1912
Department of Geology established by John A. Allan
• The new department presented a broad hands-on view of the science to students, while the faculty members undertook fieldwork across the province. Their surveys of the geology and stratigraphy of Alberta laid the foundation for the development of the province's natural resources.

1920
Vertebrate paleontology starts at University of Alberta
• John A. Allan acquired dinosaur and other vertebrate fossils excavated from the bone-beds of south-central Alberta by the famous dinosaur hunter George F. Sternberg. This acquisition started the vertebrate fossil collection of the University that now totals more than 1000 species and 44,000 specimens.

1922
Maps of the coal fields of Alberta published • Throughout his career, even when it wasn't obvious, John A. Allan, chair of the Department of Geology, was convinced Alberta's economic future lay in natural resources. Allan was instrumental in conducting the original survey of the Drumheller Coal Fields and then publishing the first maps of Alberta's coal fields.

1925
Geological map of Alberta
• The publication of the geological map of Alberta was the culmination of the early fieldwork of the department. It encapsulated the geological framework of the entire province and set the stage for advances in the scientific understanding and economic utilization of Alberta's mineral wealth.

1947
Oil discovered at Leduc
• EAS Professor Emeritus Charles R. Stelck is considered a founding father of Alberta's energy industry, having helped to guide the discovery of oil in Leduc. "Everybody else was drilling blind, but we were actually looking for the reefs. That was how we found the Leduc deposits."

1957
Department of Geography established by William C. Wonders • The Department of Geography offered physical, applied, and human geography, a specialization in meteorology, and developed western Canada's premier map collection. As an integrative discipline straddling both the physical and social sciences, it provided a spatial perspective on the dynamics of a rapidly-changing world.

1957
Geochronology begins at the University of Alberta
• Geochronology is the scientific study of the absolute ages of rocks using radioisotopes. From this beginning, EAS built geochronology into a major strength of the department and is now a world leader in this research area.

1960
Canadian Circumpolar Institute (CCI) • The Canadian Circumpolar Institute promotes interdisciplinary research and education about northern and polar research at the University of Alberta, serving faculty, students, residents of circumpolar regions, government, industry, and the public.

1965
Vertebrate Paleontology Program starts • The vertebrate paleontology program of teaching and research was established by the then Departments of Geology and Zoology, and built on the University's collection of fossil vertebrates that had started in the 1920s.

1988
Superpress installed
• This national user facility, unique in Canada, consists of equipment that simulates conditions in Earth's upper mantle. Experiments undertaken at high pressures and temperatures with this instrument provide unparalleled insight into the deep Earth.

1991
Diamonds found in Canada's North • The discovery of diamond-bearing kimberlites in Canada's North started a new industry for the country, and catapulted it into the position of the third-largest diamond producer worldwide.

1995
Department of Earth & Atmospheric Sciences formed
• EAS was formed by the merger of the Departments of Geology and Geography. It offers an interdisciplinary approach to teaching and research in atmospheric sciences, environmental earth sciences, human geography and planning, paleontology, and solid earth sciences.

2003
Shell Canada Core Viewing Facility established
• The donation of over 6000m of drill core by Shell Canada laid the foundation of EAS's drill core collection. The support of Shell Canada has provided an important facility in which to train students in reservoir description and provide them the opportunity to gain hands-on experience with subsurface samples.

2003
De Beers Laboratory for Diamond Research opened
• The generosity of De Beers Canada established the Laboratory for Diamond Research in EAS. The lab's research expands scientific understanding of diamond formation and provides insights that help industry to locate diamond deposits and to predict their quality.

2003
Radiogenic Isotope Facility opens
• RIF provides instrumentation and expertise to facilitate trace-element and geochronological measurement and research. Users of RIF include local, national, and international scientific collaborators, government agencies, and commercial users.

2006
Centre for Earth Observation Sciences (CEOS) founded
• CEOS uses remote sensing, intelligent image analysis, and spatio-temporal data management to undertake research in environmental change and resource management. CEOS provides information and support to Alberta's natural resource industries and public sector agencies that provide stewardship, set policy, and identify long-term strategies.

2007
Institute for Space Science, Exploration and Technology (ISSET) established • ISSET was established as a hub to drive space and planetary science exploration, discovery and development through partnerships and collaborations.

2009
Integrated Petroleum Geosciences (IPG) Program inaugurated • IPG brings together geophysics and geology to address the complexities of petroleum exploration and production. Guided by the needs of industry, the IPG comprises a single-year course-based M.Sc., offered jointly by the Departments of Earth and Atmospheric Sciences,and Physics.

