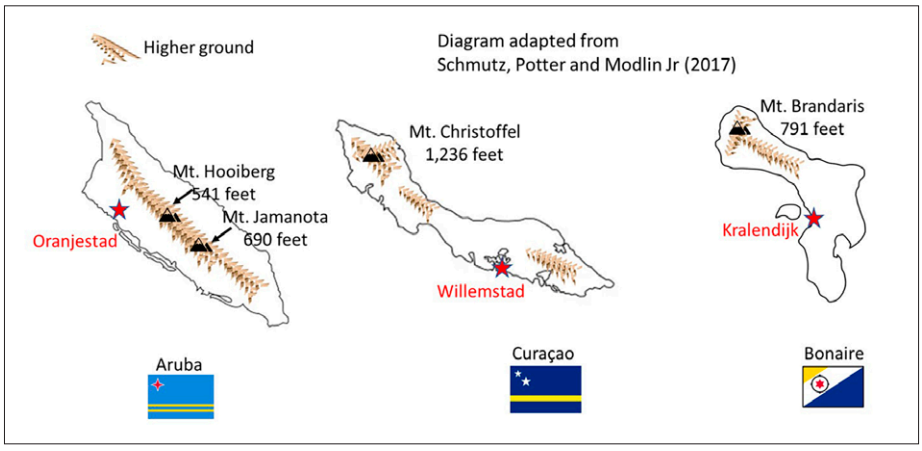


Figure 38. Sketch map of the Dutch Leeward Islands.

Aruba has an area of 69 square miles. The highest point on the island is Mt. Jamanota at 690 feet.

Curaçao encompasses 171 square miles. Mt Christoffel at 1,236 feet is its tallest point.

Bonaire covers 111 square miles. Brandaris Hill at 787 feet depicts the maximum elevation on the island.

Geological summary:

The islands of Aruba, Curaçao and Bonaire are aligned along the crest of a 125-mile-long segment of the east-west trending Leeward Antilles ridge within the Caribbean and South America plate boundary area. This region is currently undergoing east-west, right-lateral strike-slip motion.

Basement rocks include deformed intrusive and extrusive igneous lithologies, such as diorite and gabbro, as well as radiolarian chert, limestone, and greywacke. The basement rocks were deformed in Cretaceous time.

Quartz-augite diorite and quartz diorite intrude the basement rocks in Curaçao and Aruba, respectively.

The deformed igneous rock units in the Dutch Leeward Islands are unconformably overlain by Cretaceous to Eocene sediments. Compressional stresses resulted in additional folding of strata in Eocene time.

Core rocks in Aruba, Curaçao, and Bonaire are described in table 13 (p. 52).

Trinidad, Tobago, and Margarita Island (Venezuela)

Physiography:

Although I have not visited these islands (Fig. 39, p. 53)) in person, during the years that I taught professional courses for PDVSA (Petróleos de Venezuela) in Caracas, I became somewhat familiar with the region. A synopsis of the area is presented below.

Trinidad has an area of 1,850 square miles. It lies about seven miles northeast of Venezuela and is part of the South American continent. The highest point of the island is El Cerro del Aripo at 3,083 feet.

Trinidad is crossed by three distinct mountain ranges that are a continuation of the Venezuelan coastal cordillera. The Northern Ranges is an outlier of the Andes Mountains of Venezuela and forms rugged hills that parallel the coast. El Cerro del Aripo is located within this range. The Central Range extends diagonally across the island and is a low-lying range with swampy areas with a maximum elevation of 1,066 feet. The Southern Range contains a broken line of hills with a maximum elevation of 1,001 feet.

Tobago has an area of 115 square miles and is located 20 miles northeast of Trinidad. Tobago is mountainous and dominated by the 18-mile long Main Ridge with elevations up to 1,800 feet.

Table 13. Aruba, Curaçao, and Bonaire – Description of the core rocks.

Island	Core rocks
Aruba	Core rocks in Aruba are stratified basalts and volcanoclastics intruded by a tonalite batholith. The oldest rocks are Cretaceous and are found from north to south along the eastern and central portions of the island. Miocene, Pliocene, and Pleistocene reefs, eolianites, and terraces cover the western, southernmost, and southeast areas of Aruba.
Curaçao	Core rocks in Curaçao include lava flows, silica-rich lithologies and clastic sediments such as conglomerate, sandstone and shale. The oldest rocks are Cretaceous which cover most of the southern part of the island and the northwest end. A few Eocene lithic units occur east of the Cretaceous zone. Miocene, Pliocene, and Pleistocene terraces occur close to the coast, especially on the east side.
Bonaire	Core rocks in Bonaire are basaltic flows and pyroclastic deposits interbedded with pelagic radiolarian chert and limestone. This sequence is overlain by turbidite conglomerates, fluvial sediments, and limestone. Cretaceous strata are found in the central zone and in the northwest tip of the island. Everywhere else Miocene, Pliocene, and Pleistocene terraces are found.

Table 14. Trinidad, Tobago, and Margarita Island (Venezuela) – Geologic summary.

Island	Geological summary
Trinidad	The Eocene clastic sedimentation and diastrophism, and Miocene-Pliocene folding of Barbados is represented in Trinidad. Jurassic and Cretaceous rocks crop out on the island as part of the folded North Range. The oldest sequence includes phyllite, quartz veins, and limestone. A younger system of less metamorphosed Cretaceous rocks includes limestone and shale. Folding in the North Range occurred first in Cretaceous time, followed by some minor volcanic activity. Sedimentary deposition followed. Folding resulted from a strong Miocene diastrophic episode. The schists found in the North Range of Trinidad and in northern Tobago exhibit a similar degree of metamorphism. Tobago lacks the limestone and graphite schist of Trinidad. Trinidad lacks the metavolcanic schist of Tobago. Igneous activity in Trinidad was minimal, compared to that in Tobago.
Tobago	Cretaceous metamorphosed volcanic rocks are found along the northern part of the island. Schists and phyllite are seen in isoclinal folds. To the south, there is an igneous belt of ultramafic rocks and diorite-rich plutons, as well as andesite and basaltic volcanic lithologies. These rocks were later faulted in the Eocene. Undeformed fossiliferous clay and sand of Miocene to Pliocene age lie unconformably over the deformed igneous belt.
Margarita Island (Venezuela)	Schists intruded by sheared quartz diorite, and serpentinized peridotite are found on the northern part of the island. South of the schist area, slightly metamorphosed sediments are found. Further south and along the southern coast of the island, Cretaceous sediments are folded into a syncline. The main diastrophic episode occurred in Cretaceous time. Miocene ultramafic rocks are seen on the island. Moderate deformation occurred in the Eocene to Miocene time frame.

