TPG is a publication of the American Institute of Professional Geologists

THE PROFESSIONAL GEOLOGIST

VOLUME 63 NUMBER 4 OCT.NOV.DEC 2026

AIPG 2026 Honors and Awards

A Five-Gate AI Workflow for Defensible Geological Reports

Field Guide: Mafic Magmatic Mineral Systems of the Duluth Complex





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The Professional Geologist

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AIPG 2026 NATIONAL ELECTIONS

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On the Cover: 2026 Photo Contest Winner - Micro Geology - **Orbicular Granite Talkeetna Mountains, Alaska**

Description: *Orbicular* structures in Quartz Diorite, Talkeetna Mountains, *Alaska* *– These rare concentrically layered spheroidal structures are believed to have formed by nucleation around a mineral grain in a cooling magma chamber. It is envisaged that the developing spheres were swept up and down by currents in the molten rock, gaining new layers of minerals throughout the trip. The concentric layers are composed of plagioclase feldspar along with dark minerals consisting of hornblende and biotite. In this example hornblende needles make up the core surrounded by alternating layers of biotite and plagioclase feldspar in a quartz diorite matrix.*

*Photograph by **Joseph M. Kurtak, CPG-11359,** AIPG Alaska Section, 2007.*

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The Professional Geologist (USPS 590-810 and ISSN 0279-0521) is published quarterly by the American Institute of Professional Geologists,10701 Melody Drive, Suite 630, Northglenn, CO 80234. Periodicals Postage Paid at Denver, Colorado and additional mailing offices.

POSTMASTER: Send address changes to *The Professional Geologist*, AIPG, 10701 Melody Drive, Suite 630, Northglenn, CO 80234

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.

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

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No One Works Alone

Adam W. Heft, CPG-10265

Autumn is right around the corner, and we have just returned from this year's Annual Conference in Duluth. It was a packed four days; from the Executive Committee, Advisory Board, Student and Early Career Professional Workshop, and Foundation meetings to field trips, two days of technical presentations, and the awards reception, and silent auction, there was always something to do. And of course the opportunity to renew friendships with other members around the country who I typically see only once a year was every bit as important to me. All in all, the Annual Conference is an opportunity not to be missed. I even managed to indulge my rock collecting habit on our way home. I obtained pieces of the Watersmeet Gneiss, which if you were at the keynote address at the meeting, you know is the oldest rock formation in the US.

This issue of *TPG* is the final one for the year, and it includes the Section Leadership awardees, and the National Awards recipients' comments. Hopefully, reading these will provide an inspiration for a reader to nominate an individual for one of these awards for next year.

Additionally, you will see that in this issue we have included an Erratum, which pertains in particular to the article by **Regina Molloy**, CPG-12345 on *Mapping at East Canyon U-V Project in Utah, USA: A Source of Carbon Free Energy Sitting in the Ground*, which was included in the Apr/May/Jun 2026 edition of *TPG*. One of our readers submitted a letter to the editor regarding this article (and another article as well), indicating there were problems with it. I won't repeat all of the comments here, as those are included in letter and the response or the Erratum. But as indicated, our review process needs to be further improved.

This is where you come in. While there are typically four individuals who have eyes on the final issue layout before it goes to print, each of them (myself included) focuses on a different aspect of the content. While I try to look over the entire layout, by this time, I have seen the content more than once, and as many of you have probably experienced, you sometimes look right past certain mistakes because you've seen it already. I want to minimize the possibility of this happening in the future. To that end, I am asking for individuals to volunteer to assist with reviewing content. We are in need of subject matter experts to assist with peer reviews of articles submitted for publication as well as individuals to review the layout of the publication.

Peer review articles have not been submitted very often – typically only one article per quarter – and of course, the subject of the articles varies. As we have more members who practice in the environmental geology discipline, we get more articles that fit within that area of expertise. We also have more peer reviewers with that subject expertise. But we still get articles on all other geology disciplines, and unfortunately, we don't always have sufficient reviewers to look at these articles, or if we do, those individuals may not be available to conduct a peer review when an article is submitted. What happens then? There has been one instance where this exact situation occurred, and I was only able to resolve it in a timely manner by contacting university professors I knew with that expertise. Fortunately, one was willing and able to perform the review.

So we definitely need more individuals willing to conduct peer reviews. The more reviewers we have, the better. I will have a larger pool to draw from, and consequently the time commitment for individual reviewers will be less since any one particular person will be called upon less frequently to do the review. For any particular article, I would estimate the review process would take between four and eight hours in total; more if the article is very technical and lengthy.

As for the general review process, there are two components. The first will occur when an article is submitted, has been accepted, and is being sent back to the author with edits. While most articles are not submitted for peer review, they still require being looked at. Once any edits/comments have been addressed, the article will be laid into the *TPG* edition, and the final layout will need to be reviewed. I am planning to have each article reviewed by the author in the final layout, but after the entire draft layout has been completed, we will need other eyes on it to help ensure that there are no obvious mistakes (as discussed above) are present. This review will take a greater number of hours to complete, but we need the review finished and back to me in a short time, probably one to three days, as we are usually needing to get the issue submitted to the publisher quickly so it can go out to our members on time.

Adfditionally, authors of our content have their responsibility as well. I ask that before you submit a technical article for publication, you review it carefully to be sure that the technical content is correct and complete. Please consider having one of your colleagues review it as well. Having another set of eyes on your article before sending it for publication will help ensure that it is less likely to contain errors or omissions, and will help speed the review process. Please check it against our publication guidelines, which are included on the AIPG website at: https://aipg.org/page/TPGInformation. Look under the link on this page for "How to Submit an Article."

I appreciate your help, and if you have any suggestions, questions, or comments, please feel free to email me at adam.heft@wsp.com. I look forward to hearing from you. Don't forget that the next edition will be the Student Edition, and we need content specific to students. And if you haven't already, please be sure to opt in for the member list that will be included in the next edition – this is the third year that this list will be published, and I want everyone that wants to show they are part of the Gold Standard of the Geosciences to be included!

Hi Adam and Aaron,

Congratulations on another excellent edition of the *TPG* — a great effort and thank you both for your continued volunteer contributions to the AIPG in promoting geoscience professionalism.

I always enjoy reading about what inspires young students to pursue geology, and it was particularly pleasing to see the student articles aligned with the AIPG scholarship awards.

I also noted the article on uranium by Barney Paul Popkin, which provides a compelling overview of global uranium resources by tonnage and % of the world per country. It is encouraging to see broader engagement with uranium as a topic, given its significant potential as a source of green energy and public scrutiny/sensitivity. On that note, I recently attended a professional meeting in southwest Colorado in Durango, where I am currently working on the La Plata porphyry copper project. Interestingly, I was advised not to raise the topic of uranium during the meeting — which I found somewhat ironic, given that the town itself sits within the Morrison Formation, a unit well known for hosting substantial uranium resources across Colorado and Utah. The experience reinforced for me that there is still considerable work to be done in educating the broader community on geoscience and the diversity of critical minerals available within the USA, and how it can be used to create positive society impact rather than historically perceived as negative.

Over the Christmas break, I will try to revisit my files on East African uranium with a view to writing a follow-up uranium article comparing my field observations in the USA with those from East Africa. I hope this will help illustrate why the US deserves further study in managing and utilizing its natural uranium endowment for common good but also recognizing where these endowments are naturally occurring within the rocks where people do reside.

Thank you again and take care.

Regina Molloy, CPG-12345

Dear Editor,

I read "Mapping at East Canyon U-V Project in Utah, USA" by Regina Molloy, CPG-#12345, page 23 in the April, May, June issue (vol.63 no. 2 2026) of *The Professional Geologist* hoping to find something new about one of the areas I worked in Utah and Colorado as a uranium exploration and mining geologist for more than 40 years. Instead, I was dismayed to see an article in a professional publication with so many mistakes, unsubstantiated assumptions, erroneous interpretations, exaggerations, inconsistencies, and incorrect facts.

Some examples (certainly not all-inclusive):

Mistakes:

1) Two identical photos (photo 1 and 2) with widely differing descriptions.

2) Sixth paragraph of Introduction describing the length of the trend says 3.0 miles plus 1.5 miles plus 0.7 miles equals 2.2 miles.

3) In section 2 b. it says 0.3 ft = 1 m.

Inconsistencies:

1) Sometimes writes "Salt Wash" (correct) and other times writes "Saltwash" (incorrect).

2) Carmel Formation in the stratigraphic column and Camel Fm in the text more than once.

Assumptions and Interpretations:

1) In the Introduction, Molloy suggests that uranium produced in SE Utah could be "locally consumed" as "zero carbon energy" without any discussion of the numerous other steps naturally occurring U must undergo to become reactor fuel.

2) Insinuates that the dry, unconfined, irregular pods of U-V ore of the Salt Wash Member of the Morrison Formation could be extracted by in-situ leaching as in Wyoming (which takes place in permeable sandstones, below the water table, confined by impermeable layers, with very low vanadium content). Despite what is implied in many junior mining companies' press releases, Salt Wash U-V deposits are not the same as Wyoming or South Texas roll-front deposits!

Incorrect Facts:

1) In section "2. District Scale Key Considerations" b. "Only the outcropping exposures were previously explored and mined." Companies working in this and other areas of the Uravan Mineral Belt were exploring on the mesa tops with drill holes from 600 to over 1,000 feet depths in the late 1960s and aggressively in the 1970s to early '80s (the AEC and USGS even earlier). The East Canyon district is larger than the property Molloy is describing. It is sometimes included with Dry Valley and Deer Neck Mesa as a district. South Canyon Point included in her discussion is usually considered part of the much larger Sage Plain district to the east where deep drilling found numerous mineable deposits in the 60s and 70s one or more miles from Salt Wash outcrops.

Exaggerations:

1) In the fifth paragraph of the Introduction, Molloy says "The East Canyon stratigraphic sequence is impressively unique … where the full sequence of Brushy Basin and Saltwash (sic) are exposed…". Calling East Canyon an "impressively unique" exposure of the Morrison Formation suggests to me the author has not visited any of the scores of miles of exposed Morrison (and adjacent strata) in the rest of the Uravan Mineral Belt (which Molloy incorrectly calls Uravan belt arc).

I thought of writing this letter to the Editor earlier, but I only mentioned my frustration to a few colleagues. Then I read another article about uranium in the July, Aug, Sept 2026 issue (*TPG* vol.63 no. 3 p.28), "Insights into Uranium" by Barney Paul Popkin. Again, it had errors, inaccuracies, and false statements about uranium.

For instance, in the fourth paragraph, Popkin says, while describing uranium that it "occurs … in ultramafic rocks…and their derived soil and dust". Ultramafic rocks have extremely low uranium concentrations (1-50 ppb) that is three orders of magnitude less than most other crustal rock types. A concentration that low would not leave much in its dust. The first sentence of the next paragraph makes no sense at all to say "the percentage of uranium in most rocks is very low, from 0.01 to 0.1%" (which we all know is 100 to 1,000 ppm) and conclude with "average concentration of 2.5 ppm". The worst false statement is the last two sentences of two paragraphs later. In speaking of "… concentration of U235. Nuclear power plants require about 60% concentrations, but nuclear weapons require over 90%". Popkin is correct as to weapon grade, but the concentration of U235 (the fissionable isotope which occurs in natural uranium at about 0.7%) is usually enriched to between 3% and 5% in order to sustain a controlled chain reaction in a nuclear power plant reactor core.

I realize that the authors must take responsibility for the content of their articles. However, I also believe the Editor of a professional publication bears some blame for printing articles with glaring errors. Does no one proofread or seek input from peers anymore?

I read *TPG* articles to try to learn about areas and geologic topics that I am not well-versed in. Seeing articles on topics that I am familiar with riddled with errors in two consecutive issues lessens my confidence in the accuracy of other articles. AIPG is founded on the principles of competence and ethics. CPGs can and should do better.

Respectfully,
Richard L. White CPG-08792

Richard,

Thank you for sending me your Letter to the Editor. I appreciate your pointing out the problems with the articles. As far as the mistakes go, I do apologize for them – our review process did not catch the obvious errors, and they should have. There are generally three or four different individuals involved in the final review, though each person is generally focused on different things. And of course, as Editor, I take responsibility for errors that sometimes occur, and when someone points them out, I try to rectify them with an Erratum or other means, as appropriate. In any event, showing corrections in a subsequent edition as a follow up to someone identifying them is the best we can do to fix problems after the fact. If you look back at previous issues, you will find one or two instances where someone pointed out some kind of error that made it into print, and an Erratum to address it. I believe that the frequency of errors has decreased with time, but they still occasionally happen.

We do have other individuals review articles before they go to print – I generally try to find someone with experience related to the article to provide a review, but please also understand that unless the article is submitted for peer review (these two articles were not) the review is generally not as rigorous as those that are peer reviewed. But as you point out, we do rely on authors (and reviewers) to have their facts correct to the best of their knowledge.

Once again, thank you for your respectful comments on these articles. I will strive to ensure that mistakes are kept to a minimum and corrected when identified.

Adam Heft, CPG-10265
Editor

Erratum

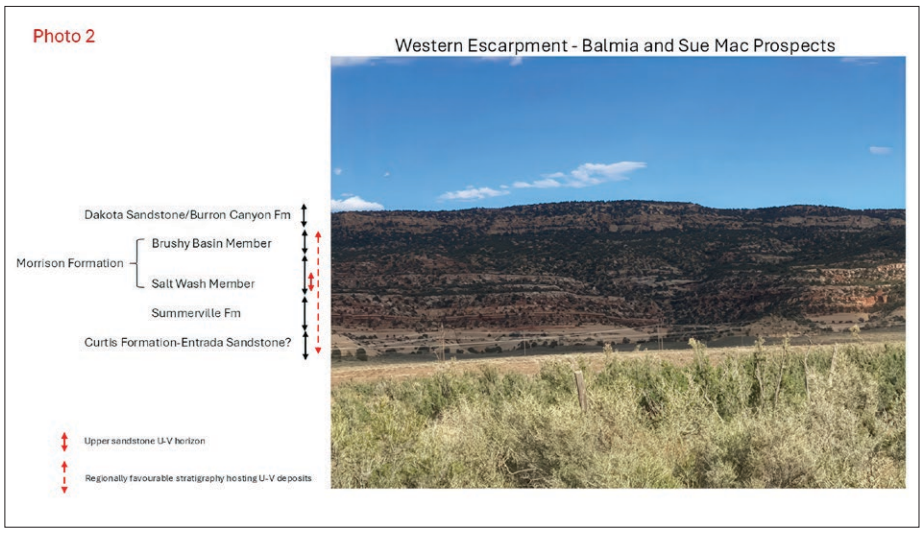
Dear Editor,

I appreciate the reader taking the time to give "Mapping at East Canyon U-V Project in Utah, USA" (*TPG*, vol. 63, no. 2, 2026) such a close and careful read. As a former Utah and Colorado uranium geologist with more than 40 years of experience in the region, they brought real district-level knowledge to that read, and I welcome the opportunity to respond. Some of the points raised are legitimate errors that I regret and am happy to correct for the record. Others reflect a difference in scope and interpretation rather than factual error, and I'd like to clarify those as well.

Corrections

The reader is right on several counts, and I thank them for their sharp eyes:

- Photos 1 and 2 were mislabeled as duplicates with differing captions. This was a photo-labeling error identified after publication; the correct, distinct images should have appeared for each. The correct Photo 2 is below.
- The sixth paragraph of the Introduction refers to two trends: the 3-mile (5 km) East-West Trend, and the Loya Ray Trend, made up of a 1.5-mile main segment plus a further 0.7-mile southern extension, totaling 2.2 miles. The paragraph should have referenced Figures 8 and 9, which show the combined Loya Ray segments, in addition to Figure 2. I'd also note the draft was originally prepared in kilometers for an Australian investment audience, with some rounding applied when converting to miles for a U.S. readership, which added to the confusion. I apologize for this inconsistency. For reference, the article text reads: "The mineralized horizon was intermittently mapped along two trends being the 3-mile (5km) East-West Trend, and the 1.5-mile (2.4km) Loya Ray Trend and a further 0.7 miles (1.2km) for a total length of 2.2 miles (3.6km). Figure 2 depicts the trends and uranium prospects where uraninite..."
- The unit conversion in section 2(b) is wrong as printed — it should read approximately 1 ft (0.3 m), not "0.3 ft (1 m)."
- My spelling of "Salt Wash" was inconsistent (correctly as two words in some places, incorrectly run together elsewhere). It should be "Salt Wash" throughout. This highlights the importance of peer review, which I will seek before publishing in the future.
- "Camel Formation" is a typo for "Carmel Formation," and I should have caught this given it also appears correctly in the stratigraphic column.
- "Uravan Belt Arc" is not standard usage — the established name is the Uravan Mineral Belt (or Uravan Belt), and I've adopted an incorrect variant of it throughout the article.



That's on me, and I'll use the correct terminology going forward.

I'll ask the editor to run a correction notice covering these items in the next issue.

On exploration history and depth

This is the most substantive point raised, and I want to address it directly rather than gloss over it. The statement that "only the outcropping exposures were previously explored and mined" was written with reference to the specific East Canyon property boundary I mapped, not the wider Uravan Mineral Belt. I agree that framing was too narrow as published: companies and government programs (AEC, USGS) conducted deep drilling on the mesa tops — 600 to over 1,000 feet — through the late 1960s and into the early 1980s across the broader district. I should have distinguished more clearly between the limited historical work directly on the East Canyon property and the extensive subsurface exploration across the wider belt, and I'll make that distinction explicit in any future writing on this project.

I also take the reader's point on district nomenclature. The property boundary I mapped and described as "East Canyon" sits within a broader area that is sometimes grouped together with Dry Valley and Deer Neck Mesa under a single district name; my intention was not to imply that East Canyon stands alone, and I should have made that context explicit. My focus was on the field mapping and not the regional classification of the deposits, but I take the point and will adopt more precise district terminology in future writing.

On interpretation and scope

A few of the points raised are, I think, matters of emphasis rather than error, and I'd like to explain my reasoning:

- My comment on locally consumed, zero-carbon energy was intended as a big-picture framing for a general geoscience readership, not a claim that uranium moves directly from ore to reactor. The purpose of the article was to raise awareness that these uranium deposits exist at outcrop and could merit investigation for energy production with the right technical studies and investment behind them. The project has struggled to secure funding for its future exploration program, and part of my motivation in writing was to share these observations with a wider geoscience audience. I agree the article would have benefited from at least a line acknowledging the conversion, enrichment, and fuel-fabrication steps between mining and power generation, and I'll include that context in future writing on the topic.
- On in-situ recovery: I did not intend to equate Salt Wash tabular deposits with Wyoming or South Texas roll-front systems, and I agree they are geologically distinct — the Salt Wash mineralization at East Canyon that I observed is tabular and sandstone-hosted. My reference to Wyoming was meant only to note that ISR expertise exists domestically, not to suggest the Salt Wash ore bodies are amenable to the same extraction method. I recognize the article didn't make that boundary clear, and any implication otherwise was unintentional.
- "Impressively unique" was a personal, first-hand impression of the exposure quality and mineralized-horizon continuity at this specific property, not a comparative claim against the rest of the Uravan Mineral Belt, much of which I have not personally mapped or observed. My frame of reference includes East African uranium deposits hosted in the Karoo Supergroup across Tanzania, Mozambique, Malawi, Zimbabwe, and Zambia, where grades are typically measured and mined in parts per million rather than in percentage grades and which tabular sandstone horizons are displaced by faulting. By comparison, what struck me about the Colorado Plateau mineralization is the combination of high grade at surface with associated vanadium — economically notable for a sandstone-hosted deposit, and worth highlighting to a broader geoscience audience less familiar with this style of mineralization and commodity. I also noted the stratigraphic continuity of mineralized sandstone horizons at East Canyon with limited observed displacement faulting indicating basin tectonic stability compared to the East Africa rift basin deposits which are faulted.

In that sense, this exchange itself demonstrates that the article reached its intended audience: a geologist with direct, decades-long experience in this exact stratigraphy and commodity engaged with the grade and mineralization data closely enough to scrutinize it in detail — which is precisely the awareness this piece set out to raise.

I'm grateful for a reader with this depth of district experience taking the time to engage with the article in such detail, and I'd welcome further correspondence — including, if the reader is open to it, a short joint follow-up piece that puts the East Canyon property mapping into the fuller regional context of the Uravan Mineral Belt's exploration history.

I'll also note that the field mapping stratigraphic interpretation in the article, which was my primary focus given limited time and budget in the field, drew no comment from a reader with this level of regional experience, which I take as a useful data point in itself.

