Arizona Geological Society Newsletter

ARIZONA GEOLOGICAL SOCIETY, INC., TUCSON, AZ APRIL 2010

April 6, 2010 DINNER MEETING

Rachelle Wagner will speak on *Miocene Fault and Basin Analysis along the Boulevard and Dry Wash Faults, Northern Frenchman Mountain, Lake Mead Domain, Nevada*

Sheraton Four Points, Wild Cat Room: 1900 E. Speedway Blvd. in Tucson (Speedway Blvd. at Campbell Ave.).
Cash Bar at 6 pm, Dinner at 7 pm, Talk at 8 pm.
Cost: With reservation, members $24, guests $27, Students $10. Without reservation, $3 additional.
RESERVATIONS: CALL 520.663.5295 by 5 p.m. on April 2, 2010. Indicate low-salt, vegetarian, or vegan meal preferences. A coffee/salad/roll/dessert option is also available for $18.

ABSTRACT

Miocene Fault and Basin Analysis along the Boulevard and Dry Wash Faults, Northern Frenchman Mountain, Lake Mead Domain, Nevada

WAGNER, RACHELLE R., Northern Arizona University, Flagstaff, AZ

The Frenchman Mountain block is located in the western portion of the Lake Mead domain in southern Nevada. The block translated to its current location during the Miocene epoch through the interaction of the left-lateral Lake Mead fault system, the right-lateral Las Vegas Valley shear zone, and associated detachment and normal faults. The Paleozoic and Mesozoic units of the Frenchman Mountain block correlate across the Lake Mead domain to the SW Colorado Plateau. Previous studies have modeled how and when the Frenchman Mountain block translated to the west from an origin near or on the Gold Butte block, with most agreeing that east tilting occurred during the later stages of translation during deposition of the upper Horse Spring Formation and red sandstone.

This study focused on the lower Horse Spring Formation near the left-lateral Dry Wash and Boulevard faults. The exhumation history of the Gold Butte block in eastern Lake Mead domain, which forms the footwall of the major South Virgin-White Hills detachment fault will be presented. The Gold Butte block megabreccia deposits in the study area were most likely deposited when the Frenchman Mountain block was adjacent to, or on top of, the Gold Butte block during the early to peak stages of detachment faulting from 17-14 Ma.

This study has shown that the Dry Wash and Boulevard faults are oblique, left-lateral, strike-slip faults with 1.7 to 3.1 km offset. Three new Ar ages were obtained from the Rainbow Gardens (18.41 Ma) and Thumb Members (15.30 and 14.53 Ma). Map and facies relationships show that the Thumb Member deposits were faulted locally during deposition at ~16 Ma, with increased fault activity throughout the Thumb Member after 14.53 and before 8 Ma. A focused analysis of structures in the Frenchman Mountain block results in a new model of progressive clockwise rotation and faulting along the eastern Las Vegas Valley shear zone that for the first time honors paleomagnetic results and accounts for all major faulting south of the shear zone. Most of this complex faulting occurred from ~13.5 to 8 Ma.

Rachelle Wagner received the 2008 J. Harold Courtright Scholarship to help fund this research. The scholarship fund, set up by the AGS in 1986 and funded largely by AGS members, is designed to promote graduate research in all geology fields with special emphasis on field geology, economic geology, and the study of ore deposits. Students at the University of Arizona, Arizona State University, and Northern Arizona University are eligible to apply.

April Member Spotlight—Ann Pattison

Ann Pattison has traveled the world as a geological consultant to the mining industry. She is a past president (2007) of AGS and currently sits on the Executive Board. Ann attended University of Arizona for her Bachelor's degree in geology, and she received her Master's Degree from University of Texas at El Paso. She lives in Tucson.

When did you first become interested in geology? My aunt and uncle were both geologists, and since they were fun, it always seemed to me that geology should also be fun. Of course, I could never really figure out what was so neat about rocks until I took my first geology class at the U of A. The professor of that first 'Geology 1A' class was a politically outspoken grad student by the name of Doug Shakel.

What was your first job? My father paid my brother and me one cent for each sticker weed we pulled (but only if we got the roots). Shortly after my 16th birthday, I got a job in the kitchen at Caruso's Restaurant on Fourth Ave. Three generations of the Zagona family members worked there and the job had a wonderful family atmosphere. The restaurant is still there and is still run by the same family.

What was your first job as a geologist? My first full time job as a degreed geologist was as a field assistant sitting RC rigs at Summitville for Anaconda. Despite the state-of-the-art sampling being carried out, the job's best education was in how NOT to run a field program and morale got pretty low after a couple of management incidents, but what a fantastic location for a first 'real' job!

What is your most memorable field experience? There are so many memories, and I've worked in some very spectacular places. Fear tends to etch some images a little deeper, so I'll pick my experience riding a mule in the Andes. I'm pretty sure I had never ridden on the back of an animal before I got onto that mule. We were trying to reach an interesting strongly altered zone high up in the range but we were barred by a couple of deeply incised canyons. The slope was covered by loose cobbles, and my mule preferred a thin strip at the edge of the precipice where there were no rocks. I was terrified of the mule slipping and sending us both over the edge (at least 15-20 feet to the first bounce). Unfortunately, it was an Argentine mule that didn't speak English, so he ignored my pleas and insisted upon walking along the cliff. Yikes! On the way back down, I made certain that the mule didn't even see that strip.