Table 15. The Virgin Islands – Lithologies of the northern and southern areas.

Area	Description
Northern area	Igneous rocks in the north are Cretaceous in age, but the strata are Miocene in St. Croix. Igneous rocks in the north are intrusive and extrusive keratophyres of intermediate composition. These are mainly lava flows, volcanic breccia deposits, and tabular dikes. Lesser amounts of basalt, gabbro and radiolarian chert can also be seen. The igneous lithic units are overlain by clastic and carbonate sediments.
Southern area	The Southern sedimentary section contains fossiliferous shale, sandstone, turbidites, conglomerates, and tuffaceous deposits. The youngest sedimentary units are mainly shale with interbedded conglomerates overlain by foraminifera-rich and gastropod-rich limestones.

Geological summary:

A summary of the geology of Trinidad, Tobago and Margarita Island is given in table 14.

The Virgin Islands

Physiography:

A discussion of the Caribbean region would not be complete without mentioning the Virgin Islands. The Virgin Islands (Fig. 40, p. 53) lie along the northern boundary of the Caribbean Tectonic Plate. These islands are located at the eastern end of the Greater Antilles and at the

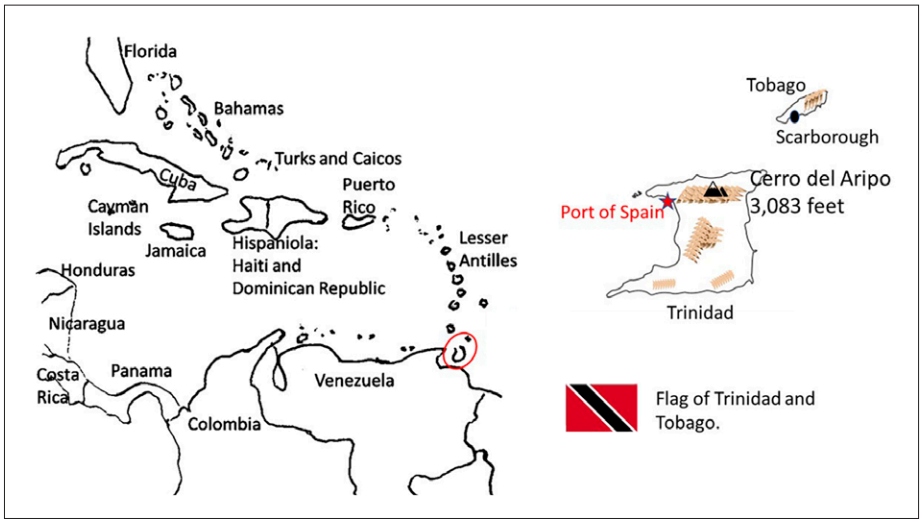


Figure 39. Sketch map showing location of Trinidad and Tobago.

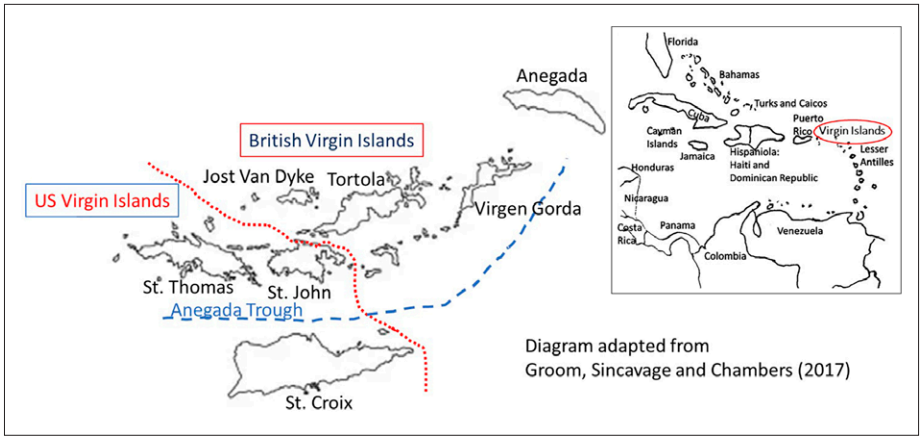


Figure 40. Sketch map of the Virgin Islands.



Figure 41. The impressive topography of St.John, US Virgin Islands.

northern end of the Lesser Antilles, at the transition between strike-slip motion and subduction activity. Islands in the northern section have higher elevations than those in the south. Mt. Sage on Tortola and Crown Mountain on St. Thomas stand at 1,709 feet and 1,551 feet, respectively. In contrast, Mt. Eagle in St. Croix reaches an elevation of 1,161 feet. The interior landforms of the northern igneous section are dominated by steeps slopes and deep ghauts (Fig. 41). In addition to references already cited, the article by Groom, Sincavage, and Chamber (2017) is most informative.

Geological summary:

The area of the Virgin Islands may be divided into two ENE-WSW veering tectonic zones separated by the Anegada Trough. The northern section is dominated by igneous lithologies and is a continuation of Puerto Rico. It encompasses the U. S. Virgin Islands of St. Thomas and St. John, as well as the British Virgin Islands of Tortola, Virgen Gorda, and Anegada. This zone exhibits north-trending, steeply dipping beds related to post-Eocene tectonics and is not associated with the intrusion of the Virgen Gorda batholith. The southern section is primarily formed by sedimentary units. It contains a submarine ridge south of and parallel to the Anegada Trough, in addition to the island of St. Croix. St. Croix is characterized by a central graben filled with Tertiary strata bound by horsts of Cretaceous rocks.