Sincerely, Regina Molloy, CPG-12345
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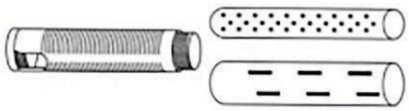
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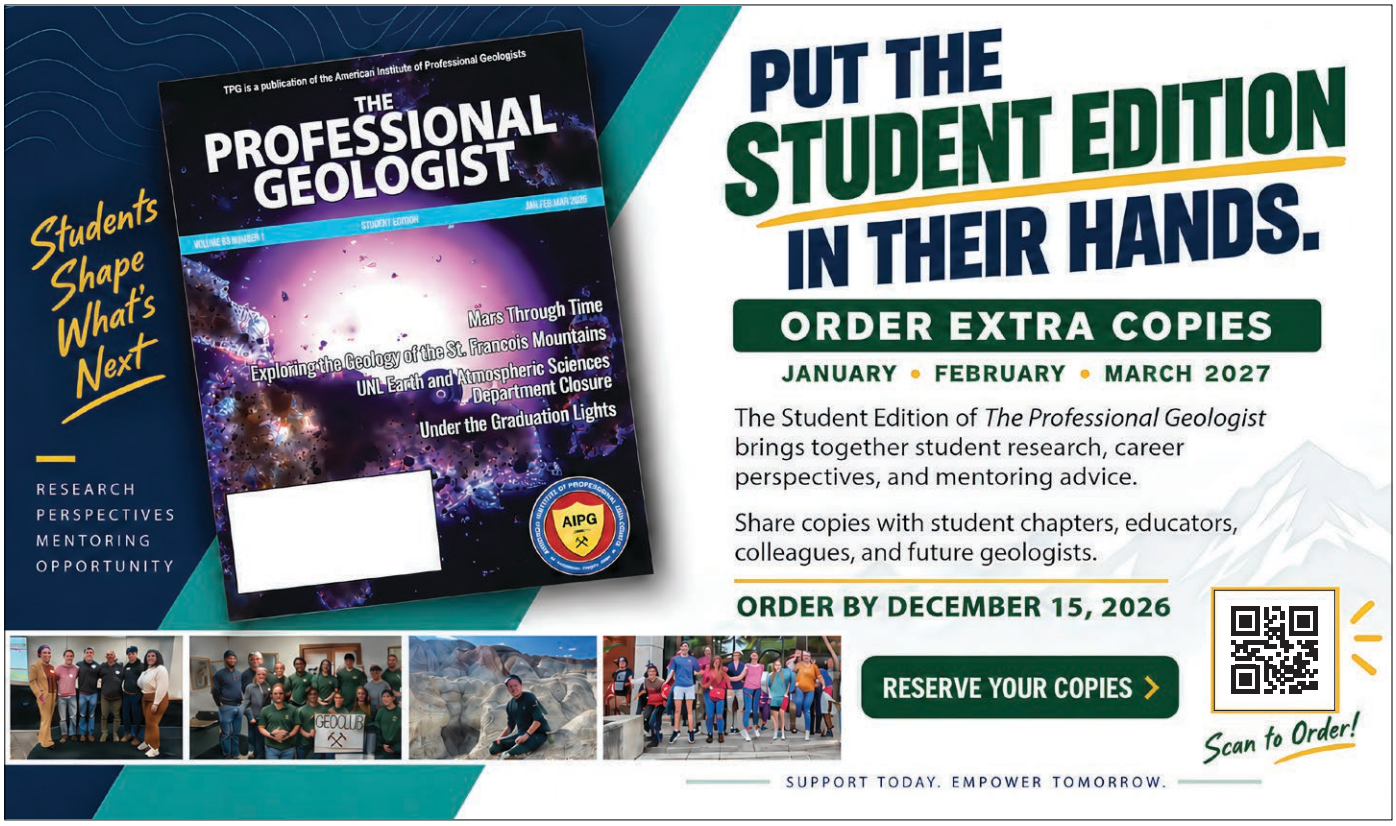
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A Five-Gate AI Workflow for Defensible Geological Reports

Gleb Tsipursky, PhD

Abstract

Generative artificial intelligence can help professional geologists organize field observations, compare documents, develop report outlines, identify inconsistencies, and draft routine language. It can also produce polished statements that lack support, blur observation and interpretation, expose confidential information, or conceal uncertainty. A defensible AI workflow[1] therefore needs more than a final human review. It needs control points throughout the path from source material to signed report. This article proposes five gates for professional geological work: approved environment and data classification, source-bounded input and provenance, independent geological reasoning, verification and quality control, and documentation with professional sign-off. The gates treat generative AI as a controlled assistant rather than an authority. They preserve traceability to field notes, maps, laboratory results, calculations, and regulatory sources while keeping interpretation and accountability with qualified professionals. The result is a practical method for gaining efficiency without weakening the competence, integrity, candor, and public responsibility expected in professional geology.

Keywords: Generative AI, professional geology, geological reporting, quality assurance, data provenance, human oversight, professional judgment, scientific integrity

The New Risk Is Plausible Language

Professional geologists routinely make decisions under uncertainty. A boring log samples a narrow part of a heterogeneous subsurface. An outcrop exposes part of a structure. A laboratory result may carry qualifiers. Historical maps may use different coordinate systems, stratigraphic terms, or standards of precision. The geologist's work connects incomplete evidence while keeping observation, inference, assumption, and conclusion visible through transparent scientific information practices.[2]

Generative AI introduces a different kind of uncertainty. A language model can produce an orderly paragraph even when its source support is weak. It can merge two separate observations, smooth over contradictions, invent a transition, or present an inference as a fact. The danger comes partly from fluency. Awkward prose invites scrutiny. Confident prose can lower it. Nature Geoscience has warned that authors remain responsible for research integrity and should evaluate AI-suggested text critically because human responsibility for scientific accuracy[3] does not transfer to a language model.

That principle fits the profession's existing obligations. AIPG's Code of Ethics places accuracy, truthfulness, competence, confidentiality, and protection of public health, safety, and welfare at the center of geologist accountability.[4] AIPG also treats site-specific professional judgment[5] as essential because geological conditions resist blind application of prescriptive rules. An AI system can assist with language and pattern comparison. It cannot accept professional responsibility, understand a site's full context, or decide which uncertainty matters most.

The practical question concerns workflow design. The U.S. Geological Survey recognizes applications in data discovery, analysis, modeling, manuscript improvement, and automation through carefully governed scientific AI use.[6] Where should controls sit so efficiency gains do not weaken traceability, confidentiality, independent reasoning, or accountability?

1. https://www.usgs.gov/data-management/workflow-capture.
2. https://www.usgs.gov/office-of-science-quality-and-integrity/fundamental-science-practices/usgs-information-quality-guidelines.
3. https://www.nature.com/articles/s41561-024-01475-5.
4. https://aipg.org/page/ethics.
5. https://aipg.org/page/Policies.
6. https://www.usgs.gov/office-of-science-quality-and-integrity/fundamental-science-practices/faq/209-generative-artificial-intelligence.

Why a Final Review Is Too Late

A common policy calls for human review before use. That helps, but sound AI assurance across data and performance risks[7] requires more than a final reading. A reviewer may see only the finished paragraph, without knowing which documents entered the model, which claims the model inferred, whether the prompt constrained the sources, or whether confidential data went into an unapproved system. By the time a polished draft reaches the reviewer, unsupported assumptions may already have become embedded in the report's structure.

The USGS takes a more rigorous position for public scientific products. Its guidance keeps authorship with humans, requires approved tools, preserves ordinary review requirements, and calls for AI use to be documented in support of accuracy, reproducibility, transparency, and scientific integrity through restrictions on direct AI output.[8] Its related reliability guidance connects AI-generated material to data-quality validation, transparent methods, and rigorous peer review through scientific verification requirements.[9]

Professional practice needs the same logic even when a report falls outside federal publication procedures. Review should begin before the first prompt and continue through the final approval. The five gates apply testing, evaluation, verification, and validation[10] as stopping points where the geologist decides whether work can proceed. Each gate answers a different question: May this information enter this system? Can every draft statement be traced to evidence? Has a geologist reasoned independently? Has the output survived technical verification? Does the record show what happened and who accepted responsibility?

Gate One Establishes the Approved Environment

The first gate occurs before anyone copies text into an AI tool. The user identifies the task, the information involved, the approved system, the intended output, and the consequences of error. This gate protects field data integrity[11] by treating data handling as part of technical quality rather than an administrative afterthought.

Following quality assurance project planning[12], a firm can ask three questions. What information will enter the system? Where will it be processed and retained? What decision could the output influence? Public regulatory guidance creates a different exposure from unpublished assessments, client records, sensitive locations, personal information, or contract-controlled data. A tool approved for public information may remain unsuitable for project material.

USGS guidance on safeguarding proprietary information in AI systems[13] emphasizes privacy, confidentiality, intellectual property, and the use of controlled environments when needed. Private firms and agencies should translate that principle into a short data-classification rule that staff can apply under deadline pressure. If users cannot determine whether the tool and the data combination is approved, the work stops at Gate One.

Task risk also matters because human roles in AI decisions[14] should reflect context and consequence. Low-consequence uses may include organizing nonconfidential notes, improving grammar, developing a checklist, or standardizing approved terminology. Moderate-consequence uses may include drafting factual sections from controlled sources, comparing document versions, or identifying inconsistencies for review. High-consequence uses include deciding whether contamination has migrated, choosing a remedial approach, assigning a stratigraphic contact, estimating a reserve, interpreting slope stability, or making a conclusion that affects public safety, permitting, litigation, or investment. AI may support the high-consequence workflow, but it should never supply the controlling judgment.

The first gate should also capture the tool name, model or service version when available, user, date, project, approved purpose, and data category. NIST's generative AI profile frames AI risk management[15] across the system lifecycle rather than as a one-time review. A simple intake record gives the firm the beginning of that lifecycle evidence.

Gate Two Builds a Source-Bounded Evidence Packet

The second gate separates source material from generated language. Following the scientific data lifecycle[16], the geologist first creates a defined evidence packet containing the materials the AI may use. Depending on the assignment, that packet may include field notes, photographs, boring logs, sampling records, laboratory reports, maps, cross sections, calculations, database extracts, previous reports, client instructions, and applicable regulatory text.

Each item needs enough context to remain intelligible. The USGS describes geoscience documentation[17] as a record of who, what, where, when, why, and how, including methods, processing, accuracy, precision, and quality assurance. Without that context, a

7. https://www.nist.gov/publications/path-consensus-artificial-intelligence-assurance.
8. https://www.usgs.gov/office-of-science-quality-and-integrity/fundamental-science-practices/faq/210-restrictions-using-generative-ai.
9. https://www.usgs.gov/office-of-science-quality-and-integrity/fundamental-science-practices/faq/211-ensure-reliability-and-accuracy-ai.
10. https://airc.nist.gov/.
11. https://aipg.org/page/Policies.
12. https://www.epa.gov/quality/quality-assurance-project-plan-qapp-guidance.
13. https://www.usgs.gov/office-of-science-quality-and-integrity/fundamental-science-practices/faq/212-safeguarding-usgs-info-using-ai.
14. https://airc.nist.gov/airmf-resources/airmf/appendices/app-c-ai-risk-management-and-human-ai-interaction/.
15. https://www.nist.gov/publications/artificial-intelligence-risk-management-framework-generative-artificial-intelligence.
16. https://www.usgs.gov/data-management.
17. https://www.usgs.gov/data-management/describe-metadatadocumentation

model may compare numbers that use different datums, confuse preliminary and validated data, miss laboratory qualifiers, or treat an old conceptual site model as current.

The source packet should distinguish evidence from background material, identify superseded documents, and preserve file names, dates, versions, coordinate systems, units, qualifiers, and page or table locations. Formal practices matter because complete metadata preserve interpretability[18] and help users judge fitness for use.

The prompt should restrict the model to the packet and apply scientific data citation[19] principles by identifying the file and page, table, sample number, boring identifier, or note entry supporting each factual statement. The model should label missing support rather than fill gaps. It should separate observations, calculations, interpretations, assumptions, and recommendations. It should list conflicts among sources and avoid resolving them without an explicit human decision.

This method creates data provenance[20] for the draft. Provenance records where information originated and what transformations occurred. In geological reporting, the same idea means that a reviewer can move backward from a sentence to the source evidence and forward from the evidence to its treatment in the report.

Source bounding does not make the model reliable by itself. It makes errors easier to detect. NIST's work on factual grounding audit trails[21] evaluates whether claims faithfully, completely, and sufficiently reflect trusted source documents. A geological workflow should demand the same three tests. Does the cited source support the statement? Does the draft omit a qualification that changes its meaning? Does the evidence carry enough weight for the conclusion drawn?

Gate Three Protects Independent Geological Reasoning

The third gate requires the responsible geologist to reason before adopting AI-generated interpretation. Research on automation bias in decision support[22] shows that users can over-rely on automated recommendations and miss new errors. Once a coherent explanation appears, reviewers may shift from generating alternatives to editing the explanation in front of them.

Before reviewing an AI interpretation, the geologist should record a preliminary conceptual view. That record can be concise, but it should identify the main observations, working hypotheses, competing explanations, uncertainties, and additional information needed. For a site investigation, the record might address likely source areas, migration pathways, hydrostratigraphic controls, data gaps, and plausible alternatives. For geologic mapping, it might identify contact relationships, structural interpretations, conflicting age evidence, and locations requiring field confirmation.

This requirement preserves the profession's comparative advantage. Generative models manipulate patterns in language and supplied data. Geologists integrate spatial relationships, scale, field context, process understanding, uncertainty, and experience. The 2026 USGS AI strategy calls for AI adoption that maintains scientific quality and integrity[23] while building workforce skill, governance, trustworthy use, infrastructure, and innovation. The strategy supports adoption, but it does not treat automation as a substitute for domain expertise.

After the independent view exists, AI can play a useful adversarial role because models can produce both accurate and misleading narratives.[24] The geologist can ask the model to identify observations inconsistent with the preferred hypothesis, propose alternative explanations grounded in the packet, list assumptions, locate unresolved contradictions, and specify what new evidence would discriminate among interpretations. This turns the model into a structured challenger rather than an answer engine.

The exchange works best when terminology stays precise. USGS researchers have documented how geoscientists and machine-learning specialists can use the same words differently, creating avoidable errors unless teams establish a shared geoscience and machine-learning vocabulary.[25] Similar problems arise with generative AI. Words such as confidence, validation, prediction, model, accuracy, and uncertainty can carry different technical meanings. Prompts and review records should define what those terms mean in the project.

Gate Three ends with a human decision memo or tracked review note. The geologist identifies which AI suggestions were accepted, rejected, or left unresolved and why. The note does not need to become part of the client deliverable. It becomes part of the technical file supporting the report's reasoning.

Gate Four Applies Verification and Quality Control

The fourth gate applies data quality management[26] by treating every AI-generated statement as unverified until checked against original evidence, calculations, and authoritative sources.

A useful review follows geospatial data quality planning[27] by classifying claims before selecting checks. Factual claims include dates, locations, dimensions, units, sample results, formation names, regulatory requirements, citations, and descriptions of

18. https://www.usgs.gov/data-management/metadata-creation.
19. https://www.usgs.gov/data-management/data-citation.
20. https://www.usgs.gov/data-management/process.
21. https://www.nist.gov/programs-projects/building-evaluation-probes-agentic-ai.
22. https://pubmed.ncbi.nlm.nih.gov/21685142/.
23. https://pubs.usgs.gov/publication/cir1562.
24. https://www.nist.gov/publications/2025-nist-genai-text-challenge-evaluation-plan.
25. https://www.usgs.gov/publications/what-did-they-just-say-building-a-rosetta-stone-geoscience-and-machine-learning.
26. https://www.usgs.gov/data-management/manage-quality.
27. https://www.epa.gov/quality/guidance-geospatial-data-quality-assurance-project-plans-epa-qag-5g.

methods. Analytical claims include calculations, comparisons, trends, classifications, and model outputs. Interpretive claims connect evidence to geological meaning. Recommendations connect interpretation to action. Each class needs a different check.

The reviewer uses independent technical assessment[28] to compare claims with the source packet and reproduce calculations in the original spreadsheet, GIS, model, or hand calculation rather than asking the language model to confirm itself. Interpretations must fit all material observations and survive alternatives. Recommendations must fall within the geologist's competence and the project's legal, contractual, and technical context.

USGS guidance distinguishes quality assurance, which prevents defects, from quality control, which detects them, and recommends project-level AI quality control[29] through defined objectives, methods, staff capabilities, quality criteria, assessments, and correction procedures. EPA guidance likewise separates environmental data verification and validation[30] so that records can be checked for completeness and correctness and then evaluated for suitability for their intended use.

That distinction matters for AI-assisted reports. A sentence may accurately reproduce a value yet use it improperly. A concentration can match the laboratory table while ignoring a dilution qualifier. A coordinate can match the field form while using the wrong datum. A cited regulation can exist while applying to a different jurisdiction or project category. Verification asks whether the draft matches the record. Validation asks whether the information supports the use the report makes of it.

An independent reviewer should participate when consequence or complexity warrants it. NIST's framework says that human oversight[31] should be defined and documented, and that independent review can improve testing by reducing internal bias and conflicts. The reviewer should receive the source packet, the AI-assisted draft, and the decision notes, rather than only a polished final version.

The quality-control record should capture corrections. Recurring failures may show that the prompt, source packet, approved use, or review checklist needs revision. The Government Accountability Office organizes responsible AI around governance, data, performance, and monitoring through an AI accountability framework.[32] Monitoring turns individual corrections into organizational learning.

Gate Five Documents Use and Preserves Sign-Off

The fifth gate creates the audit trail and confirms final responsibility. The record should identify the tool, user, date, purpose, source boundaries, generated sections, verification steps, corrections, reviewers, and final approver. Detail should scale with risk.

Documentation supports reproducibility and later review. USGS guidance on capturing analytical workflows[33] recommends recording processing and analysis activities as they occur because retrospective reconstruction is less accurate and less efficient. That observation applies directly to AI-assisted drafting. A team will struggle to reconstruct weeks later which files entered a model, which output shaped a conclusion, or why a statement changed.

Disclosure requires judgment. Some clients, agencies, employers, or publications may require a specific statement. Others may treat AI-assisted editing like other software use. The internal record should remain more detailed than the external disclosure because the firm needs enough information to investigate an error, respond to a challenge, repeat a process, or demonstrate compliance with policy.

The final sign-off must remain unequivocal. USGS states that human authors remain responsible for AI-assisted scientific products, and AGU's guidance on ethical AI in Earth science[34] emphasizes transparency, documentation, interpretation, replication, risk, bias, and organizational responsibility. In professional practice, the geologist who signs or approves the report accepts responsibility for the work regardless of which software helped prepare the language.

That responsibility includes knowing when AI use should stop. If the source packet remains incomplete, the evidence conflicts, the model's transformations cannot be traced, the reviewer lacks the needed expertise, or the consequences exceed the organization's controls, the report should proceed without AI assistance or pause for additional work. A gate has value only when people can close it.

A Field-Notes-to-Report Example

Consider an environmental investigation in which a project geologist returns with field notes, photographs, boring logs, groundwater elevations, sampling records, laboratory reports, survey coordinates, and earlier site documents. The team wants generative AI to accelerate preparation of the site activities and results sections.

At Gate One, the project manager confirms that the firm's approved enterprise system can process the relevant client information, records the intended use, and excludes material that the contract or policy does not permit. The team classifies drafting of factual sections as a moderate-consequence use. Conclusions about source, extent, migration, and remedy remain high-consequence decisions reserved for the project geologist.

At Gate Two, the team assembles a dated source packet. Each boring log, laboratory report, and field record retains its identifier. Superseded files are removed or clearly marked. The prompt permits the model to draft only from the packet and requires source locators for every factual statement. The model must place conflicting groundwater elevations, missing samples, unmatched identifiers, and laboratory qualifiers in an exception list.

28. https://www.epa.gov/quality/epa-quality-management-tools-projects.
29. https://www.usgs.gov/data-management/quality-assurance-plans-recommended-practices-and-examples.
30. https://www.epa.gov/quality/guidance-environmental-data-verification-and-data-validation.
31. https://airc.nist.gov/airmf-resources/airmf/5-sec-core/.
32. https://www.gao.gov/products/gao-21-519sp.
33. https://www.usgs.gov/data-management/process-and-analyze-closely-related-activities.
34. https://news.agu.org/press-release/agu-publishes-guidelines-for-the-ethical-use-of-ai-in-the-earth-and-space-sciences/.

At Gate Three, the project geologist prepares the conceptual interpretation before reading machine-generated conclusions. The geologist then asks the model to challenge that interpretation against the source packet. The model identifies a boring whose lithology may complicate the assumed pathway and notes a date mismatch between a field record and a laboratory chain-of-custody entry. Neither observation becomes a conclusion automatically. The geologist investigates both.

At Gate Four, a second geologist checks the draft against the underlying records. The reviewer recalculates elevations and gradients in the approved spreadsheet, checks coordinates in the GIS, confirms analytical qualifiers, reviews units, and tests whether each interpretive sentence reflects the full evidence. EPA's systematic planning approach[35] supports defining data needs, quality criteria, QA/QC activities, verification, validation, uncertainty treatment, and intended communication before decisions are made.

At Gate Five, the technical file records the AI-assisted sections, source packet, exception list, review notes, calculations, corrections, and final approval. The client report remains a geological work product authored and approved by professionals. The audit trail shows that AI accelerated organization and drafting without becoming the source of the geological opinion.

Building the Workflow Into Practice

A firm should begin with one narrow, repetitive, and visible workflow. Suitable starting points include organizing field records, developing report outlines, checking terminology, producing tables of source references, comparing draft versions, or identifying internal inconsistencies. Starting with a controlled use creates evidence about actual benefits and failure modes.

The pilot should measure more than time. It should track unsupported claims, missed qualifiers, citation failures, unit errors, reviewer corrections, confidentiality incidents, rework, and user compliance with the gates. NIST's evaluation program emphasizes testing AI capabilities and limitations[36] rather than assuming that fluent output demonstrates reliability. A geological practice needs the same discipline.

Training should use authentic examples with confidential details protected. Participants should compare an AI-assisted draft with its sources, identify assumptions, and practice stopping a gate. Early-career geologists need to learn that polished prose does not demonstrate competence. Senior geologists need enough familiarity to review the process critically.

