



Arizona Geological Society Newsletter

JANUARY 2012

January 3, 2012 DINNER MEETING

Dr. Poul Emsbo will be our featured speaker. See abstract below.

Where: Sheraton Four Points Hotel, Wild Cat Room, 1900 E. Speedway Blvd. in Tucson
When: Cash Bar at 6 p.m.—Dinner at 7 p.m.—Talk at 8 p.m.
Cost: With reservation, members \$24, guests \$27, Students free with online reservation (\$10 without).
Without a reservation, a \$3 surcharge will be added (if the hotel is able to accommodate you).

RESERVATIONS: CALL 520.663.5295 by 5 p.m. on December 30, 2012 or reserve on the AGS website.

Please indicate low-salt, vegetarian, or vegan meal preferences. A coffee/salad/roll/dessert option is also available for \$18.

Please cancel if you are unable to attend. The hotel cannot guarantee that meals will be available without a timely reservation.

Sedex Deposits, Black Shales, and Anoxic Events

by Poul Emsbo

Recent work suggests that sedimentary-exhalative (sedex) ore deposits were formed by discharge of metal-rich basinal brines into ancient ocean basins. Empirical and temporal relationships between these ore-forming exhalative events and metalliferous black shales and anoxic events have been previously noted. Despite the common occurrence of these phenomena in age correlative strata, genetic links between sedex deposits, exhalative events, black shales, and oceanic anoxia are poorly understood. In contrast, these temporal relationships were previously ascribed to the development of euxinic conditions necessary to precipitate and preserve ore sulfides on the seafloor.

New data and interpretations are consistent with correlative anoxic conditions and the formation of metalliferous black shale as a consequence of the discharge of brines into the ocean by sedex systems. Chemical, isotopic, and geologic data from several Paleozoic sedex districts suggest that brine discharges also supplied enormous quantities of radiogenic Sr and biolimiting nutrients to the oceans. Strong temporal correlations combined with mass balance evidence and oceanographic modeling suggest that the flux of radiogenic Sr-rich sedex brines may have been sufficient to cause prominent short-duration positive excursions (“spikes”) in the global marine Sr-isotope record. If indeed these sedex hydrothermal events are recorded in the secular record, they define the enormous scale of these hydrothermal systems and indicate that the $^{87}\text{Sr}/^{86}\text{Sr}$ curve may prove to be a unique indicator of ore-forming processes useful in assessing the mineral resource potential of sedimentary basins of different ages.

Moreover the enigmatic $^{87}\text{Sr}/^{86}\text{Sr}$ maxima correlate with global $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ spikes, periods of global anoxia, deposition of metal-rich black shales, climate change, and significant mass extinctions. While the relationships among these phenomena remain poorly understood and diverse models for these events have been proposed, most invoke an increased flux of biolimiting nutrients resulting in ocean eutrophication. Evidence that the flux of key biolimiting nutrients and metals contained in sedex brines may have been equivalent to or surpass that of the total modern riverine flux to the ocean suggests these massive brine exhalations as a plausible trigger for global chemical events.

About the Speaker

Poul Emsbo is a Research Geologist with the Central Mineral and Environmental Resources Science Center in Denver. His primary expertise is in the geologic and geochemical analysis of ore deposit genesis. Poul has a Ph.D. from the Colorado School of Mines. Much of his research has been directed towards an improved understanding of the genesis of Carlin-type gold and sedex Zn-Pb deposits. Of late, Poul has been studying the impact of sedex systems on marine chemistry and its potential application to mineral assessment.

From the Arizona State Geologist's Blog:

Lee Allison, Arizona State Geologist, Director of the Arizona Geological Survey and AGS member, posts timely (and fascinating!) information on his blog at <http://arizonageology.blogspot.com/>. Some of the great stories you can find there:

Lee has reported on many occasions since April about small intensity (magnitude ± 2) earthquakes near and under Lake Mead. The frequency of these quakes has increased since August. Lee speculates that rapid filling of Lake Mead is a possible cause.

On December 23, 2011, Lee reported that Prospect Global Resources has released the Preliminary Economic Assessment for the American West Potash LLC potash resources in the Holbrook basin of eastern Arizona. The 79-page report expects 2 million tonnes per year of finished product, a mine cost of \$1.334 billion dollars, a workforce of almost 390, with hourly wages of \$25 and management/supervisory salaries of \$80,000. At the projected production rate and value of potash, they calculate a 39.7% internal rate of return that would pay off their investment in 2.1 years.

