



Arizona Geological Society Newsletter

APRIL 2017

April 4, 2017 DINNER MEETING

Who: David London is the featured speaker. See abstract below.

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 **SABINO 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 \$30, Guests \$33, Students Members free with on-line reservation (\$10 without).

RESERVATIONS ARE REQUIRED: Reserve on the AGS website (www.arizonageologicalsoc.org) by **11 a.m. Friday, March 31**. Please indicate Regular (Lemon Rosemary Chicken), Vegetarian (Risotto) or Machaca Chicken Salad meal preference. Please cancel by **Friday, March 31 at 11 a.m.** if you are unable to attend - no shows and late cancellations will be invoiced. (Please call or text Alison Jones at 520-270-2825 if you must cancel after the deadline. We may be able to sell your meal and you won't be billed).



AGS is grateful to

LAYNE

for sponsoring the April Dinner meeting.
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ABSTRACT

The Nature and Origins of Internal Zonation within Granitic Pegmatites David London, School of Geology & Geophysics, University of Oklahoma

A comprehensive understanding of the complex internal zonation of pegmatites has eluded petrologists for over a century. Explaining the origins of the zonation represents a challenge to our understanding of igneous and hydrothermal processes, and our ability to discern them.

Liquidus Undercooling. Liquidus undercooling of hydrous and flux-bearing (but not exotic) granitic liquids by $\sim 200^{\circ}\text{C}$ is the single most important step in the formation of zoned pegmatites. The crystallization of pegmatites commences at $\sim 450^{\circ}\text{--}500^{\circ}\text{C}$, $\sim 200^{\circ}\text{C}$ below the liquidus temperature of granitic melts. In response to undercooling, the first-formed zones exhibit anisotropy as unidirectional solidification inward, graphic intergrowths, and sequential mineralogical assemblages.

Abstract Continued on Page 2

Abstract Continued from Page 1

Feldspar and Quartz. The most common and prominent manifestation of zonation entails feldspathic outer zones and quartz-rich cores. This zonation arises from differences in the Gibbs Free Energies of crystallization ($\bar{G}_{i,\text{liquid}} \rightarrow \bar{G}_{i,\text{crystal}}$, where i is a component of the melt with crystalline stoichiometry) in the highly undercooled state of pegmatite-forming melts. At 500°C and 200 MPa, the energy released by the crystallization of (typical) plagioclase ($\text{Ab}_{85}\text{An}_{15}$) is -26839 J/m, that of alkali feldspar ($\text{Or}_{70}\text{Ab}_{30}$) is -26760 J/m, and of quartz (8 oxygen basis) is -18586 J/m. Consequently, the greater energy release from feldspars favors their crystallization over quartz at the start, and the commensurate quartz component missing in the outer zones is deposited sequentially in the interior portions of pegmatite bodies.

Zonation of Alkali Feldspar and Plagioclase. When crystallization begins with a plagioclase or a K-feldspar assemblage along one margin of a melt body, the complementary assemblage nucleates on the opposite side of the melt body. The chemical potential gradients caused by the initial assemblage appear at the far end of the melt column because that is the finite boundary condition for the diffusive supply of ions to the crystallization front. Far-field chemical diffusion leads to spatial segregation of plagioclase and K-feldspar.

Oscillating Zonation and Chemical Fractionation. At 450-550°C, the concentrations of components that are excluded from the first crystalline assemblage build up in a boundary layer of melt adjacent to the crystallization front. Boundary layer pile-up has two consequences for zonation: (1) the crystallization front is alternately saturated in multiple mineral assemblages, or (2) constitutional zone refining leads to an accumulation of excluded components in the boundary layer liquid until the bulk melt has been exhausted, whereupon the mineralogy changes from ordinary to exotic. The formation of coarse-grained pegmatitic texture, and eventually gems, results more from process (2) than from (1).

