DEPARTMENT OF EARTH & PLANETARY SCIENCE

Alumni Update 2015-2016

University of California, Berkeley

INSIDE THIS UPDATE

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Cover image:
Simulation of a liquid iron-MgO mixture. The brown, green, and red spheres denote Fe, Mg, and O atoms. The grey surfaces show the electron density.
Image by: Burkhard Militzer

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CHAIR'S LETTER:
THE STATE OF THE DEPARTMENT, 2015-2016

Dear Friends and Alumni,

It is my pleasure to write to you as chair of the Berkeley Earth & Planetary Science Department. It is my second year at the helm, and each year it is exhilarating for me to see the range of scientific breakthroughs accomplished by our faculty and students. I invite you to explore this year's Alumni Update, and I hope it piques your interest in the latest research currently taking place at Berkeley.

EPS is recognized as a top department in the country as reflected in recent rankings. As a review, the National Research Council rates us as one of the top two earth science graduate programs in the US; *US News & World Report* ranks EPS as a top three graduate program; the *Chronicle of Higher Education* ranks us as number one in terms of faculty scholarly productivity; and the American Geosciences Institute finds that we produce the second largest number of Earth Science faculty in universities in the US. We are proud to achieve this stature while only being about half the size of similarly ranked departments.

It is bittersweet for me to announce the retirements of Professors Donald DePaolo, Lynn Ingram and Barbara Romanowicz. Over the past 40 years, Don pioneered isotopic approaches to understanding Earth. He served as chair of EPS, 1990-1993; as the director of the Earth Sciences Division, LBNL, 2007-2013; and as associate laboratory director for Energy Sciences, LBNL, 2013-present. Don plans to continue his research and occasionally contribute to teaching, in his recent appointment as Chancellor's Professor, Emeritus. Lynn Ingram came to Berkeley in 1994, working her way up to full professor and was a Miller Professor. Her research interest is paleoclimatic and paleo-environmental reconstruction in aquatic environments and environmentally-sensitive isotopic tracers. In 2013 Lynn published what turned out to be a very timely book for California titled "The West Without Water: What past floods, droughts, and other climatic clues tell us about tomorrow."

In 1991, in the aftermath of the Loma Prieta earthquake, Barbara Romanowicz came to Berkeley as Professor of Geophysics and Director of the Berkeley Seismological Laboratory. She served as director from 1991-2011 and as chair from 2002-2006. With her interest in deep earth structure and planetary seismology, Barbara helped organize the Cooperative Institute for Deep Earth Research Program (CIDER), a workshop that continues until today. Barbara plans to maintain her research group and contribute to teaching and service as Professor of the Graduate School. I want to thank all three for their outstanding contributions to research, teaching and university service, and we all look forward to continued interactions as we know that Berkeley faculty never really retire!

In other news, the department is pleased to welcome Daniel Stolper as assistant professor. Daniel is a geochemist interested in problems related to the rock record and biogeochemical cycles. He was awarded a doctorate in geobiology from Caltech and then an NOAA Climate & Global Change Postdoctoral Fellowship. We are very grateful to the Heising-Simons Foundation for awarding a grant of $1.2M to fund Daniel's spectrometer and to Dr. Iris Borg for her contributions to the Turner Memorial Fund, which is helping support Daniel's start-up and students.

State funding for UC Berkeley as a public university continues to decline, and as chair I ask alumni and friends to donate to EPS. Please consider giving to the Friends of Earth and Planetary Science Fund, the EPS Scholarship Fund, or the Field and Digital Mapping Fund. The Friends of Earth and Planetary Science Fund is used to support new faculty set up their labs and research groups, the scholarship fund supports students, and the Field and Digital Mapping Fund provides tools for undergraduate field work. We are extremely grateful if you would consider donating to these specific funds.

One very recent alumni who benefited from funding is Daniella Rempe. Daniella is a hydrologist and geomorphologist who received her doctorate in 2016. Daniella did her fieldwork at the National Critical Zone Observatory in Northern California (see page 2), where she studied actively eroding landscapes and the effects of weathering on moisture transport in fractured rock. We are excited to follow Daniella as she develops the "Rempe Lab" as an assistant professor at UT Austin.

The previous academic year was exhilarating for all of the research accomplishments and faculty developments that took place in the department. In conclusion, I want to use my letter to encourage alumni to update us about recent developments in their lives and careers.

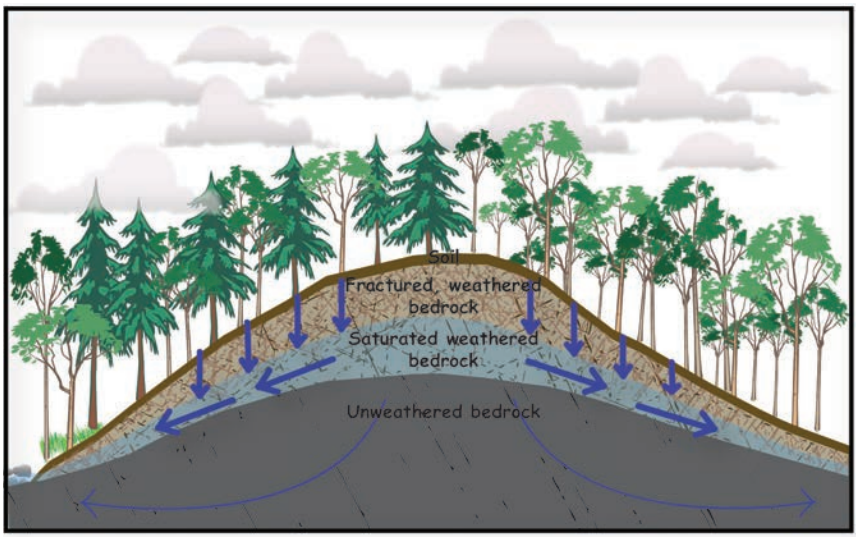
You may also contact me via email to inquire about how donations help with our educational mission. On behalf of all the members of EPS, I invite you to read on, and I hope the following pages provide a glimpse into the continued excellence of this department.

