PCPG Newsletter

Communicating Key Information & Concerns to Geologists and Environmental Professionals

Issue 2 / 2020

BOARD OF DIRECTORS

INSIDE THIS ISSUE...

MESSAGE FROM THE PRESIDENT

FULFILLING MY DESTINY

As I write this, we are under the Governor's directive to work from home to try and limit the spread of coronavirus. Many PCPG members work from home as private consultants so this is nothing new, while for others this is uncharted territory. I worked from home for many years when my children were young and I can relate to the feelings of isolation from coworkers and the difficulty of trying to work with children around. I hope and pray that all of you stay safe and healthy, practice social distancing, and together (digitally) we will all get through this unprecedented situation.

Prior to social distancing restrictions, I got a text from my daughter along with a picture from a rock shop with a caption of "fulfilling my destiny." None of my children are geologists, but this isn't the first time they have sent pictures of rocks while exploring somewhere. Often, they buy a few items like agate slices to make coasters or small rocks to make jewelry, etc. As a family, we had many vacations/geology excursions. We visited dinosaur museums and made footprint casts, collected geodes from a streambed, searched through a tailings pile at an abandoned fluorite mine, and once hunted fossils in a roadcut by headlights. My children liked these adventures at first, but as they got older, rocks became boring, not cool or interesting, and certainly not something they wanted to do as an adult.

Might education play a role here? Geology is not really taught in Pennsylvania after middle school. Physics, chemistry and biology are the core sciences while geology is often taught with the humanities. Watersheds or mountain range locations are discussed in geography class, development of natural resources is with economics and environmental issues are often discussed very generally as in what to recycle or simply that "pollutants" are bad. Many high school students express an interest in the "environmental field" yet don't realize that geology is at the core of understanding environmental issues. When I started college, I didn't know geology was an option. I changed my major, as did many of my peers, which means we played catch-up to fit the geology requirements into a four-year degree.

Continued on Page 3

UPCOMING PCPG EVENTS

September 18, 2020
The Big Picture: Geologic and Environmental Applications of Drones
Cranberry Township, PA

August 18, 2020
Hydrostructural Geology: The Geology within Hydrogeology
(405 mins.)
Cranberry Twp., PA

PCPG is developing webinar topics that we hope to announce in the near future. Notice will be posted in our biweekly eBlast and on our home page calendar when registration is open.

For a complete list of upcoming events or to register online, check our HOME PAGE event calendar, or visit PCPG'S COURSES AND EVENTS web page.

Strategic Objectives: PCPG Progress Report

By Tiffani Doerr, P.G., Strategic Planning Chair

Due to Covid-19 restrictions on gatherings across the state, PCPG has been working hard to develop additional webinars so that we can provide ongoing continuing education opportunities to our stakeholders. When available, webinars will be posted to our Courses & Events section of the website and notice will be included in our biweekly eBlasts.

PCPG is now rolling out our informational series called "What Does a Professional Geologist Do" for various geoscience disciplines. This series is aimed at students and young professionals to learn what specific activities and responsibilities may be part of our daily jobs. In this newsletter you will find the first in the series, *What does a Professional Geologist Do for PA BROWNFIELD DEVELOPMENT*. Our full series to date, along with placeholder topics for future publication can be found under the Resources tab on our web site. If you would like to contribute to this series, please let us know. Email ideas to PCPG President Barb Dunst.

The annual PCPG student research poster competition was held during the 2020 Annual Meeting where they present results of original research projects. Students from Pennsylvania and adjacent states submitted abstracts of their work from which the 10 most promising studies were selected for presentation at our annual meeting. A summary of the competition will be provided in the next newsletter.

This year, in addition to the student poster competition, PCPG organized a student mentoring workshop where select board members held a breakout session with the students to have frank discussions and provide honest advice. More information on the workshop will be provided in the next newsletter.

Student Resource: Career Pathfinder

PCPG has developed a spreadsheet for college students who are unsure which college courses are most applicable to various industries or career paths. The PATHFINDER spreadsheet is a suggested guide for helpful courses based on PCPG member input and experience. Geologists will often draw on knowledge learned from many different courses depending on the particular site geology. Find the PATHFINDER spreadsheet by visiting the Colleges and Students web page.

