geophysics

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International Ocean Discovery Program (IODP)

Above Picture -Credit: Hugo Pouderoux, University of Rennes I

Front Cover picture: -Credit: Marina Frederik, BPPT

More about Dr. Brandon Dugan's IODP Article: "Researchers drill deep to unearth cause of 2004 Sumatra megaquake", Go to Mines News Room.

SAVE THE DATE

Look for **Geophysics** participation in the upcoming *#idigmines* campaign in **FEBRUARY 2018**!

Thank you, Dr. Bob Benson for your many years of dedicated service and contributions to RCP. Bob will be moving on to other opportunities in academia and industry.

MINES PROMOTES WOMEN IN STEM

Mandy Schindler & Katherine Biegel were among the many volunteers from Colorado School of Mines who partnered with Dr. Martin Luther King Jr. Early College in Denver on Saturday, April 15, 2017. They set up presentations and demonstrations, which included drilling for oil—aka maple syrup—with the Petroleum Engineering Department, and mining for chocolate chips from cookies with the Mining Department.. The Geophysics Department demonstrated small-scale earthquakes using a watermelon as a model for Earth.

GEORGIANNA ZELENAK

Georgiana graduated from Mines with a bachelor's degree in geophysical engineering and then went to Grad school at Scripps Institution of Oceanography. Now she is a SEA's science operations coordinator.

Learn more about Georgianna, click here.

From the Department Head...

It is a pleasure to write this introduction together as outgoing department head and incoming department head. The department has gone through a tumultuous season of change, as we had a huge turnover of faculty members. Fortunately, the CSM administration has allowed the department to make 6 new hires in the last two years, and the department did well in attracting top-candidates. The new hires of the last year are described on page 4. Going through this hire process was labor-intensive, and the rate of change in the department was an emotional drain at times. But this process was all carried out in a great spirit of collaboration and comradery. We especially want to thank Michelle Szobody and Joana Perez for their support in this time of change. It is a pleasure to work with the wonderful faculty and staff in our department.

But the department went beyond replacing its ranks. The ability to make new hires was an opportunity to strike out in new directions. Such new directions are also needed to make the department, and its students, less dependent on fluctuating energy prices. We have started the Reimagine Geophysics project, which is described on more detail on page 11. We expect to roll out a new geophysics curriculum in the 2018-2019 academic year.

At the beginning of the fall semester Roel Snieder moved out of the department to be Professor of Professional Development Education, while John Bradford joined CSM in his role of Department Head of Geophysics. To make the transition as smooth as possible we collaborated intensively during the spring and summer, and continue to do so in the fall semester. It is pleasure for both of us to serve the geophysics department and to work together in such a collegial way.
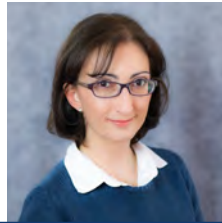
Roel Snieder

John Bradford

Welcome to the Department. . .

*The department has seen a 50% turnover in the last few years. We are thrilled that the Mines administration allowed us to hire new colleagues, which provide us with an opportunity to move in new directions.
We welcome our new colleagues and are excited to work with them.*

EBRU BOZDAG

is Assistant Professor in global computational seismology. Ebru received a PhD from Utrecht University, did a postdoc at Princeton University, and most recently worked at the University of Côte d'Azur in France, as Assistant Professor and held a Chaire d'Excellence position. Ebru's work will help the department to broaden out in whole-earth geophysics, and in numerical global wave simulations.
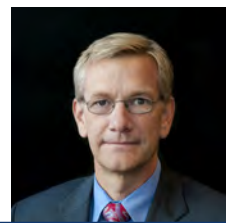
JOHN H. BRADFORD

joined us in August as the new Department Head. He came from the Department of Geosciences at Boise State University. As past President of the Society of Exploration Geophysicists, John is well connected in the geophysics community. John runs an active research program in near-surface geophysics, and has been supported through the program Geoscientists Without Borders in a project to characterize aquifer degradation in Bénin, West Africa.

JOANA E. PEREZ

joined the Geophysics Department last September as Administrative Assistant. She worked at the University of Colorado Anschutz Medical Campus for several years before moving to Florida. She is a Colorado native who returned home last year, and fortunately joined the department.

