



Arizona Geological Society Newsletter

NOVEMBER 2014

November 4, 2014 DINNER MEETING

Who: Isabel Fay Barton will speak about; “Historical Development and Current Status of Geological Research in the Central African Copperbelt”.

Where: Sheraton Phoenix Airport Hotel, 1600 South 52nd Street, Tempe Arizona 85281.

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

Cost: Members \$27, Guests \$30, Students Members free with online reservation (\$10 without).

RESERVATIONS ARE REQUIRED: CALL (520) 663-5295 or reserve on the AGS website (www.arizonageologicalsoc.org) by 7 a.m. by Thursday, October 30th. Please indicate regular (Chicken Breast) or vegetarian meal preference. Please cancel by Thursday, October 30th at 7 a.m. if you are unable to attend—no shows and late cancellations will be invoiced.

CAR POOLING — Contact info of attendees, who have made reservations for the November dinner will be made available to those signed up for this meeting. This will enable you to make your own car pooling arrangements.

The November dinner meeting is sponsored by Skyline Assayers & Laboratories



AGS is grateful for Skyline Assayers and Laboratories' sponsorship, which helps us to offset dinner meeting costs

Abstract

Historical Development and Current State of Geological Research in the Central African Copperbelt

by

Isabel Fay Barton

The Central African Copperbelt of northern Zambia and southern Democratic Republic of Congo contains nearly half of the world's cobalt resource and a significant fraction of its copper in Neoproterozoic sedimentary rocks. The Congolese people mined, smelted, and traded copper from exposed oxide deposits starting around the 6th century A.D., but the Western world only found out about the resource in 1892 through the

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travelogue of the Belgian explorer and geologist, Jules Cornet. Geological research and economic exploitation have continued in the region since then. This presentation offers an overview of the history and present state of geological research in the Copperbelt.

The Copperbelt host rocks are the Katangan Sequence, Neoproterozoic sedimentary rocks dominated by siliciclastics in Zambia and carbonates in the Congo. By the 1930s geologists recognized the Zambian and Congolese strata as part of the same system, but the first complete regional lithostratigraphic correlation between the two sides was only published in 1994. The facies interpretation had changed by then: in the early 1900s geologists thought the Katangan rocks were continental sediments, but the discovery of large-scale crossbeds, ripple marks, and mudcracks in the 1960s converted most geologists to belief in their nearshore-marine deposition. The recognition in the 1980s of relict evaporites throughout the Congolese and Zambian sides of the Copperbelt deepened the (interpreted) waters, and the Katangan strata are now generally accepted as the sediments of a restricted basin in an arid environment. However, their current mineralogical makeup is almost as much a result of alteration as of depositional facies: multiple pervasive episodes of hydrothermal alteration, recognized as early as 1914, modified the host rock mineralogy and introduced large volumes of Cu-Co and Cu-Fe sulfides. The details of the alteration mineralogy vary between deposits, and no one has yet presented a Copperbelt-wide study of alteration.

It was obvious to the earliest Copperbelt geologists that the Katangan strata had been tectonically deformed. By the 1910s they had sorted the various structure types and orientations into categories corresponding to multiple episodes of folding, and by the 1930s the standard interpretation was that the Copperbelt rocks had been deformed by three different orogenies. Dating and other work in the late twentieth century has reduced this number to one, though modern geologists still sometimes subdivide this Lufilian orogeny (ca. 570-510 Ma) into two or three distinct episodes of deformation. Radiometric dating during the 1980s and afterward has shown that some of the alteration minerals, including some of the stratiform and all of the vein-hosted ores, formed during the Lufilian orogeny. The orogeny is interpreted as responsible for forming the vein- and breccia-hosted Pb-Zn-Cu-Au-Ag-U-REE-(PGE) deposits common in the upper Katangan stratigraphy. Its relationship to the stratiform Cu-Co deposits in the basal Katangan strata is much less clear and is one of the many subjects of historical and present debate in Copperbelt literature, with various authors attributing none, some, or all of the stratiform ores to hydrothermal fluid flow accompanying the Lufilian orogeny. The relationship of stratiform to vein-hosted deposits is likewise in dispute. It has been discussed since the 1930s, remains unclear today, and probably will not be settled until the metallogenesis of the stratiform deposits is established.

