



# Arizona Geological Society Newsletter

JANUARY 2016

## January 5, 2016 DINNER MEETING

**Who:** **Sarah Baxter** will speak about “Calc-Silicate Alteration and Ore Characterization, ASARCO Mission Complex, Pima County, Arizona: Implications for the Optimization of Molybdenum Recovery”

**Where:** Sheraton Tucson Hotel and Suites, 5151 East Grant Road, (at the intersection of Grant and Rosemont on the North side of Grant in the **PIMA BALLROOM** (enter at northwest corner of the building) and go upstairs to the meeting room.

**When:** Cash Bar at 6 p.m.—Dinner at 7 p.m.—Talk at 8 p.m.

**Cost:** Members \$27, Guests \$30, Students Members free with on-line reservation (\$10 without).

**RESERVATIONS ARE REQUIRED:** Reserve on the AGS website ([www.arizonageologicalsoc.org](http://www.arizonageologicalsoc.org)) by **11 a.m. Thursday, December 31st**. Please indicate Regular (Chicken Cacciatore), Vegetarian, or Cobb Salad meal preference. Please cancel by **Thursday, December 31st at 11 a.m.** if you are unable to attend - no shows and late cancellations will be invoiced.



## The AGS Thanks Our 2015 Sponsors for their Support

**Calc-silicate Alteration and Ore Characterization, ASARCO Mission Complex, Pima County, Arizona: Implications for the Optimization of Molybdenum Recovery**  
by Sarah Baxter, Consulting Geologist

This study contributes a better understanding of the mineralogy and zoning of skarns and related mineralization in three parts of the ASARCO Mission Complex: 1) San Xavier South (SXS), 2) East Mission, and

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3) Mission-Pima (PS). In addition, it better characterizes various types of associated Mo mineralization. A combination of field and laboratory work to these ends built on previous work.

The SXS, Mission, and PS ore bodies occur within calc-silicate altered (skarn or tactite), calcareous, dolomitic, and siliciclastic upper Paleozoic sedimentary rocks of the Concha Limestone, Scherrer Quartzite, and Epitaph Formation. Hydrothermal features are part of a porphyry Cu(-Mo) system generated by quartz monzonite stocks (QMP) (58-59 Ma). Alteration varies with protolith composition.

High grade Mo mineralization generally occurs in two modes: 1) disseminated masses in clinopyroxene-tremolite ( $\pm$  calcite, anhydrite) hornfels, 2) trace amounts in garnet  $\pm$  clinopyroxene skarn locally closely associated with scheelite, and 3) as fracture-controlled mineralization. Vein paragenesis plays an important role in ore characterization, which varies considerably throughout the deposit.

From this study, the relationships between mineral assemblages provide the framework for a broad time-space relationship of zonation. Zoning and mineral composition differ between skarns hosted by relatively pure and impure carbonate lithologies. The Permian Concha Limestone represents an example of a nearly pure carbonate host, whereas the older Permian Epitaph Formation, an interbedded silty carbonate-rich sediment, represents the impure carbonate. Compositions of garnet and pyroxene from mixed Permian-hosted skarn, based on microprobe analyses, indicate 1) considerable ranges in composition between lithologies, 2) differences in composition between ore types, 3) irregular zoning due to oscillations in crystal chemistry between Fe-rich cores to Al-rich rims on zoned garnets from both the Mission and Pima South orebodies, and 4) regular zonation patterns from Fe-rich garnets in areas where higher grade Cu occurs to more aluminous garnets in non-sulfide bearing calc-silicate altered units.

Garnet compositions from the garnet-anhydrite-calcite-quartz interbeds of the Epitaph Formation generally range from Adr50 to Adr91 and are more aluminous than garnets formed in the Concha Limestone. Garnet compositions in the Concha Limestone range from Adr90-Adr100 and represent the addition of Fe as well as Cu  $\pm$  Zn-Pb-Ag-Bi-W through metasomatism. In the Mission and Pima South orebodies, clinopyroxene compositions in the middle member of the Scherrer Formation are generally pure diopside and show little to no compositional zoning in individual grains. Thus, the diopside hornfels of the Mission and Pima South ore bodies, commonly nested between an upper orthoquartzite and lower silty quartzite, likely originated by isochemical metamorphism rather than metasomatism. In contrast, the clinopyroxene crystals from San Xavier South are compositionally zoned. The pure diopside cores represent an earlier alteration event influenced by isochemical metamorphic processes, whereas the rims contain a higher Fe<sup>2+</sup> content--a more common composition of clinopyroxene formed by metasomatic processes, which is largely governed by protolith chemistry. Largely, the mineral compositions of garnet and pyroxene crystals of the San Xavier South-Mission-Pima ore bodies represent mineral composition profiles compatible with metasomatism.