2010
Canadian Centre for Isotopic Microanalysis (CCIM) officially opened • CCIM provides academia, government, and industry with the capability to measure isotopes at the microscopic scale. Its centerpiece is the Cameca IMS-1280 ion microprobe. Research at CCIM is focused on resources, but includes biogeochemistry and geochronology.

2010
Canada Excellence Chair in Arctic Resources awarded
• EAS was awarded one of 19 CERC positions, with the appointment of Professor Graham Pearson to undertake research in Arctic resources. In 2012 the Arctic Resources Geochemistry Laboratory opened, integrated with, and expanding CCIM.

2011
Centennial Centre for Interdisciplinary Science (CCIS) opens • CCIS is a signature LEED-certified building that sets the stage for interdisciplinary collaborations by five research groups within the Faculty, across campus, and around the world. New lecture halls and teaching labs provide an unprecedented learning experience for students campus-wide.

2012
Planning Program launched
• As a partnership with municipalities and the planning industry, the Planning Program was established to embrace Alberta's sustained growth. The Program addresses a shortage of planners by providing students with both an Arts and a Science stream of study that comprises classroom studies and applied field experience.

2013
Campus Alberta Innovation Program Chair in Enhanced Geothermal Energy • This chair undertakes research to develop and advance methods and technologies for geothermal use in Alberta. Geothermal power is clean, sustainable energy that can be utilized for direct heat use or electricity production, and forms part of the province's modern energy structure.

2013
EnCana Chair in Water Resources established
• This academic position will serve as the catalyst for comprehensively documenting, analyzing and protecting groundwater systems in Alberta. EnCana describes the University of Alberta as a leader in developing new ways to assess the impact of industry on water quality.

100 Years of Leading in Teaching and Research in EAS

ATMOSPHERIC SCIENCES investigates the forces and interactions in the atmosphere and oceans that shape weather and climate.

ENVIRONMENTAL EARTH SCIENCE explores past and present environmental changes, including any relationships to human activity.

GEOLOGY OR SOLID EARTH SCIENCES is the study of the materials that make up the Earth and planets, and the processes that formed and shape them.

HUMAN GEOGRAPHY examines the relationships between societies and the constructed or built environment and the natural environment.

PALEONTOLOGY interprets the evolution and behaviour of life over geologic time. This research looks back hundreds of millions of years over the fossil record to the present day's astonishing diversity of organisms.

Dr. John A. Allan

Dr. John A. Allan founded the Department of Geology at the University of Alberta in 1912, and subsequently helped establish both the Alberta Research Council and the Alberta Geological Survey. During his 37-year academic career, he published more than 100 research papers and created one of the best geological collections in the country. He meticulously photographed his many field trips, with the University of Alberta Archives holding almost 7,000 of his negatives. Mount Allan in the Rocky Mountains was named in his honour in 1948. Dr. Allan remained the head of the Department of Geology until his retirement in 1949.

Dr. Robert E. Folinsbee

Dr. Robert E. Folinsbee joined the Department of Geology in 1946. During his time as chairman, from 1955 to 1969, he built the department into a well-staffed and enviably equipped centre of excellence that gained international stature. He made important contributions in the fields of geochronology, ore deposits, and meteoritics, and founded the meteorite collection at the University of Alberta. His enthusiasm and knowledge were passed on to many successful exploration geologists in the spheres of base metals, gold, uranium, and diamonds. In recognition of his accomplishments, he was made an Officer of the Order of Canada in 1973.

Dr. Charles R. Stelck

Dr. Charles R. Stelck was appointed to the Department of Geology in 1946 to teach returning veterans. Now Professor Emeritus of the University of Alberta, he has served Canada for more than fifty years as a teacher, a founder of the Canadian petroleum industry, and an internationally renowned research scientist. He is one of Canada's preeminent geologists. Among his many awards and honours are Officer of the Order of Canada (1997), and Inductee of the Petroleum Hall of Fame (2005). He has been an inspiration and a role model to thousands of students over the last three generations.

