

**WELCOME TO THE FCGS!**  
**Annette Patton @ FLC on February 11<sup>th</sup>**



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# February 2025 MEETING

<https://www.usgs.gov/programs/landslide-hazards/where-do-landslides-occur>

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### SPEAKER:

**Annette Patton, Oregon State University**

### TITLE:

***Landslides in Southeast Alaska: Community-driven Research to Reduce Risk***

### DATE:

Tuesday, February 11<sup>th</sup>, 2025

### TIMES:

**5:00-5:30: Happy Hour**

5:30-6:30 pm: Dinner

6:30-7:30 pm: Society Business / Presentation

7:30-7:45: Raffle to raise money for students

### LOCATION:

Vallecito Room, Student Union Building  
Fort Lewis College

### COST:

\$25/person. *PLEASE RSVP by Friday, February 7<sup>th</sup>. WE NEED TO KNOW HOW MANY DINNERS TO ORDER.*

### RESERVATIONS:

Use this link (also available on website) to reserve your place. You will be given the choice to either pay now or pay at the door. You can also choose to sponsor a student.

[RESERVATIONS LINK](#)

STUDENTS AND FACULTY: Please RSVP to Dr. Gonzales at [gonzales\\_d@fortlewis.edu](mailto:gonzales_d@fortlewis.edu). Most students will be sponsored. Get on the list! All faculty will be sponsored.

### ZOOM:

[ZOOM LINK](#)

Passcode: **797930**

Zoom starts at 6:30pm

### NEXT MTG:

*Date:* March 27<sup>th</sup>

*Speaker:* Wade Aubin, Colorado Mesa University

*Topic:* Volcano dynamics as informed by Mt. Mazama



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## Abstract of Talk



Landslides pose significant hazard to communities in mountainous regions, particularly where residential areas are built directly on or below steep slopes. Improved knowledge about when and where landslides are likely to happen is critical to mitigating risk to human safety and infrastructure. Equally important are community and individual-level decisions that help reduce exposure to the highest-risk areas. This talk explores insights from landslide and risk research conducted in collaboration with Southeast Alaska communities, integrating geomorphic processes and social factors. A key example includes the development of a public-facing landslide risk awareness dashboard, [SitkaLandslide.org](http://SitkaLandslide.org), created by an interdisciplinary team of researchers and community leaders to improve public awareness and preparedness.

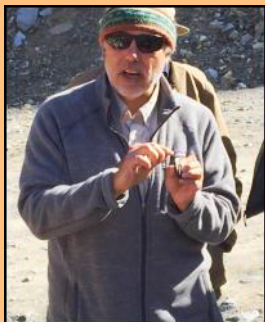


## Speaker Biography



Annette is the statewide Extension Specialist in Watershed Science in the OSU College of Forestry. She is a geomorphologist who specializes in hillslope and watershed processes. Her recent research has focused on landslide initiation, including triggering rainfall and characteristics of susceptible hillslopes. Prior to her current position, Annette worked for the Sitka Sound Science Center, a nonprofit research organization, where she managed a community-driven project to reduce landslide risk. Annette has a B.A. In Geology from Whitman College and an M.S. And Ph.D. From Colorado State University.

## Pres Sez, by Dr. David Gonzales



### A Play on Color

*"Mere color, unspoiled by meaning, and unallied with definite form, can speak to the soul in a thousand different ways."* Oscar Wilde

Color is an attractive force that draws humans to desire certain natural materials. Most of the colored objects we experience are created by the absorption of the red, orange, yellow, green, blue and violet energies of visible light. The spectra of light that are not absorbed by an object are mixed to create the color we observe. Absorption is influenced at the atomic scale. This can include the presence of a certain elements that are an essential part of the mineral composition, a minor chemical impurity, physical defects in the crystal structure, mechanical mixtures of very fine impurities, and presence of finely-spaced structures in the minerals. In this essay I will focus on the ways that colors can be created by phenomenon aside from absorption.

