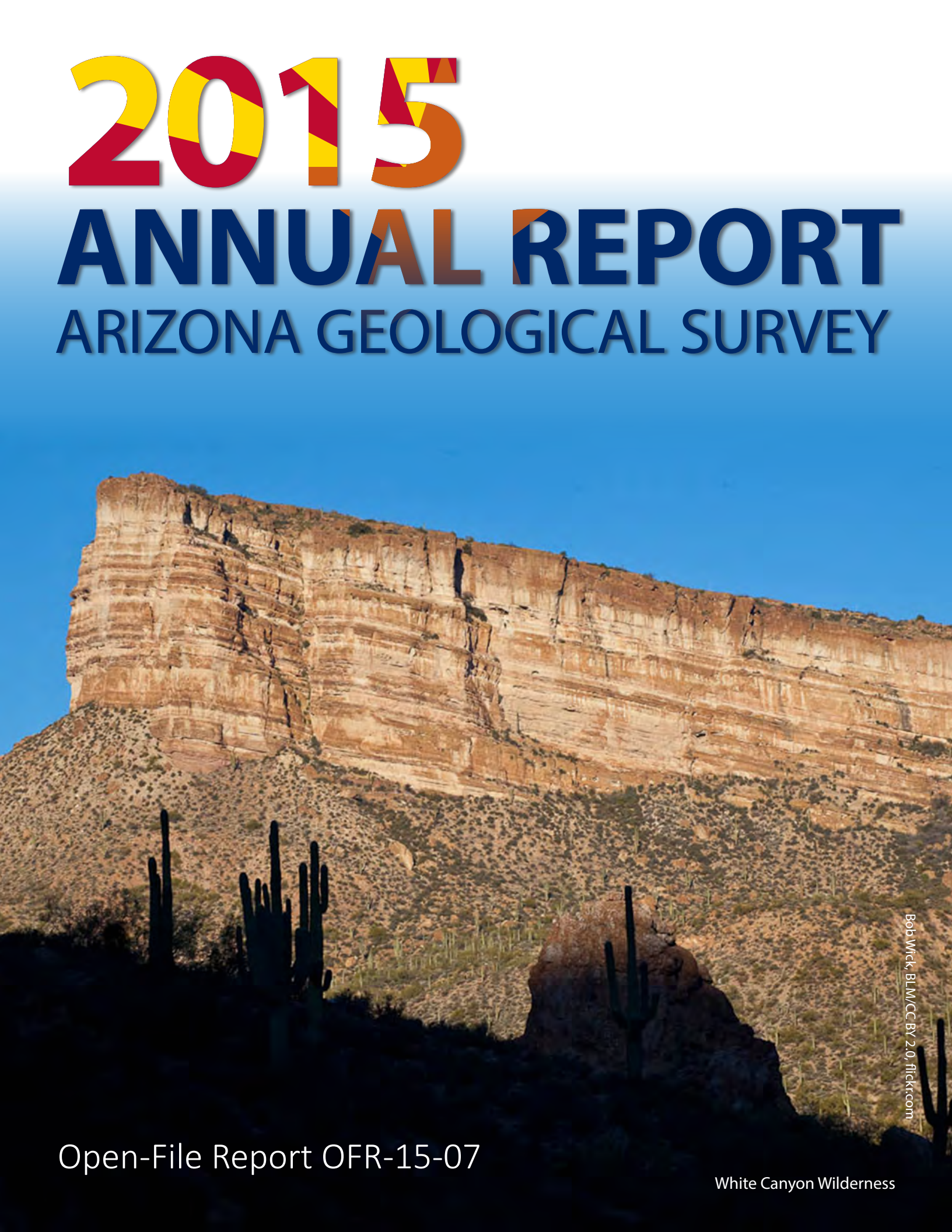
2015 ANNUAL REPORT

ARIZONA GEOLOGICAL SURVEY



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Open-File Report OFR-15-07

White Canyon Wilderness

Arizona Geological Survey

M. Lee Allison, State Geologist and Director

Manuscript approved for publication in November 2015
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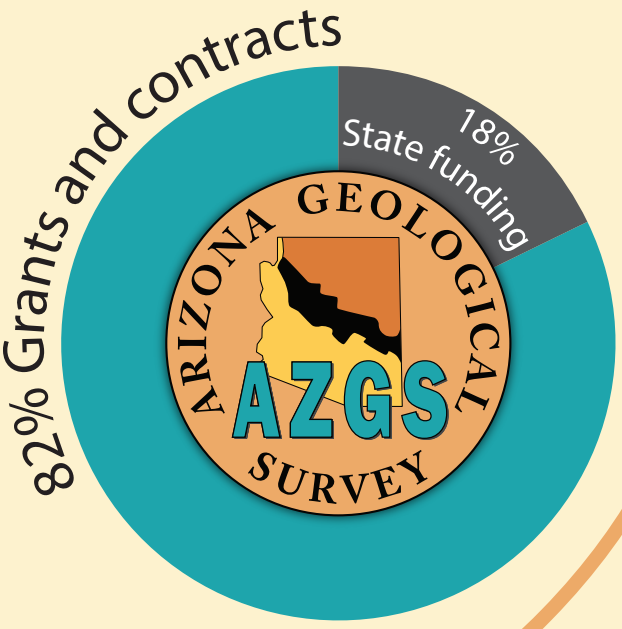
Recommended Citation: Conway, F.M., and Mar, S., (eds.), 2015, Annual Report of the Arizona Geological Survey: Fiscal Year 2015. Arizona Geological Survey Open File Report, OFR-15-07, 53 p.

AZGS 2015 by the numbers



AZGS Document Repository

repository.azgs.az.gov

23
New maps & reports

16
New maps

32,545
Downloads from the document repository

Historical Mining Data: Scanned and uploaded

minedata.azgs.az.gov

300+
Mine photos

2,300
Reports

2,000+
Maps

74
Professional presentations

45
Media interviews

24
Workshops & Townhalls

Social Media

https://www.facebook.com/AZ.Geological.Survey
https://twitter.com/azgeology

72%
increase in followers

41%
increase in followers

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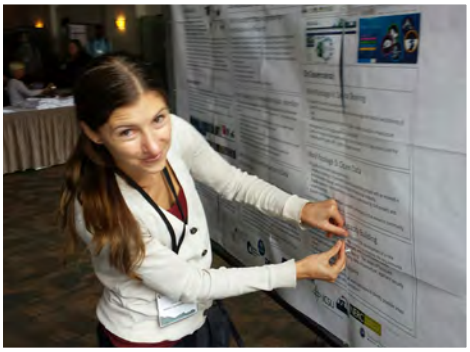
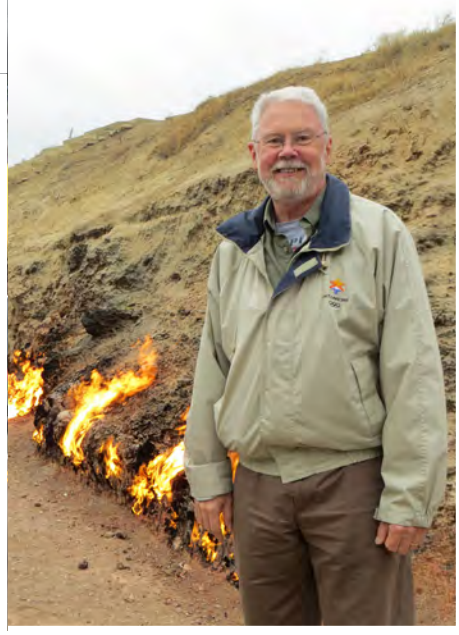
Our Mission

- Serve as a primary source of geologic information to enhance public understanding of the State's geologic character, geologic hazards and mineral resources.
- Inform, advise and assist the public in matters concerning the geological processes, materials and landscapes and the development and use of Arizona's mineral resources. Encourage the prudent use of lands and mineral resources.
- Provide technical advice and assistance in geology to other State and local governmental agencies engaged in projects in which the geologic setting, character or mineral resources of the State are involved. Provide technical advice and assistance in geology to industry toward the wise development and use of Arizona's mineral and land resources.



AZGS out off the office

Top left: Nancy Greene at the 2015 Tucson Gem and Mineral Show.
Top middle: Joe Cook installing a camera to monitor debris flow in Oak Creek Canyon.
Top right: Jeri Young installing a seismic station, Duncan, AZ.
Middle: Jon Spencer in Western AZ—Statemap 14 mapping season.
Middle left: Brian Gootee in Grand Canyon with a Desert Bighorn sheep skull.
Middle right: Anna Katz at a Earth Science Information Partners (ESIP) meeting, Frisco, CO.
Bottom left: Jaimie Ryan manning the EarthCube booth at Annual Meeting of The Geological Society of America 2014, Vancouver, BC Canada.
Bottom middle: Chris Hanson, Nyal Niemuth, and Stephanie Mar filming AMR during Mining Day at the Capitol in Phoenix.
Bottom right: Lee Allison in front of Yanar Dag (translated as "burning mountain") the fire naturally occurs and continually burns, located in Azerbaijan.



Director's Column FY15 Annual Report

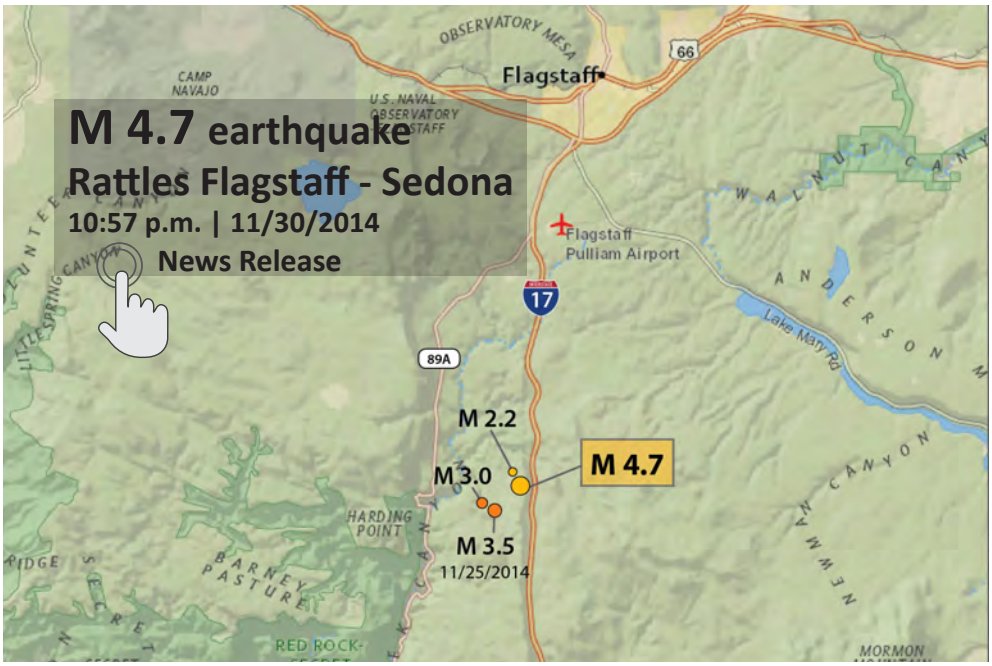
Lee Allison
Director and State Geologist

This past year marked a major milestone for AZGS. The 4-year, $22 million National Geothermal Data System (NGDS) project formally ended on December 1, 2014, and with it a special period in AZGS history. This was the largest, most ambitious project we have ever undertaken. We had 45 subcontractors in 45 states and a number of other collaborators and contributors. NGDS is now operational, with 60+ data providers sharing more than 10 million records from all 50 states. We are deploying that same open source, open access data integration framework for a variety of other applications, not only in AZGS but nationally and internationally. This has been a great effort, for the Survey, both technically and financially. The project began just as the recession budget cuts slashed state support, so that today, AZGS is 85–90% funded with grant funds. State funds have been providing less than 10% of our annual budget. The NGDS project allowed the Survey to not only survive but thrive during a period of economic challenges.

Despite the lack of state funds, AZGS has maintained its core state functions in encouraging the wise development of our natural resources and in identifying, mitigating, and responding to natural and geologic hazards. Our state statutes also direct us to make sure that these results are suitably translated and communicated to our stakeholders in business, industry, government, and the public.

We are finalizing the first state-wide inventory of earth fissures while continuing to identify new or reactivated fissures. As this program milestone approached, we directed internal resources to building the first statewide inventory of landslides in Arizona history. Mapped landslide deposits are being digitized and will be accessible through the AZGS's online interactive hazards viewer. More than 4,000 landslide deposits have been compiled from existing maps and reports so far.

Earthquakes continue to surprise many Arizonans and the November 2014, Kachina Village quake of magnitude 4.7 shook communities from Flagstaff to Prescott. Aftershocks remind us that north-central and northern Arizona have been the most seismically active areas in the state. AZGS operates a 7-station seismic network to detect and locate every magnitude 3.0 earthquake or larger, anywhere in the state. We receive no state, federal, or private funds to run the system or interpret the results.



We continue to digitize hundreds of thousands of pages of historical mining and mineral resource files, maps, and photos that we acquired in 2011 with the merger of the Department of Mines and Minerals. Digitizing is the easy part. Georeferencing each document, correctly identifying the information and source, and creating the details needed for the online catalog so users can quickly find exactly what they are looking for is the hard, time-consuming part.

AZGS continues to successfully meet all our challenges. We have a talented, well-educated, innovative, and dedicated team of professionals and support staff who regularly exceed expectations. The results in this report demonstrate that.

Deputy Director's FY15 Annual Report

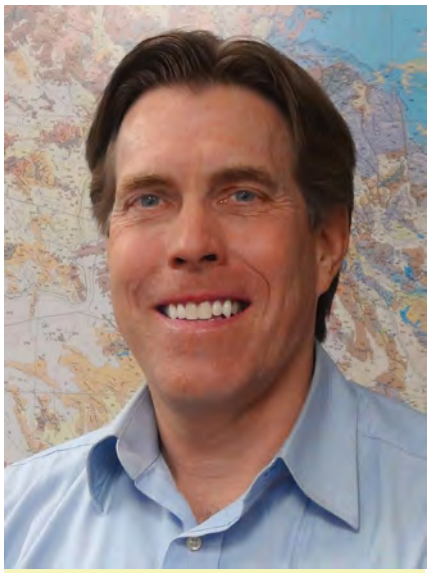
As you will read in this report, the Arizona Geological Survey (AZGS) has had numerous accomplishments in Fiscal Year 2015, spanning natural hazards, mineral and other natural resources, mapping, community outreach and education, and geoinformatics. AZGS is also making significant contributions on a global scale.

It could not be possible to achieve these significant milestones without having an effective organization built around a world-class staff. AZGS' entrepreneurial approach is reflected in the results. Not only is the Survey's budget nearly 90 percent grant-funded, AZGS has been very successful in obtaining highly competitive grants with success rates frequently running only 8–25 percent. These grants typically span one to three years and must be continually replaced when they are completed. AZGS continually provides a strong return on investment, returning more than $4.50 for every dollar in State appropriations.

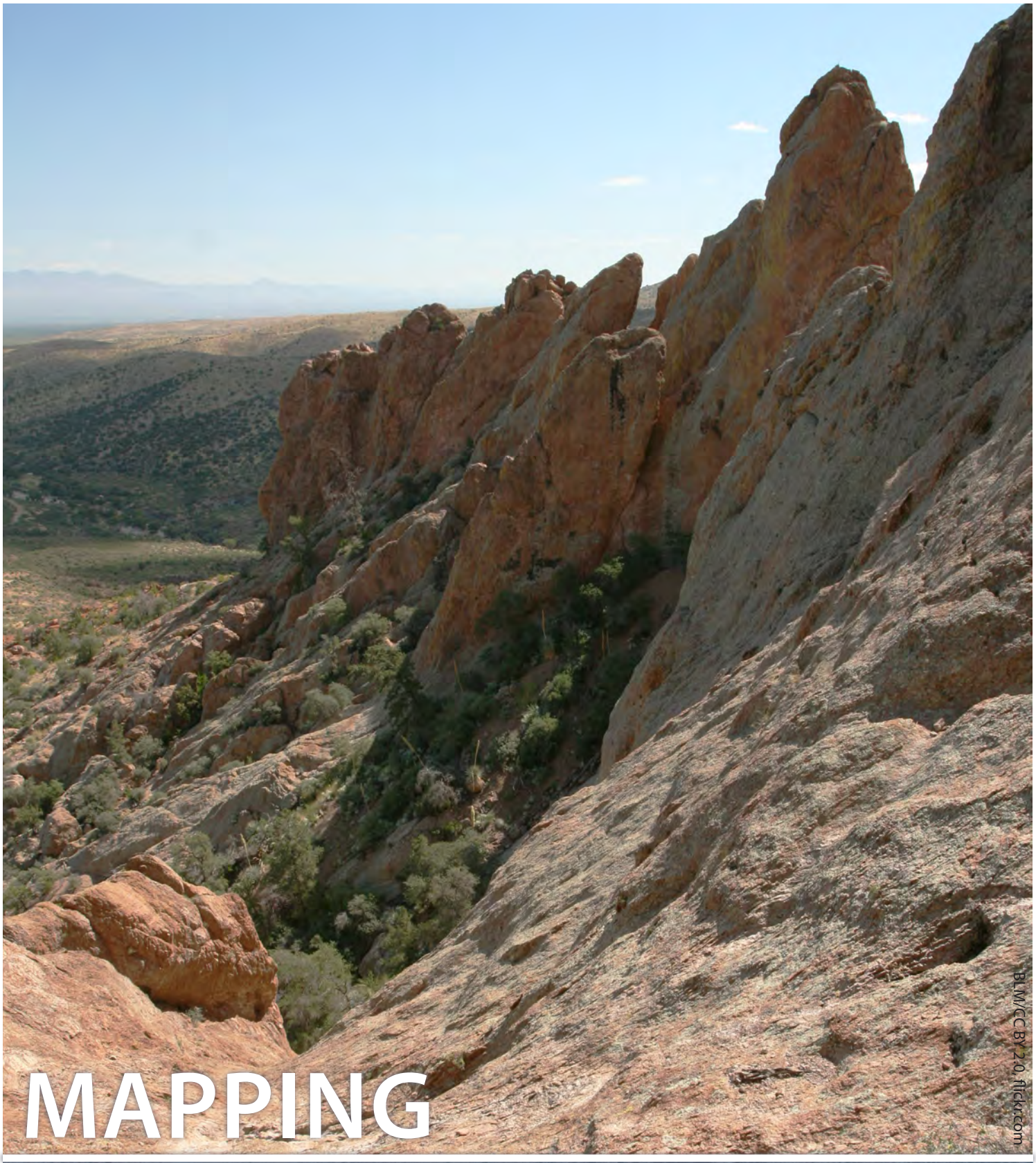
AZGS looks to build on this success and expand its services and partnerships. In putting its capabilities towards the effective and wise use of the State's mineral and natural resources, solving challenging problems through its scientific expertise, or helping protect people and property from geologic hazards, AZGS is dedicated to addressing local and global needs.

As the Survey breaks new ground through its grant-funded initiatives, it building an expertise base for the future. An example is the U.S. Geosciences Information Network (USGIN), which AZGS has spun off as a stand-alone organization resulting from a USDOE grant for which AZGS spearheaded a national coalition of 45 states to develop the National Geothermal Data System. Another prime example is the multi-year award from NSF to provide the back office support for developing the governance structure and operations for the national EarthCube initiative for developing a geoscience cyberinfrastructure. AZGS' leadership role in the Belmont Forum project to gather the world's major funders to develop opportunities for research in e-infrastructures and data management, has further positioned the Survey in the global arena.

As we move into FY16 and beyond, AZGS looks ahead to continue expanding its services, developing new funding opportunities, and strengthening and building its partnerships.



Chris Hanson
Deputy Director



MAPPING

Geologic maps are the backbone of geologic investigations

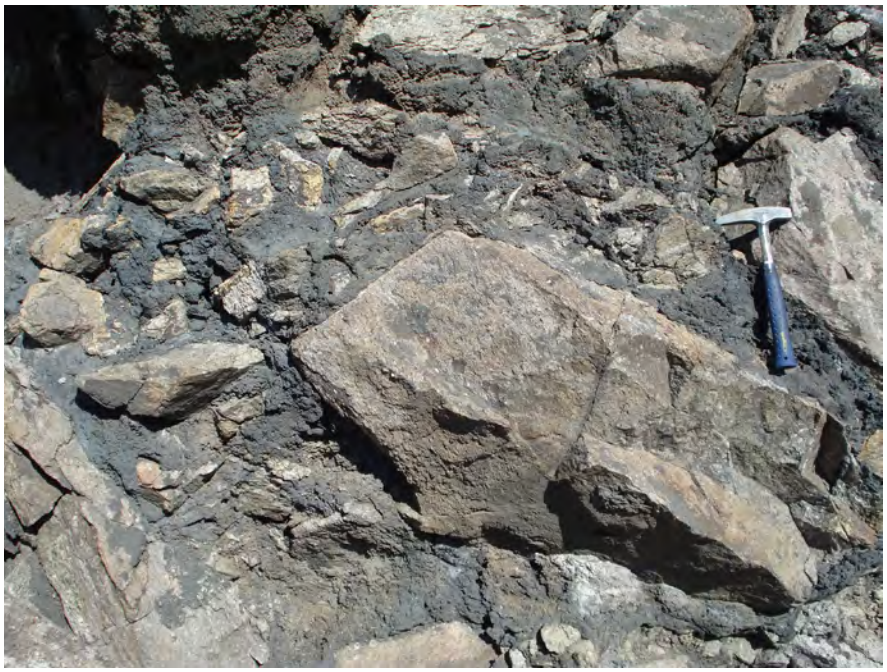
North Santa Teresa Wilderness

Geologic mapping in Arizona: The Statemap Program

Geologic mapping is one of the most basic functions of state geological surveys. Geologic maps have diverse uses, and have an unusually long shelf life compared to other types of scientific publications. Some maps made over 100 years ago are still in use because no new mapping has been done. Their most important uses are for mineral- and energy-resource exploration and geologic-hazard identification. They are also used for scientific investigations to determine geologic history and to better understand geologic processes.

