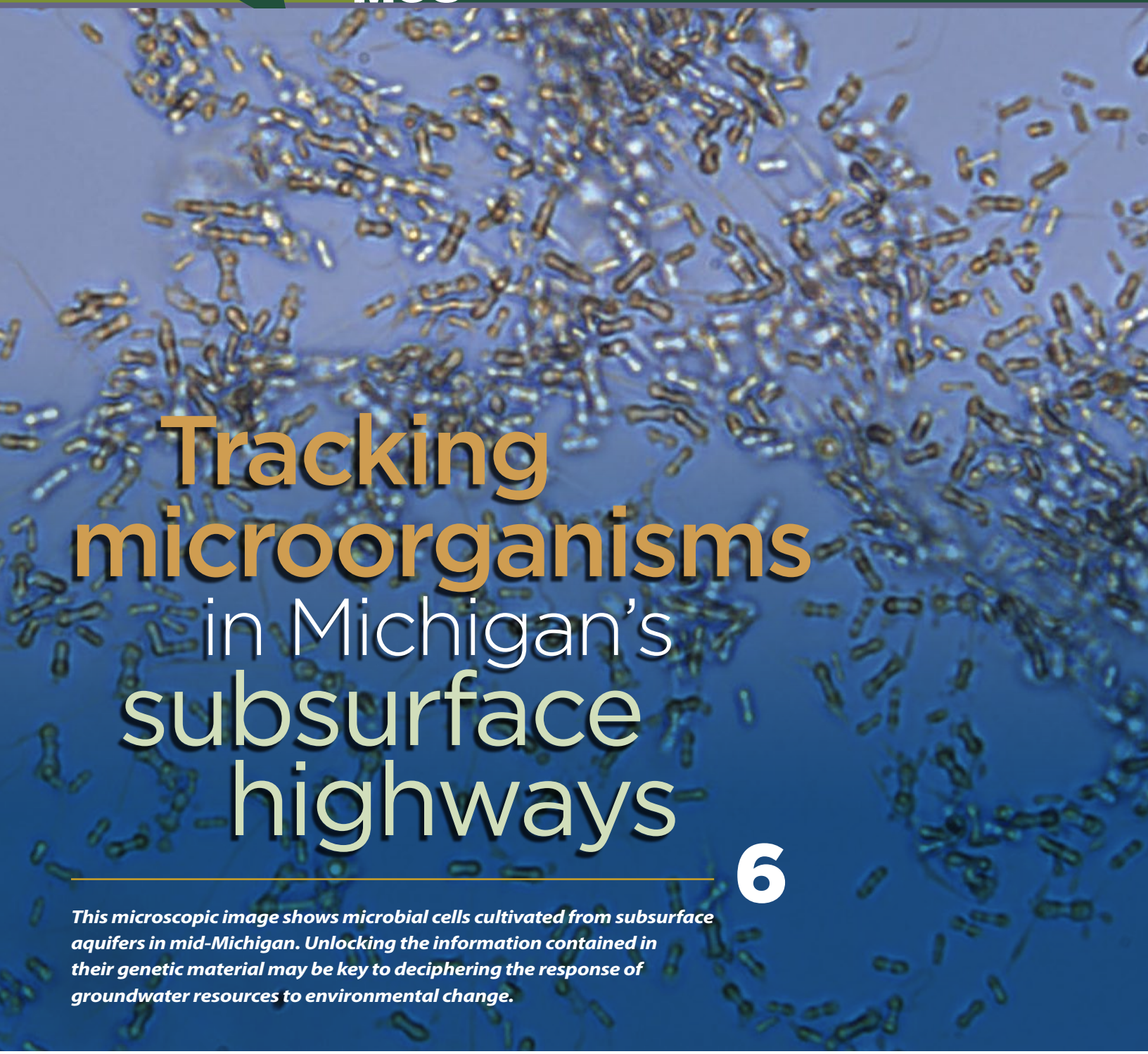
SPRING 2022

DEPARTMENT OF

Earth & Environmental Sciences

MSU College of **Natural Science** | *Newsletter for Alumni and Friends*



Tracking microorganisms in Michigan's subsurface highways

6

This microscopic image shows microbial cells cultivated from subsurface aquifers in mid-Michigan. Unlocking the information contained in their genetic material may be key to deciphering the response of groundwater resources to environmental change.

