

THE VORTEX

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CALIFORNIA SECTION
DECEMBER 2016



Molecular Foundry Building. Lawrence Berkeley Laboratory

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CALIFORNIA SECTION, ACS
JANUARY MEETING

“Can Geochemistry Help Solve our CO₂ Problem?”

Guest Speaker: Greg H. Rau

Senior Research Scientist, Institute of Marine Sciences, Univ. California, Santa Cruz
and Visiting Scientist, Lawrence Livermore and Berkeley National Laboratories

Date: Thursday, January 19, 2017

Time: Reception: 5:30 – 6:00 pm, Talk: 6:00-7:00pm.

Place: USDA, 800 Buchanan St., Albany, CA 94706.

Cost: \$10 for light refreshments to be served from 5:30-6:00pm.

Reservations: Please register for meal or talk only by email, office@calacs.org or 510-351-9922, no later than Monday, January 16, 2017. You may prepay by mailing your check to Cal. Section ACS at 2950 Merced St. #225, San Leandro CA 94577 or with PayPal using our email address office@calacs.org.

Abstract: Because the Earth's surface is primarily composed of alkaline minerals, it is their slow chemical reaction with water and acidic CO₂ to form stable (bi) carbonates that largely dictates global atmospheric CO₂ concentrations on geologic time scales. In contrast, through combustion of fossil fuels and disruptive land use, humans have managed to release CO₂ to the atmosphere and increase its global concentration at a rate that has significantly overridden geochemical and other natural CO₂ control mechanisms. Long-term, deleterious climate change and ocean acidification are the consequences unless

we can drastically reduce our CO₂ emissions or stabilize or reduce atmospheric CO₂ concentrations by other means. To this end, this talk explores various possibilities in industrial or natural settings for enhancing or accelerating the high capacity but otherwise slow geochemical consumption of CO₂ and the storage or beneficial use of the resulting products. Such approaches might help to cost effectively and safely manage global CO₂ on times scales relevant to humans and the biosphere as we also attempt to rapidly transition to a non-fossil-energy economy.

CAL ACS Election Results

Chair-elect: Margareta Sequin

Secretary: Michael Cheng

Director: Wallace Yokoyama

Members-at-Large: Lee Latimer Peter Olds, Linda Wraxall

Councilors and Alternate Councilor: Bryan Balazs, Dan Calef, Don MacLean, Paul Vartanian, Xiaoxi Wei, Elaine Yamaguchi

The proposed change to the Section bylaws passed and has been submitted to National for approval.

THE VORTEX

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California Section Web Site: <http://www.calacs.org>

Chair's Message



This is a terrible time of year. Soft sultry breezes are supplanted with damp, drizzly drops. Our clocks move only in one direction insisting that 2016 morph into 2017 and followed by who knows what. And I have to give

up being Chair of the California Section.

Fortunately there are other perspectives. Jim Postma, the 2017 Chair, travels 3 hours one way from Chico to attend ExCom meetings. You know he will be motivated so that his time is not wasted and the plans and programs of the Section get implemented.

There are also some 1000 or more K-12 children who will in 2017 do chemistry as they did in 2016 at one of the Section's outreach programs like National Chemistry Week and Family Science Night. Alex Madonik, long term coordinator for these programs, will again direct, with his colleagues, the magic act of turning kids into science-loving students.

There is Elaine Yamaguchi, like a zipped file, ready to expand into the new year and extend the horizon of students and members through her work and influence in the Section and through the WCC and Project SEED programs.

Somewhat younger than many ExCom members and that is a really good thing. Co-Chairs of the Younger Chemist Committee, Stephanie Malone and Xiaoxi Wei, will continue providing networking opportunities and technical programs for those young in heart or age.

There is Attila Pavlath, past ACS President and 3 times Chair of the California Section is quietly behind the scenes, well not always so quietly, doing all the hard work to bring another Historic Chemistry Landmark into California and the Bay Area.

We did lose some long term friends of the Section in 2016, in particular Rollie Myers; sadness turned to inspiration from hearing his friends and colleges celebrate his life at the Memorial Service in the Oakland Hills.

Then there is the new slate of Section Officers, as shown on page 2, with some new faces. All without exception have been active volunteers and contributing to Section events.