Jon Spencer
Chief of Mapping Program

The Arizona Geological Survey (AZGS) has had a strong geologic mapping program for over 30 years. For the past 20 years geologic mapping has been supported with Federal funds provided through the STATEMAP program, which is a component of the National Geologic Mapping Act of 1992. STATEMAP is a matching fund program in which States must contribute matching funds equal to or greater than awarded Federal funds. The AZGS received an award of $171,331 for FY2015, which was matched with $171,501 in State funds. The AZGS has received $3.94 million in Federal funds since the STATEMAP program began.



Manganese oxides within talus breccia below Bouse Formation

Along with AZGS Research Geologist Phil Pearthree, I am responsible for submitting STATEMAP proposals, carrying out funded geologic mapping, and supervising mapping geologists. As part of the program, I spend many weeks mapping in Arizona each year. Arizona has such great geology, and the rocks are so well exposed, that I am reminded every field season of how fortunate I am to be able to do geologic mapping and related studies in Arizona. What a great State!

Each year the Arizona Geologic Mapping Advisory Committee (GMAC) recommends to the AZGS several map areas that are considered high priority for new geologic mapping. GMAC members represent government, industry, and academic interests in Arizona geology.

During FY2015 the AZGS STATEMAP mapping program was targeted at three map areas recommended by the GMAC, as follows: (1) New geologic mapping east of Oatman (west of Kingman) to improve understanding of the geology around Arizona's most productive gold-mining district and to delineate areas of potential flooding in western Sacramento Valley. (2) New mapping southwest of Quartzsite improved understanding of the distribution of sand and gravel resources derived from the ancestral Colorado River and determined the geologic setting of the historic Ehrenberg placer-gold deposits. (3) New geologic mapping south of Tucson identified potential geologic hazards associated with flooding, improved mapping of an active fault at the foot of the Santa Rita Mountains, and outlined the extent of limestone resources.

Mapping rugged terrain in western Arizona

Charles Ferguson
Research Geologist

Over the last year I have been mapping one of the most rugged areas I have ever worked in. The Mount Nutt 7.5' quadrangle includes parts of two wilderness areas along the crest of the Black Mountains on either side of old US route 66 east of Oatman, Arizona. The Mount Nutt Wilderness to the north includes Mount Nutt, at 5,216 feet, the highest point in the Black Mountains and the Warm Springs Wilderness to the south that includes some of the most remote and inaccessible geology in the state of Arizona. Geologically, the range appears relatively simple with Miocene volcanic strata tilted gently to the east, and cut by what appear to be minor, and relatively simple normal faults. The faults are not difficult to map, but they are complex in terms of their timing with respect to the volcanic strata. This is important because determining whether a fault is overprinted by or offsets mineralization is of utmost importance for exploration in the area.

Several buttress unconformities are present that overlap the upper parts of many of the area's down-to-the northeast normal faults. These faults are important because they belong to a set of faults that host many of the area's famous low-sulfidation, quartz-calcite-adularia banded, gold-bearing veins. The veins, which are the main source of the Oatman district's rich epithermal gold deposits, intrude down-to-the-northeast normal faults that can be traced up the west-facing escarpment of the Black Mountains and seen to be truncated erosionally by northeast-facing buttress unconformities that are draped with a suite of voluminous, middle Miocene (~15-11 million years old) basaltic lavas that cap the range crest. The basaltic lavas are in turn cut by a suite of down-to-the west normal faults, one of which apparently forms the west facing geomorphic escarpment just east of the town of Oatman. Another, called the Roadside Mine fault, apparently, forms the west-facing range bounding fault just east of Bullhead City.

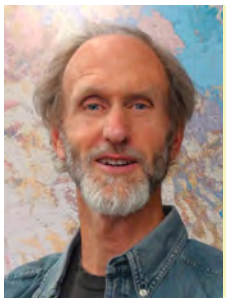
The other main down-to-the west normal fault occurs, non-intuitively, along the east flank of the range in a place where the offset, which is major, is opposite to the dramatic east-facing geomorphic escarpment. This geomorphic complexity attests to the range's complex middle to late Miocene history. Rocks in the footwall of the range's east-bounding, west-side-down fault, exposed sparingly in the eastern foothills of the range, reveal another important unconformity along which the ~ 20 million year old basal volcanics directly overlie Proterozoic (~1600 million years old) granitic and metamorphic rocks. This is significant because there is currently some interest for oil and gas exploration in the area which is based on the premise that Phanerozoic sedimentary rocks at depth in Golden Valley are legitimate targets for exploration. This seems highly unlikely since it is well known that ~20 million year old volcanics directly overlie Proterozoic basement on the east side of Golden Valley as well.

I have also been supervising a PhD student (J. D. Mizer) as part of my adjunct researcher duties at the University of Arizona.

My other research activities in 2015 include undergraduate teaching and supervision of research for the 2nd year of a 3 year REU (Research experience for undergraduates) grant in collaboration with Vanderbilt and Mercyhurst universities. This teaching and research relates to recent (2014) mapping of the Kingman area and investigation of ignimbrite outflow sheets related to the Peach Spring Tuff supereruption.

I have also been active as a research associate with the New Mexico Bureau of Geology where I have been completing the Montoya Butte 7.5' quadrangle in the southern part of the Alamosa graben, near Winston. The work is related to a regional study of groundwater resources in the Plains of San Agustin and how they relate (or do not relate) to groundwater of the Rio Grande Valley.

Geologic mapping in the Santa Rita Mountains



Brad Johnson
Research Geologist

Geologic mapping has been a function of the Arizona Geological Survey since the inception of its predecessor agencies, before Arizona statehood. The work that I do is focused on mapping and interpretation of bedrock geology as part of the STATEMAP program, which supports 1:24,000-scale mapping of selected areas of the state. During the winter and spring of FY2015, I worked in the northern Santa Rita Mountains, in an area centered about 25 miles southeast of Tucson near the community of Corona de Tucson. A growing community, Corona de Tucson sits on the alluvial piedmont that fringes the mountains. Near the mountain front, piedmont gravel deposits overlie shallow bedrock. Accurate maps that show the distribution of gravel and bedrock are important for civil engineering considerations and groundwater models.

The Santa Rita Mountains host numerous mineral deposits, including the currently active Imerys marble quarry and the Rosemont copper-molybdenum skarn deposit. Our knowledge of mineral deposits and our ability to keep discovering new ones depends on our understanding of their geological settings, which is achieved in part through geologic mapping.

The bedrock geology in the Corona de Tucson area consists of Paleozoic and Mesozoic sedimentary rocks intruded by Tertiary granitic and dioritic rocks. The sedimentary rocks have been folded, and all of the rocks have been sliced up and shuffled around along multiple generations of faults. Although portions of some of the faults are visible on satellite imagery, they can only be identified with confidence and completely mapped out by first-hand observation on the ground. In any case, the only way to determine what the rocks are is to walk on them in the field, often stopping to break them open with a rock hammer and to observe their component minerals and textures with a hand lens.

The Paleozoic rocks of southern Arizona are predominantly limestone, which have largely been metamorphosed to marble in the northern Santa Rita Mountains. The thick layered succession of mostly limestone comprises several distinct intervals that each have certain characteristics, and in some cases subtle, distinguishing features. The same sequence of layered intervals (which are called "formations") has been identified in nearly every mountain range in southeastern Arizona. As such, correctly identifying and mapping these formations is important in order to maintain regional consistency. This can pose a great challenge in places where the layered sequence has been sliced up by faults. And that's part of what makes my job interesting and enjoyable!

Folded marble with thin layers of siliceous hornfels. The northeastern (left) limb of the fold has been thinned along a ductile shear zone. This is an outcrop-scale example of a structural style that is displayed on the limbs of several folds mapped on the regional scale. Pencil for scale points north.

Oil and Gas Program—including potash and CO_2 sequestration activity

Oil and Gas Conservation Commission

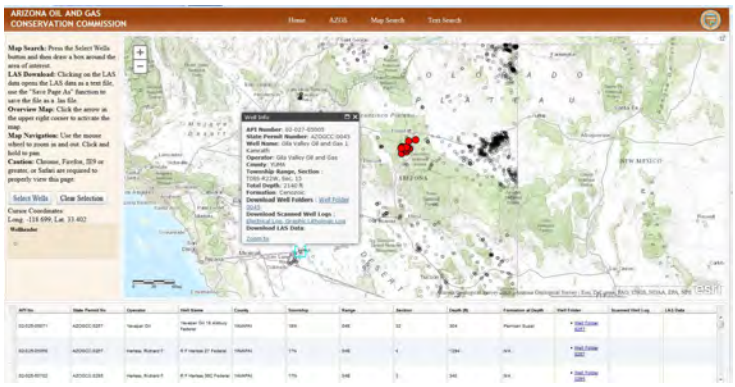
Steven Rauzi
Oil and Gas Administrator

The Arizona Geological Survey (AZGS) provides administrative and staff support for the Arizona Oil and Gas Conservation Commission (AZOGCC). The AZOGCC consists of five members appointed by the Governor and one ex-officio member, the State Land Commissioner. Current Commission members include J. Dale Nations, Tucson, Chairman; Stephen R. Cooper, Casa Grande; William C. Feyerabend, Prescott Valley; Frank Thorwald, Sun City; Robert L. Wagner, Mesa; and Lisa Atkins, ex-officio member and State Land Commissioner. Steven L. Rauzi is the administrator. The AZOGCC held four regular meetings in fiscal year 2015. Links to rules and statutes and other information about oil and gas in Arizona may be found on the Commission's web page at www.azogcc.az.gov.

Regulatory Highlights

Six drilling permits were issued and eight wells were drilled in fiscal year 2015. Of the wells drilled, six were for CO_2 near St Johns in eastern Arizona and two were for helium in the old helium fields east of Holbrook in eastern Arizona. No wells were drilled for potash in fiscal year 2015. Oil production totaled 56,239 barrels from 19 producing wells in calendar year 2014, down from 60,072 barrels from 25 wells in 2013. All production is on the Navajo Nation in northern Apache County. Gas production totaled 106 million cubic feet from six producing gas wells in calendar 2014, up from 72 million cubic feet from five wells in 2013. No CO_2 was produced in 2014. There were two active disposal wells and nine shut-in wells at year end 2014, including seven oil, one gas, and one CO_2 well. There were 940,000 acres leased for oil and gas in Arizona as of June 30, 2015, up from the 891,000 acres on June 30, 2014.

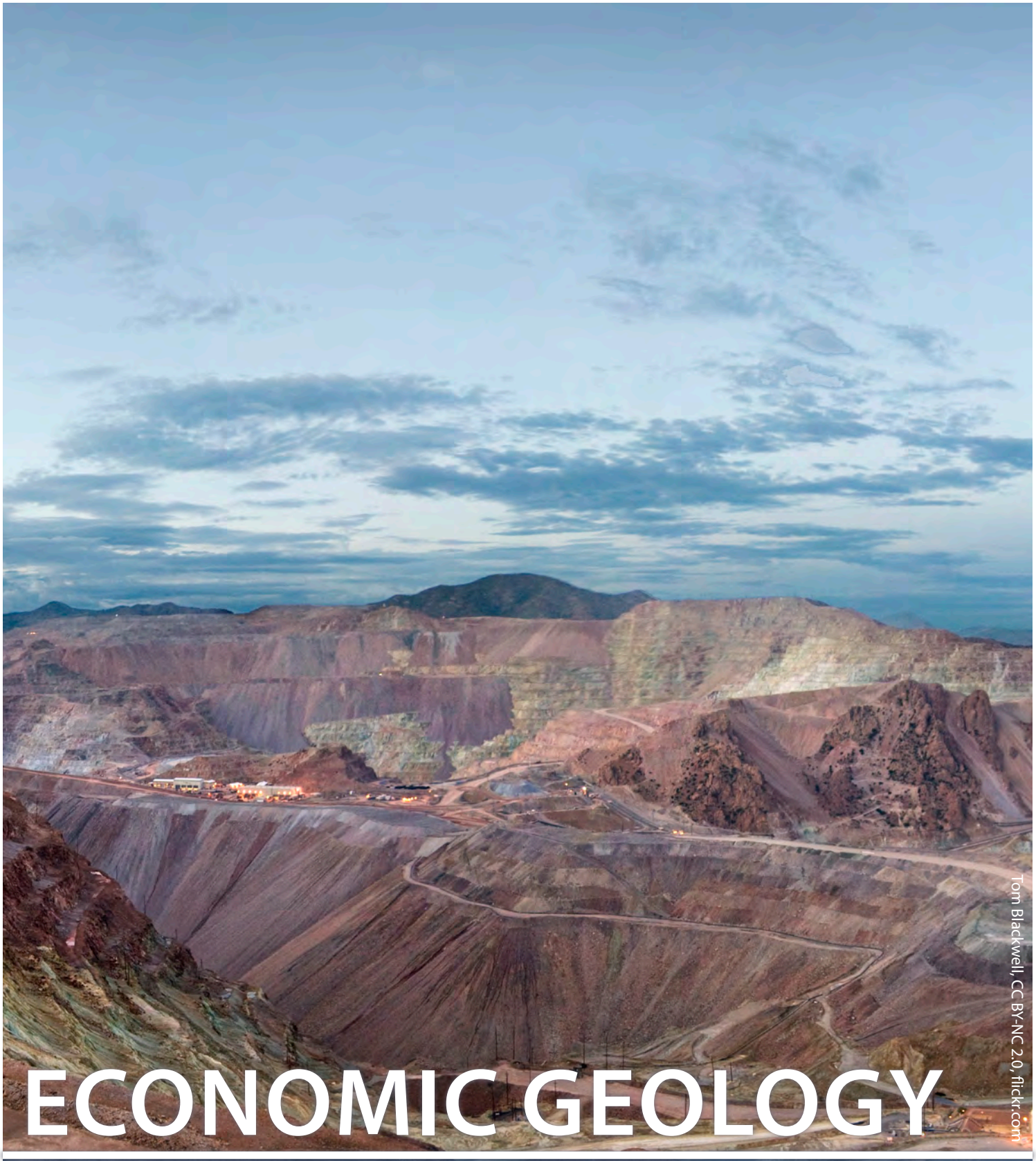
Drilling for oil near San Simon in 1997. Note the man in the doorway for scale.



Screen shot of the Arizona Oil and Gas Online Well Viewer.

Arizona Oil and Gas Online Well Viewer

The AZGS joined the Rocky Mountain Carbon Capture and Sequestration partnership (RMCCS) to study CO_2 sequestration or storage potential across the Colorado Plateau region. One of the deliverables was to digitize oil and gas well logs into computer usable LAS (Log ASCII Standard) format to aid subsurface investigations using well logs. The AZGS developed a user-friendly web application to make the digitized well data including the well folders with formation top and testing data available online. The online search and download map, the Arizona Oil and Gas Well Viewer, is hosted under the Online Data tab on the AZOGCC website. The AZGS made several improvements to the online viewer in fiscal year 2015.



Tom Blackwell, CC BY-NC 2.0, flickr.com

ECONOMIC GEOLOGY

Arizona — the #1 mining state in the U.S. in 2014

Morenci, Arizona

We're no. 1 in mining

At the beginning of FY2015, AZGS' Economic Geology Section started serving clients from the Phoenix Branch's new location at 3550 North Central Avenue. Using our comprehensive library and archive of geologic and mineral reports, we assist exploration geologists and others, directing their activities to favorable geologic environments. These records are also preserved for the next generation of explorationists to follow those working in the present commodity/technology boom-bust cycle.

Nyal Niemuth
Chief Economic Geology

In my role as chief of the Economic Geology section, I respond to inquiries about mining, mineral resources, and other related requests, while overseeing progress in our digital records program. AZGS websites' host the largest number of primary geologic publications and mineral resource reports in Arizona. This online content grew in two significant ways this year. First, a number of documents from the Arizona Dept. of Mines and Mineral Resources were added to the document repository http://repository.azgs.az.gov/. Second, over 2,300 digitized reports were posted to the mine data portal http://minedata.azgs.az.gov. The latter stemmed from the donated records of eight individual consultants and mining companies. Our digitizing efforts are ongoing, and thousands of mine photos, maps from special collections, and with historic publications and documents will be posted at AZGS repositories.
We now curate and distribute information about prospects, discoveries, and mining from records that span more than 130 years.

Inquiries come to us from the public, industry, and local, county, state and federal government agencies. Requests for property data and commodity information from consultants, exploration groups, and mining companies have strong economic potential. Their interest in Arizona leads to expenditures and investment through exploration, project development, and ultimately, to producing mines.

Arizona mining performed well in 2014, displacing Nevada as the number one mineral-producing state in the U.S. In 2014, Arizona produced non-fuel minerals with a value of $8.06 billion dollars, accounting for 10.4% of all U.S. mineral production. This required thousands of highly skilled, well paid workers in both rural and urban Arizona.

Arizona continues to lead the nation in the production of newly mined copper. Total output in 2014 was 2.0 billion pounds worth over $6.36 billion. This is two thirds of the nation's newly mined copper.

In addition to copper, Arizona also produces fuels and other minerals worth over $1.7 billion. The principal minerals, in descending order of value are molybdenum concentrates, sand and gravel for construction, Portland cement, and crushed stone. Other minerals produced include, crushed stone, dimension stone, clay, lime, gemstones, gold, gypsum, perlite, pumice, salt, silver, and zeolites. In addition Arizona also mines energy fuels coal and uranium.

As in years past, we continue to monitor Arizona's mineral industry for unscrupulous companies and individuals who would exploit Arizona's reputation for successful and profitable mining ventures.

AZGS Mining Data—Arizona's largest online inventory of unpublished historic mining reports & maps

AZGS's mining preservation program made substantial progress this year in digitizing and curating special collections, which generally include geological exploration documents donated by mining consultants and companies. In collaboration with our contractor, DataBank, we digitized 285,000 file pages in FY-2015. Many of these collections have since been cataloged and released online at Arizona Geological Survey Mining data website (minedata.azgs.az.gov): W. Heinrichs, G. Heinrichs, Cambior, R. Mieritz, G.M. Colvocoresses, J. Kinnison, Anderson Mine, and West Oatman Project. Others remain to be cataloged and metadata constructed that includes commodity and content information.

Casey Brown
Digital Librarian

Since moving to our new Phoenix location at 3550 N. Central Avenue, we moved over 500 map tubes and their contents from our Tucson office for digitization and cataloging. The Walter and Grover Heinrichs' collections are so large, we previously did not have room for them in Phoenix. Rolled maps are first flattened and mended to prepare them for scanning with our DJ4500 scanner. (The fragile conditions of some maps pose a challenge to digitization, but we have become adept at scanning even the most fragile maps.) Flattening the maps makes them suitable for storing in map cabinets, which provides for more efficacious storage and retrieval.

Over the past year, we cataloged a combination of Heinrichs Geoexploration Co. maps from Tucson and Phoenix, resulting in almost 2,000 new maps added to the AZGS Mining Data site this summer. Due to their focus on geophysical exploration methods, there are more induced polarization and magnetic survey map products than in other collections. There are still many mine plans, cross sections, sample locations, property maps and geologic maps in this collection. Expect to see more maps from this collection as we complete the digitization and catalog process next year.

Diane Bain cataloged several photo collections in FY-2015, including: Richinbar, Atlee, Osborn and Flagg photo collections. The first three are now available online. She inventoried 660 ADMMR publications for scanning by DataBank. These include directories, circulars, mineral reports, special reports, statistical reports, mineral resources, and more. Diane has since begun work on projects outside Mining Preservation, but we look forward to her help with the digital photographs next year.

The richness of these collections is in the unpublished field work documented by their creators. In some instances, however, geologists included newsprint in their files, which we have digitized for preservation purposes, but cannot publish online due to copyright constraints. Thus, each file was reviewed for published articles such as The Arizona Republic, Pay Dirt, Mining World, and more. Where feasible, the title and date are visible for reference.

There are tens of thousands of abandoned mine workings in Arizona

Diane Bain
Records Archivist

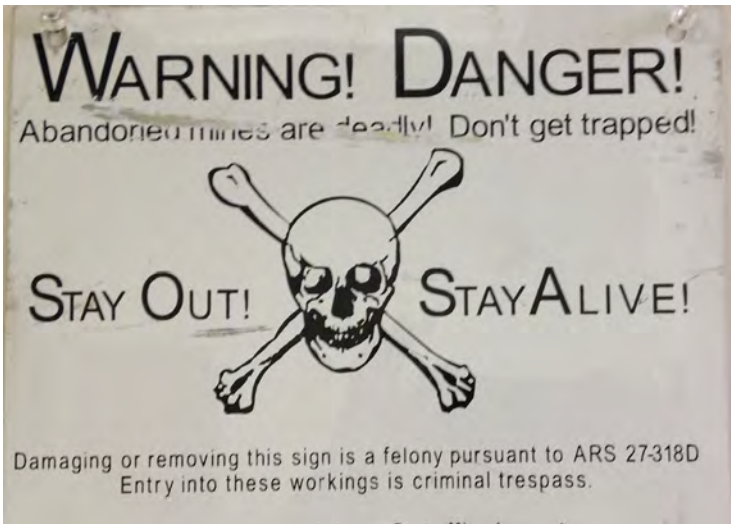
The AZGS Phoenix office continues to assist in the State Mine Inspector's Abandoned Mine Program. The program identifies and, as necessary, remediates old mine hazards statewide, with special attention to those that are close to inhabited places and areas of high public use.

