Arizona Geological Society Newsletter

MARCH 2016

March 1, 2016 DINNER MEETING

Who: **Peter R. Johnson** will present "Tectonics and Mineral Deposits of the Arabian-Nubian Shield: Base-Metals and Gold in Earth's Largest Mineralized Neoproterozoic Crystal Block"

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 $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, February 26th. Please indicate Regular (Grilled Salmon with Caper Cream Sauce), Vegetarian, or Cobb Salad meal preference. Please cancel by **Friday, February 26th at 11 a.m.** if you are unable to attend - no shows and late cancellations will be invoiced.

The March dinner meeting is sponsored by Excelsior Mining Corporation

The AGS is Grateful for Excelsior Mining's Sponsorship, which helps us fund our Scholarship Programs

Tectonics and Mineral Deposits of the Arabian-Nubian Shield: Base-Metals and Gold in Earth's Largest Mineralized Neoproterozoic Crustal Block

by Peter R. Johnson, Retired Consulting Geologist

The Arabian-Nubian Shield (ANS) is Earth's largest block of juvenile Neoproterozoic crust and its largest repository of Neoproterozoic metallic minerals. As is evidenced by innumerable ancient workings, hundreds of smelting sites, 14C dating of charcoal, and the ruins of mine camps, the ANS has been the source of gold, copper, and lead for more than 7000 years up to, and including, the present. Seventeen mines are currently

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HB 2613

by Alison H. Jones

On February 4, 2016, HB 2613 was introduced to the Arizona legislature that, among other things, would eliminate the registration of geologists (in addition to assayers, landscape architects, fruit and vegetable packers, athletic trainers, yoga instructors, and those who operate free-standing crematories) in the State of Arizona. The full text of the bill can be read here.

On February 17, the House Commerce Committee convened to listen to testimony regarding the bill. Four Arizona-registered geologists, Stephen Noel, Dawn Garcia, Tiana Rasmussen, and Barbara Murphy, spoke in opposition to the deregulation of geologists, based on the technical aspects of geology and implications for public safety. Steve Noel pointed out that State agencies (such as the Arizona Department of Environmental Quality) that hire geologists understand the value of registration and require (by statute) that the geologists working on their projects have Arizona registration. Steve also pointed out that geologists have had a major role in defining and protecting Arizona's water resources under regulations such as the Groundwater Management Act. Dawn Garcia explained the differences between certification and professional registration licensure and the importance of administration of the professional geologists by the Arizona Board of Technical Registration (ABOTR). Licensure is more robust than certification. Barbara Murphy spoke about what geologists do and the broad range of expertise they provide, the importance of licensure through the ABOTR, and the requirements of agencies such as ADEQ, ADWR, ADOT, and others that the work be conducted and signed/sealed by a registered geologist. The importance of Arizona licensure in working on federal projects in Arizona was also mentioned. Several others provided testimony in support of professional registration of geologists, including the value of their input for engineering and mining projects.

In the end, the Committee agreed to send the bill to the House floor by a vote of 5 to 3. Based on the testimony and strong opposition to the bill (evidenced by numerous emails to legislators and as shown on the bill tracking web site and from observations of those in attendance at the hearing), the Commerce Committee chair, Rep. Warren Petersen (R-Gilbert) and several others on the committee conceded that the bill will need significant revision if it is to become law.

The bill is not a cost-saving measure. Rather, the goal is to reduce regulation and government oversight. Unfortunately, the proposed legislation, as it pertains to geologists, appears to have negative implications for public safety and the stature of our profession. Arizona was the first state to require technical registration for geologists, and with good reason given the state's history of mining and mineral resource development. Protection of the public was then, and is now, the principal reason that registration for geologists is important. The work of geologists is as pertinent to public safety as that of engineers. Geologists are critical to providing expert knowledge and evaluation for mining and mineral resources (locating of minerals, development of mine plans, compliance with environmental conditions and permitting), water projects (groundwater supply, water recharge/storage, pipelines, canals, hydrogeology, etc.), geological hazards (earth fissures, land subsidence due to extensive groundwater withdrawal, landslides, identification of active faults, earthquake potential, floodplains, foundation stability, swelling soils, etc.), environmental issues (identification of contamination and remediation related to soil, water, air), and construction (geotechnical knowledge for the location of and input on the design of highways, dams, bridges, etc.) all of which have the potential to directly or indirectly impact the health, welfare, and safety of the public.