What do you consider your greatest professional achievement? Years ago, I was running a drill program at one of the mines in central Arizona, and Peter Kirwin was reviewing older work to develop new ideas for exploration. From the beginning of the project, I had been puzzled by the discrepancy between the local descriptions of the Whitetail Fm. and what I was seeing in the core. Finally, a pushback exposed some of the Whitetail in the mine. As it happened, AGS had recently run a Field Trip through the region which included a stop at the Carlota project. I noted that the 'Whitetail' we were looking at was a dead ringer for the Cactus Breccia, and Peter agreed. Over the next few months, as we reviewed the previous data, we became convinced that two of the deposits in the mine were landslide breccias similar to the Cactus Breccia. The theory is significant because it implies a strongly uplifted highland with a large ore body (now eroded away) that could have been the source of other landslides now hidden by a cover of Gila Conglomerate and Tertiary Volcanics.

What do you consider your greatest achievement EVER? I hope I have not yet encountered my greatest achievement EVER. I am proud that as graduate school at UTEP, I established their first symposium, which I patterned after the Geoscience Daze I had experienced at the U of A. It continues to this day. I just attended the 24th Annual University of Texas at El Paso Geological Sciences Colloquium! It's grown from the one-day affair to a three-day event with a volume of abstracts, a collection of judges from industry and academia (to determine which students are awarded the several thousand dollars of prize money), a keynote speaker, and a field trip.

What are your hobbies? Gardening: I'm converting my front yard to Tucson Basin natives and growing vegetables in my back yard.

Water, whiskey, or wine? I'm an equal opportunity imbiber.

Thanks, Ann!

Do you know someone who would be an interesting subject for a "Member Spotlight" column? Email his/her name and contact information to ajones@clearcreekassociates.com.

Announcements

The 2010 **Arizona Hydrological Society Symposium** will be held September 1-4 at the Westin La Paloma in Tucson, Arizona. The theme is Dryland Hydrology: Global Challenges / Local Solutions. More information at http://azhydrosoc.org.

ABSTRACTS are due April 16! Check the website for more information.

WANTED: Loan or donation of a scannable copy of ***AGS DIGEST 1***. AGS is compiling an electronic archive of all AGS publications. If you have a copy of *AGS DIGEST 1* in your library, please notify Kevin Horstman (520.742.1083) who is leading up the archiving project. The first responder to this request will receive a FREE meal at a dinner meeting.

REMINDER to ALL MEMBERS: Send in your annual AGS dues using the form on the back page of this newsletter! If you have not paid for 2010, you are overdue! If you receive a hard copy of the AGS newsletter, the year of your membership expiration is noted on the corner of the address label.

WELCOME NEW AGS MEMBER: *Anthony Williams,* self-described "sole proprietor and diligent investor". Thanks for joining, Anthony!

Upcoming AGS Dinner Meeting Speakers

May 4, 2010: Dick Tosdal, *Thayer Lindsey Lecturer for 2009*

Topic: Tectonic transitions between porphyry and epithermal ore deposits.

June 1, 2010: Alex Iriondo

Topic: New ideas on the distribution of Paleoproterozoic provinces in NW Mexico: Possible basement influence on subsequent geological events in SW North America.

Experts Reaffirm Asteroid Impact Caused Mass Extinction

AUSTIN, Texas, March 4, 2010—Responding to challenges to the hypothesis that an asteroid impact caused a mass extinction on Earth 65 million years ago, a panel of 41 scientists re-analyzed data and provided new evidence, concluding that an impact in Mexico was indeed the cause of the mass extinction.

Thirty years ago, Luis Alvarez, Jan Smit and their coworkers suggested a large meteorite slammed into Earth 65 million years ago and caused one of the most severe mass extinctions in Earth's history, ending the age of the dinosaurs. In 1991, a more than 200-kilometer-wide impact crater was discovered in Yucatan, Mexico, that coincided with the extinctions. Since then, the impact hypothesis has gained overwhelming acceptance within the scientific community.

Still in recent years, a few scientists have challenged this hypothesis. To address their claims, a panel of 41 experts from Europe, the U.S., Mexico, Canada and Japan provide new data from the analysis of ocean drilling and continental sites and re-analyze the relevant literature in the field, including the most recent research. The team is not only multinational, but also multidisciplinary, including experts on impact modeling, tsunamis, radioactive dating, geology, paleontology, sedimentology, microbiology, ecology, petrology and geochemistry. In a review paper in the March 5 edition of the journal *Science*, they find that alternative hypotheses are inadequate to explain the abrupt mass extinction and that the impact hypothesis has grown stronger than ever.

The fossil record clearly shows a mass extinction event across the planet at about 65.5 million years ago. Because this change is so dramatic, geologists use it to define the end of the Cretaceous period and the start of the Paleogene period (formerly called the Tertiary period). They refer to the time of the extinctions as the K-Pg boundary.