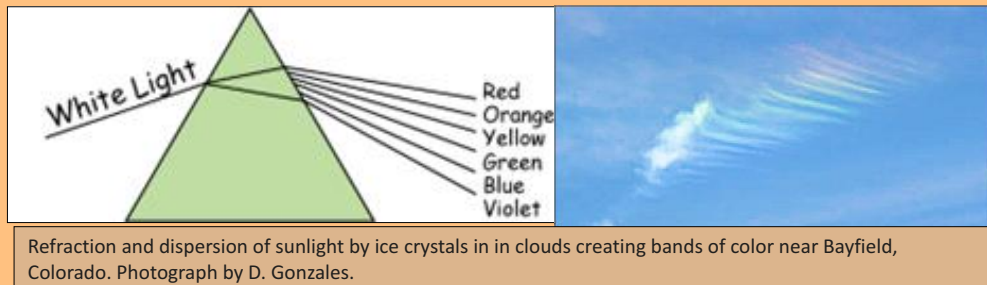
Before we can discuss ways that non-absorptive colors are created it is important to establish the concept of light waves. We all know what waves are, and the most familiar waves are those produced in water. But light moves in waves



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also, just on a smaller scale. Just for the sake of thought, imagine we could view waves of light. We would witness a motion similar to waves on water but there will be different colored waves, violet to red. The distance between the crests of violet waves will be less than those for red waves which means that for a given amount of time more violet waves will pass a certain point.

One way that colors can be created in nature is by refraction and dispersion of light. When light travels from air into a substance (e.g., glass, water, mineral) it slows down and the waves of light are bent or refracted. The amount that light is bent depends on the color since



Refraction and dispersion of sunlight by ice crystals in in clouds creating bands of color near Bayfield, Colorado. Photograph by D. Gonzales.

violet light is bent more than red. The refraction of light by water drops or ice in clouds creates rainbows, and the spectrum of color presented by prisms are also created by refraction and dispersion. Refraction does not typically create color in minerals but the two images you can witness when you hold a piece of clear calcite over an image is caused by refraction and is called "double refraction." In this instance light is forced into two atomic paths in which light travels in different velocities expressed by the two different images.

There is another phenomenon that creates colors that most people have observed in soap bubbles, the surface of an oil slick, the wings of black birds, and some specimens of volcanic glass. These colors are not created by absorption but by the process of reflection and interference. Let us focus on the soap bubble for a moment. When light interacts with the outer surface of the bubble some is reflected. Then when the light interacts with the inner surface of the bubble some of the light is again reflected. The light waves reflected from the inner and outer surfaces of the bubble are not travelling together since the outer surface reflected the light before the inner surface. So, when the two light rays interact, a dynamic interplay of interference colors is generated by the simultaneous reflection of light from both the



Interference colors created by reflection and interference of light in a soap bubble. Photograph from <https://www.sciencefocus.com/science/why-are-soap-bubbles-rainbow-coloured/>

inside and outside surfaces of the bubble. If the inner light waves lag behind the outer waves by exactly a distance of a full wavelength (distance from top one crest to another crest), constructive interference occurs, and those colors are enhanced (brighter). If certain waves of color are out of step by a full wavelength, destructive interference transpires, canceling the reflected light and the color. The colors that are in between these two states create different intensities of a certain color. When all of the available energies mix, it creates a rainbow of colors called interference colors.

In minerals, this phenomenon

is expressed as iridescence on mineral surfaces such as chalcopyrite and bornite. When chalcopyrite is oxidized a thin coating is produced that interacts with light in the same way that a film of oil on water creates a play of colors. Iridescence or "play of colors" on the oxidized surface of bornite, Dzhezkazgan mining district, Kazakhstan. Photograph from <https://www.mindat.org/photo-233221.html> .

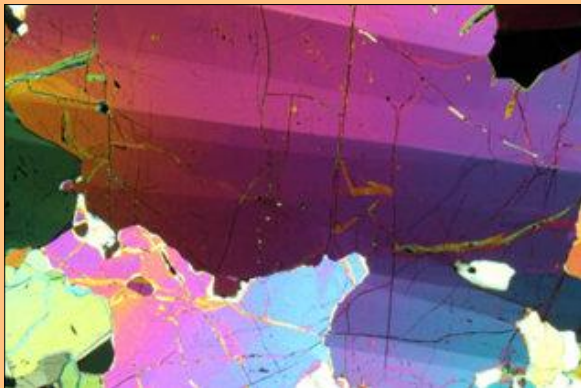
Interference colors are easily viewed in minerals under a petrographic microscope in which two pieces of Polaroid are aligned at right angles. Minerals that are not isometric or opaque can polarize light into two or three atomic planes where light travels with different velocities and can create interference. You can create this same effect by taking two pieces of Polaroid with the planes of polarization at right angles. Place a thin piece of non-isometric mineral (e.g., quartz) between the sheets and observe the interference colors.