Rocks in the Virgin Islands are older in the north and younger is the south. A description of the strata found in the north and south is shown in table 15 (p. 52).

Two tonalite batholiths are worthy of mention. These are the Virgen Gorda batholith and the Narrow batholith, the latter positioned between St. John and Tortola. Diabase and diorite dikes were fed from these batholiths resulting in contact metamorphism of some of the Eocene rocks.

As a personal note, one of my most memorable diving experiences was in the waters of St. Thomas. Along with a group of scuba divers we descended to a shipwreck. Inside the ship was a large nurse shark. As some of my companions took pictures of the animal, it became spooked and as it swam away with a flick of its tail took the mask from my face. I was lucky it did not knock me

unconscious or drive my regulator down my throat. As you can imagine that incident made a lasting impression on my diving adventures.

References

Allen, Casey D. (2017): Landscapes and Landforms of the Lesser Antilles. Springer, 321 p.

Arkle, Jeanette C., Lewis A. Owen, and John C. Weber (2017): Trinidad and Tobago. *in* Landscapes and Landforms of the Lesser Antilles, Springer, p. 267-291.

Bally, Albert W., and Allison R. Palmer (1989): The Geology of North America – An Overview. Chapter on the geologic history of the Caribbean and Central America. The Geological Society of America, Vol. A.

Barnes & Noble (2007): The Illustrated World Atlas. Published by Barnes & Noble, Inc. by arrangement with Weldon Owen, Inc. 352 p. The West Indies, p. 92-93.

Bateman, Graham, and Victoria Egan (1996): The Encyclopedia of World Geography. Barnes & Noble, New York, 512 p.

Beinroth, Friedrich H. (1969): An Outline of the Geology of Puerto Rico. University of Puerto Rico, Mayagűez Campus. Rio Piedras, Puerto Rico, 31 p.

Bowin, Carl (1975): The Geology of Hispaniola. *in* Ocean Basins and Margins, Vol. 3, The Gulf of Mexico and the Caribbean, Springer, p. 501-552.

Cobiella-Reguera, J. (2002): Remains of Oceanographic Lithosphere in Cuba: Types, Origin, and Emplacement Ages. *in* Caribbean Geology in the Third Millennium, p. 35-46.

Christman, R. A. (1953): St. Bartholomew, St. Martin, and Anguilla, Lesser Antilles. Geological Society of America Bulletin 64, p. 65-96.

Day, Mick, and Patty Day (2017): Barbados. *in* Landscapes and Landforms of the Lesser Antilles, Springer, p. 209-221.

Dengo, Gabriel and J. E. Case (1991): DNAG Geology of North America; the Caribbean Region. Chapter on Marine Geology, Ridges, and Basins of the Plate Interior by Troy L. Holcombe, et al.

Donovan, Stephen, and Trevor A. Jackson (1994): Caribbean Geology: An Introduction. University of West Indies Publisher's Association, 289 p.

Draper, G., G. Gutierrez, and J. F. Lewis (1996): "Thrust Emplacement of the Hispaniola Peridotite Belt: Orogenic Expression of the Mid-Cretaceous Caribbean Arc Polarity Reversal?" *Geology*, Vol. 24, No. 12, p. 1143-1146.

Draper, G., and T. A. Jackson (1994): Geological Provinces of the Caribbean. *in* Caribbean Geology: An Introduction. University of West Indies Publisher's Association, p. 3-12.

Draper, G., P. Mann, and J. Lewis (1994): Hispaniola. In Caribbean Geology; An Introduction. University of West Indies Publisher's Association, p. 129-150.

Eardley, A. J. (1951): "Structural Geology of North America." Harper & Brothers Publishers, New York, 624 p.

Edward, Richard, and Arnold Robertson (2017): "St. Kitts and Nevis." In Landscapes and Landforms of the Lesser Antilles, Springer, p. 85-98.

Fielding, Russel (2017): Saint Martin/ Sint Maarten and Saint Barthélemy. *in* Landscapes and Landforms of the Lesser Antilles, Springer, p. 45-59.

García- Casco, A., J. A. Proenza, and Manuel A. Iturralde-Vinent (2011): Subduction Zone of the Caribbean: The Sedimentary, Magmatic, Metamorphic, and Ore-Deposit Records. Geologica Acta: An International Earth Science Journal, 93, p. 217-224.

Garmin, W. T., Casey D. Allen, and Kaelin M. Groom (2017): Geologic and Tectonic Background of the Lesser Antilles. *in* Landscapes and Landforms of the Lesser Antilles, Springer, p. 7-15.

Groom, Kaelin M., Ryan Sincavage, and Frederick Chambers (2017): The Virgin Islands. In Landscapes and Landforms of the Lesser Antilles, Springer, p. 17-30.

Howard, Richard A. (1962): Volcanism and Vegetation in the Lesser Antilles. Journal of Arnold Arboretum, Vol. XLIII, No. 3.

Humphrey, J. D. (1997): Geology and Hydrology of Barbados. In: Vasher, H. L. and T. M. Quinn Geology and Hydrology of Carbonate Lands. Elsavier, Amsterdam, p. 381-406.

Iturralde-Vinent, Manuel A., and L. Gahagan (2002): Late Eocene to Middle Miocene Tectonic Evolution of the Caribbean: Some Principles and their Implications for Plate Tectonic Modeling. *in* Caribbean Geology in the Third Millennium, p. 47-62.

Iturralde-Vinent, M. A., A. García-Casco, Y. Rojas-Agramonte, J. A. Proenza, J. B. Murphy, R. J. Stern (2016): The Geology of Cuba: A Brief Overview and Synthesis. GSA Today 26 (10), p. 4-10.