Sincerely,
Richard M. Allen
Professor and Chair, Deptartment of Earth & Planetary Science | rallen@berkeley.edu

EXPLORING THE CRITICAL ZONE

by William Dietrich
Professor of Earth & Planetary Science

In 2014, deep into the California drought, then graduate student Daniella Rempe made repeated trips to a steep forested hillslope along the Eel River in northern California where 12 wells had been drilled (some > 25m deep) through the soil and weathered bedrock, down into fresh impermeable argillite of the Coastal Belt of the Franciscan formation. Using a neutron probe, she profiled the moisture content in the weathered bedrock (above the groundwater perched on the fresh bedrock). In water year 2014, this study site received only 1000 mm of rain (compared to an annual average of 2000 mm). Yet Daniella discovered that the weathered bedrock zone held 300 mm of that 1000 mm in May and by October all of that moisture was absent, having either been pulled up and transpired by trees or drained to groundwater which slowly discharged from the hillslope, sustaining flow in a salmon bearing creek. This "rock moisture," as we now call it, supports forests and possibly river ecosystems (we lost no trees and had no fish declines that summer) but until now, it has never been systematically mapped, and is absent from climate models. One-third of the annual water budget that we didn't know existed!



Daniella (now Assistant Professor at the University of Texas, Austin) made these measurements at the Eel River Critical Zone Observatory in the University of California Angelo Coast Range Reserve. The Critical Zone is a new concept that recognizes that vegetation, soil, weathered bedrock, and fresh bedrock, normally studied separately, belong to a single co-evolving entity—a land boundary layer that interacts with the atmosphere and mediates currencies-- water, sediment, gas, biota, solutes, energy and momentum—of entire watersheds. One succinct definition of the Critical Zone is the thin veneer of Earth that extends from the top of the vegetation to the base of weathered bedrock.

Few studies have attempted to investigate the critical zone in its entirety, and the deeper subsurface processes have, until recently, largely gone unmeasured. In 2013, nine Berkeley faculty (including Inez Fung, Jim Bishop, Jill Banfield and Bill Dietrich in our Earth and Planetary Science Department) were funded by the National Science Foundation to establish for a five-year period the Eel River Critical Zone Observatory. Over 23 undergraduates, 15 graduate students, and four post-doctoral researchers have been involved in this effort. We are connecting the atmosphere, lithology, hydrology, geomorphology, deep subsurface microbial communities, runoff and gas chemistry, stream flow, river ecosystems and water supply. We are making surveys down the entirety of the South Fork Eel River into the mainstem Eel, noting fish, insects, and algae, all of which depend on stream flow controlled by the summer groundwater drainage from the critical zone. The research group is now seeing worrying evidence of increasing occurrence of cyanobacteria outbreaks in the reduced and warmer flows of the Eel River.

The Critical Zone research demands a diversity of research knowledge (nine different fields of specialization are represented in our group) but rewards us with a new view of a world we thought familiar, but was actually largely unseen and thus unnoticed.

NEW DNA PROCESSING TECHNOLOGY

by Paul Henshaw
Visiting Professor & BA Geology, 1969

Life has been good since graduation from UC Berkeley in 1969. Three years active duty with the Navy followed by five years of grad school at the University of Washington in Oceanography, then 30+ great years with Chevron Corporation working in Exploration & Production, including R&D and Operations around the world. I also kept my hand in teaching by offering, on occasion, science courses at several universities. I am currently a Visiting Professor and teacher of Petroleum Geology (EPS 111) in the EPS Department (since 2008).

Since my retirement from Chevron (and 20 years with US Navy Reserves in Oceanography and Office of Naval Research), I did consulting work as the Geology Discipline Manager for PetroSkills, and dabbled as an advisor to several Bay Area start-ups; most actively with Biota Technology and Knowledgette.

Since 2013, I have been on the Advisory Board of Biota Technology. Biota Technology has recently completed a suite of field tests using DNA Sequencing technology to help resolve complex oil field reservoir production problems, with a focus on tight sand/shale reservoirs. This unique application of DNA technology was developed to extend and improve upon conventional oilfield geochemical techniques. Development of this DNA technology is continuing for application in conventional settings and for offshore production facilities optimization.

Biota Technology has used its DNA techniques on 60 wells from six different US oil shale producers.

The technology development took novel DNA processing procedures (developed by Illumina) and oilfield geochemical concepts to create faster, cheaper, and more precise information to assist oilfield operators in optimizing drilling and completion procedures for improved production. The technology is being integrated into field development programs.

There are hundreds of thousands of different microbes in rock formations. Certain species are associated with hydrocarbons and can be quantified using proprietary sample preparation and data processing. Samples of oil/water/well cuttings are collected in various

stages, ranging from during drilling, well testing and/or production. The DNA are extracted, identified, quantified and presented in “oil patch friendly” displays that operators can readily use to help better select horizontal well sites, and improve well completions—leading to improved field performance.