The firm should also involve the people who perform and review the work. Recent USGS guidance on engaging end users in scientific tool development[37] draws lessons from projects that worked with practitioners and experts to create useful decision-support tools. Geologists, field staff, data managers, quality leaders, legal counsel, information security staff, and report reviewers will see different risks. Their combined perspective produces a stronger workflow.

With experience, the organization can formalize approved tasks, prohibited data, source-packet templates, reviewer checklists, disclosure, incident reporting, and retention. Controls should change with models, contracts, regulations, and client expectations. USGS guidance explains that consistent data standards support understanding and exchange.[38] Consistent AI records provide the same benefit across projects.

The Professional Standard Should Remain Higher Than Fluency

Generative AI can reduce time spent arranging information and drafting routine language. It can also help a reviewer locate inconsistencies and force a team to articulate assumptions. Those benefits justify experimentation, but never a lower evidentiary standard for a professional report.

The five gates preserve a simple chain of responsibility. Approved systems protect information. Source-bounded packets preserve traceability. Independent reasoning protects geological judgment. Verification and validation protect technical quality. Documentation and sign-off protect accountability. Together, they turn generative AI from an informal shortcut into a controlled part of responsible AI adoption.[39]

The profession can gain efficiency through workflows that make rigor visible at every stage. A language model may help draft the report. Only a professional geologist can decide whether to trust it.

Adapted from: *The Psychology of AI Adoption at Work: From Resistance to Results*[40] (Georgetown University Press, 2026).

About the Author

Dr. Gleb Tsipursky[41], a behavioral scientist called the "Office Whisperer"[42] by *The New York Times*, helps tech-forward leaders stop overpaying for AI while boosting engagement and innovation. He serves as the CEO of the AI consultancy Disaster Avoidance Experts,[43] and wrote eight books, including *The Psychology of AI Adoption at Work: From Resistance to Results* (Georgetown University Press, 2026).

35. https://www.epa.gov/quality/epas-elements-systematic-planning data-quality-assurance.
36. https://ai-challenges.nist.gov/genai.
37. https://www.usgs.gov/publications/practical-guidance-engaging-end-users-and-experts-developing-scientific-tools.
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42. https://www.nytimes.com/2023/04/11/magazine/return-to-office-consultants.html.
43. https://disasteravoidanceexperts.com/.

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The AIPG Honors and Awards Program celebrates individuals who have gone above and beyond in advancing the profession, serving the Institute, and contributing to society. During the 63rd AIPG National Conference in Duluth, Minnesota, AIPG recognized the 2026 honorees whose accomplishments reflect the Institute's mission and the highest standards of professional practice.

AIPG bestows seven national honors:

- **Ben H. Parker Memorial Distinguished Service Medal**
- **Martin Van Couvering Memorial Service to the Institute Award**
- **John T. Galey, Sr. Memorial Public Service Award**
- **Award of Honorary Membership**
- **Outstanding Achievement Award**
- **John Stewart Memorial Early Career Professional Award**
- **Presidential Certificate of Merit**

No nominations were received in 2026 for the John T. Galey, Sr. Memorial Public Service Award or the Outstanding Achievement Award, and neither award was presented. These open categories represent important opportunities to recognize individuals whose public service, leadership, accomplishments, or contributions have strengthened the geoscience profession and its connection to society.

Together, AIPG's honors recognize excellence throughout a professional career—from the contributions of early-career geoscientists to distinguished service and lifetime achievement. The following pages recognize the 2026 recipients and share their reflections on their careers, their service, and the people and experiences that shaped them. Their stories demonstrate the many ways geoscientists strengthen the profession, serve their communities, and create opportunities for those who follow.

The Honors and Awards Program is made possible through the work of the AIPG Honors and Awards Committee, whose members carefully review nominations and help ensure that outstanding contributions to the Institute and the geoscience profession receive the recognition they deserve.

Thank you to our 2026 Awards Committee members: Mark Schaaf, CPG-11960, Chris Hogan, CPG- 10723, David M. Abbott, Jr, CPG-04570, Shanna Schmitt, CPG-11781, and Sara Pearson, CPG-10650.

BEN H. PARKER MEMORIAL DISTINGUISHED SERVICE AWARD

DEBRA W. STRUHSACKER, CPG-08259

Nevada Section



Debra Struhsacker and her husband, Eric Struhsacker, CPG-11107, at the AIPG awards banquet in Duluth.

ABOUT THE AWARD

The Ben H. Parker Memorial Distinguished Service Medal is the most prestigious award given by the Institute. Established in 1969, it honors Ben H. Parker, a dedicated leader who worked to improve the quality of geology, geologists, and their services. The medal is awarded to individuals with a long history of distinguished service to the profession.

I've been fortunate to capitalize on my geological background throughout my lengthy and varied career.

I spent the first dozen years of my career evaluating geothermal resources and exploring for gold and other minerals.

My career shifted abruptly in 1986, when I took a consulting job to write the Environmental Assessment for the proposed Big Springs Mine in Elko County, Nevada. Little did I know at the time that I had just unlaced my boots and put my rock hammer away - never to use them again. To my great surprise, I discovered that I really enjoyed this work because it allowed me to integrate my geologic, communication, and writing skills.

It was an interesting time to get involved with environmental permitting because many of the applicable regulations were new and everyone - both companies and regulators - were trying to figure out what the regulations meant and how they worked.

As proposed mining projects became increasingly controversial and difficult to permit, my career morphed again in the early 1990s and expanded to include advocacy and government relations because there was an urgent need to gamer lawmakers' support for specific projects and defend the industry against onerous state and federal proposed legislation and regulations to curtail mining.

I credit my effectiveness in the permitting and government affairs arenas and as a mining industry advocate to my underlying foundation as a geologist, which gives me the necessary technical skills to understand how mining impacts the environment and how modem mining practices can avoid, minimize, and mitigate these impacts. I describe myself as a fact-based industry advocate who can explain why mines can be built, operated, and closed to protect the environment in compliance with modem environmental laws and regulations.

My career thus illustrates the diverse ways in which a geologic background is so useful in many endeavors. Beyond its obvious

> *"My career thus illustrates the diverse ways in which a geologic background is so useful in many endeavors."*

applicability to exploring for and developing mineral resources, it is equally pertinent to a wide array of environmental protection and regulatory issues and careers associated with natural resource development.

For the students and early-career professionals in the audience, I urge you to think broadly of how to use your geologic background. You can play an essential role in helping the U.S. address our current minerals emergency due to our dangerous dependence on China and other adversaries for the minerals that underpin our national defense, our economy, our infrastructure, and our manufacturing and technology sectors. Your involvement can range from finding and developing mineral deposits, to designing mines with effective environmental protection measures, and to regulating mining projects in a way that properly addresses public concerns about mining and the environment but that does not obstruct responsible mine development.

I'm sure many of you are aware that Minnesota has been a battleground for hardrock mining for decades. Categorically saying "no" to mining by putting world-class mineral deposits like Minnesota's Duluth Complex copper-nickel-cobalt-platinum group elements deposits cannot be the answer during this minerals crisis. We must have a thoughtful dialogue about how to develop the country's mineral endowment and at the same time protect the environment. We cannot allow this to be simplified into the false binary choice between mining versus the environment. Our national and economic security demand a more fact-based and detailed evaluation of whether and how we can both develop mines and protect the environment.

In April, Congress rescinded the 20-year mineral withdrawal of 225,500 acres in the Superior National Forest where the Twin Metals and other known Duluth Complex deposits are located. The mineral exploration and rigorous and comprehensive state and federal permitting processes can now restart to assess whether these deposits can be developed in a manner that will fully protect the environment.

If you live in Minnesota, I urge you to use your technical backgrounds to carefully and objectively examine the facts and the project's proposed environmental safeguards to make an informed decision about the future of these projects.

If you work for a Minnesota regulatory agency with jurisdiction over these projects, I recognize you have a difficult job. But please know that Minnesota has some of the most stringent mining regulations in the country. I am confident that you have the necessary regulatory tools to ensure that if a mine is built in Minnesota, it will meet all applicable regulatory requirements, employ numerous environmental protection measures, be carefully monitored and regularly inspected, and will have financial assurance to guarantee the mine will be reclaimed.

Thank you for the opportunity to speak tonight. I am truly honored and humbled to be receiving the Ben H. Parker Memorial Medal.

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R. DOUGLAS BARTLETT, CPG-08433

Arizona Section

"While service requires time and commitment, the rewards are substantial..."

ABOUT THE AWARD

The Martin Van Couvering Memorial Service to the Institute Award, established in 1979, honors the Institute's first president. Van Couvering dedicated himself to making the presidency a full-time job during the Institute's first two years. His dynamic leadership and organizational skills built the solid foundation on which the Institute has grown. The award recognizes those who have given outstanding service to the Institute.



Doug and Lori Bartlett at the AIPG awards banquet in Duluth.

Although 48 years may sound like a long time, my career has passed in what feels like an instant, and I stand here today in profound appreciation of the many professionals with whom I have been fortunate to work. A consulting career of this length is never a solo endeavor; it is the product of collaboration with academic and professional mentors, colleagues, clients, dedicated society members, and—most importantly—a supportive family. My career in geology has taken me across the United States and around the world, and I am deeply grateful for the opportunities, experiences, and friendships that journey has provided. While many of my peers have chosen retirement, I have found it difficult to step away from a profession I truly love. I continue to be energized each day by my work and inspired by the curiosity and enthusiasm of the talented younger staff and colleagues around me. I feel extraordinarily fortunate.

The American Institute of Professional Geologists has played an important role throughout my career, and I have greatly enjoyed supporting the organization in whatever ways best served the society. I am truly humbled to follow last year's Martin Van Couvering Award recipient, John Berry—an exceptional supporter of AIPG and someone I have long admired. To those in the audience just beginning their careers in the geosciences, I encourage you to step forward and volunteer—whether with AIPG or another professional society. While service requires time and commitment, the rewards are substantial, and it will connect you with a remarkable group of talented and generous professionals you might not otherwise have the opportunity to know.

This year, I am honored to assume the Presidency of the American Geosciences Institute (AGI), a national organization representing approximately 250,000 geoscientists across the United States. Over the past three years, I have greatly enjoyed working with AGI leadership, particularly Executive Director Jon Arthur. AGI's mission has never been more important. Our profession faces significant challenges, including attracting the next generation of geoscientists to replace those who are retiring. Meeting the world's growing demands for metals, minerals, water, and energy will require a strong, vibrant, and engaged geoscience community. AIPG, AGI, and AGI's member organizations play a critical role in that effort, and I encourage everyone to support professional societies through active participation and service.

I have never sought recognition for my roles in professional service—it simply is not in my nature. However, receiving the Martin Van Couvering Award is especially meaningful to me, and I am deeply appreciative of AIPG for this honor.

RAYMOND W. TALKINGTON,
PhD, PG, CPG-07935

Northeast Section

"AIPG is essential to a broad, well-rounded career in the geosciences."

Thank you, AIPG Executive Committee, AIPG CPG's, Members, Student Members, and Guests.

How time flies. Seems like a few years ago when a colleague asked me about AIPG. My reply was – What is AIPG? At that moment the ball started rolling on my association with AIPG - that was 37 years ago!

Although I was involved with New England Professional Groundwater and Geological organizations at the time, there were only a couple of states that offered a professional geology license – Maine being one. I investigated AIPG and the requirements for a CPG and applied! What a journey and experience over the years. I think it was my experience doing research and technical writing that I was asked to run for Editor of *TPG*. I thought I was in, but then I was out. Hmm! Strange. A couple years later I was elected Editor. It was a lot of work, but rewarding.



Ray and Lynda Talkington at the AIPG awards banquet in Duluth.

I thoroughly enjoyed my time as a member of the Ex Com and President of AIPG along with working with others on committees, the Foundation, and student Geology Clubs.

Most importantly, mentoring the next generation of students and young professionals has been what I am most proud of. I was asked to speak at a career fair at a university and said to the students that a large part of what I do in my job is to mentor young professionals. I was asked an interesting question by one student. He asked – Aren't you afraid that you will lose your job to someone you have mentored? My response was if that happens, then I know that I've done a great job.

Honors are not something I look for. Rather they are given to you by the people or organizations you have helped and been a valuable contributor. I am humbled and most greatful that AIPG is honoring me with this Honorary Membership Award.

ABOUT THE AWARD

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

SIENNA MEEKHOF, ECP-0983

Michigan Section

"Supporting each other, cheering each other on, and holding each other accountable."

I am honored to be recognized for my contribution to AIPG and to our profession, as Geologists. Being an Early Career Professional in any industry can be daunting. It can feel like there's a lot on the line when you have your whole career in front of you and so many paths to choose from. I am truly blessed to have had AIPG as I've entered this chapter of my life and to have met the most passionate peers and mentors. Something I love about AIPG is our enthusiasm for students, early career professionals, and one another. It goes beyond our passion for geology, to a passion for making each other better as professionals. We all walk vastly different career paths, yet you can always count on an AIPG member of any state, membership, or industry for support and to me that is what being in a professional organization is all about. Supporting each other, cheering each other on, and holding each other accountable. I hope I can continue to give back to AIPG everything you have all given to me. Thank you, from the bottom of my heart, for this award and thank you, to all the members of AIPG, for such a supportive and passionate organization- it wouldn't be possible without each and every one of you.



Sienna Meekhof with her parents Randy and Kim Meekhof at the AIPG awards banquet in Duluth.

ABOUT THE AWARD

The John Stewart Memorial Early Career Professional Award was established in 2019 to honor John Stewart. He generously gave his time to AIPG and encouraged the professional growth of geologists early in their careers. This award recognizes an Early Career Professional member who has demonstrated a commitment to the geologic profession and to AIPG, especially by mentoring and helping to advance other early career members.

SECTION LEADERSHIP AWARDS

2026 RECIPIENTS

Honoring four members whose initiative, commitment, and service strengthen AIPG from the Section level up.



Kelvin J. Buchanan, CPG-06058
NEVADA SECTION

"Kel strives to increase the visibility of AIPG in the mining community of northern Nevada, focused in Reno with outreach at University of Nevada and an annual fund-raising event, the AIPG Exploration Round-up."

In addition to promoting the AIPG, Kel assists with the Nevada Section CPG application screening committee.

He is a consistent presence and finds innovative approaches to engage professional members, students, and industry leaders.

Nominated by: **Brooke Miller Clarkson, CPG-11668**



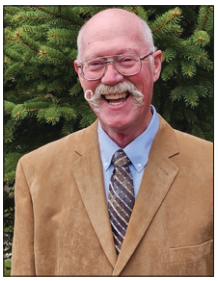
Jake T. Dalbec, MEM-1599
MINNESOTA SECTION

"Jake has been actively involved in the AIPG Minnesota Section for many years and has helped us provide incredible value to our members."

Jake's involvement with the section has helped our section get our business done, raise thousands of dollars for undergraduate scholarships and other education purposes, and bring new members into the community.

Jake has served in several leadership roles, including, Vice-President (twice), President, Director, and several committee chair positions.

Nominated by: **Shanna Schmitt, CPG-11781**



Daniel E. Hunter, CPG-10091
MINNESOTA SECTION

"Dan has been actively involved in the AIPG Minnesota Section for many years. His contributions include leadership, getting business done, showing up to events, and providing community."

Dan's involvement with the Section, over decades, has helped the Section get our business done and provide value to our members.

Dan's held many leadership positions, including Vice President (twice), President, Director, and several committee chair positions.

Nominated by: Shanna Schmitt, CPG-11781



Robert "Joey" McKinnon, MEM-3205
FLORIDA SECTION

"In 2019, Joey was the primary driver to enhancing and developing the Florida Section's legislative presence at the Florida Capitol."

Joey was our first board member as the Legislative Lead. Joey brought a depth of understanding of Florida politics that allowed us to leverage relationships and outward messaging to protect the Florida license from removal three times over the past six years. He has volunteered his expertise countless times and expanded our political and social footprint.

His contributions to the section include: 1. Advanced the public-facing by reviving and expanding both our Lobby Days and social media presence; 2. Raised new donations to help our legislative agenda; 3. Heightened our lobbyist representation at the Capitol without impacting our budget; 4. Provided key expert political advise to influence lawmakers enough to protect our license; 5. Advocated for Florida PGs in front of Florida lawmakers.

He was also our outstanding Legislative Leader for six years.

Nominated by: Clint Noble, MEM-1938

STUDENT CHAPTERS OF THE YEAR

2026 HONOREES

In 2026, two Student Chapters tied for the top honors as AIPG Student Chapter of the Year—setting the bar for student involvement, initiative, and leadership within the organization.

Eastern Michigan University



Chapter Sponsor: Walt Bolt, CPG-10289

Faculty Sponsor: Chris Gellasch, PhD, CPG-10964

Student Chapter Officers:

President - Alexander Bashaw, SA-12542

Vice President - Vanessa O'Brien, SA-12375

Treasurer - Alex Smith, SA-12632

Secretary - Josh Dominick, SA-12187

Member at Large - Mckenzie Hatfield, SA-12721

Western Michigan University



Chapter Sponsor: John Barkach, PhD, CPG-09121

Faculty Sponsor: Thomas Howe, SA-05050

Student Chapter Officers:

President - Erin Hunter, SA-12542

Vice President - Moira Burns, SA-11403

Treasurer - Tori Brown, SA-12774

Secretary - Jordyn Gibbs, SA-11836

WSA Representative - Max Copus, SA-12585

ABOUT THE AWARD

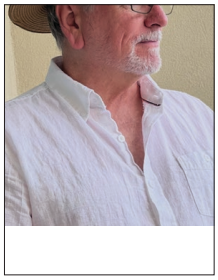
The national award recognizes the AIPG student chapter that most actively contributes to the Institute's mission through organized events, outreach, and chapter development. The selected student also gains the opportunity to experience how a professional organization runs and to network with geoscience professionals from many disciplines nationally and internationally.

AIPG HONORS & AWARDS

PRESIDENTIAL CERTIFICATE OF MERIT

2026 RECIPIENTS

Presented by Chuck Drake, 2026 President



Jonathan D. Arthur,
MEM-0932
VIRGINIAS SECTION

For your lifelong dedication in all aspects of geosciences at the local, state and national levels.



Barbara J. Bickford,
MEM-3667
MINNESOTA SECTION

For your dedication in championing networking for early career professionals and student members.



James W. Pease,
CPG-07797
FLORIDA SECTION

For your dedication to geosciences in Florida and encouraging membership in AIPG.

2027 AIPG HONORS & AWARDS

RECOGNITION STARTS WITH A NOMINATION

Exceptional work does not always call attention to itself. Consider the AIPG colleagues whose service, leadership, professional achievement, and commitment to the geosciences deseerve national recognition.

NOMINATIONS DUE JANUARY 15, 2027

Review the award criteria and submit a nomination at aipg.org.

www.aipg.org/awards

scan

FOUNDATION OF THE AIPG

WILLIAM J. SIOK

Graduate Scholarship Program

Supporting the next generation of geoscientists.

$5,000

ONE GRADUATE SCHOLARSHIP

APPLY BY FEBRUARY 1

PURPOSE

To assist graduate students with their education costs and to promote student participation in the American Institute of Professional Geologists (AIPG). One scholarship will be awarded to a declared graduate student in an accredited geoscience program in applied geosciences. Details for applying for this scholarship are provided below.

SCHOLARSHIP AWARDS

Scholarship award in the amount of $5,000.00 to an eligible graduate student attending a college or university in the U.S. The scholarship is intended to be used to support student needs.

ELIGIBILITY REQUIREMENTS

Any graduate student who is majoring in the geosciences (as defined by the American Geosciences Institute) in the U.S. can apply. This includes international student members. Also, the student must be either a student member of AIPG or must have applied for student membership at the time the application for the scholarship is submitted. The AIPG student membership application form is available online at: https://aipg.org/general/register_member_type.asp? Student Membership is Free!

APPLICATION PROCESS

1. Cover letter: A formal letter introducing yourself, your accomplishments in college, involvement in any research



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projects, club activities, and outside activities in the community. Address your short term and longer-term career goals. Address why you should be a recipient for an AIPG scholarship. Limit the letter to one page completely formatted as a letter.

2. Essay: A one page, 12 pt Times New Roman, 1- inch margins, left justify in a Word doc file. The scholarship essay topic is:

   AIPG is devoted to ethical and professional practices in Geology/Geoscience. Our logo portrays a shield with three terms: competence, integrity, and ethics.

   Create your own ethical dilemma scenario setting for a graduate geoscience student conducting research or for an employed geologist/geoscientist engaged in professional practice. Describe that setting briefly in a sentence or two. Then, describe how those three concepts would apply to the practitioner in the performance of that work.

   Scholarship winner's essay will be printed unedited and in its entirety in the AIPG publication The Professional Geologist (TPG). Make sure to include your name and essay title on the page of your essay submission.

3. Submit a copy of your transcript (unofficial) and documentation that you are a current student. Requisite standards to apply are a minimum GPA of 2.8 (on a 4-point scale) and a minimum of 12 semester credits of geology/geoscience courses with a 3.0 GPA in these courses completed at time of application. Those credits can come from previous graduate or undergraduate studies.

4. Submit a Letter of Recommendation from a geology/geoscience professor that knows you and provides an emphasis on your performance and activities in the classroom, in the department, and your character in how you work and help other students. Professors can email the letter to aipg@aipg.org or upload the letter online at https://aipg.org/page/GraduateRecLtr. **Applicant is responsible for informing their professor where to email or upload the Letter of Recommendation.**

The application packet can be submitted online (preferred) or emailed to aipg@aipg.org. Questions regarding the application process can be directed to (303) 412-6205 or e-mail: aipg@aipg.org.

