

MINES GEOPHYSICS

REVEALING THE DYNAMICS OF THE EARTH | FALL 2023



COLORADO SCHOOL OF
MINES
@150 | 1874-2024

Fall 2023

Department Head

Dr. Paul Sava
psava@mines.edu

Associate Department Head

Dr. Brandon Dugan
dugan@mines.edu

Department Manager

Lynn Lundebrek
llundebrek@mines.edu

Newsletter Staff

Ilya Tsvankin
Noelle Vance
Melinda Gale
Ahmed Ahmed
Brett Bernstein
Ashish Kumar
Chloe Locke
Job Urang
Cullen Young
Shihao Yuan

Cover Photo

Ahmed Ahmed

- 3 On the Cover
- 4 Welcome from the Department Head
- 6 New Directions in Research
- 10 Research Conversation
- 12 Kudos and Congratulations
- 14 Fall Social Events
- 16 Student Clubs
- 18 Introducing New Graduate Students
- 20 Field Camp
- 22 Summer Internships
- 26 Alumni News
- 28 In Memoriam

connect with us



www.facebook.com/MinesGeophysics



[@MinesGeophysics](https://twitter.com/MinesGeophysics)



[@SGGSMines](https://www.instagram.com/SGGSMines)



www.linkedin.com/groups/13829862

COLORADO SCHOOL OF MINES

1500 Illinois Street
Golden, CO 80401
303-273-3000 or
800-446-9488

GEOPHYSICS ADDRESS:

Geophysics Office, Room 283,
Green Center
924 16th St.
Golden, CO 80401
303-273-3451
geophysics.mines.edu

From the Department Head



Dear Friends and Colleagues,

Greetings and a warm welcome to the latest edition of the Geophysics Newsletter. We hope this message finds you in good health and engaged in pursuits that bring you joy and fulfillment.

We are thrilled to share some of the exciting developments shaping our program. This newsletter highlights the great strides we are taking in our research by exploring new frontiers in CO2 sequestration, searching for geological hydrogen resources, and monitoring permafrost, among many others. These initiatives underscore our commitment to addressing pressing global challenges and advancing the boundaries of our profession. Our researchers stand at the forefront of these groundbreaking efforts, exemplifying the strength and dedication of our community. We invite you to explore their achievements and learn about the recent notable recognitions of our researchers.

I also encourage you to explore the dynamic activities of our students, witnessing how the next generation of geophysicists actively contributes to and shapes our enduring legacy. We are also delighted to share the success of our recent Geophysics Field Camp. The presence of VIP visitors, including President Johnson and esteemed alumni, underscores the wide recognition of our field program and the deep connections we maintain within the Geophysics family across generations.

With a heavy heart, we also acknowledge the recent passing of Dr. Alexander Kaufman, a legendary Mines Geophysics professor. His indelible mark on our program, through exceptional teaching and unwavering student support, is a reference point for our continued commitment to excellence. As we mourn his loss, we also celebrate his enduring legacy and rededicate ourselves to the pursuit of teaching excellence for future generations of geophysicists.

As we look ahead, we are excited to remind you of the upcoming GP@100 celebration in 2026. Join us in celebrating a century of distinctive geophysics scholarship! Please explore the historical journey of our program in Melinda Gale's article, and mark your calendars for the array of events planned throughout the coming years. Your participation is invaluable in making this celebration unique, honoring our shared history, and envisioning a bright future for Mines Geophysics. We look forward to celebrating, connecting, and advancing the legacy of our program with each of you.

Be safe! Stay in touch!

Paul

Cover Photo: The United States Geological Survey (USGS) and Mines broke ground on a new Energy and Minerals Research Facility in November. Funded by the Bipartisan Infrastructure Law, the research facility will be built on the Mines campus and house both USGS researchers and university professors. Specifically, the USGS Geology, Geophysics and Geochemistry Science Center and the Central Energy Resources Science Center will be located in the building as will several of the Mines Geophysics Department's faculty and labs. On the cover is the official groundbreaking of the building. —Noelle Vance

CARBONSAFE AIMS TO SEQUESTER CO₂ WHILE ENGAGING COMMUNITY

Carbon capture, utilization, and storage (CCUS) technologies offer a crucial way to mitigate global climate change, create economic opportunities and provide clean energy in the United States and globally. A \$32.6 million grant has been awarded to Mines, Carbon America, and Los Alamos National Laboratory through the U.S. Department of Energy's Carbon Storage Assurance Facility Enterprise (CarbonSAFE) initiative. This grant aims to advance the development of a potential carbon storage hub for the Pueblo, Colorado, area, while garnering community support by emphasizing both technical and social facets. The project will accelerate large-scale, commercial carbon storage pro-

targets.”

Over three years, the project will cover a range of substantial tasks, such as data collection (geological and geophysical), detailed site characterization, planning, drilling, and the submission of two well permit applications. Additionally, the project will conduct essential studies on CO₂ sources, pipeline capacity, transportation logistics, job creation, and community engagement.

The project's groundbreaking aspect is its equal emphasis on both technical and social science facets. “Though sequestering 50 million metric tons of CO₂ represents only a fraction of emissions reduction goals, this project

“Though sequestering 50 million metric tons of CO₂ represents only a fraction of emissions reduction goals, this project serves as a model for community-centric CCUS, inclusive of community feedback, to support sustainable economic and social development goals.”

—Manika Prasad, Director, Mines CCUS Innovation Center

jects capable of securely storing 50 million metric tons or more of CO₂ deep underground (> 800 meters).

“In Colorado, there is currently limited activity related to carbon storage, nothing on the scale of sequestering 50 million metric tons of CO₂ over a 30-year period,” said Geophysics Professor Manika Prasad, director of the Mines CCUS Innovation Center and principal investigator of the project, called Eos. “This project will assess the potential for long-term, cost-effective CO₂ storage to meet regional emission

serves as a model for community-centric CCUS, inclusive of community feedback, to support sustainable economic and social development goals,” said Prasad. “We need to avoid operations without due diligence, community acceptance, and responsible management.”