David London will speak at the USGS on April 4 at 12:10 pm. The title of his talk will be **Ore-Forming Processes within Granitic Pegmatites**. The talk will be in room 353. The USGS is located at 520 N. Park Ave., at the northeast corner of Park Ave. and 6th St. Parking is available in the parking garage east of the USGS building on 6th St. **Abstract on Page 5.**

About the April Dinner Speaker



David London obtained his B.A. in geology (1975) at Wesleyan University, Connecticut, after which he worked as a field geologist for the U.S. Geological Survey from 1975-1976. He received his M.S. (1979) and Ph.D. (1981) in geology from Arizona State University. Following a postdoctoral research fellowship at the Geophysical Laboratory of the Carnegie Institution of Washington (1981-1982), London joined the faculty of the School of Geology and Geophysics at the University of Oklahoma, where he is the Stubbeman-Drace Presidential Professor, the Norman R. Gelpman Professor of Geology, and director of the University's electron microprobe lab. London also is the chair and managing editor of the "Pegmatite Interest Group" of the Mineralogical Society of America. He is the author of the book *Pegmatites*, which was published in 2008 as Canadian Mineralogist Special Publication 10, and he is the namesake of the mineral londonite, isometric $\text{CsAl}_4\text{Be}_4[\text{B}_{11}\text{Be}]\text{O}_{28}$ (Can. Mineral. 39: 747-755).

LINDGREN COLLECTION REPORT – MARCH 2017

Carl Bowser

As many of you know, in 2002 AGS helped to purchase a collection of rock and mineral specimens once owned by renowned economic geologist Waldemar Lindgren (1860-1939) that was going to be thrown away by Harvard University. The collection is owned by UA. In the past couple of years, AGS has been trying to come up with a way to curate/catalog/display the collection.

Several developments on the status and progress with the Lindgren collection have occurred in the last few weeks. At the Tucson Gem and Mineral, show I met with Jolyon Ralph of MinDat.org who has agreed to put our documented collection on line on their web site, one seen by mineralogists and petrologists worldwide. He is very excited to participate with us and provide the web presence for the collection as a defined part of the mindat.org database. He's willing to share software for entry for our approval, and I'm currently discussing parameters he will need to integrate the collection information data (and photos) into their database. This is better than we had imagined for our goal of making the collection more broadly available, and eliminates the need for a web site specialist to put the collection on line. Jolyon has an international following for his database, and it has received even more attention with the recent focus on mineral ecology and mineral evolution pioneered by Bob Downs and Bob Hazen's work. I'm convinced this will be a fruitful collaboration and save AGS considerable effort (and money).

Plans are currently underway to remodel the now abandoned Pima County Courthouse to eventually house the mineral collection of the Flandrau Science Center and Bob Downs has enthusiastically endorsed housing the Lindgren collection there as well. Funding and approval for the museum are nearly in place, and an announcement is expected soon on plans for the future of the building. Once approved the remodeling will be done on an accelerated pace with a possible "Centennial" opening at the end of next year, the 100th year of the establishment of the Arizona Mineral Museum.

Given that short a time, it eliminates the need to build shelving at the USGS storage building on the campus of the USDA Bee Lab, saving AGS and UA several thousand dollars. Specimen cabinets for the Lindgren collection are part of the remodeling plan and are of a type called rolling shelving used by libraries and warehousing for efficient use of space (see example below). Our focus is now in starting the work of specimen documentation.

With the help of Bob Kamilli and Mark Bultman (USGS) we have located space within the USGS facility on campus where we can move boxes from the Bee Lab and begin the work of describing, photographing, and entering data into a form suitable for conversion to the Flandrau and MinDat databases. Working space has been identified that will include a binocular microscope and workstation for a laptop computer and a stand for specimen photography. Several volunteers who have experience with rock/mineral description have stepped up to volunteer, but more will be needed if we are to make progress in the coming years. Please contact Carl Bowser (bowser@geology.wisc.edu) for information, or talk to me at the upcoming AGS meeting.