If you are submitting your application materials by email (aipg@aipg.org), please format the subject line as follows: Foundation Scholarship - Type of Scholarship (Undergrad or Grad) - Last Name of Applicant - Submission. For example, Foundation Scholarship -Graduate - Doe – Essay - Cover Letter. You may submit all application materials in one email, and, if necessary, one file.

APPLICATION DEADLINE AND AWARD DATE

Applications must be received by midnight Mountain Standard Time (MST) on February 1st, which is to say, before February 1st. **Awarded the month of May.** Incomplete applications will not be considered.

BASIS OF AWARDS

The scholarship is awarded on a competitive basis, based on review of the cover letter, recommendation, transcript and the content and creativity of the essay as judged by the Education Committee. The decisions of the Education Committee are final.

The scholarship is made possible by the support of the Foundation of the American Institute of Professional Geologists and the AIPG members' voluntary contributions.

South Dakota Section



ABOVE: Joanne M. Noyes receiving the AIPG South Dakota Section 2026 J.P. Gries Geologist of the Year Award from South Dakota State Geologist and SD Section Past President Tim Cowman. The award nomination letter for Ms. Noyes can be viewed at https://sd-aipg.org/j-p-gries-geologist-of-the-year-award/ (Photo by J. Foster Sawyer).



The AIPG South Dakota Section 2026 staffed an AIPG booth at the 2026 Western South Dakota Environmental and Hydrology Conference on April 16, 2026 in Rapids City, South Dakota. South Dakota
Section members from left to right: Gary Haag, Tom Durkin, and Foster Sawyer (Photo by Matt Hicks).

Dr. Adeel Nazeer Elected to Full Membership in Sigma Xi

Dr. Adeel Nazeer (Member ID 20269992890) was duly elected a full member of Sigma Xi, The Scientific Research Honor Society in 2026. Sigma Xi is the world's largest general research honor society. It is an international, multidisciplinary organization for research scientists and engineers.

Over the course of the Society's distinguished history, more than 200 members have won the Nobel Prize and many more have earned election to the National Academy of Sciences and National Academy of Engineering. Members in the Society hold a full or associate membership based on research achievements or potential.

Membership in Sigma Xi is by nomination only. Selected individuals who have shown potential as researchers are invited to join as associate members. Full membership is conferred upon those who have demonstrated noteworthy achievements in research. Sigma Xi interprets "noteworthy achievement" to include primary authorship of two papers. ("Paper" includes refereed journal articles, patents, or internal reports. An earned doctoral degree may be substituted for one paper.) The Society also considers career preparation, career path, quality of research and similar factors.

The "Criteria for Membership" can be found in Section 2 of the Society's Bylaws:

General Requirements: Nomination of an individual engaged in scientific research may be made provided that the nominee is, by the quantitative emphasis of the work combined with its synthesis and qualitative stature, deemed eligible for nomination.

Noteworthy Achievement: Noteworthy achievement in research specified for election or promotion to full membership, in accordance with Article II, Section 3 A of the Constitution, must be evidenced by publications, patents, written reports or a thesis or dissertation. Membership in the Society is neither linked to the possession of any degree nor contingent upon belonging to some other organization.

If you have any questions or need additional assistance, please feel free to contact the Society's Membership Office: membership@sigmaxi.org or call 1 - 800 - 243 - 6534. Thank you for your consideration.

Dr. Adeel Nazeer (CPG-11771) Resides in Islamabad, Pakistan. He is the Deputy Chief Geologist of Pakistan Petroleum Limited

Mafic Magmatic Mineral Systems of the Duluth Complex: A Descriptive Summary and Field Trip Guidebook into the South Kawishiwi Intrusion and Adjacent Terranes (abridged)

Dean Peterson, PhD

Acknowledgement

The American Institute of Professional Geologists is pleased to share this abridged version of *Mafic Magmatic Mineral Systems of the Duluth Complex: A Descriptive Summary and Field Trip Guidebook into the South Kawishiwi Intrusion and Adjacent Terranes*, prepared by Dr. Dean Peterson of Big Rock Exploration for the 2026 AIPG National Conference, held August 29 - September 1, 2026, in Duluth, Minnesota.

Field trips are one of the most meaningful parts of an AIPG conference. They give us the opportunity to step out of the meeting room and into the geology itself—to see, question, discuss, and better understand the natural systems that shape our work as professional geologists. The original guide is 44 pages and this abridged version aims to provide the highlights of the field trip.

AIPG sincerely thanks **Dr. Dean Peterson** for developing this guidebook and for sharing his knowledge with conference participants. We also appreciate Big Rock Exploration for its support of the field trip and teh Annual Meeting.

AIPG is pleased to make this valuable field resource available in *TPG* to a broader audience and to preserve the learning and professional exchange that were part of the 2026 National Conference in Duluth.

Introduction

Mineral deposits are concentrations of specific ore-minerals that society utilizes in immeasurable ways. They have formed from Archean times up to the present, and vary greatly in commodity, mineralogy, alteration, trace element signature, geophysical properties, and grade-tonnage. Individual ore deposits are always unique, and this uniqueness arises from two main sources: 1) fundamental differences in geologic processes and environments; and 2) local, site-specific, geologic variations and associated bounding geometries. The seemingly limitless number of permutations of these (and other) features of mineral deposits defies imagination.

Geologists employed in the search for ore deposits have, over the last century, developed the intellectual concept of **Ore Deposit Models**, which seek to organize many of these variables, lump individual mineral deposits into classes, and establish criteria to aid mineral exploration (Peterson, 2001a). Such models may be strictly empirical – a collection of observable facts associated with the occurrence of certain metals in economic proportions – or genetic – which attempts to describe the physical and chemical processes responsible for the development of an ore deposit and its related empirical features.

Advances in our collective understanding of ore deposit types are nonlinear and develop in fits and starts. Take, for example, the great advance in knowledge – and thus mineral exploration models and exploration success – for porphyry copper deposits in the 1960s and 1970s (Lowell and Guilbert, 1970), volcanogenic massive sulfide deposits in the 1970s and 1980s (Franklin et al., 1981), and mesothermal lode gold deposits in the 1980s and 1990s (Hodgson, 1993). These advances were the product of many factors that perhaps most importantly was collaborative ore deposit research between the mineral industry, academia, government agencies, and research organizations.

We are currently in the midst of a similar great advance in knowledge of magmatic Ni-Cu-PGE deposits (Arndt et al., 2006; Barnes and Lightfoot, 2006; Eckstrand and Hulbert, in prep.). Perhaps the most important impetus for this current revolution was the fall of the Iron Curtain, which opened the door in the early 1990s to some of the world's greatest magmatic Ni-Cu-PGE deposits, i.e., the Noril'sk-Talnakh deposits in Russia and Jinchuan deposit in China, to economic geologists trained in open western societies (especially Canada). In addition, the 1993 discovery of the magmatic Ni-Cu deposit at Voisey's Bay, Labrador, Canada, and its inferred origin as a magmatic feeder dike, has brought about a revolution in our collective understanding of the origin of magmatic Ni-Cu±PGE deposits. This revolution can simple be stated as ***"find the magmatic feeder dike and/or channelized magma flow zones"*** to the ore- bearing mafic/ultramafic intrusion(s). A magmatic conduit that experienced repeated influxes of magma appears to be the key to the formation of high-grade, world-class, Ni-Cu-PGE deposits (Naldrett, 1997).

Field Trip Tenets

Many basic attributes of the Duluth Complex Cu-Ni-PGE sulfide deposits resemble those of deposits at Noril'sk, Russia, Jinchuan, China, and Voisey's Bay, Canada that are associated with sulfide mineralization in intrusive feeder zones. Such attributes include shallow tholeiitic intrusions associated with plateau basalt volcanism, external sedimentary sources of sulfur, and openness to repeated magma influx and expulsion. However, the biggest difference between these world-class magmatic ore systems and the deposits of the Duluth Complex is the lack of significant nickel-rich (Ni>Cu) massive sulfide orebodies at Duluth. A critical attribute of the high-grade Noril'sk–Talnakh and Voisey's Bay deposits, **not previously positively** identified in the Duluth Complex, is the location of a magmatic conduit, i.e., the feeder zone.

Several geologists have previously identified possible conduits that may have fed the Partridge River (PRI) and South Kawishiwi (SKI) intrusions of the Duluth Complex. Severson and Zanko (unpub. data)

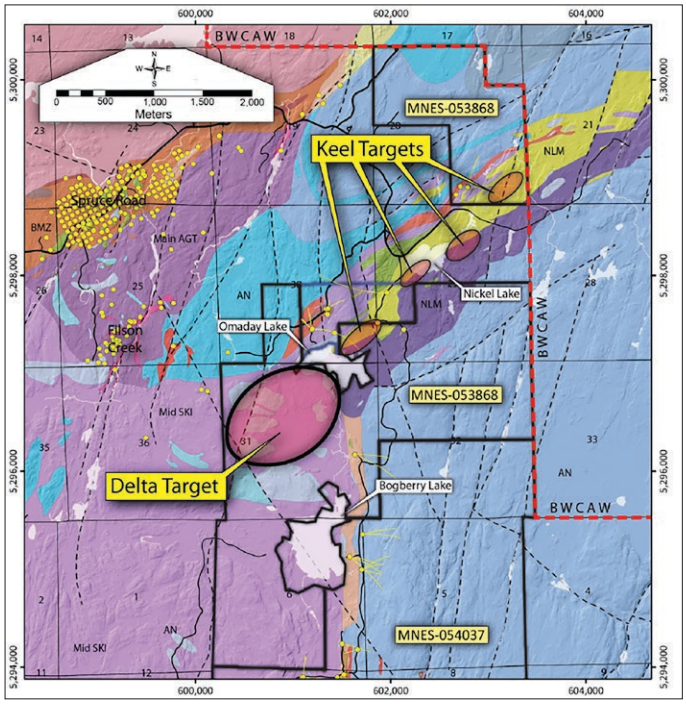


Figure 1. Interpreted target areas where the accumulation of liquid sulfide may have occurred within and adjacent to the NLM. Keel targets would form in undulations of the base of the NLM and the Delta target is located where the NLM and SKI intersect.

suggest that the Grano fault might mark a possible feeder zone for the Local Boy ore zone at the northeast end of the PRI. Thériault et al. (2000) postulated that a PRI conduit was present somewhere between the Wetlegs and Dunka Road deposits. Another possible PRI feeder zone may have been along the prolongation of the Siphon fault, which is a Paleoproterozoic growth fault (Graber, 1993) that may have been reactivated during emplacement of the Duluth Complex (Severson and Hauck, 1997). Several authors have suggested the presence of a sub-vertical magmatic feeder beneath the Bald Eagle intrusion (BEI) based on field relations (Weiblen and Morey, 1980) and geophysical attributes (Chandler, 1990).

Peterson (2001b) interpreted the systematic variation in Cu-Ni-PGE mineralization in the Maturi deposit and its extension east to Maturi Extension, as indicative of magma input from the east-northeast via an arcing macrodike (herein first termed the Nickel Lake Macrodike (NLM)) that connects the deep-seated source of the BEI and the SKI. Subsequent mapping and research (Peterson, 2002a-f, 2006a, Peterson et al., 2004, Peterson and Hauck, 2005) has built on this model, which recently culminated with the publication of a new detailed bedrock geology map of the area (Peterson et al., 2006). If correct, this model predicts that a Voisey's Bay-type Ni-Cu-PGE massive sulfide body may exist at depth in the area where the NLM meets the SKI, south-southeast of the Spruce Road deposit (see Figure 1).

The fundamental tenet of this field trip is to convey to the participants the notion that science gives one the ability to **imagine reality**. Herein, *science* is geologic research of the Duluth Complex (geologic mapping, drill core logging, geochemical studies, and exploration drilling), and reality is new understanding how this magmatic system concentrated and enriched known and potential concentrations of Ni-Cu-PGE at the base of the NLM in the field trip locale as well as adjacent areas of the SKI. The field trip leaders ask the participants (and others who may use the guidebook in the future) to use their imaginations throughout the field trip (or subsequent field excursions) to think about a few basic known and possible realities of the Duluth Complex:

1. The Duluth Complex is perhaps the world's largest untapped resource of Ni-Cu-PGE, with multi-billion tons of geologic resources estimated to be worth >1 trillion dollars, (Peterson, 2006c),
2. The general geologic setting of the deposits in the Duluth Complex is similar to other world class Ni-Cu-PGE mining camps hosted by rocks in rift settings (Noril'sk-Talnakh, Jinchuan),
3. Overall, the ratio of Ni to Cu in Duluth Complex deposits average 1:3,
4. Worldwide, the ratio of Ni to Cu in similar deposits averages between 1:1 to 2:1,
5. By analogy, there seems to be an enormous mass of missing Ni-rich mineralization, and
6. At depth, the Nickel Lake Macrodike may host a large percentage of this missing Ni in the SKI.

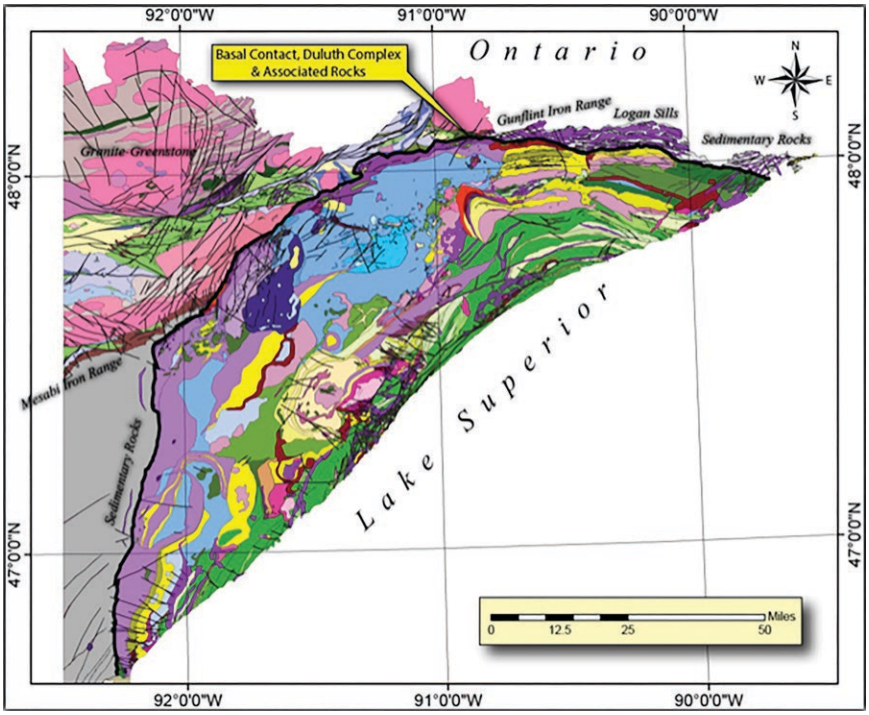


Figure 2. Geologic map of northeastern Minnesota.

Regional Geologic Setting, Duluth Complex

The Duluth Complex and associated intrusions of Keweenawan age (~1.1 billion years) in northeastern Minnesota constitute one of the largest mafic intrusive complexes in the world, second only to the Bushveld Complex of South Africa (Miller et al., 2002). These rocks cover a 2,200 square mile (5,700 square km) arcuate area associated with the two strongest gravity anomalies (+50 and +70 milligals) in North America, implying intrusive roots over 8 miles (13 km) deep (Allen and others, 1997). The comagmatic flood basalts and intrusive rocks underlying much of northeastern Minnesota were emplaced during development of the Mesoproterozoic Midcontinent rift, which can be traced geophysi-

cally from exposures in the Lake Superior region along a 1250 mile (2,000 km) long, segmented, arcuate path to Kansas and Lower Michigan. The Duluth Complex is defined as the more or less continuous mass of mafic to felsic plutonic rocks that extends for >170 miles (275 km) in an arcuate fashion from Duluth nearly to Grand Portage (Figure 2).

It is bounded by a footwall of Paleoproterozoic sedimentary rocks and Archean granite-greenstone terranes (Peterson and Severson, 2002), and a hanging wall largely of comagmatic, rift-related flood basalts and hypabyssal intrusions of the Beaver Bay Complex. In genetic terms, the Duluth Complex is composed of multiple discrete intrusions of mafic to felsic tholeiitic magmas that were episodically emplaced into the base of a volcanic edifice between 1108 and 1098 Ma.

The geology of the Duluth Complex and adjacent areas has been described in two major publications by the Minnesota Geological Survey (MGS). These include a 1:200,000 scale regional bedrock geological map of northeastern Minnesota (Miller et al., 2001), and a comprehensive written description of the geology depicted on this map (Miller et al., 2002), commonly referred to as the "bible" by geologists working on Duluth Complex geology. Readers interested in more detailed descriptions of the geologic setting of the Duluth Complex should download publications from the MGS website (https://conservancy.umn.edu/handle/11299/58804). Within the nearly continuous mass of intrusive igneous rock forming the Duluth Complex, four general rock series are distinguished on the basis of age, dominant lithology, internal structure, and structural position within the complex.

Felsic series—Massive granophyric granite and smaller amounts of intermediate rock that occur as a semi-continuous mass of intrusions strung along the eastern and central roof zone of the complex, that were emplaced during early-stage magmatism (~1108 Ma).

Early gabbro series—Layered sequences of dominantly gabbroic rocks that occur along the northeastern contact of the Duluth Complex, emplaced during early-stage magmatism (~1108 Ma).

Anorthositic series—Structurally complex suite of foliated, but rarely layered, plagioclase-rich gabbroic anorthosite emplaced throughout the complex during main stage magmatism (~1099 Ma).

Layered series—Suite of stratiform troctolitic intrusions that comprises at least 11 variably differentiated mafic layered intrusions that occur mostly along the base of the Duluth Complex. These intrusions were emplaced shortly after the Anorthositic series (~1099 Ma).

Description of Field Trip Stops

The location of the South Kawishiwi Intrusion (SKI) field trip stops is presented in Figure 3, and short descriptions of the geology and important take-away knowledge (bedrock geology, glacial geology and dynamics, exploration geochemistry, environmental review, etc.) from each stop is given in the following descriptions. It is important to note that the whole northern SKI is located in the scoured bedrock terrain of the last cycle of the Pleistocene Laurentide ice sheet (herein the Rainy Lobe about 12,000 years ago). The local end moraine of the Rainy Lobe is located immediately south of Stop #1 along the new Tomahawk Road. Work by Duluth Metals has positively shown that the mean transport length (the distance where ½ of material in the glacial deposits is sourced from) in the field trip area is <0.5 miles.

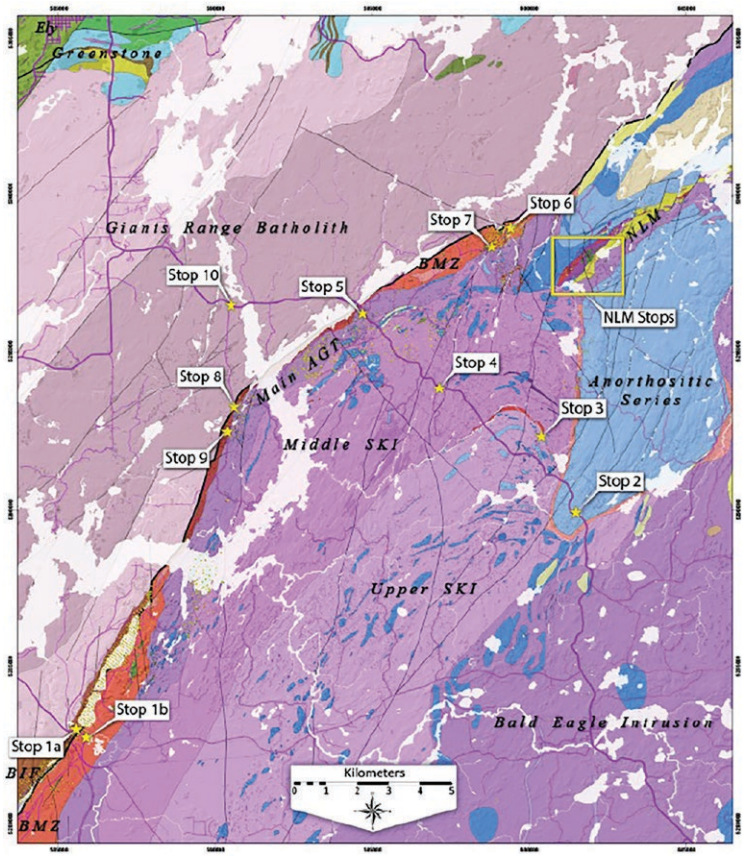


Figure 3. Location map of the field trip stops in the South Kawishiwi Intrusion.

STOP 1: Footwall Biwabik Iron Formation and Contaminated Basal SKI

UTM NAD83 Coordinates: 585537E, 5282978N. PLS: T60N, R12W, S10

Stop 1 is geared towards understanding the interaction of the basal mineralized zone of the SKI in areas where the footwall rocks are the shallow-dipping, Paleoproterozoic metasedimentary rocks of the Animikie Group. The rocks of the Animikie group in this area include the easternmost exposures of the Biwabik Iron Formation as well as remnants of the overlying basal Virginia Formation, a sequence of greywackes, argillites, and black shales that locally contain syn-sedimentary beds of pyrite/pyrrhotite.

We'll first look at a roadside outcrop of the Biwabik Iron Formation (Stop 1a) and get some views into Cleveland Cliffs active Peter Mitchell pit of the Northshore Iron Mine. Immediately to the southeast along the roadway are several exposures of the highly contaminated, sulfide-rich (though only weakly Cu-Ni-PGE mineralized) basal SKI. Severson (1994) would classify these biotitic basal SKI rocks into his BAN unit, which is his acronym for Bottom Augite Norite.