JEFF SHRAGGE

joins us as an Associate Professor. He arrived in July from the University of Western Australia in Perth. Jeff received a PhD degree from Stanford University and has broad experience in Exploration Seismology and near-surface Geophysics. He will join the Center of Wave Phenomena (CWP) and will bring in expertise in industrial aspects of computational seismology and high-performance computing. He is known for his enthusiasm and perseverance, which he recently showed by bicycling across Australia, a distance of 2600 miles, in six weeks.

ALI TURA

became Director of RCP in December, 2016. His expertise is in the areas of seismic data processing, seismic analysis, time-lapse seismic, rock physics, fiber optic technology and data analytics. Prior to joining the department, he was a Geophysical Senior Fellow at ConocoPhillips and Geophysical Advisor at Chevron. Ali was also a founding member of a seismic R&D company. Ali leads RCP research as Phase XVII begins with a focus on a unique and comprehensive integrated pilot project in the Eagle Ford Basin.

HONORS & KUDOS

YAOGUO LI

will receive Honorary Membership of the Society of Exploration Geophysicists at its Annual Meeting in September. Yaoguo serves as an Associate Editor of the journal *GEOPHYSICS*, and has contributed to the field of gravity, gradiometry, magnetic, and electrical methods by publishing more than 80 papers on leading geophysical journals.

ANDREI SWIDINSKY

received the Geophysics Senior Class Faculty Award. Andrei not only runs an active research program, but he is a much-appreciated teacher. Andrei also leads the annual Geophysics Field Camp, which is an important part of our curriculum and which provides a formative, hands-on, applied geophysical experience for our students.

ILYA TSVANKIN

will take a sabbatical leave in the spring of 2018. He will work on joint research projects at the Curtin University of Technology in Perth, Australia, and the Free University of Berlin in Germany. During the sabbatical he also plans to teach his professional short course on seismic anisotropy for local geophysical societies.
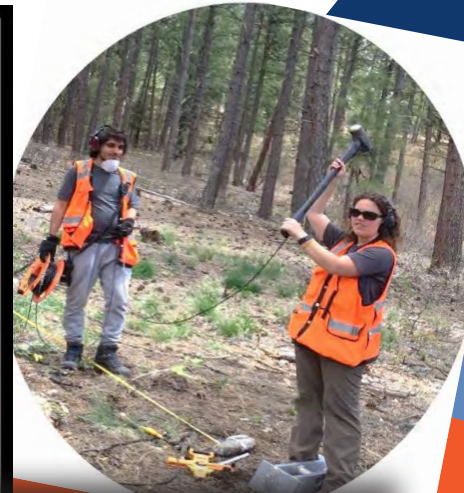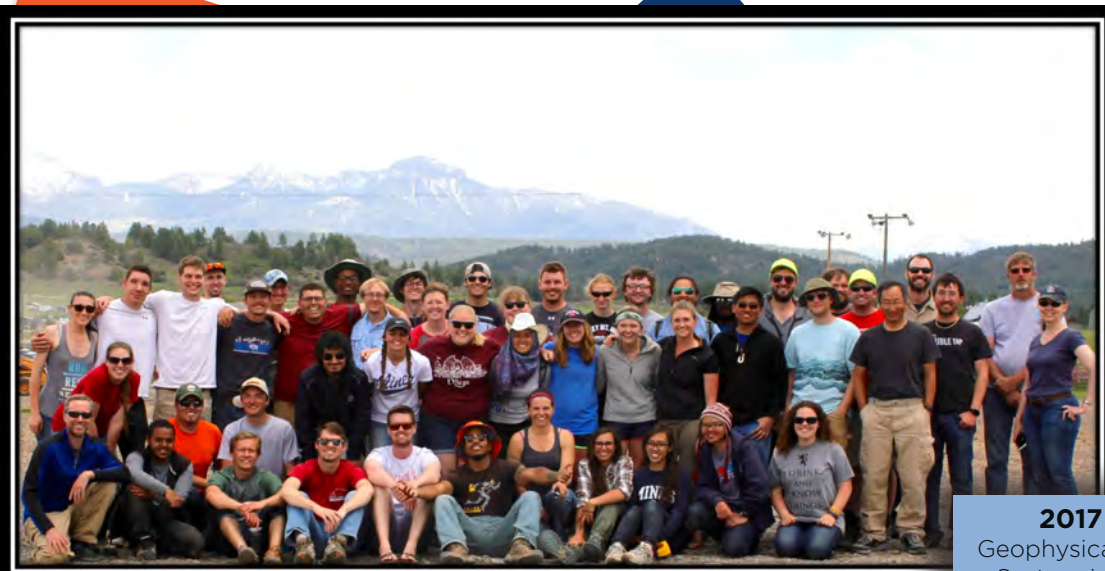
Your Support Matters !