Iridescence or "play of colors" on the oxidized surface of bornite, Dzhezkazgan mining district, Kazakhstan. Photograph from <https://www.mindat.org/photo-233221.html> .



Yet another way that colors can be created is by process called diffraction. Diffraction is a process that happens when light waves interact with an obstacle, an opening or fine parallel features (e.g., diffraction grating). One way this color phenomenon is presented is on the surface of a CD or DVD. The fine parallel grooves on the surface of these



Interference colors in olivine under crossed polarization viewed in a petrographic microscope. From <https://www.alexstrekeisen.it/english/pluto/olivine.php>

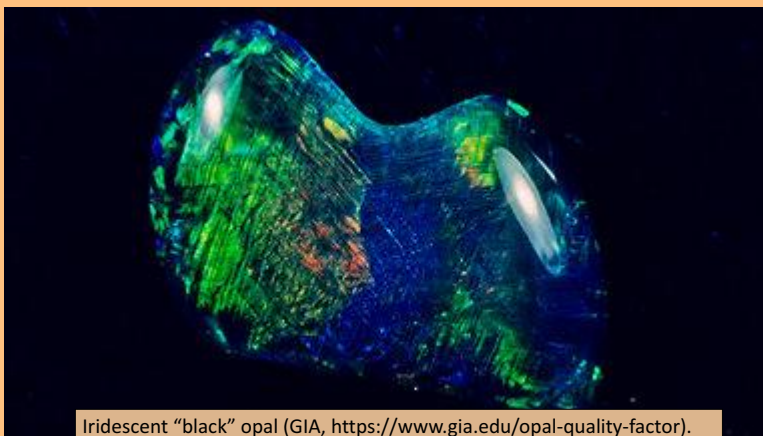
devices interact with the light. Depending on the angle the light strikes the surface a variety of colors are created. This happens because at different angles the grooves can block out or allow the passage of different energies (wavelengths) of light. If a diffraction grating blocks out the longer wavelengths (red) the violet and blue colors are reflected into our eyes.

Minerals such as opal and plagioclase feldspar are also diffraction magicians. In these minerals the presence of closely spaced structures interacts with light to produce an iridescence or play of colors. Consider opal which is composed of silicon, oxygen, and water. And, by the way, opal is not a mineral since it does not have an ordered arrangement of silicon and oxygen (crystalline as

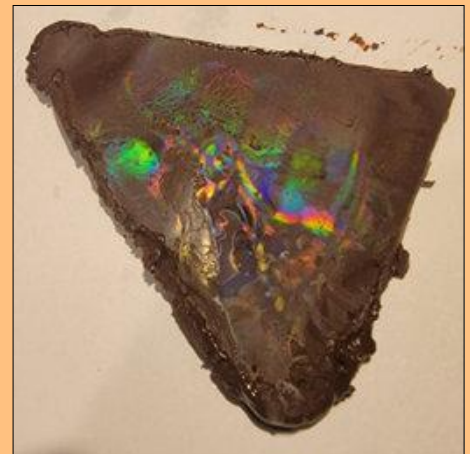
in quartz) but instead the water causes the silicon and oxygen to form in submicroscopic spheres. If these spheres are random in shape and arrangement then common opal is created (i.e., patch). If the spheres are uniform in size and arrangement then light interacts with structure and is forced between the spheres (diffracted) and can then interfere. The colors created depend on the size of the spheres and thus the space between them

([www.webexhibits.org/causesofcolor/15F.html](http://www.webexhibits.org/causesofcolor/15F.html)). If the spheres are relatively small (150 nanometers or 6.5 million spheres per millimeter) then violet and blues waves pass through the spaces. Larger spheres (350 nanometers of 3 million spheres per millimeter) produce orange and red play of colors since more of the longer wavelengths are allowed to pass. As the stone is moved in sunlight the angle of the light on the atomic sphere changes and can create a spectrum or flash of color.

Some plagioclase feldspar is known for iridescence or play of colors created by closely spaced intergrowths of different composition. A crude analogy of intergrowths or exsolution in mineral is the separation of water in oil. Plagioclase contains both sodium and calcium which can vary in proportions. Under certain conditions the sodium and calcium plagioclase can separate to create microscopic lamellae of one composition in another (e.g., albite in oligoclase = moonstone). The lamellae are exceedingly small features, but the repetition of these intergrowths is about the same as the wavelength of visible light, so the lamellae act as a diffraction grating (Nesse, 2017, Introduction to Mineralogy). Of course, iridescence does not occur in all plagioclase crystals and tends to be more common in the calcium-rich varieties. No matter the composition, however, it is the closely spaced intergrowth structures that produce an iridescence of colors with changing angles of incident light (see the display of feldspar minerals).



