

UC Santa Barbara Earth Science



Chair's Letter: Andy Wyss

Alumni & Friends,

With solstice near, it's time for an update on the department. My hope is to convey a sense of the energy and excitement coursing through Webb Hall and beyond, by providing you glimpses of recent events. We cannot be prouder to announce that Professor Emerita Tanya Atwater

was awarded the Penrose Medal by the Geological Society of America, its highest scholarly distinction. Art Sylvester's poignant citation (p. 5), beautifully encapsulates her paradigm-shifting career. We recognize two talented current graduate students (p. 8–9), the accomplishments of Distinguished Alumni Susan Hubbard and Joe Acaba (p. 4), and the distinguished career of Professor Bruce Luyendyk (p. 11). Wishing you a healthy and gratifying 2020.

In the trenches

UCSB-led research team uncovers a previously unrecognized active fault in British Columbia, Canada

by Kristin Morell



During the summer of 2019, a UCSB-led research team found evidence for at least five Holocene ruptures on the Beaufort Range Fault, a major 100-km-long fault in southwestern British Columbia, Canada. The team used a back hoe to dig a 10-meter-deep paleoseismic trench across this fault (see photo), to make detailed maps of the fault and adjacent deposits, and to collect samples for radiocarbon dating.

The results of this work are

exciting, as Holocene activity of this fault has important implications for how strain is accumulating in the northern portion of the Cascadia subduction zone. The study also has improvement implications for local seismic hazard assessments, as several dams are located near this major fault zone. Funded by the NSF, the research team includes scientists from UCSB and Northern Arizona University, assisted by the USGS and the University of Victoria.

IN THIS ISSUE | FALL 2019

NEWS FROM THE FIELD:

Summer Field	2
Santa Cruz Island	3

DISTINGUISHED ALUMNI:

Joe Acaba	4
Susan Hubbard	4

FACULTY AWARDS

Tanya Atwater	5
Francis Macdonald	5
Robin Matoza	6
Susannah Porter	10

GIVING & DONORS:

We Wish For ...	6
With Appreciation	7

GRADUATE STUDENT SPOTLIGHT:

Kaelynn Rose	8
Jiong Wang	9

FACULTY IN THE FIELD:

Montecito Debris Flow	10
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EMERITUS SPOTLIGHT:

Bruce Luyendyk	11
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Photo: Santa Cruz Island by Scott Condon

Summer Field Geology (Earth 118): The 2019 Edition

by Phillip Gans

The 2019 edition of our capstone summer field course (Earth 118) was a great success. Eighteen energetic undergraduate majors completed the intensive 6-week geologic mapping course under the expert guidance of Professor Phil Gans with TAs Evan Monroe, Justin Newmann, and Amy Moser. A rustic but scenic base camp, complete with a large office, cook tent, and gourmet meals prepared by Libby Gans, was set up on the flank of the Schell Creek Range in east-central Nevada. It served as our home for the physically and mentally demanding weeks ahead. With its incredible diversity of rock types and complex deformational history, this region provides an exceptional laboratory for students to hone their field skills.

The first several weeks were devoted to structured exercises, including a crash course on the 20+ different formations of the Paleozoic marine shelf stratigraphy, a mapping exercise devoted to unraveling the geometry and kinematics of a superposed extensional fault systems,

and an introduction to interpreting eruptive and structural histories from Eocene volcanic successions. With these skills under their belts, students devoted the remaining weeks to independent mapping projects in small groups, focusing on previously little-studied areas in order to explore various aspects of the Cenozoic volcanic and structural history of the eastern Great Basin.

Exciting novel outcomes from this year's field camp investigations include: (a) the discovery of an upper Permian marine conglomerate that records significant late Paleozoic uplift and erosion, (b) identification of the likely location of a major Eocene eruptive center, and (c) clear evidence for an episodic history of Paleocene to Miocene extensional faulting as recorded by disparate normal fault systems with different polarities and extension directions. Students returned from their summer adventure exhausted but in great spirits and with newfound confidence in their field abilities.



Summer Field 2019, Ely, Nevada. Photo: Justin Newman

Annual Trip to Santa Cruz Island

by Andrew McGrath



Santa Cruz Island, 2019. Photo: Cameron Gernant.