PRESIDENT'S MESSAGE *Continued from Page 1*

The Pennsylvania Department of Education is currently examining the Academic Standards for Science and Environment and Ecology. PCPG submitted a letter for the PA DOE's consideration expressing the importance of geology, especially in light of today's environmental concerns. In that letter, PCPG expressed the need to teach additional earth science curricula in high school along with the other core sciences. Additionally, an expanded set of geologic topics with more detail would introduce students to the wide variety of earth science careers available and also allow more students to realize the implications of their interactions with our environment. I must thank board member, Vince Carbone, and former board member, Valerie Holliday, for all of their hard work in this effort.

As I mentioned in our last newsletter, public perception of geologists is an issue we are trying to tackle. Included in this newsletter is our first installment in a series: *What does a Professional Geologist Do for PA Brownfield Development*. Other subjects in this series will be forthcoming and available in the Resources section of our website. Please feel free to direct people to this link.

In the meantime, while working from home remember to take breaks, go outside and explore with your kids. Walk a stream and turn over some rocks to see what's there, explain jointing pairs in the streambed or ripple marks on a rock. I encourage you to keep explaining even if the kids seem bored. My children eventually realized the importance of geologic work and understood the connection to our environment. After life returns to normal, I encourage you to spread the word about careers in geology: volunteer for a science fair or offer to provide a geology lesson to your child's school. Let's keep looking to the future of professional geology in Pennsylvania!

Very truly yours,

Barbara J. Dunst, P.G., C.P.G.

PCPG Annual Meeting 2020

The annual meeting provides several valuable opportunities for PCPG members and stakeholders who attend: updates on relevant legal and regulatory changes in our industries, education on geology and related technical advances (e.g., drilling), professional networking, an opportunity to connect with old friends and meet new colleagues in the business, perhaps a welcome escape from the office for a day, and of course, those PHDs we all need to maintain our licenses. This year's annual meeting in Harrisburg provided all of these opportunities, and more, to the record-breaking 165 attendees.

PCPG President **Barb Dunst, P.G.**, updated members on the current and planned activities of the PCPG, and reviewed our Council's successes over the past year.

Technical program

Troy Conrad, Director of the PA-DEP's Bureau of Environmental Cleanup & Brownfield Program opened the session with a review of the PA DEP's Land Recycling Program (Act 2 which provides financial assistance and standardized recommendations for voluntary cleanup of contaminated sites) and the Hazardous Site Cleanup Fund. He also described what the Bureau is doing to protect and advise about two emerging contaminants: Per- and Polyfluoralkyl Substances (PFAS).

Mike Maddigan, Environmental Group Manager in the Standards Section of the PA-DEP's Bureau of Environmental Cleanup & Brownfield Program, gave a very helpful technical talk that summarized the recent revisions of the Land Recycling Program's Technical Guidance Manual (TGM). This was particularly valuable to people working in the field because it highlighted key changes in the 502-page document, which helped members be more efficient in updating of their understanding of current rules. Mr. Maddigan also summarized the guidelines in the new TGM appendix describing Use of Caps as Engineering Controls.

Joe McNally, P.G., Principal Hydrogeologist, GeoServices, Ltd. is one of the two governor-appointed Professional Geologist

Continued on Page 11

What does a Professional Geologist do for

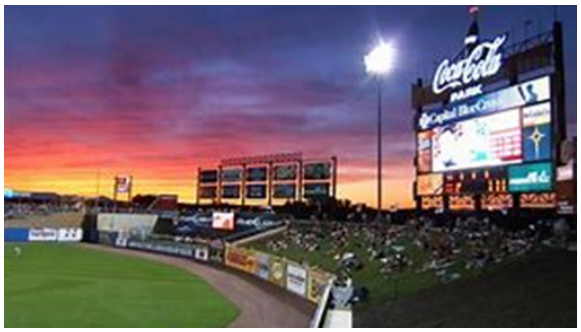
Visit our
What Does a Professional Geologist Do
web page for more in this series.

PA BROWNFIELD DEVELOPMENT

A Professional Geologist (PG) works on brownfield development sites to protect human health and the environment during construction and future use of a property. Generally, the PG is required to sign reports proposing Act 2 liability protection with the Pennsylvania Department of Environmental Protection (PADEP) Land Recycling Program.