Iridescent "black" opal (GIA, <https://www.gia.edu/opal-quality-factor>).



This is a piece of chocolate showing interference colors. My sons, Alex and Jon, created this by placing a piece of diffraction-grating material with 13,500 lines per inch on the chocolate when it was soft. Once the chocolate cooled the diffraction sheet was removed and the fine lines in the surface of the chocolate interacted with light to create a play of colors.



## Foundation News- M.S Thesis Grants and New Interim Director Edition, by Cindy French

**M.S. THESIS GRANTS AVAILABLE:** Your Foundation has launched its MS Thesis Grants Program for 2025. Now chaired by Cindy French, *this program has supported 60 Master's degree candidates since it was started by the Society in 1991*. The grant helps to support students conducting research in any of the Four Corners states, but they can be enrolled anywhere in the U.S. If you know students who may be interested, please direct them to the application at <https://fourcornersgeologicalsociety.org/scholarships/>. Applications are due March 1.

**HELP CHOOSE AWARDEES:** This year, we're inviting volunteers to help us choose the grant awardees! It's a great chance to meet your Foundation board. It's also inspiring to see the quality of applicants and the variety of their projects. Cindy will distribute the applications digitally in early March. Then we'll meet in person or by Zoom in late March so we can announce the winners around April 1. This year, thanks to your generosity and a very good 2024, we expect to award as much as \$3000 in total, perhaps more.

**MEET NEW INTERIM DIRECTOR, MICHELE TUTTLE:** In other news, the Foundation has appointed Michele Tuttle as an interim director, pending her election by Society members to a regular term – please vote for her in May! She retired in 2014 after 37 years as a research geochemist at the USGS.



Michelle is a native Coloradan with a BS/Chemistry Univ of Colorado, and Ph.D./Geochemistry from CO School of Mines. At the USGS Michelle conducted field and laboratory research related to geochemistry of mineral and energy deposits, weathering of rocks and soils, surface and groundwater quality, and accumulation and release of toxic carbon dioxide in crater lakes. Notably, Michele served as a scientific consultant and member of an interdisciplinary disaster response team to the U.S. State Department for hazards associated with CO<sub>2</sub>-charged crater lakes.

She has presented at national and international conferences and published in USGS reports and peer reviewed journals. Michele has a long history of volunteerism in professional societies supporting both science in general and specifically geology.

We are fortunate to have her breadth of experience on the Foundation Board. Welcome Michele!!



### ATTENTION STUDENTS: \$3,000 FIELD CAMP SCHOLARSHIPS!!

The American Association of Petroleum Geologists (AAPG) Foundation has just revised their L. Austin Weeks Undergraduate Grant Program from a \$500 award to a Field Camp Scholarship worth \$3,000. All students who are attending a U.S. university and who will be attending a summer geology field camp can apply. The new program will open on November 30<sup>th</sup> and accept applications through February 28<sup>th</sup>. Requirements and guidelines are now posted: [HERE](#).

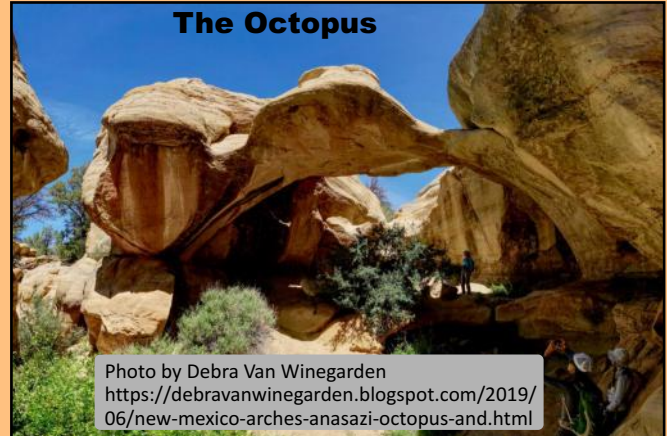
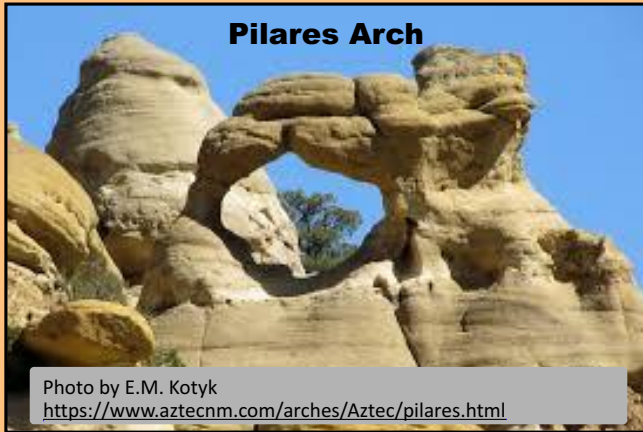