Geophysics plays a pivotal role in advancing and supporting CCUS efforts. Project Eos will train a generation of CCUS professionals and chart a new direction for Mines as it develops innovative geophysical methods and technologies.—*Shihao Yuan, Research Associate*

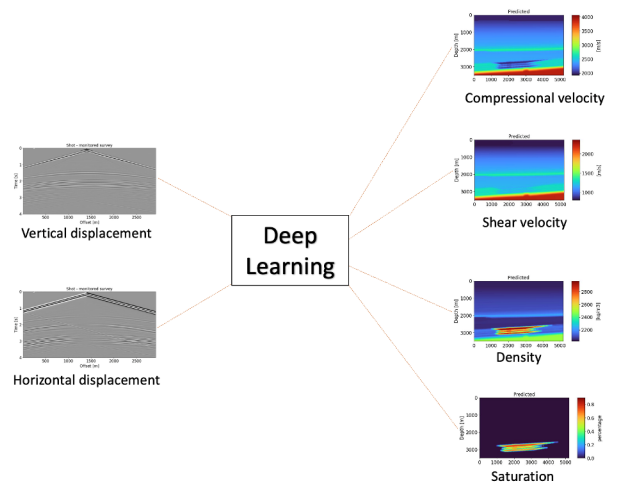
PROJECT SEEKS NEW METHOD TO MONITOR CO₂ SEQUESTRATION

Professor Ilya Tsvankin and PhD student Ahmed Ahmed are extending a novel methodology for time-lapse seismic monitoring developed for acoustic models to elastic (and, potentially, anisotropic) media. The work should make this technique applicable to a wide range of time-lapse projects dealing with hydrocarbon production and CO₂ sequestration.

The work builds upon a joint project with INPEX (the largest Japanese oil/gas company) on elastic full-waveform inversion (FWI) of time-lapse seismic data from anisotropic media. Within the framework of the project, which began in 2022, INPEX has provided research funding and a field data set to the Center for Wave Phenomena (CWP).

The first goal of the project was to extend time-lapse FWI to elastic transversely isotropic models with a tilted symmetry axis (TTI media), which describe dipping anisotropic formations, such as shale layers near salt domes in the Gulf of Mexico. The TTI time-lapse FWI algorithm developed by Yanhua Liu '23, PhD geophysics and Tsvankin was successfully tested on realistic synthetic models. The results were described in Liu's thesis and will be published.

The second phase of the project involved application of anisotropic time-lapse FWI to seismic surveys (baseline and monitor) acquired in the oil/gas Pyrenees field located offshore Australia. This work, performed by Liu and Tsvankin in collaboration with Drs. S. Masaya and M. Tani from INPEX, has produced high-resolution estimates of the temporal variations in the medium parameters and valuable insights into the reservoir's production. A paper based on the results



Ahmed Ahmed

Prediction of reservoir parameters from full-waveform inversion combined with convolutional neural network.

of this case study is being prepared for publication.

In 2023, INPEX and CWP decided to extend this project to monitoring of CO₂ sequestration (a potentially important technology that should help reduce carbon emissions) using machine learning. Liu, who defended her PhD thesis in August 2023, has combined elastic FWI and physics-based information with a convolutional neural network capable of predicting temporal changes in velocity and saturation for acoustic models. This network has been successfully applied to the synthetic Kimberlina data set provided by the Department of Energy. Tsvankin and Ahmed are expanding the scope of this research by generalizing the developed methodology for elastic and anisotropic media.

—Ahmed Ahmed, Student

NEW CONSORTIUM FOCUSES ON THE FUTURE OF HYDROGEN

A new consortium focused on hydrogen gas research is forming as a collaboration between Mines and the United States Geological Survey (USGS). The consortium is led by Dr. Geoffrey Ellis (USGS, Mines-affiliated faculty), Dr. Yaoguo Li (Geophysics), and Dr. Mengli Zhang (Geophysics). The consortium will receive several million dollars of funding over five years and includes support from companies including BP, Chevron, Fortescue Future Industry, HyTerra, Koloma, and Petrobras. It forms at a time when a new wave of hydrogen research is emerging in developing clean and sustainable energy resources. Hydrogen as an energy source could replace fossil fuels in long-haul transport and heavy industries, such as steelmaking.

Today, the world's hydrogen is manufactured industrially, but new research has found that Earth may hold vast deposits of the gas that could be extracted directly or through stimulation by pumping water or catalysts. Researchers have a "Hydrogen Rainbow" chart to distinguish the different ways in which hydrogen is acquired, and the resulting emissions associated with each type.

Gray hydrogen is the result of a manufacturing process that "combines steam and methane in factories, [which has the drawback of] emitting carbon dioxide and adding to global warming" [1]. Efforts are being made to make hydrogen cleanly by capturing the carbon dioxide from gray hydrogen and then sequestering it underground with regular monitoring, which produces blue hydrogen. Outside the manufacturing process, hydrogen can be acquired without carbon emissions by using renewable electricity to split water and capture the resulting

hydrogen, known as green hydrogen. The last color of interest, and the focus of the new consortium, is gold hydrogen, which is naturally occurring, accumulated deposits in the subsurface.

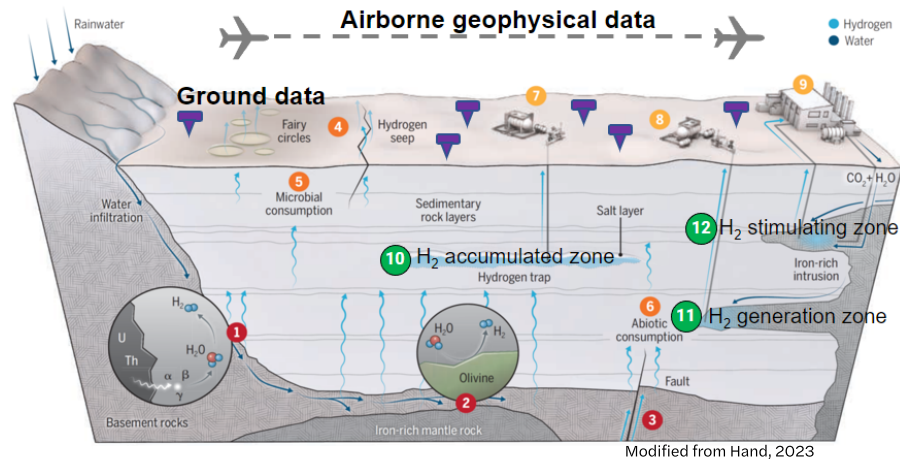
The Hydrogen Rainbow

-  **Gray hydrogen** Made from fossil fuels, which release carbon dioxide and add to global warming.
-  **Blue hydrogen** Same as gray hydrogen, but the carbon is captured and sequestered.
-  **Green hydrogen** Made without carbon emissions by using renewable electricity to split water.
-  **Gold hydrogen** Tapped from natural subsurface accumulations.
-  **Orange hydrogen** Stimulated by pumping water into deep source rocks.