### **About the January Dinner Speaker**

Sarah is a southern Californian from Torrance, California who learned to love camping, mineral collecting, prospecting, and geology from her father, Pete Baxter; a former mine engineering student of the Mackey School of Mines. In 1999, she graduated from the University of California, Davis with a degree in Political Science and a minor in US History. It was not until after working in law for five years as a Business Finance and Insolvency paralegal in San Francisco, California and Portland, Oregon that she realized her true calling; life-long career as an Economic Geologist.

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Sarah graduated from Oregon State University with a Bachelor's of Science in Geology in 2008. Under the advisement of John H. Dilles, she completed a senior thesis project on an underground mesothermal gold deposit in the Klamath Mountain range entitled: Mineralogy of Gold-Quartz Veins of the French Gulch District, Shasta County, California; funded by department scholarship Sarah was awarded for academic excellent in Geosciences.

In 2008, Sarah began her career as a geologist for Freeport McMoRan in Morenci, Arizona. Following work in Alaska for Pathfinder Mineral Services and Sumitomo Metal Mining in 2009, she formed Klondike Mountain Geological Services and has worked as a contract geologist for Kinross Gold Corporation and ASARCO. In her short career, Sarah has worked as exploration and production geologist in several different types of ore deposits. Her diverse career ranged

from a helicopter supported reconnaissance field geologist in the Alaskan Interior to near mine-site exploration and production geologist at both underground and open pit operations in Nevada, Alaska, Washington, and Arizona.

Recently, Sarah earned her Professional Science Master's degree in Economic Geology from the University of Arizona. As a student at the U of A, she was awarded the 2013-2014 SRK Consulting scholarship for academic excellence and was a distinguished speaker in Economic Geology at the 43 annual GeoDaze symposium. Her talk this evening entitled: Calc-Silicate alteration and ore characterization, ASARCO Mission Complex: Implications for the optimization of molybdenum recovery was the subject of her graduate research sponsored by ASARCO.

**Up-coming Arizona Geological Society Dinner Meetings**

Date	Speaker	Title of Presentation
2/2/2016	Karen Wenrich	The Ga-Ge Rich Apex Mine, Utah - A Tsumeb, Namibia Analogue
3/1/2016	Peter Johnson	Tectonics and Ore Deposits of the Arabian-Nubian Shield
4/5/2016	-	To be Announced

**Arizona Geological Society Membership Stats (12/19/2015)**

Total Membership	Professional Members	Student Members	Organizational Members
503	399	97	7

## 2015 Scholarship Recipients Announced at December Meeting



**2015 Courtright and AGS Scholarship Recipients, Alexandra Macho (left) and Enrique Chon (right)**

The Arizona Geological Society awarded Alexandra Macho and Enrique Chon scholarships at the December 2015 dinner meeting.

The 2015 Courtright Scholarship was awarded to Alexandra Macho for her research of Eocene Intrusions and Associated Hydrothermal Systems in the Egan Range, White Pine County, Nevada. Allie is currently pursuing a Professional Science Masters degree in Economic Geology at the University of Arizona. She plans to continue for a Ph.D. at the U of A in the Lowell Program in Economic Geology.

The 2015 Arizona Geological Society Scholarship was awarded to Enrique Chon, a senior at the University of Arizona, where he is majoring in Geoscience with an emphasis in Geophysics. Enrique expects to complete his B.S. in the spring of 2016 and plans to pursue a graduate degree in Geological Engineering and the Peace Corps Masters Program at Michigan Technological University.

## Bob Kamilli Honored for his Service to the Arizona Geological Society



Bob Kamilli received a life time membership at the December meeting in recognition for his long-time service to the Arizona Geological Society. Over the years, Bob has held the following positions on the AGS Executive Committee: councilor (1994 and 2001-2003), President (1999), Past President (2000) and Vice President, Programs (1995-1998 and 2004-2015).

His hard work has also contributed to the success of the Doug Shakel Memorial Student Poster Events. Bob also served as chairman for the 2007 Ores and Orogenesis Symposium and was also the editor for the Arizona Geological Highway Map.

**Bob Kamilli poses with certificate recognizing his service to the Arizona Geological Society.**

## Future Direction for the Arizona Geological Society

By Donald Applebee, 2016 AGS President

I would like to put more focus on outreach programs in the elementary schools, middle schools and high schools on basics of the geological sciences and how important they are to everyday life. I would like to see several society members volunteer to speak to various school groups during the course of the year about their work in geology with emphasis on how the work benefits society as a whole. It would include geologists from the many sub-disciplines of geology including hydrogeology, environmental, geotechnical, economic geology, and the various government agencies. Arizona with its large geologic community could have several members give one or two talks per year at the schools, which would really help get out the word on how important it is to understand the geological sciences. I found out as being a parent of a child that grew up in Arizona that there is a lack of emphasis on geological/earth sciences within the state educational system. Getting professionals out to the schools will help the educational system fill this void.