I expected that the responsibility of planning the annual graduate student retreat to Santa Cruz Island—making sure everyone was fed, on time, and safe—would make for a stressful trip. Luckily, this group’s unbridled enthusiasm and the island’s natural beauty easily overcame whatever roadblocks we encountered.

The trip didn’t start auspiciously: a high wind forecast would require a much earlier departure for the return leg of the trip than originally planned.

Continuing his generous tradition, Professor Emeritus Jim Boles (accompanied by Dr.—and Cookie Chef Extraordinaire—Stacey Boles) was our guide for the island’s geology. All alums who have had the privilege to take classes from Jim know his uncanny knack for explaining geology to novices (or vertebrate paleontologists) and experts alike. From rough-roading to sightseeing, from campfire to singing, and from hiking to swimming, the weekend was soon over.

Due to the boat’s change in schedule, it fell on me to get everyone packed up and ready to leave by sunrise Sunday morning. Although his might have worried me, it didn’t since I knew the type of unflappable students this department attracts.

Our return served up one more surprise, however. Groggily, but disciplined, we packed up swiftly and got under way ahead of schedule, only to be notified later that the ferry was delayed an hour. Our diligence turned out to be judicious. Barely thirty minutes into the bumpy, dusty ride from Christy Ranch to Prisoner’s Harbor, a truck got stuck in a rut. We tried everything, but it simply wouldn’t budge. So much for the extra hour we thought we had for a leisurely drive along the island’s mountainous spine. Jim charged ahead to the UC Research Station for towing straps. We were back in a race against time, but everyone felt calm—perhaps thankful for the extra time we had the Island practically to ourselves: new friends, old friends, and astounding views over the Santa Cruz central valley. Or perhaps because there was nothing more we could do—our fate was out of our hands. I noted this was the very serenity I strive for in daily life when faced with stressful situations. How lovely to achieve that state almost accidentally. I wondered if inner calm required being nearly marooned on a beautiful island surrounded by new friends. Perhaps not, but it certainly helped.

DISTINGUISHED ALUMNI 2019

Annually, the Department honors two of its alumni—one from academia, and one from elsewhere—celebrating their accomplishments and providing our current students exemplary role models.

Joe Acaba



While attending UCSB, Joe Acaba became a member of the United States Marine Corps, Reserves. Upon graduating in 1990, with the encouragement of Prof. Art Sylvester, Joe attended the University of Arizona, where he earned an MS in Geology. He worked as a hydro-geologist in Los Angeles, California, primarily on Superfund sites, and was involved in the assessment and remediation of groundwater contaminants. Following up on an interest he formed while at UCSB, Joe joined the United States Peace Corps as an Environmental Education Awareness Promoter in the Dominican Republic. He then managed the Caribbean Marine Research Center at Lee Stocking Island in the Exumas, Bahamas and taught one year of

high school science and four years of middle school math and science.

In 2004, Joe was selected as an Astronaut Candidate by NASA. In February 2006, he completed astronaut candidate training that included scientific and technical briefings, intensive instruction in shuttle and International Space Station systems, physiological training, T-38 flight training, and water and wilderness survival training. Joe's first mission to the International Space Station was in 2009 aboard the Space Shuttle Discovery. The primary objective was to deliver the last set of solar arrays to the ISS. In addition, Joe has flown two long duration missions to the ISS, launching on Russian Soyuz

(Continued on page 9)

Susan Hubbard



Susan Hubbard (née Sharpless) received her BS in Geological Sciences from UCSB in 1985. She subsequently received an MS in geophysics from Virginia Tech and a PhD in Civil and Environmental Engineering from UC Berkeley. Susan is currently the Associate Lab Director at Lawrence Berkeley National Laboratory, where she leads all Earth and Environmental Sciences research. Prior joining Berkeley Lab, she was a geologist at the US Geological Survey and a geophysicist in industry.

Susan's research focuses on quantifying the organization and function of terrestrial systems with a particular emphasis on using geophysical methods to explore how hydrological, geochemical, and biological processes interact

to govern larger scale system behavior. She has developed and used new geophysical approaches to understand processes critical for water resources, carbon cycling, contaminant transport, and sustainable agriculture challenges. She currently leads a multi-disciplinary project focused on developing a predictive understanding of how mountain watersheds respond to early snowmelt, and the associated ramifications for downgradient water availability and water quality. She is also involved in investigating the influence of thawing Arctic permafrost on carbon-climate feedbacks, and quantifying vineyard soil-plant interactions under environmental stress.