The report includes an analysis of world potash demands and production, mine operations, mineral processing, salt tailings storage, hydrogeology, and environmental and permitting issues.

From the report conclusions:

- The resource will be mined by conventional underground mining methods accessed by shaft which will allow for the production of 2,000,000 tonnes per year of finished product. In order to achieve this production target it is estimated that 13.5 MMT of mineralized material (sylvinitite) are required to be mined. The estimated life of the mine, considering both indicated and inferred, is approximately 40 years.
- Tetra Tech prepared an economic analysis for the Holbrook Basin Project based on assumed design preparation and cost estimates. The analysis was prepared for a 13.5 Mtpy production scenario. The project operating costs are estimated at US\$97/tonne. Total estimated initial capital cost for the Holbrook Basin Project, including indirect and contingency costs are estimated at US \$1,334 million, over the initial 3 year pre-production period. Additional, incremental operating or sustaining capital will be required over the 40 year mine life and is estimated at a total cost of approximately US \$643 million. Project economic analyses were performed on a before tax basis, with a base case assuming 85% mill recovery rate, an MOP price of US \$496/tonne (\$450/ton) and a 10 percent discount rate. This base case resulted in a net present value (NPV) of US \$3,818 million, an internal rate of return (IRR) of 39.7% and a payback period of approximately 2.1 years.
- Project economics are most sensitive to variances in potash price. At a price of US\$397/tonne (\$360/ton) the project NPV declines to US\$2,413 million compared to the base case NPV of US\$3,818 million. On the other hand at a 20 percent higher price (US\$595/tonne) the project NPV increases significantly to US\$5,223 million.



Welcome New AGS Members!

We are pleased to welcome the newest members of the Arizona Geological Society. If you are a new member and I failed to include you, please send me an email at ajones@clearcreekassociates.com.

Monte Matthew, MJI Resources, Gilbert, AZ
 Christine Willmott, ASARCO, Tucson, AZ
 Amber Huntoon-Colvin, ACS, Avondale, AZ
 Tom Prisciantelli, retired, Vail, AZ
 Ralph Ghazal, retired, Olympia, WA

James Girardi Receives Courtright Scholarship

At the December 6, 2011 dinner meeting, the Arizona Geological Society awarded the 2011 Courtright Scholarship to **James Girardi**, a Ph.D. candidate at the University of Arizona. James is conducting a field and lab study involving geologic and alteration zone field mapping, geochemistry, geochronology, and petrogenetic and tectonic interpretation of Jurassic arc rocks titled, "Jurassic Volcanism and Magnetite-Apatite Mineralization in the Southern Palen Mountains, Southeastern California."

James received a B.S. in 2005 from the State University of New York at Stony Brook and an M.S. in Geochemistry from UA. He is currently working under Mark Barton at UA, and plans to complete his Ph.D. in 2013.



At Left: Bob Powell presents James Girardi with the \$2000 Courtright Scholarship award at the AGS December dinner meeting.



At Right: James Girardi accepting the award and providing the membership with some of the details of his work.

James's abstract that he submitted to the selection committee is provided below:

Jurassic Volcanism and Magnetite-Apatite Mineralization in the Southern Palen Mountains, SE California by James Girardi

The Southern Palen Mountains (SPM) provide exposures of Jurassic mafic hypabyssal-volcanic rocks that host magnetite-apatite mineralization. Mapping in this range was an independently funded (USGS-EDMAP) field component of my PhD thesis, which is focused on the tectonic setting, geochemical, and metallogenic evolution of the Jurassic arc of SW US. Current mapping results indicate extensive sodic-calcic alteration in the igneous rocks. Altered igneous rocks are thrust over advanced argillic alteration hosted in the lower(?) McCoy Mountains (MM) fm. by an early-Tertiary fault, and thus can be considered a segmented hydrothermal system of late-Jurassic age. Hydrothermal alteration occurred at 161 ± 3 Ma (U-Pb igneous zircon and hydrothermal titanite).