A summary of the new technology has been published in JPT (Journal of Petroleum Technology), May 2016, (**www.spe.org/jpt**), or you may contact me for more details.

The strength of UC Berkeley networks is evident in the fact that Ajay Kshatriya, CEO of Biota Technology has an Engineering BS from and an MBA from Berkeley, the latter from the Haas School of Business.

It was good to see all who came to the EPS, multi-year, “40th” Reunion in 2008. For those of you not ready for “Full” retirement, come on back to Berkeley: give a seminar, teach a class, or even mentor some students!

To conclude, GO BEARS!!

NEW DATA FROM PREVIOUSLY UNSTUDIED GEOLOGICAL ENVIRONMENTS PROVIDES AN UPDATED VIEW OF THE TREE AND LIFE'S DIVERSITY

By Jill Banfield
Professor of Earth & Planetary Science
and Environmental Science, Policy & Management

Studies of Earth's ecosystems, especially sediments and groundwater, are adding many new branches to the Tree of Life. The microbes found in these environments have remained hidden for two main reasons: a) in part due to limited access to suitable samples and, b) in part because conventional methods to identify organisms relied upon laboratory experiments involving single species cultures that are not available for the vast majority of microbial life. The need to decipher the roles of microorganisms in shaping Earth's biogeochemical cycles has motivated new studies of the microbiology of natural systems using methods that do not require laboratory growth. These methods employ DNA sequences and target all organisms present in samples simultaneously. Intensive bioinformatics methods are then used to sort out which sequence belongs to which organism (an approach referred to as metagenomics). A remarkable picture has emerged from some of the first such studies: most life in the world "down under" is very different from life we are familiar with. The divergences are substantial, probably because these newly detected organisms belong to branches of the tree of life that diverged from well-studied microorganisms billions of years ago. A group led by the Banfield Lab in the Department of Earth and Planetary Science, University of California, Berkeley, has discovered hundreds of new groups of Bacteria and Archaea and has dramatically rejiggered the tree to account for these microscopic life forms.

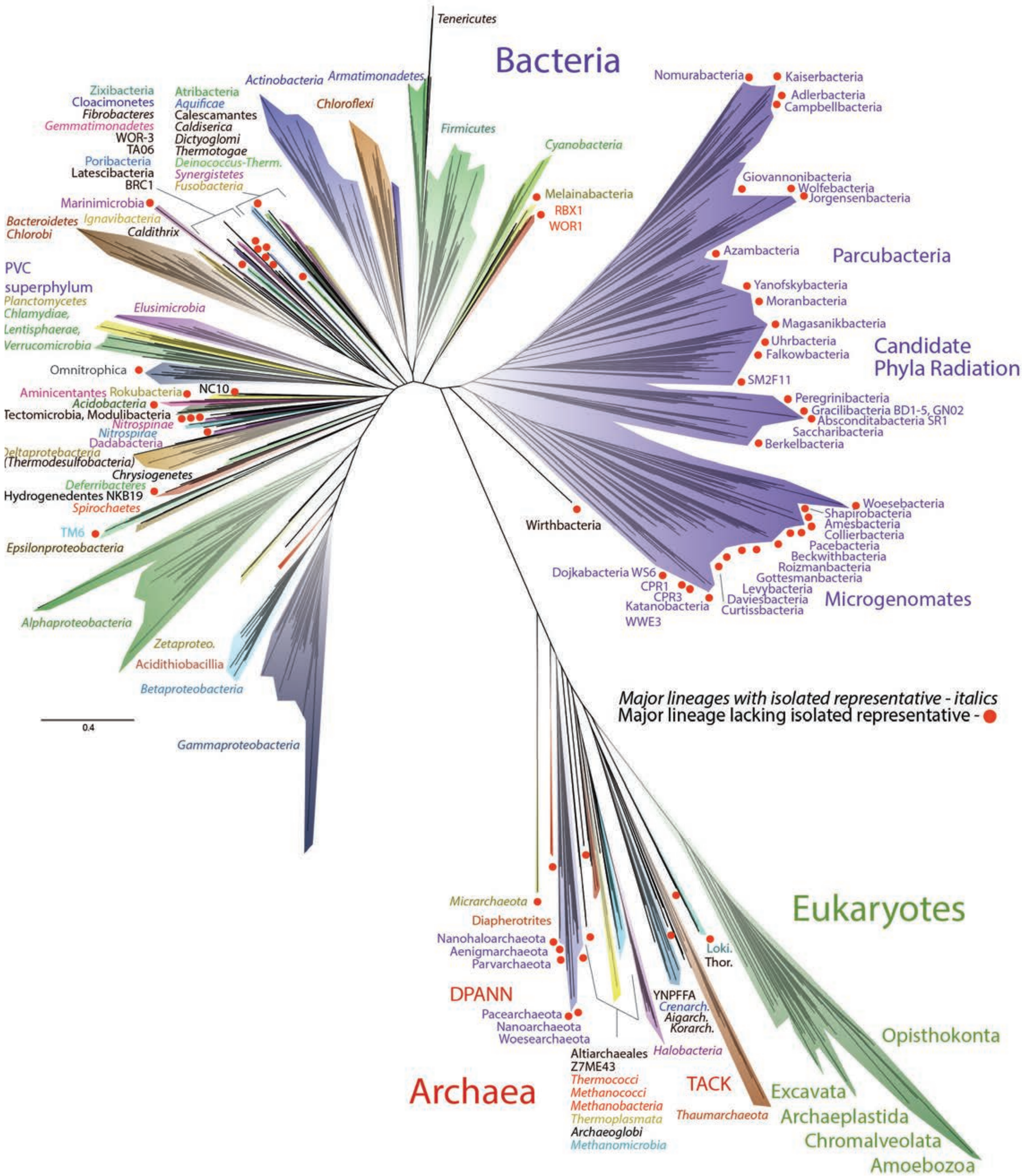
The tree of life is one of the most important organizing principles in biology. This new depiction will be of use not only to biologists who study microbial ecology, but also to biochemists searching for novel genes and to researchers studying evolution and earth history.