- A brownfield is a former industrial or commercial site where future use is affected by real or perceived contamination from various chemicals of concern (COCs) attributed to historical use of the property.
- Brownfield development has three primary goals: make contaminated sites safe for future re-use, return sites to productive use for the public or business community, and reduce sprawl and preserve green space.
- The PG serves as the technical lead to determine if COCs are present in various environmental media (soil, groundwater, surface water, sediment, and soil vapor) and evaluates if the site is safe for the intended future use of the property. This determination includes various tasks such as environmental due diligence, site characterization or remedial investigation and cleanup.
- Often a PG signs off on due diligence, which is a review of the current and historical site uses to identify source areas and potential COCs. This is called a Phase I Environmental Site Assessment (ESA). The PG investigates contaminant sources such as spills or releases from historical sources that could include tanks, industrial activities, construction, mining, and unauthorized dumps.
- If COCs are identified, the PG develops, implements, and provides a Phase II ESA. The PG collects samples to quantify the levels of COCs. The concentrations of COCs are compared to regulatory standards to determine if they can be harmful to human health and the environment. In Pennsylvania's Land Recycling (Brownfield) Program (Act 2) project, this is referred to as Site Characterization or Remedial Investigation and a PG signature along with their professional seal is required for PADEP submittals.

Bell Laboratories in Allentown, PA manufactured electric components like vacuum tubes for the telecommunications industry.



Coca Cola Park Lehigh Valley Iron Pigs stadium was constructed on a portion of the former Bell Lab site. Cleanup efforts included soil contaminated from heavy metals, including arsenic, from electronic components found on a section of the property prior to stadium construction.

- As part of the remedial investigation, the PG develops a Conceptual Site Model (CSM), which identifies and delineates sources of COCs; defines the transport mechanisms of the COCs through environmental media; and evaluates the impacts to receptors such as fish, wildlife, and humans.
- The PG may oversee geophysical studies to locate infrastructure, underground storage tanks, or other subsurface structures (i.e., product lines, septic tanks, etc.) that may be sources of contamination.
- Depending on the proximity of a COC source to occupied buildings, the PG may also evaluate soil vapor which can be done outside or inside a structure.

Continued on Page 5

- Integral to the CSM is the characterization of the geologic and hydrogeologic conditions of the brownfield site. The PG may conduct hydrogeologic tests to determine flow characteristics of the aquifer and help the PG define the transport mechanisms for the COCs.
- To sample groundwater, the PG designs and installs a monitoring well network with consideration of groundwater flow direction and chemical properties of the COCs. If groundwater chemical data is in excess of regulatory standards, the PG will often complete or oversee contaminant transport modeling.
- Other data gathered during an investigation may include rainfall and climate data, historical aerial photos, regional groundwater variations, and changes to drainage pathways along with a thorough search of published and unpublished sources to get a total hydrogeologic picture.
- Based on the results of the CSM, the PG may assist in performing a risk assessment. With appropriate training, the PG will review toxicology information for exposure pathways such as ingestion, skin contact, or inhalation. Based on COC concentrations, the route, and duration of exposure, the PG may determine alternative protective measures or concentrations to protect human health or the environment.
- The PG then develops a Cleanup Plan to be implemented to make the site safe for the intended use.
- The PG often speaks at stakeholder meetings to present data on the broader redevelopment to the community. These stakeholders often include the site owner, perspective redeveloper, PADEP, municipal and county officials, and various subcontractors to integrate information obtained from the CSM into the redevelopment process.

When performing brownfield work, the PG works internally with risk assessors, chemists, geochemists, statisticians, construction specialists, engineers, soil scientists, biologists, remediation specialists, land management personnel, permitting specialists, and urban or municipal planners. The PG also works externally with regulators, attorneys, and various subcontractors.

Work Resources:
Computers, GIS, state regulator data bases, geologic and hydrogeologic modeling programs, regulatory and municipality file reviews.

Work Environment:
Office and field work. Field work may entail irregular or evening/weekend hours, visiting property owners, and working in varying outdoor conditions throughout the year.

Helpful Skills & Experience:
Research skills, landowner relations, negotiations with PADEP, ability to explain technical material to non-technical personnel, grasp of legal issues, water chemistry evaluation, and fate and transport modeling. Good management, writing, patience and communication skills are necessary for PA Brownfields Development.

Tools of the Trade:
Combustible gas indicators (CGI), photoionization detectors (PIDs), pumping equipment, flow meters, water level gauges, pH and conductivity meters, water/soil sampling equipment, and chain of custody documentation.