Fig. 1. The Hydrogen Rainbow chart shows the types of hydrogen that exist and the corresponding acquisition and emissions from each type. Figure modified from Science [1].

Naturally occurring hydrogen can form in a few different mechanisms/sources including radiolysis, serpentinization, and deep-seated hydrogen source. Radiolysis (red (1) in Figure 2) is when "trace radioactive elements in the rock emit radiation that can split water. This process is slow, producing small amounts of hydrogen a year, so ancient rocks are most likely to generate hydrogen" [2]. Serpentinization (red (2)) occurs at "high temperatures, when water reacts with iron-rich rocks to make hydrogen" [3]. This fast reaction drives most production. The process can continue as long as there is an iron

Fig. 2. Conceptual geologic cross-section of hydrogen deposits in the subsurface, highlighting generation, loss mechanisms, and extractions.



deposit and only takes months instead of years as in radiolysis. Deep-seated (red (3)) is when streams of hydrogen rise along tectonic plate boundaries.

Deposits of gold hydrogen may pave the way for a boom in the energy industry as it looks to achieve net-zero emissions. The current hydrogen market is estimated around \$130 billion, but is expected to reach \$220 billion by 2030 [4]. This increase could be contributed to by the discovery of geologic hydrogen deposits, estimated to be extracted at a rate of 23 million tons per year [3]. An increase in hydrogen availability may help bolster industries such as steel manufacturing. Potentially, up to 10% of steel produced worldwide will use hydrogen to replace coal as a reductant [5]. Transportation industries, such as trucking, shipping, and avia-

tion, are poised to benefit from hydrogen as a low-emission, synthetic fuel [6]. The pursuit of gold hydrogen resources will be a multidisciplinary effort by many organizations worldwide that may increase the worth of the energy industry and help transition it to a cleaner future.

The USGS-Mines consortium will focus on modeling and imaging of existing gold hydrogen deposits and develop methods to explore for new deposits. The group will use experimental simulations, field-based modeling, and numerical simulations to understand hydrogen generation and migration mechanisms, as well as reservoir properties. The aim is to use a variety of geophysical methods including electromagnetics, gravity magnetics, and seismic to improve our understanding of geologic hydrogen exploration.

— Brett Bernstein and Cullen Young, Students

[1] E. Hand, "Hidden hydrogen," *Science*, vol. 379, no. 6633, pp. 630–636, 2023. doi:10.1126/science.adh1477

[2] E. Hand "U.S. bets it can drill for climate-friendly hydrogen-just like oil," AAAS Articles DO Group, 2023. doi:10.1126/ science.adk7193

[3] P. Day, "Startups race to strike Hydrogen Gold," *Reuters*, <https://www.reuters.com/business/energy/startups-race-strike-hydrogen-gold-2023-09-07/> (accessed Oct. 17, 2023).

[4] Lee, J. (2022, December 2). Nov 21, 2022: Green Hydrogen. learn climate with me. <https://www.learnclimatewithme.com/nov-21-2022-green-hydrogen/>

[5] M. Wu, "Green Steel: Three milestones on the road to lower carbon emissions," *Wood Mackenzie*, <https://www.woodmac.com/news/opinion/green-steel-three-milestones-on-the-road-to-lower-carbon-emissions/> (accessed Oct. 26, 2023).

[6] "The Blue Green Planet: How Hydrogen can transform the Global Energy Trade," *Wood Mackenzie*, <https://www.woodmac.com/horizons/the-blue-green-planet-how-hydrogen-can-transform-the-global-energy-trade/> (accessed Oct. 26, 2023).

CONVERSATION WITH DR. BENJAMIN HILLS



Tell us about yourself and what you do.

I am a postdoctoral researcher here at Mines. I use geophysical methods to study Earth's ice sheets, how they are

changing and contributing to sea-level rise. Some of the tools I use include ice-penetrating radar, global positioning system (GPS), satellite remote sensing, and numerical models.

What project are you working on?

I am working on a project called “Disentangling Ice-sheet Internal and Basal Processes through Novel Ice-penetrating Radar Integration Built on Scalable, Cloud-based Infrastructure.” The work is funded by the National Science Foundation (NSF) Office of Polar Programs under a Postdoctoral Research Fellowship, a program designed to help early-career scientists become leaders in their field. I work under the mentorship of Dr. Matthew Siegfried.

What is your research goal?

My research has broadly been in polar science with a focus on glacier geophysics. I am generally interested in ice and its behavior as a fluid. A large unknown in projections of future sea-level rise is the dynamic uncertainty in ice sheets, especially the Antarctic ice sheet. Essentially, we still don't have a good idea how quickly it could collapse when the climate changes. My various research projects have either been to investigate past behavior of ice flow or to think about the fundamental fluid properties of ice.

The goals of my postdoctoral research project, specifically, are mainly focused on reprocessing previously collected ice-penetrating radar datasets, creating data products, and integrat-

ing data across instruments using statistical methods. I hope that these newly processed radar data will allow us to tease apart some of the complicated processes that control ice sheet behavior to help understand which are most important in particular ice-sheet settings.

How is your work charting a new course in Antarctica studies and also in geophysics?

Much of the interpretation of ice-penetrating radar data in Antarctica is relatively simple. By that I mean that we use it to constrain the geometry of the ice sheet to know how much ice there is and to input the results into an ice-sheet model. Our work aims to reuse previously acquired radar data in a slightly more sophisticated way to make more profound inferences about ice flow behavior. We hope to make these newly processed datasets and data products available to future researchers as well, so they can build on what we have done.



Kelsey Kushneryk

Ben and colleague, Liam Kirkpatrick, after a day collecting ice-penetrating radar data at Hercules Dome, Antarctica.

How will your research impact the world?

This work is a part of a broader effort to constrain the ice sheet contribution to global sea-level rise. We hope to better understand how ice behaves as a fluid, including past ice flow, both of which will help us make better future projections.