The new tree, published in *Nature Microbiology*, reinforces once again that the life we see around us—plants, animals, humans and other so-called eukaryotes—represent a tiny percentage of the world's biodiversity. It shows that Bacteria and Archaea from major lineages completely lacking isolated representatives comprise the majority of life's diversity. This is the first three-domain genome-based tree to relatively comprehensively incorporate these uncultivable organisms, and it reveals the vast scope of as yet little-known lineages. The more than 1,000 newly reported organisms appearing on the revised tree are from a range of environments, including a hot spring in Yellowstone National Park, a salt flat in Chile's Atacama desert, terrestrial and wetland sediments, a sparkling water geyser, meadow soil and the inside of a dolphin's mouth. All of these newly recognized organisms are known only from their genomes.

First author Laura Hug, previously a postdoc in the Banfield lab and now an assistant professor at the University of Waterloo, Canada, points out that what became really apparent on the tree is that so much of the diversity is coming from lineages for which we really only have genome sequences. She also notes that we don't have laboratory access to them, we have only their blueprints and their metabolic potential from their genome sequences. This is telling, in terms of how we think about the diversity of life on Earth, and what we think we know about microbiology.

One striking aspect of the new tree of life is that a group of bacteria described by the Banfield group in 2015 as the "candidate phyla radiation" forms a very major branch. It seems to be comprised only of bacteria with symbiotic lifestyles. The candidate phyla radiation now appears to contain around half of all bacterial evolutionary diversity. While the relationship between Archaea and eukaryotes remains uncertain and highly controversial, it's clear that this new rendering of the tree offers a new perspective on life's diversity.

Charles Darwin first sketched a tree of life in 1837 as he sought ways of showing how plants, animals and bacteria are related to one another. The idea took root in the 19th century, with the tips of the twigs representing life on Earth today, while the branches connecting them to the trunk implied evolutionary relationships among


Bacteria
Tenericutes
Armatimonadetes
Actinobacteria
Chloroflexi
Firmicutes
Cyanobacteria
Melainabacteria
RBX1
WOR1
Zixibacteria
Cloacimonetes
Fibrobacteres
Gemmatimonadetes
WOR-3
TA06
Poribacteria
Latescibacteria
BRC1
Atribacteria
Aquificae
Calescamantes
Caldiserica
Dictyoglomi
Thermotogae
Deinococcus-Therm.
Synergistetes
Fusobacteria
Marinimicrobia
Bacteroidetes
Ignavibacteria
Chlorobi
Caldithrix
PVC superphylum
Planctomycetes
Chlamydiae,
Lentisphaerae,
Verrucomicrobia
Elusimicrobia
Omnitrophica
NC10
Aminicentantes
Rokubacteria
Acidobacteria
Tectomicrobia, Modulibacteria
Nitrospinae
Nitrospirae
Dadabacteria
Deltaprotebacteria
(Thermodesulfobacteria)
Chrysiogenetes
Deferribacteres
Hydrogenedentes NKB19
Spirochaetes
TM6
Epsilonproteobacteria
Alphaproteobacteria
Zetaproteo.
Acidithiobacillia
Betaproteobacteria
Gammaproteobacteria
0.4
Nomurabacteria
Kaiserbacteria
Adlerbacteria
Campbellbacteria
Giovannonibacteria
Wolfebacteria
Jorgensenbacteria
Azambacteria
Parcubacteria
Yanofskybacteria
Moranbacteria
Magasanikbacteria
Uhrbacteria
Falkowbacteria
SM2F11
Candidate Phyla Radiation
Peregrinibacteria
Gracilibacteria BD1-5, GN02
Absconditabacteria SR1
Saccharibacteria
Berkelbacteria
Wirthbacteria
Woesebacteria
Shapirobacteria
Amesbacteria
Collierbacteria
Pacebacteria
Beckwithbacteria
Roizmanbacteria
Gottesmanbacteria
Levybacteria
Daviesbacteria
Curtissbacteria
Microgenomates
Dojkabacteria WS6
CPR1
CPR3
Katanobacteria
WWE3
Major lineages with isolated representative - italics
Major lineage lacking isolated representative - ●
Micrarchaeota
Diapherotrites
Nanohaloarchaeota
Aenigmarchaeota
Parvarchaeota
DPANN
Pacearchaeota
Nanoarchaeota
Woesearchaeota
Archaea
Altiarchaeales
Z7ME43
Thermococci
Methanococci
Methanobacteria
Thermoplasmata
Archaeoglobi
Methanomicrobia
YNPFFA
Crenarch.
Aigarch.
Korarch.
Halobacteria
Loki.
Thor.
TACK
Thaumarchaeota
Eukaryotes
Opisthokonta
Excavata
Archaeplastida
Chromalveolata
Amoebozoa

these creatures. A branch that divides into two twigs near the tips of the tree implies that these organisms have a recent common ancestor, while a forking branch close to the trunk implies an evolutionary split in the distant past.