Training:
OSHA 40 Hour HAZWOPER, First Aid/CPR

Micro-Raman Spectroscopy in Thin Section Analysis of Rock Mineralogy

Peter Muller, Ph.D., C.P.G., Muller Geological Consulting, LLC

Introduction

Correct identification of mineral phases in rock thin sections (Figure 1) is essential to petrographic and petrologic analysis of rocks. Traditionally, analysis using polarized transmitted light and reflected light microscopy have been the standard techniques employed, with optical cathode-luminescence microscopy used to a much more limited extent. Optical microscopy techniques are taught in core courses in all undergraduate geology curriculums and petrographic microscopes are part of the basic instrumentation of all academic geology departments, most State and Federal geology agencies (e.g. U.S. Geological Survey), and many private consulting companies in the mineral and energy resources sector.

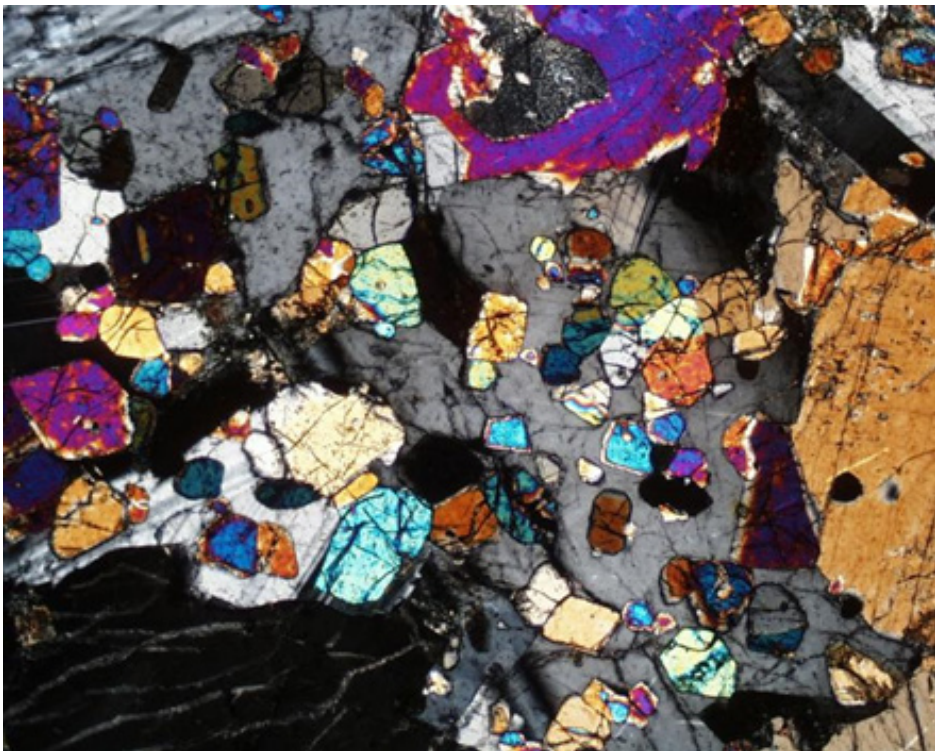


Figure 1. Photomicrograph of a rock thin section showing a variety of silicate mineral phases in cross-polarized light.

Successful identification of most mineral phases using a variety of standard optical characteristics visible under low to moderately high-resolution (20x-1000x) is fairly routine. However, as the sizes of mineral phases decrease to the sub 100-micron level standard optical techniques become much less successful. Additionally, many common minerals are solid solutions chemically and identification of the various members of a series is either much more difficult or simply not possible using optical techniques alone. To overcome the limitations of simple optical examination, geologists have resorted to a variety of very high-resolution techniques providing chemical as well as optical information. These include scanning electron microscopes with energy dispersive spectrometers (SEM-EDS), electron microprobes (EMP) and Raman microscopes (RM). While SEMs and EMPs, provide both very high-resolution imagery (sub-micron scale) and mineral phase chemistry (micron scale) their acquisition costs range from hundreds of thousands to over a million dollars, annual maintenance costs of thousands to over ten thousand dollars, dedicated climate-controlled lab space, and usually a salaried technician. Micro-Raman spectroscopy offers modest acquisition costs of several tens of thousands of dollars not including a petrographic microscope, no manufacturer maintenance contracts, no dedicated climate-controlled lab space, and no specialized technicians. Commercial thin section preparation costs are also modest (@ $40 per polished section) and many geology departments already have facilities that can prepare thin sections in-house.

