



# AGS NEWSLETTER

ARIZONA GEOLOGICAL SOCIETY, INC., TUCSON, ARIZONA

November 2008

## NOVEMBER 11, 2008 DINNER MEETING

Comparative Global Production of the Chemical Elements,  
A Geochemical Perspective; and the Concept of *Underutilized Elements*  
Gordon Haxel, U.S. Geological Survey (retired)

**ABSTRACT**—In the upper continental crust of the Earth, abundances of the 81 stable or effectively stable elements (H-Bi, except Tc and Pm) and the two long-lived radioelements (Th, U) span some 10 orders of magnitude. Human utilization of these elements, as indicated by annual global production, spans a similarly large range, about 11 orders of magnitude. If short-lived artificial radioelements are included, this range is expanded to nearly 18 orders of magnitude. A few elements are obtained from the atmosphere or the ocean, but most are mined from ore deposits or other rock units of the upper continental crust. Natural abundances of the elements in the upper crust provide a necessary background to discussion of their production. In general, these upper crustal concentrations have been established over geologic time by chemical fractionation within the Earth, acting upon primordial abundance patterns created by pre-Solar System stellar nucleosynthesis. The very low crustal abundances of most of the heaviest (transbismuth) elements are determined by terrestrial nuclear processes involving Th and U.

A graph of annual production versus atomic number ( $Z$ ) for 95 elements shows that they can be classified into three categories: high-, medium-, and low-production. The high-production group comprises elements with annual production between that of Fe (the preeminent industrial metal),  $10^{12}$  kg/y, and Au (the quintessential precious metal),  $10^6$  kg/y. This group contains about one-half of the elements, including most of the major industrial and agricultural commodities.

Medium-production elements, one-third of the total, are those with annual production less than that of Au, but the same as or greater than that of Xe,  $3 \times 10^2$  kg/y. This group includes Ga and Ge; two alkalis (Rb, Cs); three of the five stable noble gases; five of the six platinum group elements; In, Te, and Tl; Hf, Ta, and Re; 10 of the 15 stable lanthanides; and two actinides (Th, Pu). The low-production group includes only two stable elements—Sc and Os—and 11 artificial radioelements.

As might be expected, upper crustal abundance and annual production are broadly correlated. To further examine this correlation, I have normalized production to upper crustal abundance, and re-normalized to the annual production of Fe, the most important industrial metal, divided by its crustal abundance. The resulting Fe-normalized production,  $P^*$ , is dimensionless. Normalized production values span only nine orders of magnitude. Only six stable elements have  $P^* > 20$ : He, C, and Cl; Rh, Pd, and Au. The first three have moderate crustal abundances, but are extracted in relatively large quantities from very rich sources. The latter three have among the lowest crustal abundances, but are special in terms of their applications.

Eleven elements have  $P^* < 10^{-3}$  and can be considered underutilized, in that their production is disproportionately low relative to their abundance in the upper continental crust: the two heavier stable alkalis (Rb, Cs), three noble gases (Ne, Kr, Xe), Y and two odd- $Z$  lanthanides (Tb, Ho), and Sc, Ga, and Hf.

*Haxel—Continued on next page*

### Dinner Meeting Information — InnSuites, 475 North Granada Avenue, Tucson

To reserve your place for dinner, call 520-663-5295 before 5 pm, Thursday, November 6, 2008.

Cost: Members \$24, Guests \$27, Students \$10 (+\$3 for late registration)

Cash Bar @ 6 pm

Dinner @ 7 pm

Talk @ 8 pm

For dinner selection, indicate if a low-salt or vegetarian meal is required. Please cancel if you are unable to attend.

AGS CAN NO LONGER GUARANTEE DINNER SEATING FOR THOSE WHO SHOW UP WITHOUT A RESERVATION.

# AGS NOVEMBER FIELD TRIP

## 11/15-16/2008

The **AGS Fall Field Trip**, led by Dr. Gordon Haxel, USGS (retired), Flagstaff, will be a 2-day event near Tucson on November 15 and 16. The field-trip title and focus are *The Jurassic Magmatic Arc, South-central Arizona*.

