



Arizona Geological Society Newsletter

MAY 2019

May 7th, 2019 DINNER MEETING

Who: Mac Canby is the featured speaker. See abstract below.

Where: Sheraton Tucson Hotel and Suites, 5151 East Grant Road, (at the intersection of Grant and Rosemont on the North side of Grant in the **SABINO BALLROOM** (enter at northwest corner of the building) and go upstairs to the meeting room.

When: Cash Bar at 6 p.m.—Dinner at 7 p.m.—Talk at 8 p.m.

Cost: Members \$30, Guests \$33, Students Members free with online reservation (\$10 without).

RESERVATIONS ARE REQUIRED: Reserve on the AGS website (<http://www.arizonageologicalsoc.org/events>) by 11 am on Friday, May 3rd. Please indicate Regular (Grilled Chicken Breast with Sun-Dried Tomato Thyme Cream Sauce), Vegetarian (Stuffed Bell Pepper), or Salad (Cobb Salad) meal preference. Please cancel by **Friday, May 3rd at 11 am** if you are unable to attend - no shows and late cancellations will be invoiced.

The May dinner meeting is sponsored by:



ABSTRACT

Bootprints in Bear Country: Discovery History and Geology of the Malmyzh Cu-Au porphyry cluster, Khabarovsk krai, Russia

by Mac Canby, Senior President of Exploration for Freeport-McMoRan

Continued on Page 2

Malmyzh is a district-scale cluster of porphyry Cu-Au deposits located in Khabarovsk krai, eastern Russia. The district contains >5Mt Cu and >9Moz Au in a grass-roots discovery made in late 2008 by Freeport/Phelps Dodge Exploration. Porphyry affinity and significant potential of the district was initially recognized by Russian geologists working for Phelps Dodge Exploration in 2005, with initial drill discovery made in the winter of 2008-2009, when four of seven initial holes intersected ore-grade Cu-Au mineralization. Previously known as a non-economic placer gold occurrence, 1970s Soviet prospecting at Malmyzh identified low-grade vein/veinlet Au occurrences, considered at the time as the source of the widespread, low-grade, fine-grained alluvial gold. Porphyry copper potential, including possible supergene enrichment, was recognized by the Soviet exploration teams, but was never investigated. The district's placers were explored by many shallow drill holes but no deep drilling to investigate hard rock metal potential was ever done.

The four deposits containing resources and ten additional mineralized centers so far identified at Malmyzh comprise typical porphyry Cu-Au stockwork and disseminated zones associated with quartz diorite to granodiorite porphyries and intrusion breccias that intrude a relatively monotonous sequence of hornfelsed, fine-grained, thinly-bedded siliceous clastic rocks. Mineralization occurs in both intrusions and the surrounding stockworked sediments. Centrally-located quartz-magnetite-biotite+K-feldspar alteration is variably overprinted and surrounded by phyllic alteration. The geometry of the deposits ranges from shallow bowl-like shapes with low stripping ratio (Valley), to steeply-dipping pipes (Central, Flats, Freedom NW prospect) or northeast-elongated higher-grade zones (Freedom) within surrounding low-grade halos. Mineralization at the ABV prospect appears to be a partial annulus, developed around a large but barren magnetic high. Intramineral brecciation of earlier porphyry mineralization is widespread in the Freedom Northwest prospect, which has returned long well-mineralized intercepts but is not yet included in the announced resource base. Saprolitic weathering and supergene leaching of Cu, likely augmented by the widespread quartz-sericite-pyrite alteration which surrounds and locally overprints the deposits, resulted in subdued surface Cu geochemistry, and generated thin supergene enriched profiles (tens of meters) with grades locally of >1% Cu. Small, late-stage intermediate-sulfidation quartz-pyrite+carbonate Au-Ag-polymetallic veins occur locally both within and around the deposits. Advanced argillic alteration is notably absent, except for small linear zones identified in the Bikha area. The deposits contain simple Cu mineralogy consisting of hypogene chalcopyrite and minor bornite, and limited supergene chalcocite, appear metallurgically straightforward, and so far lack any significant deleterious elements. Au:Cu ratios (gram : percent basis) range from ~1:4 (Central) to ~3:4 (Freedom).