The Arizona State Mine Inspector office has contracted with AZGS to inventory all shafts, adits, and other mine workings within specific townships in Arizona. We provide the Mine Inspector's Office with data sheets that generally cover between four to seven townships each.

Information on the spreadsheet includes the location of all mine workings in multiple coordinate systems, including: latitude and longitude; township, range and section; and Universal Transverse Mercator (UTM). Additionally, we include the mine name, when known, the mineral commodity(s), citations of references, and notes or comments that may prove useful to Abandoned Mines Specialists when in the field. I am often able to provide information on the reported depth of the shafts and locations of any drifts or stopes. Also, when available, information of mine workings with symbols for shafts, adits, prospect pits, quarries, is also included.

The task is formidable since estimates of the number of abandoned mine workings in Arizona varies between 50,000 to 100,000. Fortunately, AZGS has the largest holdings of Arizona mining archives in the state, availing me with vast research options.

In FY2015, my search for abandoned mines focused on central Arizona, an area of vein and massive sulfide deposits of copper, lead, silver, gold, manganese, tungsten, and mercury. This is an area of highly concentrated abandoned workings. For example, one section in Maricopa County, near the Vulture mine, has over 200 shafts, adits, and other mine workings in a single square mile.

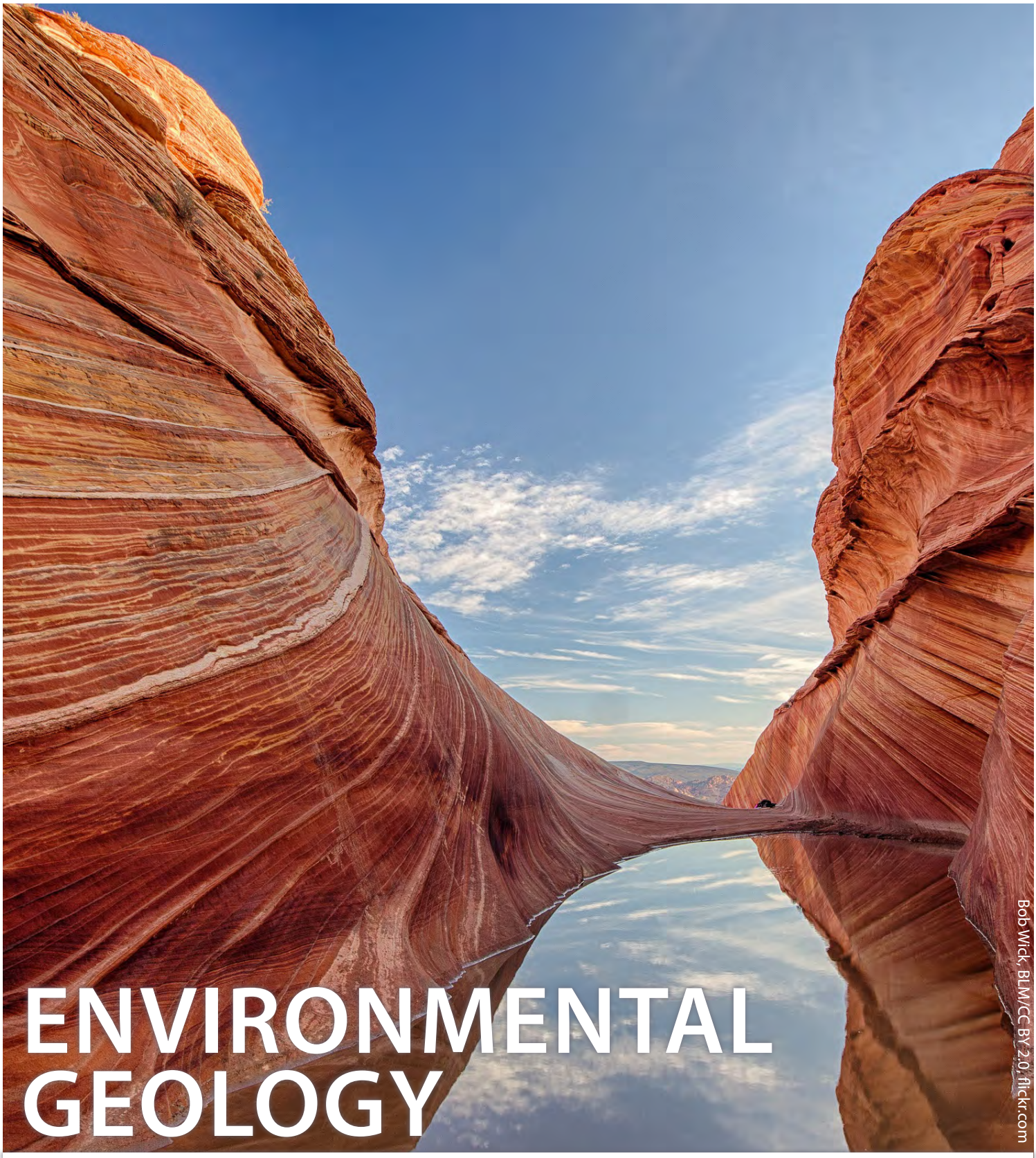


Volunteers from the Economic Geology Office

Kevin Hart has worked on digitizing photographs for several years. This year his focus was on digitization of 35mm slides for both the Mining Preservation project as well as Online Earth Science Image Atlas and Story Maps funded by American Association of Petroleum Geologist.

Cynthia inventoried the Thornwell Rogers collection and organized the library

Charlie is the go-to handyman has assisted with flattening maps and inventorying Mines and Minerals publications.



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ENVIRONMENTAL GEOLOGY

Addresses the interactions between humans, ecosystems, and the earth

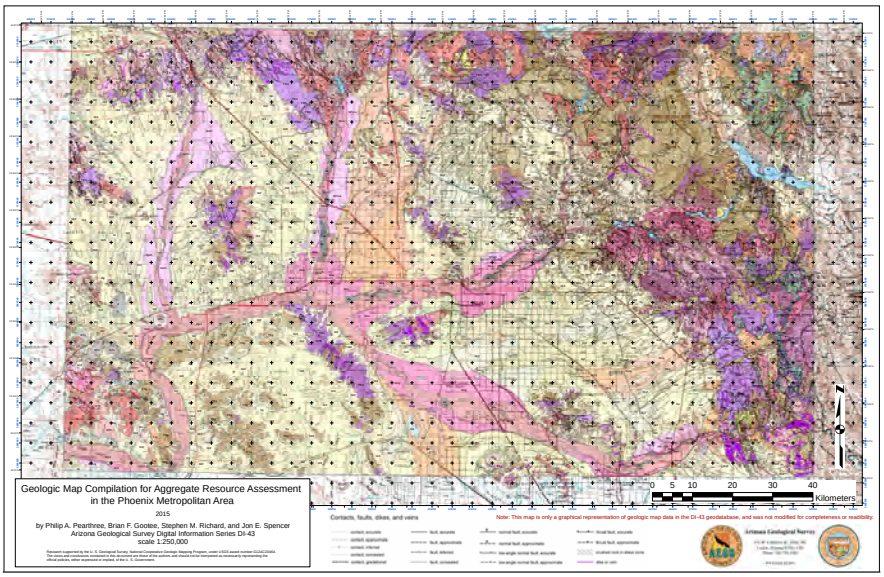
Vermilion Cliffs National Monument in Arizona

New compilation geologic map—database highlights potential aggregate resources in the Phoenix metropolitan area

Phil Pearthree
Chief, Environmental Geology

Access to aggregate resources at a reasonable cost has been a critical component in growth and development in Arizona, and this is particularly true of the Phoenix metropolitan area. Abundant, locally available, high quality aggregate extracted primarily from river deposits has been a critical component of the vast building and road construction associated with the tremendous growth of the Phoenix area over the past century. As urban areas have expanded, however, development has rendered large areas of potential aggregate resources unavailable, and urban encroachment near existing aggregate operations has resulted in land-use conflicts.

Recognizing the need to ensure that access to aggregate resources be preserved, the Aggregate Protection Act (Senate Bill 1598) was passed in 2012 requiring local governments to include areas of potential aggregate resources in their planning processes. The primary intent of this legislation was to provide a framework in which local government planners could work with the mining industry to ensure continuing access to affordable construction materials. Existing geologic maps of the Phoenix area included some information that could be used to this end, but mapping was not uniform and generally did not depict deposits of the larger drainages as clearly as would be optimal for use in assessments of aggregate resource potential.



Pearthree, P.A., and others, Geologic Map Database for Aggregate Resource Assessment in the Phoenix Metropolitan Area and Surrounding Regions, Arizona. Arizona Geological Survey Digital Information DI-43, 11 p., map sheet, Shapefiles, ArcGIS Map Packages, polygons and geologic features. (repository.azgs.az.gov/uri_gin/azgs/dlio/1640)

Over the past several years, we have developed a new geologic compilation map, database and report that cover the Phoenix metropolitan area (Pearthree and others, 2015). The primary purpose for developing this new compilation is to depict uniformly and relatively simply the main geologic units that have been and could potentially be exploited for aggregate resources. The main sources of aggregate have been deposits of the five major rivers (Salt, Gila, Verde, Agua Fria, and Hassayampa) that cross the Phoenix area, and our map differentiates young, intermediate, and old river deposits. Each of these rivers drains a large watershed with diverse types of bedrock; gravel and sand deposited in the Phoenix area has commonly been transported for tens of miles or more, so the deposits of these rivers produce generally high-quality aggregate products. Deposits of the next smaller set of fluvial systems (New River, and Skunk, Cave and Queen Creeks) are quite extensive, but the mixes of rock types typically are much less diverse.

Deposits from the smaller river systems may yield high-quality aggregate, and they have been exploited with a few moderate or large aggregate pits, but they have been less important sources of aggregate. The bedrock units in the Phoenix area are quite complex, but we present a much simplified version of the bedrock using 24 different rock units. Some of these bedrock units have been mined for landscape or decorative rock, but the usefulness of a particular rock may depend on local conditions that are not captured in this map. Together, these data can be used by local governments as one important tool as they include potential aggregate resources in their land management planning, as mandated by the Aggregate Protection Act of 2012 (SB 1598). These data should also serve as a useful reconnaissance tool for aggregate producers when they evaluate potential future resources.

AzSLID—A statewide landslide inventory database for a safer Arizona

Reports of numerous, devastating landslides filled the news in 2014. These included massive and deadly landslides such as the Oso Landslide in Washington State and the West Salt Creek Landslide in Colorado, and slower moving, non-lethal landslides in several other states that were still very damaging and costly, destroying roads, cars and homes. Here in Arizona, our most recent large and expensive landslide occurred in February of 2013.

Ann Youberg
Research Geologist

The Bitter Springs Landslide destroyed Highway 89 south of Page and required $45 million dollars and two years to repair and re-open the road. Other more recent landslides in Arizona include 1000 small-volume debris flows in four southeastern mountain ranges resulting from a five-day extreme precipitation event in July of 2006, and numerous debris flows from rains falling on areas recently burned by wildfires (e.g. 2010 Schultz Fire, 2011 Horseshoe 2, Wallow and Monument Fires, 2012 Gladiator Fire).

The author and Joe Cook establishing a rainfall-triggered debris flow monitoring site in Oak Creek Canyon.

Our current understanding of the nature and extent of landslide activity in Arizona is rudimentary, making it difficult to assess the hazards associated with landslides. Indeed, the 2013 State of Arizona Hazard Mitigation Plan—Risk Assessment provides only a brief description of some recent landslide events in the Landslide Profile. The limited nature of these data accentuates how our incomplete knowledge of the scope and extent of landslides in Arizona has hampered identifying, documenting and mitigating landslide hazards.

To address this knowledge gap, the Arizona Geological Survey (AZGS) implemented a Landslides Hazards Program in 2014. Working with our partner agency, the Arizona Division of Emergency and Military Affairs (DEMA), we obtained funding from FEMA to conduct the first comprehensive landslide inventory for the State of Arizona.

Conducting a statewide inventory can be challenging, time consuming, and expensive. Our work on the landslide inventory, however, is progressing nicely. We created the Arizona Statewide Landslide Inventory Database (AzSLID) early in the year and began populating the database with documented landslides that includes all forms of mass movements: rotational, translational, and block/Toreva slides, rock falls and topples, earth slides and flows, and debris flows and avalanches. The AzSLID database now includes 4,420 individual landslide polygons totaling ~528 mi^2; we are approximately 75% finished with entering data for documented landslides. Our next step is to work with our partner agency, DEMA, to engage stakeholders (local, county and tribal governments, and departments of transportation) to identify critical areas with potential landslides that require new mapping to identify and define the hazard. Work here is just beginning. Once completed, AzSLID will be used to update the Landslide Profile in the upcoming 2018 State of Arizona Hazard Mitigation Plan. The database will be available to all local, county and tribal governments to use in updating their hazard mitigation plans. Finally, the inventory will be posted to AZGS' Arizona Natural Hazards Viewer, http://data.azgs.az.gov/hazard-viewer/, for the public to see and explore the data.

Landslides, earth fissures and geologic mapping—all in a year's work

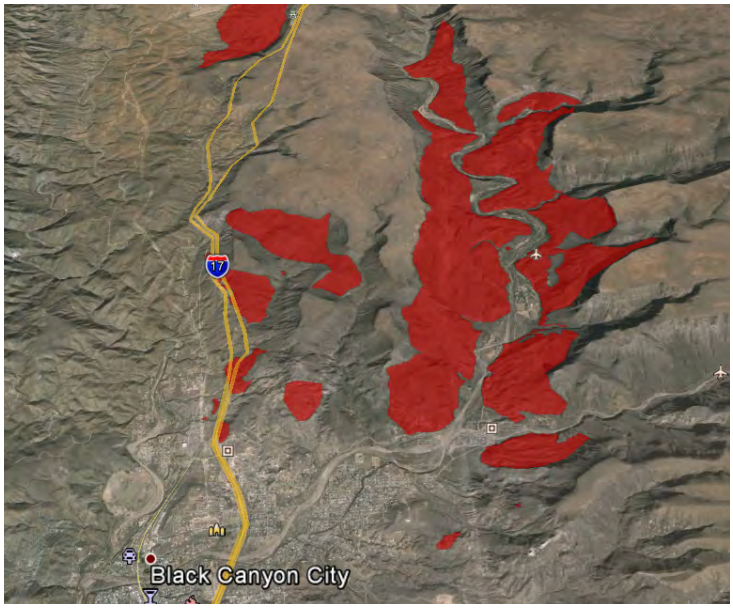
In my role as research geologist, I work on a number of interesting projects, including assisting in building a statewide database of landslides and mass movement hazards in Arizona. This involves compiling previously mapped landslide deposits from existing geologic maps and reports. I searched 100s of AZGS, US Geological Survey, and other agencies' archives to find all previously mapped and described landslides. In collaboration with Ann Youberg (AZGS), I identified a number of new landslide deposits using aerial photography reconnaissance. To date, we have compiled over 4,400 individual landslides in Arizona with an areal extent of more than 520 square miles. Next, we'll partner with other state and county agencies to add more detail to the database and make all the information available to the public. This will be Arizona's first comprehensive statewide landslide inventory. It should prove useful for planning and mitigation efforts by state and local agencies for years to come.

Joe Cook
Research Geologist

As manager of AZGS' earth fissure mapping program, I update our existing fissure maps as needed. During September and October, 2014 record rainfall in the Phoenix basin and surrounding areas caused widespread flash flooding, inundation, and erosion yielding new earth fissures in several areas. Newly formed fissures in Wintersburg, Luke, and Chandler Heights were mapped and existing fissure maps updated. Re-versioned fissure maps are available at AZGS's online earth fissure viewer and as a google earth kml file; both are available at www.azgs.az.gov/map_services.shtml.

Rapid land subsidence near Willcox Playa in Cochise County is yielding subsidence rates greater than 7 cm (2.8 inches) per year. Land subsidence is driven by expansion of agricultural land use and increased groundwater pumping. With increased subsidence comes the formation of new earth fissures and extension of existing fissures. In 2014, new fissures were mapped in the Dragoon Road, North Sulphur Springs Valley, and Three Sisters Buttes study areas. New versions of these maps are currently in preparation.

Among other things, I did surficial geologic mapping in the Mount Nutt quadrangle near Oatman, Arizona as part of the STATEMAP National Geologic Mapping program. I've taken a lead role in creating the layout for some map projects, which are laid out using ESRI GIS software and exported to PDF format for web distribution. Every map must be proofed and checked for errors and unit descriptions, map text, and the geologic map features are incorporated into the final map layout. This year I completed layouts for the finalized versions of the Kingman and Kingman NW 7 ½' quadrangles. These maps will soon be published and made freely available at the AZGS Online Document Repository (repository.azgs.az.gov).



The author and Joe Cook establishing a rainfall-triggered debris flow monitoring site in Oak Creek Canyon.

Monitoring earthquakes in Arizona

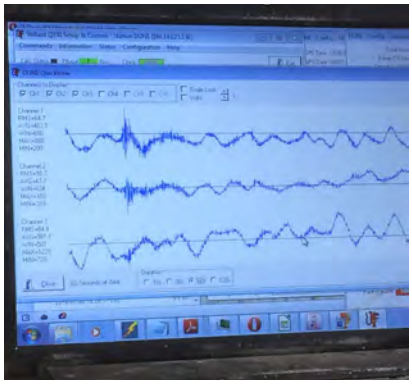
Arizona indeed experiences earthquakes, some of which can be damaging. The Arizona Geological Survey operates the state's first broadband seismic network that is capable of recording earthquakes greater than M 3.0 throughout the state. In addition, other entities such as the United States Geological Survey (USGS), the California Integrated Seismic Network, the Utah Seismic Network, and Mexican Seismic Network, share data with the AZGS so that regional earthquakes can be detected throughout the southwest.

Jeri Young
Research Geologist

Author deploying and programming a temporary seismometer near Duncan, Arizona, July 2014.

Understanding Arizona's seismicity can go a long way in helping people prepare for potentially damaging earthquakes. Seismic records generated by the AZGS are used in ground-motion modeling by the USGS and are used to determine what seismic building codes are appropriate for the state. In addition, information gathered by our network of seismometers is used to understand how the ground moves under critical structures such as Palo Verde Nuclear Generating Station. Often seismicity occurs in close proximity to known active earthquake faults; however, there are cases where seismicity occurs in areas without known faults. Repeated earthquakes in such areas provide clues to where previously unknown active faults could be.

As the seismic network manager, I keep the broadband seismometers working by monitoring their health and visiting them for repairs from time to time. In addition, I maintain near-real time data flow from each station so that when an important earthquake occurs, the data can be used by AZGS and other entities. This past year, an M5.3 earthquake occurred near Duncan Arizona, and was followed by hundreds of aftershocks. I set up a temporary seismic network with equipment loaned to the AZGS by PASSCAL to capture most of the aftershocks and use them to delineate act faults in the area of the mainshock. In December of this past year, I collaborated with NAU to more accurately locate the M4.7 event and associated foreshocks and aftershocks. Our analysis revealed that the M4.7 occurred only 7km south of Kachina Village, and was not located in northern Arizona as first reported by the USGS.



Seismograph of aftershock near Duncan, AZ, July 2014.

Last, when an Arizona earthquake larger than M 3.0 occurs, I analyze multiple seismic records (seismograms) from our stations and those surrounding Arizona so that I can locate where the earthquake occurred, estimate its size (magnitude) and record it in the Arizona Geological Survey Earthquake Catalog. All of this information is eventually disseminated to the public via an active webpage and in articles for Arizona Geology.

Boots on the Bouse and Bullhead: Field mapping in southern Blythe basin

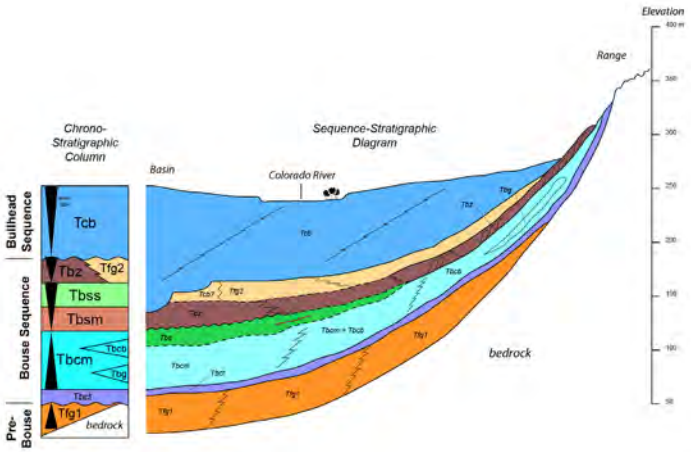
Brian Gootee
Research Geologist

The Blythe basin is one of the largest basins along the lower Colorado River corridor and contains a sequence of deposits that record the first arrival of Colorado River in the region. This sequence is preserved in the Bouse and Bullhead Formations, and is exceptionally well exposed in southern Blythe basin near Cibola, Arizona. Evaluating the two formations provide an opportunity to test hypotheses about the origin, timing and mechanisms of the Colorado River integration story. As part of the AZGS STATEMAP Program, I've been mapping the extent, structure, stratigraphy, and sedimentology of the Bouse and Bullhead formations.

The origin of the Bouse Formation is enigmatic; it's been the center of much debate since the 1970's. Originally interpreted as marine deposits of a proto-Gulf of California, more recent studies suggest that the Bouse formed in a series of large lakes, which spilled over bedrock divides between western Grand Canyon and Parker ~6 million years ago (Ma). Downstream of Blythe Basin, the Colorado River filled in the Yuma basin and Salton Trough after ~4.8 Ma. Excellent exposures of the Bouse and Bullhead formations are found in the Blythe basin, which AZGS and USGS are currently mapping in detail. These deposits provide excellent exposures of the Bouse and overlying Bullhead formations ideal for testing multiple hypotheses of the evolution of the Colorado River system. To test such a hypothesis, field mapping hundreds of exposures is critical and necessary. My experience mapping structure, stratigraphy and sedimentology in central Texas and Antarctica has helped to tackle details of the Bouse formation. And as part of the AZGS mapping team, I've collaborated, mapped and published with geoscientists from other research institutions on basic yet important geologic problems.