(Continued on page 9)

Atwater Penrose Medal

by Arthur Gibbs Sylvester, Citationist

Professor Emerita Tanya Atwater is universally celebrated for her pioneering role in establishing our current understanding of the geological workings of our planet. The Geological Society of America's highest honor, the Penrose Medal, which recognizes "eminent research in pure geology, for outstanding original contributions or achievements that mark a major advance in the science of geology," could not have been awarded to a worthier recipient.

Plate tectonics shattered previous paradigms about the mechanics and evolution of Earth, revolutionizing the geosciences. Tanya was the first scientist to translate the concepts of plate tectonics, developed for oceanic crust, to the continents. In 1970, through the analysis of ocean floor magnetic anomalies and transform faults, she singled-handedly reconstructed the history of Pacific plate motion, and demonstrated its profound influence on the geologic evolution of western North America. In one bold stroke, she elegantly proved how seemingly simple relative plate motions explained countless geologic observations on the continental margin. Tanya's spectacular findings laid to rest decades of conflicting and confusing geotectonic speculations. Her subsequent publications refined and added details to her analysis, changing forever our thinking about continental dynamics.

Tanya joined UC Santa Barbara's faculty in 1980 after stints at Massachusetts Institute of Technology, Woods Hole Oceanographic Institution, and Scripps Institution of Oceanography. She received her bachelor's degree from UC Berkeley and her doctorate from Scripps. During the course of her career, she participated in or led numerous field expeditions both on land and at sea, including 12 dives to the deep ocean floor—to depths as great as three kilometers—in the tiny submersible "Alvin." Tanya was a trailblazer for women, fighting for their right to conduct oceanographic field research, a practice not generally permitted when she began her studies. She retired from university teaching in 2007 but continues to deliver lectures and teacher workshops, and to lead field trips for the community.

Over the past decade, Tanya has turned her attention to hand-crafted animations. Available over the internet, these graphics compellingly illustrate key geological



phenomena. They highlight her own discoveries (e.g., the origin of the San Andreas fault), other aspects of plate tectonics, as well as a host of other geological processes and events, bringing to life the intricacies of how our planet works (Google "Atwater animations" or search for them on YouTube). Although her goal in this endeavor was to educate the public about the wonders of geological science, these animations are widely used by professors to illustrate lectures—many, sadly, unaware of the scientific eminence who crafted them.

Francis Macdonald

Francis Macdonald was awarded the prestigious James B. Macelwane Medal by the American Geophysical Union in recognition of "significant contributions to the geophysical sciences by an outstanding early-career scientist" Prof. Macdonald, a multifaceted Earth Scientist



uses a combination of field geology and analytical tools to tackle a wide array of fundamental questions related to the co-evolution of tectonics, surface environments, and life. His contributions include developing a timescale for Neoproterozoic Snowball Earth glaciations and a theory for Phanerozoic ice ages.

We Wish For...

Revitalization of department's space: especially main office.

Bruntons: These are vital to our field work.

Microscopes: These are vital to our labs.

New field equipment: camp stoves and field-oriented technologies

Your Ideas Welcome

We are deeply grateful to our many alums, colleagues, and friends who have helped us financially this past year! We truly welcome your thoughts. What lessons did you take away from here? What needed the most support? We are very interested in your input, and greatly value your perspective.

Thank you all so much!

Andy Wyss, Chair

Your Donation Dollars at Work



We are deeply grateful to our many alums, colleagues, and friends of the department who have helped us financially this past year!

WHAT ARE OUR ALUMNI DOING?

We'd love to hear from you. Send us your information and we'll include it in our next issue, as space permits.

Robin Matoza



At the summit of Mount Yasur, Tanna Island, Vanuatu, with aerostat infrasound sensor hovering in background. Photo credit: Allison Austin.

Robin Matoza received a coveted NSF CAREER Award for research on the seismo-acoustic signatures of volcanic unrest and eruption. His research will include collecting next-generation, multi-parametric seismo-acoustic field data at active volcanoes in Vanuatu, Mexico, and Chile. In tandem, he will develop an array of computationally intensive data processing methodologies, plus modeling and inversion strategies.