STOP 2: Anorthositic Series

UTM NAD83 Coordinates: 601471E, 5289868N. PLS: T61N, R10W, S19

The Anorthositic Series of the Duluth Complex is a structurally complex suite of medium- to coarse-grained, variably foliated, plagioclase-rich cumulates that occurs over the entire breadth of the complex from the western edge of the Poplar Lake intrusion to the southern terminus of the Duluth Complex at Duluth. The upper contact of the anorthositic series against volcanic or granophyric rocks is typically sharp and somewhat chilled. The lower contact is commonly formed against layered series rock. Over the entire

exposure area of the anorthositic series, its lithologic character, internal structure, and contact relationships with adjacent rocks remain fundamentally constant. The series seems to have been emplaced more or less synchronously over its entire extent, as two samples from very different parts of the complex (one from the north-central part, the other from the Duluth area) have nearly identical U-Pb ages of 1099.1 ± 0.6 Ma. The Anorthositic Series forms the eastern sidewall of the SKI and undoubtedly formed the hanging wall to the SKI.

STOP 3: The SKI Break - Middle to Upper SKI Troctolite Contact

UTM NAD83 Coordinates: 600417E, 5292338N. PLS: T61N, R10W, S18

Duluth Metals geologists first took interest in the rocks of this field trip stop in 2011 during follow up field work around several highly anomalous till geochemistry (Cu, Ni, Pt and Pd) samples. Numerous angular boulders of melatroctolite and peridotite were discovered containing highly anomalous Cu-Ni- PGE geochemistry. A detailed mapping and sampling program ensued and the locally sulfide-bearing, chromium oxide-rich ultramafic SKI Break was discovered in outcrops along the valley of Keeley Creek.

This stop will involve a moderately long walk (½ mile) walk through large exposures of anorthosite xenolith-rich, shallow dipping (here to the west-southwest), foliated troctolite of the lowermost portion of the Upper SKI into the recessive weathering SKI Break (see Figure 4). As we walk along U.S. Forest Service road 1468, please note the rugged topography of the glacially scoured outcrops of the Upper SKI. The rugged nature of the topography in the Upper SKI becomes more subdued in glacially polished outcrops of the Middle SKI. Subtle differences in geochemistry/ mineralogy/texture of these SKI units must have resulted in differential weathering and saprolite development of these similar troctolite units of the SKI.

STOP 4: Middle SKI Troctolite

UTM NAD83 Coordinates: 597134E, 5293919N. PLS: T61N, R11W, S11

At this stop, massive, moderately layered and foliated troctolite (strike 45°, dip 22°) of the Middle SKI is exposed in numerous outcrops. This stop epitomizes the "Sea of Troctolite" that occurs throughout the vast majority of the SKI. We will take a short walk to the south onto large, massive exposures of glacially scoured troctolite to investigate weak jointing developed along the eastern margin of the bedrock exposures and discuss the interpretation of the NNE trending topographic lineaments.

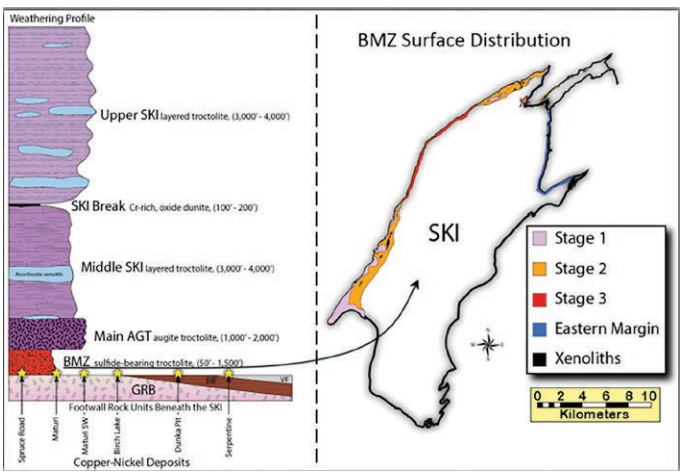


Figure 4. Simplified igneous stratigraphy of the SKI (left) and outcrop distribution of BMZ stages (right).

STOP 5: Main Augite-Troctolite, the "Main AGT"

UTM NAD83 Coordinates: 594743E, 5296267N. PLS: T62N, R11W, S33

Recent road cut along the south side of Minnesota Highway #1 of massive, extremely homogeneous augite troctolite of the Main AGT unit of Severson (1994). Troctolite of the Main AGT unit differs from the Middle and Upper SKI troctolite in two distinctive ways: 1) ophitic augite crystals are black, distinctly associated with Fe-Ti oxides + apatite, and occur as high-density ophitic crystals from 1 to 3 inches in diameter. In the Middle and Upper SKI, ophitic augite crystals are brown, not associated with Fe-Ti oxides, and occur as large (up to 15 inches) low-density grains, and 2) distinct layering of olivine is common in the Middle and Upper SKI troctolites and has not been observed in the Main AGT.

The ***lack of layering*** in the Main AGT has led to the interpretation by Big Rock Exploration geologists that the homogeneity of this map unit and lack of layering is evidence that the Main AGT magma lacked phenocrysts of olivine and plagioclase and represents the end product of top- down and bottom-up solidification of a basaltic liquid. We currently interpret the Main AGT as the solidification of much of the "carrier liquid" of the underlying sulfide-bearing BMZ magmatic slurry.

STOP 6: Basalt Xenolith in the BMZ, the Spruce Road Deposit

UTM NAD83 Coordinates: 599404E, 5298990N. PLS: T62N, R11W, S24

A short field trip stop up onto a small knob of basalt hornfels within the center of the Spruce Road Cu-Ni deposit. Sulfide-bearing troctolitic rocks of the Spruce Road Cu-Ni deposit are distinctly different in several ways to similar rocks within the Maturi Cu-Ni-PGE deposit. First and foremost is the fact that the precious metal content (Pt-Pd-Au) of Spruce Road ores are much less than within Maturi. The second fact is that the Spruce Road deposit contains a large number of xenoliths. In fact, the mapped proportion of barren xenoliths at Spruce Road approaches 15% of the total rocks within the heart of the deposit. At Maturi, such accessory and exotic xenoliths account for <<1% of the Cu-Ni-PGE mineralized zone. The difference between these deposits is interpreted to be the result of the timing of magma injection. The Spruce Road deposit is believed to have formed prior to Maturi and the lithology and concentration of xenoliths are the end product of the system cleaning out the pathways that the magma traveled upwards from depth (Peterson and Boerst, 2013).

STOP 7: U.S. Forest Service Borrow Pit, BMZ in the Spruce Road Deposit

UTM NAD83 Coordinates: 598826E, 5298384N. PLS: T62N, R11W, S25

Beginning in the late 1940s, the U.S. Forest Service utilized locally derived glacial tills and weathered bedrock gossans as road building materials during the construction of the Spruce Road. As we take a short hike into one of these borrow pits, we will walk by the 1973 INCO bulk sample site in the Spruce Road deposit. This short stop will examine the bottom of an old borrow pit where participants can walk on and sample sulfide-bearing troctolite gossans. Please note the friable nature of the rocks in the weakly saprolitic exposure and look for rounded core-stones where weathering over the eons was less intense.

STOP 8: Sulfide-bearing Troctolite & layered Melatroctolite, Maturi SW Deposit

UTM NAD83 Coordinates: 590572E, 5293036N. PLS: T61N, R11W, S7

Classic roadside exposures of heterogeneous sulfide-bearing troctolite and layered melatroctolite of Severson's (1994) Basal Heterogeneous (BH) and Ultramafic 3 (U3) units of the SKI. A large

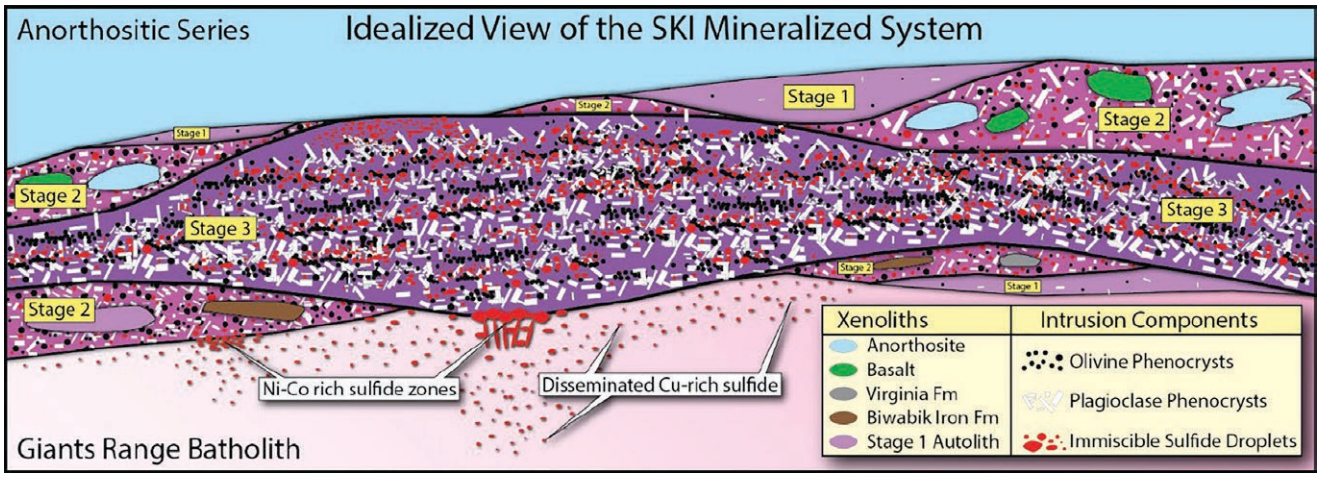


Figure 5. Detailed idealized view of the BMZ intrusive stages at the Maturi Cu-Ni-PGE deposit.

core-stone is well exposed in the weakly saprolitic heterogeneous troctolite outcrop. Several small xenoliths of fine- grained troctolite can be observed on top of the outcrop and are interpreted as Stage 1 chilled margin autoliths (Peterson and Boerst, 2013). Within the exposure of the overlying U3 layered melatroctolite, olivine layers strike 17° and dip steeply 51° to the ESE. The steep dip is apparently associated with two defined north-south trending faults east of these exposures. Recent drilling by Twin Metals Minnesota in this area has led to the definition of the Maturi SW deposit.

STOP 9: Basal Heterogeneous, Sulfide-poor Troctolite

UTM NAD83 Coordinates: 590313E, 5292211N. PLS: T61N, R11W, S18

At this stop, we'll examine perhaps the best exposure of Severson's (1994) BH unit in the whole of the SKI. The heterogeneous troctolitic rocks at this stop are generally poorly mineralized and thus lack a gossanous saprolitic weathering profile which lets one see the true nature of the heterogeneity within the troctolite. I believe that all geologists who ever will log drill core within the Cu-Ni deposits of the Duluth Complex (or who attempt to model such deposits for mine planning purposes) should be required to spend several days examining the rocks within the area around both Stops 8 and 9. All participants should imagine a drill core cutting this exposure and how they would interpret the geology of that core without first examining this outcrop. Such thoughts are why the Precambrian Research Center's field camp has for many years had its students complete a 1:5,000 scale bedrock geology map of this area.

STOP 10: Giants Range Batholith, the Footwall

UTM NAD83 Coordinates: 590518E, 5296544N. PLS: T62N, R11W, S31

The footwall rocks of the whole northern SKI consist of the Neoarchean Giants Range batholith (GRB), such as is exposed along Highway 1 at this field trip stop. The rocks here consist of porphyritic hornblende quartz monzonite with distinctive 1-2 cm potassium feldspar phenocrysts. The massive nature of this unit creates an excellent footwall for the intrusions Cu-Ni-PGE deposits as it lacks bedding and thus rarely (if ever) gets incorporated into the mineralized zone as barren xenoliths. In addition, the melting of the GRB beneath long-lived magma channels (Peterson and Boerst, 2013) at the base of the Maturi deposit has contaminated the SKI and induced additional sulfide immiscibility and the formation of Ni- and Co-rich massive sulfide bodies (see Figure 5).

STOP 11: Nickel Lake Macrodike Traverses

This stop consists of several walking traverses into the Nickel Lake Macrodike. The general location of these traverses is given in Figure 6, and selected annotated outcrop photographs from within the NLM are presented in Figure 7.

Traverse #1

This walk in the bush begins within numerous outcrops of the bounding Anorthositic series rocks (map unit A-tA) on the northern

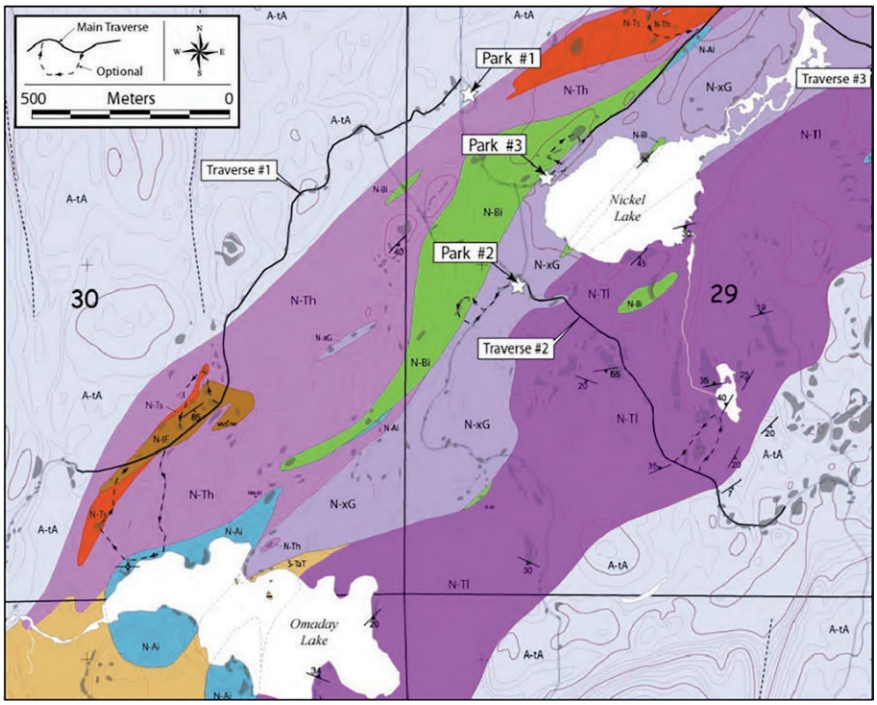


Figure 6. Bedrock geology map of portions of the southwestern end of the Nickel Lake Macrodike in Sections 29 and 30, T62N, R10W. Dark lines are superimposed locations of field trip traverses along logging roads and snowmobile trails. Dashed lines represent short traverses through the bush to additional known outcrops.

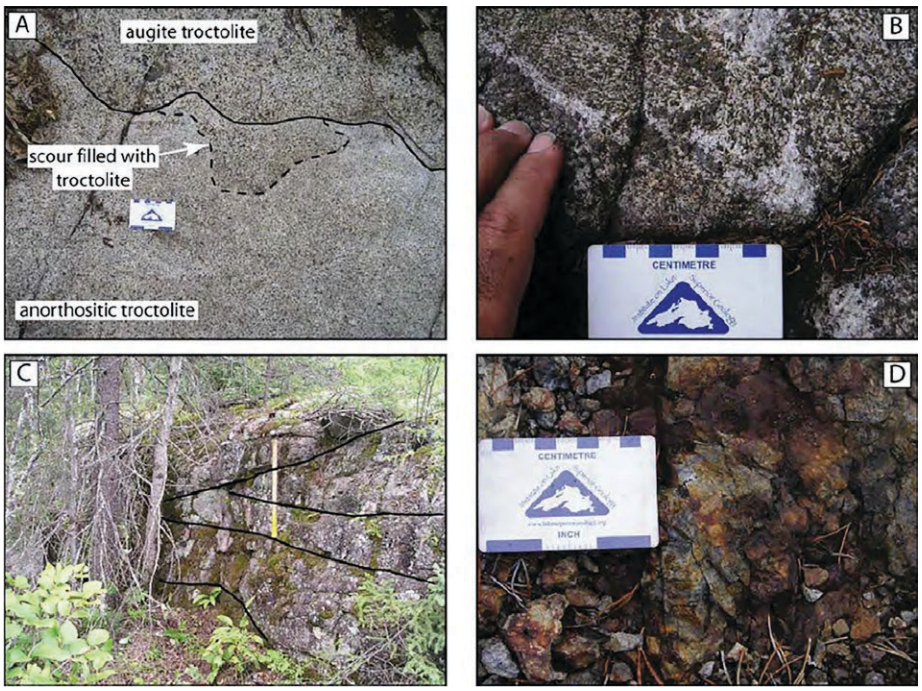


Figure 7. Photographs of selected outcrops that give clues to the dynamic nature of the magmatic processes which ultimately led to the formation of the NLM, and by interpretation, the northern portion of the SKI and its associated Cu-Ni-PGE mineralization. A) Scour structure in map unit N-Th. B) Disrupted igneous foliation along the southern margin of map unit N-Tl. C) Cross-bedding of olivine phenocrysts within troctolitic rocks of map unit N- Tl. D) Cu-Ni sulfide mineralization in map unit N-Ts.

margin of the NLM. The trail will take us southwest into inclusion-rich heterogeneous troctolitic rocks (map unit N-Th) and into southwestern most zone of known Cu-Ni-(PGE) mineralization in the NLM (map unit N- Ts), which in this location is associated with a large, sub-vertical inclusion of Biwabik Iron Formation (map unit N-IF). One must try to imagine from where such an inclusion came from (see Figure 8), how it relates to the model that the NML is a feeder dike to the SKI, why it and other large mapped inclusions in the NML (see Figure 3) are concentrated at the southwestern end of the NML (magma velocity). Think back to the previously described fundamental tenet of Ni-Cu-PGE magmatic sulfide deposits, *"… realization that decreases in the flow rate of magmas, principally due to the geometry of the conduit, is a major factor in settling entrained sulfide droplets and forming sulfide-rich ore bodies…"*.

Traverse #2

This walk to the southeast along a logging road/snowmobile trail begins in coarse-grained, oxide-rich olivine gabbro to melagabbro of map unit N-xG. Contact relationships between the N-xG and layered troctolitic to dunitic rocks (map unit N-Tl) can be complex, and we'll investigate these relationships early on the traverse. The bulk of this traverse will be through the widest section (>650 m) of unit N-Tl that has been mapped in the NLM. Careful attention should be directed towards igneous textures in the N-Tl, and what they imply to magmatic processes (expanding dike with time, modal layering, pasting plagioclase and olivine phenocrysts on dike walls, solidification fronts, etc…). Optional traverses shown include a walk to outcrops of the very large (~ 1.5 km long) basalt inclusion (map unit N-Bi), and to exceptional exposures of layered troctolite and dunite around a small beaver pond.

Traverse #3

This walk to the north-northeast of Nickel Lake will traverse through most of the main units identified in the NLM, including map units N-Th, N-xG, N-Tl, N-Ts, N-Bi, and N-Ai. An important walk through the bush will visit several Cu-Ni-(PGE) mineralized outcrops near the northwestern margin of the NLM, and allow us to view some spectacular exposures, around the margin of a drained beaver pond, of the Anorthositic series rocks immediately northwest of the NLM. The authors cannot speak to strongly on the importance of finding these types of exposures (totally free of lichen, moss, trees, etc…), early in a mapping program, as they provide proxies for subsequent mapping of outcrops deep in the bush, where trees, shrubs, shade, forest litter, dirt, and black flies partially obscure exposures and/or one's willingness to observe them.

Field relationships that offer evidence that a dike-like mafic to ultramafic intrusion is a conduit through which magma ascended upwards in the Earth's crust all lead back to the fundamental tenets of the Ni-Cu- PGE ore deposit model. Such relationships provide evidence that the rocks formed in a dynamic, sulfide- bearing magmatic system (once again, think like a person fly fishing a trout stream) that include: 1) early phases should be inclusion-rich (some of which should be from a deeper crustal level) and form as the igneous conduit breeches upwards into the Earth's crust, 2) imbrication and/or elongation of entrained country rock inclusions parallel to igneous foliation, 3) igneous scour struc-

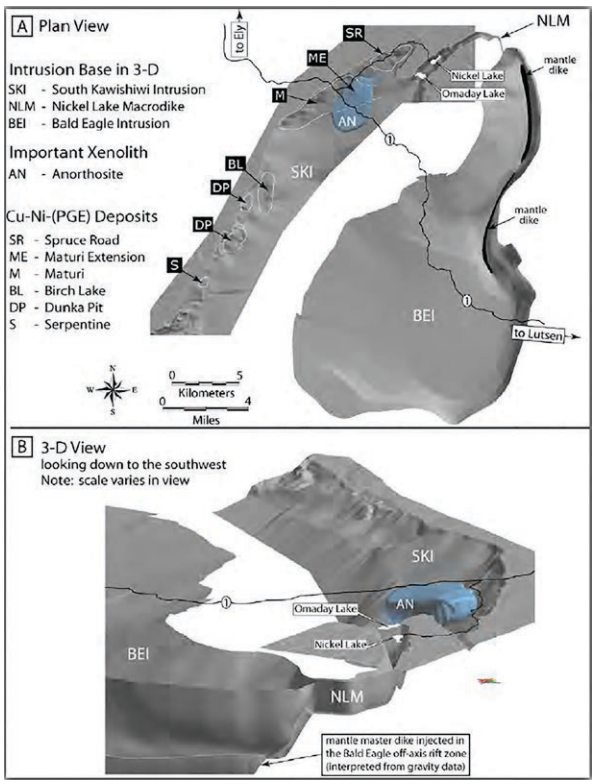


Figure 8. Simplified views of an integrated 3D model of the BEI, NLM, and SKI of the Duluth Complex. A. plan view and B. view to the southwest. Model surfaces built from drill hole piercing points, detailed geological mapping, and interpretation of gravity and aeromagnetic data.

tures, 4) prominent steeply- dipping igneous foliation and localized disruption due to magmatic injection, 5) cross-bedding of modal layering, 6) evidence of sulfide mineralization, and 7) evidence that that magma velocity varies.