A group of geologists and students discuss stratigraphy and sedimentology of the Bouse Formation.

Mapping the Bouse and Bullhead formations is important from the standpoint of expanding on previous reconnaissance maps and collecting basic field data to characterize the structure, stratigraphy, lithology, fossil content, mineralization, permeability, porosity, thickness, and age to address mineral and water-resource potential. This is critical for characterizing the lower Colorado River drainage. Detailed field observations are the backbone of evolving models illustrating the landscape evolution of the Colorado River and its tributaries in Arizona and the Southwest.



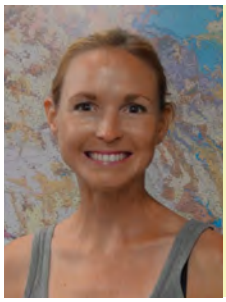
GEOINFORMATICS

How we discover, access, organize and distribute geoscience data

Bob Wick, BLM/CC BY 2.0, flickr.com

Muggins Mountain Wilderness in Yuma County, Arizona

Building out the National Geothermal Data System—One year at a time



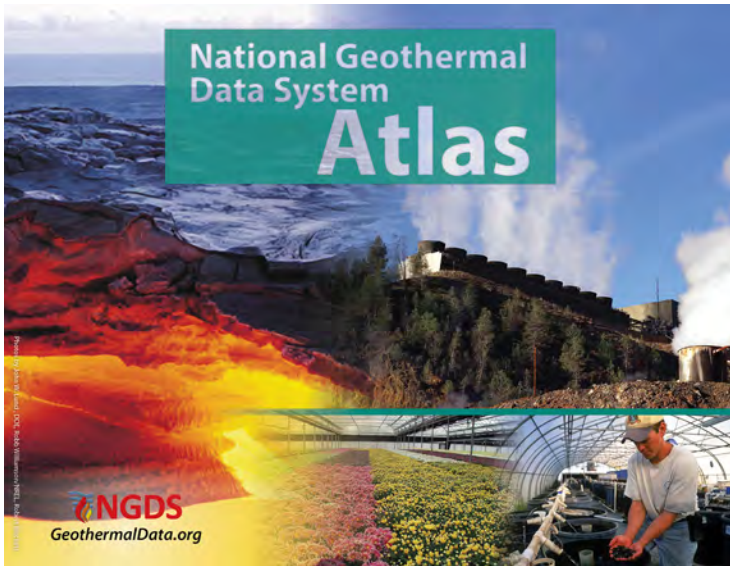
Christy Caudill
Deputy Section Chief of Geoinformatics

Over this past year, we have focused work on implementing the simple yet innovative architecture of the National Geothermal Data System (NGDS) with partners all over the country. Through this collaboration, NGDS data partners utilized open-source free software and USGIN (usgin.org) metadata standards to curate and serve their own data resources. This allows data providers, including more than a dozen State Geological Surveys, to manage resources on a publicly accessible website while enabling them to engage global partners for information exchange. These resources support the broad and distributed network of NGDS.

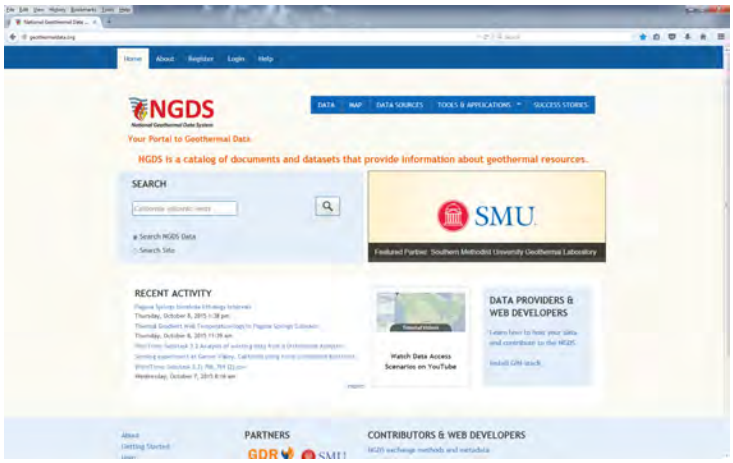
Some principal data providers, include: Southern Methodist University Geothermal Laboratory (SMU), Energy & Geoscience Institute (EGI), US Geological Survey, and State Surveys Alabama, Alaska, Delaware, Michigan, and Indiana, among others.

Additional NGDS partners include the Geothermal Data Repository and Geothermal Prospector application developers. These collaborations were funded through the National Renewable Energy Laboratory (NREL) and Sandia National Laboratory. Not only is data disseminated through NGDS available to the public at no cost, but it provides researchers with the tools to share information, and a space to create their own data and information sharing tools.

External funding of NGDS is essential to our mission of serving the public and fulfilling the primary function of a state survey. We'll continue to grow NGDS and provide the research community with the data they require for research and for building out America's geothermal energy portfolio.



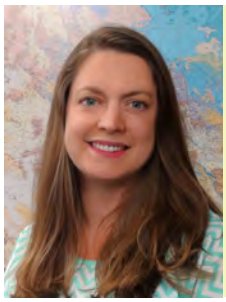
An illustrated guide to the geothermal resources of the National Geothermal Data System. Download it at http://geothermaldata.org/sites/geothermaldata.org/files/document/NGDS-Atlas-small.pdf.



Screenshot of National Geothermal Data System web portal, geothermaldata.org.

Strabo—A mobile application to promote structural geology data collection and sharing

This past year we've had a new type of project for geoinformatics; the development of a mobile app. The current working name for the app is Strabo Mobile, named by one of the project PIs after a Greek geographer and historian. As the lead developer, I am responsible for everything from the initial project design and scope requirements to the build itself and field testing with geologists.



Jessica Good
GIS Applications Developer

The app is part of a larger data system for the structural geology and tectonics community. Other important components in this data system include a database and Web application; those are under construction by team members at other organizations. The mobile app provides a platform for geologists to collect and map field data. The app is developed specifically for geologists and is tailored to the data geologists collect in the field. That data then displays on a digital map with the appropriate geologic symbols. Strabo Mobile also communicates with a central database to allow users to upload their field data and then download it on other devices or share it with members of their community. This works in reverse too, where a user can log on the web application, upload previously collected place-based data from a GIS to the database for viewing in the mobile app. This app is still in development—it is a project to span multiple years. One day the Strabo Mobile app will make collecting and sharing data easier and more attractive for geologists.

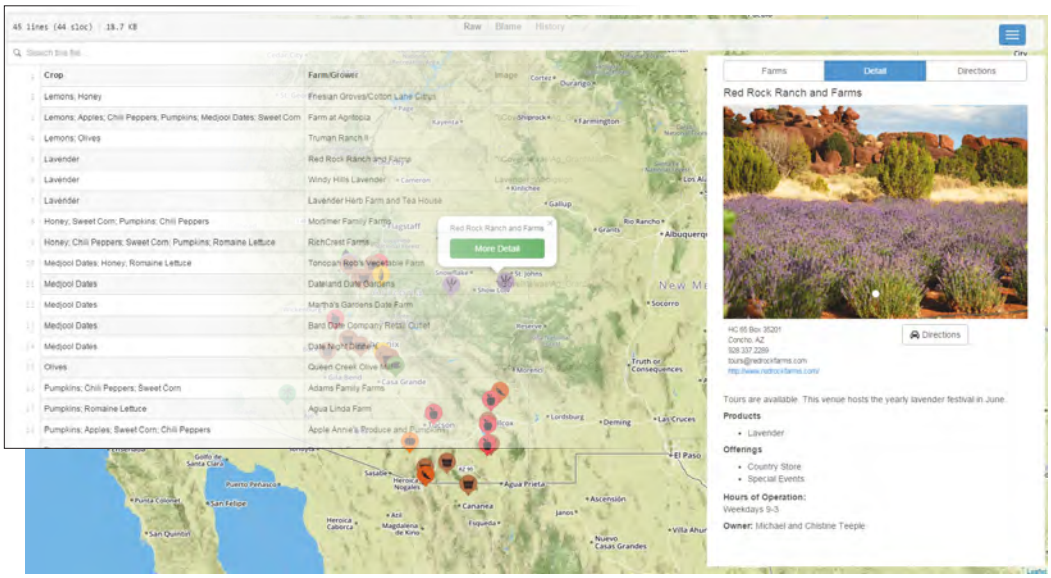
The PIs on this project are Basil Tikoff (University of Wisconsin-Madion), Julie Newman (Texas A&M), and Doug Walker (University of Kansas) and we are working off an NSF grant. We've done some beta testing already but since that mostly occurred after the start of the new fiscal year I didn't include it. We'll be doing more testing over the coming year. All of the components of the project will be free.

Arizona Experience's interactive U-pick farm map promotes Arizona's specialty crops

Laura Bookman
GIS Specialist

Every team needs a good utility infielder—as AZGS' GIS specialist that is my role. I have my hands on all sorts of spatial projects, such as the National Geothermal Data System (NGDS), building a database to host Arizona's landslide inventory, and working with the Arizona Experience team to build out interactive maps for their stakeholders. I came to the NGDS project late and I was chiefly responsible for capturing and inputting metadata to accompanying geothermal data. Working with the Arizona Experience team, I helped build out a web map application—interactive U-Pick Farm Map—showcasing select specialty crops and U-pick farms.

Crops displayed on the map, include: apples, honey, dates, lemons, lettuce, lavender—we grow lavender, who knew?—olives, sweet corn, pumpkins and chili peppers. Ideally, mainstreaming this information online will help rural Arizona grow its agritourism industry. The map tool allows for seasonal searches and provides directions if needed.



The Arizona Experience U-Pick Farm Map, http://arizonaexperience.org/live-maps/u-pick-farm-map.

One really interesting project involves working with Ann Youberg and the Environmental Geology team to structure and build the Arizona statewide landslide inventory database (AzSLID). The objective is to compile landslide information—location, age, type of landslide, cost (damages), photos, notes and comments, among other things—from the geologic literature and from observations using Google Earth and other imaging software. The database will comply with the NCGMP09 ArcGIS toolbar; a tool AZGS geologists use in constructing geologic maps. The goal of AzSLID is to mitigate landslide hazards, save lives and minimize damage to property.

Earthcube—Blazing a cyberinfrastructure trail for the global science community

Since 2011, AZGS has played a major role in the development of EarthCube, a community-driven, National Science Foundation (NSF) -funded initiative to create cyberinfrastructure for managing, sharing, and exploring geoscience data. With 2,000 community members and more than 25 funded projects drawing tens of millions in funding, EarthCube is swiftly gaining visibility in the geosciences and open data communities.

EarthCube will accelerate understanding of the Earth system, improve the productivity of the geosciences, and pave the way for cyberinfrastructure developments for science communities across the globe.

The organizational structure of EarthCube is taking shape through the efforts of the EarthCube Test Enterprise Governance project (ECTEG), led by Dr. Lee Allison and based here at the Arizona Geological Survey. Put simply, ECTEG is a two-year, large-scale, NSF-funded project to design and test a governance structure for EarthCube. Since the project began in September 2013, our small team has executed vast engagement and planning efforts, incorporating the collective effort and expertise of the EarthCube community into a structure that will not only support EarthCube itself, but can also be replicated as a viable model for future NSF initiatives, changing the way virtual science organizations may be run for years to come.

The progress we've made this year has been substantial. We implemented the organizational framework developed in Year 1 and tested the experiment in multiple ways to make progress toward longer-term enterprise governance for EarthCube. Opportunities to test and stress this system came with each new development, including election of leadership, setting up budget and decision-making processes, developing staff roles,

Rachael Black & Kate Kretschmann
Project Coordinator

Anna Katz
Project Coordinator
Jaimie Ryan
Graduate Research Assistant

establishing an EarthCube Charter and bylaws, and addressing National Science Foundation requirements. The ECTEG team also played a second role as the EarthCube Office (the organization's support and logistics arm), supporting the committees and teams virtually and through the planning of multiple in-person meetings and workshops.

In turn, the volunteers populating these new governance bodies made huge strides in addressing the science, technology, and engagement aspects of EarthCube, quickly establishing charters, articulating long-term visions for moving forward, bringing together the science and technology communities, mapping the landscape of potential EarthCube collaborators, and beginning real work on standards, use cases, and system architecture. The highly conceptual EarthCube of 2013 is quickly evolving into a living, breathing initiative making real strides toward building a dynamic cyberinfrastructure for the geosciences.

Contact the EarthCube team at http://earthcube.org/contact.

Belmont Forum—establishing sustainable e-infrastructures for global change research

The Belmont Forum, established in 2009, comprises the world's major funding agencies of global environmental change research and international science councils, and serves as a roundtable for these agencies to collectively address issues related to global environmental change. It is guided by the Belmont Challenge, which aims, "To deliver knowledge needed for action to avoid and adapt to detrimental environmental change including extreme hazardous events."

Genevieve Pearthree
Project Manager

Community Edition

10th August 2015

A Place to Stand: e-Infrastructures and Data Management for Global Change Research

Belmont Forum e-Infrastructures & Data Management Community Strategy and Implementation Plan

"Give me a place to stand, and I will move the world" - Archimedes

Steering Committee, Belmont Forum e-Infrastructures and Data Management Collaborative Research Action
Lee Allison, Arizona Geological Survey (Co-Chair)
Robert Gurney OBE, University of Reading (Co-Chair)

The Belmont Forum coordinates funding for Collaborative Research Actions (CRAs), which are high-priority research and community-building activities to improve the way funding agencies collaborate with each other and develop opportunities for research. In 2013, the Belmont Forum initiated the e-Infrastructures and Data Management CRA, which brought together 120 natural scientists, computer and information scientists, legal scholars, social scientists, and other experts representing more than 10 countries to establish recommendations on how the Belmont Forum can implement a more coordinated, holistic, and sustainable approach to the funding and support of global environmental change research. An international steering committee of experts led working groups and provided the guidance needed to see this project through.

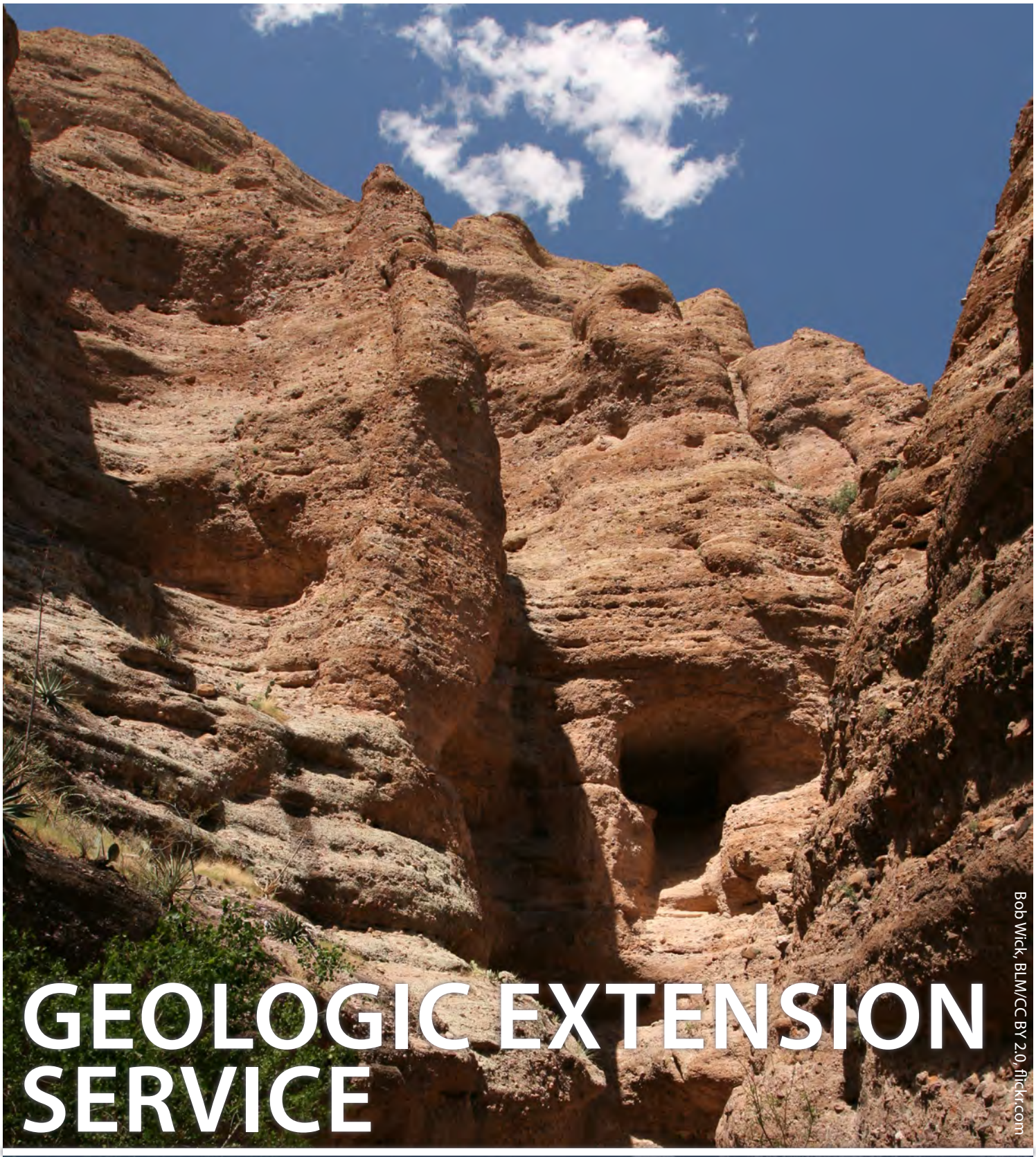
Arizona Geological Survey Director Lee Allison (US) co-leads this project with University of Reading Professor Robert Gurney (UK) under a joint United States/United Kingdom Secretariat. I manage the US Secretariat Team, which includes AZGS project coordinator Anna Katz.

After two years of work, including more than 50 virtual meetings and a dozen in-person workshops across six continents, we delivered a Community Strategy and Implementation Plan to the Belmont Forum at the end of June, 2015. The Plan identifies five recommendations encompassing short- and long-term funding investments and strategic science policies that the Belmont Forum can implement:

1. Adopt Data Principles that establish a global, interoperable e-infrastructure with cost-effective solutions to widen access to data and ensure its proper management and long-term preservation. Researchers should be aware of, and plan for, the costs of data intensive research.
2. Foster communication, collaboration and coordination between the wider research community and the Belmont Forum, and across Belmont Forum projects through a Data and e-Infrastructure Coordination Office established within a Belmont Forum Secretariat.
3. Promote effective data planning and stewardship in all Belmont Forum agency-funded research to enable harmonization of the e-infrastructure data layer through enhanced project data planning, monitoring, review and sharing.
4. Determine international and community best practice to inform Belmont Forum research e-infrastructure policy, in harmony with evolving research practices and technologies and their interactions, through identification and analysis of cross-disciplinary research case studies.
5. Support the development of a cross-disciplinary training curriculum to expand human capacity in technology and data-intensive analysis methods for global change research, and increase the number of scientists with cross-cutting skills and experience in best practice.

These recommendations have the potential to transform the way data are used and research is conducted by accelerating discovery, increasing the value of research in decision-making, and catalyzing changes throughout the economy and society that are of value to all citizens.

The Belmont Forum member agencies will consider these recommendations during the annual Belmont Forum meeting in Oslo, Norway, in October, 2015. The full Plan is available on the project knowledge hub at www.bfe-inf.org.



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GEOLOGIC EXTENSION SERVICE

In our service to the Arizona public we embrace transparency, forthrightness and strong customer service values.

Aravaipa Canyon Wilderness

Getting the word out to AZGS stakeholders

Mike Conway
Chief, Geologic Extension

Until recently, most state geologic surveys went about the business of geologic investigations and geohazard assessment with little effort to alert any but the most proximal of stakeholders. Times have changed.

A primary role of AZGS's Geologic Extension Service is to support the communication and outreach objectives of the agency's Geoinformatics, Geology, Economic Geology, and Environmental Geology sections. In FY2014, we released information, graphics and publications for each section (azgs.az.gov; arizonaexperience.org, and at our online publication repository—repository.azgs.az.gov). To keep people apace of Arizona's rapidly evolving mining industry, we filmed and broadcast the Arizona Mining Review on the last Wednesday of each month.

Besides supporting our other divisions, and operating the Arizona Experience Bookstore, we worked on two externally funded projects: an online geologic photo gallery of Northern Arizona; and promoting specialty crops in Arizona. The former is in collaboration with Dr. Dale Nations, Emeritus Professor at Northern Arizona University, and involves funding from the American Association of Petroleum Geologists Foundation. As part of this project, we are building and publishing story maps of Grand Canyon and the Verde Valley using ESRI Story Map technology.

Mike Conway overseeing the production of the Arizona Mining Review.

Promoting specialty crops is funded by the Arizona Department of Agriculture and the promotional products—festival videos and web pages—are online at our Arizona Experience (arizonaexperience.org) educational website. Our U-Pick Crops map is the cornerstone of this project (http://arizonaexperience.org/live-maps/u-pick-farm-map).

In FY 2014, we made dozens of public presentations, including TV and radio interviews, on a whole host of topics, including: gold in Arizona, earth fissures, earthquakes and earthquake preparedness, Holocene geology of the San Pedro River, geology of Grand Canyon, fate of the San Bernardino volcanic field, and the relationship and hazards of wildfires and subsequent debris flows, among other topics.