INSIDE

From the Department Chair: Thriving and growing in a new era

Just as each geologic era leaves its imprint on the earth, so too has the pandemic left its mark on our personal and professional lives. Perseverance has been the word of the past two years. But thankfully, as we wrap up our second academic year with COVID-19, the Department of Earth and Environmental Sciences (EES) finds itself thriving and growing.

Our talented faculty have brought in a record number of externally funded research grants, which has fueled an expansion in our graduate program. This is exactly what we were aiming for with the revitalization of the department since 2010—a multi-year process of hiring new faculty members that was made possible by generous donations of our alumni.

One example of these new research projects is Matt Schrenk's NSF Idea Machine grant to track microorganisms in Michigan's subsurface superhighways (see page 6). Our faculty members have also garnered a variety of accolades, including the fourth NSF Early CAREER awardee in the department since 2018, and two of us being named AAAS Fellows (see page 5).

We have seen several faculty departures, transitions and additions over the past year.

In January 2021, we bid farewell to long-time EES chair David Hyndman, who accepted a position as dean of the School of Natural Sciences and Mathematics at the University of Texas at Dallas. We are grateful for his service and dedication to EES over the past 10 years and wish him well on his new adventure.

In August 2021, EES associate professor Julie Libarkin was named associate dean for STEM education research and innovation in the MSU Office of the Associate Provost for Undergraduate Education. Read more on page 5.

Faculty growth came with the addition of Julie Elliott in May of 2021 as a research assistant professor (see page 4), and we are on the verge of filling a tenure-stream position that focuses on water science.

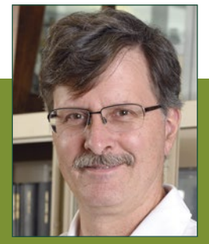
Last summer, EES mourned the passing of our colleague Min Chen. She was a brilliant scientist, mentor and friend. Her loss inspired the establishment of a fellowship in her name and two commemorative sessions at the 2021 AGU fall meeting, which you can read more about on page 3.

> "As we look to the future, EES is poised to do great things."

EES is now home to one of the largest classes of graduate students in department history, with a total of 29 new students joining us in 2020 and 2021. This year also saw the revival of our undergraduate Geology Club after a pause because of the pandemic, and the creation of a new space in the Natural Science Building for undergraduates to gather and work together.

As we look to the future, EES is poised to do great things. We know we have what it takes to ride out the hard times and we have a plan to move forward in making this a destination department for faculty members and students of the geosciences.

Please keep in touch with us at geosci@msu.edu. We thank you, as always, for your unwavering support in helping EES to make its mark and look forward to hearing from you soon.



Jeffrey Freymueller, Interim Chair
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ALUMNI CLASS NOTES

K. Rodney Cranson, geology, '61; M.S., physical science interdepartmental, '65, shared that the Michigan EARTH Science Teachers Association recently held its 50th Anniversary meeting. Cranson's former colleague, **Dr. Harold Stonehouse,** and the geology group played an important role in Earth science education in Michigan and across the United States for many years.

Burrell Shirey, B.S., physical science, '76; M.S., geology, '83, retired this past year after 40+ years as a geologist for the state of Michigan, rising from a journeyman geologist in the Water Supply Division in the old Michigan Department of Public Health to section chief of the Geological Services Section of the Remediation and Redevelopment Division of Environment, Great Lakes and Energy (formerly the Department of Environmental Quality).

Tom Taylor, M.S. geology, '79, Ph.D., geology '82, has written a book titled *Sandstone Petrography, Petrology, and Modeling* published by SEPM. Taylor retired from Shell Research and splits time between Tucson, Ariz., and Pagosa Springs, Colo.

Matt Schuchardt, earth science, '03; M.S., physical science, '10, has been a middle school science teacher since graduation. This past fall, he was recognized as the Michigan Earth Science Teachers Association Outstanding Earth Science Teacher of the Year for 2021.

Kayla Cotterman, M.S., environmental geosciences, '16, recently accepted a new job with the Lochmueller Group, Evansville, Ind., as an environmental scientist.

In Memoriam

Remembering Min Chen

The Department of Earth and Environmental Sciences (EES) was saddened by the passing of Assistant Professor Min Chen in July 2021. Chen joined the department in 2017 with a joint appointment in EES and MSU's Department of Computational Mathematics, Science and Engineering (CMSE).

"This was a great loss, not only for the department, but also for the scientific community," said Jeff Freymueller, EES interim chair. "Min was an outstanding seismologist and a valued colleague and friend. She cared deeply about diversity, equity and inclusion in the geosciences, and she worked tirelessly to make her own research group a model for others to emulate."