Thirty states (plus two more in 2016) currently have geologist registration. Registration offers a clear process and remedy for the public to obtain redress should a registrant not provide services in a competent manner, which may include revocation of the individual's registration and ability to practice within the State. Without registration there would be no process for technical oversight or public recourse except through the judicial

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judicial system which may be difficult, if not impossible, when the person practicing geology is from out-of-State. In addition, should this legislation pass, there may be an unintended consequence of putting Arizona geologists at a competitive disadvantage or putting engineers in the strange position of stamping a geologist's work.

Professional organizations, including the Arizona Sections of the American Institute for Professional Geologists (AIPG) and the Association of Environmental and Engineering Geologists (AEG) are teaming together to retain a lobbyist to oppose HB 2613. The AGS Executive Committee met on February 18 and agreed that this legislation devalues the science of geology and our profession's contributions to public safety. The Executive Committee agreed to join up with AIPG and AEG, to the degree that our 501-c-3 tax-exempt status allows us to do so, to oppose the legislation. As a 501-c-3 organization, lobbying cannot be a "substantial part" of AGS activities, and the IRS specifies limits to what we may spend for lobbying based on our total expenditures. This action is not something to be taken lightly. However, as the pre-eminent professional geological organization in Arizona, it was decided that we must take a position.

AGS members are encouraged to write their legislators regarding this bill. We will keep the membership apprised regarding its status. The legislature is moving very quickly on this bill and others related to geologists and trying to finish this legislative session, so please contact your legislators and other key members as soon as possible through: http://www.azleg.gov/.

New Field Trip Guidebooks

New Ferguson, C.A., 2003, Tortolita Mountains, Arizona: Arizona Geological Society Fall Field Trip, December 6, 2003, Guidebook, 16 p.

New Maher, David, Martin, Aaron, Mauel, David, Bryan, Deborah, Hubbs, Steven, and Seedorff, Eric, 2004, Mid-Tertiary synextensional sedimentation and structure in the northern Tortilla Mountains, Pinal County, Arizona: Arizona Geological Society Spring Field Trip, April 17, 2004, Guidebook, 27 p.

HARVARD MINERALS COME TO TUCSON

This new special exhibit, "American Mineral Heritage: The Harvard Collection," produced by the Mineralogical & Geological Museum at Harvard University (MGMH) in collaboration with the U of A Mineral Museum, will debut at the Flandrau Science Center & Planetarium on Saturday, February 6, 2016 and will run through December 2016. The exhibit features an exquisite selection of minerals from Harvard's collection, the oldest university mineral collection in the United States, and one of the most admired collections in the world.

Harvard Minerals Come to Tucson continued on page 4

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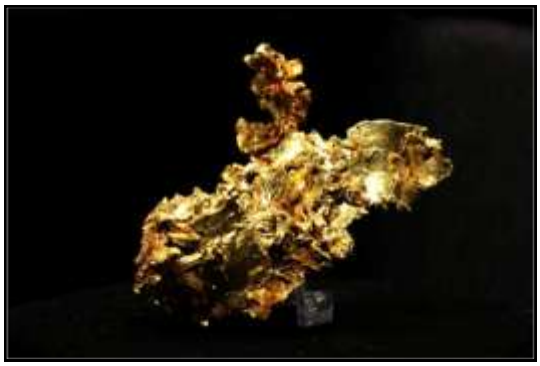

Most of the minerals in this exhibit have never been seen before in Arizona. The few exceptions appeared in past years at the Tucson Gem and Mineral Show. You'll see world-famous gold specimens from the esteemed collection of A.C. Burrage that were donated to the MGMH. You'll enjoy an entire case of minerals acquired through the bequest of A. F. Holden, a giant in the history of mineral collecting. And you'll marvel at the "Rose of Maine," a massive translucent pink morganite of beryl, on display next to the "The Peach" another stunning morganite from the same mine, which in turn shines next to a slice from the Smithsonian's famous "Jolly Green Giant" tourmaline.