The Great Arizona Shakeout continues to be AZGS' most prominent public outreach event. In October 2014, with our partners at the Arizona Dept. of Emergency and Military Affairs, the Arizona County Emergency Management offices, educators and Arizona's health community, we organized the two-minute emergency preparedness drill, 'drop, cover, and hold on'. More than 124,000 Arizonans participated on Thursday, 16 October 2014. This included more than 80,000 K–12 school children and another 20,000 college students. In FY-2016, we hope to increase the total number of participants to 140,000.

Our social media program topped 4,000 likes (Re. followers) on Facebook, and 3,200 followers on Twitter. Most weeks our Facebook posts reach between 10,000 and 20,000 people. In the past 12 months, AZGS Geologic Extension Service published 16 geologic maps—several of which include GIS geodatabases—five open-file reports, one contributed report, three Arizona Geology e-Magazine issues, and two special papers.

Sharing Our Work on the Web

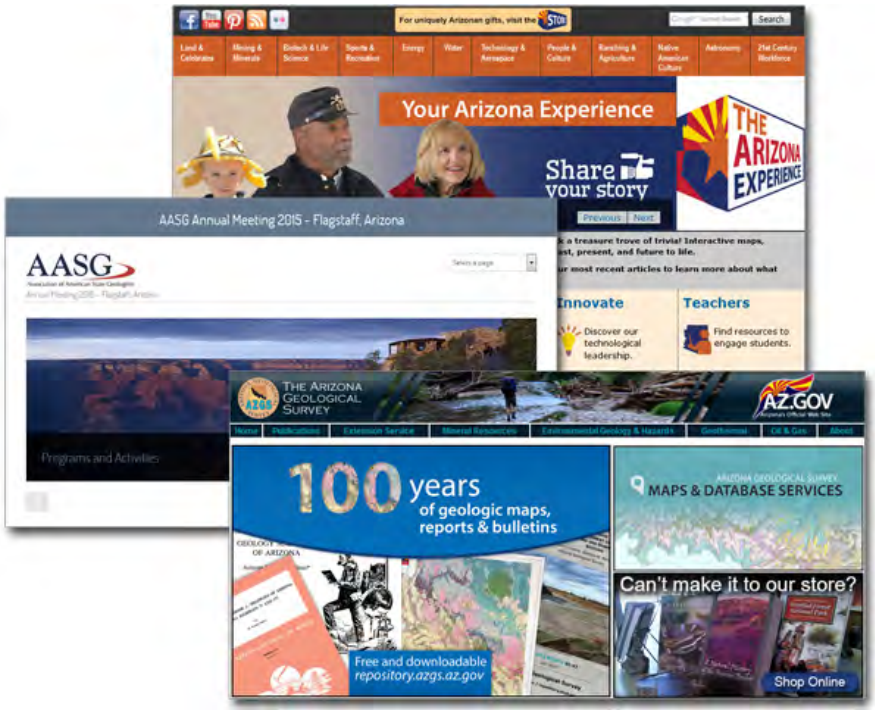
As with most agencies, public or private, much of the work we do involves sharing that information with others. And every year, the bulk of that information is shared online. Whether it's done informally via tweets or on Facebook, or done by posting more formalized news releases and reports on a website, the role of the Geological Extension Service of the Arizona Geological Survey (AZGS) continues to be to get that information out to the public. My role is to make it as easy as possible to get that information posted to our many websites.

Pam Barry-Santos
Web Developer

As a web developer with the AZGS, I help the geologists and other staff share their work outside the agency. We have over a dozen public-facing sites that have been created over the years to answer specific goals or were built in response to specific grants. All are done in-house, in addition to the main AZGS website. Each site needs to be kept updated with information, announcements and also maintained in its technical aspects, including applying ongoing security updates.

This year, in addition to rebuilding a couple websites from scratch to streamline the most-used features, we continued work on our ongoing projects and associated websites, and played host for two science conferences. With the planning of the conferences came the task of figuring out how to share information about them, process registrations, plan field trips and receive payments. To save on external costs we decided to create our own registration site and manage all aspects of the registration in-house. This led to navigating the new waters (to us) of online registration forms and processing.

While almost every aspect of my role here involves incorporating existing knowledge and learning and applying new concepts, almost all of creating, and then using, the registration site required learning something new. And this is why I love my job here at the AZGS. I can count on each year bringing new challenges.



Select AZGS Website Environments

Arizona Geological Survey: azgs.az.gov
Arizona Experience: arizonaexperience.org
Arizona Experience Store: store.azgs.az.gov
AZGS Mining Data: minedata.azgs.az.gov
AZGS Online Repository: repository.azgs.az.gov
Arizona Oil & Gas Conservation Commission: azogcc.az.gov
Belmont Forum: bfe-inf.org
EarthCube: earthcube.org
National Geothermal Data System: geothermaldata.org
US Geoscience Information Network: usgin.org

Exploring the landscape of place-based learning

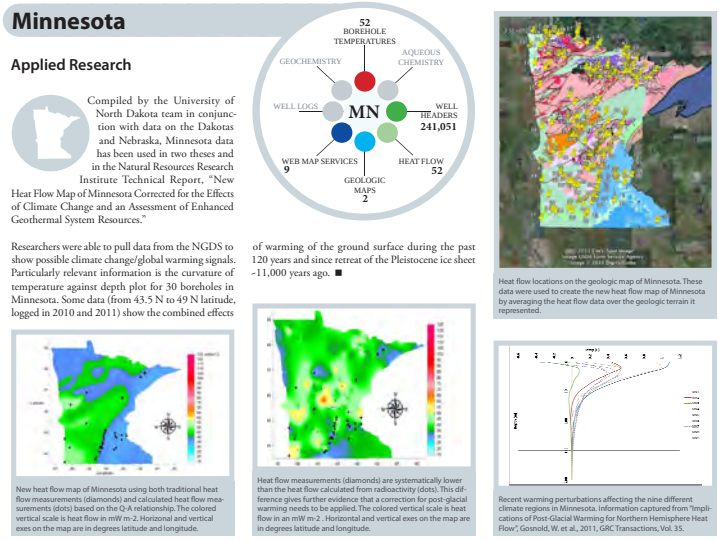
Rowena Davis
Content Manager

Maps are a high priority here at the Arizona Geological Survey. The survey has pioneered online access to geologic maps, built interactive map-based tools (http://data.azgs.az.gov/hazard-viewer/), and generated dynamic map-based educational resources.

This year, I had the good fortune to work on several projects that both extended our innovative uses of maps and increased the survey's role in education, outreach, and engagement. As a web content manager and a member of the Geologic Extension Services, I collaborate on numerous projects with the goal of disseminating information in a dynamic, useful, and digestible way. Often, maps were the preferred vehicle for promotion and information transfer.

Take for example, our creation of an atlas showcasing the National Geothermal Data System, http://geothermaldata.org/sites/geothermaldata.org/files/document/NGDS-Atlas-small.pdf. This year, approximately 10 million data points from approximately 65 participating data repositories, academic institutions, and state geological surveys went live in a distributed online data network. How did we showcase these decades of new and legacy data? With maps, of course.

Working with the Department of Energy, we created an atlas that used maps to illustrate the data contributions of all 50 states. The atlas has been used in presentations and online as a primary promotion tool for this massive, three year project (Digitizing Earth: Developing a cyberinfrastructure for the geosciences, http://www.earthmagazine.org/article/digitizing-earth-developing-cyberinfrastructure-geosciences).



Minnesota

Applied Research

Compiled by the University of North Dakota team in conjunction with data on the Dakotas and Nebraska, Minnesota data has been used in two theses and in the Natural Resources Research Institute Technical Report, "New Heat Flow Map of Minnesota Corrected for the Effects of Climate Change and an Assessment of Enhanced Geothermal System Resources."

Researchers were able to pull data from the NGDS to show possible climate change/global warming signals. Particularly relevant information is the curvature of temperature against depth plot for 30 boreholes in Minnesota. Some data (from 43.5 N to 49 N latitude, logged in 2010 and 2011) show the combined effects of warming of the ground surface during the past 120 years and since retreat of the Pleistocene ice sheet -11,000 years ago. ■

Heat flow locations on the geologic map of Minnesota. These data were used to create the new heat flow map of Minnesota by averaging the heat flow data over the geologic terrain it represented.

New heat flow map of Minnesota using both traditional heat flow measurements (diamonds) and calculated heat flow measurements (dots) based on the Q-A relationship. The colored vertical scale is heat flow in mW m-2. Horizontal and vertical exes on the map are in degrees latitude and longitude.

Heat flow measurements (diamonds) are systematically lower than the heat flow calculated from radioactivity (dots). This difference gives further evidence that a correction for post-glacial warming needs to be applied. The colored vertical scale is heat flow in an mW m-2 . Horizontal and vertical exes on the map are in degrees latitude and longitude.

Recent warming perturbations affecting the nine different climate regions in Minnesota. Information captured from "Implications of Post-Glacial Warming for Northern Hemisphere Heat Flow", Gosnold, W. et al., 2011, GRC Transactions, Vol. 35.

34 NGDS Atlas

One of my favorite accomplishments this year was working with our in-house map makers to build and launch an interactive U-Pick Farm Map as part of a specialty crop block grant received from the Arizona Department of Agriculture. Users can find over 30 of Arizona's agritourism destinations, learn more about specialty crops or just spend a day at the farm. Immediately upon release, this fun and timely tool, which features seasonal search filters and dynamic directions to and from a chosen location, was showcased by several news outlets, Arizona Local First, and the Arizona Farm Bureau. It is currently housed on the Arizona Experience website (http://arizonaexperience.org/live-maps/u-pick-farm-map) with a portal from the Arizona Office of Tourism.

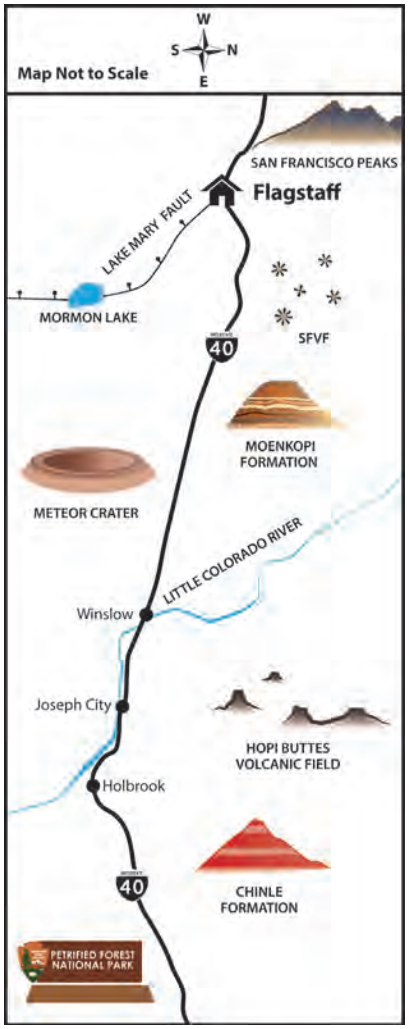
Work has also started on a project funded by the American Association of Petroleum Geologists to bring geologic slides into the classroom via maps. ESRI's ArcGIS Online offers a user-friendly story map application that uses locations as the connecting point for themes and ideas, resulting in a cohesive narrative. The Geologic Extension team has been curating slides of the Grand Canyon and using the ESRI application to build story maps that create engaging lessons connecting the geologic formations of the Grand Canyon with the processes and landscapes that made them happen.

Much like the contours of our landscape have shaped Arizona's use of resources, our innovative approach to mapping continues to drive our outreach and education efforts.

Will design for rocks

As the leader of AZGS' graphic design team, I design and build original graphics to showcase AZGS publications, projects and exhibits. This includes infographics, logos, flyers, large displays, web banners, and front-end web design. A new task I took on this year is the videography and editing of the Arizona Mining Review, an online e-video magazine exploring and reviewing mining in Arizona, https://www.youtube.com/user/azgsweb.

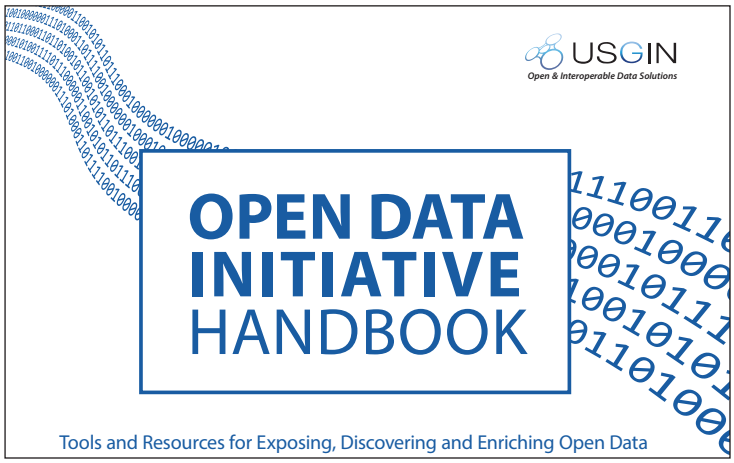
Stephanie Mar
Graphic Designer



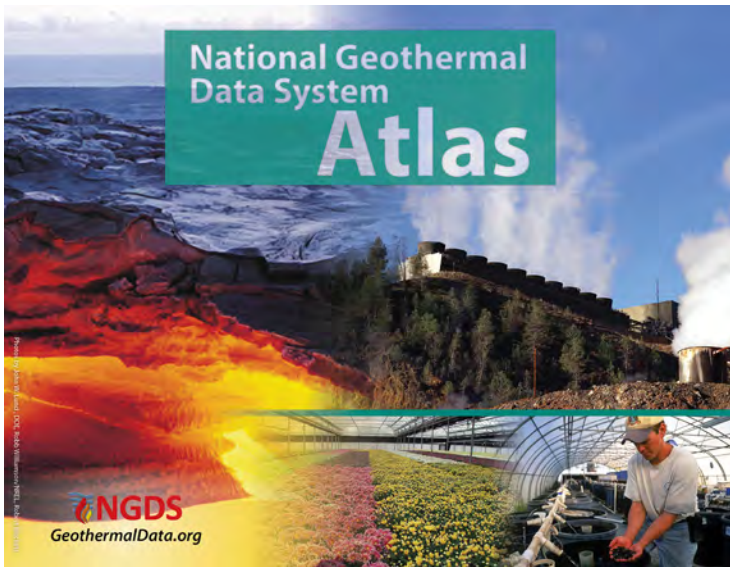
Graphic created for the AASG Annual Meeting

My work as a graphic designer keeps me busy, but I make time to contribute to activities that are somewhat unrelated. This year I assisted Christy Caudill, NGDS project manager, with quality assessment and control of data contributed to the National Geothermal Data System. This work has a parallel to my role as graphic designer. Instead of designing something that is easily readable to people, I make sure the data is machine-readable.

And I work closely with our web developer, Pam Barry-Santos, in design and construction of our many web environments. In particular, I've been instrumental in designing elements and web graphics for the Arizona Experience.org, USGIN.org, and the Belmont Forum Data Management Project (bfe-inf.org) websites.



Cover for the USGN Open Data Imitative Handbook, http://usgin.org/content/usgin-open-data-compliance-guide



Cover for the NGDS Atlas, http://geothermaldata.org/success-stories

One of the most enjoyable parts of graphic design is taking a raw idea to a finished project. Working here at Survey allows me to do just that through the cause of sharing educational and geoscience information.

All things Arizona in a Tucson storefront

My job with the survey is to manage the daily operations of our Arizona Experience Store. That makes me the face of AZGS at street level and the first point of contact for most people. And I make it my mission to welcome our visitors and provide the highest standards in customer service.

Nancy Greene
Bookstore Manager

The Arizona Experience Store is Tucson's one-stop shop for all things Arizona. With over 2,500 topo, geologic, raised relief and hiking maps in stock, we are the premier destination for Arizona maps in the area. You will find publications from Game and Fish, Arizona Highways, State Parks and Western National Parks on our shelves. To assist customers, we host a touch-screen kiosk for locating online resources at local, state and federal agencies. The store offers a valuable selection of books on natural history, geology, rocks and minerals, mining, hiking and general Arizona interest with many titles by local and regional authors. Local works of fiction and memoir as well as a few spooky tales now brighten our selection.

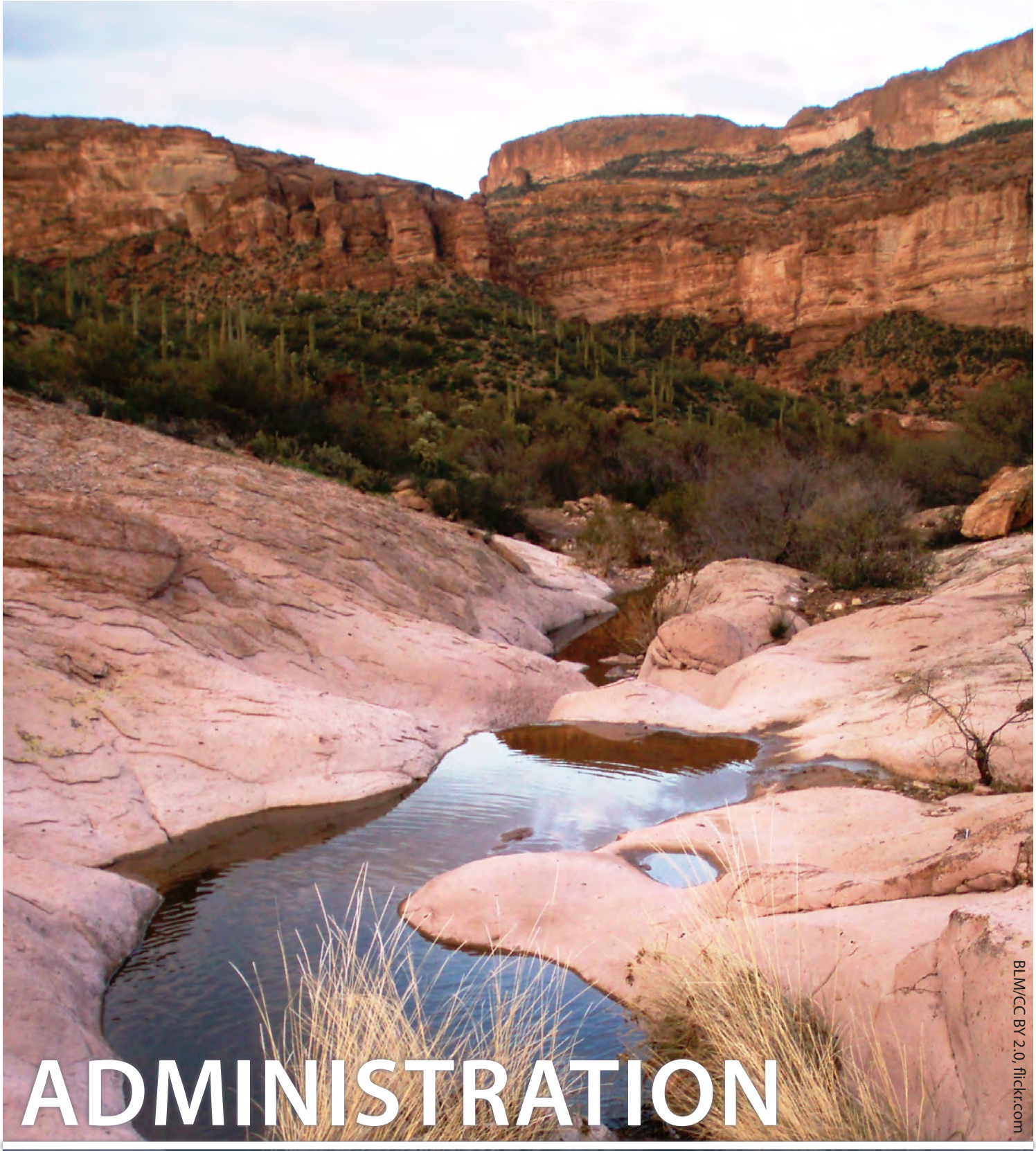
For the geoscience community, we provide AZGS technical geologic reports and maps and a select suite of US Geological Survey publications. The Arizona Experience Store is the sole distributor of Arizona Geological Society Digests.

New this year: hats embroidered with animals of the Southwest and dishtowels embroidered with Arizona and Grand Canyon themes; our customers love them! We've added greeting cards and stationery from local artists and continue to expand our selection of consigned items. Including, natural stone sculptures, terra cotta luminarias, hand-made hair ornaments, hand-made soaps, tote bags and native heirloom beans. Our children's section continues to grow, with new educational toys, books and plush animals.

Our off-site efforts this year included the Tucson Gem and Mineral Show in February and the Tucson Festival of Books in March where we had an impressive showing. The Book Festival offered us an opportunity to showcase several local authors with book-signings. Social media—Facebook and Twitter—are helping us reach new customers.

We continue to tinker with store design, so we can bring you more of Arizona. Our free recreational publications section hosts 100s of flyers, brochures, catalogs and maps showcasing local, state and federal recreational sites.

The Arizona Experience store packs loads of Arizona into a Tucson storefront. Drop by and say hello or shop us online at store.azgs.az.gov.



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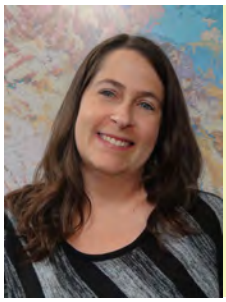
ADMINISTRATION

A funding stream comprised largely of external grants and contracts makes for a rewarding and challenging administrative environment.