Phelps Dodge Exploration acquired the initial 20-year exploration and mining license in 2005, and as a result of the 2008-09 financial crisis and a strategic shift away from Russia after acquisition by Freeport in 2007, entered a JV with Fortress Minerals (subsequently IG Copper) in 2009. IG Copper and its various partners, most notably Eurasian Minerals (now EMX Royalty), advanced the project through license expansion, drilling and other work leading to an initial NI 43-101 compliant resource of 1.661Bt at 0.34% Cu and 0.17g/t Au in 2015. A corresponding, non-compliant, Russian GKZ (state reserves committee) C1+C2 resource contains 1.261Bt at 0.41% Cu and 0.22g/t Au. As operator, IG Copper and partners accomplished several outstanding community and operational achievements in Russia, including Explorer of the Year award (Minex, 2015), nominations of its key personnel with business and geologic awards, and finally in July 2016, receipt of Strategic Industries Law (SIL) approval, allowing 100% foreign ownership and development of a major 'strategic deposit.' IG Copper's in-house geologic, drilling, modelling and operational teams accomplished remarkably cost-effective and safe exploration programs at Malmyzh. This, and continuing exploration success, established credibility and an excellent working relationship with Russian regulatory, business community and other local stakeholders - all at a time when international relations were disintegrating as a result of events in Ukraine. The latter ultimately led Freeport to divest of its interest completely by late 2018.

Phelps Dodge's regional porphyry search started in ~2003, following a previous successful regional Russian gold program that discovered the Svetloye high-sulfidation Au deposit in Khabarovsk krai. Keys to success in identifying a potentially-economic deposit at Malmyzh were: 1) training key Russian geologists on

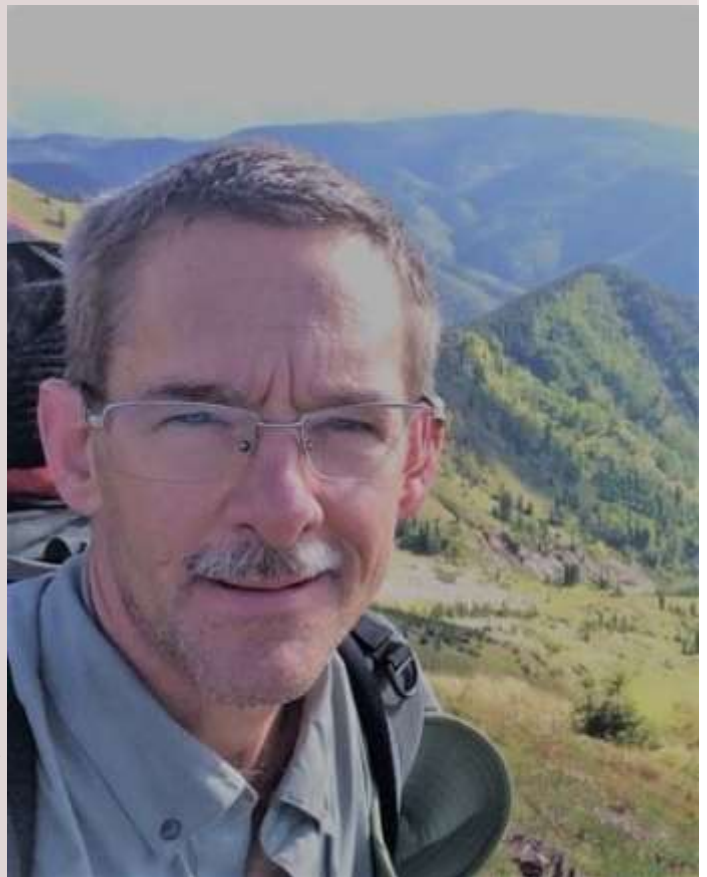
the empirical characteristics of porphyry deposits, in particular the field- and literature-appearance of leached caps in historic Soviet geologic literature; 2) restricting target search to areas within 100 km of a road, railroad, navigable river or coastline; 3) ignoring geologic preconceptions of the region as a ‘tin province,’ lacking ability to host major copper deposits, and: 4) funding a multi-year effort of prospect exams. Of five targets eventually acquired in the region, two weakly-mineralized targets were drilled prior to the Malmyzh discovery, and two additional weakly-mineralized/barren porphyry targets drilled in parallel. Malmyzh was the third target drilled in the program. The prospect has a distinct Cu-Au geochemical signature, unlike the Cu-Mo affinity of three of the other prospects acquired. Initial field visits identified leached, stockwork-veined, but geochemically barren qtz-sericite-pyrite altered sediments in a small quarry excavated for road metal. Later field work identified two small (<30m diameter) areas of float with quartz-magnetite veined rock containing traces of copper oxides, but in general float was disproportionately represented by more durable but barren qtz-sericite-iron oxide leached cap, and boulders of mostly unaltered late-stage hornblende diorite. These observations somewhat downgraded the project’s perceived prospectivity and internal ranking, until the initial drilling confirmed the existence, potential scale, and grade of porphyry Cu-Au mineralization.