The wonders don't stop there. Also on display are specimens of fluorapatite, babingtonite, wulfenite, bornite and exceedingly rare spangolite that are among the best in the world. Another case contains one of the world's top collections of fluorescent minerals from the famous Franklin, New Jersey locality. and you'll see them glow in luminous colors. Even better, the massive "Fleur de Lis" specimen features a dazzling deep red elbaite crystal that's nested among a bloom of frothy white albite crystals and a giant clear quartz crystal – its magnificent.

Harvard's collection dates back to 1784 when chemistry Professor Benjamin Waterhouse, appointed at the personal petition of founding father John Adams, assembled a small collection of minerals for course instruction. Since then, through donations and endowment, the collection has grown into one of the best in the world. Now, for the first time in Arizona, a captivating and comprehensive selection of Harvard's minerals appears in a sensational public display. Whether you're a newcomer to the world of minerals or a seasoned collector, this exhibit is not to be missed.

We hope you'll bring the whole family to behold these amazing specimens in "America's Mineral Heritage: The Harvard Collection." You can also experience our new Full Dome shows, science and math exhibits, and laser music shows. Go to www.flandrau.org for more information about this and other events.

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 | 520.209.4146) for additional information and to discuss the benefits of underwriting.

Arizona Geological Society Membership Stats (2/17/2016)

Total Membership	Professional Members	Student Members	Organizational Members
497	400	90	7

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operating in the region, producing: (1) gold from orogenic- and epithermal deposits; (2) copper, zinc, and gold from VMS deposits; (3) gold from weathered caps above VMS deposits; and (4) tantalum from pegmatite in Ethiopia, the world's 7th largest producer (40 tons in 2014). Exploration is underway in many parts of the shield, and thousands of artisanal workings produce gold amounting, in 2014, to 62 tonnes in Sudan and 8 tonnes Au in Ethiopia. Other types of occurrences that are sub-economic, are merely at the exploration stage, or are hypothetical targets include BIF, Nb-Th-U, Sn-W, PGM, Cr, porphyry copper, Fe(oxide)-(Cu-Au), and sedimentary-hosted Cu and Pb. This range of deposit types and the value of current metal production are the direct results of the rock types and tectonic evolution of the ANS. This presentation focuses on VMS, orogenic gold, and epithermal mineralization.

The Arabian-Nubian Shield is a Neoproterozoic accretionary orogen that developed in the Mozambique Ocean between ~870 and 550 Ma, bracketed by the break-up of Rodinia and assembly of Gondwana. By the end of the Neoproterozoic, the ANS was the northern (present-day coordinates) part of a larger orogenic belt referred to as the East African Orogen (EAO). At its origin, the EAO formed the axial region between convergent blocks of eastern and western Gondwana and was one of the Neoproterozoic orogenic belts that intertwined through Greater Gondwana. The EAO is now dispersed in the Nubian, Arabian, Indian, and Antarctic Plates. The ANS is exposed in the Nubian and Arabian Plates, divided by the Red Sea, which began to open ~25 M. It extends ~3500 km N-S from Jordan and Israel to Kenya, and ~1500 km W-E from the River Nile in Egypt and Sudan to the central part of the Arabian Peninsula, underlying an area of ~2.7 km2, and representing a crustal block about 27 times larger than Arizona.