Gila River Canyons

From project conception to closeout, expanding the AZGS footprint



Randi Bellassai
Chief Operating Officer

The Arizona Geological Survey continues to expand its scope, and so do my duties. In addition to managing several high-profile projects, I also assumed the duties of Human Resources. This provided me the opportunity to streamline numerous polices and processes, as well as work closer with all sections. There have been numerous changes and improvements within our administration department. The launching of the new state accounting system provided us the ability to transfer all proposals, grants, and contracts into E-Civis.

Having a hand in so many projects creates an opportunity to showcase AZGS success in different ways. In September 2014, the National Geothermal Data System received the "Special Recognition Award" by the Geothermal Energy Association. Additionally, I was able to set up the USGIN Foundation, Inc. as a 501 (c) 3 organization, providing AZGS the ability to seek funding from additional resources.

A main part of my responsibilities at AZGS continues to be the identification, organization, and submitting of new grants and contracts. In December 2014, we successfully closed out a four year, $22.1 million grant from DOE. With the closing of our largest grant, we did reduce the total number of staff and reallocate duties amongst existing team members. During FY15 I participated in the submitting of 16 proposals, of which 5 were funding and 8 more are still pending.

In June 2015, AZGS hosted the 107th Annual Association of American State Geologists Meeting in Flagstaff. I was responsible for all aspects of planning and executing the conference logistics. I am pleased to say that the conference had record attendance. It was not only a boost to the local economy, but also to the Survey as a whole.

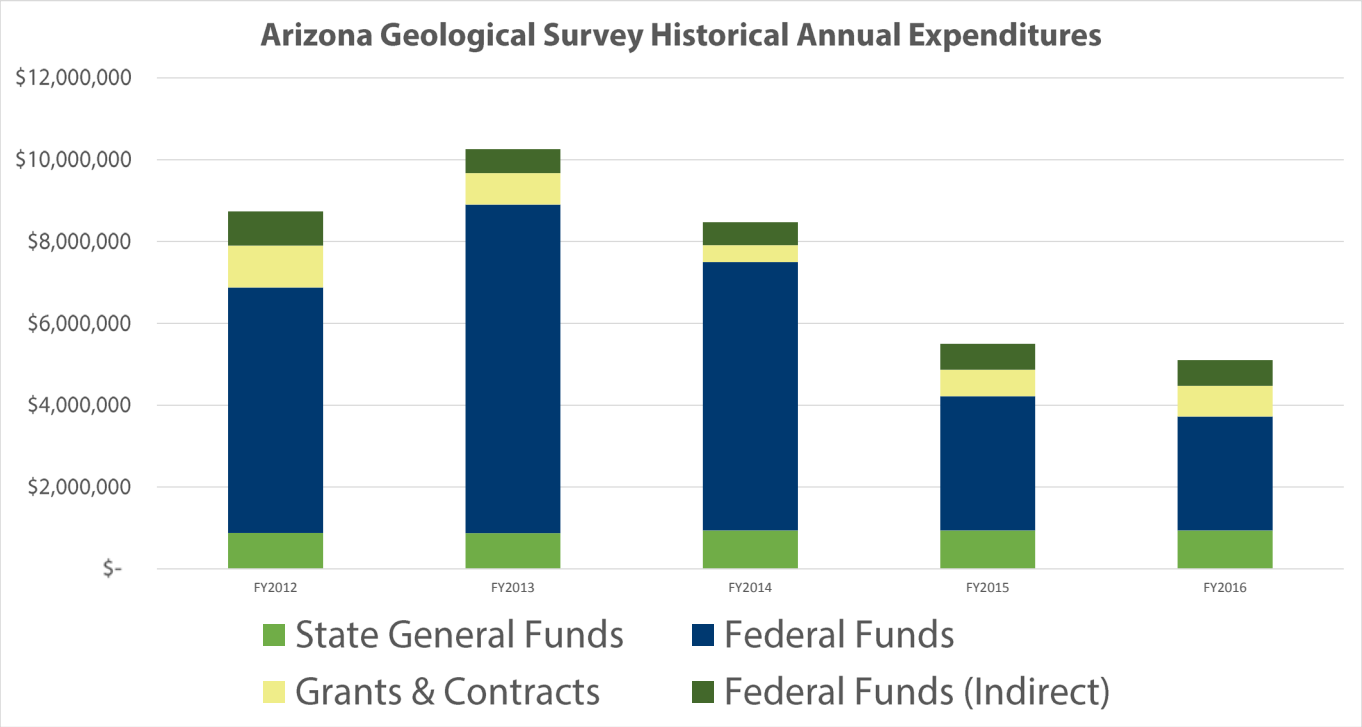
Following the money!

This year, the accounting team ushered in a new accounting system as implemented statewide by the General Accounting Office (GAO) for the State of Arizona. With our accounting staff of two, it was a challenge to train and prepare for the change. As the new system is used daily, important strides are made in understanding its functionality. The former state accounting system was a COBOL-based system; the new system is web-based and is more robust in managing financial data. While the system is already operational, the AZGS accounting team will be refining our knowledge of the new accounting system in FY16 as it takes hold of Arizona's finances statewide.

Fritz Schellenberg
Budget and Accounting Officer
Adrie Madero
Fiscal Services Specialist

Revenues

	FY2012	FY2013	FY2014	FY2015	FY2016
State General Fund	$876,200	$871,200	$941,400	$941,700	$941,000
Federal Funds	$5,951,700	$8,054,700	$6,471,900	$3,258,800	$2,838,300
Federal Funds (Indirect)	$562,100	$626,200	$648,900	$520,400	$695,200
Grants & Contracts	$1,062,200	$749,200	$556,000	$542,300	$706,200
	$8,452,200	$10,301,300	$8,618,200	$5,263,200	$5,180,700



Grants FY 15

Federal	Amount	End Date
National Science Foundation—EarthCube Test Governance	$3,482,199	2/29/2016
National Science Foundation—Belmont Forum	$652,648	3/31/2016
U.S. Department of Energy—Sandia National Laboratory	$420,000	4/30/2016
USGS The State Component of the National Cooperative Geologic Mapping Program (STATEMAP)—FY 2015	$171,331	9/14/2015
University of California @ San Diego—Digital Crust	$165,446	9/30/2015
USGS The State Component of the National Cooperative Geologic Mapping Program (STATEMAP)—FY 2014	$151,200	9/14/2014
FEMA Pre-disaster Mitigation Program—Creating a statewide inventory of landslides	$150,657	12/22/2016
University of California @ San Diego—EarthCube CINERGI	$117,600	8/31/2015
University of Kansas—Structured DB	$149,002	7/31/2016
National Science Foundation—EarthCube Workshop (Data Facilities)	$93,147	12/31/2015
University of California @ San Diego—Big CZ Software	$62,237	11/30/2015
University of California @ San Diego—EarthCube Conceptual Design	$57,240	12/31/2015
U.S. Geological Survey—Post Fire Debris Flow	$40,000	6/14/2016
USGS National Geological & Geophysical Data Preservation Program FY14	$27,300	9/1/2014
USGS National Geological & Geophysical Data Preservation Program FY15	$27,190	9/1/2015
Columbia University—Digital Environment for Sample Curation	$18,000	11/30/2014

State, Local, Other		
AZ State Lands Department—McMullen Valley	$227,000	5/29/2015
Arizona Dept. of Agriculture—Specialty Crop Block Grant Program	$109,228	9/30/2015
Salt River Project—Subsurface Hydrogeologic Investigation of the Superstition Vistas Study Area Contract	$99,734	3/31/2016
AZ State Lands Department—Butler Valley Basin Project	$82,213	5/29/2015
American Association of Petroleum Geologists Foundation—Online Earth Science Image Atlas and Story Maps	$59,205	2/1/2016
NREL—Technical Support for the National Geothermal Data System	$45,000	4/15/2015
Arizona State Mine Inspector—Abandoned Mines Project	$21,875	10/30/2015
US Energy Association—Ethiopia	$10,000	4/30/2015
McDowell Sonoran Conservancy	$3,500	on-going

AZGS FY15 Staff Directory

Allison, M. Lee	Director and State Geologist	lee.allison@azgs.az.gov
Hanson, Chris	Deputy Director	chris.hanson@azgs.az.gov
Administration		
Bellassai, Randi	Chief Operating Officer	randi.bellassai@azgs.az.gov
Castro, Cindy	Fiscal Services Specialist	*
Larue, Paula	Human Resources / Business Manager	*
Madero, Adrieanna	Administrative Services Officer	adrieanna.madero@azgs.az.gov
Schellenberg, Albert, F.	Budget and Accounting Officer	fritz.schellenberg.azgs.az.gov
Economic Geology/Phoenix Branch		
Bain, Diane	Records Archivist	diane.bain@azgs.az.gov
Brown, Casey	Metadata Librarian	casey.brown@azgs.az.gov
Eden, Becky	Records Archivist	*
Niemuth, Nyal	Phoenix Branch Manager	nyal.niemuth@azgs.az.gov
Environmental Geology		
Cook, Joseph	Research Geologist	joe.cook@azgs.az.gov
Gootee, Brian	Research Geologist	brian.gootee@azgs.az.gov
Pearthree, Philip	Chief, Environmental Geology	phil.pearthree@azgs.az.gov
Youberg, Ann	Research Geologist	ann.youberg@azgs.az.gov
Young, Jeri	Research Geologist	jeri.young@azgs.az.gov
Geoinformatics		
Claudill, Christy	Geoinformatics Content Specialist	*
Bookman, Laura	GIS Specialist	laura.bookmanazgs.az.gov
Good, Jessica	GIS Application Developer	jessica.goodazgs.az.gov
Musil, Leahanna	Information Technology Specialist	*
Palmer, Ronald	IT Support Specialist	ron.palmer@azgs.az.gov
Pape, Esty	Geologist	*
Richard, Stephen	Chief, Geoinformatics	steve.richard@azgs.az.gov
Sonnenschein, Adrian	GIS Specialist	*

Continued on next page >>

* No longer affiliated with the Arizona Geological Survey.

Geologic Extension Services		
Barry-Santos, Pam	Web Developer	pam.barrysantos@azgs.az.gov
Conway, M.	Chief, Geologic Extension Service	michael.conway@azgs.az.gov
Davis, Rowena	Web Content Manager	rowena.davis@azgs.az.gov
Greene, Nancy	Bookstore Manager	nancy.greene@azgs.az.gov
Mar, Stephanie	Graphic Designer	stephanie.mar@azgs.az.gov
Matti, Jordan	Tech Transfer Specialist	*
Geologic Mapping		
Ferguson, Charles	Research Geologist	charles.ferguson@azgs.az.gov
Johnson, Brad	Research Geologist	brad.johnson@azgs.az.gov
Rauzi, Steve	Oil and Gas Administrator	*
Spencer, Jon	Chief, Geologic Mapping; Senior Geologist	*
Special Projects		
Black, Rachael	Project Coordinator	rachael.black@azgs.az.gov
Katz, Anna	Project Coordinator	*
Kretschmann, Kate	Project Coordinator	*
Pearthree, Genevieve	Project Manager	*

* No longer affiliated with the Arizona Geological Survey.

Professional Accomplishments

M. Lee Allison, Ph.D., AZGS Director

Adjunct Professor, University of Arizona Dept. of Geosciences.
Advisory Committee, Advanced Cyberinfrastructure, U.S. National Science Foundation, 2013–2015.
American Association of Petroleum Geologists, Astrogeology Committee, October 2006–present.
American Geophysical Union Board on Data Maturity Modeling, Member, 2015–present.
American Geophysical Union, Eos Editorial Advisory Board, Representative for Informatics, 2008–present.
Association of American State Geologists, Chair, Information Committee, 2008–present.
Belmont Forum e-Infrastructure Steering Committee and Secretariat, Co-chair, 2013–2015.
Coalition on the Public Understanding of Science, co-founder 2006, member Core (Steering) Committee, 2007–present.
Earth and Space Science Informatics (ESSI) Section, Executive Committee, American Geophysical Union, Member, November 2008–present.
Geological Society of America, Geoinformatics Division, Chair, 2014–2015.
National Data Repositories consortium, Chair, 2014–2016.
Natural Resources Review Council, gubernatorial appointment by Executive Order, 2013–present; GIS Subcommittee, Chair.
OneGeology Board of Directors, North American Member, 2013–present.
Preservation of Geoscience Data Committee, American Association of Petroleum Geologists, Member, 2015–2017.
Western Regional Partnership, GIS Liaison, 2010–present.

Michael Conway, Ph.D., Chief, Geologic Extension Service

President, Arizona Geological Society.
Field Trip Organizer—Arizona Geological Society.
Member, Western States Seismic Policy Council.
Arizona Representative to the National Earthquake Managers Council.

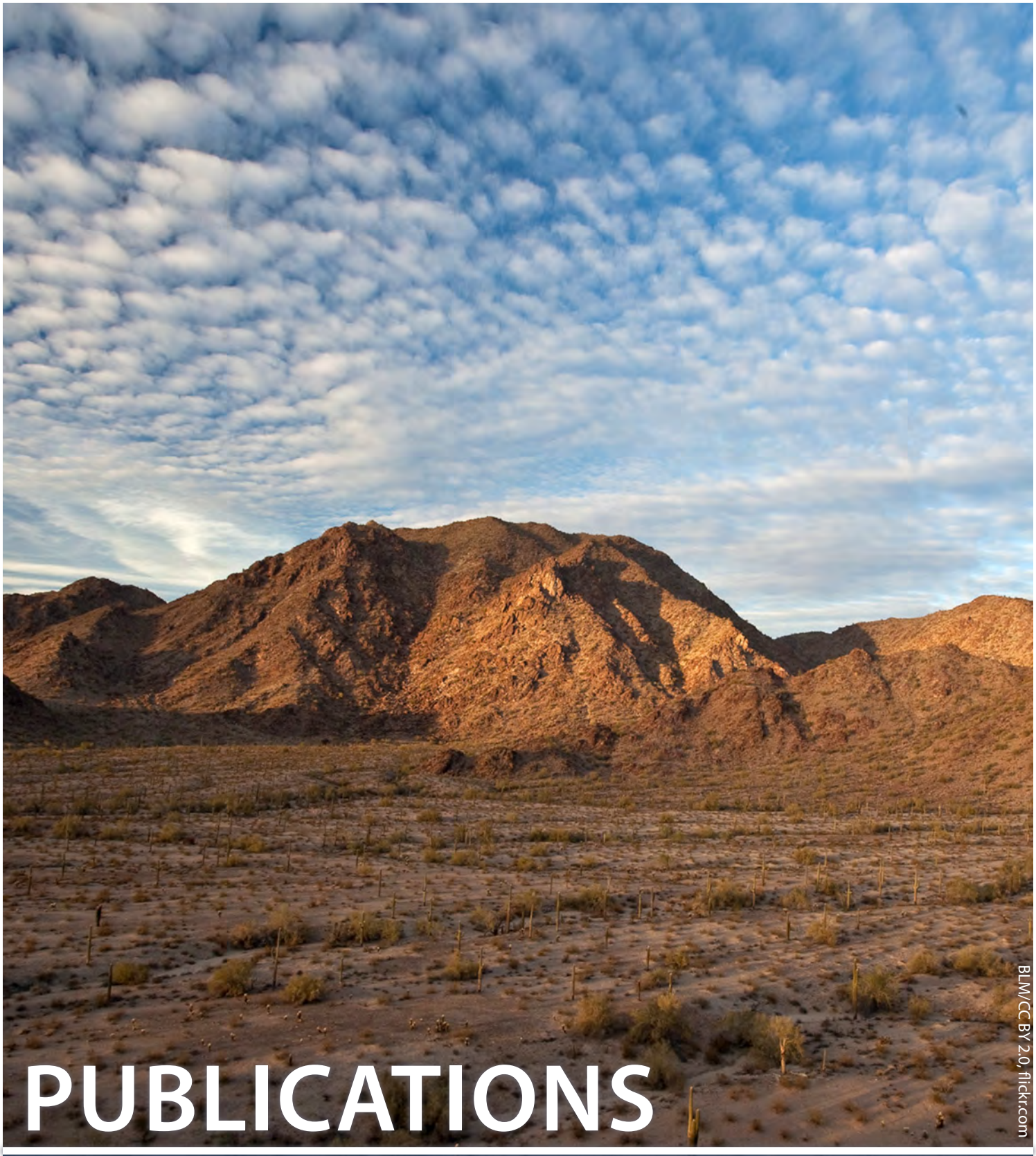
Nyal Niemuth, Chief, Economic Geololgy

Mining Foundation of the Southwest—Board of Governors, Hall of Fame Committee.

Awards and Honors

Geothermal Resources Council, Best Presentation Award, Geothermal Resource Council Annual Meeting 2012: "A Geothermal Data System for Exploration and Development."
Phil Pearthree was elected as a Geological Society of America Fellow in July, 2014.

OneGeology Board in Canberra, Australia



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PUBLICATIONS

The past, present and future of the Arizona Geological Survey

Sonoran Desert National Monument

Arizona Geological Survey Publications FY 15

Arizona Geology E-Magazine, azgeology.azgs.az.gov

Summer 2015

- Conway, M. and Brown, C. 2015, The Colvocoresses Collection: Mines & mining in Arizona, Circa 1910–1950.
- Jackson, L. and Sekhon, N., 2015, Review: *San Andreas*—The Movie.

Spring 2015

- Staff, 2015, New geologic map index for Arizona Geological Survey map products published between 1925–2015.

Fall 2014

- Conway, M, 2014, Social Media: a conduit for communicating earthquake information.
- Young, J. and Pearthree, P.A., 2014, Duncan M5.3 Earthquake of June 2014 and Temporary Seismic Network Deployment.
- Conway, M, 2014, Arizona Geological Survey at GSA 2014.

Contributed Maps

Cave, S.R., 2014, Geologic Map of the Sentinel-Arlington Volcanic Field, Maricopa and Yuma Counties, Arizona. Arizona Geological Survey Contributed Map CM-14-A, map scale 1:100,000, 11 p.

Holm, R.F., 2015, Geologic map of the Page Springs 7.5-Minute Quadrangle, Yavapai County, Arizona. Arizona Geological Survey Contributed Map CM-15-A, map scale 1:24,000, 16 p, four map sheets.

Singleton, J, Bird, E. and Hatfield, M. 2014, Geologic map of the southern Lincoln Ranch basin, Buckskin Mountains, west-central Arizona. Arizona Geological Survey Contributed Map CM-14-B, map scale 1:10,000.

Contributed Report

Briggs, D.F., 2015, Recovery of Copper by Solution Mining Methods. Arizona Geological Survey Contributed Report CR-15-A, 10 p. Digital Geologic Maps.

Ferguson, C.A. and Johnson, B.J., 2014, Geologic map of the western half of the Columbia 7 ½' Quadrangle and the eastern half of the Copperopolis 7 ½' Quadrangle, Yavapai County, Arizona. Arizona Geological Survey Digital Geologic Map DGM-109, map scale 1:24,000.

Johnson, B.J., Spencer, J.E. and Pearthree, P.A., 2015, Geologic map of the Arizona part of the Gene Wash 7.5' Quadrangle, Mohave and La Paz Counties, Arizona. Arizona Geological Survey Digital Geologic Map DGM-110, 1 map scale, 1:24,000.

Pearthree, P.A., Spencer, J.E., Youberg, A. and House, P.K., 2014, Geologic Map of the Black Peak and Bobs Well 7.5 Quadrangles, La Paz County, Arizona. Arizona Geological Survey Digital Geologic Maps DGM-108 v1, map scale 1:24,000.

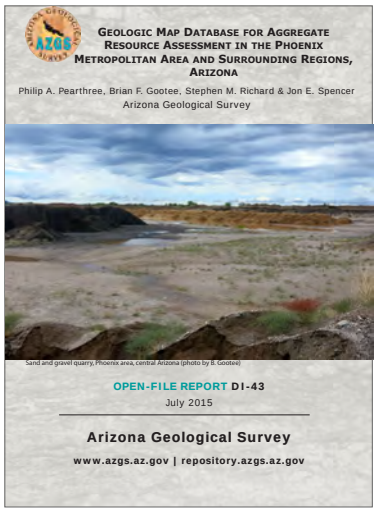
Spencer, J.E., Richard, S.M., Johnson, B.J., Love, D.S., Pearthree, P.A. and Reynolds, S., 2015, Geologic map of the Artillery and Rawhide Wash 7.5' minute Quadrangles, Mohave and La Paz Counties, Arizona, Arizona Geological Survey Digital Geologic Map, DGM-100 v 2.0, map scale 1:24,000, 2 map sheets.

Spencer, J.E., Youberg, A., Love, D.S., Pearthree, P.A., Steinke, T.R. and Reynolds, S.J., 2014, Geologic map of the Bouse and Ibex Peak 7.5' Quadrangle, La Paz County, Arizona. Arizona Geological Survey Digital Geologic Map DGM-107, v1.0, map scale 1:24,000.

Digital Information

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.

Spencer J.E., Wenrich, K. and Cole, T., 2015, Partial database for breccia pipes and collapse features on the Colorado Plateau, northwestern Arizona. Arizona Geological Survey Digital Information, DI-42, 5 p., 1 map scale, shapefiles, and Excel Workbook.



Pearthree, P.A., Gootee, B.F., Richard, S.M. and Spencer, J.E., 2015, Geologic Map Database for Aggregate Resource Assessment in the Phoenix Metropolitan Area and Surrounding Regions, Arizona. Arizona Geological Survey Digital Information DI-43, 11 p., map sheet, Shapefiles, ArcGIS Map Packages, polygons and geologic features.

Youberg A., 2015, Geodatabase of Post-Wildfire Study Basins: Assessing the predictive strengths of post-wildfire debris-flow models in Arizona, and defining rainfall intensity-duration thresholds for initiation of post-fire debris flow. Arizona Geological Survey Digital Information, DI-44, 10 p., geodatabase, and Excel workbook.