A fellowship named in her honor, the Min Chen Graduate Award for Computational and Earth Sciences, was established to continue her legacy at MSU through supporting efforts to promote diversity and future trainees in computational and Earth sciences.

Funds from the endowment will support graduate students pursuing an advanced degree in EES or CMSE. Preference will be given to applicants whose enrollment will contribute to MSU's commitment to diversity, equity and inclusion while enhancing their program's academic excellence and diversity, and graduate students in the field of seismology, or who use advanced computational methods in their work.

Those interested in donating to the fund can visit https://givingto.msu.edu/gift/?sid=12770 or use the Business Reply Envelope included in this newsletter.

Min Chen

In addition to the endowment, colleagues offered two sessions at the fall 2021 American Geophysical Union (AGU) Conference to pay tribute to Chen's research interests and contribution.

"These AGU sessions and the graduate award fund are strong indicators of the fondness and esteem Min's colleagues have always felt for her," Freymueller said. "The AGU sessions allowed them to remember her in a way I'm sure she would have appreciated: by gathering to learn and debate about the science she loved so much."

EES funds established to sustain, support excellence

Philanthropic giving through the establishment of—and giving to—endowments and scholarship funds, supports faculty development, student activities and research and academic programming. These funds are critical to sustaining excellence and growth in these areas. The following are several funds that have been established within the Department of Earth and Environmental Sciences:

Geology Discretionary Endowment Fund (A507141)

Endowed discretionary funds help sustain academic programs, faculty development, the college's information technology infrastructure and other current needs. The purpose of discretionary funds is to help bridge the gap between appropriated funds and what is needed to provide the very best educational and research experiences.

Geology Endowed Field Study Fund (A50717)

This fund supports class field trips, geology field camp and student work experiences—which are among the most distinctive and expensive experiences shared by students in the geological sciences.

Min Chen Graduate Award Fund (A5333)

Named in memory of faculty member Dr. Min Chen, these funds will support graduate students pursuing an advanced degree in the Department of Earth and Environmental Sciences or the Department of Computational Mathematics, Science and Engineering. Preference will be given to applicants whose enrollment will contribute to MSU's commitment to DEI while enhancing their program's academic excellence and diversity; and graduate students in the field of seismology, or who use advanced computational methods in their work.

John T. Wilband Memorial Scholarship Fund (A50719)

This scholarship fund supports students who will be participating in a department-sponsored field camp experience.

If you are interested in learning more about one of the funds mentioned or other philanthropic opportunities within the Department of Earth and Environmental Sciences, please contact Corey Palmer at longleyc@msu.edu or 517-420-6810.

New Faculty

Elliott

Julie Elliott joined the department in May 2021 as a research assistant professor. Her research employs geodetic data to examine how the Earth's surface changes shape due to plate tectonics, volcanic activity and glacier change. The results of her work can help evaluate earthquake and volcano hazards and help estimate sea-level rise and its potential impacts on coastal regions.

Contact Us

The Department of Earth and Environmental Sciences newsletter is published annually by the College of Natural Science for alumni and friends of the department.

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CONNECT WITH NATSCI

Faculty Honors

Bruno Basso, MSU Foundation Professor, received a $250,000 grant from The Morgan Stanley Institute for Sustainable Solutions Collaborative for his project, "My Soil Organic Carbon." The initiative is designed to help farmers make informed decisions regarding regenerative farming practices using soil carbon measurements. Basso was also named a 2021 American Association for the Advancement of Science Fellow (AAAS) for distinguished contributions to agronomy, particularly quantitative modeling and the application of precision technologies in modern cropping systems.

Susannah Dorfman, associate professor, and **Jane Rice,** academic specialist, were each recognized at the 2021 College of Natural Science Awards Ceremony with Faculty Teaching Prizes.

Jeffrey Freymueller, Endowed Chair for the Geology of the Solid Earth, was named a 2019 AAAS Fellow for outstanding contributions to research, teaching, innovation, and service to societies and the public in geodesy, tectonics, volcanology, glaciology, hydrology and geophysics.

Dalton Hardisty received a two-year, $75,000 Alfred P. Sloan Fellowship in recognition of early career accomplishments and exceptional promise. He will use the fellowship to examine the conditions of marine iodate accumulation for Earth's earliest oxygenation 2.5 billion years ago.