Because of its origin in the Mozambique Ocean, the ANS has a distinctive juvenile character, in as much as most of the volcanic and igneous rocks of the shield have crystallization ages close to their Nd model ages, indicative of their formation from material newly extracted from a depleted mantle. Over 50% of the ANS rocks are volcanic-arc assemblages formed at convergent margins and composed of tholeiitic to calc-alkaline volcanic rocks, volcaniclastic and sedimentary rocks, and vast amounts of TTG-type intrusions. The arcs range between ~870-600 Ma, but most are Tonian and Cryogenian. They are characteristically intraoceanic arcs, apart from some that originated at ocean-continent boundaries, and tectonically include fore-arc basins and ophiolites, volcanic edifices and subvolcanic mafic-intermediate intrusions, and back-arc basins. Accretion of the arcs resulted in the build-up of composite crustal blocks, or tectonostratigraphic terranes, and the formation of ophiolite-decorated fold and thrust belts, or sutures, between the terranes. Major accretionary and suturing events occurred at 780-760 Ma, 740-715 Ma, 680-640 Ma, and 620-605 Ma. The remaining rocks of the ANS include late Cryogenian-Ediacaran volcanosedimentary successions deposited in post-amalgamation basins unconformable on newly accreted arcs, vast amounts of granitoids, and minor layered gabbro. The post-amalgamation basins range in age from ~660-550 Ma and granitoids were emplaced in pulses between ~630 and 540 Ma during a tectonic transition in the shield from orogenic, subduction settings to anorogenic, within-plate settings. Chemically, the granitoids are transitional between calc-alkaline and alkaline magmatism. Between ~650 Ma and 550 Ma, the ANS was affected by major transpressional shearing associated with final E-W convergence of Gondwana blocks, north-directed tectonic escape, and orogenic collapse. By 540 Ma, the entire region was stable continental crust: it formed a shelf at the margin of the proto-Tethys ocean, was flanked to the north by Cadomian and Amorican blocks, and passed southward into the Transgondwanan Mountains.

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The most abundant mineral-deposit types in the ANS are VMS and orogenic gold, but epithermal mineralization, exemplified by Mahd adh Dhahab, is highly valuable at the few locations where it is found. Because of varying gold contents, some VMS deposits are referred to in the literature as gold deposits, others as Cu-Zn-Pb deposits. VMS deposits are present at many locations between northern Ethiopia, northern Egypt, and north-central Saudi Arabia. Most VMS deposits in the ANS are examples of convergent-margin polymetallic sulfide mineralization, but rare deposits appear to have formed at spreading centers or in back-arcs. The deposits are hosted by bimodal (basaltic to rhyolitic) submarine volcanic rocks, as well as volcaniclastic and sedimentary rocks. They comprise lenses of massive to semimassive sulfides of iron, copper, zinc, and lead, and have variable amounts of telluride. The VMS deposits range in size from < 1 to >24 Mt, and nineteen in the Arabian shield, for example, have a median size of 1.6 Mt at a median grade of 3.2% (Cu+Zn+Pb). The largest deposit in the Arabian Shield is Jabal Sayid, which recently started mining (24.4 Mt @ 2.53 5% Cu+Zn+Pb). Bisha, the largest deposit known in the Nubian Shield, was discovered in Eritrea in 1998. Development started by mining its gold-enriched weathered cap but is now transitioning to working the primary massive sulfide zone. The current (February, 2015) indicated resource comprises 22 Mt grading 0.7 g/t Au, of which the sulfide zone grades 1 % Cu, 5.7 % Zn, 0.76 g/t Au, 45 g/t Ag. Although they are not well dated, the oldest VMS deposits in the ANS appear to be in Eritrea (~850-720 Ma) and the youngest (~690-600 Ma) in the eastern Arabian Shield.

Gold-enriched weathered caps (oxide gold) are a distinctive feature of many ANS VMS deposits. The degree of gold enrichment is particularly intense in the Nubian Shield, commonly making occurrences of oxide gold an especially valuable and intently sought ore type. At Bisha, for example, the oxide zone contains as much as ~7 g/t Au, representing a ten-fold increase in gold grade from the primary sulfides. Grades in the oxide zone in the Ariab Mineral District (Sudan) reach 5-10 g/t Au, whereas the primary sulfides have grades of ~1-1.5 g/t Au.