—Job Urang, Student



Permafrost Monitoring

This summer Dr. Eileen Martin returned to Utqiagvik, Alaska where she has been involved in a multi-year permafrost thaw monitoring project. The project, conducted in collaboration with researchers at Penn State University and University of Alaska Fairbanks, has been conducting a multiphysics monitoring campaign for more than two years, and is now recording data for a third year. The continuous monitoring includes two types of fiber-optic sensing (acoustic and temperature) done with two kilometers of fiber-optic cables embedded in the active layer, as well as borehole temperature sensing.

The team previously collected active source multichannel analysis of surface-wave data, core samples and electrical resistivity tomography at certain locations along the study region, providing more certainty in their interpretation of such features as cryopegs and ice-rich zones. You can find more information in a recent

EarthArxiv preprint and open data release led by Hydrologic Science and Engineering PhD student Ahmad Tourei. The work is funded by the NSF Signals in the Soil program.

Martin's work this year primarily focused on basic annual maintenance: copying full-resolution data (too much to be transferred remotely), checking cable installation health, improving cable/connector housing in a shared facility, and re-calibrating instruments. Following this maintenance, she participated in the Permafrost and Infrastructure Symposium, a traveling conference that connected scientists and engineers with local community and government representatives to share experiences, challenges, and mitigation strategies for issues related to permafrost and infrastructure throughout the North Slope, and continuing south to Fairbanks.

—Eileen Martin, Faculty

KUDOS and CONGRATULATIONS

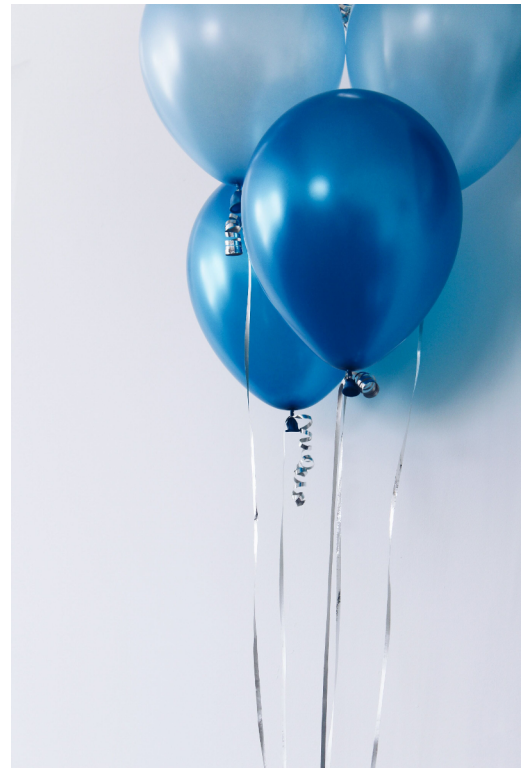
Garcia-Ceballos Takes Top Poster Award



PhD student Ana Garcia-Ceballos' poster, "Monitoring a gas hydrate field with distributed temperature sensing for long-term well integrity," was selected as the Top Student Poster Paper presented at the 2023 International Meeting for Applied Geoscience & Energy (IMAGE). The Society of Exploration Geophysicists (SEG), the American Association of Petroleum Geologists (AAPG) and the Society for Sedimentary Geology (SEPM) hosted IMAGE 2023 in August. SEG and AAPG are global leaders in disseminating high-quality applied-geoscience knowledge and data.

CONGRATULATIONS SUMMER/FALL GRADUATES

Khalid Almuteri, PhD Geophysics
Mohammed Alnabbat, BS Geophysical Engineering
Hani Alzahrani, PhD Geophysics
Wadyan Ayyad, MS Geophysics
Marihelen Held, MS Geophysics
Owen Heupel, BS Geophysical Engineering
Yanhua Liu, PhD Geophysics
Jared Low, MS Geophysics
James McCall, BS Geophysical Engineering
Ali Rabaan, MS Geophysics
Tyler Singleton, BS Geophysical Engineering
Danielle Vonlembke, BS Geophysical Engineering



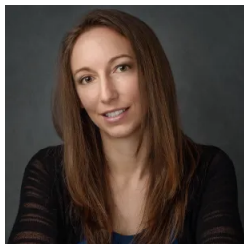
Siora Photography on Unsplash

Bozdağ et al. honored for most influential work



Ebru Bozdağ and her collaborators received the honor of being part of the 100 most influential papers published in *Geophysical Journal International*. The paper, "Global adjoint tomography: First-generation model" is featured in the collection on the revolution in seismic tomography in the first two decades of this century. The journal writes "Bozdağ et al. (2016) led the newest generation of global adjoint tomographic models that revealed an ever more complex and intriguing Earth, interpretable in all of its exquisite detail: the first in a sequence making history that continues to be written (e.g., Karaoğlu & Romanowicz 2018; Lei et al. 2020)."

Snow wins AGU inaugural Open Science Prize



Research Associate Tasha Snow won the inaugural Open Science Prize from the American Geophysical Union's (AGU's) awards, medals, and prizes program. Dr. Snow is one of the leaders in the cloud-computing transition for the NASA Cryospheric Sciences program, developing and supporting a cloud computing environment used by researchers, workshops, and hackweeks across the country. This prize is a (huge) recognition of her hard work over the past two years in the name of open and collaborative science.

Wald Receives USGS Presidential Rank Award



David Wald, USGS Seismologist and GP Affiliate Faculty Member, is one of the 2023 Presidential Rank Awards recipients. The Presidential Rank Awards are the most prestigious honor in the federal career civil service. They are given annually by the President to recognize and celebrate career Senior Executives (SES) and senior career employees — Senior Level (SL) and Scientific or Professional (ST) — for exceptional performance over an extended period of time. Recipients of this award are acknowledged as strong leaders, professionals, and scientists who achieve results and consistently demonstrate the strength, integrity, industry, and relentless commitment that signify excellence in public service.

Jin to Represent District 3 on SEG Council



Assistant Professor Ge Jin has been elected to represent District 3 of the Society of Exploration Geophysicists (SEG) Council. The SEG is a nonprofit organization with 11,000 members in 126 countries. The organization provides information, tools, and resources to advance the science of exploration geophysics, support humanitarian efforts, and accelerate geophysical innovation. Jin hopes to involve more early-career geophysicists in the organization. He will represent Arizona, California, Colorado, Kansas, Nevada, New Mexico and Utah.

FALL SOCIAL EVENTS



Ice Cream Social



The Department kicked off the Fall semester with its annual ice cream social and Welcome Back Barbecue. Good food, good friends, and great geophysics! (Photos by Ahmed Ahmed.)