Julie Libarkin, professor, was named associate dean for STEM Education Research and Innovation by MSU's Office of the Associate Provost for Undergraduate Education. She was also part of a team that received an AGU Citation for the creation of the Call for a Robust Anti-Racism Plan for the Geosciences.

Julie Libarkin, professor; and **Stephen Thomas,** academic specialist, will use a grant they received through MSU Creating Inclusive Excellence Grants (CIEG) to improve STEM experiences for historically underrepresented groups by developing and implementing a system for mentoring faculty on how to facilitate inclusive experiences.

David Long, Professor Emeritus, was named the 2021 Israel C. Russell Awardee by the Geological Society of America's Limnogeological Division in recognition of major achievements in limnogeology through his contributions in research, teaching and service.

Songqiao "Shawn" Wei, Endowed Assistant Professor of Geological Sciences, received a 2021 NSF Early CAREER Award to conduct a series of seismic attenuation studies on regional and global scales to advance understanding of seismic interpretation, upper-mantle dynamics and material recycling in the Earth's interior.

Student Honors

Barnes

Nathan

Pease

Lv

Pletcher

Jackson Barnes, Gabriel Nathan and **Allison Pease** were each awarded a $5,000 Michigan Space Grant Consortium Graduate Fellowship, which supports NASA's research and public service projects on aerospace, space science and Earth system science.

Mingda Lv, a 2021 Ph.D., received two awards from the AGU: the John C. Jamieson Student Paper Award for his publication in *Nature Communications* and the 2021 SEDI Section Award for Graduate Research for the interdisciplinary nature and wider application of his research to other disciplines.

Addy Pletcher received a Grand Prize in the AGU Freilich Visualization Competition for her project to improve decision-making for lake management of harmful algal blooms through improved real-time monitoring of relevant environmental proxies using remote sensing and artificial intelligence.

Tracking microorganisms in Michigan's subsurface superhighways

Groundwater is a critical component of Michigan's natural resources, including supplying a major portion of clean drinking water. A number of processes at the Earth's surface have the potential to impact groundwater, including the introduction of contaminants, changes in land use and over-extraction.

In 2020, geomicrobiologist Matt Schrenk submitted a novel and interdisciplinary proposal, "Groundwater Microbial Communities as Sentinels of Environmental Change," which was selected by the National Science Foundation's 2026 Idea Machine as one of 25 projects funded to explore bold and potentially transformative new ideas.

"I study what I like to call the subsurface superhighways for microorganisms," said Schrenk, an associate professor in the Department of Earth and Environmental Sciences (EES). "My research aims to understand how microbes get into groundwater in the first place and how human activities and the environment at the surface influence biogeochemical processes in groundwater and vice versa."

MSU geomicrobiologist Matt Schrenk (center) and lab members Maria Berry (left) and Osama Alian (right) take a groundwater sample from one of about a dozen demonstration wells located on the MSU campus to study how the chemistry and microbes change along the area's flow pathway.

> **"This work is exciting because, in principle, these microbes contain a record of the past conditions they have experienced. . ."**
>
> MICROBES

Schrenk's lab is using high-throughput DNA sequencing approaches to study in detail the composition of groundwater microbial communities in three mid-Michigan aquifers— Glacial Drift, Saginaw and Marshall. These aquifers host water, microbes and chemicals that have been decoupled from the surface for different lengths of time, from decades to tens of thousands of years.

"This work is exciting because, in principle, these microbes contain a record of the past conditions they have experienced, which persists as they are carried through the subsurface," Schrenk said. "These interdisciplinary data sets will help us build better models linking human activities, water quality and environmental health."

Research challenges caused by the pandemic led Schrenk and his team to shift gears to start the project. They began by data mining using existing public genome resources from both natural and human-impacted groundwater to figure out which gene signatures are most common in different types of systems.

"As pandemic restrictions eased, we were able to directly sample aquifers using an array of wells in mid-Michigan, including those that feed the MSU campus," Schrenk said. "We are carrying out coordinated analyses to quantify different groups of microorganisms and how they differ at a genetic level so we can parse out which microorganisms are favored under different environmental conditions and how they are dispersed through the subsurface."

The researchers also sampled waters throughout the Saginaw Bay watershed to measure for the presence of pharmaceuticals and personal care products (PPCPs), to consider how these recent anthropogenic compounds could be reflected in the groundwater microbial communities.

