



# Arizona Geological Society Newsletter

JUNE 2015

## June 2, 2015 DINNER MEETING

**Who:** Jan C. Rasmussen will speak about “Arizona Mineralization through Geologic Time”

**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 online reservation (\$10 without).

**RESERVATIONS ARE REQUIRED:** Reserve on the AGS website ([www.arizonageologicalsoc.org](http://www.arizonageologicalsoc.org)) by **11 a.m. Friday, May 29th**. Please indicate regular (Chicken Marsala over Linguini), vegetarian, or Cobb salad meal preference. Please cancel by Friday, May 29th at 11 a.m. if you are unable to attend - no shows and late cancellations will be invoiced.

**The June dinner meeting is sponsored by SRK Consulting**



**The AGS is grateful for SRK Consulting’s Sponsorship, which helps us to  
offset dinner meeting costs**

## Arizona Mineralization through Geologic Time

Jan C. Rasmussen, Consulting Geologist

Numerous orogenic (mountain building) episodes generated mineralization when Arizona was on the leading edge of a continent. Arizona was subjected to volcanism and plutonism that rose from the plate that was being subducted under the westward-advancing North American continent. Deposition of minerals is associated with five orogenies (mountain building episodes) in the Proterozoic and five orogenies in the Mesozoic and Cenozoic. Three orogenies in the Paleozoic that affected the eastern United States influenced the deposition of sedimentary rocks in Arizona. The thirteen orogenies that affected deposition of collectible minerals and productive mining districts in Arizona are listed in Table 1.

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## ABSTRACT - Continued from Page 1

Orogeny	Orogenic Phase	Age (Ma)	Age (period)	Arizona Magmatism	Alkalinity	Resources	Mining districts
San Andreas	Basin & Range	13-0	Latest Tertiary	anhydrous basaltic volcanism	Metalum. Alkalic	Sand, gravel, salt, zeolites, gypsum	San Francisco volcanic field, San Carlos olivine, Emerald Isle exotic Cu
Galiuro	Late (Whipple)	18-13	Late Tertiary	volcanics & local epizonal stocks	Metalum. Alkalic	Cu-Au-Ag in veins; epithermal Au-Ag veins	Oatman, Mammoth, Rowley, Swansea
	Middle (Datil)	28-18	Mid-Tertiary	alkali-calcic ignimbritic volcanics & plutons	Metalum. Alkali-calcic	Pb-Zn-Ag F veins, replace.; epithermal	Silver (Red Cloud), Castle Dome, Starley, Aravaipa
	Early (South Mountain)	30-22	Mid-Tertiary	calc-alkalic volcanics & plutons	Metalum. Calc-alkalic	Au +/- Cu-W veins & disseminated	Little Harquahala, Kofa
	Earliest (Mineta)	38-28	Mid-Tertiary	mostly within 'volcanic gap'	-	Uranium, clay, exotic copper	Ajo Comelia, Copper Butte (from Ray)
Laramide	Late (Wilderness)	55-43	Early Tertiary	2-mica, garnet-muscovite granitic stocks, sills, dikes	Peralum. Calcic, Calc-alkalic	Au dissem. & qtz veins; W veins,	Oracle (Wilderness granite), Boriana, Las Guijas, Gold Basin, Copperstone
	Middle (Morenci)	65-55	Cretaceous-Tertiary	granodiorite - quartz monzonite porphyry stocks, NE to ENE-striking dike swarms	Metalum. Calc-alkalic	large disseminated porphyry Cu systems, local skarns & veins, fringing Zn-Pb-Ag	Ajo, Ray, Christmas, San Manuel, Mineral Park, Pima, Bagdad, Silver Bell, Globe-Miami, Morenci, Superior
	Early (Tombstone)	85-65	Late Cretaceous	qtz. monz. porph. stocks; ash flows	Metalum. Alkali-calcic	Pb-Zn-Ag veins & replacement deposits	Tombstone, Tyndall (Glove), Washington Camp, Salero
	Earliest (Hillsboro)	89-85	mid-Cretaceous	Volcanics, small stocks	Metalum. Alkalic	Cu-Au hydrothermal	Hillsboro, NM
Sevier		145-89	mid-Cretaceous			Sedimentary rocks	Bisbee Group sediments
Nevadan	Late	160-145	Late Jurassic	volcanics			
	Middle	205-160	Late & Middle Jurassic	Canelo Hills volcanics; plutonic rocks	Metalum. Alkalic	porphyry Cu-Au at Bisbee, Gleeson	Warren (Bisbee mine), Turquoise (Courtland-Gleeson)
	Early	230-205	Late Triassic	Fluid flow thru sedimentary rocks	Metalum. Alkalic	Uranium, vanadium, copper	Orphan, Grandview, Monument Valley
Alleghenian (Ouachita)		325-220	Miss. - Triassic	None	-	U in sed. rocks	Payson uranium
Acadian/ Caledonian		410-380	Devonian	None	-	Limestone	
Taconic.		490-445	Cambrian - Ord.	None	-		
Grenville		1200-900	Late Middle Proterozoic - Early Late Proterozoic	basalt flows, diabase dikes	Metalum. Alkalic	Serpentine asbestos	Sierra Ancha uranium Chrysotile (Salt R. Canyon)
"Oracle/Ruin"		1440-1335	Middle Proterozoic	K-feldspar megacrystic or porphyritic granites	Peralum. Calc-alkalic, Alkali-calcic	Pegmatites & greisens - Be, Li, Ta-Nb, U & W	White Picacho, Tungstona, Four Peaks
Mazatzal		1750-1600	Late Early Proterozoic	Basalt & rhyolite metavolc., schist	Metalum. Calcic	Cu-Zn-Ag VMS	Old Dick (Bruce)
Yavapai		1800-1775	Late Early Proterozoic	Andesite, schist, metarhyolite	Metalum. Calcic	Cu-Zn-Au VMS, Cu-Zn-Ag	Big Bug (Iron King), Verde (Jerome)
Penokean/ Hudsonian		2000-1800	Middle Late Proterozoic	Schist, banded cherty iron formation	Metalum. Calcic	BIF (Banded iron formation)	Pikes Peak iron