Continued on Page 7

MICRO-RAMAN *Continued from Page 6*

Micro-Raman System

The examples provided below exhibit the application of micro-Raman spectroscopy to mineral identification in polished rock thin sections using a B&W Tek i-Raman Plus portable Raman system (785 nm laser excitation and spectrometer with BWID software) interfaced with an Olympus BX-40 microscope equipped with an X-Y mechanical stage and 10x, 50x, and 150x metallurgical objectives (Figure 2). The 785 nm laser provides the greatest flexibility for mineral analysis in terms of excitation energy, fluorescence, and light absorption/heating.

Figure 2. Photograph of the B&W Tek i-Raman Plus Raman system (left) interfaced with an Olympus polarizing microscope (center) as described in the text. Desk is 48 inches wide.

Mineral Identification in Rock Thin Section Using Micro-Raman Spectroscopy

Micro-Raman mineral analysis offers several important enhancements to standard optical techniques (Nasdala and others, 2004). First, based on the diameter of the excitation beam and the specifications of microscope objective lens, illuminated spot sizes of single digit to several tens of microns can be attained. This results in the ability to generate spectra from very-fine grain sizes, sizes that are difficult to impossible to acquire standard interference figures for birefringent minerals. Because many accessory and secondary alteration minerals occur in very fine grain sizes, this greatly improves the ability to identify minerals in their in-situ textural context with other minerals in the rock. Secondly, micro-Raman analysis can provide semi-quantitative chemical information on many solid-solution minerals as well as distinguishing polymorph phases of the same chemical composition. Finally, micro-Raman spectroscopy offers the ability to switch seamlessly from optical to Raman analysis simply by turning off the microscope light source during laser illumination (***This article will only address mineral identification in thin section using standard widefield microscopy, not confocal laser scanning. All 'acquired spectra' from ~16 micron excitation spot diameters.**)

While polished (no cover-slip) thin sections provide superior conditions for Raman analysis, covered thin sections also can be used. In both cases, because the rock specimen is mounted on a glass microscope slide using an organic epoxy resin (plus hardener), all acquired Raman spectra will include the scattering signal of the slide and bonding agents. Fortunately, the dominant signal of these materials is uniform and easily recognized and therefore, can be distinguished from diagnostic mineral peaks when making mineral identifications (Figure 3).

Continued on Page 8

MICRO-RAMAN *Continued from Page 7*

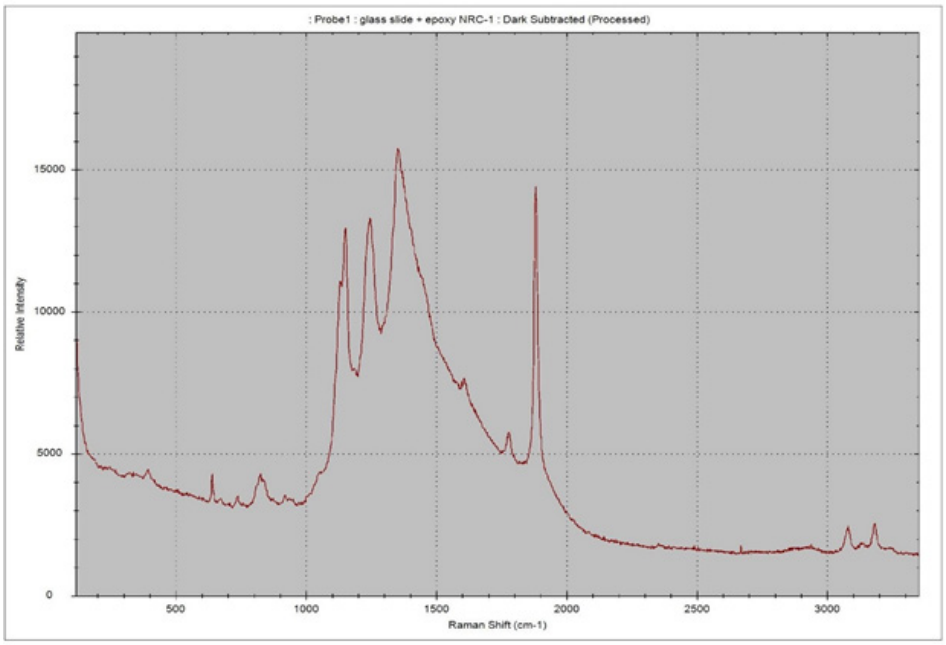


Figure 3. Acquired spectrum of standard glass microscope slide coated with epoxy.