Staff Spotlight: Lee Sharpnack



and liquid crystals using a variety of x-ray techniques.

He enjoys tinkering. So if you're having difficulties with an instrument or machine please forward inquiries to him.

After his PhD, he spent 1.5 years working for the ESRF, mostly studying Janus nanoparticles and traveling in his time off. He invites anyone who is planning to visit France or Italy to stop by his office if they're interested in travel advice.

Lee Sharpnack joined the Department as a Research and Development Engineer on April Fools' Day, 2019. Lee completed his PhD in Physics at Kent State University in 2017 studying liquid crystal alignment layers

With Appreciation

The Department of Earth Science profoundly thanks the following individuals and institutions for their generous donations between July 2018 and June 2019

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Graduate Student Spotlight



Kaelynn Rose

I am a second year MS student working with Prof. Robin Matoza, studying volcano geophysics. Before starting at UCSB, I attended UC Davis, earned my BS in Geology in 2014,

and then spent 3.5 years working as a staff geologist in the environmental consulting industry. After working on a geophysical fieldwork project, I realized I still had a strong curiosity for geophysics and decided to apply for grad school.

At UCSB, I use infrasound (atmospheric sound at frequencies from 0.01 to 20 Hz, below the range of human hearing) and hydroacoustic signals generated by volcanic eruptions to study volcanoes that are partially or entirely submerged beneath the ocean. The main focus of my research has been using infrasound and hydroacoustic data from the Comprehensive Nuclear-Test-Ban Treaty (CTBT) International Monitoring System (IMS) to study Anak Krakatau volcano in Indonesia. A large eruption at Anak Krakatau in 2018 triggered the collapse of the volcano's cone

into the ocean, generating a tsunami. Using waveform and frequency content analysis and array processing tools, I am seeking to constrain the timing of the eruption, determine whether there is a hydroacoustic signature of the cone collapse, and observe if there was any signal content evolution that could indicate a change from submarine to subaerial activity.

This research is a case study that I hope will help advance the detection and hazard identification of remote volcanic eruptions in the future. I am looking forward to presenting my findings at AGU this December. I am grateful for all the support I have received from the Department of Earth Science and my fantastic fellow students, and happily anticipate learning as much as I can as I continue into my second year of graduate studies.

Staff Spotlight: Todd Penniman

Todd Penniman was born and raised in Goleta California, graduated from Dos Pueblos High School, and attended Santa Barbara City College (SBCC) where he discovered geology. After SBCC, Todd moved to Santa Rosa, California where he studied geology at Sonoma State University before completing his summer field course in the Black Hills of South Dakota through Eastern Illinois University.

After college, Todd joined an environmental consulting firm and began traveling to various private properties and government bases in California and Nevada. For 15 years Todd performed oversight as the Field Team Leader and Site Health and Safety Officer on various field projects. Field

work included logging of soil types, well installations, remedial construction, and groundwater injection projects.

Having access to highly classified areas on government bases (including NASA) provided Todd unforgettable experiences. Although this part of his career was amazing, Todd decided to work near home to be closer to family. In 2018, Todd joined the UCSB Department of Earth Science as the Principal Shop Mechanician, Department Safety Representative, and Laboratory Safety Representative. Working at UCSB created a balance of being at home versus traveling that suits Todd's lifestyle.

Thanks to his new position at UCSB, Todd is able to go home and enjoy



his family after work every day and still get into the field on occasion when working with field courses. Todd really enjoys working with the staff, students, and faculty in the UCSB Department of Earth Science and looks forward to many fruitful years ahead.

Jiong Wang

I am a fourth year Ph.D. candidate working with Professor Tanimoto on seismic noise. In 2013, I left my hometown of Ningbo, a coastal city in the Zhejiang Province of China, and started my undergraduate study at UCSB. After earning a BS degree in Earth Science in 2016, I decided to stay put in Webb Hall to pursue a Ph.D. degree in Seismology.