Jackson, Trevor A. (Editor), (2002): "Caribbean Geology in the Third Millennium." Transactions of the Fifteenth Caribbean Geology Conference. University of West Indies Publisher's Association, 272 p.

Jackson, T. A., and P. W. Scott (2002): The Paleogene Volcanic Rocks of Cuba and Jamaica: Similarities and Differences." In Caribbean Geology in the Third Millennium, p. 107-118.

James, Keith H. (2005): A Simple Synthesis of Caribbean Geology. Caribbean Journal of Earth Science, No. 39, p. 69-82.

James, K. H., M. A. Lorente, and J. L. Pindell (2009): The Origin and Evolution of the Caribbean Plate. The Geological Society (London), Special Publications (Lyell Collection), Vol 328, 542 p.

Kaye, Clifford A. (1957): Notes on the Structural Geology of Puerto Rico. Geological Society of America, GSA Bulletin Vol 68, No. 1, p. 103-118.

Khudoley, K, M., and A. A, Meyerhoff (1971): Paleogeography and Geological History of the Greater Antilles. Geological Society of America, GSA Memoir 129 XVI, 200 p.

King, Philip B. (1977): The Evolution of North America. Princeton University Press, Princeton, New Jersey, 197 p.

Mann, Paul, Grenville Draper, and John F. Lewis (1991): An Overview of the Geologic and Tectonic Development of Hispaniola. GSA Special Papers. The Geological Society of America, Vol. 262.

Martin-Kaye, R. H. A. (1969): A Summary of the Geology of the Lesser Antilles. Overseas Geology and Mineral Resources, Vol. 10, No. 2.

Mattson, Peter H. (1984): Caribbean Structural Breaks and Plate Movements. The Geological Society of America, Memoir 162.

Modlin Jr., E. Arnold, and Casey D. Allen (2017): Martinique. *in* Landscapes and Landforms of the Lesser Antilles, Springer, p. 173-189.

Nagle, Frederick, H. Currie Palmer, and Gustavo A. Antonini (1979): Hispaniola: Tectonic Focal Point of the Northern Caribbean. Three Geologic Studies in the Dominican Republic." Miami Geological Society.

Nairn, Alan E. M., and Francis G. Stehli (1975): The Ocean Basins and Margins. Volume 3: The Gulf of Mexico and the Caribbean. Springer, 706 p.

Palmer, R. H. (1945): Outline of the Geology of Cuba. The Journal of Geology, Vol. 53, No. 1. The University of Chicago Press, 34 p.

Pardo, Georges (2009): The Geology of Cuba. AAPG Studies in Geology 58. The American Association of Petroleum Geologists, Tulsa, Oklahoma, 73 p.

Pindell, J. L., and S. T. Barret (1990): Geological Evolution of the Caribbean Region: A Plate Tectonics Perspective. *in* the Caribbean Region, Volume H, of the Geology of North America. The Geological Society of America, p. 405-432.

Pindell, J. L. (1994): Evolution of the Gulf of Mexico and the Caribbean. *in* Caribbean Geology; An Introduction. University of West Indies Publisher's Association, p. 13-39.

Pindell, J. L., and L. Keenan (2009): Geologic Evolution of the Gulf of Mexico, Caribbean, and Northern South America in the Mantle Reference Frame: An Update.The Geological Society (London), Special Publications, Vol. 328, p. 1-55.

Potter, Anthony R. D. et al (1982): Minerals and Rocks of Jamaica. Jamaica Publishing House.

Potter, Amy E., Sean Chenoweth, and Mick Day (2017): Antigua and Barbuda. *in* Landscapes and Landforms of the Lesser Antilles, Springer, p. 99-116.

Robinson, E. (1994): Jamaica. *in* Caribbean Geology; An Introduction. University of West Indies Publisher's Association, p. 111-127.

Schmutz, Phillip P., Amy E. Potter, and E. Arnold Modlin Jr. (2017): Aruba, Bonaire and Curaçao. *in* Landscapes and Landforms of the Lesser Antilles, Springer, p. 293-317.

Sealey, Neil (1992): Caribbean World: A Complete Geography. Cambridge University Press. 256 p.

Slinger-Friedman, Vanessa, Susana Diller, and Lauren Parkinson (2017): St. Lucia. *in* Landscapes and Landforms of the Lesser Antilles, Springer, p. 191-207.

Sutter, H. H. (1954): The General and Economic Geology of Trinidad. BWI Colonial Geological and Mining Resources. London: HM50.

Walper, J. L. (1982): Geologic Evolution of the Greater Antilles. *in* Transactions of the 9th Caribbean Geological Conference, Santo Domingo, Dominican Republic, 1980, p. 13-22.

P.G. Deregulation, continued from p.21



Landslide damage. Barranquitas, Puerto Rico.



Residential earthquake damage. Guánica, Puerto Rico.

renewed, the Board will resume the process for administering the ASBOG examination for new PG candidates.

Since 2018, Puerto Rico professional geologists have been struggling with the negative impact that resulted from having an inactive Board. Many geologists lost job opportunities or could not get promoted since the professional geologist license is a requirement for many local and federal government positions. In addition, many geologists could not complete and/or stamp their jobs since they did not have a current license. Geologists in Puerto Rico work in the environmental, construction, geotechnical, and seismological fields, among others. Soil, surface water, and groundwater contamination are a major concern due to limited natural resources, such as



Rockfall Road block. Photo: Juana Díaz, Puerto Rico

rivers and aquifers, on the island. The construction industry faces many geographic limitations on the island of Puerto Rico. There are not many lands available to be developed without susceptibility to a geologic process, such as landslides, erosion, seismic activity, and others. Puerto Rico is in an active seismic zone where earthquakes have in recent years caused a lot of damage to the southern areas of the island. Professional geologists with their expertise have a key role in all these areas and their public responsibility is of paramount importance.