I would also like continue the work on the Lindgren Collection in order to get as much of the collection photographed so that it could be stored digitally and put on website for anyone that is interested to have access to. I would also seek several society members who are talented photographers of rock specimens volunteer their time over the years to continue this endeavor. I believe that this work needs to be completed in order that geologists, mineral collectors, and anyone else, who is interested, can enjoy this collection. This could also be a very enjoyable work for the volunteers who participate.

### Geology in the News — with Emphasis on Southwestern United States

Steven Fortier, John DeYoung, Jr., Elizabeth Sangine, and Emily Schnebele, [Comparison of U.S. Net Import Reliance for Nonfuel Mineral Commodities — A 60-Year Retrospective \(1954-1984-2014\)](#): U.S. Geological Survey, National Minerals Information Center.

Michael Zientek and Alex Demas, [New Method for Ranking Global Copper Deposits Saves Time and Money](#): U. S. Geological Survey Newsroom, December 14, 2015.

Lee Allison, [\\$100 million Cost to Permit Rosemont Copper Mine](#): Arizona Geology, December 7, 2015.

Dylan Smith, [Sierrita Mine Shutdown Confirmed, to put 1,000+ Out of Work](#): Tucson Sentinel, December 9, 2015.

David Stringer, [Copper Faces at Least Two More Years of Pain, Rio Estimates](#): Bloomberg Business, November 25, 2015.

Ryan Randazzo, [Rio Tinto Sees Potential in Resolution Copper Mine near Superior Despite Low Prices](#): Arizona Central, December 10, 2015.

Mark Matthews, [Congress Calls for New Gold King Mine Investigation](#): The Denver Post, December 9, 2015.

Cardero Resource Corporation, [Cardero Reports NI 43-101 Resource Estimate for Zonia Copper-Oxide Deposit, Arizona, USA](#): Nasdaq Globe Newswire, December 3, 2015.

Megan Van Wyngaardt, [PEA Shows Solid Case for Copper Fox's Arizona Project](#): Creamer Media's Mining Weekly, November 26, 2015.

William Ascarza, [Castle Dome's Rich History Includes Mining, Gunfights](#): AZ Daily Star, Dec. 13, 2015.



### In Memoriam David M. Spatz (1947-2015)

David was an exploration geologist who applied remote sensing techniques and an inquiring mind to his mineral exploration profession and who mentored those around him.

He grew up in Conway, AR and was elected student body president in his senior year at Conway High School. He was co-captain of the undefeated 1964 CHS football team and the Arkansas All-Star East team. He attended the University of Arkansas in Fayetteville, AR on a football scholarship and completed his B.S. degree in 1969. He earned a M.S. degree in Geology at The University of Arizona (1970-1974) and completed a PhD in Geology & Remote Sensing at the Mackay School of Mines, University of Nevada-Reno (1986-1990).

He worked as an exploration geologist with Rio Algom (1982-1986), BHP Minerals for 11 years primarily in the U.S. and Mexico (1990-2001), with Freeport-McMoRan Exploration in Africa, and as an independent consultant. Over his 36-year career, he worked on projects in 47 countries.

He was a member of the Society of Mining, Metallurgy & Exploration Geology, Society of Economic Geologists (1992-2005), Geological Society of Nevada, and the Arizona Geological Society (AGS) (1996-2000). He served as an AGS Councilor in 1997, AGS President 1998, and Past-President in 1999.

### November and December Donations to the Arizona Geological Society

Donations to the Arizona Geological Society are used to fund the Courtright and AGS Scholarship programs. The Arizona Geological Society is grateful for the generosity of the following individuals, whose contributions will help students achieve their professional goals.

David Briggs

Kevin Horstman

Robert Kamilli

William Elliot

Alison Jones

Ronald LaPoint

Stanley Evans

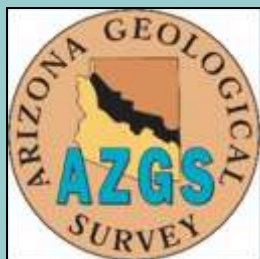
Richard Jones

Eric Seedorff

Cori Hoag

Diana Kamilli

### Underwriting Arizona Mining Review



The Arizona Mining Review, the premier e-Video Magazine addressing mining in the Southwestern U.S., is seeking underwriters for 2016 to help offset production and broadcasting costs.

Please contact Mike Conway ([Michael.conway@azgs.az.gov](mailto:Michael.conway@azgs.az.gov) | 520.209.4146) for additional information and to discuss the benefits of underwriting.