Key prospect-scale target-definition criteria, ranked roughly by effectiveness, were soil geochemistry, ground magnetics, and float rock-chip mapping and geochemistry. Individual deposits at Malmyzh show a wide range of responses, making target prioritization only partly effective: the largest deposit, with largest sub-cropping ‘footprint’ (Valley), had one of the less impressive geochemical and magnetic responses, delaying its discovery until the second phase of drilling.

This talk will focus on the discovery history, general geology, and exploration characteristics of the Malmyzh deposits.

ABOUT THE SPEAKER

Vertrees M. “Mac” Canby is currently Senior President Exploration for Freeport-McMoRan, based in Phoenix, AZ. He has worked for Freeport and Phelps Dodge (acquired by Freeport in 2007) in various exploration positions since 1987, starting in the Great Basin and western United States, central and South America, and more recently Eurasia and Africa. Mr. Canby received his B.Sc. degree in Geological Engineering from New Mexico Institute of Mining and Technology in 1987, and M.Sc. in Geology from University of Nevada/Reno in 1992. He and his team members have participated in copper and gold deposit discoveries in Asia, Europe, and the Americas. Mac is a Fellow and former Vice President/Europe of the Society of Economic Geology, a Fellow of the London Geological Society, and a member of the Colorado Scientific Society, the Geological Society of Nevada, and the Denver Regional Explorationist’s Society. He and team members received Discovery Medals of the Russian Federation for the Svetloye high-sulfidation Au deposit and Malmyzh Cu-Au deposits, and the 2016 Thayer Lindsley PDAC award for the Cukaru Peki copper-gold discovery in Serbia. He and his family currently reside in Denver, Colorado, USA.



Society Announcements



We regret to announce that long-time AGS member Keith Richard Long passed away on March 29 in Tucson from complications related to colon cancer. Keith grew up in Santa Clara, California. He completed his M.S. in Geoscience at University of Michigan (1984), and his Ph.D. in Mineral Economics at The University of Arizona (1988).

Keith joined the U.S. Geological Survey in Tucson in 1988, to work in the Center for Inter-American Mineral Resource Investigations where he participated in cooperative studies in Central and South America, especially Mexico and Bolivia. Keith devoted his career to studying mineral resources and specializing in the economic aspects of mineral resource assessment. Focus of his research in recent years included work on the economics of porphyry copper deposits, economic filters for evaluating mineral deposits, the environmental aspects of historical mine tailings, and characterization of rare earth element deposits and significant metal deposits of the U.S. He wrote more than 100 publications ranging from country-specific studies of the mineral resources of Bolivia and the United States to work identifying and classifying abandoned mines in California (upcoming). Keith also published an English-Spanish dictionary of mining and geologic terms. He ended his career as a Research Specialist in rare earth minerals. His memorial service was held on April 14.

Society Announcements

Arizona Geological Society's Topical Session for Geological Society of America Conference 2019 Accepted



The Arizona Geological Society's GSA Topical Session, “Porphyry Copper and Related Mineral Deposits of Arizona, the Basin and Range Province, and Beyond,” has been accepted for the GSA Annual Meeting in Phoenix, Arizona – 2019. Members are encouraged to submit abstracts and register for this Topical Session.