Examples

Optical identification of opaque minerals in thin section is highly limited without reflected light capabilities, and even with this capability is often difficult. Micro-Raman analysis using a standard transmitted light petrographic microscope, however, can provide clear identification of common opaque mineral phases (Fe-, Fe-Ti, Fe-Cr and Mn-oxides, graphite, and many sulfides) provided correct excitation conditions are employed (low power densities to lessen local heating/alteration artifacts (Nasdala and others, 2004). Figure 4 illustrates the comparison of an acquired hematite spectrum with a reference hematite spectrum. The agreement of the Raman peak positions and relative intensities between the collected spectrum and library hematite spectrum indicates the sample is hematite.

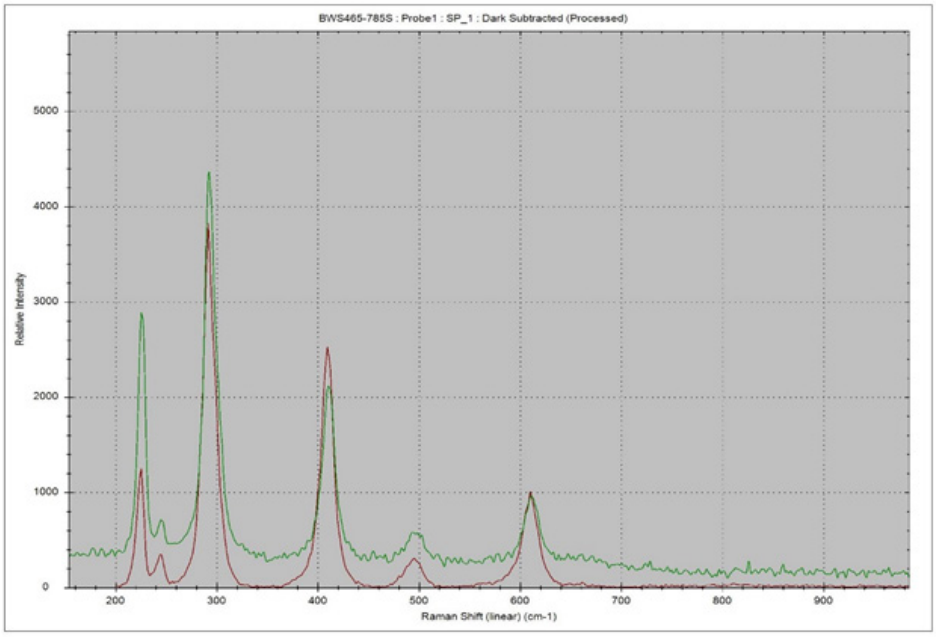


Figure 4. Acquired spectrum (green) of unknown opaque grain in polished section compared to University of Arizona RRUFF reference spectrum of hematite (brown) (100% laser power; 2 second integration time for acquired spectrum).

Continued on Page 9

MICRO-RAMAN *Continued from Page 7*

Garnet, a common metamorphic mineral occurs in several isomorphous solid-solution series, the Ca-Fe/Ti-Cr garnet series and the (Mg-Fe-Mn) series. Micro-Raman analysis can provide valuable semi-quantitative chemical information about members of these series (Kolesov and Geiger, 1998). The spectrum in Figure 5 illustrates how variations in major Raman peak position can be used to estimate ranges of mole percent MnO/FeO in the spessartine-almandine garnet series. The primary A1g peak around 900 cm-1 indicates a mole percent spessartine component in the 25-50% range.