## Arizona Geological Survey News Brief



### **Arizona Mining Review (AMR) e-Video Magazine – Special Edition** **SME's Arizona Conference on 7 Dec. 2015**

December's **Arizona Mining Review (AMR)** was filmed at SME's Arizona Conference at Starr Pass on 7 Dec. 2015. The individual interviews will be posted at our [YouTube channel](#) the week of 21 December.

- Give me my tablet computer, but hold the mine: Nyal Niemuth, AZGS
- SME welcomes Arizona Mining Review: David Kanagy, SME Executive Director
- Hayden Smelter's \$130 M Conversion: Staging for the next 40 years: Joe Wilhelm, General Manager, ASARCO Hayden
- Mining challenges in Mexico: Euridice Gonzalez, Country Manager, McEwen Mining
- Managing mineral development on Arizona State Trust Lands: Joe Dixon, Manager Mineral Section of AZ State Land Dept.
- Abandoned mine lands in Arizona: Dan Moore, Geologist Bureau of Land Management

### **New AZGS Publications: Online at the AZGS Document Repository**

Arizona Geology – [Preview of Arizona Geological Survey's Annual Report 2015](#).

Briggs, D.F., 2015, [Superior, Arizona - An Old Mining Camp with Many Lives](#). Arizona Geological Survey Contributed Report, CR-15-D, 13 p.

Caudill, C.M., 2015, [Geochemical databases for characterization of K-metasomatized Tertiary units in central-western Arizona](#). Arizona Geological Survey Digital Information DI-45, 6 p., Shapefiles, Excel spreadsheets.

Conway, F.M., and Mar, S., (eds.), 2015, [Annual Report of the Arizona Geological Survey: Fiscal Year 2015](#). Arizona Geological Survey Open File Report, OFR-15-07, 53 p - Topped 300 reads at AZGS Doc Repository in 4 days.

Gootee, B.F., Willard, D.J., Wilson, M.J., Barba, W., Jablonsky, J., McCrea, B., Muncaster, G., Nations, J., Rowan, C. and Wescott, J., 2015, [Aerial and Topographic Analysis of Quaternary Faulting at SP Crater Lava Flow, San Francisco Volcanic Field, Arizona, USA: Highlighting Undergraduate Research in Geology](#). Arizona Geological Survey Open File Report, OFR-15-11, 8 p, 1 appendix.

Spencer, J.E., Ferguson, C.A., Johnson, B.J., Gehrels, G., Pecha, M. and Doe, M., 2015, [A partial compilation and database of U-Pb geochronologic data and sample locations in Arizona and southeastern-most California](#). Arizona Geological Survey Digital Information DI-46, 2 p., Shapefiles, Excel Table and 2 appendices.

Spencer, J.E. and others, 2015, [Geologic map of the Cross Roads 7.5' Quadrangle and the southern part of the Gene Wash 7.5 Quadrangle, La Paz County, Arizona, and San Bernardino County, California](#). Arizona Geological Survey Digital Geologic Map DGM 111, 1 map sheet, 1:24,000 scale. (This map was dedicated to Jon Spencer upon his retirement.)

Youberg, et al, 2015, [Building a statewide inventory of landslides in Arizona](#). Geological Society of America Annual Conference 2015, poster.

# ANNOUNCEMENTS

## Welcome New AGS Members

Andrew Bochko

Guanhui Cheng

Michael Ellis

**Arizona Geological Society is grateful to Freeport-McMoRan, Inc. for their generous support of our student members!**



# FREEPORT-McMoRAN

**Freeport-McMoRan sponsors student dinners for the 2016 AGS monthly meetings.**

### 2016 AGS MEMBERSHIP APPLICATION OR RENEWAL FORM

Please mail check with membership form to: Arizona Geological Society, PO Box 40952, Tucson, AZ 85717

Dues (check box)  1 year: \$20;  2 years, \$35;  3 years: \$50;  full-time student (membership is free)

NEW MEMBER or RENEWAL? (circle one) Date of submittal \_\_\_\_\_

Name: \_\_\_\_\_ Position: \_\_\_\_\_

Company: \_\_\_\_\_

Mailing Address: \_\_\_\_\_

Street: \_\_\_\_\_ City: \_\_\_\_\_ State: \_\_\_\_\_ Zip Code: \_\_\_\_\_

Work Phone: \_\_\_\_\_ Home Phone: \_\_\_\_\_

Fax Number: \_\_\_\_\_ Cellular Phone: \_\_\_\_\_

E-mail: \_\_\_\_\_ Check this box if you do not have an email address

*All newsletters will be sent by email. If you do not have an email address, we will mail a hard copy to you, but we cannot guarantee timeliness.*

If registered geologist/engineer, indicate registration number and State: \_\_\_\_\_

Enclosed is a \_\_\_\_\_ tax-deductible contribution to the  J. Harold Courtright or the  Arizona Geological Society Scholarship Funds.