Welcome Back Barbecue



SWIG CREATES SPACE FOR WOMEN IN GEOSCIENCES

After little activity in recent years, the Society of Women in Geoscience (SWIG) has been revived

by Geophysics sophomore Peyton Chandler who said, “SWIG is important to have on campus because the geoscience majors are small and often overlooked by other organizations, so through SWIG, we can bring this group of people together.”

Chandler, along with the rest of the executive board including Vice President Bee Alcorn (Geology and Geological Engineering), Treasurer Sarah Gerot (Geology and Geological Engineering), Social Chair Chloe Locke (Geophysics), and faculty advisor Manika Prasad (Geophysics), have been working hard to gather interest and create a solid foundation to keep the club going for years to come.

The club’s first official meeting was on September 18, creating a space for women in geosciences around campus to socialize through games and food. Two major goals for SWIG are to highlight successful women in geosciences

and to introduce members to many different career paths in the field. Moving forward, the

executive board intends to host successful women in geoscience fields to speak throughout the year, plan bonding activities for graduate and undergraduate students to build a strong community and do outreach to younger girls to encourage them to pursue a career in geoscience. If you would

be interested in speaking to the group, or getting information on upcoming meetings, the club can be found @minesswig on Instagram and via their email, swig@mines.edu.

In the words of astronaut Sally Ride, “all adventures, especially into new territory, are scary.” As women embark on the adventure of pursuing a career in geosciences, it is ever so important to have guidance and a supportive group to fall back on and encourage them through all aspects of their journey. SWIG intends to be that organization for women on Mines campus.

—Chloe Locke, Student



SGGS HAS FALL FUN

The Society of Geophysics Graduate Students (SGGS) is a group of student leaders within the Department. We are committed to helping bring students together for social activities, and we act as a relay for campus-wide graduate resources. So far this semester we have hosted a number of events such as the weekly departmental coffee hour, a Mines football tailgate, and weekly volleyball games. We are happy with the turnout for our events, and hope that students will continue to stay engaged as we transition into the colder months! Stay on the lookout for more opportunities to socialize and connect with your fellow students in the coming months!

—Brett Bernstein, Student



Nikhil Punithan



Samara Omar

INTRODUCING NEW GRADUATE STUDENTS

Twenty-three graduate students joined the Department this fall. We caught up with a few of them to learn more about them.



Arsya Kadyanto

From: Indonesia

Undergraduate degree: BS in Geophysical Engineering from Mines

Currently working on: MS in Geophysics

What do you do in your free time? I sing for a few Denver barbershop choruses and quartets!



Robert Crummett

From: Nevada

Undergraduate degree: BS in Geophysics, University of Nevada-Reno

Currently working on: PhD in Geophysics

What do you do in your free time? I enjoy live, classic music.



Gianna Job

From: Trinidad & Tobago

Undergraduate degree: BS in GP engineering at Mines

Currently working on: MS in Geophysics

What do you do in your freetime? Read, watch movies, and listen to music.



Nikhil Punithan

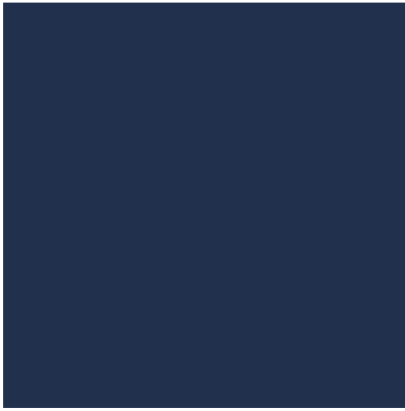
From: Texas

Undergraduate degree: BS in Geophysics at Texas A&M

Currently working on: MS in Geophysics

What do you do in your free time? I enjoy hiking, video games and playing the cello.

New Students



Maksat Jazbay

From: Kazakhstan

Undergraduate degree: BS in Geophysics, University of Texas-Austin

Currently working on: PhD in Geophysics

What do you do in your free time? I like to run, hike, play soccer, work out, and sit in the sun.



Tiago Cabral

From: Brazil

Undergraduate degree: BS in Geophysics, Federal University of Bahia

Currently working on: MS in Geophysics

What do you do in your free time? I enjoy video games, calisthenics and reading.



Scott Mello

From: California

Undergraduate degree: BS in Physics from CU-Boulder

Currently working on: MS in Geophysics

What do you do in your free time? I like to spend time outside hiking, mountain biking, and skiing when I can.



Daniel Davis

From: Kuala Lumpur, Malaysia.

Undergraduate degree: Physics at University Putra Malaysia

MS Degree: Geophysics at Imperial College London

Currently working on: PhD degree in Geophysics

What do you do in your free time? I like to read, travel, video games, and the occasional scuba diving. I also do a bit of Latin dance, namely salsa and bachata.



Undergraduates Jackson Howard and Salem Bin Zaqr honing hammer seismic skills.

Seth Haines

FIELD CAMP 2023

This year's Field Camp continued its tradition of being a transformative experience that immerses undergraduate students in the fascinating world of geophysics. Held in Steamboat Springs, Colorado, students embarked on two weeks of intensive data collection. Students were tasked with designing and executing various geophysical surveys each day. These surveys encompassed a wide range of methods, including hammer seismic, deep seismic, ground-penetrating radar, DC resistivity, Magnetotellurics, and transient electromagnetics.

Twelve undergraduate students, five teaching assistants, and eight faculty members participated in the camp, along with Mines Presi-

dent Paul C. Johnson. In addition, experts from industry and government agencies including the United States Geological Survey (USGS), University of Nevada-Reno, Colorado Geological Survey, and Denver Museum of Nature & Science also shared their knowledge with the students and offered practical guidance on field procedures. The partnerships with professionals in the field ensures students not only gain theoretical understanding but also develop the skills needed to implement these techniques in the field and their future endeavors. Several companies made equipment contributions including GTI, Stryde, and Digital Geo Specialists.