The old year has been a polarizing and divisive time for our country. We are not likely to change the mind of those with opposing views by logic or loud arguments but we can move forward by lowering the emotional temperature with random acts of kindness, whenever and however we can.

Warmest holiday greetings to you and yours.

Lou Rigali



THE VORTEX

Chemists take advantage of cutting edge nanoscience resources at the Molecular Foundry

Ronald Zuckermann, Ph.D., Sr. Scientist and Facility Director, Biological Nanostructures Facility, Molecular Foundry, Lawrence Berkeley National Laboratory

The Molecular Foundry is an interdisciplinary nanoscience research institute located on the campus of the Lawrence Berkeley National Laboratory (LBNL), supported by the Department of Energy. The Molecular Foundry has a staff of world-class scientists with expertise across a broad range of disciplines and state-of-the-art, often one-of-a-kind, instrumentation. We study the frontiers of fundamental and applied science in the areas of energy, electronics, materials science, and biology.

A unique feature of the Molecular Foundry is that it is a national User Facility, which makes all of its fantastic resources available for use by the scientific community free of charge. Now in its 10th year of operation, we serve a growing number of users (over 774 in FY2016) from all over the world, drawing from industry, government labs and academia. Access to the instrumentation and staff expertise is granted after external peer-review of a short proposal outlining the planned work. The average acceptance rate for these proposals is ~75%, and access is granted for up to one year upon approval.

The Foundry research staff comprises 45 scientific and technical staff that work under an unusual “50/50 model”. This means staff spend 50% of their time working on their own research programs, and the other half of their time training users and assisting and/or collaborating with them on their research. This allows the staff to not only follow their curiosity and develop their own expertise, but also facilitate and advance science in the community. Each user who comes to the Foundry works with an assigned scientist on staff who provides personalized training, scientific input and

help navigating the Lab’s facilities. Together, the Foundry staff and its users have been extremely productive, producing well over 300 publications each year.

Chemists of all types are taking advantage of many of the advanced synthesis, characterization, and computational resources available. The Foundry staff has expertise with wide range of nanomaterials, including synthetic polymers, biomolecular assemblies, biomimetic polymers, inorganic nanocrystals, porous 2D and 3D framework materials, nanocomposites and much more. Additionally there is an extensive suite of microscopy tools; spanning electron, optical and scanning probe microscopy. The Theory facility helps tie all this data together to provide a deeper level of understanding.

As a scientist in the Biological Nanostructures Facility of the Foundry, I have established a research program to create artificial protein-like nanomaterials made from non-natural polymers. We aim to bridge the materials gap between traditional polymers, which are cheap and durable, and folded proteins which can be selective and efficient catalysts, but are not stable. To achieve this, we developed a new class of sequence-defined polymers, called peptoids, which are made by stepwise solid-phase synthesis. Because the building blocks are cheap (primary amines) and can be efficiently coupled together by automated synthesizers to make chains up to 50 monomers in length, we have been able to support a diverse population of users. We built a core facility at the Foundry equipped with automated peptoid synthesizers, HPLCs for their purification and analysis, along with mass spectrometers and a host of bioanalytical instrumentation for their

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characterization. Users of the Foundry have taken advantage of these resources to study a variety of scientific problems, including antimicrobial therapeutics, biomineralization, anti-fouling surfaces, drug-delivery vehicles, supramolecular self-assembly, and polymer physics.

For more information on all the Molecular Foundry has to offer, including information on our User Program, please visit our website at: <http://foundry.lbl.gov>, or feel free to contact me directly at rnzuckermann.lbl.gov. We accept user proposals two times per year, and the next call opens in March of 2017.



Christine Kang (U. Washington) synthesizes a sequence-defined peptoid polymer in the Foundry's automated synthesis facilities.



*Happy Holidays and a Happy New
Year
Best wishes to all this
Holiday Season from the Executive
Committee
and The Vortex Staff*



Only at Oklo?