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Jim Corken, Field Trip Committee Chair

## SPRING FIELD TRIP 1 - AZTEC ARCHES



- DATE:** April 12, 2025.  
**LEADER:** Dr. Jeff Geslin.  
**DESCRIPTION:** This trip will travel east out of Aztec on highway 173 (the Navajo Dam Road) looking at natural arches formed in the Paleogene Nacimiento and San Jose Formations. The focus will be on fluvial depositional facies as well as arch formation.  
**COST:** \$15pp.  
**TRANSPORTATION:** Carpooling from Durango.  
**LIMIT:** 25.  
**REGISTRATION:** Will open in early March.

**DISCLAIMER:** Locations are still being worked out. The arches pictured above may not be visited on this trip.

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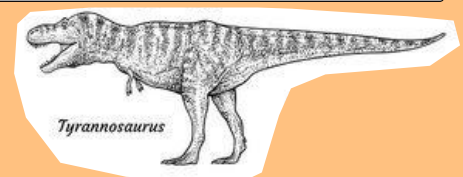
## SPRING FIELD TRIP 2

### BISTI BADLANDS WITH JOHN HANKLA

The committee is also working to schedule a return to the Bisti de na Zin Badlands with vertebrate paleontologist John Hankla. Dr. Hankla runs the "Dinosaur Discovery Adventure Program" for middle schoolers each summer. The group attends an orientation workshop at the Denver Museum of Nature and Science, where Dr. Hankla is a Research Associate, then spends nearly two weeks at fossil sites in Wyoming and South Dakota. He has also worked with FLC students doing their senior theses in the Bisti Badlands.



<https://john-hankla-w2wr.squarespace.com/new-page>



Adobe stock images



# January Meeting Pics



Sabina Kraushaar receives the Speaker's Mug at the January FCGS Meeting.





## Upcoming Meetings



**Abstract Submission now open for  
N.M.G.S. SPRING MEETING,  
April 25<sup>th</sup> at New Mexico Tech  
in Socorro, N.M.**

The theme this year is *Earth Science, Environmental Change, and Health*. Abstract submission is open now to April 5<sup>th</sup>.

Special session topics include:

- Earth science and health,
- Water quality changes,
- Wildfire and post-landscape processes,
- The water/energy nexus, and
- Impacts of climate change on natural resources.

Submit abstracts through the spring meeting website:  
<https://nmgs.nmt.edu/meeting/home.cfm>

### 2025 Water Workforce Career Fair

Thursday, Feb 13, 2025; In-person

CSU Spur, 4777 National Western Dr, Denver, CO

The Colorado Water Center's second annual Water Workforce Career Fair is designed to connect students across Colorado with water-related employment and education/training opportunities. The Fair will feature over 30 exhibiting water professionals, a speed-dating networking session for students and professionals, and water education for all ages!

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### 2025 North American Helium & Hydrogen Conference hosted by R.M.A.G.

**Dates:** April 8 - 10, 2025

**Location:** Hyatt Regency Aurora-Denver Conference Center, 13200 E 14th Pl., Aurora, CO

**Registration:** Early bird rates are available until **January 15, 2025**.

To register or get more info, go to:

<https://www.rmag.org/index.php?src=events&submenu=Events&srctype=detail&category=Symposiums&refno=334>

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#### SEG Virtual Global Groundwater Workshop

**DATES / TIME:** Tuesdays: 11, 18, and 25 February 2025

#### WORKSHOP DESCRIPTION

This workshop will raise global awareness of understanding, quantifying, managing, and communicating uncertainty in groundwater studies and identify research imperatives and best practices that industry practitioners and researchers can adopt. Hydrogeologists and hydrogeophysicists aim at characterizing the subsurface regarding its hydrogeological and geophysical properties and geometries. We see potential for inter-disciplinary learning by recognizing the relationship between hydrogeological and hydrogeophysical properties, conceptual approaches, analytical solutions, algorithms, and assumptions involved in modelling the subsurface in both disciplines.