Archaea were first added in 1977 after work showing that they are distinctly different from bacteria, though they are single-celled, like bacteria. A tree published in 1990 by microbiologist Carl Woese was a transformative visualization of the tree. With its three domains, it remains the most recognizable today.

The new analysis, representing the total diversity among all sequenced genomes, produced a tree with branches dominated by bacteria, especially by uncultivated bacteria. A second view of the tree grouped organisms by their evolutionary distance from one another rather than current taxonomic definitions, making clear that about one-third of all biodiversity comes from bacteria, one-third from uncultivable bacteria and a bit less than one-third from Archaea and eukaryotes. The two main take-home points in this tree, Banfield said, are the prominence of major lineages that have no cultivable representatives, and the great diversity in the bacterial domain, most importantly, the prominence of candidate phyla radiation. In fact, the candidate phyla radiation has as much diversity within it as the rest of the bacteria combined, making it a key target for future studies.

Co-authors with Hug, Banfield and Baker are Karthik Anantharaman, Christopher Brown, Alexander Probst, Cindy Castelle, Cristina Butterfield, Brian Thomas, Alex Hernsdorf, Ronald Amundson and Kari Finstad of UC Berkeley; Yuki Amano and Kotaro Ise of the Japan Atomic Energy Agency; Yohey Suzuki of the University of Tokyo; Natasha Dudek of UC Santa Cruz; and David Relman of Stanford University. The research was supported primarily by the Department of Energy through Lawrence Berkeley National Laboratory, with metagenomic sequencing by DOE's Joint Genome Institute in Walnut Creek, California.

ALUMNI UPDATES

1949

Charles W. Welby M.S.

….My late wife's step-father was a 1906 graduate of Berkeley who was at the Palace Hotel at the time of the San Francisco earthquake. He had the story that when Bacon Hall was built, the structure was tested by having the Army ROTC march around the balcony. I believe the building was built in the late 1880's. I guess those who constructed the building had a lot of good nails.

1953

Giles Maloof B.A. Geophysics

Still teaching 2 classes a semester. Have taught in college since 1958.

1968

James Murray B.A. Geology

This year I will be in the second year of my term as PJ –President of the Ocean Science Section of the AGU. I'm also finishing up a study of particulate matter in the Arabian Gulf around Qatar. I'll spend June at the Rockefeller Center at Bellagio, Italy on Lake Como to write a paper on the impacts of ocean acidification on marine biology.

1974

John Knapp AB Geophysics

I've retired and moved to Bella Vista, AR where there is a lot of bicycling, kayaking, and golf. I bought an RV and Walmart parking lots are serving as my second home. I'm still teaching via distance learning…all I need is a wifi hotspot!

1975

Charles R. Bacon Ph.D. Geology

I am very much enjoying emeritus status at USGS. Recently published two papers with my wife, Cynthia Dusel-Bacon, on interior Alaska geology, a change from Quaternary volcanoes. Still cranking away on the latter however.

2003

Seth St. Martin, B.A. Geology

I live in San Francisco with my wife, Susan, and son, Joseph. A year ago I left the world of environmental consulting and became the full time Administrator of Congregation B'Nai Emmanuel in San Francisco. I miss working outdoors, but I love working all day to support the community I care about.

2011

Atif Saleem B.A./M.A. Marine Science

I am in my 4th year of medical school pursing pathology and especially pulmonary pathology. Since I am still intrigued by the effects of climate on health.

GROUND-BASED RADIO MAPS OF JUPITER REVEALED WHAT'S BENEATH COLORFUL CLOUDS

by Imke de Pater
Professor of Earth & Planetary Science and Astronomy

Just before the insertion of NASA's Juno spacecraft into orbit around Jupiter, we published a paper in Science titled: "Peering through Jupiter's Clouds with Radio Spectral Imaging" (Science, 352, 1198-1201). We used the Karl G. Jansky Very Large Array (VLA) of radio telescopes in New Mexico, which had improved in sensitivity by an order of magnitude since we last used it. We observed Jupiter over a range of frequencies, 4-18 GHz (~2-6 cm), probing down to pressures of ~8-10 bars, ~100 km below the cloud tops, a largely unexplored region where clouds form.

Jupiter's atmosphere emits thermal (blackbody) radiation that we observed at radio wavelengths with the VLA. In the past we had to integrate over many hours to build-up sufficient signal-to-noise to distinguish latitudinal features, such as the prominent white zones and brown belts at visible wavelengths. After the VLA upgrade, and using sophisticated software to "de-rotate" the data (essentially taking out Jupiter's rotation), we produced maps of the planet that now show both latitudinal and longitudinal structure, at a typical spatial resolution of ~1200 km (1 deg. in longitude/latitude at disk-center; Jupiter's diameter is ~140,000 km). Various maps of Jupiter's observed brightness temperature, after subtraction of a best-fit uniform limb-darkened disk to enhance image contrast) are shown in Figures 1 and 2. Figure 1 shows a composite image constructed from images obtained at 12-18 GHz (2 cm), 8-12 GHz (3.5 cm), and 4-8 GHz (6 cm), smeared in longitude; Figure 2 shows longitude-resolved maps at these wavelengths, side-by-side with visible-light maps constructed by the ameteur astronomy community.