Part 2

Bill Motzer

In Part 1 (September 2016 Vortex) I described the story behind what was believed to be the world's first self-sustained nuclear chain reaction. This occurred on December 2, 1942, in the world's first nuclear reactor designated as Chicago Pile-1 assembled under supervision of physicist Enrico Fermi. Almost 30 years later, in May 1972, a routine mass spectrometry analysis of uranium hexafluoride (UF_6) showed a discrepancy in the amount of uranium-235 (^{235}U) isotope contained in analyzed samples at the French Pierrelatte Uranium Enrichment Facility. Normally, uranium ore's ^{235}U concentration is 0.7202%, but these samples contained only 0.600%. Concern over this discrepancy resulted in an investigation team led by French physicist Francis Perrin who tracked the depleted uranium's source back to the Oklo Mine, in Gabon, Central Africa (Figure 1). Sampling and analyses of different ores resulted in discovery of the Oklo Fossil Reactors confirming that nature had beaten humans to a sustained nuclear fission reaction by about 1.8 billion years.

Perrin, however, was not the first to suggest and determine this phenomenon and his team was aided in part by a 1953 paper published by geochemist George W. Wetherill, professor of geophysics and geology of the University of California at Los Angeles and physicist Mark G. Ingheim of the University of Chicago. They postulated that some past uranium deposits could have operated as natural analogs of

modern nuclear fission reactors that were then under construction. In 1956, Paul K. Kuroda, a University of Arkansas nuclear chemist, calculated requirements for such a fossil uranium ore body to have initiated and maintained a self-sustaining fission reaction:

(1) The uranium deposit's size should exceed the average length that fission-inducing neutrons travel; this is approximately 0.67 meters, ensuring that neutrons from one fissioning nucleus are absorbed by another before escaping from the uranium layer or seam.

(2) In table A, Kuroda showed that ^{235}U must occur in sufficient abundance for a natural fission reaction to occur.

Today's uranium has only 0.72% ^{235}U , which has a half-life of about 700 million years and ^{238}U has a half-life of about 4.5 billion years. Therefore, ^{235}U decays approximately six times faster than ^{238}U , indicating that the fissile fraction was much higher 1.8 billion years ago. When Oklo's uranium was deposited, ^{235}U constituted about 3%, which is the approximate amount required for artificially enriched uranium used in most nuclear power plants.

(3) A neutron's moderator should be present. This is a substance slowing neutrons emitted when the uranium nucleus splits allowing or inducing other uranium nuclei to split. In the past ordinary water could be such a moderator. For today's reactors, it is possible to sustain a nuclear reaction using a one percent density, but special artificial moderator conditions (i.e., deuterated or heavy water) are required.

(4) Finally, there should be no "poisons"

Table A

| Geological Time (million years before present) | 0 (present) | 700 | 1,000 | 1,400 | 2,100 | 2,800 |
|--|-------------|-----|-------|-------|-------|-------|
| ^{235}U enrichment (percent) | 0.7 | 1.3 | 1.6 | 2.3 | 4.0 | 7.0 |

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(Motzer continued from page 6)

present that would inhibit nuclear fission reactions. These include substances with large neutron-capture cross sections such as naturally occurring boron, lithium, or other neutron absorbers that would rapidly halt nuclear reactions.

The above conditions actually prevailed 1.8 billion years ago in three uranium deposits at 16 separate natural reactor areas within the Oklo and adjacent Okelobondo uranium mines. These reactors ran for a few hundred thousand years, averaging about

100 kW per day of thermal power during their operating time with a total output of perhaps 15,000 MW-yrs. But Oklo is currently the only known location for this phenomenon and older uranium deposits (e.g. 2,800 million years ago) that had higher ^{235}U concentrations (e.g. 7.0%) may exist that could also have been natural reactors. So why have not these been found? The reasons that they have not been discovered lies in the unique circumstances that occurred only at 1.8 billion years in the past and I will explore these in future articles.



Figure 1: Location Map for the Oklo Uranium Deposit in Gabon, Central Africa

Source: <http://palgrave.nature.com/scientificamerican/journal/v293/n5/images/scientificamerican1105-82-12.jpg>

Dr. Dawn Shaughnessy, Speaker at the WCC October Meeting

By Idan Siman-Tov and Jessica Fung

The Women Chemists Committee of the CA Section and California State University East Bay (CSUEB) Department of Chemistry and Biochemistry sponsored this very special talk on Saturday, October 29, 2016 on the CSUEB campus in Hayward, CA. Dr. Shaughnessy, project leader of the Lawrence Livermore National Lab's (LLNL) heavy element program, gave a talk that was both amazing and informative. She made sure her talk was not overly complicated so that a non-chemist major could understand. In fact, young chemists-to-be, such as the 5th grade son of Professor Monika Sommerhalter, our WCC co-sponsor at CSUEB, learned about how target atoms are bombarded with other atoms with the goal of producing one of these new heavy elements through fusing together.