Our generous individual and corporate donors have made possible many projects this year. This includes the Geophysics field session, and travel funding for students to attend scientific conferences or to participate in specialized design projects and undergraduate research experiences. We have been able to assist our new faculty with professional development opportunities and new research projects. Your contributions also make this annual newsletter publication possible.

In particular, we acknowledge our biggest financial sponsors, including **Anadarko Petroleum Corporation**, **Apache Corporation**, **Chevron**, **ConocoPhillips**, **ExxonMobil**, **Hess Corporation**, and **Shell**. We thank in particular a donor, who wishes to remain anonymous, who pledged $25,000 to establish the *Terence K. Young fund*. Your gifts, whatever the size, are all the more significant to us, given the variable markets. **We appreciate all of our sponsors.**

Thank you

COLORADO SCHOOL OF MINES
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DEPARTMENT OF **GEOPHYSICS**

> Studying abroad was the single best experience of my undergraduate career. Students come from all over the world to attend the University of Cape Town, so I was able to connect with people from Namibia, Uganda, Norway, Kenya, Denmark, Angola, Canada, etc. The global perspective I gained by studying abroad also benefited my career by showing me first hand the types of problems that are prevalent in the world and how the tool's I've gained at Mines can help solve some of these problems. I would recommend studying abroad to everyone interested in personal and professional growth.
>
> –Aspen Anderson, Senior Class of Dec. '17

2017 Geophysical Field Camp
Geophysical Investigation of the Geothermal System in Chromo & Pagosa Springs, CO.
http://geophysics.mines.edu/GEO-Field-Camp

Senior Design Projects - Hawaii Volcanoes National Park
Monitoring changes in lava lake level in the Halema'um'u crater on Kilauea Volcano (with gravity and EM) and detection of ancient agricultural walls at Kahuku (EM, mag, GPR)

Center for Wave Phenomena

Space Research

*Alicia Arias, MS Student; Thomas Rapstine, MS Student;
Paul Sava, Associate Professor*

Environmental impact and the cost of acquiring geophysical data are major factors to consider when designing and conducting a geophysical survey. Modern advances in robotics, computing, and sensor design have allowed for the innovation of conventional geophysical acquisition instruments and surveying methods. The Center for Wave Phenomena (CWP) is currently collaborating with the Electrical and Mechanical Engineering departments to develop autonomous airborne and land-based acquisition systems to propel geophysics into the 21st century.

There are many geophysical data types; however, in CWP we are currently focusing on gathering ground penetrating radar (GPR) and seismic data using autonomous vehicles. Development of such systems is motivated by current inefficient and inaccurate acquisition techniques, which commonly rely on human-driven instruments. Survey efficiency, accuracy, and safety can be improved by removing the reliance on a human driver through the integration of robotic autonomy.

The Geobot project, led by Alicia Arias, uses an autonomous terrestrial vehicle to gather high density GPR data for more accurate shallow subsurface prospecting.

Thomas Rapstine is leading an airborne project aiming to acquire seismic data by incorporating stereo camera and laser systems. The Geobot and drone vehicles are shown on CSM campus in front of Mt. Zion. To date, several reports and presentations at the CWP sponsors CWP Project Review Meeting and the SEG Annual meeting have been submitted pertaining to this project.
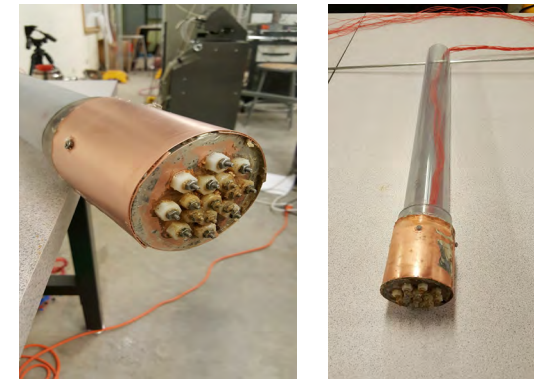

For more information about CWP.