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Courtright Scholarship Award (continued from Page 3)

Objectives for proposed research are: 1) build on district-scale mapping, with a focus on major vein systems; and 2) better constrain key aspects of the tectonic history. 1:50 scale vein mapping will be conducted at the Iron King claim, where an ~80 m vertical section is exposed along a series of four 50-80 m long benches. Selected district mapping (1:5K) will focus on Jurassic structures that host mineralization, and early-Tertiary structures that segment the hydrothermal system. Key features to describe are: 1) time-space distribution of mineralization; 2) nature of syn- and post-mineralization structures/deformation; and 3) timing of igneous activity and alteration to McCoy Basin deposition in the extensional late-Jurassic arc (e.g. Spencer et al., 2011).

The proposed work can be accomplished with field observations supplemented by analytical work. Petrographic/microprobe analysis of alteration and vein assemblages will enable full characterization of these deposits. Whole-rock major and trace elemental analysis of the igneous rocks will allow characterization of their geochemistry and altered compositions. This work has implications for understanding the styles and setting of Fe-oxide(-Cu-Au) "IOCG" mineralization in the Jurassic arc in SW North America (e.g. Barton et al., 2010). A detailed characterization of the SPM magnetite veins will enable comparison to larger more complex, better-mineralized IOCG systems in the region and worldwide. This work is planned for mid-January 2012, with an estimated completion date of April 2012.

If new facts arise from field observations, a detrital zircon analysis of sediments in the lower(?) MM fm. may be conducted. This could constrain timing of McCoy deposition relative to volcanism and alteration. Such a study would help clarify often confusing regional interpretations of Jurassic pyrophyllite-sericite-hematite alteration, and metamorphic sericite associated with Cretaceous to early-Tertiary Maria fold-thrust belt deformation.

December Dinner Meeting Highlights



Left: Carmon Bonanno and Kim Wilson discuss oil and gas exploration activity in Cochise County where Carmon's firm, Arizona Oil and Gas, is currently active.



Right: Ann Pattison (right) chats with student members. We are happy to see an increase in student attendance and we look forward to getting to know these student members better! Student numbers were impressive in December, and their areas of study are varied and fascinating.



**December
Dinner
Meeting
Fun!!**



ANNOUNCEMENTS

Congratulations to John Bolm on his recent marriage to Irma Jimenez!

John and Irma will make their home in Mexico City. At right, John (third from left) makes a point while Irma (second from left), Diana Kamilli (right) and Courtright Scholarship winner John Girardi (left) listen intently.



(You can see a better photo of John in the April 2011 Newsletter, where he was featured in the Member Spotlight" column. The newsletter editor makes no claims to being a capable photographer.)

AGS members ***Richard Ahern*** and ***Karl Sandwell-Weiss*** recently received Masters of Engineering degrees from the University of Arizona Department of Mining and Geological Engineering.

Congratulations!

AGS dues are based on a calendar year. That means your dues for 2012 are payable by January 1, 2012. You should have received an email from AGS to let you know if you owe dues for 2012. Many of our members are paid up for a few years in advance. If that's you, THANKS!

New AGS Policy in 2012

AGS loses money on dinner meetings, largely because of no-shows. Therefore, the AGS Executive Committee has decided to invoice those members who reserve a meal and do not show up for the meeting. ***This new policy will be in effect for the January 3, 2012 meeting.***

Reservations can be cancelled *without penalty* by calling the AGS reservation line (520-663-5295) before 8 a.m. on the Monday before the dinner meeting. We are unable to respond to every message left on the answering machine, but if you cancel a reservation in time, you will not be charged. Even if you are unable to cancel before Monday at 8 a.m., please let us know you are unable to attend. We may be able to give the reservation to someone else who forgot to reserve a meal.

In order to encourage interaction between students and working professionals, **BHP Billiton** is proud to sponsor student dinners at monthly Arizona Geological Society dinner meetings. **BHP Billiton** is a global mining, oil and gas company headquartered in Melbourne, Australia. The company mines copper, iron, gold, and coal, and has proven oil reserves. It is the world's largest mining company measured by revenue and, as of February 2011, the world's third-largest company measured by market capitalization.

AGS is grateful to BHP Billiton for their generous support of our student members!

In order for students to receive dinner at our monthly meeting compliments of BHP, students must make an **online** dinner reservation.

2012 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 Scholarship Fund.