The metallogenesis of the stratiform Cu-Co ores is the most contentious issue in Copperbelt geology and has been for a century. Most of the earliest metallogenic concepts were magmatic-hydrothermal, though Waldemar Lindgren dissented in favor of an amagmatic, epigenetic model in 1911. Subsequent hypotheses shifted from amagmatic (1910s) back to magmatic-hydrothermal (1930s-1950s), then to syngenetic (1950s-1960s), then to diagenetic (1970s and thereafter). Modern ideas vary but are generally diagenetic or epigenetic, and many of them invoke multiple stages of mineralization. The number of these varies between one and five depending on the geologist, and estimates of the timing of mineralization ranges from nearly syngenetic (ca. 850 Ma) to late- or post-Lufilian (ca. 500 Ma). Every possible source has been suggested for the metals: meteorites, mafic intrusions, basement porphyry deposits, redbeds, and many others.

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Copperbelt geology has made great progress, but this and many other questions remain to be solved. But, as illustrated by the current consensus on amagmatic post-depositional metallogenesis of the stratiform deposits, a century of research and technological advancement has at least enabled the scholarly community of 2014 to reach the interpretation of Copperbelt mineralization that Lindgren formed in 1911.

About the November Speaker

Isabel wanted to be a geologist at age 11, but was growing up on the Gulf Coast of Florida at the time, which made it difficult to find a rock, let alone a field site. So she headed for Norman, Oklahoma to get her B.S. in geology. There she took a sedimentology class from Lynn Soreghan, who suggested she apply to the University of Arizona for grad school.

Isabel came to Arizona with two goals: to get an M.S. and then to get into industry. Six years later, her record at achieving those goals is a bit uneven: she has a Ph.D., but she still hasn't left academia for industry. Instead, she has settled into a research and teaching position in applied mineralogy and geometallurgy with the University of Arizona's Lowell Institute for Mineral Resources.

Isabel has worked closely with Freeport-McMoRan, who sponsored her dissertation on the Tenke-Fungurume project. She continues to collaborate with Freeport and other mining companies on projects ranging from a study of historical mining in Central Europe to developing a geometallurgy program at the U of A, to continuing research on the geology of the Central African Copperbelt, which is the topic of tonight's presentation.

Isabel is a member of the AGS and SEG and a member of the AGS Executive Committee. In her free time she enjoys reading to expand her knowledge of geology, history, and philosophy.

Donations to the Arizona Geological Society

Donations to the AGS are used to fund the Courtright and AGS Scholarship programs. The Arizona Geological Society is grateful for the generosity of the following individuals, whose contributions will help students achieve their professional goals.

Jonathan Boswell	Scott Donaldson	James Hayes	Alison Jones
David Briggs	John Driskill	Cori Hoag	Sean Keel
Mike Conway	Stanley Evans	Kevin Horstman	Alexander G. Schauss
Jeff Cornoyer	Dennis Hall	Lily Jackson	Bruce Walker

When did You become a Member of the Arizona Geological Society?

The AGS is attempting to update its database. Data on the years that many of our members joined is incomplete. For those who became members prior to January 1, 2010, please send the approximate date that you joined the AGS to David Briggs at geomineinfo@aol.com.

Arizona Geological Society Fieldtrip – Fall 2014
Debris flows shape the Sabino Canyon landscape – look out below!
Ann Youberg and Phil Pearthree
Arizona Geological Survey – Environmental Geology Section

Saturday, November 15, 2014

In July, 2006, southern Arizona experienced a rare five day series of storms generated from monsoonal moisture mixing with a persistent low-pressure system centered over northwestern New Mexico. These increasingly wet storms culminated on July 31, 2006, with floods of record levels occurred on several larger drainages, and triggered numerous debris flows in the Santa Catalina Mountains and elsewhere in southeastern Arizona mountain ranges. Over 500 failures occurred on steep slopes in the Santa Catalina Mountains alone. These slope failures coalesced into large debris flows in five canyons along the range front. These debris flows did a remarkable amount of geomorphic



work in a very short time, eroding hill slopes and channels and transporting very coarse sediment that garden-variety 100-year floods likely will not move. On this field trip to Sabino Canyon, we will consider the mechanisms responsible for triggering debris flows, the damage they can do, how frequently they may occur, and the importance of these extreme events in shaping the mountain landscapes of Arizona.