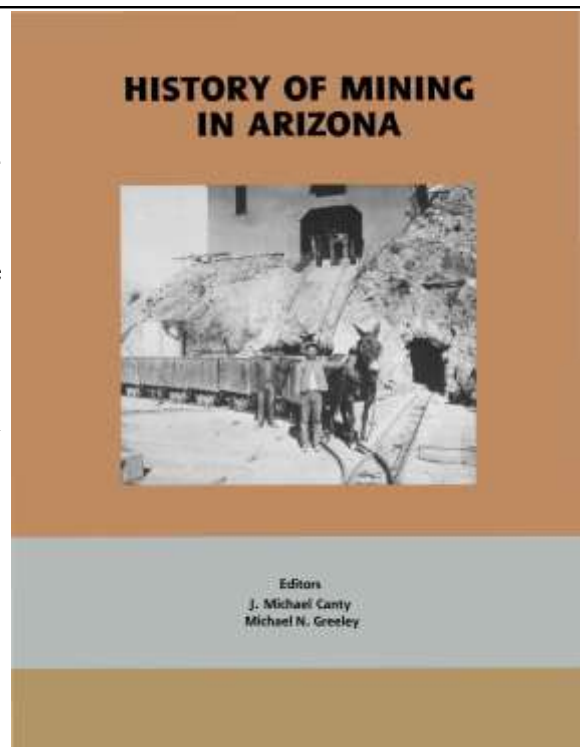


AVAILABLE ONLINE

Interested in the fascinating history of Arizona's early mining days? Download short articles from the three-volume set *History of Mining in Arizona*, edited by J. Michael Canty and Michael N. Greeley, and published by the **Mining Foundation of the Southwest** between 1987 and 1999. Read about the explorers, immigrant miners from Mexico and Europe, and the development of mineral resources found in the remote corners of Arizona from Ajo, Big Bug, and Old Dominion to Humboldt, Oatman, Tombstone, and Morenci. You can order a copy from MFSW or enjoy the individual chapters posted on the Mining foundation website at

<http://www.miningfoundationsw.org/page-1823768>

Kudos to AGS Members Kevin Horstman and David Briggs for making these valuable works available.

**Spring Field Trip - The Laramide-age Chilito Porphyry Copper Deposit**

Field Trip Leader: Don Applebee, Asarco LLC

Acknowledgements - The Arizona Geological Society thanks ASARCO LLC for granting us permission to visit their Chilito property and providing geologists to lead the tour.

Field Trip Description - AGS Members and their guests are invited to visit Asarco's Chilito porphyry copper deposit in Gila County, Arizona.

The Chilito deposit is situated in the central Dripping Springs Mountains and is one of the last largely undeveloped deposits remaining in the prolific porphyry copper province of southeastern Arizona. The planned program will include an examination of skeleton core and stops at significant geologic outcrops in the vicinity of the deposit.

Tour Date/Time - Saturday, April 22, 2017, 7:30 AM.

Carpool Locations - Due to limited space, carpooling is encouraged. The field trip will require 4-wheel drive vehicles, no exceptions. It is encouraged that participants arrange beforehand to share rides with those, who go on the trip with their 4-WD vehicles. Tucson area attendees will assemble at 7:30 AM in Oro Valley at the Walmart parking lot located at 2150 East Tangerine Road, Oro Valley, AZ. (Note: please park in the outer areas, not immediately adjacent to Walmart). We will leave parking lot promptly at 7:45 AM, so don't be late. Carpool locations will be established from Phoenix area once participant interest is known. Participant contact information will be sent in advance so carpool arrangements can be made prior to the trip.

Route - Tucson based participants will travel north from Oro Valley, along Highway 77, through Oracle Junction and then northeast to Winkelman, Arizona. The approximate travel time is 1 hour 15 minutes.