The first day will include a brief introduction to the Jurassic magmatic arc, stops to examine exposures of Jurassic Kit Peak Granodiorite and Pavo Kug Granite in road cuts along AZ Hwy 386 (the road to Kit Peak), and views of regional geology from Kit Peak. Stops on the second day will examine exposures of Jurassic interbedded quartz arenite and rhyolite welded tuff on the south side of Las Guijas Mountains and Jurassic leucogranite, middle Tertiary minette dikes, and Jurassic or middle Tertiary wolframite-bearing quartz veins (Las Guijas tungsten district) on the north side of Las Guijas Mountains. There may be other impromptu geologic stops.

The full field-trip schedule was published in the October AGS newsletter and is on the AGS web site. There will be a full-color field trip guidebook and a nominal charge to cover guidebook and other costs (\$30, first person; \$15, second person (without guidebook)). Students are free but must purchase a guidebook.

Please contact Rich Brown (rbrown@clearcreekassociates.com; cell: 520-240-8265) if you plan on attending this field trip. Information on the Saturday meet-up location will be provided at that time and also will be posted on the AGS web site. In particular, Rich would like to hear from attendees who will be driving a 4-wheel-drive vehicle and (or) have space for other attendees in their vehicle.

#### **Guidebook References** (\* to be used for figures for guidebook)

\*Anderson T.H., Rodríguez-Castañeda, J.L., and Silver, L.T., 2005, Jurassic rocks in Sonora, Mexico: relations to Mojave-Sonora megashear and its inferred northwestward extension, in Anderson, T.H., Nourse, J.A., McKee, J.W., and Steiner, M.B., editors, *The Mojave-Sonora megashear hypothesis: Development, assessment, and alternatives: Geological Society of America Special Paper 393*, p. 51–95.

\*Beikman, H.M., Haxel, G.B., and Miller, R.J., 1995, Geologic map of the Tohono O'Odham Indian Nation, southern Arizona: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-2017, scale 1:125,000.

**CONTACT RICH BROWN FOR INFORMATION ON POSSIBLE CAR POOLING FOR THE FIELD TRIP.**

### **RESERVATIONS ARE REQUIRED**

## **Kudos for our 2008 Member Directory Advertising Sponsors**

Thanks to the great support of our advertising sponsors, the preparation and printing of the 2008 Member Directory was completely subsidized. The directories were bulk mailed at the end of September to the member address on file it but copies won't be forwarded if you have a new address. If you haven't received your copy yet, please contact Cori Hoag, choag@srk.com.

Please thank our sponsors in person when you next get the chance!

#### **Haxel**—Continued from page 1

One attribute most of these underutilized elements have in common is a tendency to remain widely dispersed in common rock forming minerals rather than concentrated in exploitable ore deposits. Some of them (most likely Sc, Y, Tb, Ho, Ga, or Xe) have potential for increased production for expanded or new applications; others probably will remain underutilized.

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# The President's Column

## SPECIAL REPORT ON AGS INVESTMENTS, PREPARED BY LEE ALLISON, PRESIDENT

### ANN PATTISON, PAST PRESIDENT, AND OTHER MEMBERS OF THE INVESTMENT COMMITTEE

The AGS Investment Committee has been working diligently to protect the Society's investments during this time of great uncertainty. The Society is invested in a conservative- to medium-risk mix of bonds, savings, and securities to meet our formally adopted strategy. The AGS investment policy states that the desired objectives are:

- maximizing return within levels of risk that are reasonable and prudent and establish policies based on total return;
- limiting risk exposure through diversification;
- exposing the funds to a wide range of investment types; and
- controlling the costs of administering and managing the portfolio.