Dr. Shaughnessy talked about her work on super heavy elements and how they are conceived. Dawn explained that once we start getting to these heavier elements their fundamental chemistry changes due to their sheer size; for example, the number of electrons that they can hold seems to be less than expected due to the exterior protons/neutrons blocking the pull of the interior ones. Much of the science that goes into creating one of these new elements focuses on elements that are more stable than the average element. This is due to a "magic number" of protons/neutrons in their shells which configure in such a way that makes them tough to split. This is important for fusing to occur. To create the new elements, scientists first extract ionized $^{48}\text{Ca}^{5+}$, then use a series of figure 8 shaped magnets to speed it up in a particle accelerator. At a specific high speed they shoot them onto a dish of a given target element. The hope is to produce a head-on collision so that the two fuse together to form a new heavier element.

The reason that they use Ca is because most of the time when the collision occurs, the two elements split instead of fuse. By using an element like Ca that is hard to fracture, they increase the likelihood that the two will fuse. It takes an average of 1018 attempts to create just one heavy element

atom; thus, this process can take about 3 months of constant Ca bombardment. One has to be patient! Once detected (radiation energy), these new heavy elements don't persist for a long time; their lifetimes are on the seconds-timeframe. Thus, any chemistry done on the collected atoms is done by inference. There is ample computer work involved in this type of research. Dawn used supercomputers to analyze the creation and decay processes of the new heavy element.

She also talked about some of the politics surrounding heavy element science. Apparently LLNL was partnered with another lab over in Russia during the height of the Cold War. Even then, she explained that the scientists of the two labs concentrated on doing good science. In this branch of chemistry, there is a strong emphasis on proper preparation since the materials used for the experiments are time sensitive and radioactive. You can imagine how difficult it was to ship something radioactive to Russia during the Cold War.

Despite all the hurdles, elements 114-118 have been discovered and independently verified by other scientists' experiments. Now remains the even more difficult process of finding them a suitable name. Once this takes place, students and textbooks all over the world will have a new periodic table.

Unfortunately, it looks like there will be very few new elements that will be discovered in the near future seeing that the next step requires a completely new machine, one that can use a heavier element instead of Ca, and the estimates of building such an instrument seem to be about 20 years down the line.

Note from Elaine Yamaguchi, Co-Chair, WCC of CA Section, ACS: This talk was truly unique for this WCC/CSUEB collaboration. Having the co-discoverer of 5 new elements of the periodic table was the highlight of our 2016 WCC events. Furthermore, this meeting provided an opportunity for two undergraduates from Las Positas College to volunteer and write the minutes of this meeting.



Stephanie Malone, Chair of the CA Section YCC, thought of having this panel on this very important topic. This event brought in about 35 attendees, and some were not ACS members. The panel consisted of young women chemists with children under 10 years of age and more mature women chemists who have grown children. Both single parent families and two parent families were represented. The panel was held at the USDA Lab in Albany, and both the YCC and the WCC are most grateful for the hospitality that this lab has repeatedly given us.

After introducing themselves and addressing questions they were given ahead of time regarding their backgrounds, the panel talked about the following topics.

Balancing Aids For Women Chemists Mothers:

Over the years women chemists had many different aids for childcare: home day care facilities; cooperative nursery schools, like one in Albany, that allows parents to learn from teachers and each other at relatively reasonable rates; flexible work schedules, such as the 9/80 schedule; and parent participation at local community daycare co-ops. Industry vs. Government vs. Academic work environments:

One mature woman chemist, Anne Taylor, had worked in a small college and found it to be quite time consuming; thus, she opted to look for industrial employment with regular hours. Our academic chemists from University of the Pacific lauded the work-life balance present there, emphasizing that if one liked the academic life UOP is a great environment. Trudy Lionel, an industrial chemist, likes working in teams at Bayer. Sarah Throne loves work at the UDASA labs in Albany because of the collaborative atmosphere. Sheila Yeh opted for industry (nearly 30 years at Chevron) because she was concerned about the demands on her family while seeking tenure, if she chose academic life. She found the industrial experience to be very rich in the variety of experiments and collaborators.