The datasets generated through this study will also be used to develop exploratory, three-dimensional projections for outreach events at the MSU Museum and will also be made available to local communities where the research is being conducted through MSU Extension.

"This project presents a tremendous opportunity to engage people in groundwater science, which is critical to our lives, but which most people are unaware of," Schrenk said.

The project continues this summer with researchers sampling more of these deep groundwater circulation pathways.

Long-time Spartan engages with EES department

Kyle Lewallen was a pre-med student when he first came to MSU. But after enrolling in Geology 101— "just to fulfill an elective requirement"—he switched his major to geological sciences.

Kyle Lewallen in 1983 on his Geology Summer Field Camp in Alaska.

Kyle Lewallen

"As it turns out, the class was very interesting and was taught by one of the most dynamic professors in the department at the time—David Long," said Lewallen, who worked for more than 30 years as a geophysicist in the oil and gas business until retiring last year.

After receiving his B.S. in geological sciences (now environmental sciences) from Michigan State University in 1984, he went on to earn his M.S. in geophysics from Texas A&M University and eventually a Ph.D. in geophysics from the University of Wisconsin–Madison.

"Although I have had plenty of years of education, I believe the fundamental geoscience principles learned during my undergraduate years at Michigan State set me up for career success," said Lewallen, who was born into a Spartan family. A native of Niles, Mich., he and his family regularly spent time on the MSU campus—from attending football games, to visiting the museum, to enjoying picnics on the banks of the Red Cedar River.

> **". . . I believe the fundamental geoscience principles learned during my undergraduate years at Michigan State set me up for career success."**
>
> SUCCESS

He was hired in 1986 by a large independent exploration and production company and was responsible for drilling two successful offshore Gulf of Mexico wells and numerous horizontal wells along the Gulf Coast region. In 1996, he was hired by Exxon (now ExxonMobil) in Houston.

"I worked nearly half my ExxonMobil career designing and acquiring seismic surveys for ExxonMobil's worldwide affiliates," he said. "The remainder of my career was spent researching new geophysical equipment and technologies to improve subsurface imaging as well as establishing innovation best practices.

"Michigan State did a great job teaching the basic sciences and the fundamental geoscience principles I've used throughout my graduate school training, as well as my business career," Lewallen said.

Facilitating excellence in geoscience education is why he feels it's important to give back to MSU, the College of Natural Science (NatSci) and the Department of Earth and Environmental Sciences (EES).

"Over the years, I have found meaningful ways to personally engage with the department," he said. "I have written letters to MSU's Board of Trustees, proclaiming my support for the value and necessity of geoscience education, especially as a land-grant university."

He also contributes financially to the John T. Wilband Memorial Scholarship Fund in Geological Sciences (which supports geology field camp experiences), and currently serves on the NatSci Dean's Board of Advisors.

"Now, more than ever, it's important to engage with EES students at MSU. There are many ways to help, and I encourage you to explore options that are meaningful to you," he added. "The future of the Department of Earth and Environmental Sciences at MSU is bright. Your personal engagement will make it even better."

key grants

Bruno Basso, MSU Foundation Professor, received a $3.37 million, five-year, USDA Farm Service Agency grant to determine how much carbon the soil in unproductive farmlands can hold. This information helps farmers know when to remove depleted land from agricultural production and instead plant crops that improve soil health by adding nutrients back into the land. Basso also received a four-year, $2.57 million USDA Natural Resources Conservation Service grant to help farmers improve the ecological friendliness of their fields while boosting their farms' profitability.

Jeffrey Freymueller, Endowed Chair for the Geology of the Solid Earth, received a four-year, $311,000 National Science Foundation (NSF) grant to study the magnitude 7.8 Simeonof earthquake that occurred in the Shumagin Islands in Alaska on July 22, 2020, to learn about the character of fault slip before, during and after earthquakes.

Tyrone Rooney, professor, received a four-year, $350,000 NSF grant to explore the mechanism of magma generation, which forms the basis of oceanic crust, within continental rifts. Focusing on the East African Rift, Rooney will study how magmas are generated in the mantle, evolve in the crust and eventually erupt in this rift.

Matthew Schrenk, associate professor, and Julie Libarkin, professor, received a three-year, $280,000 NSF grant to build a transferable, sustainable model for enhancing Latinx participation and retention in the geosciences through exposure to research opportunities and engagement with peer-to-peer mentoring that ultimately leads to graduate training.