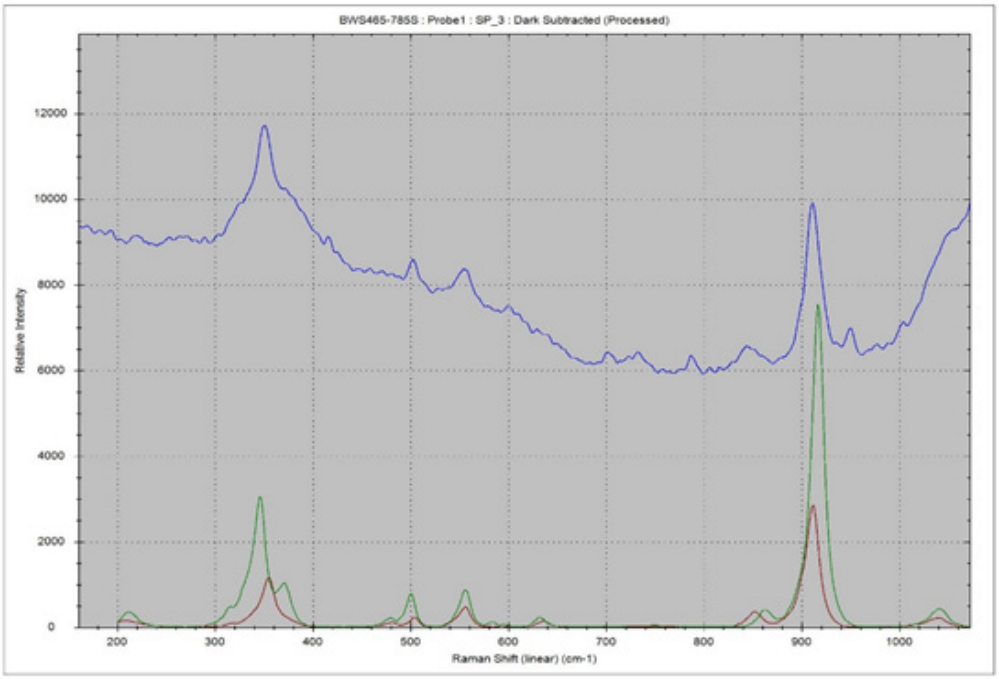


Figure 5a. Acquired garnet spectrum (blue) plotted with RRUFF reference spectra of almandine garnet (green) and spessartine garnet (brown). Acquired garnet spectrum shows an intermediate composition in the almandine-spessartine solid solution series. 100% laser power, 10 second excitation time for acquired spectrum.

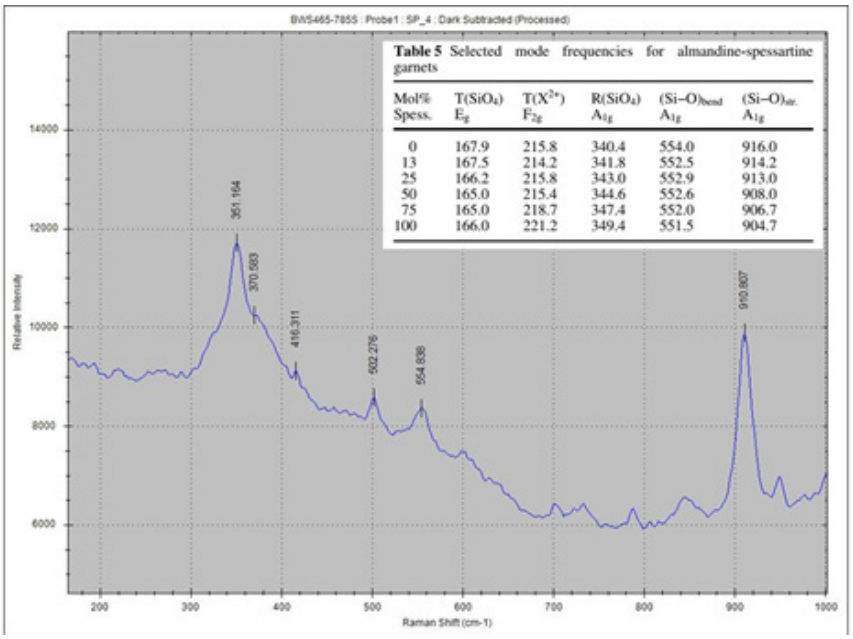


Table 5 Selected mode frequencies for almandine-spessartine garnets

Mol% Spess.	$T(SiO_4)$ E_g	$T(X^{2+})$ F_{2g}	$R(SiO_4)$ A_{1g}	$(Si–O)_{bend}$ A_{1g}	$(Si–O)_{str.}$ A_{1g}
0	167.9	215.8	340.4	554.0	916.0
13	167.5	214.2	341.8	552.5	914.2
25	166.2	215.8	343.0	552.9	913.0
50	165.0	215.4	344.6	552.6	908.0
75	165.0	218.7	347.4	552.0	906.7
100	166.0	221.2	349.4	551.5	904.7

Figure 5b. Same acquired garnet spectrum as in 5a showing main Raman peaks and Table 5 of Kolesov and Geiger (1998) illustrating ranges of mole % spessartine component in almandine-spessartine solid solution.