Orogenic-gold occurrences are largely the product of the late Cryogenian-Ediacaran transpressional shearing event that affected all parts of the ANS. Concomitant metamorphism and (or) intrusion of granitoid stocks and plutons led to elevated temperatures and the resulting hydrothermal activity focused along extensional shears was favorable for epigenetic mineralization. The orogenic gold deposits typically consist of gold-bearing quartz±carbonate vein systems concentrated in dilatant-extensional en-echelon fractures in sheared and strongly altered volcanic and volcaniclastic rocks, small felsic intrusions, and ultramafic rocks. The quartz-vein arrays may exhibit both reverse and normal senses of shear and, in places, cut through or structurally overprint VMS deposits. They are characterized by native gold or gold in sulfides and tellurides. As is the case with its VMS deposits, the ages of orogenic gold formation in the Nubian Shield are not well established, but available data suggest that orogenic gold formation postdated VMS formation by as much as 100-150 million years. Arsenopyrite in quartz veins at Fawakhir in the Nubian Shield, interpreted as the most likely chronologic indicator of mineralization, yields a Re-Os age of 601±17 Ma. The Ad Duwayhi deposit in the Arabian Shield is estimated to be ~650 Ma and Sukhaybarat <620 Ma.

The preeminent epithermal gold deposit in the ANS is Madh adh Dhahab – meaning Cradle of Gold – is a polymetallic Zn-Cu-Au-Ag deposit. Mahd adh Dhahab is operated by the Saudi Arabian Mining Company (Ma'aden) and in 2014 produced 34,280 oz gold from 200,710 Mt ore grading 5.95 g/t Au. The deposit consists of fault-related quartz veins and stockwork in andesitic tuffs, flows, and agglomerate. Veins range from

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hairline fractures to stockworks as much as 10 m across, but the majority are 0.1-1 m. The veins are composed of quartz, chlorite, potassium feldspar, calcite, and sulfides. Several generations of quartz are evident, with banded, cockade, and cockscomb textures indicative of multiphase injection and incremental open-space filling under conditions of dilation. Primary sulfides include sphalerite, chalcopyrite, galena, and pyrite. In places, sulfides dominate and form pyrite-sphalerite veins. Gold and silver are present as gold-silver tellurides (hessite, petzite, and rare sylvanite), and gold occurs in native form as inclusions in sphalerite, along grain boundaries, and as small grains in quartz. The current size of the deposit is not published but, as of 2007, the mine had a reserve of 1.2 Mt grading 8.7 g/t Au. Production is in the form of concentrates grading ~150 g/t Au, 1,500 g/t Ag, 19% Cu, and 12% Zn, and as silver-gold doré obtained by cyanide leaching and electrolysis of slurry from the flotation cells.

The rock types of the ANS (bimodal volcanic assemblages, TTG complexes, and calc-alkaline to alkaline granitoids), their origins at convergent margins, and the pervasive development of shear zones that commonly form the site of increased hydrothermal activity in and around granitoid intrusions are geologic features highly favorable for base-metal sulfide and gold mineralization. Historically, attention focused on gold in quartz veins, a deposit type now known to belong to the class of orogenic gold, with lesser exploitation of copper and lead from gossans and sulfides at what are now known to be VMS. These deposit types – VMS and orogenic gold – are the primary focus of exploration today and are being successfully mined at localities throughout the region. Many successful exploration programs targeted ancient working in areas of outcropping gold-bearing quartz veins or gossans, but most modern mines have been developed by following geologic clues in addition to signs of previous mining. There is every reason to expect that a strategy of continuing to follow the favorable lithologies and structures so abundant in the ANS will lead to further successful development of the metal-mining sector in the region.

About the March Dinner Speaker

Peter R. Johnson, a graduate of London University (B.Sc) and Calcutta University (D. Phil), has spent most of his career as a geologist working on the Neoproterozoic rocks of the Arabian Shield in western Saudi Arabia. He started his career as an exploration geologist with Rio Tinto Zinc Corp., initially working on a copper-porphyry project in Wales, UK, then as Research Geologist at the corporation head office in London, and as manager of an exploration program in Norway. In 1977, he joined the Riofinex (RTZ) Geological Mission in Saudi Arabia, as a member of exploration teams looking for VMS, gold, and Sn-W. This work introduced him to the regional geology and tectonics of the Arabian Shield, which he pursued in the 1980s by compiling a new geologic map of the shield for the Saudi Arabian Deputy Ministry of Mineral Resources and helping to complete 250.000-scale quadrangle maps and reports for the U.S. Geological Survey Saudi Arabian Mission. In the 1990s, he was a Technical Expert helping with USGS Mission projects on the Arabian Shield, and in 2000, he became a Technical Advisor to the newly established Saudi Geological Survey. While with SGS, he was responsible for compiling a digital geologic map of the Arabian Shield, which gave him the