An active licensing Board guarantees that professional geologists practicing geology for the benefit of the public in Puerto Rico have the academic requirements and professional expertise to be able to provide quality, and appropriately experienced, services to our society, to protect life, health, property, the environment, and public welfare, as established by law No. 163 for the Board of Examiners of Geologists in Puerto Rico. The new members of the Board will formulate plans to promote keeping the Board active, perhaps by maintaining a continuous dialogue with legislature (as is the mission of FAPG) and communicating with active Puerto Rico geologists to encouraging them to support their professional Board and advocate for their profession so that deregulation does not occur again in the future.

What are you waiting for?

Renew your dues before January 1, 2024

CPG certifications lapse with nonpayment of dues.
Your membership will lapse on February 15, 2024 if dues are not paid and renewal will be subject to late fees.

Pay online or by mail.

Why wait?
Pay online today!

National Mining Hall of Fame to Induct Five Individuals

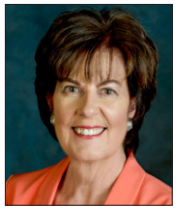
National Mining Hall of Fame Media Release.

First Modern Living Woman, Long-Time Champion of Responsible Mining, Builder of a Diversified Multi-Billion Dollar Company, Innovator in Coal Mining, and Leader in Historic Mining; as the 2023 Class of Inductees.

The National Mining Hall of Fame and Museum (NMHFM) is pleased to announce the class of 2023 National Mining Hall of Fame inductees and the Prazen Living Legend of Mining Award. The 2023 Induction Gala will be October 28, 2023 at the Gaylord Rockies in Aurora, Colorado with Mr. Stephen Enders as Emcee.



Richard Adkerson: Chairman and CEO of Freeport-McMoRan, Richard Adkerson has been a long- time champion of responsible mining. As a founding member and past Chair of the International Council on Mining and Metals, he advanced initiatives to strengthen environmental and social performance in the mining sector. Today, all 12 of the company's copper producing sites globally have achieved the Copper Mark, a comprehensive responsible production assurance framework, developed specifically for the copper industry.



Carolyn Loder: Carolyn Loder devoted her life to preserving mining viability and promoting fair treatment of native americans and local communities, while protecting access to mineral resources on public lands. Her dedication to the industry spans more than forty years, from early work in federal land management planning identifying the loss of federal lands to mineral entry in the 1970's to defeating multiple anti-mining initiatives. Carolyn was honored by the U.S. Department of Agriculture for her "Significant Contribution to the Nation's Energy Program" for "protecting access to our nation's mineral resources." She served as President of Sonora Mining Corp. Jamestown Mine, the nation's largest gold flotation facility and was the first woman elected to President of the California Mining Association in the 1990's. She spent a decade initiating a landmark land exchange among two federally recognized Tribes in New Mexico and the U.S. Bureau of Land Management (BLM), which resulted in the resolution of a 400-year tribal land dispute thus allowing mining on tribal lands.



E. Morgan Massey (1926-2021): Morgan Massey dedicated his life to improving coal mining technology and productivity while elevating the health and safety of miners. He was a highly successful Chief Executive Officer at A.T. Massey Coal Company, Asian American Coal, Asian American Gas, Inter-American Coal, Evan Energy Investments, and Minerals Refining Company. Massey was pivotal to the U.S. coal industry by developing Martin County Coal Company in 1969. Afterretiring from A.T. Massey in 1991, Massey was instrumental in developing world-class mines in Venezuela and China.

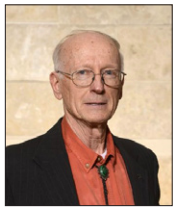


Albert Reynolds (1840-1921): A.E. Reynolds was a mining pioneer in Colorado, owning and operating numerous gold and silver mines between 1879 and 1921. A man of meager beginnings, he personified the American dream, becoming one of Colorado's most successful mining magnates. Reynolds was an intensely private man, and in 1898, the Cripple Creek Citizen characterized him "The Biggest Mine Operator in the State is Almost the Least Known." His story was memorialized in a 1995biography Albert Eugene Reynolds, Colorado's Mining King by Lee Scamehorn.



Dennis Washington: Dennis R. Washington is founder of The Washington Companies, an international group of companies with thousands of employees worldwide. Dennis is known throughout the industry as an efficient, safe, and innovative miner. Montana Resources, LLC, his open pit copper and molybdenum mine in the historic mining city of Butte, Montana, USA, produces high-quality metal concentrates for the global market. An ardent philanthropist, Dennis and his wife formed the Dennis and Phyllis Washington Foundation in 1988, which has donated nearly a half billion dollars to regional non-profit entities focused on education, health and human services, arts and culture, and community service.

Prazen Living Legend of Mining Award



Richard Beach: Born and raised in Connecticut, Dick Beach "came West" as a young man to study minerals and graduated from the Colorado School of Mines with a professional degree in geological engineering. After serving in the U.S. Army Corps of Engineers in Virginia and Vietnam, Dick worked as a geologist and physical scientist for the U.S. Bureau of Mines, assessing the mineral resources needed to sustain our economy and standard of life. Since retirement, Dick has continued to be actively involved in professional activities, especially with the Society for Mining, Metallurgy & Exploration, Inc.; as Chair of the SME Colorado Section Minerals Education Coalition. Dick makes presentations in Denver Metro area classrooms, and at other venues, about mining and minerals; works with Scouts earning the Mining In Society merit badge; and judges science fair projects.

In Memoriam

Paul B. DuMontelle, CPG-02032

Indianapolis, Indiana

June 22, 1933 - June 22, 2023

Member Since 1969

Obituary excerpted from the News-Gazette on the Legacy.com website

Paul Bertrand DuMontelle, 90, of Indianapolis, died June 22, 2023.