Jay Zarnetske, associate professor, received a three-year, $477,000 NSF grant to study the release of nutrients found in Arctic permafrost as it melts. Because variations in nutrient concentrations within Arctic stream networks can reveal where permafrost nutrients are released, this research can improve understanding of how water flow, plant life, and soil and bedrock conditions are affected by wildfire, permafrost degradation and extreme weather conditions.

Innovative method develops more accurate corn yield predictions

Yield predictions are of great importance, from national and international food supply chains to the individual grower. This study shows that incorporating in-season water deficit information into remote sensing–based crop models drastically improves corn yield predictions.

Yield predictions are of great importance, from national and international food supply chains to the individual grower. In addition to ensuring food security, highly consequential financial decisions are made based on this information. For example, growers must decide how much fertilizer and other inputs to apply to their fields—areas in which costs have soared for numerous reasons, including climate change and global conflict.

To improve this decision-making process, research led by Bruno Basso, an ecosystems scientist in the Department of Earth and Environmental Sciences and a W.K. Kellogg Biological Station faculty member, shows that incorporating in-season water deficit information into remote sensing–based crop models drastically improves corn yield predictions. Guanyuan Shuai, a graduate student in Basso's lab, also participated in the study.

"An accurate knowledge of yield predictions before the end of the season is of paramount importance for grain prices, which affects profitability for farmers, as well as commodity traders and food companies," Basso said.

Historical weather forecasts and crop yields from a given location are often used to predict the next season's performance, but there are flaws in this methodology. This can be unsettling when growers are searching for as much certainty as possible.

"It's important that farmers have confidence in the data they use to make decisions, and we're trying to help them improve that decision-making process at the right scale. Farmers are interested in profitability, which is also linked to environmental sustainability."

For the project, Basso and Shuai evaluated 352 fields of varying sizes in Michigan, Indiana, Illinois and Iowa. The team collected climate and soil data in addition to more than 2,500 yield maps over several years—2006 to 2019—directly from farmers. They also obtained high-resolution images from the private company Planet, and the European Space Agency and NASA, along with digital elevation models from the U.S. Geological Survey dataset to calculate the green chlorophyll vegetation index—an indication of plant vigor.

> **ACCURACY**
>
> **"It's important that farmers have confidence in the data they use to make decisions..."**

Basso and Shuai then implemented the System Approach to Land Use Sustainability (SALUS) program, which models crop, nutrient, soil and water conditions each day over many years using different management techniques. SALUS provided the daily crop drought index (CDI), designed to highlight the effect that in-season water shortages have on crops.

"We found that the inclusion of the CDI substantially improved the accuracy of in-season predictions," Basso said.

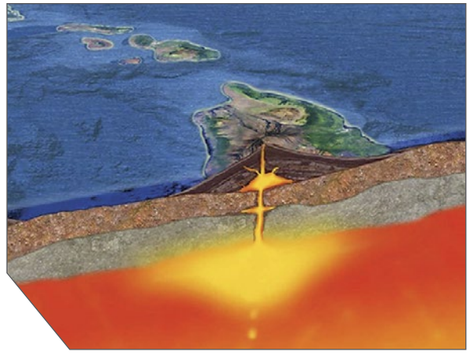
Basso believes that subfield-level analyses are a promising way to ensure accurate and precise predictions, and that decisions should be made based on real-time data rather than historical guidelines alone.

"Our novel, integrated approach of coupling crop-modeled water stress with high-resolution images provides more reliable and timely information for farmer cost savings and environmental protection," Basso said.

This research was supported in part by the U.S. Department of Agriculture's National Institute of Food and Agriculture; the Great Lakes Bioenergy Research Center; the U.S. Department of Energy's Office of Science; and the Biological and Environmental Research program.

MSU researchers discover "missing" piece of Hawaii's formation

An oceanic plateau has been observed for the first time in Earth's lower mantle, 800 kilometers deep underneath Eastern Siberia, pushing Hawaii's birthplace back to 100 million years.



Hawaiian islands were generated by a mantle plume rooted in the deep Earth.

The discovery came when MSU geophysicist Songqiao "Shawn" Wei noticed something unusual in his data using groundbreaking techniques.

Earth's mantle is mostly solid, but at a mid-ocean ridge it melts, creating new oceanic crust between two tectonic plates. As the plates continue to move, a hot plume of solid rocks slowly rises in the mantle, melting the tectonic plate to create volcanoes like the Hawaiian Islands. The mantle plume has a mushroom-like shape with a wide head that is thousands of miles across and a thin tail that is only a few hundred miles across.