A wealth of structure is visible in each radio map, and there is a striking resemblance with the visible-light maps. Brightness temperatures in the radio maps in excess of the best-fit subtracted disk show up as bright (light-colored) regions, and lower temperatures are dark. A higher temperature indicates probing deeper levels in the atmosphere. Since at radio wavelengths the main source of opacity is provided by ammonia gas, bright regions indicate a low NH3 concentration, and dark regions correspond to a high concentration. By modeling the emissions with detailed radiative transfer calculations, we determined in essence the 3-dimensional distribution of ammonia gas, which we then used to trace the dynamics: ammonia-rich gases are rising into and forming the upper cloud layers: an ammonium hydrosulfide cloud at a temperature near 200 K, pressure near 2.5 bar, and an ammonia-ice cloud in the approximately 160 K cold air near the 0.8 bar level. Ammonia-poor air indicates subsidence of dry air from above the cloud layers.

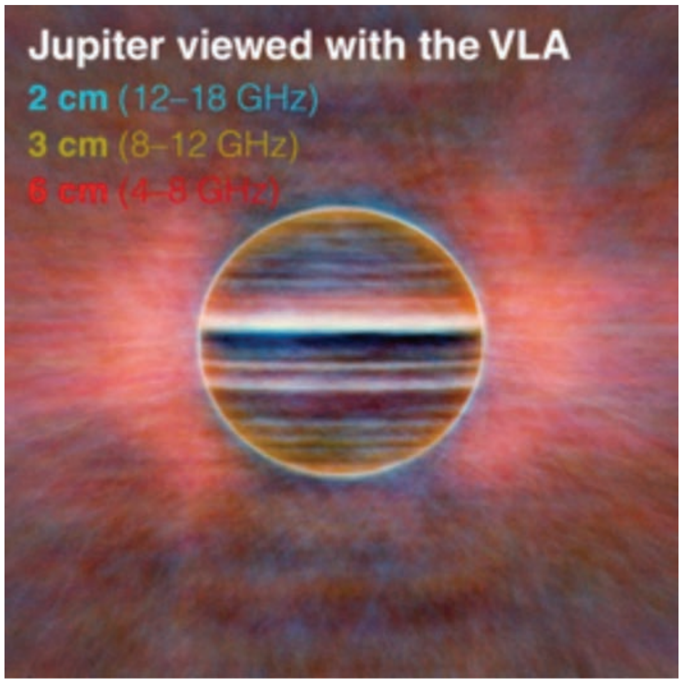


Fig. 1: A radio image of Jupiter from the VLA at three wavelengths: 2 cm in blue, 3.5 cm in gold, and 6 cm in red. A uniform disk has been subtracted to better show the fine banded structure on the planet. The pink glow surrounding the planet is synchrotron radiation produced by spiraling electrons trapped in Jupiter's magnetic field. Banded details on the planet's disk probe depths of 30-90 km below the clouds. This image is averaged from 10 hours of VLA data, so the fine details seen in the other maps are smeared here by the planet's rotation. (CREDITS: Imke de Pater, Michael H. Wong (UC Berkeley), Robert J. Sault (Univ. Melbourne))