Unlike conventional seismology, which uses earthquakes and seismic waves, our research uses seismic noise—non-earthquake signals that can be detected continuously—to examine the interaction between the solid Earth and atmospheric pressure. A better quantitative understanding of such interaction is our primary goal. Furthermore, we aim to employ this

methodology to investigate near-surface structure. Soft, low-rigidity surface layers can dramatically amplify incoming seismic waves, making our research important for studying seismic hazards.

We use data from the 'Transportable Array,' a dense seismic network throughout the U.S. Based on the rigidities at over 700 seismic stations calculated from pressure-generated seismic noise, our rigidity map correlates with surficial geological features such as the Appalachian Mountains (hard surficial rock) and the Mississippi Alluvial Plain (soft surficial sediment). Our approach provides a cost-effective way to analyze seismic hazards compared to traditional methods, which usually involve laborious fieldwork.

Before starting my graduate work at UCSB, I did not realize how much



information about the Earth is hidden within 'trivial' seismic noise. The program has helped me to explore innovative interests in seismology, and to promote my ideas to the scientific community.

Joe Acaba

(Continued from Page 4)

space crafts. In total, Joe has conducted three spacewalks and has accumulated 308 days in space.

Joe recently served as Director of Operations Russia in Star City supporting crew training in Soyuz and Russian Segment systems. He is currently working in the Astronaut Office in Houston as a representative for the Commercial Crew Vehicle program. This program will return crew launch capability to U.S. soil for the first time since 2011, as crews currently launch and land on Soyuz spacecrafts in Kazakhstan.

The ground truth found in geological field studies... imprints on young minds the realization that we really don't know what we don't know... but that there is value in striving to understand how things might possibly have happened.

—Steve Comstock (Distinguished Alumnus)

Susan Hubbard

(Continued from Page 4)

Susan regards the educational foundation and mentorship that she received at UCSB as a critical springboard for her career. She learned to appreciate geological heterogeneity through field method classes and departmental field trips. The geophysics class she took in her senior year revealed to her how geophysical data can provide a 'window' into the complex subsurface. She sought advice from Prof. Ralph Archuleta about geophysical career paths, which led to her position as a geologist at the USGS. This was a critical step in Susan's research trajectory, which has since focused on developing methods to integrate spatially extensive yet indirect information from geophysics with sparse but direct measurements to interpret heterogeneous Earth systems.

Susan is an elected member of the American Academy of Arts and Sciences, a Fellow of AGU and GSA, and a recipient of several SEG awards. In addition to science, she enjoys winemaking, traveling, and raising chickens.

Montecito Debris Flow

by Ed Keller

A series of massive debris flows tore through Montecito early in the morning of January 9, 2018. Residents stood in shock and horror as several-meter-thick debris flows raced through the community at ~7 m/s, taking 23 lives and damaging or destroying several hundred homes. These destructive flows were tightly linked to the Thomas Fire that had scorched the hills above Montecito less than a month earlier. Around 3:40 am that fateful morning, an intense cloudburst dropped 15 mm of rain in only five minutes, the debris flows beginning within minutes. A large gas explosion and fire along San Ysidro Creek stemming from a ruptured gas pipeline illuminated the destruction. The intensity of the flow's quickly moving front of mud and boulders (some bigger than cars) shook the ground, generating the loud, grinding rumble of a freight train.

The following days, UCSB assembled a team of 12 physical and social scientists to study the flows' aftermath. Earth scientists involved include two graduate students, Chandler Adamaitis and Paul Alessio, as well as professors Tom Dunne, Chen Ji, Ed Keller, and Kristin Morell. Their objective is to better understand how and where the mud-matrix of the flows was generated, and to determine their volume. Before and after LiDAR images are being employed to quantify the topographic changes wrought by the catastrophe. They are also studying and dating other flows that have occurred in Santa Barbara and Montecito



over the past 100,000 years to better understand the recurrence interval of these events. The objectives of the social scientists on the team, professors Sarah Anderson (Bren School) and Summer Gray (Environmental Studies Program), and graduate students Michelle Shetyne and Erica Goto, include evaluating how people perceive hazard and the factors influencing decisions to evacuate. To this end, the results of 535 questionnaires completed by Montecitans, and the transcripts of ~20 comprehensive interviews, are being evaluated.