"Normally, you would see a pancake-shaped oceanic plateau created by the mushroom's head, followed by a dotted chain of islands created by the mushroom's tail," Wei said. "The Hawaiian Islands are the end of the tail—but where is Hawaii's pancake head?"

Wei's team compiled the largest dataset of a specific type of seismograms and conducted big data analysis and numerical simulations, using a new technique that combines the strengths of seismic tomography, seismic reflection and mineral physics.

Plate reconstruction modeling helped the researchers link the newly found oceanic plateau to the Hawaiian "pancake" that was created during the formation of the Hawaii hotspot approximately 100 million years ago.

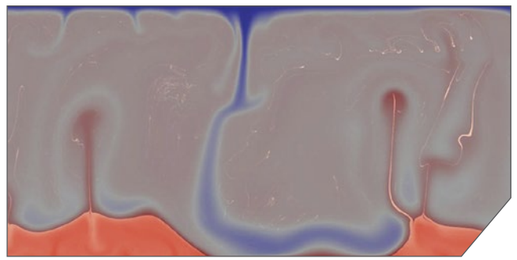
Researchers plan to use this new technique to find other missing pancakes and to continue looking for evidence of older pieces of Earth's oceanic crust in the deep Earth.

Rusting rock may explain two of Earth's deepest mysteries

Scientists have known about two of the most enormous and mysterious regions of the Earth's lower mantle—Large Low Shear Velocity Provinces (LLSVPs)—for decades, but no one knows what they are made of or where they came from.

Susannah Dorfman, MSU associate professor, led an experimental study of rusting rock that may finally explain the mysterious existence of Earth's LLSVPs. Along with a team of international researchers, Dorfman has pieced together a way to make an iron-rich form of the mineral bridgmanite—a rusting rock. The study combined high-pressure high-temperature experiments with computational techniques and geodynamic simulations.

"We don't know whether these blobs date back to a dense residue of goo from when the Earth originally crystallized, or if they have been growing over time," Dorfman said. "Our experiment is about testing the major hypothesis that the LLSVPs are thermochemical piles—warm and soft and with a different chemical composition than the mantle material around them."



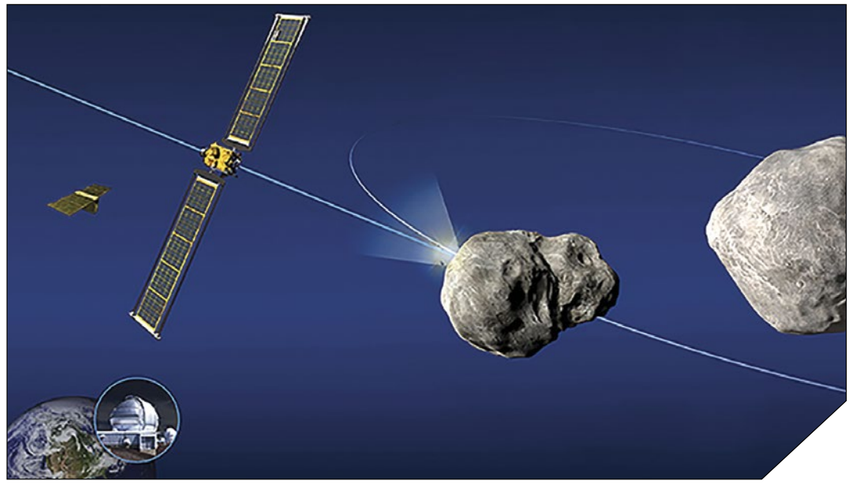
This image from a computer simulation model shows intrinsically dense materials being accumulated into blobs (orange) at the bottom of the model, like the LLSVPs at the bottom of Earth's mantle. Wisps of materials from the blobs are carried up to shallower depths, which may eventually be sampled in the source of volcanoes.

Jiachao Liu, a former MSU postdoctoral researcher on the team, synthesized the "rusting" bridgmanite in a multi-anvil press. Instead of dissolving into bridgmanite, the oxidized iron stayed unexpectedly distinct. Researchers then determined the crystalline structures of the coexisting silicates, discovering that both minerals adopt perovskite structure under the lower-mantle pressure and temperature conditions.

Had they stumbled onto a possible component of the mysterious LLSVPs? Their coauthor's calculations demonstrated that the newly discovered Fe^{3+}-bearing bridgmanite had low sound velocities at lower-mantle conditions that could well explain the observed features of the LLSVPs.