He was born June 22, 1933, in Kankakee, to Lester V. DuMontelle Sr. and Helen Edith McKinstry. He grew up and graduated from Momence High School and enrolled at DePauw University, Greencastle, Ind., where he was a member of the Men's Hall Association. There he met his future wife, Dollie Bridgewater, and married on June 5, 1955, before moving for Paul's graduate studies at Lehigh University, Bethlehem, Pa.

His work as a geologist took them to the Catskills in New York, St. Paul and Hastings, Minn., Egypt, Pa., Hauber, Wyo., then to Lead, S.D., when he joined Homestake Gold Mining Co. In 1963, they moved to Urbana, where they remained until he retired in 1996 from the Illinois State Geological Survey; Paul was a past Illinois State Geologist. After retirement, he spent 10 years as gatekeeper at the Assembly Hall. They moved to Indianapolis to be near family.

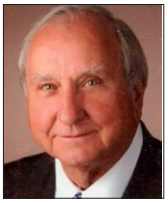
Paul was actively involved with his professional organizations SME, GSA, AEG, AIPG, Sigma Xl, CUSEC, as well as a registered geologist in Illinois, California, and Indiana. He was coordinator for the State Illinois Junior Academy of Science competition for many years. He was active in Urbana First United Methodist Church, Lodges 636 and 157 AFAM, Valley of Danville Consistory, Kiwanis, Scouting, SAR and as Boneyard Creek commissioner. He worked over 15 years at welcoming receptions for new American citizens.

Larry R. Rhodes, CPG-02250

Lexington, Kentucky

August 22, 2023

Member Since 1971



Obituary and photograph excerpted from the legacy.com website.

Larry R. Rhodes, 85, passed away on August 22, 2023. He had been active with AIPG for 51 years.

Larry was the youngest of 8 children born to Henry and Lillian Rhodes in Murray, Kentucky. He is survived by his wife of 62 years, Lois Rhodes; children Melody (Jeff) Searcy; Stephen Rhodes; and grandchildren Wyatt Searcy and Lily Searcy.

Larry moved to Lexington to attend the University of Kentucky and graduated in 1969 with his BS in Geology. He started his career in Geology working for Stokely and Associates in Lexington. There he was responsible for the coordination and supervision of all phases of projects both in the field and office.

In 1971, he became President, co-owner and Principal Geologist for Geisler-Rhodes and Associates, Inc in Lexington. There he managed geological projects and rock core drilling and performed foundation investigations for various structures. In 1975, Larry started his own company called Rhodes and Associates Inc in Lexington where he was the President, owner, Chief Administrator and Principal Geologist. He managed all geotechnical engineering projects and rock core drilling for mineral exploration. Larry ran that company until 1995 when it changed to Rhodes Incorporated where he also added expert witness testimony in his field to his accomplishments. In 2004, Larry became Vice President of Central Associated Engineers and Geotechnical Services in Lexington where he managed geotechnical projects for bridges, highways, multi-story buildings and more. He was also in charge of marketing these services. From 2006-2008, Larry was the Geology Manager for FRA Engineering in Danville, Kentucky where he continued his work. From 2008-2009, he served as Vice President and Coal Geologist for TEE Engineering Company in Lexington. Here he prepared the geology for coal mining permits and worked with the Division of Mine permits at the Kentucky Department of Natural Resources on behalf of his coal company clients. From 2009 until he passed, Larry was the President, owner, Principal Geologist and Kentucky Monitoring Well Driller for Rhodes Consulting Group, LLC in Lexington. He continued all of his geological work here and also performed environmental site assessments, sinkhole investigations and oversaw the drilling of monitoring wells.

Larry was the President of the Kentucky Section of the American Institute of Professional Geologists from 1976-1989. Larry served as AIPG National Secretary in 1990-91, and was an Advisory Board representative in 1989. He served as Annual Meeting Chairman for the 1987 meeting in Lexington, Kentucky. Among his numerous awards and honors are the Kentucky Section Committee Outstanding Service Award and the 2008 Martin Van Couvering Memorial Award for outstanding service to the institute. Larry also was a 1988 Presidential Certificate of Merit recipient. Larry was Chairman of the Geology Board from 2009-2018 and was a member of AIPG Foundation from 2000-2007 where he was recognized for 45 years of active service from AIPG.

Larry was also involved in many community activities including serving on various boards and committees at Southern Hills United Methodist Church where he and Lois have been members for over 50 years. He was on the Kentucky Colonel Commission from 1969-2011 and the God's Pantry Board of Directors from 1986-1992. He also served many appointed terms with the Environmental Commission for Lexington-Fayette County, Kentucky. He was a member of Phi Sigma Kappa National Social Fraternity.

David B. Roberts, CPG-02429

Westminster, Colorado

November 2022

Member Since 1972

Information provided by David's wife, Marilyn Roberts

Paul Bertrand DuMontelle, 90, of Indianapolis, died June 22, 2023.

David died in November 2022. Next to his family, he loved his profession, no matter where it took him around the world. His son and daughter were very good students in school science classes because they "listened to dad."

ences, and mentored many IIMA members on their path to certification.

John was also an active member of AIPG and the Colorado Section for many years. He served as Colorado Section Vice President in 1981 and President in 1982. At the National level, John served as an Advisory Board Member in 1983, 1984, and 1985 and was the recipient of a Presidential Certificate of Merit in 1982. John also was a presenter of several Annual Meeting workshops on "Appraisals" and "Market Research."

John was a kind and generous man and will be deeply missed by the entire mineral valuation community. He was always willing to help others, chat with colleagues and offer insights and experiences to beginners, and to help out with the next conference, seminar, or short course.

John B. Gustavson, CPG-02637

Boulder, Colorado

July 27, 2023

Member Since 1974



Obituary from the 2023 IIMA President, David Shetler; photo from LinkedIn.

It is with great sadness that I inform you of the passing of one of our founders, John Gustavson. John passed away on July 27 at the age of 90 after a courageous battle with cancer.