Digital Maps

Arizona Geological Survey, 2014, Earth Fissure Map of the Luke Study Area: Maricopa County, Arizona: Arizona Geological Survey Digital Map—Earth Fissure Map 8 v. 2.0 (DM-EF-8, v. 2.0), map scale 1:24,000.

Arizona Geological Survey, 2014, Earth Fissure Map of the Chandler Heights Study Area: Pinal and Maricopa Counties, Arizona: Arizona Geological Survey Digital Map—Earth Fissure Map 1 v. 2.0 (DM-EF-1, v. 2.0), map scale 1:24,000.

Arizona Geological Survey, 2015, Earth Fissure Study Area of Avra

Valley, Pima County, Arizona. Arizona Geological Survey Digital Map Earth Fissure Series-27, map scale 1:24,000.
Arizona Geological Survey, 2015, Earth Fissure Study Area of McMullen Valley, Maricopa County, Arizona. Arizona Geological Survey Digital Map Earth Fissure Series-28, map scale 1:24,000.
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Open-File Reports

Conway, F.M. and Davis, R., (eds.), 2014, Annual Report of the Arizona Geological Survey: Fiscal Year 2013. Arizona Geological Survey Open-File Report, OFR-14-01, 54 p.
Love, D.S., Gootee, B.F., Cook, J.P., Mahan, M.K. and Spencer, J.E.,2014, An Investigation of Thermal Springs throughout Arizona: Geochemical, Isotopic, and Geological Characterization, Arizona Basin and Range Province, Arizona Geological Survey Open-File Report OFR-14-06, 129 p.
Gootee, B.F. and Gruber, D.G., 2015, Quartz vein investigation, McDowell Sonoran Preserve, Scottsdale, Maricopa County, Arizona. Arizona Geological Survey Open File Report, OFR-15-03, 69 p.
Niemuth, Nyal, 2014, Arizona Mining Claim Forms, Arizona Geological Survey Open File Report, OFR-14-05, 11 p.
Spencer, J.E., Richard, S.M., Ferguson, C.A., Compilation geologic map of the Oracle 7.5' Quadrangle, Pinal and Pima Counties, Arizona. Arizona Geological Survey Open-File Report, OFR-00-05, map scale 1:24,000, 32 p. report. (Now available online.)
Spencer, J.E. and Richard, S.M., 2015, Map index for geologic maps available from the Arizona Geological Survey. Arizona Geological Survey Open File Report, OFR-15-01, 32 p.

Special Papers

Murray, K., Dixon, J., Meier, L., Dennis, M. and Schieffer, J., 2014, Industrial Minerals on Arizona State Trust Land, in, Conway, F.M., ed., Proceedings of the 48th Annual Forum on the Geology of Industrial Minerals, Phoenix, Arizona, April 30 - May 4, 2012. Arizona Geological Survey Special Paper #9, Chapter 7, p. 1–9.
Pearthree, P.A. and Cook, J.P., 2015, Geology and Geomorphology of the San Pedro River, Southeastern Arizona. Arizona Geological Survey Special Paper 10, 24 p.

External Publications

Allison, M.L., & Gurney, R., co-editors, "Belmont Forum e-Infrastructures and Data Management Collaborative Research Action: Interim Report," submitted to the Belmont Forum Group of Program Coordinators, September 15, 2014, 195 p.
Allison, M.L. (2014). Data Integration between State and Federal Agencies in the U.S. National Data Repository Meeting publication.
Allison, M.L., & Gurney, R., 2015, "A Place to Stand: e-Infrastructures and Data Management for Global Change Research—Belmont Forum e-Infrastructures & Data Management Community Strategy and Implementation Plan," submitted to the Belmont Forum, June 30, 2015, 53 p.
Allison, M.L., Patten, K., Black, R., Katz, A., Kretschmann, K., & Pearthree, G., 2014, "EarthCube: A Community-Driven Organization for Geoscience Cyberinfrastructure," Geological Society of America Abstracts with Programs. Vol. 46, No. 6, p. 740
Allison, M.L., Richard, S.M., & Patten, K., 2014, "Providing Free and Open Source Access to Geoscience Data Worldwide," Geological Society of America Abstracts with Programs. Vol. 46, No. 6, p. 476
Allison, M.L., Richard, S.M., Patten, K., Caudill, C., & Anderson, A. (2014). Open Access to Geoscience Data for Exploration and Assessment. Proceedings from the World Geothermal Congress.
Allison, M.L., Richard, S.M., Patten, K., Caudill, C., & Anderson, A., 2015, "Open Access to Geoscience Data for Exploration and Assessment," World Geothermal Congress, Melbourne, Australia, 11 p.
Black, R., Katz, A., & Kretschmann, K. (2014). EarthCube: A community-driven organization for geoscience cyberinfrastructure. *Limnology and Oceanography Bulletin*. 23(4), p. 80–84.
Brown C., & Allison, M.L., 2014, "Arizona Geological Survey Mining Site – Leveraging 100 Years of Mining Reports, Maps, and Photographs for the Next 100 Years," Geological Society of America Abstracts with Programs. Vol. 46, No. 6, p. 621.
Caudill, C., Richard, S.M., Musil, L., Sonnenschein, A., & Good, J. (2014). National Geothermal Data System: Open access to geoscience data and digital technologies. Geological Society of America Abstracts with Programs. Vol. 46, No. 6, p. 620.
Claiborne, L. L., McDowell, S. M., Miller, C. F., Lang, N. P., and Ferguson, C. A., Cribb, J. W., and Covey, A., (2014), Prelude to a super volcano: REU investigations in the Miocene volcanic field of the southern Black Mountains: Geological Society of America abstracts with programs, v. 46, no. 6, p. 825.
Evenson, N.S., Reiners, P.W., Spencer, J.E., & Shuster, D.L., 2014, Hematite and Mn oxide (U-Th)/He dates from the Buckskin-Rawhide detachment system, western Arizona: Gaining insights into hematite (U-Th)/He systematics: *American Journal of Science*, v. 314, p. 1373–1435; DOI 10.2475/10.2014.01.
Gootee, Brian (2014). Milky Quartz: A common mineral, but still a mystery. *The Field Institute Insider*, July 2014.
Gurney, R., & Allison, M.L., 2014, "E-infrastructure and Data Management for Global Change Research," Geological Society of America Abstracts with Programs. Vol. 46, No. 6, p. 620
Howard, K.A., House, P.K., Dorsey, R.J., and Pearthree, P.A., 2015, River-evolution and tectonic implications of a major Pliocene aggradation on the lower Colorado River: *The Bullhead Alluvium: Geosphere*, v. 11, n. 1, p. 1–30.
Komac, M., Duffy, T., Robida, F., & Allison, M.L., 2014, "OneGeology: Providing Global Open Access to Geoscience Data," Geological Society of America Abstracts with Programs. Vol. 46, No. 6, p. 476.
Niemuth, N. & Singh, M., 2015, The Mineral Industry of Arizona 2010–2011, *U.S. Geological Survey Minerals Yearbook, Volume II - Area Reports: Domestic*, p. 5.1-5.12 http://minerals.usgs.gov/minerals/pubs/state/2010_11/myb2-2010_11-az.pdf
Pearthree, P.A., and House, P.K., 2014, Paleogeomorphology and evolution of the early Colorado River inferred from relationships in Mohave and Cottonwood valleys, Arizona, California, and Nevada: Geosphere, v. 10, n. 6, p. 1139–1160.
Pratt, R. D., Claiborne, L. L., Miller, C. F., and Ferguson, C. A., (2014). Investigation of a pre-super eruption ignimbrite, petrology of the

Miocene Cook Canyon Tuff, Black Mountains, Arizona: Geological Society of America abstracts with programs, v. 46, no. 6, p. 511

Richard, S.M., Diggs, S., Percival, G. (2014). EarthCube: Seeking community convergence on geoscience cyberinfrastructure architecture. Geological Society of America Abstracts with Programs. Vol. 46, No. 6, p. 620.

Rockwell, T. Dawson, T., Young, J. and Seitz G., 2015, A 21-Event, 4,000-Year History of Surface Ruptures in the Anza Seismic Gap, San Jacinto Fault, and Implications for Long-term Earthquake Production on a Major Plate Boundary Fault, Pure and Applied Geophysics: Volume 172, Issue 5, Page 1143–1165

Youberg, A.M., Webb, R.H., Fenton, C.R., and Pearthree, P.A., 2014, Latest Pleistocene–Holocene debris flow activity, Santa Catalina Mountains, Arizona; Implications for modern debris-flow hazards under a changing climate: Geomorphology, v. 219, p. 87–102.

Geomorphology 219 (2014) 87–102

Contents lists available at ScienceDirect

Geomorphology

journal homepage: www.elsevier.com/locate/geomorph

Latest Pleistocene–Holocene debris flow activity, Santa Catalina Mountains, Arizona; Implications for modern debris-flow hazards under a changing climate

Ann M. Youberg [a,*], Robert H. Webb [b,1], Cassandra R. Fenton [c], Philip A. Pearthree [a]

[a] Arizona Geological Survey, 416 W. Congress, Suite 100, Tucson, AZ 85701, USA
[b] U.S. Geological Survey, 520 N. Park Avenue, Tucson, AZ 85719, USA
[c] Helmholtz-Zentrum Potsdam - Deutsches GeoForschungsZentrum, Telegrafenberg, D-14473 Potsdam, Germany

ARTICLE INFO

Article history:
Received 9 June 2013
Received in revised form 22 April 2014
Accepted 23 April 2014
Available online 9 May 2014

Keywords:
Debris flows
Surficial geology
Cosmogenic ^{10}Be dating
Debris-flow modeling
Semiarid
Arizona

ABSTRACT

Hazard mitigation for extreme events such as debris flows requires geologic mapping and chronologic information, particularly for alluvial fans near mountain fronts in the southwestern United States. In July 2006, five consecutive days of monsoonal storms caused hundreds of debris flows in southeastern Arizona, particularly in the southern Santa Catalina Mountains north of Tucson. Before 2006, no historical debris flows from the Santa Catalina Mountains reached the populated mountain front, although abundant evidence of prehistoric debris flows is present on downslope alluvial fans. We used a combination of surficial geologic mapping and ^{10}Be exposure dating to produce a debris-flow history for Pima and Finger Rock Canyons. The largest debris flows, of latest Pleistocene to early Holocene age, covered much of the apices of alluvial fans formed at the mouths of these canyons and extended up to 3 km downslope. These debris-flow deposits were inset against higher and older alluvial surfaces with few debris-flow deposits of late Pleistocene age. The ^{10}Be ages in this study have considerable scatter for surfaces believed to be of uniform age, indicating the dual possibilities of inheritance from previous cosmic-ray exposure, as well as the potential for composite deposits derived from numerous debris flows. We then used an empirical inundation model, LAHARZ, to assess probable magnitudes of the older debris flows to evaluate possible initiation mechanisms. In-channel and terrace storage within the canyons is not sufficient to generate volumes likely needed to produce the larger late Pleistocene to early Holocene debris-flow deposits. The abundance of latest Pleistocene and early Holocene deposits suggests that large debris flows were generated during the instability associated with climate and vegetation changes at the Pleistocene–Holocene transition. Under present watershed conditions with limited sediment supplies, modern debris-flow hazards are generally limited to within mountains and near mountain fronts.

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1. Introduction

Urban development on alluvial fans near mountain fronts exposes housing and infrastructure to numerous geologic and hydrologic hazards. In the arid and semiarid southwestern United States, historical debris flows have commonly occurred following extreme precipitation or following high frequency, low magnitude rainfall in recently burned watersheds (Wohl and Pearthree, 1991; Pearthree and Youberg, 2004; Cannon et al., 2008; Kean et al., 2011). In this environment, debris flows are extreme hydrologic events that deliver considerable amounts of large-caliber sediment to active alluvial fans (Wells and Harvey, 1987), dominating fan deposition patterns and profoundly influencing flow paths during smaller floods. Floodplain management strategies typically focus on 100-year floods or smaller, and flood control measures in this region generally utilize channel–bank stabilization measures or require building above the calculated 100-year water surface, ignoring the potential for channel aggradation and subsequent overbank deposition during debris flows (Webb et al., 2008). An understanding of past debris-flow magnitude and frequency, as well as of prehistoric areas of deposition, is essential for placing the hazard of debris flows into a temporal framework in order to assess risk (Youberg et al., 2008). Moreover, because evidence left by debris flows tends to persist in the landscape for a long time, the significance of abundant undated debris-flow deposits is difficult to evaluate when assessing modern hazards.

During the last week of July 2006, southern Arizona experienced five consecutive days of early morning storms generated from monsoonal moisture interacting with a persistent low-pressure system centered over northwestern New Mexico (Magirl et al., 2007). This series of

* Corresponding author.
E-mail address: ann.youberg@azgs.az.gov (A.M. Youberg).
[1] Present address: School of Renewable Natural Resources, University of Arizona, Tucson, AZ 85719, USA.

http://dx.doi.org/10.1016/j.geomorph.2014.04.034
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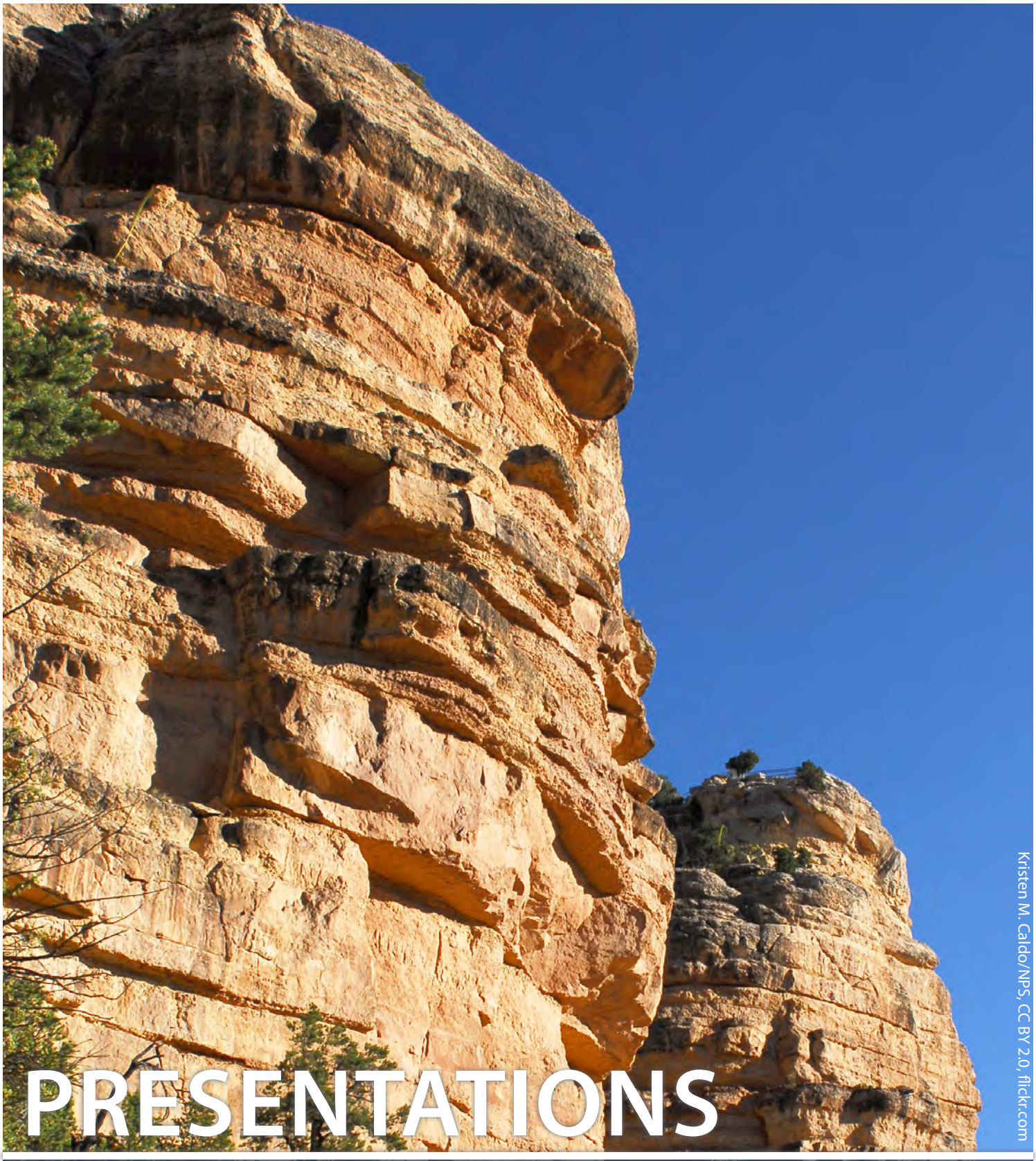

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PRESENTATIONS

Professional conferences, exhibits and public presentations are unequaled opportunities for AZGS staff to share our products, programs and aspirations.

Grand Canyon National Park

Presentations by AZGS Staff FY 15

Professional Presentations

Allison, M.L., "EarthCube standing committees & teams: Priorities and next steps," national webinar, July 17, 2014. [presentation repeated July 21, 2014]

Allison, M.L., "Preserving access to aggregate resources in the Phoenix metropolitan area," Arizona Mining Alliance luncheon meeting, Tucson, AZ, August 8, 2014.

Allison, M.L., "Arizona potash," Society for Mining, Metallurgy & Exploration Tucson Section, Tucson, AZ, August 13, 2014.

Allison, M.L., "EarthCube," panelist (via webex), Insights from Knowledge Commons Practice, 2nd Thematic Conference on Knowledge Commons: Governing Pooled Common Resources (with special attention to the fields of medicine and the environment), NYU School of Law, NY, NY, September 5, 2014.

Allison, M.L., "Cyberinfrastructure for the geosciences: EarthCube and beyond," Department of Atmospheric Sciences, University of Arizona, Tucson, AZ, September 18, 2014.

Allison, M.L., "Data integration between state and federal agencies in the U.S.," National Data Repositories consortium general assembly, Baku, Azerbaijan, October 3, 2014.

Allison, M.L., Richard, S.M., & Patten, K., "USGIN: A geoscience solution for open data access requirements," Geological Society of America Annual Meeting, Vancouver, Canada, October 21, 2014.

Allison, M.L., S.M. Richard, and K. Patten, "Providing free and open source access to geoscience data worldwide," Geological Society of America Annual Meeting, Vancouver, Canada, October 21, 2014.

Allison, M.L., K. Patten, R. Black, A. Katz, K. Kretschmann, and G. Pearthree, "EarthCube: A community-driven organization for geoscience cyberinfrastructure," Geological Society of America Annual Meeting, Vancouver, Canada, October 22, 2014.

Allison, M.L., "NRRC DSS update," WRP GIS Committee webinar, December 1, 2015.

Allison, M.L., "Geoscience Cyberinfrastructure: EarthCube and beyond," University of Arizona Colloquium Talk Civil Engineering Department Graduate Seminar, Tucson, AZ, December 4, 2014.

Allison, M.L., "Union AGU-EGU great debate: open data policies questions," American Geophysical Union Fall Meeting, San Francisco, CA, December 15, 2014.

Allison, M.L., et al., "E-Infrastructure and data management for global change research" American Geophysical Union Fall Meeting, San Francisco, CA, December 16, 2014.

Allison, M.L., S.M. Richard, and K. Patten, "Geoscience Information Network (USGIN): Solutions for interoperable open data access requirements," American Geophysical Union Fall Meeting, San Francisco, CA, December 17, 2014.

Allison, M.L, "Belmont Forum e-infrastructure for global change research," The Federation of Earth Science Information Partners Winter Meeting, Washington, DC, January 8, 2015.

Allison, M.L., "Data management resources for geothermal energy," Formulation of an East African Geothermal Code of Practice Workshop, Entebbe, Uganda, February 12, 2015.

Allison, M.L., "AZGS update," American Institute of Professional Geologists Arizona Section Annual Business Meeting, Tucson, AZ, February 14, 2015.

Allison, M.L., "Mine locally for renewable energy," Asarco's Avalon Solar Project Ribbon Cutting Ceremony, Sahuarita, AZ, February 27, 2015.

Allison, M.L., "Coordinating international data interoperability efforts," Birds of a Feather Session, Research Data Alliance 5th Plenary Meeting, San Diego, CA, March 9, 2015.

Allison, M.L., "How can science and technology contribute to sustainable development," e-infrastructure Contributing to Sustainable Development Symposium, Tokyo, Japan, April 8, 2015.

Allison, M.L., "EarthCube," e-infrastructure Contributing to Sustainable Development Symposium, Tokyo, Japan, April 8, 2015.

Allison, M.L., "Open access to geoscience data for exploration and assessment," World Geothermal Congress, Melbourne, Australia, April 24, 2015.

Allison, M.L., "The Digicene: the age of big data in the geosciences," National Research Council Board on Earth Science and Resources, Program on Earth Data Science in the Era of Big Data and Computing, Washington, DC, April 29, 2015.

Allison, M.L., "EarthCube Test Governance: results and recommendations," EarthCube All Hands Meeting, Arlington, VA, May 28, 2015.

Allison, M.L., "Breccia pipe Uranium resources in northern Arizona," Arizona Mining Alliance Luncheon, Tucson, AZ, June 12, 2015.

Allison, M.L., "Sustainability of state geological survey's," Association of American State Geologists Annual Meeting, Flagstaff, AZ, June 15, 2015.

Anderson, A., M.L. Allison, S.M. Richard, C. Caudill Daugherty, and K. Patten, "National Geothermal Data System: case studies on exploration of potential geothermal sites through distributed data sharing," Geothermal Energy Association Annual Conference & Expo, Portland, OR, September 30, 2014.

Black, R., "EarthCube: It's place and purpose," American Meteorological Society Annual Meeting, Phoenix, AZ, January 8, 2015.