For more information and to sign up: <http://arizonageologicalsoc.org/event-2478964>

**Minerals of Arizona
Twenty-Fifth Annual Symposium
Friday March 31, Saturday April 1, and Sunday April 2, 2017**

Go to *flaggmineralfoundation.org* for more information

In Memoriam

Condolences to the family and friends of long-time member **Robert E. West**, who passed away on March 19th. Robert completed his M.S. and Ph.D. studies in geophysics at The University of Arizona, under the direction of Dr. John Summer. He worked as an exploration geophysicist in the fields of mineral and water resources. We are unable to find details of a service at this time.

USGS Lunchtime Talk—April 4, 2017

David London will present: Ore-Forming Processes within Granitic Pegmatites

Granitic pegmatites constitute ore bodies for a wide spectrum of commodities, including industrial minerals (feldspars, micas, quartz, lithium aluminosilicates), rare metals (principally Li, Cs, Be, Nb, Ta, Sn, and U), and valuable mineral specimens and gem rough for the jewelry industry. Typically, a pegmatite body is worked for only one or two of these commodities, though in principal most pegmatites could be mined completely for saleable ores with little or no waste byproducts.

Large pegmatite bodies in and near their granitic sources constitute the principal deposits of feldspar for glass manufacture and of high-purity and ultrahigh-purity quartz for the electronic industries. Low levels of trace impurities in both minerals stem from the fractional crystallization of granite that precedes the pegmatite-forming stage. Much of the Fe, Ti, and Ca that would be considered undesirable in feldspar and quartz is removed by that prior crystallization. Deposits at Spruce Pine, NC, are a classic example of the large tonnage, high purity, and efficient utilization of these ceramic materials.

Rare-element granitic pegmatites represent the end stages of crystallization of much larger volumes of granitic magma. A simple Rayleigh fractionation model predicts that 95-99+% of a source melt must crystallize to achieve the lower limits of saturation in rare-element ores. Even so, pegmatite-forming melts are likely to be undersaturated with respect to the ore-forming minerals at the solidus temperatures of the melts. Extreme undercooling of melts prior to the onset of crystallization is what brings pegmatite-forming melts to saturation in exotic minerals.

For example, based on its bulk composition, the giant Tanco rare-metal pegmatite, Manitoba, became saturated in beryl, columbite, montebasite, pollucite, tantalite, and tourmaline at temperatures in the range of ~ 525° down to ~ 390°C.

Pegmatites that contain miarolitic cavities are exploited for mineral specimens and for gem rough of the varieties of beryl (aquamarine, emerald, heliodor,morganite), elbaite (rubellite, verdelite, indicolite, and Paraíba), topaz, spodumene (kunzite, hiddenite), spessartine, fluorite, quartz, and a few others. The gem-forming process entails the accumulation of fluxing components (principally B, Li, and F) along with H₂O in pegmatite-forming melt as the crystallization fronts advance inward from the margins. The principal gem-forming fluid is likely a dense hydrosilicate liquid rich in the fluxes, H₂O, and other incompatible components. A low density aqueous solution appears toward the end of pocket formation, but it is not the principal medium from which the gem crystals grow. Upon the final exsolution of aqueous solution, the remaining components of the silicate liquid precipitate as a dense mass of pocket-filling kaolinite, in which the gem crystals are commonly embedded and supported.

Welcome New AGS Members

Shrijita Basu Dhar

Jennifer La Sure

Michael McCarrel

Martin Rex

George Riddle

David Stoller

Arizona Geological Society is grateful to Freeport-McMoRan, Inc. for their generous support of our student members! Freeport-McMoRan sponsored student dinners for the 2017 AGS monthly meetings.



2017 AGS MEMBERSHIP APPLICATION OR RENEWAL FORM

YOU CAN RENEW OR SIGN UP as a new member and pay online. Please go to our website, arizonageologicalsoc.org. Or use the form below if you are more comfortable with the old school approach.

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 M. Lee Allison Scholarship Funds.