Continued on Page 10

MICRO-RAMAN *Continued from Page 9*

Conclusions

Identification of mineral phases in rock thin section is sometimes difficult to impossible using traditional optical techniques alone, especially for very fine-grain sizes (< 100 microns), common solid-solution series members (e.g. plagioclase, garnet, pyroxene series members), and opaque minerals. Micro-Raman imaging using an interfaced laser/spectrometer system such as the B&W Tek i-Raman Plus system with a standard petrographic microscope with 100x-150x objective lenses (e.g. Olympus BX 40 and 50 series) can overcome these optical identification issues while allowing the microscope platform to be used for traditional petrographic analysis as well. Micro-Raman analysis also can provide valuable semi-quantitative chemical information about mineral phases. Given the relatively modest acquisition costs, almost zero annual maintenance costs, and lack of dedicated operational technician and special lab space requirements, micro-Raman systems represent a very attractive technology enhancement for all College and University geoscience departments, as well as government geoscience agencies, and private geoscience consulting firms.

References Cited

Freeman, J.J., Wang, A., Kuebler, K.S., Joliff, B.L., and Haskin, L.A., 2008, Characterization of Natural Feldspars by Raman Spectroscopy for Future Planetary Exploration: The Canadian Mineralogist, v.46, p. 1477-1500.

Kolesov, B.A. and Geiger, C.A., 1998, Raman spectra of silicate garnets: Physics and Chemistry of Minerals, v.25, p.142-151.

Nasdala, L., Smith D.C., Kaindl, R. and Ziemann, M.a., 2004, Raman Spectroscopy: Analytical perspectives in mineralogical research, European Mineralogical Notes in Mineralogy, v. 6, p. 281-343.

Dr. Peter Muller is an independent consultant (Muller Geological Consulting, LLC) based in Philadelphia, Pennsylvania specializing in field-oriented structural geology, geologic mapping, mineral resource exploration, mineral analysis using Raman spectroscopy, and geoscience teaching. He may be reached via Email.

ANNUAL MEETING *Continued from Page 3*

members on the State Registration Board for Professional Engineers, Land Surveyors and Geologists who oversee the granting and auditing of PG licenses. He gave an update on trends in licensing in the Commonwealth, as well as an overview of the current process of auditing of PDH's.

Kevin M. Beer, manages the Environmental Group of the PA-DEP Bureau of Waste Management program. When earth is moved and fill becomes necessary, it is important to have clearly-defined and measurable guidelines on what constitutes clean fill. The Fill Policy Technical Guidance Document underwent improvements this year that simplified and clarified the guidelines, which Mr. Beer explained.

Brian J. Dunst, P.G., – Geologist Supervisor at the PA Geological Survey (PADCNR) – gave a fascinating talk about subsurface storage of Natural Gas Liquids (NGLs). The tri-state region of PA-OH-WV produces large volumes of NGLs. Tight, cavernous rock formations potentially have the volume needed for long-term storage of NGLs for strategic purposes and/or "buffering" of the supply to best provide for major fluctuations in demand. Working with several other agencies, the PA Geological Survey is researching potentially safe, suitable formations for an Appalachian Storage Hub for Natural Gas Liquids.

Vice President and Chief Operating Officer for ARM Geophysics, **Scott Wendling, P.G.,** gave a fascinating overview of the horizontal directional drilling (HDD) process, as well as an update on the developments in PA DEP's Stakeholder Workgroup for Horizontal Directional Drilling and Other Trenchless Construction Methods as they develop a guidance document (draft as of July 2019).

DEADLINE FOR OUR NEXT NEWSLETTER IS JULY 15, 2020

For more information, contact our PCPG Newsletter Editor and Communications Committee Co-Chair - Tiffani Doerr, P.G., by eMail or telephone at 302-477-1305.

2020 PCPG MEMBER SPONSORSHIP RATE

(Rates are listed as amount per issue)

Size	Commitment:	1x	4x
1/2 Page (8" x 5")		$225	$150
1/4 Page (3.875" x 5")		$140	$95
Business Card (H or V)		$75	$50

2020 PCPG NON-MEMBER SPONSORSHIP RATES

(Rates are listed as amount per issue)

Size	Commitment:	1x	4x
1/2 Page (8" x 5")		$300	$240
1/4 Page (3.875" x 5")		$185	$150
Business Card (H or V)		$100	$80

SPONSORS: Please remit payment to PCPG, 116 Forest Drive, Camp Hill, PA 17011

PCPG's Associate Member for 2020:

elk Environmental Services
experienced and equipped to respond
An Empire Group Company

Elk Environmental
Contact: Jestyn Newswanger
Phone: (610) 372-4760

Please consider the environment before printing this newsletter.