After the data acquisition concluded, stu-

Field Camp



Matthew Siegfried



Brett Bernstein

Left: Undergraduate Haya Alhammad explains how to plant a one-component nodal geophone from Stryde to Mines President Paul Johnson while students, faculty, and alumni look on. Right: Undergraduates Dawn Lipfert and Pablo Chang Huang display the sign announcing their roadside presence as they deploy one-component GTI nodal.

dents returned to the Mines campus to process and interpret their data. Students used their acquired programming skills and existing software to process and model data and produce meaningful information that is interpretable for the purpose of decision making or as research findings while learning to work as a team. In this year's camp, one group of students used transient electromagnetic data they collected to map and characterize a fault in Steamboat

Springs. Another group, harnessing the power of high-performance computing resources, unraveled the mysteries of the Rio Grande rift's extension through northwestern Colorado. These results are being prepared for publication and presentation to the scientific community.

The Field Camp's resounding success and its status as the cornerstone of the Mines' geophysics curriculum underscore its excellence.

—Job Urang, Student



Matthew Siegfried

Summer Internships

MS student **Joseph Cherayil** worked for California Resources Corporation where he was building a geophysical framework in the Sacramento Basin.



MS student **Nicholas Dorogy** worked for BHP in Tucson, Arizona as a member of the Americas Exploration Geoscience team. He focused on new techniques to analyze and incorporate drill hole data in exploration regions.



MS Student **David Herman** interned at Oxy, working with the onshore Permian team. He used a large multiclient 3D seismic survey encompassing several counties on the central basin platform to construct a structural framework and locate prospects in currently held lease areas with potential to expand to new land acquisition. Since this is a new



dataset, his work will be shared with all the business units in the area to aid in the development of exploration resources.

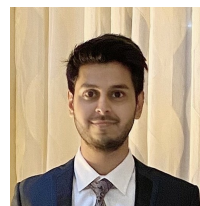
After graduating from Mines with her bachelor's degree, MS student **Gianna Joab** interned with EOG Resources at their headquarters in Houston. She worked as a Geology & Geophysics (G&G) Intern on the International New Ventures team. She evaluated a block in



offshore Malaysia using multiple 3D seismic datasets and well logs. To evaluate the block successfully, she was tasked with understanding the geology and the past productivity rate of the area, as well as the petroleum system. Additionally, once she chose the horizons of interest and the mapped area, she conducted RMS amplitude analysis to understand the meaning and distribution of the amplitudes.

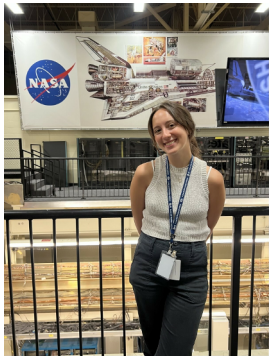
After identifying leads in the area, she computed volumetrics to describe the volume of hydrocarbons in the targeted reservoirs. The internship lasted three months, after which she presented her work to the company's CEO, fellow interns, the chief geophysicist, and exploration managers of the different divisions.

PhD student **Ashish Kumar** had a great summer working as a machine learning intern in the Earth Model building team at Schlumberger (SLB) in Houston. He worked on developing a U-Net workflow based on using a convolutional neural network to automate the process of horizon picking on marine seismic data used for building velocity models. He was also a runner up in the Global Intern hackathon. He cultivated strong and meaningful relationships with both his team members and fellow interns and looks forward to the possibility of maintaining the relationships he forged during the internship.



Internships

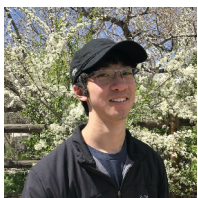
Junior **Chloe Locke** participated in the Lunar and Planetary Institute's internship program. She worked in the Simulant Development Lab at



NASA's Johnson Space Center where she did research on the geotechnical

properties of the lunar regolith. Throughout the program, she participated in professional development seminars and met people in all areas of NASA, learning about their careers and touring the facilities. She is excited to present her research at the Lunar and Planetary Science Conference in March.

MS student **Jared Low** has interned with Olson Engineering in Wheat



Ridge, CO for the past three summers. The company focuses on non-

destructive testing (NDT) and contracting near-surface geophysics. He worked with the geophysics groups on various surveys for site classification, utility detection, and void detection using such instruments as ground- penetrating radar

(GPR), frequency-domain electromagnetics (FDEM), electrical resistivity tomography (ERT), magnetics, and acoustic methods. His work has been heavier on the processing and report generation side as he has learned industry software and practiced the generation of client-friendly results within Surfer and QGIS.

PhD student **Samara Omar** interned with ExxonMobil where she was tasked with evaluating a suite of 4D-seismic inversion tools toward identifying a



best-suited theoretical approach and best-practice workflow for application to

ExxonMobil's reservoir management and development needs in Guyana.

During his Chevron CTC (Chevron Technology Center) internship, PhD student **Adesh Pandey** worked on a research project within the Quantitative



Interpretation and 4D chapter in Houston. He focused on developing machine-learning algorithms for predicting rock properties, such as acoustic impedance and Vp/Vs ratio, using well and seismic data. He compared the

results with deterministic simultaneous inversion. Collaborating with different teams, he forged strong relationships with fellow team members and other colleagues. His internship gave him valuable insights into the energy industry, particularly the research and development divisions. Based on his limited time there, he says that Chevron is a great company to work with, and he looks forward to building on the relationships and knowledge he gained.

MS student **Noah Perkovich** interned with GeothermEx, a geothermal consulting company. The company is headquartered in Richmond, Cali-



fornia, but he worked in their Denver office under the supervision of experienced Geol-

ogist Logan Hackett. His task was to study and outline the possible applications and areas for research and development for using borehole EM methods to characterize and monitor geothermal reservoirs. He consulted with exceptional geophysicists both inside and outside of the company. One of these mentors was Dr. Michael Wilt, who, among others, is responsible for many technical advancements in extended borehole

Internships

EM logging. His internship was extended, and he continues to work on this study when he finds time, as well as contributes to discussions when the company is considering using borehole EM for their clients.

PhD student **Wilson Sauthoff** held a machine-learning (ML) operations (MLOps) engineering internship in Lockheed

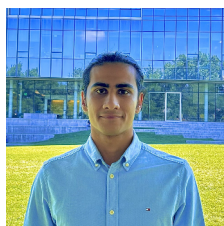


Martin Space in Littleton, Colorado. The internship centered around

Lockheed Martin's growing climate intelligence business. He worked to improve data pipelines to integrate more training datasets into ML models, conducted ML model validation, and contributed continuous integration and continuous delivery to Lockheed Martin's customers. This experience allowed him to explore a scientific career in applied science with tangible climate intelligence deliverables. He has accepted an offer of

employment with Lockheed Martin throughout the academic year and a second summer internship during summer 2024.