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Continued on p. 51



Honoring Service, Shaping AIPG's Future

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By the time each of you reads this article, the 2026 AIPG Annual Meeting in Duluth, Minnesota will be complete. Each year at our Annual Meeting, we make decisions that help to shape AIPG's future. Some of those decisions are in the form of electing Advisory Board Representatives to the National Executive Committee. Those representatives become the voice of AIPG sections, identifying concerns, creating opportunities, and serving as a liaison between the National Executive Committee and individual AIPG sections. This line of communication is critical for the future success of AIPG at the National and Section level.

We also recognize the efforts of outstanding individuals within AIPG. Over the 63 years of our existence, many outstanding people have laid the foundation for this vibrant, active organization. Our National Awards recognize the contributions of these individuals. These awards include:

- The Ben H. Parker Memorial Distinguished Service Medal
- The Martin Van Couvering Memorial Service to the Institute Award
- The John T. Galey Sr. Memorial Public Service Award
- The John Stewart Memorial Early Career Professional Award

AIPG also recognizes Outstanding Achievement and Major Contributions to the field of geology along with providing an award of Honorary Membership to the Institute, and Presidential Certificates of Merit to recognize outstanding contributions that may not rise (yet) to the level of a national award. The list of recipients of awards reads like a Who's Who of geology and includes internationally recognized scientists and authors (e.g. Stephen J. Gould, John McPhee) along with members of AIPG who have made lasting impacts on our organization and our field. I hope you'll take some time to read about the fantastic honorees in this edition of TPG. I also strongly encourage you to nominate deserving geologists and scientists to receive AIPG's highest honors. You can find more information and links to make nominations at aipg.org/page/Awards.

The Annual Meeting is also host to one of our National Executive Committee meetings. At these meetings we take up the important business of the institute. Often our fall meeting includes discussion of the proposed budget for the next fiscal year. Our budget process starts with the National Treasurer and Executive Director working together to propose a draft budget. That budget then goes to the AIPG Finance Committee for review and comment. Following any changes that may be recommended, the Finance Committee then sends that budget to the National Executive Committee for review and approval. When the process is complete, as many as 20 people will have reviewed the budget providing critical feedback and oversight. This budget process helps us wring every dollar of value from the funds you, our members, entrust to us. Each of our Executive Committee meetings is open to all AIPG members and a virtual option is provided. I invite all our members to attend our Executive Committee meetings and participate in the governance of our organization. Your perspectives and voices play a critical role in determining the direction AIPG will take.

The 2027 Annual Meeting will be held from September 25-28 in Salt Lake City, Utah. I encourage all of you to mark that date on your calendar and come to join us for another outstanding AIPG Annual Meeting. I hope we will see you there.

With warmest wishes,

Aaron W. Johnson, CPG-12229



Annual Meeting field trips are another highlight of the event. Attendees of the Hidden High Grade - Exceptional Nickel and Manganese Deposits of Minnesota. Photo credit: Jess Scanlan, MEM-3979.



How do you spend Sunday at the AIPG Annual Meeting? On a field trip, of course! Attendees of the Classic Outcrops of Northern Minnesota. Photo credit: Jess Scanlan, MEM-3979.



Continuing Education

Chuck Drake, CPG-11197
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In the context of this President's Message, I'm referring to my personal continuing education in geology and the AIPG. I learn and re-learn continually about the importance of geology to the global economy and how the AIPG promotes our profession. At AIPG National, the staff works behind the scenes every day running our organization so that the Ex Com has an easier job of fulfilling their responsibilities and making AIPG the Gold Standard. Thank you to Wendy, Cathy, Kathy, Kayla, Mona, Ashley and Aaron for another outstanding year!

My continued education in geology happens on our incredible field trips held during and part of our National conference and while I'm on vacation…I never stop looking at rocks and wondering about the geologic processes that created them and put them there for us to see.

I met a former colleague and backpacking freak (freak in a good way!) near Leadville, Colorado in July and we took a couple of easy hikes to Ptarmigan Peak and Resolution Hill. We took it easy because going from sea level in Orlando to 12,000 feet above sea level is sometimes a little difficult.

We were close to 12,000 feet and saw some very interesting conglomerates and then recognized limestone and chert along the trail. We weren't sure about the chert so we did the smell test by first striking two pieces together; and it indeed smelled burned (photo left). A little way down the trail (photo upper right) we saw what was, surely, limestone so we concluded that the other sample we saw was also limestone. Someone had found a large specimen along the trail and kindly put it on a boulder so that the few of us that hiked up there could see it. To that person, I thank you. It is a very cool specimen of limestone and chert with the chert all throughout it like veins.


Limestone and chert sample

I checked it out online when I got cell service and found that we had been in the Leadville Limestone Formation and which was around 320 million to 350 million years old.

It still boggles my mind that limestone and chert are now at 12,000 feet above (current) sea level and that the uplift that caused it started happening shortly after it was deposited hundreds of millions of years ago. I have a copy of *"Colorado Rocks"* that I referred to and started reading about the Leadville Limestone and the local geology. Continuing education…


Limestone cliff


Large limestone and chert sample

Being from Florida, I see limestone quite often, in our springs, in limestone mines in the middle of the state and in core borings. Knowing that that limestones were formed under the oceans and see some that are at sea level, 12,000 feet above sea level, and in Florida from 200 feet below land surface to several thousand feet below land surface, really makes me think about our dynamic Earth and the scale of it all.

On one of our AIPG National conferences in Traverse City, in 2007, we went to a limestone quarry in eastern Michigan near the shore of Lake Huron. There, I saw what I thought were *turritella* fossils but have recently learned, again more continuing education, they probably weren't true *turritella*.

Continued on p. 44



You Don't Have to Have It All Figured Out:

Building Your Career as an Early Career Professional

Skylar Vertes, ECP-1122

A few months after graduating, I realized I was already being asked questions I did not know how to answer. Where did I see myself in five years? What did I want to specialize in? Did I plan to pursue a master's degree? What kind of role did I ultimately want to have?

None of these questions are unreasonable. They are often asked by people who genuinely want to assist us with a plan for career establishment and direction. Still, when you are just getting started, they can create the impression that you should already have a clear roadmap for your career before you have had a chance to explore it.

I did not have a clear picture of where my career would lead then, and I have learned that I did not need one. What I have learned is that a career in geology rarely follows the neat, predictable path we imagine as students. The geosciences are simply too broad for that. There are industries you may know little about, technical specialties you have not encountered, and opportunities that do not appear on your radar until you are already working. Many of the experiences that shape us are things we could not have planned when we graduated.

A career does not have to begin with certainty. It can begin with curiosity, a willingness to learn, and the confidence to take the next step even when you cannot see the entire path.

Your First Job is Not Your Final Destination

Like many geologists, I entered the workforce with a idea of where I thought my career might go. Then I started working and realized how much larger the profession really is. School teaches us geology. The workplace teaches us what it means to be a geologist.

Projects introduce us to new technical challenges. Clients and colleagues expose us to different perspectives. A field assignment can spark an interest in work you had never considered, while a difficult project can show you which skills you want to strengthen. Some experiences confirm interests you already had. Others change the way you think about your career altogether.

That is not a sign that you are off course. It is the process of finding your direction.

Early-career professionals sometimes put unnecessary pressure on themselves to choose a specialty immediately or decide exactly where they want to be ten years from now. But your first job is not a commitment to one path forever. It is a starting point. Every project and responsibility teaches you something about what you enjoy, what you are good at, and what kind of work motivates you. Just as important, some experiences teach you what is not the right fit. That knowledge is valuable too.

Instead of treating each early decision as permanent, focus on building a strong foundation. Learn the work in front of you, ask thoughtful questions, and pay attention to the parts of the job that make you want to learn more. Your direction will become clearer as your experience grows.

Say Yes to Opportunities That Stretch You

Some of the most valuable opportunities I have had were the ones that initially made me wonder whether I was ready. Giving presentations, taking on unfamiliar responsibilities, volunteering with professional organizations, attending conferences, writing articles, and stepping into leadership roles all required me to move beyond what felt comfortable.

It is easy to assume that confidence should come before action. In my experience, it usually works the other way around. Confidence grows after you try something difficult, work through the uncertainty, and realize that you can handle more than you thought.

Saying yes to everything is not a scalable approach to growth. Protecting your time, managing your workload, and recognizing your limits are also important professional skills. The point is to notice the opportunities that align with your interests and offer a meaningful chance to grow. You do not have to feel completely prepared before taking one on. Sometimes figuring it out is exactly what prepares you for the opportunity that follows.

Growth often begins with a little discomfort. If something interests you and challenges you in the right way, do not let the fact that it is new become the reason you turn it down.

Being a Good Geologist Is About More Than Technical Knowledge

As geologists, we naturally spend a great deal of time developing technical knowledge. That foundation matters. It allows us to

understand complex conditions, evaluate evidence, and produce work that others can trust. But it did not take long for me to realize that technical ability is only part of being effective in a professional setting.

At some point, every geologist has to explain complicated information to someone who does not speak the language of geology. That person may be a client, regulator, project manager, colleague from another discipline, or member of the public. In those moments, success is not only about reaching the right conclusion. It is about communicating that conclusion in a way someone else can understand and use.

Can you write a clear report? Can you explain why a technical detail matters without losing your audience? Can you present your work with confidence, collaborate across disciplines, and ask the right questions when you do not know the answer? These skills may receive less attention in school than technical coursework, but they become more important as our responsibilities grow.

For early-career professionals, developing communication skills alongside technical expertise is one of the best investments we can make. Being able to do the work is essential. Being able to explain why the work matters is what helps that work make an impact.

Build Your Professional Identity Early

I once thought professional involvement was something people pursued after they became established in their careers. Over time, I have come to see it differently. Getting involved early can help shape the professional you become.

Professional organizations give us opportunities to meet people outside our immediate workplaces, learn about career paths we may not otherwise encounter, and develop skills that do not always fit within our day-to-day roles. They also remind us that geology is larger than any one company, project, or job title.

My involvement in a leadership role with AIPG has been one example of this for me. It has given me the chance to work with people from different sectors and career stages, think about what early-career professionals need from the broader geoscience community, and see how many different ways there are to build a meaningful career in geology.

You do not have to wait until you are a senior professional to contribute. You can volunteer at an event, help organize a webinar, attend a conference, write for a professional publication, or simply make an effort to connect with other geoscientists. Small steps can expand your perspective and strengthen the community around you.

Your professional identity is not defined only by your job title. It is shaped by the skills you build, the relationships you develop, the work you contribute, and the ways you participate in the profession.

Find People Who Will Help You Grow

No one builds a career entirely on their own. We learn from supervisors, coworkers, professors, peers, mentors, and people we meet through professional organizations. Each relationship can offer something different.

One person may help you strengthen a technical skill, while another offers perspective on a career decision. Someone else may encourage you to pursue an opportunity you would not have considered on your own. Mentorship does not have to come from one person, and it does not always need a formal structure. Often, it begins by finding people whose experience you respect, asking thoughtful questions, and staying open to what they can teach you.

The most valuable professional relationships are not necessarily transactional. They often grow through shared work, genuine curiosity, and mutual respect. A conversation at the right moment can change the way you view an opportunity or give you the confidence to take your next step.

Those relationships can also work in both directions. Early-career professionals may not have decades of experience, but we bring our own perspectives, skills, and questions to the profession. A strong professional community gives people at every career stage room to learn from one another.

You Are Allowed to Change Your Mind

Perhaps the most important realization I have had is that it is perfectly fine for your goals to change. The work that interests you today may not be the work that interests you five years from now. You may discover a technical specialty you did not know existed, develop an interest in project management or leadership, decide to continue your education, or realize that a path you once imagined is not the right fit.

Changing direction does not mean the time you spent getting there was in vain. Every experience gives you more information about what you value, what energizes you, and where you want to grow next. Even the experiences that lead you away from something help you make better decisions about what comes after it.

Early career should be a period of exploration. It is a time to build technical skills, develop professional relationships, try different kinds of work, and learn what kind of professional you want to become. There is value in setting goals, but there is equal value in leaving room for those goals to evolve.

Exploration is not a sign that you are behind. Exploration is part of the work of building a career.

Keep Moving Forward

If there is one message I would share with other early-career geoscientists, it is this: do not let the pressure to have everything figured out keep you from moving forward.

It is easy to compare your path with someone else's, especially when it seems that everyone around you has already found a specialty, earned another degree, moved into management, or established a clear professional identity. Career development rarely happens as neatly as it appears from the outside.

Instead of focusing on a perfect five-year plan, focus on continuing to build your skills and seeking experiences that help you grow. Ask the question. Volunteer for the opportunity. Attend the conference. Reach out to someone whose career you admire. Learn something outside your job description. Take on a challenge that makes you a little uncomfortable and pay attention to the work that makes you want to learn more.

A career is built one experience at a time, and we cannot always predict which experiences will shape us most. As early-career professionals, we have room to explore, make mistakes, change direction, and continue learning. We do not need to know exactly where the road ends to take the next step.

Sometimes the path becomes clear only after we start walking it.

Answers on Page 43



Robert G. Font, CPG-03953
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1. Which of these was not an apex predator in Jurassic time?



a) Allosaurus.
b) Liopleurodon.
c) Saurosuchus.
d) Torvosaurus.
e) Genius paleontologist/biologist at W.E.R.M.A.D. University states: "Using DNA, I crossed an allosaurus with a parrot. I don't know what I have, but WHEN IT TALKS, YOU BETTER LISTEN!"

2. Victor Moritz Goldschmidt (1888-1947) is considered the "father of modern geochemistry." A mineralogist and geochemist, he came up with the concept of the mineralogy phase rule that states that the number of minerals in any rock will not exceed the number of chemical components.

P + F = C + 2

Which country claims this distinguished scientist?

a) Germany
b) Denmark
c) Norway
d) Italy
e) "Country road, take me home, to the place, I belong…"

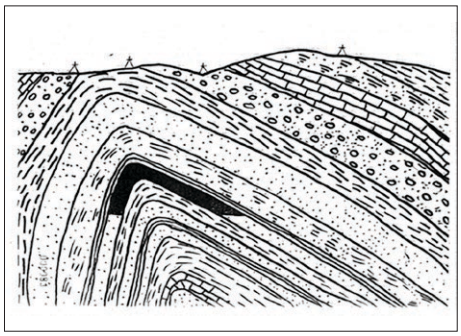
3. What is vanadium used for?

a) To power commercial nuclear reactors that produce electricity, as well as to produce isotopes used for industrial, military (defense), and medical purposes.
b) To make paint, ceramics, pipes and plumbing materials, solders, as well as gasoline, batteries, cosmetics, and ammunition.
c) Mainly to produce lithium-ion batteries, and in the manufacturing of magnetic, wear-resistant, high-strength alloys. Also, to make air bags in automobiles and as a catalyst in the chemical and petroleum industries.
d) To produce tough steel alloys used in the making of tools, axles, piston rods and for usage in space vehicles, aircraft carriers and nuclear reactors.
e) Man, I would say that vanadium tablets are good for motion sickness when you ride to the stadium in the back of a passenger van."

4. We are describing a "benthic organism." What is it?

a) An animal that lives on the sea floor.
b) An aquatic organism (plant or animal) that is a drifter or wanderer; that is moved by currents and tides and that can't swim well enough to travel against them.
c) A marine organism that can swim and move independently of moving water.
d) An organism that lives in the open seas, away from the bottom and the shoreline.
e) "Know it all" dude says: "A benthic organism is an aquatic creepy crawler that feeds on benzene and tics!"

5. What is the definition of "API gravity?" Remember that API stands for the "American Petroleum Institute." API gravity is a measure of how heavy or light a petroleum liquid is as compared to water. Designed so that most values fall between 10^{o} and 70^{o}, the formula is:



a) API gravity = (141.5/SG at 32 degrees F) + 131.5, where SG is the specific gravity of water.
b) API gravity = (141.5/SG at 60 degrees F) – 131.5, where SG is the specific gravity of the fluid.
c) API gravity = (141.5/SG at 212 degrees F) * 131.5, where SG is the specific gravity of water and the fluid.
d) API gravity = (141.5/SG at 60 degrees F) ÷ 131.5, where SG is the specific gravity of the fluid.
e) API gravity describes a grave condition of absolute, pure insanity!



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

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Non-overlapping magisteria (NOMA)

Stephen Jay Gould developed the concept of the non-overlapping magisteria between science and religion in his March 1997 essay in *Natural History*[1] and his 2002 book, *Rocks of Ages: Science and Religion in the Fullness of Life*. Gould points out that science and religion each represent different areas and methods of inquiry, fact versus values or "is" versus "ought," and that these two fields do not overlap and are therefore not in conflict. If you are not familiar with NOMA, I urge you to read either the essay or the book.

I introduce the topic of NOMA because although geology is part of the magisteria of science, professional ethics are part of the magisteria of religion (broadly defined as values or "oughts"). This leads to the following discussion of the basics of morality and ethics.

Common Morality–Deciding What to Do

(Column 99, Sep/Oct '05)[2]

In column 55 (June '00), I reviewed Bernard Gert's *Morality: Its Nature and Justification* (1998, Oxford Univ. Press, 408 p.). I find that Gert's exploration and explanations of common morality provide a fundamental and realistic basis for moral and ethical analysis, for examination of the more difficult or contentious issues presented in this column. Gert has published a much shorter and refined version of his ideas in *Common Morality–Deciding What to Do* (2004, Oxford Univ. Press, 179 p.). Everyone who is serious about the study of morality and ethics, professional or otherwise, should read this book.

Gert maintains that common morality, a system of informal rules, ideals, and procedures that are recognized by all societies we know about, "is the moral system that thoughtful people use, usually implicitly, when they make moral decisions and judgments." Gert does not claim to have created or developed common morality unlike so many philosophers. Rather, Gert has provided a detailed description of something that previously existed. Gert maintains that his "detailed description of common morality provides a framework that all parties to a moral dispute can accept, even though they may disagree with each other on what morally ought to be done in a particular case."

One of Gert's fundamental observations is that a complete moral theory should not and cannot result in unique answers to every moral question. Failure to accept that unique answers are not possible is among the reasons that ethical systems advocated by such philosophers as Kant and Mill are incomplete and impractical. Column 198's discussion of "Carnal embraces between professors and students" provided differing answers to the issue, one of them based on the principles endorsed by a small Christian university that "explicitly forbids employees from engaging in romantic relationships outside of marriage, which it defines as a union between a man and a woman." Recognition of the dietary restrictions of various religions, allergy, or personal ethical choices are considerations that those proposing a menu for a professional society gathering must consider (the AIPG's Code of Ethics, CANON 4 states, "Members should respect the rights, interests, and contributions of their professional colleagues."

Gert points out that the lack of unique answers to moral questions stems from four unresolvable difference factors.

1. The scope of morality; that is, who is covered by the moral rules. Gert points out that differences in opinion about if and when fetuses are fully human are covered by the moral rules are at the heart of the debates over abortion. Similarly, the more extreme animal rights activists who believe that all animals, or at least all mammals should be covered by the moral rules, do not represent a common view and so most of us have no moral qualms about eating meat and wearing leather shoes and belts.

2. The ranking of harms and benefits resulting from taking a particular course of moral action differs. The changes in airport security procedures, etc. following 9/11 or with mandatory masking during the Covid-19 epidemic with the consequent loss of personal freedom in order to increase the public's safety are examples.

3. The harmful and beneficial consequences of the violation of a moral rule being publicly allowed when the moral analysis is based on ideological views that are not open to empirical investigation. The debates over creation science and

1. Gould, S. J. (1997). "Nonoverlapping Magisteria" (https://web.archive.org/web/20190403152432/http://www.stephenjaygould.org/library/gould_noma.html). Natural History 106 (March 1997): 16–22 and 60–62.
2. I'm reprinting this topic because it is fundamental to understanding the applications of the AIPG Code of Ethics and other professional ethics/conduct codes.

similar alternatives to evolution are of this type.

4. "The interpretation of a moral rule, such as whether turning off a respirator of a ventilator-dependent patient who has refused further treatment counts as killing."

Recognition that common morality does not provide unique answers to all moral questions can allow those on opposite sides of an issue to mutually respect the legitimate moral position of those on the other side and this can help in arriving at solutions. Gert points out that a consequence of the inability of morality to uniquely decide such questions is one of the reasons that government and legal systems, which are devised to provide unique answers, are necessary. For example, in the discussion of whether contingency fees should be allowed for expert witnesses (a preceding topic in Column 99), Bill Greenslade noted that the argument that such fees allow those with little financial means access to experts vied with the potential for encouraging biased testimony in the Arizona Board of Technical Registration's (BTR's) debate. The BTR's decision to prohibit the acceptance of such fees legally decides the question even though some feel that this was an incorrect decision. Gert recognizes that common morality's failure to provide unique answers to all moral questions annoys some people. But he maintains that by allowing people of differing views to respectfully talk to each other, it can help eliminate dogmatism and relativism. As Gert notes, "The most persuasive argument in favor of ethical relativism, the view that equally informed rational persons need not agree on the answer to any moral question, is the falsity of the view that all equally informed rational persons must agree on the answer to every moral question." The universal agreement on a question required by either view proves them both false.