Groundwater consulting practice has to cater to the clients' need for certainty and too often resorts to deterministic solutions. Uncertainties arising from the estimation of either hydrogeologic or hydrogeophysical properties are often not fully understood and rarely systematically accounted for. Yet, a realistic and transparent estimate of uncertainty is crucial to build trust in model outcomes and inform the client's groundwater-based planning. Therefore, improving our understanding of this uncertainty is a pressing issue attracting increased interest by all stakeholders. With this workshop, we aim to identify practical approaches for a more complete treatment of uncertainty in groundwater science and management.

To get more info or to register, go to [https://seg.org/calendar\\_events/improving-understanding-and-treatment-of-uncertainty-in-groundwater-science-and-management/](https://seg.org/calendar_events/improving-understanding-and-treatment-of-uncertainty-in-groundwater-science-and-management/)

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#### *Charitable Donation*

Thank you for your philanthropic gift to the Four Corners Geological Foundation. The Foundation helps support geoscience education, fund research grants, and pay for scholarships in the Four Corners states.

If preferred, you may donate by Pay Pal or credit card online at:

<https://fourcornersgeologicalsociety.org/foundation>

Alternatively, a check or money order payable to "Four Corners Geological Foundation", along with this completed form, can be mailed to:

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Durango, CO 81301

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**Donation Amount:** \$ \_\_\_\_\_

Please do not acknowledge my donation publicly in announcements or newsletters.

**Donation Notes:**

*(For dedications, memorials, or anything else you'd like to share about this donation.)*

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# FOUR CORNERS GEOLOGICAL SOCIETY

P.O. Box 1501, Durango, CO 81302

**MEMBERSHIP RENEWAL or APPLICATION: June 1, 2024 to May 31, 2025**

\*Name: \_\_\_\_\_

\*Address: \_\_\_\_\_ City: \_\_\_\_\_ State: \_\_\_\_\_ Zip: \_\_\_\_\_

\*Email: \_\_\_\_\_ Phone: \_\_\_\_\_

\*Employer: \_\_\_\_\_



### Please Identify a Membership Category:

<b>Active Member</b>	\$30	Any person engaged in the practice or teaching of geology or who holds a Bachelor's Degree in geological science from a college of acceptable academic standards. Degree requirement may be waived if applicant has adequate professional experience. <i>*Highest Degree, Type and Year:</i> _____ <i>*College / University:</i> _____
<b>Associate Member</b>	\$30	Any person who is a graduate of a college of acceptable academic standards with major studies related to, or associated with, geology. Degree requirement may be waived if applicant has adequate professional experience. <i>*Highest Degree, Type and Year:</i> _____ <i>*College / University:</i> _____
<b>Student Member</b>	Free	Any undergraduate or graduate student majoring in geology at a college of acceptable academic standards. <i>*College / University:</i> _____ <i>*Year expected to graduate:</i> _____
<b>Emeritus Member</b>	Free	An Active Member of 65 years old or older who has been a member for 25 years including time spent in military service. <i>*Year emeritus status was awarded:</i> _____
<b>Honorary Member</b>	Free	An Active Member who has contributed distinguished service to the profession of geology and to the betterment of the FCGS. Determination is made by the FCGS Executive Committee. <i>*Year honorarium was awarded:</i> _____.

**Other Professional Interests or Comments and Concerns.**

Are you interested in Volunteering? If so, what is your area of interest?

*\* Required information for new members. Current Members, please update.*

### \*Please check your interests:

- Sedimentology & stratigraphy
- Structure & tectonics
- Mineralogy, petrology, geochemistry
- Igneous geology, volcanology
- Ore geology and hard rock mining
- Other mineral extraction
- Petroleum geology
- Geophysics
- Geological engineering
- Geomorphology
- Quaternary geology
- Hydrology & water resources
- Environmental geology
- Geography / GIS
- Other interest (see box)

**Please either print, complete and return this form with your check for dues made payable to: "Four Corners Geological Society" and mail to the address above or go online to [fourcornersgeologicalsociety.org](http://fourcornersgeologicalsociety.org) .**