Some scientists have suggested that the Chicxulub ("chik-shoo-loob") impact in Mexico happened 300,000 years before the K-Pg boundary and therefore, came too early to have been the major cause of extinctions.

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Mass Extinction—continued

They point to deposits at sites around the Gulf of Mexico with a layer of tiny glass-like blobs of melted impact material that, according to their interpretation, was deposited at about 300,000 years before the K-Pg boundary mass extinction. As an alternative, they suggest the Deccan Traps — unusually active volcanoes in what is now India — led to global cooling and acid rain, and were the major cause of mass extinction, not the Chicxulub impact in Mexico.

However, the study's authors find that what appears to be a series of layers neatly laid down over 300,000 years near the impact site were actually violently churned and then dumped in a thick pile in a very short time. Models suggest the impact at Chicxulub was a million times more energetic than the largest nuclear bomb ever tested. An impact of this size would eject material at high velocity around the world, cause earthquakes of magnitude >10, continental shelf collapse, landslides, gravity flows, mass wasting and tsunamis and produce a relatively thick and complex sequence of deposits close to Chicxulub.

"If we are to unravel the sequence of events across the K-Pg boundary, perhaps the last place in the world we should look is close to the Chicxulub impact site, where the sedimentary deposits will be most disturbed," write the authors.

In addition, the authors note, as you go farther from the impact site, these layers become thinner and the amount of ejected material decreases until it becomes one layer that can be found globally exactly at the K-Pg boundary coincident with the mass extinction. Moreover, the ejecta within the global K-Pg layer is compositionally linked to the specific sediments and crystalline rocks at Chicxulub.

The authors find that despite evidence for relatively active volcanism in India, marine and terrestrial ecosystems showed only minor changes within the 500,000 years before the K-Pg boundary. Then, precisely at the boundary, there was an abrupt and major decrease in productivity (a measure of the sheer mass of living things) and species diversity.

The Deccan hypothesis is further weakened by a review of models of atmospheric chemistry. Although significant volumes of sulfur may be emitted during each volcanic eruption and form aerosols in the stratosphere, these sulfur aerosols fall out rapidly and any adverse environmental effects are apparently only short lasting. In comparison, during the Chicxulub impact, much larger volumes of sulfur, dust and soot were released in a much shorter time, leading to extreme environmental perturbations (such as darkening or cooling).

"Combining all available data from different science disciplines led us to conclude that a large asteroid impact 65 million years ago in modern-day Mexico was the major cause of the mass extinctions," says Peter Schulte, assistant professor at the University of Erlangen in Germany and lead author of the review paper.

Artist's rendering of the moment of impact when an enormous space rock struck the Yucatan Peninsula at the end of the Cretaceous Period. Credit: Don Davis, NASA.

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Mass Extinction—continued

Far from Chicxulub, the geologic record clearly shows a single large meteorite hit the Earth exactly at the K-Pg boundary. Thickening of the K-Pg boundary layer towards Chicxulub shows Chicxulub was the impact site. The significant changes in Earth's ecosystems all occur precisely at this boundary and thus, say the authors, a large asteroid impact into the sulfate-rich sediments at Chicxulub remains the most plausible cause for the K-Pg boundary mass extinction.

Several mechanisms have been proposed to explain why the impact was so deadly. In February 2008, Sean Gulick and Gail Christeson, research scientists at The University of Texas at Austin's Institute for Geophysics, and their colleagues published a study in the journal *Nature Geoscience* finding that the asteroid landed in deeper water than previously assumed and therefore released more water vapor and sulfate aerosols into the atmosphere. Gulick, a co-author of the new review paper in *Science*, said this could have made the impact deadlier in two ways: by altering climate (sulfate aerosols in the upper atmosphere can have a cooling effect) and by generating acid rain (water vapor can help to flush the lower atmosphere of sulfate aerosols, causing acid rain). That finding and many others strengthen the case for the impact hypothesis.

CHICXULUB IMPACT QUICK FACTS:

- The asteroid was about 10 kilometers (6 miles) wide. In the UK, the city of Bristol, the Isle of Wight and Jersey are all about that size.
- The asteroid was about 10,000 times more massive than the total mass of the human world population. In other words, the asteroid was about $3x10^{15}$ kilograms (or about $3x10^{12}$ tonnes).
- At impact, the asteroid is estimated to have been traveling at 20 kilometers per second (44,640 miles per hour), roughly 10 times the speed of a rifle bullet.
- The impact released about a billion times more energy than the atomic bombs dropped on Hiroshima and a million times larger than the largest nuclear bomb ever tested.
- The initial impact crater was about 100 kilometers (60 miles) wide and 30 kilometers (18 miles) deep. After the dust cleared, the crater was about 180 kilometers (110 miles) wide and 2 kilometers (1 mile) deep.
- Impacts of this size on Earth are thought to happen on average about once every hundred million years.
- The impact released earthquakes on the order of magnitude 11. That's more than 100 times more powerful than the magnitude 8.8 Chilean earthquake on Feb. 27, 2010.

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Don’t forget to send in your 2010 dues!

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2010 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)

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