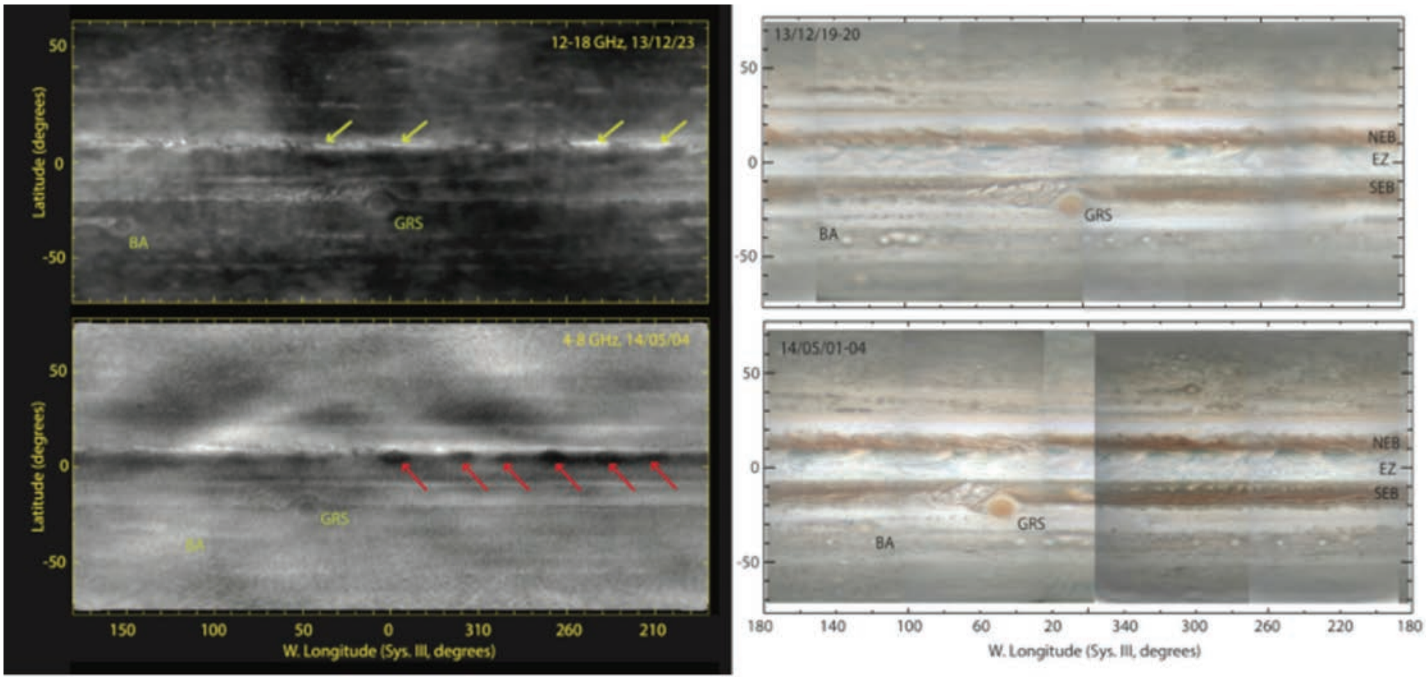


Fig. 2. Left: Longitude-resolved VLA maps of Jupiter at 12-18 GHz (2 cm) and 4-8 GHz (6 cm) after subtraction of a uniform limb-darkened disk. Right: Visible-light maps taken close in time with the VLA maps, as compiled by the amateur community. The axes indicate West longitude and planetographic latitude. The Great Red Spot (GRS) and Oval BA are indicated, as well (on the far right) the North equatorial belt (NEB), Equatorial Zone (EZ), and South Equatorial Belt (SEB). The yellow arrows on the top radio image indicate the radio-hot belt with hot spots; the red arrows on the bottom radio map indicate plume of ammonia gas. (Adapted from de Pater et al., 2016).

The maps show a series of hotspots—so-called because they appear bright in radio and thermal infrared images —i.e., ammonia-poor regions, circling the planet like a belt just north of the equator (indicated by yellow arrows in Fig. 2). Between these hotspots are ammonia-rich upwellings, or plumes, that bring ammonia up from pressures over 8-10 bar, or 100 km below the clouds (indicated by red arrows in Fig. 2). The hotspots are interleaved with these ammonia plumes, tracing the vertical undulations of an equatorial wave system, long suspected to produce the hot spots; the ammonia plumes, the counterpart of the hot spots, had never been detected before.

In conclusion, these findings solve a long-standing dilemma in that ground-based radio observations measured ammonia abundances close to the solar elemental N value at altitudes above ~4 bar, whereas the Galileo probe had measured concentrations 4-5 times higher in the deep atmosphere (pressures > 8 bar). These recent findings show that the Galileo probe and our new ground-based observations can be reconciled through models of the dynamics of the large scale up- and down-drafts in the atmosphere. The new Juno observations will extend our findings to much deeper levels in the atmosphere (few 100 bar), and thereby further help understand the large-scale dynamics in Jupiter's deep atmosphere.

For more information, see: **http://w.astro.berkeley.edu/~imke/RadioPage/Science_2016/ScienceJup.htm**

IN MEMORIUM

James Fairchild
1975 B.A. Geology

Jean-Claude Brae
1952 Ph.D. Geophysics

Francis Heuring
1952 B.A. Geophysics

DONATIONS (FROM SEPTEMBER 15, 2015 - SEPTEMBER 15, 2016)

Donation of $20,000 or more
Borg, Iris

Donation of $10,000 or more
Welsh, Thomas Chevron
Humankind

Donation of $1,000 or more
Abrahamson, Norman &
Susan
Shell matching
Alexander, Mia
Bacon, Charles
Bullitt, John
Fournier, Thomas
Shell, ExxonMobile
Grew, Priscilla
Henshaw, Paul
Maloof, Giles
Marcus, Kim
Schwartz, Morgan
Taylor, Dwight

Donations of $500 to $999
Alvarez, Walter
Bilodeau, Bruce
Merino, Enrique
Gregor, Nicholas
Heming, Robert
Huffman, Frank
Irvine, Pamela
Murray, James
Pride, Carolyn
Sutherland, Harlan
Thacher, Anson

Donation up to $499
Ague, Daria and Jay
Allen, Mary
Bevc, Dimitri
Bluth, Gregg
Boyd, Nicholas
Brown, Edwin
Butler, Paul
Cebull, Stanley
Cerovski-Darriau, Corina
Chan, Finn
Charlton, John
Cheney, Richard
Clarke Jr., Samuel
Clements, Daniel
Denoyer, John
Dermitzakis, Starvos
Doerschlag, Mark
Dugan, Mary
Einhorn, Shelia
Ford, Sean
Foxall, William
Galehouse, Jon
Gilbert, Neil
Gillerman, Virginia
Hall, Minard
Hammers, Charles
Hecht, Barry
Heming, Robert
Chevron
Higashida, Donna
Hirsch, Lee
Holdaway, Michael
Hwang, Lorraine
Johnson, Thomas
Jones, Barbara
Kandelin, John
Kavner, Abby
Kellogg, George
Knapp, John
Lackey, Larry
Langlois, Mitchell
Lathon, Robert
Lee, Richard
Leith, William
Marsh, Bruce & Judith
McCauley, Sean
McLaughlin, Keith
Moore, Donald
Nash, Barbara
Nelson, Karen
Nolan, Julie
Nord, Gordon
Ohlmann, John
Pellerin, Louise
Pendrey, Carolyn
Pexton, Robert
Plumb, Robert
Reis, Arthur
Richards, Mark
Rivers, Mark
Romey, William
Rudolf, Max
Sakeem, Atif
Savage, Brian
Savina, mary
Schetter, William
ExxonMobile
Silver, Nathalie
Schmidt, Kevin
Siekiel-Zdxienicki, Jozef
Sloan, Doris
Smart, Edward
Solomon, Ernest
Stimpson, Douglas
Taylor, Roger
Templeton, Denise
Teshima, Janet
Veeraooan, Ramanathan
Welby, Charles
Wood, Joan

SANTA BARBARA DAY




Left: Jinsol Kim, Yuem Park, Alex Robson and Nate Lindsay; Right (starting from the top left): Allison Sharrar and Tom Smart; Roland Burgmann and Mong-Han Huang; Tanis Leonardi, Michael Manga, Nate Lindsay and guest.