When fiction and real life collide: MSU's role in planetary defense

In December 2021, Netflix debuted the movie *Don't Look Up*, a fictional drama and comedy about MSU researchers trying to warn the government about a giant asteroid's impending collision with Earth. In the movie, the threat is not taken seriously; in real life, however, NASA and Michigan State University are very much engaged in the important science of planetary defense.



NASA and Michigan State University are very much engaged in the serious and important science of planetary defense.

NASA launched a spacecraft to conduct one of the world's first full-scale planetary defense tests, the Double Asteroid Redirection Test (DART) mission, on November 24, 2021 at 1:21 a.m. EST on a SpaceX Falcon 9 rocket out of Vandenberg Space Force Base in California. DART's target: the moon, Dimorphos, of the binary asteroid system, Didymos, which means "twin" in Greek.

If all goes according to plan, the DART spacecraft will slam almost directly into Dimorphos at roughly four miles per second in late September 2022, shortening the time it takes the moonlet to orbit Didymos by several minutes. Scientists will precisely measure that change using telescopes on Earth; the results will be used to validate and improve scientific computer models critical to predicting the effectiveness of kinetic impact as a reliable method for asteroid deflection.

This real-life demonstration of asteroid deflection is one of the key tests that NASA and other international space agencies wish to perform before an actual asteroid is discovered to be on a collision course with Earth.

MSU planetary scientist Seth Jacobson is part of the DART team's Dynamics Working Group, which is mandated to assess the momentum transfer efficiency of the impact, called Beta—the key unknown parameter that is a source of significant uncertainty in planetary defense planning. This group also studies the long-term past and future evolution of the Didymos binary asteroid system.

DEFENSE

"Our team models the motions of the binary asteroid system prior- and post-collision matching observations from Earth, so we determine what Beta is."

"My Ph.D. thesis was focused on binary asteroids and what their observation could tell us about the properties and histories of small bodies in the solar system," explained Jacobson. "I got involved with this project because I was very curious about the long-term evolution of Didymos and what we could learn about the interior of asteroids through deflection experiments.

"Our team models the motions of the binary asteroid system prior- and post-collision matching observations from Earth, so we determine what Beta is." Jacobson said. "The experimental data is also really interesting from a geophysics perspective, because we will learn about the interior of these objects and their history in the solar system."

Even though the main objective of the mission is planetary defense, Jacobson sees a larger scientific benefit.

"These binary asteroids are interesting little worlds that have moons and change with time," he noted. "And there's a lot of novel physics that takes place in and around them. They're crucial for understanding the cosmochemical history of the solar system, and so we need to understand that physics to ultimately unlock our own past."

MICHIGAN STATE UNIVERSITY | DEPARTMENT OF **EARTH AND ENVIRONMENTAL SCIENCES**

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From idea to impact: It takes a "Green Team"

Stroll the Spartan Stadium bridge and you'll see the Greenspace Initiative. Installed in summer 2021, these vertical planters feature a seasonal rotation of greenery. This collaboration between the student group Sustainable Spartans, the Office of Sustainability (OOS), and Infrastructure Planning and Facilities (IPF) was the brainchild of 2021 Earth and environmental sciences (EES) graduate J.R. Nosal during his senior year.

"Because I transferred [to MSU] in 2019, I wanted to get involved with the campus community," Nosal said. After his first solo attempts to launch the project fell through, Nosal partnered with Sustainable Spartans.

J.R. Nosal stands on the Spartan Stadium bridge with the vertical planters he envisioned for the Greenspace Initiative project that was installed in summer 2021.

Over the course of a year and a half, the "Green Team," as it became known, began operating in a virtual format, found a new funding source, identified and interviewed subject matter experts, settled on a project implementation plan, found a site, learned how to work with vendors and community partners, documented their progress in a lengthy Learning Matrix, participated in the installation and wrote a final report among other publications.

The team also received assistance from EES faculty members Danita Brandt and Dalton Hardisty.

"We give our students the intellectual space and encouragement to pursue these ideas and help them connect with the people and resources they need to help them accomplish their goals," Brandt said.

With the project completed, Nosal and the team have high expectations for the site going forward.

"We hope that this raises awareness of sustainability measures that can be incorporated at a Big Ten university," Nosal said. "It also shows how natural science can be applied in your own backyard."

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