Dr. William C. Wonders

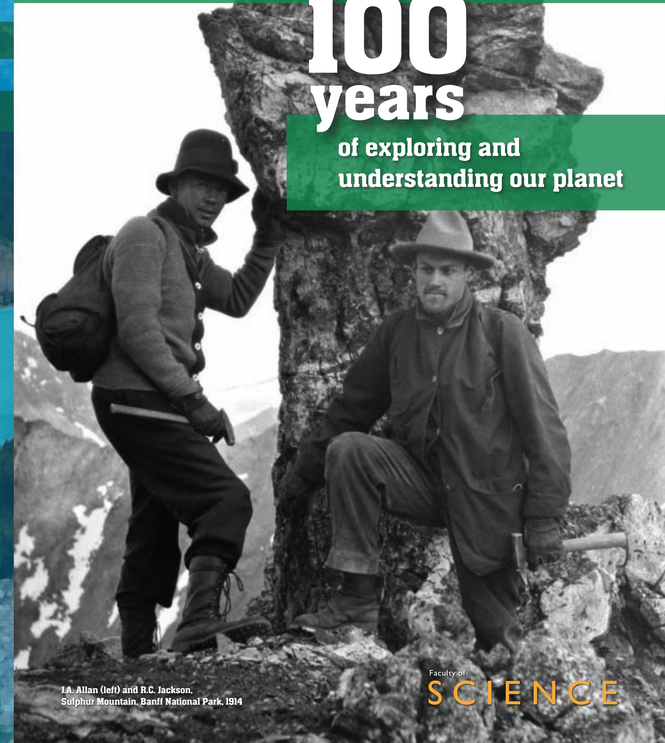
Dr. William C. Wonders founded both the Department of Geography at the University of Alberta in 1957, and in 1960, the Boreal Institute for Northern Studies (now the Canadian Circumpolar Institute). His research, teaching, publications and consulting work centred on the North (including Canada and Scandinavia), native land claims, and the Atlas of Alberta. This focus on the North has continued to be a strength of EAS to the present day. For his many accomplishments, he received both the Order of Canada and the Queen's Jubilee Medal.

UNIVERSITY OF ALBERTA

Earth & Atmospheric Sciences at the University of Alberta

100 years

of exploring and understanding our planet



I.A. Allan (left) and R.C. Jackson. Sulphur Mountain, Banff National Park. 1914

Faculty of SCIENCE

EARTH & ATMOSPHERIC SCIENCES
EAS
1912–2012
CENTENNIAL

Looking to Alberta's future, EAS will continue to build its reputation for scientific excellence—addressing critical areas of energy and resource development, and helping to ensure a sustainable future.

1905
Province of Alberta established

1906
Oldham discovers Earth's Core

NASA/NOAA/GSFC/Suomi NPP/VIIRS/ Norman Kuring

1908
Tunguska meteoroid explodes over Siberia, flattening 2000 km² of forest

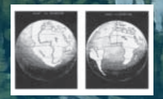
CYD – Kulick, Wikipedia

1909
Walcott discovers fossils of the Burgess Shale, Yoho National Park, BC

1912
Department of Geology founded by J.A. Allan

1914
Natural gas discovered at Turner Valley

1915
Wegener proposes continental drift



Antonio Snider-Pellegrini – Wikipedia

1925
Geological map of Alberta completed

1930s
Milankovitch proposes orbital changes as cause of ice ages

1930s
Drought and severe erosion of prairies

NOAA

1935
U of A Museum opens, first public exhibit of dinosaurs of Western Canada

1936
Lehmann discovers Earth's inner core

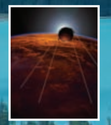
1943
General Geology of Alberta published