COMMENCEMENT 2016

Bachelor of Arts

Environmental Earth Science

Back Row L-R: Ruxun Zhang, Stuart Miller, Seamus Rucci Land, Ammon Reagan, Kaitlyn Kraybill-Voth, Daniel Joseph Hohl, Nicole Herg

Front Row L-R: Alyssa Ann Spence, Elly Lin, Anaïs Teyton, Jonathan Jeremy Eads, Michael Anthony Boyd, Savannah Blake, Ryan M. Clark

Geology

Back Row L-R: Eliel Anttila (Departmental Citation Award), Kevin Gaastra, Raysieo Duakin, Yosuke Kono

Front Row L-R: Michelle Wray, Ferron John Paul G. Cruz, Behnaz Hosseini, Alicia Agnew

Geophysics

Back Row L-R: Justin Robert de la Serna, Aaron Marriott, Benjamin Purcell, Kevin Gaastra, Ian Ekblaw

Front Row L-R: Newton Huy Nguyen, Ai Wang, Athena Anh-Thu Nghiem (AWG Outstanding Woman Student Award), Quinn Miller, Samantha Cargill

Marine Science & Planetary Science

Back Row L-R: Imari Walker, Alexandra Hope Miller Wein, Alexandria Niebergall, Sierra Smiley, Gavin VonSeggern (Planetary Sci.)

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Doctor of Philosophy in Earth & Planetary Science

Carolina Patricia Muñoz and Daniella Marie Rempe

STUDYING ABROAD AS A GEOPHYSICS MAJOR

by Eva Lopez
Current Student

In Spring 2016, as a third year geophysics major, I had the opportunity to study abroad in one of the places with the most active volcanism in the world: Italy. As a STEM major, I wanted to participate in the University of California Education Abroad Program at the University of Bologna. I jumped at the opportunity to enroll in the Introduction to Volcanology course, one of the most interesting geoscience classes offered at Bologna and a personal and professional opportunity for me to further my knowledge of volcanoes. In lectures, I learned about the theory governing volcanic processes, lava flows, lava deposits, and how to conduct stratigraphic analysis… but the best part of the class was the end-of-the-semester field trip. Because a geoscience class is not a geoscience class without a field trip, and theory is always better understood when applied and learned through hands-on experience, we headed out of the classroom and visited some active volcanoes. My classmates and I packed up our lecture notes, got on a train, a bus, and a hydrofoil, and 12 hours later, we alighted on the Aeolian Islands.

The Aeolian Islands are a volcanic archipelago in Southern Italy, in the Tyrrhenian Sea north of Sicily. This archipelago is composed of seven main islands and other islets. Out of the seven main islands, Stromboli and Vulcano are still active volcanoes. The class stayed for a week in the biggest and main island, Lipari, where we conducted most of our stratigraphy analysis. We also had the opportunity to see some of the best preserved pyroclastic density current deposits and visited the pumice quarries, as well as the stunning obsidian lava flow "Rocce Rosse" (Red Rocks).

We also traveled to Vulcano and hiked up its active crater. On the hike to the crater, the professor told us the nature of its eruptions and its explosive history as we admired the remaining deposits from viscous lava flows, and other deposits on the slope of Vulcano, such as lahars. Once we reached the top, we were able to better appreciate its geological structure and see "La Caldera del Piano" (Piano Caldera) and "La Caldera della Fossa" (Fossa

Hiking up Stromboli. Eruption in background.

PDC deposits

Columnar joints

Vulcano sulfer fumaroles

Caldera). We also got the chance to observe volcanic sulfur degassing from the Fossa Caldera and beautiful samples of bombs from previous eruptions, such spindle and bread crust bombs.

Lipari and Vulcano are the most beautiful volcanic islands, with much to offer, but the most memorable parts of my trip happened on Stromboli; this is where I truly experienced how sublime volcanoes are. Stromboli has been continuously erupting tiny, explosive lava fountains since 1932. This eruptive manner is so characteristic of Stromboli that all other similar eruptions around the world are called "Strombolian eruptions." Hiking up Stromboli was a fun challenge, especially the last couple hundred meters, where the slope was the steepest. The hike took about five hours, and, exhausted and hungry, we arrived at the crater at around 6 PM. We unpacked our sandwiches and had dinner with the most spectacular view before us. Suddenly, I found myself at the top of an Italian volcano, watching the sunset and seeing lava for the first time. I was seeing and feeling the power of volcanoes and the power of the Earth right before me, experiencing its magnificence, and falling more and more in love with geoscience and volcanoes.

Studying geophysics abroad allowed me to take advantage of opportunities not offered at Berkeley, but, more importantly, it allowed me to experience the Earth away from home.

This incredible experience could not have been possible without the support from the Earth and Planetary Science Department at UC Berkeley, which provided me financial support for my lodging, transportation, and equipment for the field trip.

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Second row down, left to right: Steve Breen and Michael Manga; Corinna Roy and Noah Luna; Roland Gritto and Rudy Wenk; David Shimabukuro and Margie Winn

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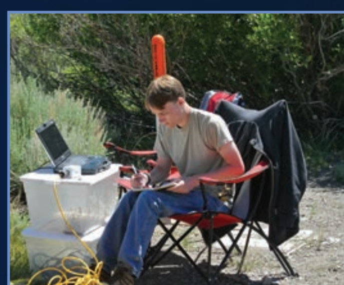


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