- GSA Topical Sessions are listed here:
<https://community.geosociety.org/gsa2019/learn/technical/topical>
- The Abstract deadline for Topical Sessions is June 25th, 2019.
- Additional information about the event can be found at:
http://www.geosociety.org/GSA/Events/Annual_Meeting/GSA/Events/2019info.aspx

Society Announcements

Additional Events of Interest



On **September 25-27, 2019**, Arizona Hydrological Society will hold its Annual Symposium at Casino del Sol in Tucson on Sept 25-27, 2019. This annual event will feature a plenary session, over 50 talks, poster sessions, workshops, social events, and more! To learn more about this event, visit AHS 32nd Annual Symposium web page below:

<https://www.ahssymposium.org/2019/>

ML 3.6 Earthquake near Duncan/Safford in southeastern Arizona

By Arizona Geology e-Magazine, Arizona Geological Survey (AZGS)

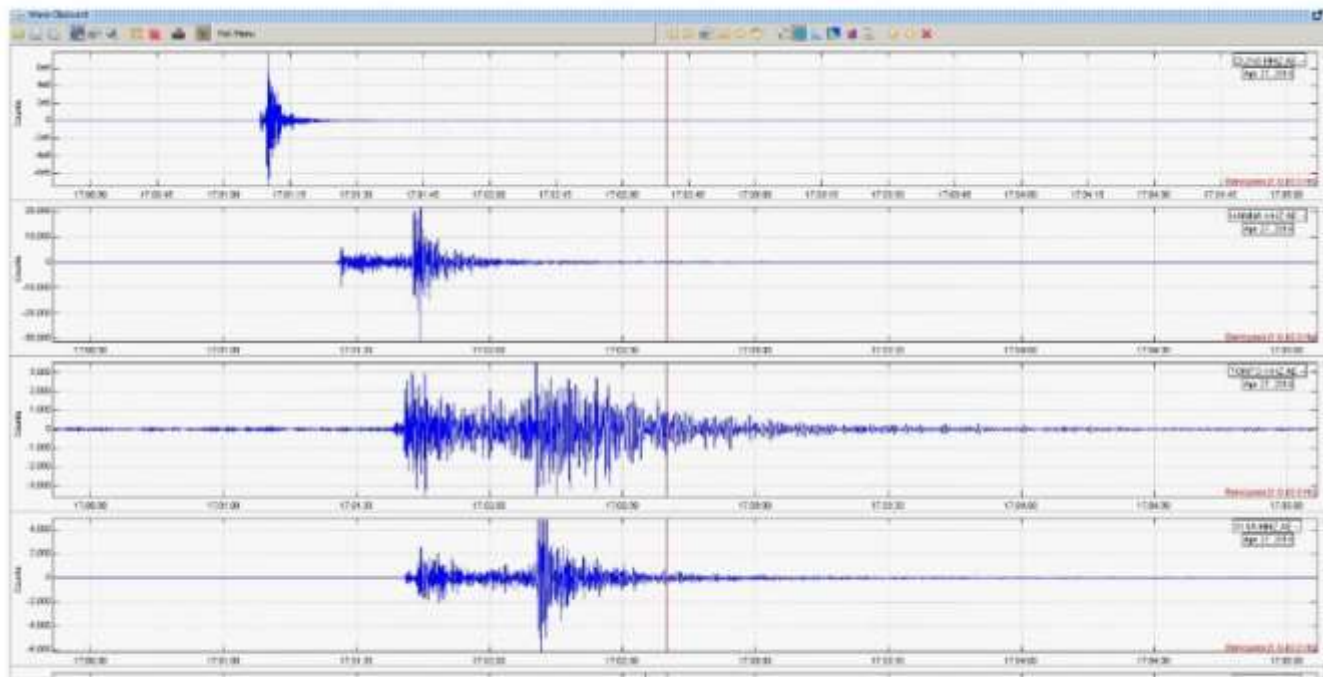


Figure 2. Seismograms from four AZGS broadband seismic stations.

At 10:01 a.m. on 27 April 2019, Duncan, Arizona and environs were rocked by an ML 3.6 earthquake. AZGS Research Geoscientist J.Y. Ben-Horin filed this preliminary report.

Preliminary Report: The Duncan/Safford area near the northern Peloncillo Mountains of southeastern Arizona experienced a sequence of relatively shallow earthquakes, with the largest being an ML 3.6 (ML – local magnitude) at 10:01 am MST on 27 Apr 2019. Local reports note moderate to light shaking (courtesy of USGS's 'Did you feel it'). There were no reports of injuries or damage.

By mid-afternoon on 27 April, there were at least two additional measurable quakes that were located just south of the ML 3.6, Md 2.4 at 11:46 a.m. and Md 2.0 (Md – duration of shaking) at 11:55 a.m. MST. In addition, there were 10 smaller quakes that range in size, but are generally below Md2.0. The depth to the focus (rupture point) of the earthquake was less than 5km, which is considered shallow.