1945
U of A establishes Calgary campus

1957
Geochronology (absolute dating using radioisotopes) starts at U of A

1957
Department of Geography founded by W.C. Wonders

1957
Launch of Sputnik satellite



Gregory R Todd – Wikipedia

1960
First PhD in Geology granted

1960
Meteorite collection started

1962
First nuclear power plant in Canada

1962
P.S. Warren Geological Society inaugurated

1965
Vertebrate Paleontology program started

1970
First Earth Day

AP Images – Copyright Associated Press

1974
Investigation of stable isotopes starts at U of A

1976
Viking 1 spacecraft successfully lands on Mars

1987
Vostok (Antarctica) ice core provides evidence of link between atmospheric CO_2 and global climate change

1988
Superpress national facility installed

1988
Intergovernmental Panel on Climate Change (IPCC) established

1991
Diamond-bearing kimberlites discovered in Canada's north

2003
Kimberley Process for trade in diamonds in effect

2003
Shell Canada Core Viewing Facility established

2003
De Beers Laboratory for Diamond Research opens

2003
Radiogenic Isotope Facility opens

2007
Fourth IPCC Report warns that serious effects of global warming have become evident

James Balog

2010
Canada Excellence Research Chair in Arctic Resources awarded

2010
Canadian Centre for Isotopic Microanalysis (CCIM) officially opens

2011
Centennial Centre for Interdisciplinary Science (CCIS) opens

1900 | 1920 | 1940 | 1960 | 1980 | 2000 | 2013

1907
Boltwood measures the age of rocks by the decay of uranium to lead

1908
University of Alberta founded

UNIVERSITY OF ALBERTA

1911
Amundsen reaches the South Pole

NOAA

1911
Nordegg coal mines open

1920
Vertebrate paleontology starts at U of A

1921
Alberta Research Council founded

1922
Maps of coal fields of Alberta published

1930
Uranium discovered at Great Bear Lake, NWT

1931
Urey discovers heavier isotope of hydrogen-deuterium

1933
Gold discovered at Yellowknife, NWT

1947
Oil discovered at Leduc, AB

1949
Uranium mining begins in Saskatchewan

1950s
Oil overtakes coal as preferred fuel

1953
Geochronology establishes age of Earth to be 4.55 billion years

1960s
Plate tectonics theory defined

1960
First large-scale geothermal power plant in the U.S.

1960
W.C. Wonders map collection started at the U of A (2nd largest collection in Canada)

1960
Canadian Circumpolar Institute started (CCI) at U of A

1966
U of C established

1967
Oil sands production begins in Alberta

1969
First lunar landing

1976
Geological validation of Milankovitch's orbital theory of climate change

1977
Two million invertebrate fossils donated by oil companies

1982
Canadian Charter of Rights and Freedoms made law

1995
Department of Earth & Atmospheric Sciences formed by merger of Geology and Geography

1997
First mass-market electric hybrid car

1999
Nunavut becomes third Canadian Territory

2006
Centre for Earth Observation Sciences (CEOS) founded

2007
Institute for Space Science, Exploration and Technology (ISSET) established

2009
Integrated Petroleum Geosciences (IPG) Program inaugurated

2009
ConocoPhillips donates a new Powder X-Ray Diffractometer to the U of A

2012
Planning Program launched

2013
Campus Alberta Innovation Program Chair in Enhanced Geothermal Energy established

2013
EnCana Chair in Water Resources established

FOR ONE HUNDRED YEARS NOW, THE ECONOMIC GROWTH OF ALBERTA AND CANADA HAS BEEN INEXTRICABLY LINKED TO THE DEPARTMENT OF EAS

"The department's influence can be seen in every area of natural resource development in our province, from the early phases of exploration for energy and mineral resources."

–Martin Sharp, chair of Earth & Atmospheric Sciences

It is without question that the work undertaken in EAS has enabled the province to maximize its resources as a powerful economic engine for Canada. Founded and led by Canadian-born John A. Allan—of Mount Allan fame in 1912—the department contributed such fundamental work for the resource sector as surveying the Drumheller Coal Field in 1922, publishing the first map of Alberta's coal fields (still in use by the Energy Utilities Board, and updated regularly), and publishing the first geological map of Alberta in 1925.

As the department grew, scientific icons like Charles R. Stelck, a founding father of Alberta's petroleum industry, persisted in exploring for hydrocarbons during the challenging times of World War II while also teaching hundreds of future oil hunters the secrets of the sub-surface world. Along with Allan and Stelck, Robert E. Folinsbee joined the department to lead in the spheres of base metals, gold, uranium, and diamonds. Jozsef Tóth, still active in the department today, made major breakthroughs in the early 1960s on gravity-driven groundwater flow—another critical contribution to the province.

Their ground-breaking work put the department on a trajectory of breakthroughs in earth sciences that include such pivotal revelations as the discoveries of gold in Yellowknife and oil under Leduc.

The vision, dedication, and spirit of discovery of these EAS researchers, and those who have followed in their footsteps, have laid the foundation for the international reputation the department holds today that continues to be felt as we move forward into the next century.

Always at the Forefront of Research and Innovation

"EAS is focused on monitoring and reducing the environmental impact of resource development through processes like carbon capture and storage, and most recently through attention to the planning issues associated with resource development."

—Martin Sharp

The Department of Earth & Atmospheric Sciences (EAS) at the U of A has grown to become the largest of its kind in Canada, based on a reputation for excellence and for its responsiveness to the ongoing needs and challenges of resource-based industries, the environment, and government.