Table 1. Mountain building episodes in Arizona

## About the June Dinner Speaker



Jan Rasmussen, formerly Jan Wilt, earned a Ph.D. in economic geology from the University of Arizona in 1993 under the direction of John Guilbert and Mary Poulton. She then went to work for Woodward-Clyde as a geochemist/stratigrapher/economic geologist on the Yucca Mountain project in Nevada. Jan's work there was recently published in the 2015 Geological Society of Nevada symposium volume.

Jan started her geological career with the Arizona Geological Survey, where she co-authored books on coal, oil, and uranium and on fossils in Arizona in the late 1960s – early 1970s. While raising a family in the late 1970s, Jan was Assistant Curator of the University of Arizona Mineral Museum. She returned to the Arizona Geological Survey in the late 1970s and co-authored books on molybdenum and uranium in Arizona. During this time, Jan was very active in the Arizona Geological Society, editing the Tectonic Digest and the Land of Cochise Guidebook and serving in various AGS offices, including president in

1985. She was co-chairman of two of the AGS symposia and program chairman for a third symposium.

Throughout her career, Jan has been committed to educating people about geology and has taught Physical, Historical, and Environmental Geology as adjunct faculty for the University of Arizona, Austin Community College, Cochise College, and Pima Community College. Jan returned to Arizona in 2001, working for MagmaChem Exploration and then SRK Consulting until 2007, when she moved to Phoenix to be Curator of the Arizona Mining and Mineral Museum. Jan received the SME Individual GEM award in 2010 for her work in educating children about the importance of mining in their lives.

After she retired from the museum in 2010, Jan returned to consulting, primarily for SRK Consulting, where she has written Canadian National Instrument 43-101 reports for mining clients, Aquifer Protection Permits, and other permitting documents. Some of her consulting has been for MagmaChem Exploration, which involved research into hydrothermal oil in the North Sea for a major Norwegian oil company.

Throughout her career, Jan has coauthored 14 books or open file reports on Arizona geology and numerous articles, most of which are available as pdf files on her website [www.janrasmussen.com](http://www.janrasmussen.com). Jan has recently started a photographic website about the Arizona Mining and Mineral Museum as it was in 2010 before the Arizona Historical Society closed it. This website is [www.MiningMineralMuseum.com](http://www.MiningMineralMuseum.com).

### Looking for a Gift for Your Favorite Geologist or Yourself?

In-print AGS publications are available for sale at the Arizona Experience Store, located at 416 West Congress Street, Tucson. Copies of current AGS Field Trip Guidebooks and Digests also will be for sale at a reduced price at the June Dinner meeting. A list of in-print publications can be found on the [AGS website](http://www.ags.org).

### Arizona Geological Society Membership Stats (5/21/2015)

Total Membership	Professional Members	Student Members	Organizational Members
497	349	141	7

## AGS Spring Field Trip | Oak Creek – Mormon Lake Graben

The Arizona Geological Society thanks Paul Lindberg for leading the spring field trip to Oak Creek-Mormon Lake Graben in north-central Arizona. Everyone enjoyed learning about the geology of one of Arizona’s newest Basin and Range tectonic features that is still actively forming. A copy of the guidebook for this field trip may be downloaded at [Oak Creek-Mormon Graben](#).



Paul Lindberg discusses the structural evolution of Oak Creek Canyon. (Photo by Mike Conway)



Diane Love and Mike Conway take a break along a babbling brook. (Photo by Cori Hoag)



Participants of the field trip pose at an overlook. (Photo by Mike Conway)



View of Sedona Red Rock Country from Sedona airport. (Photo by Mike Conway)

## Two Openings Still Available for Grand Canyon Geology Raft Trip

Alison Jones and Fred Beck are organizing another geology raft trip through 188 miles of the Grand Canyon for July 6-12, 2015. As in the past, our outfitter is Hatch River Expeditions, and we will be using 2 motorized 34-foot inflatable rafts. After launching at Lee's Ferry, we will go "down section" from the late Permian into the Precambrian, and making numerous geologic and fun stops along the way. Hatch provides all camping gear and food, and three licensed experienced guides, who run the boats, do the cooking and assure that everyone will have the experience of a lifetime. On the last day, we be lifted out by helicopter to Bar 10 Ranch on the North rim, and from there we will fly back to Marble Canyon (or Las Vegas if you prefer).