Electromagnetic Resource Exploration Group

Application of DC Resistivity to Model Tunnel Boring Machine in Laboratory Environment

Max Mifkovic, MS Student; Andrei Swidinsky, Assistant Professor

Tunnel Boring Machines (TBMs)

are mechanical feats of modern human achievement. These machines are designed for excavating subsurface material while simultaneously installing a concrete tunnel lining. TBMs are highly specialized machines and are more efficient than more traditional tunneling methods such as Sequential Excavation or Cut and Cover. Despite such advantages, TBMs and other tunneling methods suffer from a lack of geophysical knowledge. Prior to many tunneling excavations, a geological survey is performed, as well as a collecting geotechnical measurements and drilling a few boreholes. Geophysics is beneficial to tunneling because it may detect anomalies ahead of the tunneling face

that cannot be noticed with just boreholes. Anomalous features such as voids, large boulders, and man-made objects or structures can damage TBMs and impede progress. A well known geophysical method, DC Resistivity, is being applied to a model TBM on a laboratory scale. Data is being collecting in a tank that can be filled be various materials to mimic real geological environments.

Preliminary experiments include a tank filled with saline water and a homogeneous tank of sand.

These experiments are performed multiple times to calibrate the model TBMs and determine the repeatability and resolution of this method. Future experiments include homogeneous tanks with a buried target and layered geology.

Eventually the goal is applying DC Resistivity on a real TBM and advancing the tunneling industry with valuable geophysical methods.

Seattle Viaduct TBM View from Below and Above

Reservoir Characterization Project

RCP Team Members

Dr. Ali Tura joined MINES as Director of RCP and Professor of Geophysics. Previous responsibilities include technology leadership as Senior Fellow at ConocoPhillips, time-lapse seismic reservoir monitoring at Chevron and Shell, and amplitude-preserving migration-based AVO analysis at Elf. Ali received a BS degree from Istanbul University, and an MS and PhD from the University of California, Berkeley, all in Engineering Geosciences. Ali is active within the SEG, serving as SEG Vice-president, Vice-Chairman and Chairman of the SEG Global Affairs Committee, and Chairman of the SEG Research Committee. He has served as Chairman of the editorial board of *The Leading Edge* and Associate Editor of *GEOPHYSICS*.

Dr. Jim Simmons

joined RCP in April 2017 as Research Associate Professor.

Jim has over 25 years of experience in 3D 3C surface and borehole seismic data processing and imaging in the areas of multicomponent seismic, modeling, inversion, surface seismic and vertical-seismic profile (VSP) processing and analysis. Jim received his BS, MA and PhD degrees in geophysics from the University of Texas at Austin.

Sue Jackson

joined RCP in 2014. As Program Manager, Sue coordinates and tracks RCP's applied research projects with industry sponsors and student teams. She is responsible for business planning, budgeting and contracts. Prior to RCP, Sue served in management roles at ION; she began her career as a geophysicist with Anadarko. Sue holds a BS in Geology and MA in Education from the University of Colorado.

Larry Irons

came on board in April 2017 as RCP Systems and Software Support Engineer. Larry supervises and maintains RCP's computer hardware, software and data inventories. Larry has 18 years of experience in IT and software development, and 22 years of professional geophysical experience in the petroleum and environmental industries. Larry holds BS and MS degrees in geology from the University of Nebraska.

Cindy Herb

joined RCP in March 2017 as RCP's Administrator, assisting the RCP Director and Program Manager in day to day operations, including coordinating events and website maintenance.