This enduring success is founded on the principles of research and teaching excellence that were laid when the department was established—principles that it continues to celebrate and carry forward as it marks this centenary. Researchers like George Pemberton, for example, an expert in the field of ichnology, the investigation of animal-sediment interactions in both recent and ancient environments. This important research program—the impact of which is felt throughout the province and further afield—is applying a deep understanding of trace fossils in sequence stratigraphy to guide the exploration and exploitation of hydrocarbons and coal throughout Alberta.

Another example is Ben Rostron's internationally acclaimed work in carbon capture and sequestration, which has significant implications for global warming and the oil industry. Rostron's work has been a part of a project that started in 2000 to investigate the technical and economic feasibility of storing the gas in a partially depleted oil reservoir in Saskatchewan. So far, the team has demonstrated that it is possible to safely capture and store carbon dioxide that would otherwise go back into the atmosphere, enabling wider application in other parts of the country and the world.

In looking forward to Alberta's resource and energy future, Sharp says the department will continue to innovate in oil and gas exploration, work to mitigate and remediate the environmental effects of this work, capture and store carbon, and lead in hydrogeology and diamond mining—areas where the U of A already has a strong international reputation.

"Our researchers are fully engaged with what is going on in industry, and the students that graduate from our programs go on to make valuable contributions in an incredibly wide variety of fields," says Sharp.

To build even stronger support for industry, EAS has joined with Physics to create the Integrated Petroleum Geosciences (IPG) master's degree program, now in its fourth year. Program director David Potter says the initiative was created as a direct response to an appeal from industry. "We are the only one of our kind in Canada—possibly North America," says Potter. "The support and input of industry has been essential and the results speak for themselves."

This interdisciplinary approach for petroleum exploration and production is increasingly recognized as an imperative for meeting emergent challenges which require the wide perspectives of geophysicists, geologists and petroleum engineers.

In terms of other resource industry leadership, the recruitment of Graham Pearson as a Canada Excellence Research Chair in Arctic Resources has also enhanced the international profile of EAS. Diamond exploration and mining has been one of the main drivers of economic development in Canada's North during the past decade, accounting for more than $2 billion in annual economic activity. To sustain this level of economic growth beyond the predicted 10- to 20-year life spans of the current mines, more diamond deposits must be discovered. Pearson is working on the first detailed picture of rock formations hidden deep under the Earth's crust in Canada's Arctic region, revealing new data on the landmasses where diamonds are formed.

The efforts of faculty today to train and inspire the next generation of researchers and industry leaders will ensure earth and atmospheric sciences at the U of A continues to build on its already great reputation.

Approximately 7,000 people gather on Independence Mall in Philadelphia on the first Earth Day—April 22, 1970.

The real social science:

how citizen science is changing the research game

By Akila Gopalakrishnan

There's a revolution going on, and your pocket is taking a part in it—or at least your cell phone is - as powerful cellular networks and social media have revolutionized sharing accurate information reliably and instantly.

This opportunity that has not been lost on science as fieldwork research that has traditionally been conducted only by scientists is now being transformed into community-based science projects, involving science-loving, non-scientist volunteers called "citizen scientists".

U of A scientists like Dr. Erin Bayne, Associate Professor in the Department of Biological Sciences, are tapping this opportunity - stepping out of their research laboratories and getting social—while teaching their students to do the same. Bayne, along with his undergraduate conservation biology students collaborated with over 1800 citizen scientists to collect data on avian mortality in Edmonton, the results of which are published in *Wildlife Research* (2012). Bayne is enthusiastic that "academicians can now use technology to easily train interested [citizen scientists] to collect large amounts of data that would otherwise be impossible to do them ourselves". But he cautions, "Citizen Science efforts without a good understanding of scientific principles of data collection and experimental design are doomed to failure".

Citizen scientists have access to some incredible mobile apps and premade kits to share collected data with scientists, who can then compile and analyze statistical trends to make the data publishable in refereed scientific journals and conferences. These engaged volunteers are more than just data collectors—they also have ideas to share. Suhel Quader is heading two such assignments in India: *Seasonwatch*, a 20 year project studying changes in seasonal cycles of plants and *Migrantwatch*, a published 4-year research effort studying migratory patterns of birds indicative of seasonal changes. On the advantages of citizen science, he says "they help by adding to the scientific knowledge base and also change us as citizens—to care about the environment and develop a relationship with what is around us."