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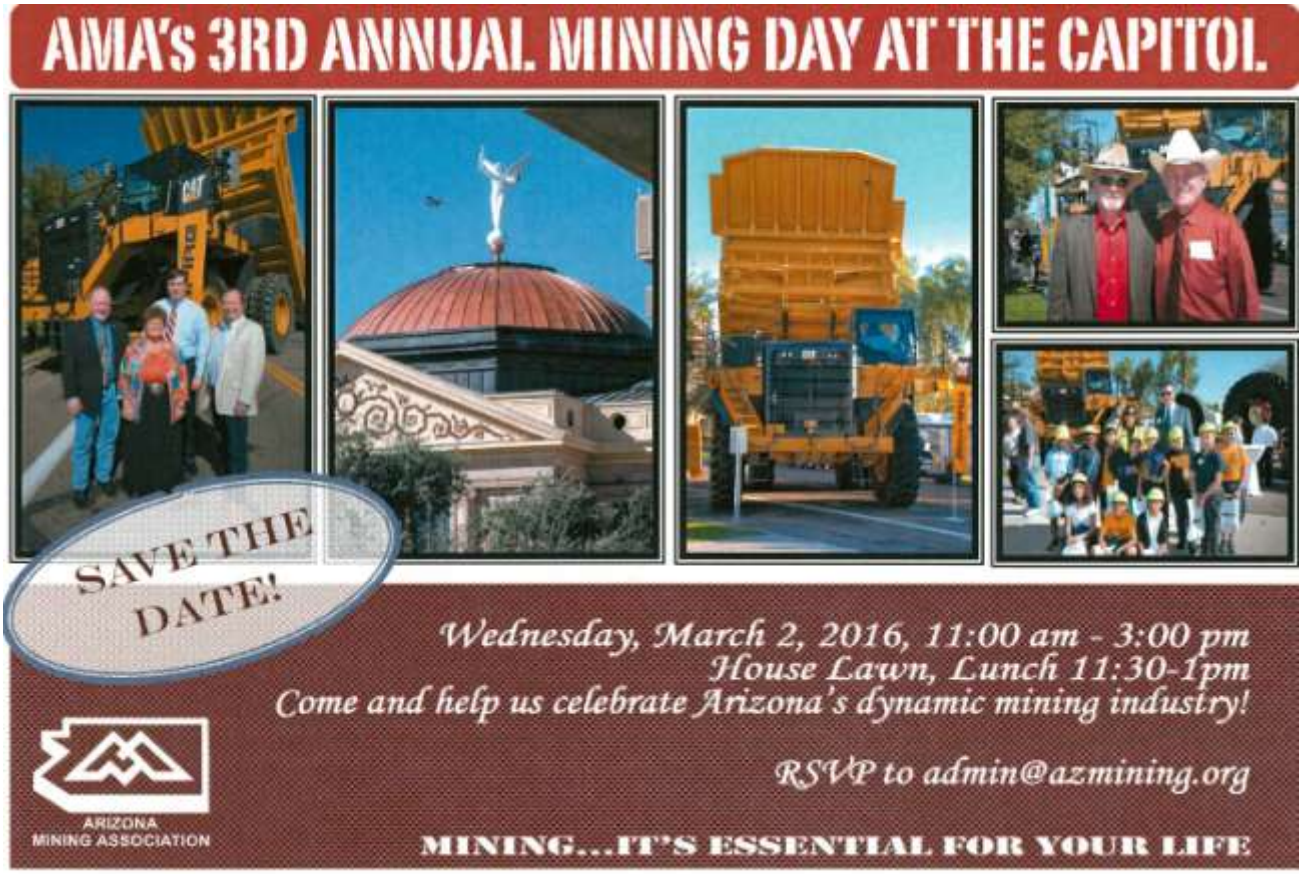
opportunity to do extensive field work resolving stratigraphic and structural problems in the region. He took part in SHRIMP dating campaigns on the shield and helped with interpretations of aeromagnetic and gravity data. Dr. Johnson is the author of more than 100 reports and papers on the Arabian-Nubian Shield, is the co-author of a book on the geology of the Saudi Arabian Shield, and is currently involved with the international team preparing a new map of Gondwana and a review of gold in the Nubian Shield for presentation at the 35th International Geological Congress in Cape Town, 2016.