In collaboration with the Department of Energy (DOE), the National Science Foundation (NSF) runs the new Geothermal INTERN program, which provides supplementary funding for NSF awards to support graduate students with experiential learning opportunities through research internships with geothermal-focused companies. Fervo Energy is a developer, owner, and operator of next-generation geothermal assets. PhD student **Ahmad Tourei** worked with Fervo and participated in de-



veloping Distributed Acoustic Sensing Data Analytic Ecosystem (DASDAE)

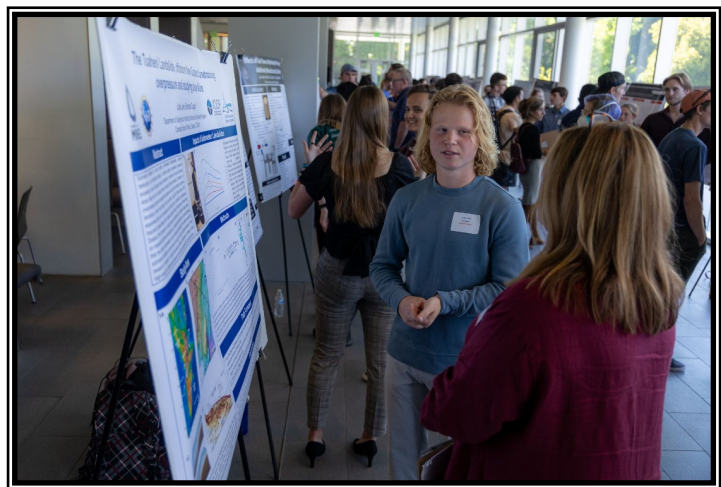
software for geothermal monitoring purposes. DASDAE is open-source software for distributed acoustic sensing (DAS) processing, and it's sup-

ported by an NSF award. Because most fiber-optic data processing commercial software has limited capabilities, is designed for a particular instrument, and has not been optimized for real-time edge processing, we are driven to develop open-source software that can handle various data formats and be used for real-time edge processing. Therefore, Dr. Eileen Martin and Tourei collaborated with Dr. Aleksei Titov (Mines '21) and his colleagues at Fervo to implement DASDAE functions to handle real-time edge processing for fiber-optic data at geothermal sites. During this internship, he optimized, developed, tested, and integrated DASDAE algorithms for low-frequency processing and visualization of historical and real-time DAS data to monitor fractures during the stimulation of geothermal wells. This internship was an excellent opportunity for him to learn more about working as a research scientist in a rapidly growing technology-oriented company.

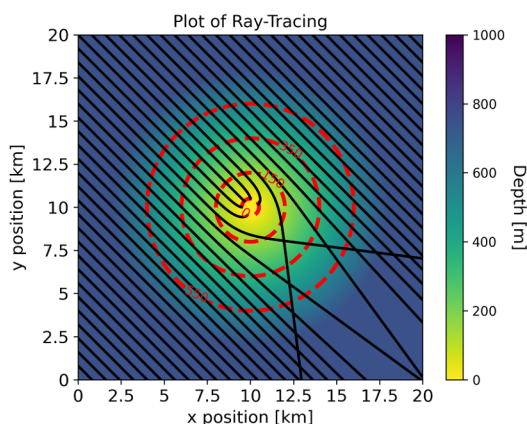
SUMMER UNDERGRADUATE RESEARCH FELLOWSHIP PROGRAM

The Mines' Summer Undergraduate Research Fellowship Program (SURF) provides funding for undergraduate students to participate in concentrated, full-time research under the mentorship of Mines faculty. This fellowship is open to students of all disciplines. In addition to focusing on an in-depth research project, students also attend professional development seminars with SURF and National Science Foundation Research Experience for Undergraduates cohort students.

Geophysics undergraduate Jude Lowe participated in SURF with his New Zealand landslide project. Working with Dr. Brandon Dugan, Lowe looked at the Tuaheni Landslide Complex offshore northern New Zealand. His research focused on overpressure development and shear strength of sediments and how these factor into sub-marine landslides.



Agata Bogucka, Mines



Waves refracting around an ideal island case

Mines Computer Science student Bryce Irving collaborated with Dr. Bia Villas Bôas, Mines Geophysics, and Dr. Gui Castelão, Scripps Institution of Oceanography, University of California-San Diego, on an oceanography-based SURF project. Irving first learned the Rust programming language and the basics of ocean wave physics. Then he ray-traced the ocean's waves. Ocean surface waves are important in understanding the ocean and atmosphere, but the ray equations describing the propagation are difficult to solve. Irving wrote the four ray equations that describe the propagation of ocean waves in the Rust programming language because of Rust's robustness and efficiency. Given the initial wave conditions, the program will integrate the use of RK4 and return the wave state at each time step. Irving wrote Python scripts that plot the (x, y) from the returned data.

MINES GEOPHYSICS: YESTERDAY, TODAY, TOMORROW

In 1925, then Mines President Dr. M. F. Coolbaugh discussed with the Mines Trustees about introducing a new method of Earth exploration called geophysical prospecting into the curriculum. This was timely since seismic refraction methods were being developed to explore hydrocarbons in the vicinity of salt domes in the Gulf of Mexico, and the Schlumberger brothers had just invented electrical logging methods in France. Once the new courses were approved in coordination with Dr. Van Tuyl, Department Head of Geological Engineering, Dr. Coolbaugh asked Dr. Carl A. Heiland, technical representative of the Askania Werke geophysical instrument division, to lead the program. However, based on the extensive proposed curriculum, instead of adding a few courses, the Department of Geophysics was officially established in late 1926. In January 1927, Heiland taught the first geophysics course to seven graduate students in a basement classroom of Guggenheim Hall, creating the foundation of a long and storied history of world-class geophysics at Mines. (Mines Magazine, October 1950, v. 40, n. 10).

Post-WWII, the Department evolved for the times. Heiland retired as department head in 1948 and was succeeded by Dr. John Hollister. While fieldwork had always been integral to geophysics coursework and summer studies, a formal Geophysics Field Camp was officially established. By 1950, the Department had graduated approximately 225 undergraduates with geophysical engineering or geological engineering (geophysics option) degrees and approximately 160 graduate students. Since then, the Department has graduated more than 2,500 geophysical engineers and geophysicists.