Gert observes that while common morality is complex, its complexity, like that of the grammar of a language, does not prevent it being understood by all rational people, even if the details of the system are not explicitly reviewed every time a moral decision is made, just as those fluent in English can use the future pluperfect even if they never learned or forgot the formal definition of that tense.

Common morality includes moral ideals and moral rules. Moral ideals and moral rules are frequently mixed together, as is the case with the AIPG Code of Ethics and most professional ethics codes and statements. Yet the distinction between moral rules and moral ideals is critical because only moral rules can be violated.

Moral ideals are intentional actions that "avoid, prevent, or relieve the suffering of harm of someone protected by the moral system." Most types of charity work qualify as acting on a moral ideal. Unlike moral rules, there is no need to provide detailed descriptions of moral ideals. Further, while people are encouraged to engage in actions that embody moral ideals, there is no requirement to do so and no punishment for not doing so, a significant difference from the requirement to follow the moral rules. Gert also points out that there is also a distinction between moral ideals, which seek to lessen harms suffered from utilitarian ideals that aim at increasing the amount of goods or benefits, although the distinction is not always clear.

Another characteristic of moral ideals is that it is not possible to achieve the ultimate goal of the moral ideal. For example, while one can contribute to a local food bank, none of us can relieve all the hunger in the world. Further, we are allowed to choose which morally ideal actions we engage in. Unlike moral rules, which should be observed impartially for all people, we can be partial in selecting both morally ideal actions and for whom those actions will be done. For example, I can choose to support AIDS education efforts and not similar efforts for heart disease. Or professionally, I can choose to contribute to the AIPG Foundation rather than similar foundations connected with other professional societies.

Gert's moral rules are:

1. Do not kill.
2. Do not cause pain.
3. Do not disable.
4. Do not deprive of freedom.
5. Do not deprive of pleasure.
6. Do not deceive.
7. Keep your promises.
8. Do not cheat.
9. Obey the law.
10. Do your duty.

Gert notes that the first five rules could be collapsed into "Do not cause harm" and the second five into "Do not violate trust" but notes that doing so results in a lack of specificity that impedes the utility of the system. For those who object to the negative "Do not" of most of the rules, remember that it is far easier to list what is prohibited than to list what is allowed, which are all other actions. Violation of a moral rule generally results in punishment of the violator if the violation becomes publicly known, unless the violation is a recognized exception to the moral rule.

Having listed the basic moral rules that all moral agents (generally but not exclusively rational adults) are expected to follow with respect to all persons covered by the moral rules, it is also clear that there are generally recognized exceptions to the moral rules. For example, self-defense is an almost universally allowed exception to the "Do not kill" rule. Likewise, most people permit surgeons to cut them open because they believe that greater harm will be avoided by the temporary harm resulting from surgery. The two-step process for determining whether a particular violation of a moral rule will be discussed below.

Gert's description of common morality also includes a eight-step procedure, again generally used implicitly, for determining whether a particular violation of a moral rule will be allowed. As explained above, we all recognize some exceptions to the moral rules such as willingly undergoing surgery that causes pain to avoid a greater harm of some sort. When everyone, or almost everyone, accepts a particular kind of violation, that violation is strongly justified. When there is disagreement about whether a violation should be allowed, for example, whether capital punishment is an allowed violation of the "Do not kill" rule, the violation is weakly justified.

The first step in the eight-step process for justifying violations of a moral rule is using the morally relevant features of the violation to describe the act. Gert provides a list for identifying the morally relevant features.

1. What moral rule(s) is involved?
2. Who is harmed?
3. What harm is avoided by the violation?
4. Can everyone violate the rule in the same way?
5. Is some sort of emergency involved?
6. Was the violation intentional?
7. Was coercion involved?
8. Are you willing to publicly acknowledge and accept the consequences of the violation? (Integrity)

Gert points out that the point of the foregoing list is to help identify the morally

relevant features and facts of the situation. Once these have been identified and agreed upon by all concerned parties, then arriving at a moral consensus may be easier, or at least the specific reasons for disagreement will have been identified.

For example, I earlier noted that most of us grant an exception to the "Do not cause pain" (and perhaps other rules) in the case of surgery. But I can think of two types of objections to surgery. One is the case of those who decide that surgery or other "heroic" procedures that will add a few more months of life due to temporary abatement of a terminal illness are not warranted. This case involves the relative rankings of harms and benefits. The other is the case of those whose religious faith objects to such procedures. This is another example of the third type of unresolvable difference discussed above.

The second step of the eight-step process is estimating the consequences of everyone knowing that kind of violation is, or is not, allowed. Gert expressly uses "estimated" in this step because accurate determination of the consequences is not always possible. When all agree that a particular kind of violation should or should not be allowed, the decision is strongly justified. When there is disagreement, particularly by a significant number of people, then the decision to allow or disallow the violation is weakly justified.

Integrity: the parenthetical after the 8th point above was *integrity*. Integrity requires three steps:

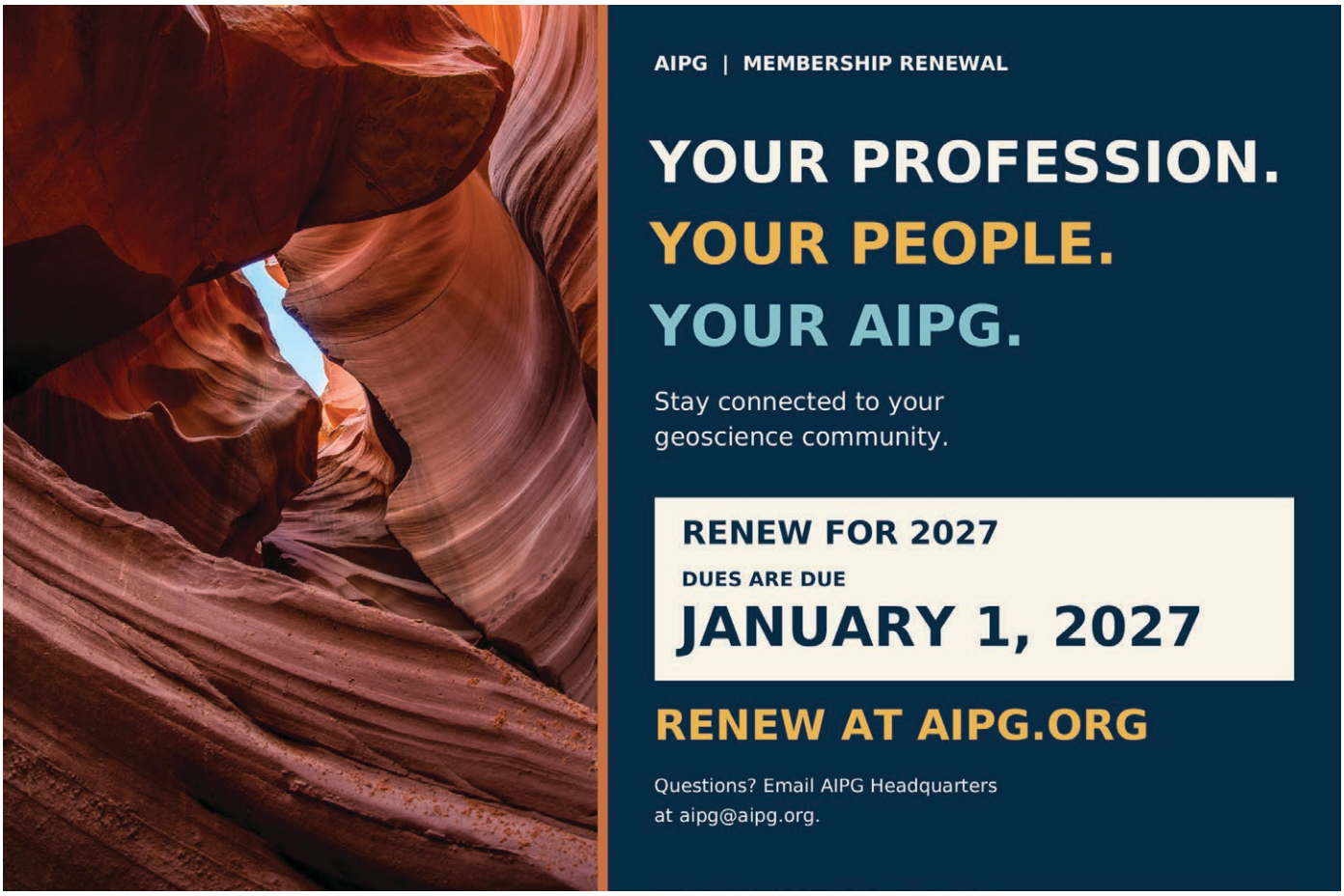
1. *Discerning* what is right and what is wrong;
2. *Acting* on what you have discerned, even at personal cost; and
3. *Saying openly* that you are acting on your understanding of right from wrong.

Integrity "conveys not so much a single-mindedness as a completeness; not the frenzy of a fanatic who wants to remake all the world in a single mold, but the serenity of a person who is confident in the knowledge that he or she is living rightly." "Integrity…is not the same as honesty…it is clear that one cannot have integrity without also displaying a measure of honesty. But one can be honest without being integral" (Stephen L. Carter, 1996, *Integrity*).

Conclusion: Ethical and moral analysis requires discrimination:

- Identifying the ethical or moral principle(s) involved.
- Discriminating between relevant and irrelevant facts.
- Being logical
- Being objective
- Being consistent—all similar cases must be treated the same way.
- Not every moral or ethical question has a unique answer or solution. Being respectful of other views can allow for discussion of the issue(s) involved.

The foregoing is a brief summary of Gert's explanation of common morality. I urge everyone to read his book, which is itself a summary of Gert's *Morality: Its Nature and Justification* (1998) that more serious students of morality will want to read as well. I believe that common morality provides a required and firm basis for the exploration of professional ethics. The ideas and procedures that Gert makes explicit in his books underlie, usually implicitly, the discussions of professional ethics in this column.





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Answers:

1. The answer is choice "c" or "Saurosuchus." Please see below:

Predator	Type	Time Span	Size (feet)
Saurosuchus	Loricatan pseudosuchian archosaurs	Late Triassic	18 -23
Liopleurodon	Plesiosaurian pliosaur	Mid-Late Jurassic	13-33
Allosaurus	Saurischian theropod	Late Jurassic	28-32
Torvosaurus	Saurischian theropod	Mid-Late Jurassic	30

2. The answer is choice "c" or "Norway." To be precise, Goldschmidt was a Swiss-born Norwegian mineralogist. A series of publications under the title "Geochemical Laws of Distribution of the Elements" is usually referred to as the start of modern geochemistry. His famous "mineralogy phase rule" is commonly presented in the form **P + F = C + 2**, where P refers to the number of phases that are present within the system, C is the minimum number of independent chemical components that are necessary to describe the composition of all phases within the system, and F refers to the variance or degrees of freedom (e.g., the number of variables, such as pressure and temperature, that can be independently changed without altering the state of the system).

3. The answer is choice "d" or "To produce tough steel alloys used in the making of tools, axles, piston rods and for usage in space vehicles, aircraft carriers and nuclear reactors."

23	
V	
Vanadium	
50.942	

Atomic number	***23***
Atomic weight	***50.942***
Atomic mass number	***51***

Vanadium

Some minerals containing vanadium include patrónite (VS_4), carnotite [$K_2(UO_2)_2(VO_4)_2 \cdot 3\ H_2O$], and vanadinite [$Pb_5(VO_4)_3Cl$]. Vanadium is also found associated with titaniferous magnetite [$Fe^{2+}(Fe^{3+},Ti)_2O_4$] ores. The top countries which produce vanadium include China, Russia, South Africa, and Brazil.

China	**~ 68,000 metric tons in 2023**
Russia	**~ 20,000 metric tons in 2023**
South Africa	**~ 9,100 metric tons in 2023**
Brazil	**~ 6,400 metric tons in 2023**

Vanadium production (top countries}

Choice "a" refers to uranium. The main ore is uraninite (pitchblende) or (UO_2). Choice "b" refers to lead. Galena (PbS) is the main ore. Choice "c" refers to cobalt. Ores include cobaltite (CoAsS) and erythrite [$Co_3(AsO_4)_2 \cdot 8H_2O$].

4. The answer is choice "a" or "An animal that lives on the sea floor." Choices "b", "c" and "d" refer to planktonic, nektonic and pelagic organisms, respectively.

5. The answer is choice "b" or "API gravity = (141.5/SG at 60 degrees F) – 131.5, where SG is the specific gravity of the fluid."

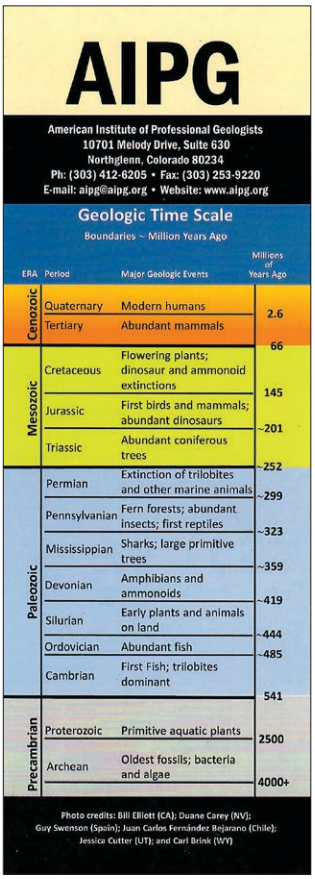


Now, about choice "e"……



President's Message, continued from p. 35

A year or so later, I was in Albuquerque, New Mexico for an American Water Resources Association (AWRA) meeting and we took a ski lift (no snow at that time of year), up to around 10,000 feet above (current) sea level and saw the same fossils that I'd seen in the limestone in eastern Michigan at around 600 feet above sea level. Seeing limestones in Florida and Colorado and eastern Michigan all at different elevations allowed me to put two and three together and realize and remember and understand how our planet is connected by geologic processes. To me, it is incredible and wonderful to see these rocks across our nation in person and have some knowledge of how they were formed.



To continue my education, I had to look up when these limestones were formed; Pennsylvanian, Mississippian and Devonian. I know limestones were formed in other Periods, such as the Permian, but I'm referring to the ones that I saw…I can read about these Periods but I haven't memorized the chronological order so I keep my AIPG Geologic Time Scale with me so that I have a handy reference. In case you're wondering, I did memorize the Periods and Eras and maybe an Epoch…but that was a long time ago…

If you'd like a few of the bookmarks (pictured left), contact National HQ and I'm sure they'll be glad to send you some. They are great things to put out at a conference and give to kids when/if you give a geology talk. They love it!

My continuing education has greatly improved because of my membership in AIPG and for the years prior, in the Florida Association of Professional Geologists. Membership has allowed me to meet in person and virtually, geologists from across the U.S.A., Canada and Europe. We all have geology in common and I am fortunate to meet so many different people that talk the same language and can explain the complicated geologic structure to me; and I mostly understand it, although I do have to read a lot and refresh and re-learn the structural geology terms. Again, continuing education!

Serving as your president this year has been and will continue to be an honor. I appreciate and thank all of you for the work that each of you does every day and that you have a profession and career that helps all of us in our daily lives.

On a personal note, I recognized a longtime friend and fellow geologist with a Certificate of Merit for his dedication to geology. I met Jim Pease at community college in Orlando around 1978 or so where we took a couple of geology courses. We went to different universities in Florida but kept in touch over the decades. When the Florida Association of Professional Geologist merged with AIPG around 2007, Jim was a reference for me to obtain my CPG. So, Jim, without your reference (and the others, too!) I wouldn't be writing this!

I'll close with what I wrote in a previous message and hope you remember; "Geology: The Foundation of Everything."

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



Do you have overflowing bookcases? Piles of geologic maps? Feel like doing some spring cleaning or looking for a good home for your unwanted textbooks and coffee table books? AIPG wants to help you reduce, reuse, and recycle!

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

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

To make a donation of materials, please contact AIPG Headquarters at aipg@aipg.org or (303) 412-6205.

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

George R.R. Martin



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. The Foundation provides support to AIPG for the undergraduate scholarships awarded by AIPG. Additionally, the Foundation awards 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. These grants are only possible through your generous donations. Every donation helps the Foundation to contribute toward building the future of geology.

This year the Foundation granted funding to AIPG in support of the undergraduate scholarships awarded by AIPG. Additionally, the Foundation awarded its own William J. Siok Graduate Student Scholarship for $5,000. Grants were also awarded to AIPG for the National Conference in Duluth for the Student/ECP Career Workshop, Student Poster Session Prizes, and Social Media Support from Mine Life Media at the Conference.

Through our relationship with Mercer Advisors, the Foundation is prepared to support a variety of additional ways to give beyond cash contributions that may allow you to align your philanthropic priorities with your broader financial and legacy goals. Methods of giving include planned gifts and bequests, donations from an IRA, and charitable trust, among others. Please contact me or any of the Trustees for additional information.

Each donor's circumstances and goals are unique. The Foundation welcomes the opportunity to work with you and your advisors to explore giving options that align with your values and support the future of the geosciences. Please contact me or any of the other Trustees 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

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YouTube Channels for Geoscience Education

Rasoul Sorkhabi, Ph.D., CPG-11981

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

When I was a student, there was no Internet, websites or emails. We read books and magazines on print paper, listened to lectures in classrooms, wrote on white or black boards, did Q&A in person, and watched documentary films on TV. Compared to today, we had fewer educational tools, but we learned from scratch. Today's students with a whole wide world loaded on their small and smart phones cannot probably imagine life, work and education without Internet. My generation has indeed witnessed one of the most dramatic social transformations in history – the emergence of a digitally connected world. Two of my favorite science films, from my school years, were (and still are) Jacob Bronowski's *The Ascent of Man* produced by BBC and Carl Sagan's *Cosmos* produced by PBS. Both BBC and PBS are still around and continue to produce good films. But a few decades ago, we could not imagine that one day any person in any part of the world could launch a TV channel of his or her own and for free. YouTube, for instance, has given everyone that capability. This kind of technological advancement has been good for education, and in my geology classes I usually use various YouTube videos for teaching. In this article I would like to share ten geoscience-related YouTube channels. Most of the videos posted on these channels are fun to watch and I have personally learned much from documentary videos on YouTube channels.

(1) Mike Sammartano Channel[1]

A former Earth Science teacher in a middle school in New York and an expert in K-12 educational technology, Mike Sammartano's YouTube channel has over 200 highly informative videos related to Earth Science. He created his channel in 2011 (one of the earliest to do so) and has close to 140,000 subscribers. Many of his videos are 5 to 15 minutes long (perfect for classrooms) and have been viewed each by tens to hundreds of thousands of people. Here are some examples: What is geology? What is the rock cycle? Understanding minerals. Mineral Identification. Igneous rocks. Sedimentary rocks. Metamorphic rocks. Understanding plate tectonics. Earthquake epicenter prediction. Seismogram analysis. How to determine Richter magnitude.

(2) London Jenks Channel[2]

An experienced high school science teacher, London Jenks created his channel in 2009 (one of the earliest). His playlist includes over 200 videos, a quarter of which are related to Earth science. His video clips are very short, 2-4 minutes each.

(3) Geoscience Videos[3]

Launched in 2014, the channel includes 42 videos, each 5 to 6 minutes each. The material and presentation are very well designed and easy to understand. Most videos are about Rocks and Minerals, Plate Tectonics, Hydrologic Cycle, and Geologic Time.

(4) Geology Hub[4]

"This channel is run by a full-time geologist/volcanologist who graduated from Arizona State University." Launched in 2017 the channel includes 1800 short videos, mostly on "state geology" (from Arizona and Arkansas to Utah and Washington) and "Volcanoes" (in Japan, Greece, Mexico, Africa, Italy, United States, and so forth).

(5) Crash Course Geology[5]

Crash Course Channel was launched in 2006. It covers various sciences including Crash Course Geology which includes 10-minute recordings on such topics as How did Earth form? What's at the center of the Earth? How do minerals form? How do mountains form? What is plate tectonics?, etc.

Also check out Crash Course Geography which has very good videos related to geoscience: Mineral Extraction; How rivers shape

1. https://www.youtube.com/@mikesammartano/featured.
2. https://www.youtube.com/@JenksScience/featured.
3. https://www.youtube.com/@GeoScienceVideos/featured.
4. https://www.youtube.com/@GeologyHub/featured.
5. https://www.youtube.com/@crashcourse/playlists

the landscape; What are rocks and how they form; The plate tectonic revolution; Climate science; Natural hazards, and so forth.

(6) Geology Science[6]

The France-based channel was launched in 2021 and includes 58 videos. They are mostly 3-5 minute video clips on "Geological Wonders" such as Carlsbad Caverns, Devil's Tower National Monument, Jordan's Petra City, etc.

(7) Geo Girl[7]

Created by Rachel Philips, PhD from the University of Texas at El Paso, and currently a National Science Foundation STEM Education Postdoctoral Research Fellow and instructor at the University of South Carolina. She was elected a GSA Science Communication Senior Fellow for 2025-26.