John was a visionary and tireless leader who led the establishment of the International Institute of Minerals Appraisers (IIMA) in 1991. He was a member of the SME Valuation Standards Committee and was one of IIMA's representatives to the International Mineral Valuation Committee (IMVAL). He was passionate about the Institute, our profession, and will be deeply missed by all who knew him.

John was educated in Denmark where he received a Master's degree in Chemical Engineering from the Technical University of Denmark in 1956. He then moved to the United States where he continued his education at the University of California, Berkeley, in Fluid Dynamics from 1957 to 1959. He was independently active in the field of natural resource development since 1966, with a brief academic leave in the mid-1970s to obtain a Master's Degree in Geology from the University of Memphis.

John specialized in resource/reserve estimates for financial reporting, market value appraisal of mineral properties, due diligence evaluation, and monitoring of extractive operations. He founded Gustavson Associates, a highly reputable consulting and mineral appraisal firm that he retired from in 2007. John also taught courses offered through the University of Tulsa on the appraisal of mineral properties and due diligence concepts for industry operators.

John's contributions to the natural resources industry include patents, several inventions, numerous white papers, and presentations. He authored or co-authored over 60 papers on a variety of topics related to the mineral appraisal profession, presented his work at numerous professional confer-

Walter (Rusty) C. Riese, CPG-04521

Katy, Texas

September 6, 2022

Member Since 1979



Obituary and photograph excerpted from the Memorial Oaks Funeral Home, Houston, Texas.

W.C. "Rusty" Riese passed peacefully from this earth on October 6, 2022, at CHI Baylor St. Luke's hospital following a protracted battle with pulmonary fibrosis. A prominent geologist, loving father, and consummate storyteller, he will be missed by countless friends, family, and colleagues.

Rusty earned his Bachelor of Science degree in geology in 1973 from the New Mexico Institute of Mining and Technology. He earned his master's and doctoral degrees in geology in 1977 and 1980, respectively, from the University of New Mexico.

The Southwest suited him. During his years as an undergraduate at New Mexico Tech and graduate student at UNM, Rusty realized and nurtured two of his most valued endeavors: his passion for cacti, and his relationships with fellow students and advisors that would endure through his life. At the time of his passing, he was in a loving relationship with Jamie Boling, a college friend turned partner in 2019.

Rusty worked as a geologist and geoscience adviser for Gulf Mineral Resources, Anaconda Minerals, ARCO Oil and Gas Company, Vastar Resources, and finally BP, having successfully navigated a series of acquisitions and mergers. He was known for his work ethic and spirited partnerships with colleagues. He traveled extensively for his work, eventually visiting every continent but Antarctica, and residing in Colorado, California, and finally Texas for the rest of his life. He authored dozens of papers and held numerous U.S. and international patents for his work. Even in retirement, he continued to give lectures on economic geology, coalbed methane sequestration, and climate change.

Though he wore many hats and held many titles-from adjunct professor at Rice University and UNM to United States Powerlifting Federation judge to board member for the American Association of Petroleum Geologists-he was

most proud of being dad and "Boris" to his two kids, Clay, and Monica, who are gutted by this loss. They will treasure their memories of family camping trips, road trips through the Southwest and up the East Coast, and steaks so good they both refuse to order them from restaurants anymore.

Everyone who knew him doubtless has a story of their own of a wonderful dinner together from the World Famous Riese Driveway Steakhouse, a neighborly chat, or conversations over glasses of wine or Blanton's. They'll recall a bit of advice he gave them or their children, a project he helped them complete, a road trip or camping adventure they experienced together (perhaps in the company of a few dozen Molloy students in a national park), and maybe even a fortuitous run-in with Santa Claus when Rusty was mysteriously absent.

He will spend his eternity becoming one with the Sangre de Cristo mountains in northern New Mexico, where he longed to spend his retirement years. Though the world is decidedly darker without him in it, his light shines on in every story you tell of him to another friend or family member.

Radu R. Conelea, CPG-06871

Reno, Nevada

August 18, 1936 - April 20, 2023

Member Since 1985



Obituary provided by long-time friend Bob Felder.

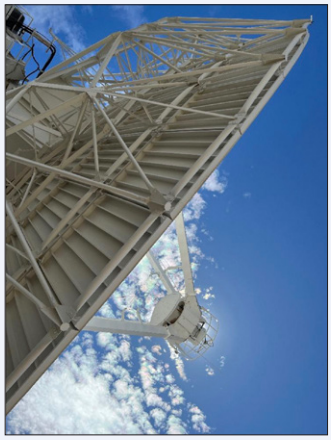
Radu Romul Conelea was born in Fagaras, Romania on August 18, 1936 and passed away on April 20, 2023 in Reno, Nevada at the age of 86.

Radu spent the first half of his life in Romania, and received his Masters degree in Engineering Geology and Hydrogeology from the Polytechnical Institute of Petroleum, Gas and Geology in Bucharest and his Ph.D. in Economic Geology from the University of Bucharest. Radu's early career was spent working as a geologist for Romania's Research Institute for industrial materials and construction, focused in the Carpathian Mountains. In 1978, Radu left Romania for the United States and in 1980 was hired by Billiton Exploration in Denver. Following Billiton, Radu joined Santa Fe Pacific Mining, first in Prescott, Arizona looking for volcanogenic massive sulfide deposits and then in Nevada working mostly on Carlin-type gold exploration. Radu played a pivotal role in figuring out the structural controls on gold mineralization at the Rabbit Creek (now Twin Creeks) deposit and the aptly named "Conelea Anticline" is a great lasting tribute to his work and contributions to the understanding of this world-class Carlin-type gold deposit. Following Santa Fe's acquisition by Newmont in 1997, Radu spent several years with Placer Dome, working primarily in the Bald Mountain district, and several more years with junior explorer Rye Patch Gold developing resources in the Willard, Colado and Lincoln Hill projects in western Nevada. Radu was a mapping specialist, who embraced new digital mapping technology late in his career and became an expert digital mapper. He loved geology and teaching his craft to younger geologists. He was a regular attendee and sometimes leader of Geological Society of Nevada field trips, often accompanied by his wife, Victoria. In retirement, he spent his time hiking in the hills near his Reno home, mapping alteration and structure in the volcanic rocks, keeping his ArcMap skills sharp, fishing and spending time with family. He is survived by his wife, Victoria, two children, Christine and John, and three grandchildren. The geologic community as a whole and in particular the Nevada community has lost a skilled geoscientist, a fine friend and dedicated family man who will be deeply missed.