Seismometers of the AZGS' Arizona Broadband Seismic Network recorded the events (Figure 2).

Warning - Residents and civil authorities of Greenlee County and environs; it's likely that small magnitude aftershocks will occur in the Duncan area for days or weeks. Most will probably go unfelt. A larger magnitude event could still occur. In the event of severe ground shaking, residents

are advised to “Drop, Cover and Hold on” (Conway and Young, 2012).

There are a number of Quaternary faults in southeastern Arizona and the area has experienced historic earthquakes. (The Quaternary Period extends from 2.58 Mya to the present.)

2014 – 2015. At approximately 10 pm on June 28th, 2014, a magnitude 5.2 earthquake rocked Duncan, AZ, (Figure 3). Ground shaking was strong and caused great consternation in the Duncan area. The event was felt throughout southeastern Arizona, including Tucson and Phoenix (Young and Pearthree, 2014; Allison, 2014). The earthquake focus originated at a depth of ~ 7 km (4.4 miles); there were no signs of ground rupture or fissuring.

Minor damage was reported in Duncan and Safford; cracks in concrete structures and at least one home foundation, several manufactured homes were knocked off their foundations, and glassware flew out of cupboards. This was the largest earthquake to occur in southeastern Arizona and southwestern New Mexico in 75 years.

The main event was followed by nearly two dozen smaller magnitude but felt aftershocks (Figure 3). The last felt aftershock occurred more than one year after the 28 June 2014 main event. In total, hundreds of aftershocks were recorded; the vast majority were less than 2.0 M and were not felt. AZGS research scientist J.Y. Ben-Horin deployed six temporary seismic stations to monitor aftershocks.

2010 - 2012. In May 2010 and October 2012, small microseismic swarms, with individual events ranging from M2.0 to M4.1, occurred about 45 miles north-northeast of Duncan, in the Morenci-Clifton area of northern Greenlee County.

1938 - 1939. An earthquake sequence along the New Mexico – Arizona border region included an M 5.5 earthquake (9/7/1938) and three M 4.5 aftershocks; the final large aftershocks occurred more than 9 months after the main event. Seismic instrumentation in the United States was sparse, so the earthquakes are likely not located accurately and the record of aftershocks is incomplete.

1887. The largest historical earthquake in the southeastern Arizona – southwestern New Mexico – northern Mexico region was the M 7.5M event in May 1887 on the Pitaycachi fault of northern Sonora, Mexico, about 25 miles south of Douglas, Arizona. The ground surface was ruptured for nearly 60 miles (100 km) producing a fault scarp with a maximum relief of 4 m (12 ft). It was felt throughout northern Mexico – more than 50 people were killed as buildings collapsed – and the Arizona Territory. This is considered the largest magnitude earthquake likely to occur in the southeastern Basin and Range Province.

Read original blog article here:

<https://blog.azgs.arizona.edu/blog/2019-04/ml-36-earthquake-near-duncansafford-southeastern-arizona>

Please contact the AGS Secretary if your company is interested in advertising in this monthly newsletter.

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

Freeport-McMoRan has sponsored student dinners for the 2018-2019 AGS monthly meetings.



AGS MEMBERSHIP APPLICATION OR RENEWAL FORM

YOU CAN RENEW OR SIGN UP as a new member and pay online. Please go to our website, arizonageologicalsoc.org. Or use the form below if you are more comfortable with the old school approach.

Please mail check with membership form to: Arizona Geological Society, PO Box 40952, Tucson, AZ 85717

Dues (check box) 1 year: \$35; full-time student (membership is free)

NEW MEMBER or RENEWAL? (circle one) Date of submittal _____

Name: _____ Position: _____

Company: _____

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Work Phone: _____ Home Phone: _____

Fax Number: _____ Cellular Phone: _____

E-mail: _____ Check this box if you do not have an email address

All newsletters will be sent by email. If you do not have an email address, we will mail a hard copy to you, but we cannot guarantee timeliness.

If registered geologist/engineer, indicate registration number and State: _____

Enclosed is a _____ tax-deductible contribution to the J. Harold Courtright or the M. Lee Allison Scholarship Funds.