> "Never doubt that a small group of thoughtful, committed citizens can change the world; indeed, it is the only thing that ever has."
>
> Margaret Mead

What's next for citizen science?

From FrogWatch Canada µBiome, which populates microbial data from hundreds of human volunteers to understand dietary and lifestyle impact on human health to gaming in the *EyeWire Project* as players map their retinal neuronal cells to study brain functions - more citizen science projects are invigorating societies, engaging in real life scientific projects, transforming the way science is perceived and performed.

Akila is a doctoral student in Molecular Biology and Genetics, focusing on cholesterol metabolism genes and nuclear receptor biology in fruit flies. She is also an avid photographer and a trained vocalist in Indian Classical music. Actively involved with many science outreach programs such as Let's Talk Science and WISEST, Akila is also passionate about science communication.

And Speaking of the Future:

Geo Fingerprinting

By Lucas Habib

Karlis Muehlenbachs (earth & atmospheric sciences) began his studies in the field around 1994. Earl Jensen, an engineer for the oil company Amoco (now part of BP), called him to discuss the problem of abandoned oil wells near Lloydminster that were leaking gas. "I had no idea it was even a problem," Muehlenbachs recalls.

As he began to investigate, he and his graduate student Kathleen Rich developed a way to identify the layer in the geological strata from which a gas is emerging. Using stable isotope analysis—a technique increasingly used in ecology, archaeology, law enforcement, and many other fields—they were able to "fingerprint" a gas and peg it to a unique depth in the Earth's layers. In the Amoco case, Muehlenbachs and Rich determined that the gas leaking to the surface wasn't from the production target area, but instead from shallower depths due to leaks higher up in the well. They then developed a technique to improve the sealing of the well columns, which has since been commercialized by an Edmonton company. In recent years, Muehlenbachs has been able to apply this same analytical system to methane leaking from fracking operations.

Muehlenbachs believes that this is a perfect case for the value of academic research. "We have a vast pool of knowledge that industry can draw on to solve an actual problem, based on pure academic lilywhite research," he says. "Society doesn't always value scientific research, but you need that knowledge to tap into—using theoretical insights, you can solve huge engineering problems."

"Society doesn't always value scientific research, but you need that knowledge to tap into—using theoretical insights, you can solve huge engineering problems."

An ear to the ground to reduce impacts from fracking

By Lucas Habib

Hydraulic fracturing, better known as fracking, is getting an awful lot of press these days. It's been lauded for opening up unconventional gas reservoirs to development—the reason that some are predicting the US will achieve energy independence in about 20 years. But it has received plenty of criticism as well for negative environmental effects—clandestine chemical compounds being pumped into the ground where they could be affecting groundwater reservoirs. Two University of Alberta researchers are working to reduce some of the negative outcomes of fracking by helping industry to minimize unintended consequences.

Geophysicist **Mirko van der Baan** (physics) is a great listener. For 15 years, he's been using microseismology to eavesdrop on oil and gas production deep beneath the ground. When energy companies use hydraulic fracturing, they inject large quantities of highly-pressurized water and chemicals into the earth to shatter the rock, creating permeable pathways for gas to trickle back to the well. All that pressure can also affect the geology of the remaining rock through compaction and shearing, which can have implications for a gas field's future production.

Van der Baan, though, has helped develop a technique to monitor these "miniature earthquakes" happening underground and to determine how they change the geology and mechanics of the reservoirs and rock surrounding them. Along with collaborators from industry, the University of Calgary, and a team of 30 graduate and undergraduate students, van der Baan is conducting experiments that he hopes will increase the energy industry's efficiency.

"Geophysics puts a lot of emphasis on critical and analytical thinking—we need people from many different disciplines who are interested in every aspect of this research."

In August, the team installed geophones—miniature versions of the seismographs used to monitor earthquakes—into a borehole on a ConocoPhillips wellsite a few weeks before hydraulic fracturing began. Since then, they have been monitoring microseismic activity during fracking, after fracking has ceased, and before it began (natural background microseismic activity). "It has really let us see how the whole cycle works," says van der Baan. He hopes that once they understand the process, they will be able to make key recommendations to industry on how to optimize water usage—it's possible, for example, that far less water could be used to achieve the same results. Van der Baan also hopes that their results will help optimize horizontal well spacing on the landscape. "We hope to predict how far from the wells a reservoir will be drained, which may result in a reduction in the number of wells," he says. "Geophysics puts a lot of emphasis on critical and analytical thinking—we need people from many different disciplines who are interested in every aspect of this research."