Field Tripping continued from p.39

We also discussed the difficulty of permitting and obtaining water rights for the mine, which is essentially holding up the planned operation of the mine.

The group enjoyed some social time at T or C Brewing Company on Friday evening and La Cocina, Los Arcos and other T or C restaurants on Saturday evening.



In the shadow of a radio telescope at VLA (photo: Michael Descour, family of Anne Descour AS-0192).

The second day the group headed to the VLA radio telescope facility on the Plains of San Agustin, located about 50 miles west of Socorro. The VLA is the same that was featured in the movie "Contact". Founded in 1956, the NRAO provides state-of the-art radio telescope facilities for use by the international scientific community. NRAO telescopes are open to all astronomers regardless of institutional or national affiliation. Observing time on NRAO telescopes is available on a competitive basis to qualified scientists after evaluation of research proposals based on scientific merit, the capability of the instruments to do the work, and the availability of the telescope during the requested time. Our tour guide, Summer Ash, received her degrees from Stanford and Cambridge University. She is an astrophysicist with a passion for scientific communication, which made her an excellent guide to not only answer all questions but also to describe how the equipment worked on a relatable basis.

The facility is in a relatively uninhabited area, which means that the electronic interference is minimal, and all devices (such as cell phones) are required to be turned off when visiting, since the radio telescopes are extremely sensitive detectors. The Plains of San Agustin is a graben and bounded by mountains that serve to shield the VLA from urban radio signals. The radio telescopes work together as a single observatory and can be moved along rail tracks to make different configurations. It was quite impressive to watch a radio telescope readjust tilt and position while standing in its shadow!

Each of the 27 antennas in the array weighs over 230 tons, is 82 feet across and over 90 feet high. The distances between the antennas along the "Y" shaped rail track are adjusted to change the level of detail the VLA can see. At its widest antenna separation, the merged observations of the VLA have the qualities of a giant telescope with an eye 22 miles across.

ADVERTISE HERE!

AIPG MEMBERSHIP TOTALS

	As of 9/1/2022	9/1/2023
CPG/Active	2,284	2,189
CPG Emeritus Member	607	613
Honorary Member	18	19
Professional Member	734	768
Professional Member/Non-Practicing	46	45
Early Career Professional	246	246
Associate Member	46	48
Student Adjunct	1,008	994
TOTALS	**4,989**	**4,922**

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
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

Engineering solutions that work for your business

Mannik Smith GROUP
www.MannikSmithGroup.com
Walter Bolt CPG, PMP | 734.397.3100
wbolt@manniksmithgroup.com

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

fishbeck
Engineers | Architects | Scientists | Constructors
800.456.3824
fishbeck.com

AIPG Is On YouTube

Subscribe to AIPG's YouTube Channel

Send your geologists in action videos to AIPG Headquarters

Scan QR code

Critical Minerals

As technology continues to advance, the need for critical minerals to support these advances grows. What approaches and techniques are used in the exploration, mining, and processing of critical minerals? Are there new technologies used in these activities? How will geoscientists be involved in the future and what will their role be? AIPG is seeking articles about critical minerals including advancements in technology for which the minerals are needed and the efforts taken to locate, extract, and process them. Please send your article to me at aipg@aipg.org

Adam Heft, CPG-10265, *Editor*

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

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	$400.00
Non-Member	$500.00

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

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

www.clearcreekassociates.com
www.geo-logic.com

SUBMISSIONS DEADLINES

JAN.FEB.MAR. - November 1, 2023

APR.MAY.JUN. - February 1, 2024

JUL.AUG.SEP. - May 1, 2024

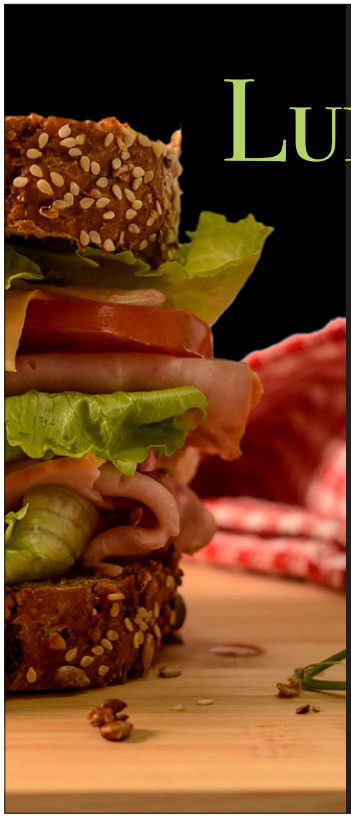
Technical writings including peer review, student writings, field experiences, career development, member news, and more accepted.

AIPG/AGI Geoscience Online Learning Initiative (GOLI)

Course Offering

"Tracking the Global Supply of Critical Materials"

Scan QR code to register.



LUNCH & *Earn!*

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

Cost:
CPG - $10
Members - $15
Non-Members - $30
AIPG Student Members - free
Earn 0.1 CEU / 1 PDH for attending!
Certificates will be emailed after the webinar.

Scan QR code to learn more.

AIPG



Share our vision?
Help us advance our mission!
Become a member today!

Online CPG application now available!

OUR VISION

Advocate for the profession of geology and certify the competency, integrity, and ethics of professionals on domestic and international levels.

OUR MISSION

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.

OUR VALUES

Competence ★ Integrity ★ Ethics ★ Equity, Diversity, Inclusion & Belonging ★ Environmental, Social and Governance frameworks