Through 97 years, the Department has had

only ten department heads. Following Drs. Heiland and Hollister, Drs. George Keller, Phillip Romig Jr., Terry Young, John Bradford, and Paul Sava led the department, while Drs. Ralph Holmer, Tom Davis, and Roel Snieder stepped in along the way as interim department heads.

Continuing to meet the challenges of our times, the Department has expanded its coursework and expertise to address the global energy transition and the many applications of geophysics in exploring our world and other destinations in the solar system. The Geophysics program aims to equip graduates with state-of-the-art multidisciplinary skills needed for addressing relevant applied geoscience and engineering challenges linking society with (1) the effective exploration of the Earth and other planetary bodies, (2) the sustainable use of natural resources (energy, minerals, water), and (3) responsible environmental stewardship.

Over the past 100 years, the Department has built a global reputation for excellence in applied geophysics teaching and research and secured a prominent position in the geophysics community. In 2023, the US News and World Report ranked Mines GP #5 in the category of Geophysics and Seismology graduate programs. The Department has helped establish the identity and excellent international reputation of Mines and is inherently aligned with the Mines' focus on Earth, Energy, and Environment. The field of geophysics is essential for addressing many grand challenges facing our planet. Mines Geophysics is committed to remaining a pivotal contributor to applied geophysics research and education necessary to solve these problems.

—Melinda Gale '88, Staff



Mines Geophysics will turn 100 in 2026!

Our program was established in 1926 as the world's first Department of Geophysics and continues strong today as one of the top applied geophysics programs worldwide. We have initiated a wide range of activities celebrating and engaging our entire Geophysics family. We hope that you will join us!

December 11, 2023	AGU Mines GP Alumni Reception, at Wine Down SF, RSVP
2024	
January	Remote Sensing Challenge Cup -Prizes Awarded!
February	Colorado School of Mines #idigmines – GP@100 Field Closet
March	Distinguished Alumni Heiland Lecture and Reception
April	GP Day Around the World - Hoist one for GP!
May 18 and 19	Field Camp Alumni Weekend - Come visit us in Steamboat!
June	EAGE Mines GP Alumni Luncheon
July	GP Virtual 5K, Challenge will post July 1, Request Info
August 27	SEG IMAGE Mines GP Alumni Reception
September	Welcome Back BBQ
October	Distinguished Alumni Heiland Lecture and Reception
November	GP Gives Workshop, topic and date TBD
December 9	AGU Mines GP Alumni Reception

Calendar updates can be found at: <https://geophysics.mines.edu/100th-anniversary/> or join our direct email distribution at: <https://forms.office.com/r/2GYr3kn4QD>. We will continue expanding the history of our department, Field Camp photo albums, events, and anecdotes as we approach our 100th Celebration. Please contribute if you have history to share!

In Memoriam



Alexander Kaufman (1931-2023)

Dr. Alexander Kaufman, professor in the Mines Geophysics Department from 1977-2005, passed away on June 7, 2023.

Dr. Kaufman was born August 1, 1931 in Moscow, Russia. He was the tenth child in a large Jewish family. As a child during World War II, he was evacuated with his mother and siblings while his father fought in the war. When he returned, antisemitism under Stalin had increased and difficult conditions would greatly impact his life.

He married his first wife Irina at the age of 27 and was blessed to be with her for 56 years. They had one child Dimitri, who survives him along with his sister Inna, six grandchildren, six great-grandchildren. Also surviving him is his second wife, Natalie, whom he married in 2017 and who lovingly cared for him until the very end.

Dr. Kaufman received his degrees in geophysics in Russia, but after experiencing anti-semitism, he moved with his family to South Siberia for 14 years where he was a professor and in charge of a research lab. In 1975, he immigrated to the West. He lived in several places before joining the Mines Geophysics Department in 1977 where he remained for 28 years until retirement. Dr. Kaufman wrote 17 books on geophysics, the last of which he completed in 2021 at the age of 91. He was known for his great heart and charitable spirit. He set up a geophysics charity for Russian scientists with medical needs and frequently went out of his way to help students and colleagues find good doctors and jobs.

TRIBUTES TO DR. KAUFMAN

As news of Dr. Kaufman's passing spread, we received several moving tributes that attest to his intelligence, kindness, and generosity. Due to space limitations, we provide excerpts here and invite you to read all of these heartwarming remembrances on our website.



From the very beginning he made an impression of a quite nontrivial and gifted personality. He had his own, non-standard opinion about virtually everything. In our communications it was, perhaps, most brightly manifested in the manner he worked on his books. Initially, they were intended for readers in his area of expertise, that is electromagnetic techniques for geologic mapping and mineral exploration, but eventually, they usually covered much broader areas of mechanics and physics. Sasha tried to understand the main physical principles “on fingers” himself, no matter how difficult it was, and for that, besides reading tons of literature, he meticulously interviewed his colleagues and friends. —*Lev Ostrovsky*



Alex was an extraordinarily gifted teacher whose greatest desire was to help others understand the geophysics which he loved so dearly. He simply had to teach and we had every reason... to learn. It was an incredible experience! —*J. Duncan McNeill*



G-d gave him a long life, full of big obstacles and struggles; but he also gave him incredible strength of mind and body and unbelievable willpower. —*Dmitri Kaufman*



He had this magnetic personality that drew students in and made them feel seen and heard. He genuinely cared about each student's dreams and ambitions, going above and beyond to nurture their potential. —*Anatoli Levchin*



He consistently exhibited a willingness to aid those facing adversity, exemplified by his establishment of the International Fund for Geophysicists. This foundation extended its support not only to geophysicists but also to geologists of diverse backgrounds.

The memory of Sasha Kaufman, a man of noble character, continues to reside in our hearts as long as we draw breath. —*Svetlana Gavrilova*



COLORADO SCHOOL OF
MINES
@ 150 | 1874-2024

1500 ILLINOIS ST.
GOLDEN, CO 80401-1887
GEOPHYSICS.MINES.EDU

SUPPORT GEOPHYSICS

The Department of Geophysics is grateful for gifts and support from alumni, friends of the Department, and corporate partners. Your support helps us deliver many of the programs from which our students benefit, including graduate and undergraduate fellowships and scholarships, opportunities for students to engage in professional development activities, computing upgrades, department initiatives, and Field Camp.

If you are interested in making a gift to the Geophysics Department or sponsoring one of its programs, please contact the Mines Foundation (303-273-3275) or weare.mines.edu/supportgeophysics