Numerous debris flows occurred in Sabino Canyon, and damage to U.S. Forest Service facilities there was extensive. The tram road was blocked by debris in at least 6 different places, the bridge across Rattlesnake Creek was plugged by boulders and the approach was washed away, and facilities at tram stops 8 and 9 were nearly obliterated. The canyon was temporarily closed due to road damage, and millions of dollars were spent to rebuild the tram road and related facilities. Although the road and facilities were repaired by the end of 2008, there is still plenty of evidence of the impact of the 2006 debris flows on the landscape and human structures and infrastructure. We plan to



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use the Sabino Canyon Shuttle to access several sites where large debris flows impacted the road or facilities. We will make short excursions away from the road to investigate relatively undisturbed debris flow deposits.

Debris flows are slurries of sediment and water that move rapidly down channels. Sediment in debris flows are typically very poorly sorted, ranging from clay-size particles to very large boulders if they are available. The finer particles, clay, silt and sand, form a dense matrix that can support and transport large boulders, making these flows very destructive due to impacts of large transported material or burial of existing infrastructure. Debris flows can be initiated when pore pressures in soils on steep slopes reach a threshold and fail, often due to intense or prolonged rainfall. This was the situation in the 2006 debris flows. Alternatively, debris flows can be generated by intense runoff from steep watersheds on slopes that have been denuded by fire. Debris flows have occurred after all of the large wildfires in Arizona that have occurred in the past few decades. As debris flows move downslope they deposit boulder levees that keep the flow confined and moving forward. Debris flows often have a bouldery snout at the front, followed by the main body of liquefied debris, and a tail, or recessional flow, which is a sediment-charged flood. We will see examples of these features at each of our field trip stops. Debris flows commonly terminate where either slopes decrease substantially or lateral confinement decreases, or both. In the case of the large debris flows in the Catalinas, they either terminated along larger, more gently sloping channels (as we will see in Sabino Creek) or where the channels leave the mountains and lateral confinement diminishes (for example, Solder Creek where the Catalina Highway begins its ascent into the mountains).

Logistics:

- Day / Date Saturday, November 15, 2014
- Time Start - 8:30 a.m. for 9:00 a.m. End - 12:30 p.m.
- Location 5900 N. Sabino Canyon Rd, Catalina Foothills, AZ
 Meet at the Sabino Canyon Visitor Center patio;
- Expenses \$5.00 parking / \$8.00 Tram ticket
- Field trip guidebooks will be provided to trip participants.
- Bring water, snack, and appropriate footwear for moderate hiking – most of our walking is on the tram road.
- Return via the tram or down the Telephone Line Trail, about a 3-mile walk.

Field trip: We'll catch the 9:00 a.m. tram and take it to Rattlesnake Wash. Here and elsewhere along the tram road, we'll investigate debris flow deposits that formed in 2006. The final stops will be at the top or NE end of the Tram Road, elevation approximately 3,300 feet.

Announcement from the Institute for Mineral Resources

Dave Lowell has written a book, which the UA Press has just published. It's available at <http://www.uapress.arizona.edu/Books/bid2494.htm> and in the UA bookstore, where the IMR is planning a book signing on Nov. 7.

The Lacy Lecture is also Nov. 7, at 5 PM in Aries Auditorium (College of Law, at the corner of Speedway and Mountain). The speaker is Goldcorp CEO Charles Jeannes. Everyone is welcome to attend.

Arizona Geological Survey News Brief



[Arizona Mining Review](#) e-Video Magazine – 29 October 2014

Guests to be announced! The October episode will be broadcast at 10:00 am MST on LiveStream (<http://new.livestream.com/accounts/2496466/azminingreview>). Immediately thereafter, it will be available on our [AZGS YouTube Channel](#) , along with episodes from January 2013 through Sept. 2014.

AZGS on Social Media

You can find the latest in Arizona geology, mining or AZGS news at our social media outlets.

- FACEBOOK –Arizona Geological Survey <https://www.facebook.com/AZ.Geological.Survey>
- TWITTER – AZ Geological Survey <https://twitter.com/AZGeology>
- BLOG – Lee Allison’s Arizona Geology Blog <http://arizonageology.blogspot.com/>

New Publications from the Arizona Geological Survey

Niemuth, N., 2014, Arizona Major Mines Map 2014. Arizona Geological Survey Map #38.