Phase XVII Eagle Ford Project:

We are proud to announce Phase XVII of RCP where we are fortunate to be exposed to a comprehensive geophysical, geological, geochemical, completions, and production data set from a massive pilot project provided by Devon Energy in the Eagle Ford, Texas. These data will enable us to integrate a vast array of observations and study new areas of research related to fiber optics and data analytics.
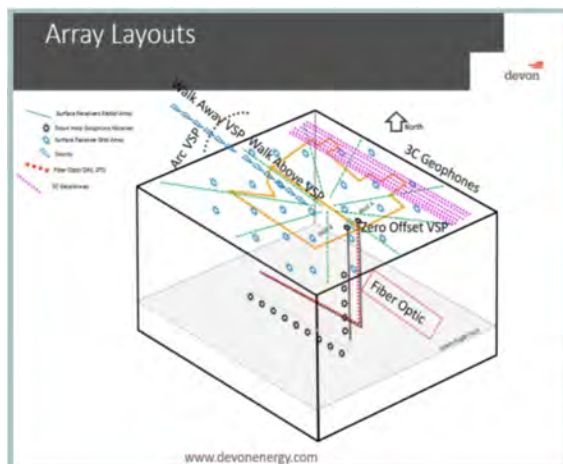
For more details about RCP, please click here.

Reimagine Geophysics

Ebru Bozdag, John Bradford, Brandon Dugan, Paul Sava (Chair), Andrei Swidinsky, Whitney Trainor-Guitton

As data sets become higher resolution and larger and as society's needs change, the Department of Geophysics developed a vision for geophysics in the 21st century and how we can set the standards for excellence in geophysics research and education that address major societal challenges. The Reimagine Geophysics committee, chaired by Paul Sava, identified three key research themes where we can build on our existing strengths and develop new lines of research:

(1) robotic and autonomous geophysical data acquisition;

(2) geophysical processing and interpretation of increasingly large volumes of data;

(3) geophysical assessment that integrates geological features and geophysical fields at multiple scales.

Inherent with each of these themes is the need for excellence in computing to meet the needs of modern computational geophysics in the high-performance computing era. The research portfolio of the department is starting to address these themes, but we see opportunities for immense growth. To continue this growth, we anticipate using future faculty positions to increase the breadth and diversity of the department.

While defining our vision, we also evaluated our current curriculum and will propose a new curriculum to the administration for implementation in Fall 2018. The proposed curriculum maintains current strengths we have – field camp, geophysics methods, and senior design – but adds new components and flexibility. With data volumes and computing being central to 21st century geophysics, we are including probability and statistics, linear algebra, data analytics, and two geophysics computing courses to the curriculum. We also added two physics of the earth courses to build strong links between geology, geophysics, geodynamics, mathematics, and computing to understand the mechanisms shaping our world and the solar system at global and planetary scales. Another adaptation is offering greater flexibility in geology and geophysics electives to allow students to design their geophysics path for their interests and needs. One last addition is a geophysics-directed communication course because geophysicists need to be prepared to communicate with scientists, engineers, and society.

As we Reimagine Geophysics within the department, we will maintain our high standards, expand our horizons, push forward research boundaries, and train the next generation of geophysicists. We welcome any input and thoughts you have on geophysics in the 21st century.

Adren Rigdon; Ammar Mohammad Anuar; Ashton Krajnovich; Blake Cross; Brennah McVey; Diana Tamayo; Eric Bunzli; Glenna Crookston; Hanna Flamme; Hannah Peterson; Hayden Powers; Hubbell Rowe; Iker Madera; Jalen Champagne; James Hogan; James Jordan; Jared J. Stultz; Jill Remmers; Joseph Halloran; Juliann Coffey; Katherine Biegel; Liam Mahoney; Logan Copass; Lorena Tello; Luke Brown; Max Mifkovic; Micaela & Michelle Pedrazas Hinojosa; Mitchell Paradis; Morgan Sander-Olhoeft; Patrick Carabello; Samuel Courville; Tasha Markley; Taylor MacKay; Teresa Pilato; Travis Hastings; Whitney Schultz; William Boni; Zucheng Zhang

Abigail Michel; Andrea Balza; Austin Bailey; Benjamin Bloss; Carlos Convers Gomez; Jacob Utley; James Johnson; Karla Avila Vizeutt; Paula Barbosa Murillo; Piyanan Chanchompoo; Prat Boonyasatphan

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