Safety Concerns:

This was of great concern during pregnancy. Our women chemists were resourceful and

safe, even working up to 8 months during the pregnancy. They did all reactions in glove boxes, wrote grants, and tried to do a minimum of lab work (computation projects are good). Anne Taylor wrote her organic chemistry Ph.D. thesis while pregnant. Another found that colleagues would help do some experiments that could be reciprocated later, since the colleagues really cared for the newly pregnant chemist. One must always be cognizant of one's environment.

Tricks to Balance one's life:

Do only what is important. Prioritize. You do not need to cook, clean, do yard work, or live in a big house. You don't need to spend 2 hours in commute traffic. Sheila Yeh, a mother of 3 grown children, told of taking 6 weeks off for her first child, having a relative in the house to help, and then realizing she was going to be tired for the next 5 years when her twins were born. Luckily, the Family Leave Act came into being, allowing her to take off 6 months. Yue-Rong Li told of how her first born resulted in a year off, since he was born in China, but the second born girl only had 6 weeks to bond with the mother in the US. Find reliable daycare, sometimes this means having grandparents living in the same house, who must always be thanked for the job they do. In academia these days, the tenure clock is stopped if one gets pregnant. Taking time off from work when the children are young is another option touted by Trudy Lionel. She did this, but continued to volunteer and served as co-Chair of the WCC. Basically, there are many ways to deal with this problem.

Support from Husband:

Some husbands are magnificent in supporting our women chemists, because, when children arrive, the number of things to manage at home is far greater than one can ever imagine. It is a several person job. Husbands may help in various ways: be the primary career chemist, by agreement with the spouse; help at night when children need to be fed, put to bed, etc.; or the husband follows the wife's career. One cannot have it all! Good friends help where there is no spouse.

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Work Satisfaction:

Qin Zhao takes great pride in seeing her students move forward in their careers in both their Master's and Ph.D. level studies, in part due to the good experiences she had in grad school and as a post-doctoral fellow. Miki Park has had a role in teaching 2400 Pharm. D. students. They are now out in the world practicing pharmacy. She also is doing her own research at UOP School of Pharmacy. Qin says taking her children to her office helped propel her ambition, and she was able to report that she had just (within the previous 24 hours) earned tenure in the Department of Chemistry at UOP. She is also the UOP Project SEED Coordinator

and works closely with the CA Section SEED program during the summer.

Challenges ahead:

All women chemists reported various upcoming challenges, regarding their professional and family lives, but it is very clear that this group of women chemists, representing the best that the CA Section YCC and WCC could find, will succeed. Discussions continued during lunch, followed by a wrap-up survey. The survey allowed our YCC and WCC to find new volunteers for upcoming events. However, we invite anyone to contact calacs.org and join us for future planning or events.

E. S. Yamaguchi, Co-Chair WCC CA Section, ACS



Donald Eugene Green 1926 – 2016



Donald Eugene Green
1926 – 2016

With sad regret, we announce the death of Donald Green, father, grandfather, uncle, friend, and a long time member of the California Section of the ACS and AXS. Don passed away peacefully in his sleep on October 1, 2016 in Chico, California after a full and productive life. The youngest of three children of Hungarian parents, Don was born on November 25, 1926 in Napa, California. He lived there until moving to Woodland for high school. His parents owned a series of neighborhood bakeries in several Central Valley towns, where his father became renowned for his unique, award-winning sugar-icing paintings and his genius as a cake decorator.

Don is survived by his immediate family, Dennis Green (San Diego, California) with Melian and Jonathan, their spouses and children, Gretchen and Stefano Bernascon-Green (Oberrieden, Switzerland) with Giuliana and Tian, Mark and Debra Green (Orcutt, California) with Kevin and Kristofer, Gary and Cindy Green (Chico, California) with Alecia, Melissa, Vanessa, Logan, Morgan and Teja, their spouses and children, Sheryl Green (Vallejo, California) with Usha and KittenLittle. More information on Donald's life can be found on the CalACS website, www.calacs.org.

The family welcomes friends and colleges to attend the Memorial Celebration Memorial Celebration on the Cal Berkeley Campus at the Alumni House Saturday December 10th at 5:00pm.

Memorial Contributions can be made to The Margaret Green Memorial Scholarship Fund Scholarship Office, Alumni House, UC Berkeley, 94720.

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