New Releases at AZGS Mine Data (<http://minedata.azgs.az.gov/>)

Guy Atlee photo collection. Guy Atlee lived and worked in the Kingman area at Mineral Park and other mines near Chloride, Cerbat, and Kingman. <http://minedata.azgs.az.gov/photo/store-ga51>

Frederick Warren Osborn photo collection. Frederick Osborn photographed mines, miners, machinery, and buildings in the area of Ajo, Arizona in the early 1900s. <http://minedata.azgs.az.gov/photo/people-truck-cul-24>

Richinbar Mine photo collection. The photos in this collection were taken by Carlton Wheeler who received his degree in geology at University of Oklahoma after WWI. Most of the photos in this collection were taken between 1933 and 1935. <http://minedata.azgs.az.gov/photo/mine-groups-047r>

John Kinnison Files (243 files). John Kinnison earned his master's in geology from the University of Arizona in 1958. He spent over twelve years with ASARCO. He was a consultant to the mining industry from 1973 to the early 1980s. He specialized in porphyry copper exploration in the Southwest U.S., but also worked in Mexico, Canada and the Western U.S., exploring base and precious metal veins and replacements, uranium, <http://tinyurl.com/kc5rd94>

AZGS at GSA 2014

The Arizona Geological Survey sent a cohort of staff led by AZGS Director Lee Allison to the Geological Society of America's annual meeting in Vancouver, BC, Canada. Staff engaged in oral and poster presentations, hosted two exhibit booths (EarthCube and USGIN) and lead two town halls (Belmont Forum and EarthCube).

AZGS at Geological Society of America 2014, Vancouver, Canada (19 – 22 Oct.)

Allison, M. Lee, Patten, Kim, Black, Rachael, Katz, Anna, Kretschmann, and Pearthree, Genevieve, "EarthCube: A Community-Driven Organization for Geoscience Cyberinfrastructure," Geological Society of America Annual Meeting, Vancouver, Canada, October 22, 2014 [poster]

Allison, M. Lee, Stephen M. Richard, and Kim Patten, "Providing Free and Open Source Access to Geoscience Data Worldwide," Geological Society of America Annual Meeting, Vancouver, Canada, October 21, 2014 [oral]

Gurney, Robert, M. Lee Allison, "E-infrastructure and Data Management for Global Change Research," Geological Society of America Annual Meeting, Vancouver, Canada, October 21, 2014 [oral]

Brown, C. and M. Lee 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 [oral].

Caudill C., Richard, S.M., Musil, L., Sonnenschein A. and 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 [poster]

Komac, Marko, Duffy, Tim, Robida, Francois, and Allison, M. Lee, "OneGeology: Providing Global Open Access to Geoscience Data," Geological Society of America Annual Meeting, Vancouver, Canada, October 21, 2014 [oral]

Richard, S.M., Diggs, S., and Percivall, G., EarthCube: Seeking Community Convergence on Geoscience Cyberinfrastructure Architecture, Geological Society of America Annual Meeting, Vancouver, Canada, October 21, 2014 [oral]

Exhibits | Events (GSA Annual Meeting 2014)

Belmont Forum Town Hall, Geological Society of America Annual Meeting, Vancouver, Canada, October 21, 2014.

EarthCube Town Hall, Geological Society of America Annual Meeting, Vancouver, Canada, October 22, 2014.

USGIN Booth 1050, Geological Society of America Annual Meeting, Vancouver, Canada, October 20-22, 2014.

EarthCube Booth 1210, Geological Society of America Annual Meeting, Vancouver, Canada, October 20 - 22, 2014.

ANNOUNCEMENTS

Welcome New AGS Members

Ursula Basinger	Eduardo Garcia	Steve Lacy	Thomas Luckie	Kristy Roberts
Austin Brown	Miles Hearn	Matthew J. Lambiotte	Arend Meijer	Mary Stollenwerk
Rob Carruth	David Hogan	Taylor Lane	Jo Miles	Brittany Trubl
Mike DeYoung	Thanh Huynh	Samantha Lesar	Nari Miller	Gary Trubl
Mark Edwards	Robert Kendrick	Norman Leslie	Mark Murphy	Rachel Tsong
Erik Fleming	Emily Kleber	Steven Lingrey	Tiana Rasmussen	Jonathan Weisiger

Arizona Geological Society is grateful to Freeport-McMoRan Copper and Gold for their generous support of our student members!



Freeport-McMoRan is sponsoring student dinners for the 2014 AGS monthly meetings.

2014 AGS MEMBERSHIP APPLICATION OR RENEWAL FORM

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

Dues (check box) 1 year: \$20; 2 years, \$35; 3 years: \$50; full-time student (membership is free)

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

Name: _____ Position: _____

Company: _____

Mailing Address: _____

Street: _____ City: _____ State: _____ Zip Code: _____

Work Phone: _____ Home Phone: _____

Fax Number: _____ Cellular Phone: _____

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

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

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

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