Last spring, the investment policy statement was amended by vote of the AGS Executive Committee on August 21 to allow the Investment Committee to deviate from asset allocation guidelines that dictated that 40 to 70 percent of the portfolio stay invested in equity-related securities, 30 to 50 percent in fixed-income securities, and 0 to 30 percent in cash and cash equivalents. The new AGS investment guidelines require a unanimous vote from Investment Committee members in order to deviate from these guidelines, since such an action was expected to be limited to times of market crisis and only to pre-serve AGS funds. At the time we made these amendments, the portfolio was already near the limits of the guidelines (at the high end of the cash range and low end of the equities range). No provision had been made previously for a sudden extreme market move which would require a change in our asset allocation.

Last summer, our financial adviser, Craig Wisness, moved from Wachovia, where the AGS portfolio has been invested, to H&R Block Financial Advisors. After meeting with representatives from both firms, the Investment Committee recommended we stay with Mr. Wisness and move the portfolio to H&R Block. In August the Executive Committee approved the recommendation and the move was initiated. These decisions were all made before and independent of the most recent market fluctuations and bank and brokerage failures.

Due to new Homeland Security requirements, the transfer of the AGS portfolio is in an extended "null" period until it passes rigorous scrutiny from both companies. All of our funds remain insured at market value against a bank or brokerage failure.

As of October 1, approximately 60 percent of the AGS portfolio is in cash or fixed income funds (bond funds). The remaining equities are well diversified in various mutual funds. The AGS portfolio has continued to do well relative to the general market. On paper, we have lost some principal in the last two months, but our portfolio is not down as much as the market. The Investment Committee continues to monitor the market and is ready to take action as needed once the transfer is complete.

Many thanks to Committee chair Don Hammer and alternate member Charles Miller (filling in for the indisposed Gordon Wieduwilt) for their thoughtful dedication to overseeing our financial resources.

## 2008—09 CALENDAR OF EVENTS

- 11/15-16/08 **AGS Fall Field Trip:** The Jurassic Magmatic Arc, South-central Arizona
- 12/2/08 **Jonathan T. Overpeck, UA:** *Global climate change and why it matters in the Southwest*
- 01/6/09 **Richard Reynolds, USGS:** *Dust in western North America*
- 02/3/09 **Vince Matthews:** *China and India's Ravenous Appetite for Natural Resources*
- 03/3/09 **Mike Clarke, Augusta Resource Corp.:** *Geology of the Rosemont Cu-Mo-Ag deposit*
- 04/7/09 **Bill Chavez, New Mexico Tech:** *Geochemical controls on the intensity and maturity of development of supergene enrichment profiles*

**The Arizona Geological Survey announces its newest contributed report, *The Geology of the Safford-San Carlos Area, Graham and Gila Counties, East-Central Arizona*, by Dr. Peter Mock.** The report, CR-08-A, includes a body of 59 pages - with 22 figures and three appendices. The report is available on CD-ROM from the AZGS for \$15.00. T

The Digest 22 editors report that publication of the digest in late 2008 remains on schedule.

**Please make your dinner-meeting  
reservation BEFORE  
Thursday, November 6, 2008.  
Call 520-663-5295 today!**



**ARIZONA GEOLOGICAL SOCIETY**

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ARIZONA GEOLOGICAL SOCIETY  
AND UPCOMING EVENTS  
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www.arizonageologicalsoc.org

AGS books and maps are sold at the monthly dinner meeting and by the Arizona Geological Survey. Visit the AZGS website www.azgs.state.az.us and click on Non-AZGS Publications



*As always, please keep us up to date as you move, change jobs, or change your e-mail address.*

**2009 AGS MEMBERSHIP APPLICATION OR RENEWAL FORM**

Please mail check with membership form to: Arizona Geological Society, P.O. Box 40952, Tucson, AZ 85717. Dues (circle one): 1 year: \$20; 2 years: \$35; 3 years: \$50. (Full-time students receive free membership. The newsletter is by e-mail only, and a membership application form must be returned to AGS annually to remain on the membership list.)

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Enclosed is a \_\_\_\_\_ tax-deductible contribution to the J. Harold Courtright Scholarship Fund.