Prior to the events of January 9th, few people in the community had more than an abstract awareness of what debris flows are, or why they happen. Since then, our team has presented a series of talks aimed at educating the public about this kind of natural disaster, one that happens with devastating frequency, even on a human timescale.

Faculty Awards

Susannah Porter

Susannah Porter was elected a Fellow of the Paleontological Society, an honor reserved for scientists who have made significant contributions to paleontology through research, teaching, and service to the profession. Dr. Porter was cited for her influential work on the Neoproterozoic and Cambrian, spanning a kaleidoscope of topics, including early eukaryotes and the evolution of animal biomineralization. In addition to her exemplary dedication to her research, she is peerless in her commitment to teaching and mentorship.



Bruce Luyendyk

During a high school chemistry class visit to San Diego State, Bruce Luyendyk discovered that the basement of the Chemistry-Geology building was lined with rock cases and photos of students on field trips—camping! That was it. He was going to study geology. A SDSU classmate joined a Scripps Institution of Oceanography research cruise. Bruce quickly followed suit, embarking on a six-month long cruise (PROA) to the southwest Pacific in 1962. More was known about the surface of the moon than about the ocean bottom, so the latter was primed for breakthroughs. He completed a Ph.D. at Scripps where he overlapped with Tanya Atwater. From there, Bruce secured a position at Woods Hole Oceanographic Institution, where he met grad student Ken Macdonald, whom he advised on Project FAMOUS centering the Mid-Atlantic Ridge. Bruce also served as co-chief scientist on legs 26 and 49 of the Deep Sea Drilling Project.

An invitation to apply for a UCSB position thrilled Bruce, but this meant trading boats for boots. Hoping that paleomagnetism might reveal the cause of the left bend in the San Andreas fault, he recruited grad student Marc Kamerling to begin work on the western Transverse Ranges. They found that the ranges had rotated 90° clockwise. Although this didn't solve the problem of the bend, it was still an astounding finding. Work over the next decade revealed similar clockwise rotations throughout Southern California.

Combining his interests in marine geology and paleomagnetism, Bruce joined Cliff Hopson's expeditions to the Oman ophiolite. He and Ron Day made two sampling trips to those spectacular outcrops, where the Moho is actually exposed!

Missing the sea, for a time Bruce surveyed faults in the Santa Barbara Channel. He then joined the RISE project on the East Pacific Rise, famed for its discovery of black smokers. Together with Ken Macdonald, Tanya Atwater, and Rachel Haymon, UCSB made history!

Bruce extended his paleomagnetic work to New Zealand, completing a project in the Southern Alps with Dave Kimbrough. Deep weathering and heavy vegetation cover prompted them to jump to Antarctica's pristine outcrops, with grad student Christine Siddoway. Bruce has since made eight more visits to Antarctica.



Left to right: Steve Richard, Christine Smith, Bruce Luyendyk, and Dave Kimbrough on Swarm Peak, Antarctica, Christmas Eve 1989. Mount Luyendyk behind Steve and Chris. Photo: Steve Tucker

With former graduate student Scott Hornafius, Bruce contributed to a decade-long survey of hydrocarbon seeps offshore UCSB. Personnel from Earth Science, Geography, and Bren became involved in this multidisciplinary study, which continues to this day.

Bruce started the department's geophysics curriculum, being the only geophysicist on staff at first. A highlight of his offerings included joint field studies with UCLA students in the Ivanpah Valley and Long Valley. Bruce also took students on five marine expeditions, including icebreaker voyages to Antarctica and a crossing of the equatorial Pacific.

Inexplicably (to him), Bruce served as director of the Institute for Crustal Studies (now joined with ERI) for ten years, department chair for six, and Associate Dean of Sciences for five! He is a Fellow of the Geological Society of America, American Geophysical Union, and American Association for the Advancement of Science. Mount Luyendyk in Antarctica, named in 2016, honors Bruce's research accomplishments there.

Bruce remains active by editing and writing articles on Antarctica, marine geology, and California geology in Wikipedia.

Bruce thanks his many colleagues over the years including Ken Macdonald, Chris Sorlien, and Douglas Wilson, his talented grad and undergraduate students, and the skilled and patient members of our staff, all of whom have contributed to our very special department.

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Summer Field 2019, Ely, Nevada. Photo: Todd Penniman

EARTH SCIENCE NEWS