Pam Wilkerson is looking for 2 to 4 volunteers for Mining Days at the Capitol on March 2, 2016. If you would like to help Pam, contact her at pakwilkinson76@gmail.com.

Up-coming Arizona Geological Society Dinner Meetings

Date	Speaker	Title of Presentation
4/5/2016	Jordon Bright	Looking for an Ocean in the Desert - the Enigmatic Bouse Formation of Southeastern Arizona and Southeastern California
5/3/2016	Peter Modreski	No title yet, but will speak on Pegmatites
6//7/2016	Robert Hildebrand	Collisions, Slab Failure Magmatism, and the Development of Cordilleran Batholiths

Arizona Geological Survey News Brief

Arizona Mining Review (AMR) e-Video Magazine's next episode will be filmed live at the SME Annual Conference in Phoenix from Feb 21-24, 2016, and released later that month.

AZGS News

The University of Arizona and Governor's Ducey's staff continue to discuss and shape the consolidation of the Arizona Geological Survey with the University of Arizona. Governor Ducey's 2017 budget zeros out AZGS funding and recommends consolidating the Arizona Geological Survey with the University of Arizona. AZGS' 2016 state allocation was $941,000.

Stay tuned to Lee Allison's Arizona Geology blog or our AZGS Facebook page for updates on AZGS going forward in 2016.

AZGS's Arizona Experience store hosted a booth at the Tucson Gem and Mineral Show from 11-14 February.

- AZGS' Nyal Niemuth and Mike Conway are hosting a booth at the 2016 SME Annual Convention and Expo in Phoenix from 21-24 February.
- New AZGS Publications: Online at the AZGS Document Repository

Arizona Geological Survey Mining Data site now complete comprises more than 20,000 documents from Arizona's mining and mineral history that are online, geolocated, discoverable and accessible.

New Publications & publications newly released online

- Six revised and one new earth fissure map were released in Feb. 2016. For details and links to the products see the listing under New Publications. The Natural Hazards in Arizona Viewer was updated with these new data.
- Arizona Geological Survey, 2016, Locations of Mapped Earth Fissure Traces in Arizona, v.01.31.2016. Arizona Geological Survey Digital Information (DI-39 v. 01.31.2016), shapefile and Google Earth .kmz file.
- Conway, M. 2016, American Mineral Heritage: Harvard Collection at the Flandrau. Arizona Geology e-Magazine.

Death in the family. Long-time Arizona Geological Survey geologist Richard Allen (Rick) Trapp , born May 25, 1949 in Missouri, passed away on January 14, 2016. Rick worked as a geologist for the Arizona Geological Survey for over 20 years. His legacy work is the Bibliography of Arizona Geology. This online bibliography comprises more than 13,000 citations of geologic studies, reports and maps documenting the geology of Arizona! Rick also served as President and Past President of the Arizona Geological Society during 1991 and 1992, respectively.

Rick was kind to animals and small children. For decades, he was a member of the Tucson Gem and Mineral Show and the voice of 'god' announcing each day's opening and closing. He played guitar and many other instruments. He was a geologist, rock hound and computer whiz. Rick's son Elijah Trapp and wife Alyce Pennington and extended family, survive him. Donations may be made in his honor to So AZ Humane Society, 3450 N. Kelvin Blvd., Tucson 85716.

ANNOUNCEMENTS

Welcome New AGS Members

Douglas Detman

Adam Majzoub

Jessie Rose

Natalie Speaks

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.