The cost for the trip is \$2,950. For more detailed information, contact Alison Jones at (520) 270-2825 or e-mail her at [ajones@clearcreekassociates.com](mailto:ajones@clearcreekassociates.com).



## U. S. Copper Production (2010-2014)

Compiled by David F. Briggs



Operation	County	State	2010 Short Tons	2011 Short Tons	2012 Short Tons	2013 Short Tons	2014 Short Tons
Bagdad	Yavapai	Arizona	101,500	97,000	98,500	108,000	118,500
Bisbee	Cochise	Arizona	138	165	246	134	0
Carlotta	Gila	Arizona	14,750	11,800	11,450	10,650	11,500
Johnson Camp	Cochise	Arizona	4,541	1,791	1,129	806	0
Miami (BHP)	Gila	Arizona	3,100	2,900	2,300	1,700	0
Miami (Freeport)	Gila	Arizona	9,000	33,000	33,000	30,500	28,500
Mineral Park	Mohave	Arizona	16,086	20,987	20,463	18,774	15,970
Mission	Pima	Arizona	91,900	72,750	67,150	57,950	66,990
Morenci	Greenlee	Arizona	257,100	307,100	315,900	331,800	406,500
Pinto Valley	Gila	Arizona	3,500	3,300	3,750	49,119	71,800
Ray	Pinal	Arizona	115,900	107,850	117,700	113,600	99,920
Safford	Graham	Arizona	71,500	75,500	87,500	73,000	69,500
Sierrita	Pima	Arizona	73,500	88,500	78,500	85,500	97,500
Silver Bell	Pima	Arizona	23,100	23,400	22,950	21,900	21,355
Eagle	Marquette	Michigan	0	0	0	0	4,305
Butte	Silver Bow	Montana	35,000	36,200	37,000	35,000	35,000
Troy	Lincoln	Montana	4,397	5,326	3,778	0	80
Robinson	White Pine	Nevada	54,484	49,947	58,755	53,949	43,300
Chino	Grant	New Mexico	17,000	34,500	72,000	85,500	125,000
Tyrone	Grant	New Mexico	41,000	38,000	41,500	48,000	47,000
Bingham Canyon	Salt Lake	Utah	275,400	215,000	179,900	232,600	225,200
Lisbon Valley	San Juan	Utah	7,800	5,818	6,500	7,850	7,200
OK/Rocky District	Beaver	Utah	20	0	550	3,000	2,900
By-Product Copper			18,304	21,602	23,826	24,448	32,293
Total U. S. Production			1,239,020	1,252,436	1,284,347	1,393,780	1,530,313

Compiled from Annual Reports, 10-K Reports & Other Financial Data. Values in yellow have been estimated.

## Arizona Geological Survey News Brief



The 27 May 2015 episode of the [Arizona Mining Review](#) (AMR) e-Video Magazine includes the following topics and guests:

- Arizona copper production in 2014 with Nyal Niemuth
- Hudbay Rosemont Project moving forward in 2015-2016 with Patrick Merrin (VP of Hudbay's Arizona Business Unit)
- Sahuarita Wins! Sahuarita High School partners with Arizona's Mining Industry to provide training & jobs, Dr. Manuel Valenzuela (Superintendent Sahuarita Unified School District)

### New Publications – Online at the AZGS Document Repository

Arizona Geological Survey, 2015, Arizona geological Survey, 2009, [Earth Fissure Map of the Wintersburg Study Area](#): Maricopa County, Arizona: Arizona Geological Survey Digital map - Earth Fissure Map 10 (DM-EF-10 v. 2.0), map scale 1:24,000.

Arizona Geological Survey, 2015, [Locations of Mapped Earth Fissure Traces in Arizona](#), v.05.11.2015. Arizona Geological Survey Digital Information (DI-39 v. 05.11.2015), shapefile.

Pearthree, P.A. and Cook, J.P., 2015, [Geology and Geomorphology of the San Pedro River](#), Southeastern Arizona. Arizona Geological Survey Special Paper #10, 23 p. (scheduled for release on 27 May 2015).



Interpretation of a stratigraphic exposure of a paleochannel of the San Pedro River along Palominas arroyo. View is looking NE, approximately perpendicular to the modern Palominas arroyo and parallel with the trend of the paleochannel and the inner valley margin.

### Upcoming Events

14-18 June 2015 - Association of American State Geologists 107th Annual Conference, Flagstaff, Arizona. We thank our friends and colleagues at the Arizona Geological Society for stepping forward to help sponsor the event.

# ANNOUNCEMENTS

## Welcome New AGS Members

Tyler Baril	Pandian Mangan
David Beeson	Ryan Stevenson
Greg Hahn	

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



**Freeport-McMoRan is sponsoring student dinners for the 2015 AGS monthly meetings.**

### 2015 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.