Brown, C., and M.L. Allison, "Arizona Geological Survey mining site—leveraging 100 years of mining reports, maps, and photographs for the next 100 years," Geological Society of America Annual Meeting,

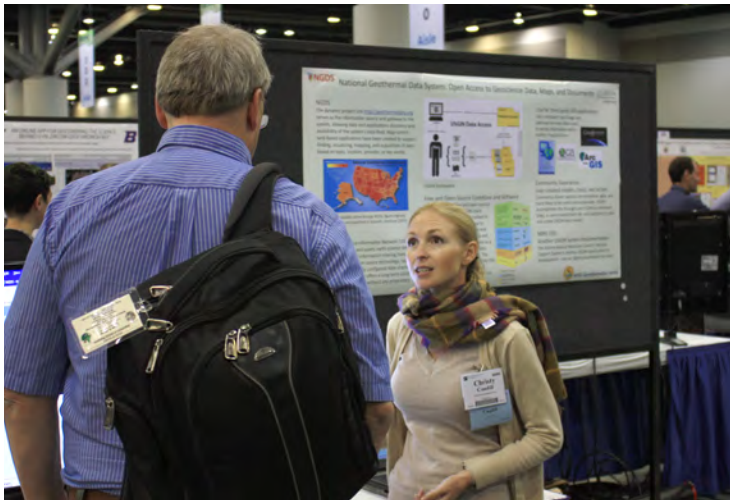
Vancouver, Canada, October 21, 2014.

Caudill, C., S.M. Richard, L. Musil, A. Sonnenschein, and J. Good, J., "National Geothermal Data System" open access to geoscience data and digital technologies," Geological Society of America Annual Meeting, Vancouver, Canada, October 20, 2014.

Caudill, C., S.M. Richard, L. Musil, A. Sonnenschein, and J. Good, "National Geothermal Data System" open access to geoscience data, maps and documents," American Geophysical Union Fall Meeting, San Francisco, CA, December 16, 2014.

Claiborne, L., S. McDowell, C. Miller, N.P. Lang, C. Ferguson, J. Xribb, and A. Covery, "Prelude to a super volcano: REU investigations in the Miocene volcanic field of the southern Black Mountains, Arizona," 2014 GSA Annual Meeting, Vancouver, BC Canada, October 19, 2014.

Claiborne, L., S. McDowell, C. Miller, N.P. Lang, C. Ferguson, J. Xribb, and A. Covery, "Investigation of a pre-super eruption ignimbrite: Petology of the Miocene Cook Canyon Tuff, Black Mountains, Arizona," Geological Society of America Annual Meeting, Vancouver, Canada, October 19, 2014.



Christy Caudill at GSA.

Conway, M., "Online resources for gold prospecting and mining archaeology in Arizona," Tucson Gold Prospecting Group, Tucson, AZ, July 16, 2014.

Conway, M., "The San Bernardino Valley: land of fire," Southwest Wings Festival, Sierra Vista, AZ, August 2, 2014.

Conway, M., "Shake, Rattle and Roll—recent seismic activity in Arizona and the great Arizona ShakeOut," Annual Meeting of Arizona Emergency Services, Tempe, AZ, August 20, 2014.

Conway, M., "Building an online STEM broadcasting network," 2014 American Institute of Professional Geologists & Arizona Hydrological Society National Conference, Prescott, AZ, September 16, 2014.

Conway, M., J.P. Cook, and P.A. Pearthree, "Earth fissures in Arizona outreach and education program to alert stakeholders," Association of Environmental and Engineering Geologists 57th Annual Meeting, Scottsdale, Arizona, September 26, 2014.

Conway, M., "Origin and distribution of Earth fissures in Cochise County," Sunsites Community Center, Sunsites, AZ, October 13, 2014.

Conway, M., "Geology of the Tucson basin," Colossal Cave Sunday in the Park Series, Tucson, AZ, November 2, 2014.

Conway, M., "Does Arizona need to prepare for earthquakes?" Structural Engineers Association of Arizona, University of Arizona, Tucson, AZ, November 19, 2014.

Conway, M., "Why is Cochise County cracking up?" University of Arizona Cooperative Extension Program, Cochise College, Sierra Vista, AZ, January 10, 2015.

Conway, M., "Rock, Rattle and Roll: Historical earthquakes in Arizona," Desert Botanical Garden, Phoenix, AZ, January 22, 2015.

Conway, M., "Yuma: Ringside seat to earthquakes of the North American-pacific Plate Boundary, Earthquake threat to Arizona business," Earthquake 2015 Business Preparedness Summit, Yuma, AZ, March 26, 2015. Conway, M. & N. Niemuth, "Arizona Earth science consortium," Arizona Mineral Symposium, Phoenix, AZ, March 27, 2015.

Conway, M., "Arizona Gold—A brief history of gold mining in Arizona," Gold Prospectors of America meeting, Tucson, AZ, April 15, 2015.

Conway, M., "Gold in Arizona," Directors Unlimited, Tucson, AZ, May 27, 2015.

Cook, Joe, "Importance and impacts of earth fissures in Arizona and the Arizona Geological Survey Earth Fissure Mapping Program," Association of Environmental and Engineering Geologists – Arizona Section, Tucson, AZ, July 30, 2014.

Cook, J.P. and M. Mahan, "Importance and impacts of Earth fissures in Arizona and the Arizona Geological Survey Earth Fissure Mapping Program," Association of Environmental and Engineering Geologists 57th Annual Meeting, Scottsdale, Arizona, September 26, 2014.

Gootee, Brian, "De-wrinkling the fabric: Northern Arizona's structural geology," 2015 Guide Training Seminar, Grand Canyon National Park, AZ, February 7, 2015.

Gootee, Brian, "De-wrinkling the fabric: geologic structures of Northern Arizona," Central Arizona Geology Club Meeting, Prescott, AZ, May 12, 2015.

Gurney, R., and M.L. Allison, "E-infrastructure and data management for global change research," Geological Society of America Annual Meeting, Vancouver, Canada, October 21, 2014.

Harrison, M., M. Komac, T. Duffy, F. Robida, and M.L. Allison, "OneGeology: providing global open access to geoscience data," American Geophysical Union Fall Meeting, San Francisco, CA, December 15, 2014.

Katz, A. and B. Caron, "EarthCube: A community-driven organization for geoscience cyberinfrastructure," The Federation of Earth Science Information Partners Winter Meeting, Washington, DC, January 6, 2015.

Kretschmann, K., "EarthCube demonstration governance," National Science Foundation—sponsored EarthCube workshop for Space Weather community, Newark, NJ, August 12, 2014.

Kretschmann, K., "EarthCube: Community-driven Cyberinfrastructure for the Geosciences", EarthCube End User Workshop: Science-driven cyberinfrastructure needs in solar-terrestrial research, New Jersey Institute of Technology, Newark, NJ, August 14, 2014.

Niemuth, N., "Arizona Copper mining and Pinal County projects," Roadrunner Prospectors Association, Phoenix, AZ, July 17, 2014.

Niemuth, N., "Industrial minerals/economic geology," 2014 American Institute of Professional Geologists/Arizona Hydrology Society National Conference, Prescott, AZ, September 16, 2014.

Patten, K. and M.L. Allison, "EarthCube: A community organization for geoscience cyberinfrastructure," American Geophysical Union Fall Meeting, San Francisco, CA, December 18, 2014.

Pearthree, P.A., and A. Youberg, "Wildfires, debris flows and erosion: Implications for debris-flow recurrence intervals in Southern Arizona," Association of Environmental and Engineering Geologists 57th Annual Meeting, Scottsdale, Arizona, Sept 26, 2014.

Pearthree, P.A., "Water influx, sediment supply and changing base level: Implications for the early Pliocene development of the lower Colorado River," Geosciences Colloquium, University of Arizona, Tucson, AZ, November 13, 2014.

Pearthree, P.A., "Particularly hazardous Quaternary faults in Arizona," United States Geological Survey Intermountain West Fault Workshop, Salt Lake City, UT, January 2015.

Richard, S.M., "Information exchanges and interoperability architecture" The Foundation for Earth Science Information Partners Summer Meeting, Frisco, CO, July 9, 2014.

Richard, S.M., "EarthCube architecture," Breakout session, The Foundation for Earth Science Information Partners Winter Meeting, Washington, DC, January 7, 2015.

Richard, S.M., S. Diggs, and G. Percival, "EarthCube: Seeking community convergence on geoscience cyberinfrastructure architecture," Geological Society of America, Vancouver, Canada, October 21, 2014.

Richard, S.M., "Design on community resource inventories as a component of scalable Earth science infrastructure: experience the EarthCube CINERGI Project," American Geophysical Union Fall Meeting, San Francisco, CA, December 16, 2014.

Richard, S.M., "A 4D framework to organize our knowledge of crustal properties," American Geophysical Union Fall Meeting, San Francisco, CA, December 17, 2014.

Richard, S.M., "The community-driven Big CZ software system for integration and analysis of bio- and geoscience date in the critical zone," American Geophysical Union Fall Meeting, San Francisco, CA, December 18, 2014.

Spencer, J.E., "Paleoproterozoic Tectonic Evolution of the Chino Valley Area: Insights from new geologic mapping," Central Arizona Geology Club, Prescott, AZ, October 7, 2014.

Spencer, J.E., "The Plicene Bouse formation and initiation of the modern Colorado River," Arizona State University School of Earth & Space Exploration Colloquium Series, Tempe, AZ, April 1, 2015.

Youberg, A.M., "Managing landscapes after fires- debris flows and flood hazards," Preparing for wildfires: Moving from crisis to opportunity Tucson Fire Workshop, Tucson, AZ, March 11, 2015.

Young, J., "Northern Arizona earthquakes, monitoring efforts and shaking –potential," Flagstaff City Hall, Flagstaff, AZ, March 5, 2015.

Young, J., "Arizona Earthquakes and Faults," AZGS Phoenix Office Brown Bag Luncheon Series, Phoenix, AZ, February 25, 2015.

Arizona Mining Review Broadcast, https://www.youtube.com/user/azgsweb

Lee Allison, host, Arizona Mining Review, online video magazine broadcast July 30, 2014.

Lee Allison, host, Arizona Mining Review online video magazine broadcast August 27, 2014.

Lee Allison, host, Arizona Mining Review online video magazine broadcast September 24, 2014.

Lee Allison, host, Arizona Mining Review online video magazine broadcast October 5, 2014.

Lee Allison, host, Arizona Mining Review online video magazine broadcast November 26, 2014.

Lee Allison, host, Arizona Mining Review online video magazine broadcast December 31, 2014.

Lee Allison, host, Arizona Mining Review online video magazine broadcast January 28, 2015.

Lee Allison, host, Arizona Mining Review online video magazine broadcast February 26, 2015.

Lee Allison, host, Arizona Mining Review online video magazine broadcast March 25, 2015.

Lee Allison, host, Arizona Mining Review online video magazine broadcast April 29, 2015.

Lee Allison, host, Arizona Mining Review online video magazine broadcast May 27, 2015.

Stephanie Mar preparing to broadcast the AMR.

Conference Booths

National Geothermal Data System exhibit booth, National Geothermal Summit, Reno, Nevada, August 5–6, 2014.

National Geothermal Data System exhibit booth, Arizona Geographic Information Council Annual Convention, Prescott, Arizona, September 3–4, 2014.

National Geothermal Data System exhibit booth, Geothermal Energy Association, Geothermal Energy Expo, Portland, Oregon, September 28–October 1, 2014.

National Geothermal Data System exhibit booth, Geological Society of American Annual Meeting, Vancouver, Canada, October 20–22, 2014.

EarthCube exhibit booth, Geological Society of America Annual Meeting, Vancouver, Canada, October 20–22, 2014.

EarthCube exhibit booth, American Geophysical Union Fall Meeting, San Francisco, California, December 15–18, 2014.

National Geothermal Data System exhibit booth, American Geophysical Union Fall Meeting, San Francisco, California, December 15–18, 2014.

EarthCube exhibit booth, American Meteorological Society Annual Meeting, Phoenix, Arizona, January 5–8, 2014.

Field Trips

Ranney, W. and Pearthree, P.A., 2014, "Field Trip: Grand Canyon—Geologic tour of central and northern Arizona," Association of Environmental and Engineering Geologists 57th Annual Meeting, Scottsdale, Arizona, September 20–22, 2014.

Youberg, A.M.. and Pearthree, P., 2014, "Debris Flows Shape the Sabino Canyon Landscape—Look Out Below!" Arizona Geological Society Field trip, Tucson, AZ, November 15, 2014.

Workshops & Town Halls

Allison, M.L. and A. Katz, EarthCube Town Hall, ESIP Summer Meeting, Frisco, CO, July 10, 2014.

Allison M.L. and G. Pearthree, Belmont Forum e-Infrastructure workshop and Steering Committee meeting, Paris, France, August 18–22, 2014.

Allison, M. L., Belmont Forum Town Hall, Research Data Alliance 4th Plenary, Amsterdam, Netherlands, September 23, 2014.

Allison, M.L., EarthCube Town Hall Meeting, Geological Society of America Annual Meeting, Vancouver, Canada, October 21, 2014.

Allison, M.L. and G. Pearthree, Belmont Forum Secretariat Meeting, San Francisco, CA, December 13–14, 2014.

Allison, M.L & R. Gurney, Townhall: e-infrastructure and Data Management for Global Change Research, American Geophysical Union Fall Meeting, San Francisco, CA, December 17, 2014.

Allison, M.L, R. Black & A. Katz, Townhall: EarthCube: Community Governed Cyberinfrastructure for the Geosciences, American Geophysical Union Fall Meeting, San Francisco, CA, December 17, 2014.

Allison, M.L. and G. Pearthree, US Delegation Belmont Forum e-Infrastructure and Data Management workshop, Tucson, AZ, March 17–18, 2014.

Allison, M.L. and G. Pearthree, Belmont Forum Steering Committee Meeting, Tokyo Japan, April 9–11, 2015.

AZGS hosts the Association of American State Geologists Annual Meeting, Flagstaff, AZ, June 13–18, 2015.

EarthCube Team, EarthCube Science Standing Committee: First Virtual Meeting, September 2, 2014

EarthCube Team, EarthCube Engagement Team: First Virtual Meeting, September 3, 2014

EarthCube Team, EarthCube Liaison Team: First Virtual Meeting, September 4, 2014

EarthCube Team, EarthCube Technology and Architecture Standing Committee: First Virtual Meeting, September 4, 2014

EarthCube Team, EarthCube Check and Adjust Meeting, Tucson, AZ, January 27–28, 2015.

EarthCube Team, EarthCube Scope & Vision Workshop, Berkeley, CA, March 25–26, 2015

EarthCube Team, EarthCube Tech Hands Meeting, La Jolla, CA, April 8–10, 2015.

EarthCube Team, EarthCube Tech Feasibility workshop, Berkeley, CA, April 23–24, 2015.

EarthCube Team, EarthCube All Hands Meeting, Arlington, A, May 27–29, 2015.

EarthCube Team, EarthCube Architecture Workshop, La Jolla, CA, June 19–20, 2015.

Steve Richard speaking to an EarthCube crowd.

Katz, Anna, EarthCube Council of Data Facilities workshop, Federation for Science Information Partners Winter Meeting, Washington, DC, January 9, 2015.

Kretschmann, K., EarthCube Demonstration Governance, National Science Foundation sponsored EarthCube Workshop for Space Weather community, Newark, NJ, August 12–14, 2014.

Richard, S.M., GeoSciML Working Group, Tucson, AZ, June 29–July 4, 2014.

Richard, S.M., The USGIN Open Access Model for Data Sharing, One Geology South American Workshop, Rio de Janeiro, Brazil, October 24, 2014.

Media (TV & Radio)

Conway, M., "Earth fissures in south-central Arizona," discussion on the Chris Dowling Show, 1420 AM KTAN, Cherry Creek Radio, Sierra Vista, AZ, March 19, 2015.

Conway, M., "Earth fissures in south-central Arizona," discussion on the Profiles in Community with Chris Fowling, 96.1FM KBRP, Bisbee, AZ, March 19, 2015.

Conway, M., "Landslides in Arizona- statewide inventory and hazard assessment program," Skype interview with KPNX-12News, Phoenix, AZ, March 25, 2015.

Conway, M., "Geologic Mapping in Arizona," discussion on KJZZ radio, Phoenix, AZ, April 15, 2015.

Young, J., "Kachina Village aftershocks," phone interview with KNXV-Channel 15 Phoenix News, Phoenix, AZ, May 5, 2015.

News Media (print)

7/2/14 "The great Arizona-Sonoran earthquake of 1887" *Arizona Daily Independent*
7/9/14 "Aftershocks continue to follow Duncan quake" *KVOA Tucson Arizon*a
7/9/14 "No injuries, major damage reported in wake of quake" *Eastern Arizona Courier*
7/11/14 "Earthquake rattles Arizona community" *Camp Verde Bugle*
7/12/14 "Quake aftershock hit near Arizona-New Mexico line" *KTAR News, Phoenix Arizona*
7/18/14 "Earthquake Aftermath" *Eastern Arizona Courier*
7/23/14 "Geothermal Industry Grows, with help from oil and gas drilling" *New York Times*
8/12/14 "EarthCube seeking members for standing committees and teams" *Eos* (vol. 95, No. 32)
9/4/14 "NJIT Features: Towards a new solar cyberinfrastructure" *New Jersey Institute of Technology*
9/20/14 "Rosemont owner drilling to confirm earlier copper estimates" *Arizona Daily Star*
9/22/14 "Arizona Geological Survey: mapping Arizona" *The Arizona Republic*
10/11/14 "Fissures a hot topic in Cochise County" Eastern Arizona Courier
11/10/14 "Is oil drilling productive in Arizona?" *The Arizona Republic*
11/15/14 "Arizona Geological Survey Fieldtrips" *Arizona Geological Survey Newsletter*
12/1/14 "Sedona, Flagstaff areas rocked by earthquakes" *CBS 5- KPHO*
12/1/14 "Arizona Geological Survey: 10 aftershocks recorded after 4.7" *ABC 15 Phoenix Arizona*
12/1/14 "Magnitude-4.7 earthquake near Arizona tourist town of Sedona rattles residents; no injuries" *Star Tribune*
12/1/14 "Quake rattles northern Arizona" *CBS News*
12/1/14 "Earthquake in Sedona, Flagstaff: 4.7-magnitude Arizona quake felt by 1,000 people" *The Latino Post*
12/1/14 "M 4.7 earthquake rocks Sedona-Flagstaff" *The Verde Independent*
12/2/14 "Moderate earthquake shakes northern Arizona" *KFYI News Talk radio, Phoenix Arizona*
11/30/14 "Tuesday update: November 30 Oak Creek Canyon Earthquake" Earthly musings Wayne Ranney's geology blog
12/2/14 "Sedona Flagstaff areas rocked by earthquake" *KPTV-FOX 12, Phoenix Arizona*
12/3/14 "Magnitude- 4.7 earthquake rattles Arizona residence" *SFGate*
1/12/15 "Rosie on the house: Make sure your Arizona home is on solid ground" *Casa Grande Dispatch*
1/14/15 "Is your Arizona home on solid ground?" *The Arizona Republic*
1/25/15 "Opponents say mine threatens Patagonia drinking water" *Arizona Daily Star*
1/29/15 "Will we soon be mining the moon?" Arizona Public Media
2/2/15 "Avra Valley Earth fissures ongoing hazard, geologist warns" *Arizona Public Media/PBS/npr*
2/8/15 "Mine tales: nonmetals a valuable resources in northern Arizona" *Arizona Daily Star*
2/15/15 "No filter: all that glitters, dig it at Sparkle Mountain" *St. George News*
2/17/15 "Senate panel passes bill to reopen Arizona Mining and Mineral Museum" *The Arizona Republic*
3/5/15 "Arizona Senate approve bill to reopen mining museum" *Arizona Capitol Times*
3/21/15 "More layoffs feared even if copper price holds steady" *Arizona Daily Star*
3/24/15 "Arizona Geological Survey launches 2-year effort to inventory landslide sites, assess hazard: *The Republic*
3/25/15 "House Committee breathes life into mining museum" *The Arizona Republic*
3/25/15 "New landslide study aims to make Arizona safer" *The Arizona Republic*
3/25/15 "Arizona Geological Survey to inventory landslides in Arizona" *Arizona Daily Independent*
3/25/15 "Legislature passes bill to reopen Mining and Mineral Museum" *ABC 15, Phoenix Arizona*
3/26/15 "Bill would reopen mining museum, but budget problems remain" *Arizona Capitol Times*
4/10/15 "Governor Doug Ducey vetoes bill to reinstate Mining Museum" *Arizona Daily Star*
4/15/15 "U-Pick farms map: online agritourism map features 37 farms throughout Arizona" *Phoenix New Times*
4/20/15 "Arizona Geological Survey looking for gold and preventing landslides" *91.5 KJZZ, Phoenix, AZ*
4/23/15 "Our readers' views: Taking issue with an editorial" *Sierra Vista Herald*
4/27/15 "Geology buffs vow to bring mining museum despite Governor's veto" *Phoenix News Times*
5/6/15 "Kachina Village area gets hit with another quake" *Arizona Daily Sun*
5/22/15 "Murky future for shut Arizona Mining and Mineral Museum" *The Arizona Republic*
5/25/15 "Arizona Geological Survey to inventory landslides in Arizona" *Arizona Daily Independent*
5/25/15 "New landslide study aims to make Arizona safer" *The Arizona Republic*

Awards and Honors

Geothermal Resources Council, Best Presentation Award, Geothermal Resource Council Annual Meeting 2012: "A Geothermal Data System for Exploration and Development"
Phil Pearthree was elected as a Geological Society of America Fellow in July, 2014

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