Philips originally started the YouTube channel in 2020 to offer remote lectures to her students during the Covid-19 pandemic, but the channel quicky grew worldwide, now with nearly 140,000 subscribers and including nearly 400 videos. The playlist includes Careers in Geoscience, Field Videos, Interviews with Geoscience Experts, Mass Extinctions & Ice Ages, Global Biogeochemical Cycles and Climate Change, Metamorphic Petrology, Sedimentology & Stratigraphy, Astrobiology & Planetary Geology, Mineralogy, Geochemistry, Depositional Environments, Earth History, Physical Geology, Invertebrate Paleontology, and Science Communication.

(8) Nick Zentner Channel[8]

Nick Zentner teaches geology at Central Washington University in Ellensburg, Washington. He created his channel in 2012 and has nearly 900 videos. His playlist includes Downtown Geology Lectures (about one hour each), Pacific Northwest Videos (about 20 minutes each), Past A to Z Videos, and Field Videos.

(9) Geology Explained by Shawn Willsey[9]

Created by an Idaho-based professor of geology, the channel (launched in 2014) offers hundreds of video recordings under several packages: Geology 101 (30-minute PowerPoint lecture style recordings), Rock Identification series, National Parks and Monuments, and very informative field trips to parts of Arizona, Oregon, Wyoming, Nevada, California, Utah, Idaho, Washington State etc.

(10) Myron Cook Geology[10]

If you are interested in in-depth geological investigations of various places in the USA, field geologist Myron Cook is your man. He launched his channel in 2016 and has created only 40 videos so far, but it takes lots of time and traveling to do such field-based geology videos. In each video he introduces a field geology puzzle and then investigates it based on evidence and geological reasoning. Fun to watch and sharpen your field geology skills.

YouTube Channels of Professional Societies

The ten YouTube channels I introduced above are mainly individual efforts. Professional societies such as American Geophysical Union (AGU)[11], American Geosciences Institute (AGI)[12], Geological Society of America (GSA)[13], American Institute of Professional Geologists (AIPG)[14], American Association of Petroleum Geologists (AAPG)[15], The Geological Society of London (GSL)[16], European Geoscience Union (EGU)[17], European Association of Geoscientists and Engineers (EAGE)[18] have their own YouTube channels which offer lots of useful educational recordings for teachers and students.

6. https://www.youtube.com/@geology-science/featured
7. https://www.youtube.com/@geology-science/featured
8. https://www.youtube.com/@GeologyNick/featured.
9. https://www.youtube.com/@shawnwillsey/featured.
10. https://www.youtube.com/@myroncook/featured.
11. https://www.youtube.com/@AGUvideos/featured.
12. https://www.youtube.com/@AmericanGeosciences/featured.
13. https://www.youtube.com/@geosociety/featured.
14. https://www.youtube.com/@aipg6684/featured.
15. https://www.youtube.com/aapgweb.
16. https://www.youtube.com/@TheGeologicalSociety/featured.
17. https://www.youtube.com/@egu/featured.
18. https://www.youtube.com/@EAGEchannel/featured.

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Guidelines: www.aipg.org/page/TPGArticleSubmittal

In Memoriam

Raymond L. Schreurs, CPG-00784

St. Louis Park, Minnesota

Passed on June 15, 2026

Member Since 1965



Photo and obituary obtained from the Quinn Shalz website.

Ray was born June 10, 1926 in Lincoln Nebraska and died quietly on June 15, 2026. Ray was very happy to celebrate his 100th birthday with family.

Providing for his family and serving his country were very important to Ray. After his South Pacific service in the Navy during WW II from 1944 to 1946 Ray graduated from the University of Nebraska on the GI Bill with a degree in Geology.

Family and career were intertwined for Ray. While conducting fieldwork for his US Geological Survey groundwater resource map of Nebraska Ray fell in love with Leola Urwiller. Le's father was a progressive farmer with some of the first irrigation wells in the Platte valley. Ray and Le married 75 years ago in 1951 and soon moved to Memphis, TN where they lived until 1956.

Ray and Le's first son Steve was born in 1956 followed by Darr in 1958. Ray's position as sales manager at Johnson Screens in St. Paul, MN involved extensive travel, keeping him away from his family, often for weeks at a time. After a few years traveling his northwest US sales territory Ray's responsibilities broadened to include the rest of the US, Canada and eventually the world. Le supported Ray's career by raising the boys, managing the household and working as a home economics instructor for underprivileged families.

Travel to interesting places continued to define Ray's family and professional life. There were many family road trips throughout the US and extensive professional travels, including flying around the world in 1966. Le accompanied Ray on many of these trips. They moved to England in 1976 for three years while Ray opened an international sales office in London to focus on Europe, Asia, and Africa.

After Ray retired from Johnson Screens in 1989 he worked as a private geology consultant until 2004, continuing his travel to far flung locations. Meanwhile Le pursued a professional career in computer programming for Wilsons Leather that took them to South Korea for weeks at a time. Ray was awarded patent #3756949 for a process to rejuvenate failing water wells and was proud of helping so many people throughout the world achieve good, clean, safe water.

Upon retirement Ray and Le continued to travel, taking many Elder Hostel and Road Scholar bicycle tours, mostly to Europe. Together they visited over 70 countries during their lifetime of travel. Ray and Le also made time to volunteer extensively at Hampden Park Co-op, Planned Parenthood, First Unitarian Society of Minneapolis and at Parkshore.

William H. Hoyt, PhD, CPG-07015

Windsor, Colorado

Passed on July 7, 2026

Member Since 1986



Photo and obituary obtained from the Mark's Funeral Service website.

William Henry (Bill) Hoyt passed peacefully to heaven at his home in Windsor, Colorado on Tuesday, July 7th, surrounded by family. Bill was born on July 5th, 1952 to parents Nelson Landon III and Barbara McAdams Hoyt in Evanston, Illinois. He spent his early life developing a steadfast love of the water, spending many summers at the old family home on Lake Michigan in Winnetka, IL. Bill attended New Trier High School, and loved playing baseball and especially soccer there in his youth. For his undergraduate degree, Bill attended Middlebury in Vermont.

He chose Environmental Studies (Geology) as his major after learning that the journalism program was full. He recalled this was "probably the best thing that happened to him". During college, Bill spent many summers as a camp counselor at a wilderness and canoeing camp in Minnesota. Adventures at Camp Koochiching fueled many stories that Bill shared with his children and later on, his grandchildren. "The Polar Bear story" (a true story of survival in the wilderness) is the most requested story. Bill had a long and successful academic career, obtaining both his master's (SUNY Albany) and PhD (University of Delaware) in Marine Geology, and going on to be a professor of Oceanography at the University of Northern Colorado (UNC) for 38 years. He served as department chair and ultimately won the M. Lucile Harrison award - the top faculty honor at UNC for lifetime achievement of outstanding teaching, research, and service.

Bill's professional career began with a heavy interest in marine geology and sedimentology research. This keen interest began because his Middlebury senior research thesis on Lake Champlain was used in a Supreme Court case. This is how he caught the "research bug." He chose professorship at UNC over other job offers because "living in Colorado is every geologist's dream." He never regretted the choice. In 1990, continuing his research took him and his young family to live in Sydney, Australia for six months so he could study the effect of the rising sea level on coral reefs. As his professional interests grew, so did his interest in mentoring and educating students. In 1998, his love of research, education, and the sea, brought a second sabbatical leave to Woods Hole, MA to be the chief scientist aboard Sea Education Association's (SEA) sailing school vessel, Westward.

Bill's love for science and education led him to play a foundational role in establishing and shaping the Poudre Learning Center (PLC) in Greeley. Beginning with visioning sessions in the mid-1990s, Bill was part of the original small group of educators, community leaders and naturalists who envisioned a nearby nature space for students. Bill helped turn a vision of environmental education into a 198 acre premier outdoor classroom. His key contributions to the center and its foundation included: co-founder and visionary, Poudre River Trail Education Committee and board member, PLC board of directors, student research sponsor and environmental mentor. Bill has used the facility to bridge higher education with community programs. Students, teachers and young scientists will benefit from his involvement for decades to come.

It's true that Bill had an amazing career and impacted many, many students during his time at UNC - and in recounting his own life, this is one of the things he would focus on. However, his family and friends will remember him for his outstanding character and deep love for those close to him. Bill always had an amazing sense of adventure, leading numerous family trips and explorations all over the world. He always found a way to provide education to his three kids on the local geological features wherever they traveled. His energy on these adventures was boundless. Bill and his wife, Cathy, were like two peas in a pod, and enjoyed so, so many adventures together while raising their kids, and in retirement as well. Bill and Cathy enjoyed backpacking, hiking, skiing, SCUBA diving, sailing and bicycling. Bill was an admired and adored uncle to many nieces and nephews, and it was often in his relationships with young people that you could see how special Bill was. He was always up to play and laugh; investing deeply in children and making them feel seen and loved. Though Bill loved to share tales of his many adventures, he was quick to listen and deeply cared for those in his life. Bill was truly the embodiment of "if it ain't broke, don't fix it" and often used clothing and various outdoor gear far past when his loving family had purchased a replacement. He was content with his life and what he had. Bill's character is perhaps best encapsulated in his favorite scripture from Micah 6:8, "He has shown you, O man, what is good. And what does the Lord require of you? To act justly and to love mercy and to walk humbly with your God."

Those who lovingly remember Bill are his wife and partner of 41 years, Cathy; his three grown children and their families; Sarah Lazear and daughter Fiona; Aaron Hoyt (Nina) and their children, Parker, Declan and Charlotte; and Anna (Tyler) Cloud and son Leo. Also mourning his loss are his siblings, Nelson Landon Hoyt IV (Debbie), Carolyn Westfall (Don), Steve Hoyt (Suzie), and Phelps Hoyt (Allison); along with siblings by marriage, Cheryl Kaufman (Gene), Dick Smith (Diana), and numerous cousins, nieces and nephews. He was preceded in death by his parents, Cathy's parents, brother-in-law, David Smith and son-in-law Danny Lazear.

If you would like to make a donation to honor Bill, please consider donating to the Poudre Learning Center, Habitat for Humanity or A Woman's Place. These are all charities that were close to his heart.

Linda M. Hensel, CPG-09867

Custer, Michigan

Passed on July 26, 2026

Member Since 1996



Photo and obituary obtained from Legacy.com website.

Linda Marie Hensel, age 68, of Custer, Michigan passed away on Sunday, July 26, 2026, at Intersect Health in Roscommon, Michigan.

Linda was born on August 5, 1957, in Highland Park, Michigan, the daughter of Stanley and Christine (Szczupak) Wieczorek.

Linda will be lovingly remembered for her deep appreciation of the outdoors and the peace she found on her property, often accompanied by her beloved cats. She took great joy in gardening, skiing, hiking, and rock hounding, and she had a lifelong appreciation for the beauty of nature. She was also a passionate sports fan, especially of the Detroit Tigers, Michigan Tech hockey, the Great Lakes Invitationals, the Detroit Red Wings, and even the Detroit Lions. She loved Music, played piano and French horn, and was involved in church choir and bells, which brought her happiness and community.

Linda had a vibrant, boisterous laugh and sparkling blue eyes that reflected her spirited personality. She was big sister to us all. She was truly one of a kind-irreplaceable-and will be deeply missed by all who knew her.

Linda was a Past President of the Michigan Section in 2015 and served on the Section Executive Committee from 2012 through 2016.

Linda is survived by her loving mother, Christine Stella Wieczorek; her sister, Jeanette Eugenia Wieczorek; her brothers, Stanley Karl Wieczorek, Carl Karl Wieczorek, Stephen Edward Wieczorek, and Jack William Wieczorek; her nephew, Jack Wieczorek Jr. (JJ); and her niece, Kayti Bowman, her husband Kyle and great nephews Wyatt, Liam and Roy. She is also survived by many extended family members and dear friends.

She was preceded in death by her husband, Jack Hensel, and her father, Stanley Joseph Wieczorek, as well as her paternal grandparents, Stanley Stephen and Monica Wieczorek, and her maternal grandparents, Stanley and Maria Szczupak. As well as her Uncle Heinz and Aunt Eugenia Hesselman.

Linda's family has chosen to remember her privately at this time and will have a celebration of life at a later date to be announced.

P. Patrick Leahy, PhD, CPG-10507

Reston, Virginia

Passed on August 7, 2026

Member Since 2000



From American Geosciences Institute (AGI) News Release, and previously published awrds content in The Professional Geologist.

The American Geosciences Institute (AGI) is saddened to share the news that colleague and friend Dr. P. Patrick Leahy passed August 7, 2026. Leahy served as AGI's Executive Director from 2007-2016 during which he oversaw AGI change its name, greatly expanding the scope and number of member societies. He transformed AGI into a globally focused organization and broadened its reach to the geoscience community. Dr. Leahy also served as Executive Director of the AGI Foundation (AGIF) from 2016-2022.

"Pat" held undergraduate and graduate degrees in geology (1968) and geophysics (1970) from Boston College. He received his doctorate in geology (1979) from Rensselaer Polytechnic Institute where he specialized in regional ground-water studies and hydraulics. In 1974, Leahy began a distinguished 32-year career with the U.S. Geological Survey (USGS) where he ultimately served as Associate Director for Geology and then Acting Director of USGS before joining AGI in May 2007.

"Everyone who had the chance to work with Pat Leahy throughout his career benefited from his steady hand in leadership while moving the geosciences forward and doing so in a collegial and approachable manner. Pat left permanent positive impacts on both the USGS and AGI as well as the entire discipline, for which we all are grateful," noted AGI Interim Executive Director, Christopher Keane.

Dr. Leahy is survived by his wife of 54 years, Cathy, their three children, and seven grandchildren. To share remembrance and more information on Pat Leahy, please visit:

https://www.dignitymemorial.com/obituaries/falls-church-va/p-leahy-13010045.

Pat received the John T. Galey, Sr. Memorial Public Service Award in 2009 and the Outstanding Acheiving Award Major Contribution to the Profession in 2016

The following are Pat's remarks orginally published in the Nov/Dec 2009 edition of *TPG*.

It is with great pleasure and honor that I accept the John T. Galey, Sr. Public Service Award of the American Institute of Professional Geologists. I am humbled to be associated even remotely with an individual of John's professional statue. Not only was John Galey a marvelously talented geologist but he certainly contributed selflessly to ensure the vitality of our profession and to AIPG. I am also humbled to be in the company of previous award recipients, many of who I know personally and hold in high regard and consider them colleagues and friends.

Since this award is focused on public service, I wanted to share a few thoughts with you relative to the importance of interacting with the public as a service to the profession. I don't think many if any individuals pursue the geosciences with the primary goal of public service. The rigorous academic preparation of developing an understanding of the earth and how it works consumes most students. However, I think that at least in the recesses of our minds during that formative period, we all harbored a desire to make a difference in both our professional and private lives. Certainly today, this desire is more visible among students than when I was a student and that is a good thing. The geoscience profession needs to build upon this ethic to serve.

Society today is confronted with critical challenges, many of which involve a geoscience component. How do we deal with increasing energy, water, and mineral demands? How do we ensure a safer and better prepared world from natural hazards like earthquakes, floods, volcanoes, landslides, and tsunamis especially in light of an increasing population that lives, works and plays in harms way? How do we provide a sound understanding of the earth's climate and its changes to the general public and policymakers so that policy is based on sound science and not speculation? How do we ensure that society will have the quality of life it desires and deserves? Helping to answer these questions for the public and for our policy makers is the essence of public service for the geoscientist.

Yet all too often, the public does not understand the significance of our profession's contribution to possible solutions and the crafting of a balanced way forward. The role of the geoscientist has changed. It is no longer enough to be one-dimensional in our professional lives. Academics can no longer be comfortable with simply conducting research or teaching students. Those in government and industry can no longer be satisfied with completed projects designed to address specific issues. We, as geoscientists have much more to offer and society needs 'Citizen Geoscientists.' It is important that we not be zealots but rather trusted sources of information and understanding of the geoscience elements of societal issues.

A new era of public service by the geoscience community is long overdue. The thirst for our wisdom is probably at its all time high and organizations like AIPG are uniquely positioned to answer the call through its membership, forums, publications and other means. I encourage all of you to find time in your professional career to perform some public service no matter how little. It will bring both personal as well a professional reward in service to our great science.

In my own case, I am certainly proud of the work I was able to publish; but I have also been fortunate that my career gives me many opportunities to discuss the geosciences with others. Early in my USGS career it was discussing ground-water availability in Delaware with policymakers at city, county, and state levels. Later in my USGS career, I often testified before Congress on issues ranging from earthquakes to energy and mineral resources and at times briefed the Secretary of Interior on a weekly basis on a wide variety of topics. I even met once with the royal family and Vice President of Afghanistan to offer them insights on the status of their energy, mineral and water resources. More recently, my position, as Executive Director of AGI, has provided me with a platform to influence the next generation of geoscientists. I hope the legacy of my efforts serve to influence young people on the importance of the geosciences as a career choice and instill a renewed spirit of public service to the professional geoscientists of the future.

I wish to thank the leadership of AIPG for this recognition and I want to thank my family, especially my wife Cathy, for the support and encouragement they have provided during my career.

In 2016, Pat was awarded the Outstanding Achievement Award Major Contribution to the Profession, and the following is the nomination that was printed in the Oct/Nov/Dec 2016 edition of *TPG*.

Dr. Leahy was born in Troy, New York. He holds undergraduate and graduate degrees in geology (1968) and geophysics (1970) from Boston College. He received his doctorate in geology (1979) from Rensselaer Polytechnic Institute where he specialized in regional groundwater studies and hydraulics. Dr. Leahy worked for the U.S. Geological Survey for 33 years, serving in various technical and managerial positions. He authored or co-authored more than 80 publications on a wide array of earth-science topics. In 2005-2006, Dr. Leahy served as acting Director of the U.S. Geological Survey. He concurrently served as Chair of the Civil Applications Committee, a multiagency consortium tasked to enable the use of classified assets for civilian purposes.

Prior to his current position, Dr. Leahy served as Associate Director for Geology of the U.S. Geological Survey, where he had responsibility for Federal basic earth science programs, which include worldwide earthquake hazards monitoring and research, geologic mapping of land and seafloor resources, volcano and landslide hazards, and assessments of energy and mineral resources. In March of 2007, he was named Executive Director of the American Geosciences Institute (AGI). Since 2014, he has also served as interim Executive Director of the American Geosciences Institute Foundation. He is both a certified professional hydrogeologist (HG-952) and professional geologist (CPG-10507).

Dr. Leahy is a Fellow and Trustee of the Geological Society of America and a member of the American Geophysical Union, the American Institute of Hydrology (Former President), International Association of Hydrogeologists (Former U.S. President), Sigma Xi, the American Association for the Advancement of Science, the American Association of Petroleum Geologists, the National Ground Water Association, and the Geological Society of Washington. He is a former board member of GeoScienceWorld. Dr. Leahy is also a Commissioner for the United States Commission for the United Nations Educational, Scientific and Cultural Organization (UNESCO). He has testified before the U.S. Congress on more than 30 occasions on a variety of geosciences topics. He serves as an expert advisor to the U. S. Senate on mineral resource issues and he serves as chair of the Mineral Science and Information Coalition to educate federal policymakers on the importance of mineral research and information.

Dr. Leahy was the recipient of the 1996 Department of the Interior Meritorious Service Award, and the 2006 Department of Interior Distinguished Service Award, and he was recognized by President George W. Bush in 2003 with a Meritorious Senior Executive Award and again in 2007 as a Distinguished Senior Executive. Dr. Leahy received the Khan Medal (the highest award for a non-Afghan citizen awarded by Afghanistan) from President Hamed Karzai. In 2005, He visited

Afghanistan and met with the King and Vice President of Afghanistan to discuss mineral, energy, water and geologic hazard issues.

He was the recipient of the 2009 John T. Galey, Sr., Memorial Public Service Award from the American Institute of Professional Geologists (AIPG). From 2008-2011, Dr. Leahy served as a judge for the National Engineering Excellence Awards. He also has received recognitions from the International Council of Scientific Union and the World Meteorological Organization for his efforts in support of the International Polar Year. His contributions have also been recognized by the National Association of Black Geoscientists, the Association of Environmental and Engineering Geologists, the American Association of State Geologists, the Heinz Center (for his contributions to producing the first 'State of the Nation's Ecosystems' report) and the AIPG, Ohio State Section.

Michael J. Zack, CPG-10641

White Lake Township, Michigan

Passed on August 29, 2026

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Photo and obituary obtained from Dignity Memorial.

Born on August 13, 1970 in Portage, Michigan to Duane and Shirley Zack, son-in-law to Martin and Barbara Horkan. Brother to Jeff Zack and Julie Seward (Scott), brother-in-law to Sandie and Tim Olsen, Marty and Terri Horkan, Patrick and Bianca Horkan, Mike and Michelle Horkan. Devoted uncle to Joe, Jenny, Julie, Andrew and Amanda. Great uncle to Elijah, and Emmanuel.

Michael graduated from Western University and went on to a dedicated career as a EHS of North America at Visteon and Mahle.

Michael was a beloved husband and best friend of Sheila Horkan Zack for 15 amazing years. Together they built a life of travel, family, friends and their fur babies.

Known for his generous heart, spirit, and witty sense of humor. He was a loyal neighbor and beloved friend. Micheal was a dedicated fan of the Detroit Tigers and the Detroit Lions. He enjoyed golf, mountain climbing, his Pontoon, and living on the lake.

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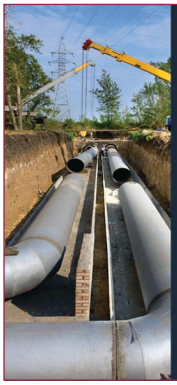
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