A road sign warning of springbok wildlife crossing is pictured along the road leading to the Southern African Large Telescope during sunrise. The astronomical facility is located in the remote desert highland of the Karoo near Sutherland, South Africa.
18  **The Fabric of Our Origins**
In the quest to understand our beginnings, researchers have forged partnerships with colleagues in South Africa and are uncovering answers and opening new scientific frontiers.

**BY KELLY TYRRELL**

26  **Artificial Intelligence. Real Stereotypes.**
English and Asian American studies professor Leslie Bow examines the implications of high-tech robots embodying female Asian features.

**BY LOUISA KAMPS**

28  **Where Do the Humanities Live?**
Inviting the public to engage with hard questions is at the heart of the humanities at UW-Madison.

**BY MARY ELLEN GABRIEL**
OF OUR ORIGINS

FABRIC

THE
In the quest to understand our beginnings, L&S researchers in astronomy, geoscience and anthropology have forged partnerships with colleagues in South Africa. By probing the dawns of the universe, life on earth and humankind, they are uncovering answers and opening new scientific frontiers.

**By Kelly Tyrrell**
Astronomical Observatory astronomer Lisa Crause. SAAO administers SALT.

Spectrographs are like sophisticated prisms that split white light into its component wavelengths, from red to green to indigo and beyond. Astronomers use this information to gain valuable insights into an object being observed — like a galaxy — from its composition to its age, distance, and even how its individual parts might be moving.

The spectrograph on SALT was built in UW–Madison’s Space Astronomy Laboratory and scientists there are working on the telescope’s next-generation instrument.

A long history of expertise

UW–Madison was invited to be involved with SALT because of its long history of expertise designing and crafting astronomical instruments.

“As we were the first place known for doing photoelectric photometry, a technique for measuring the amount of light galaxies. As hot gases cool and condense, they form stars. Dying stars return gas back to galaxies and seed the environment with the materials necessary to form planets. Understanding how materials enter into and escape a galaxy is crucial to understanding a galaxy’s metabolism, and ultimately, the evolution of galaxies like our own Milky Way.

Astronomy is a path forward

Large telescopes like SALT are essentially “light buckets,” Wilcots says. “The bigger the telescope, the more light you can collect.”

SALT’s 11-by-10-meter array of hexagonal mirrors, 91 in all, allows astronomers to see far back into time and space by gathering large amounts of starlight and transforming it into data.

The light collected by the telescope’s mirrors passes through an instrument on the telescope known as a spectrograph, which “is to an astronomer as a scalpel is to a surgeon,” says South African Astronomical Observatory professor Eric Wilcots and graduate student Julie Davis take in the immensity of the Southern African Large Telescope during Davis’ first visit to the astronomical facility.
in the galaxy and quantifying starlight,” says Wilcots.

UW–Madison astronomy professor Joel Stebbins pioneered this technique in the 1920s and ’30s, utilizing the photoelectric effect, the concept for which Einstein won his Nobel Prize.

Stebbins helped recruit the faculty who would become leaders in developing and advancing astronomical instrumentation. Among them was Kenneth Nordsieck, emeritus professor of the astronomy department and the original designer of the Robert Stobie Spectrograph, named for SAAO’s former director.

The telescope saw its “first light” in 2005, capturing images that included a galaxy 30 million light years from the Milky Way. By then, UW–Madison had already begun to play a role helping train the next generation of South African scientists.

Science that can change the world

Since the fall of apartheid more than two decades ago, South Africa has embraced astronomy as one of its scientific pillars.

After SALT was commissioned, UW–Madison created the Wisconsin Teacher Enhancement Program to help train South African teachers in the years after apartheid and help contribute to the nation’s transformation. It brought South African teachers to Madison for several weeks in the summer to take science and health courses.

UW–Madison also helped train one of South Africa’s first black astrophysicists, Ramatholo Sefako, who studied under Wilcots in the early 2000s.

Now, local scientists like Lisa Crause (who is working on another future spectrograph for SALT), are leading the charge to re-shape the future of South Africa through science. The telescope has even supported a tourism industry in Sutherland and boosted its economy.

For graduate student Julie Davis, pursuing astronomy has meant being able to follow her dreams and collaborate with people across the world.

“There is so much human effort that goes into this,” she says. “Hundreds of people came together to build this telescope. We are driven by curiosity. Regardless of the tongue we speak, we have a common language.”

“A boy pauses on his bicycle in Sutherland, South Africa, a small town with a population of under 3,000.
CHAPTER 2
LIFE ON EARTH

The Makhonjwa Mountains, on the eastern edge of South Africa, are not particularly majestic. The highest peaks are just 6,000 feet above sea level. But these mountains, also known as the Barberton Greenstone Belt, happen to be among the oldest in the world. They were born on a cool and strange early Earth nearly 3.6 billion years ago. And they are one of the few places on the planet where evidence of ancient life can be found.

This is what brought UW–Madison professor of geoscience Clark Johnson to South Africa. Johnson and his collaborators around the world study Earth’s geologic past in order to better grasp when and how life on the planet began. They also hope to better understand where we are headed.

Rocks uncovered in these mountains have helped to tell part of that story, in part because they unravel some of Earth’s history with oxygen, a critical element in the tale. Oxygen transformed the planet from a mostly inhospitable, barren chunk of rock to a wildly diverse domicile for everything from bizarre single-celled organisms to complex animals like apes and people.

In 2013, Nicolas “Nic” Beukes, a South African geologist at the University of Johannesburg who has been a longtime collaborator of Johnson’s, was studying Barberton’s rocks when he and his team found something unusual. As Johnson recalls it, Beukes got in touch with him and said, “You have to come down and see this!”

This is what a rock can tell you

Much like astronomers, who can look back in time by capturing data from many light years away, geologists can peer back into Earth’s history by studying rock records that extend miles beneath the planet’s surface.

The key is to find rocks that have not had their records altered over time by high temperatures, pressures and mechanical forces, known collectively as metamorphism. Rocks like this can be found in South Africa, and Beukes has access to rare and deep (old) deposits to study.
That was how he came to possess the 3.2-billion-year-old richly colored, layered rock that Johnson traveled to South Africa to examine in 2013.

“Some layers have darker color, some pinkish, some lighter gray, made up of little granules of iron washed in from somewhere in the shallow part of the ocean,’’ Beukes explains. “Clark and his students discovered that these lighter layers have a different composition from ones that formed in deep water.’’

Using methods to look at the complex geochemistry of these layers, they showed that the lighter layers once existed in a shallow sea shelf above a deeper ocean and contained evidence of oxygen. This oxygen could only have been produced by living organisms — in this case, microbes known as photosynthetic cyanobacteria.

“We didn’t know it was this exciting until Clark did his sophisticated analysis and we said, ‘See, this is what a rock can tell you,’” Beukes says.

**Paving the way for complex life**

Around 600 million years ago, just a blink of an eye by geologic time, oxygen became one of the predominant gases in Earth’s atmosphere. This coincided with an explosion of complex lifeforms in the sea, like soft-bodied jellyfish and bug-like trilobites. Later, primitive plants began to flourish on land and animals ultimately evolved on dry ground.

But oxygen — and life — were present much earlier. Johnson and Beukes focus on the rock record because “we would actually be missing the whole story if we only focused on Earth’s atmosphere,’’ says Johnson. “It was the last to be oxygenated.’’

Once oxygen-based organisms appeared, “it was the most important biological innovation on the planet,’’ he says. It set in motion an evolutionary chain of events that ultimately led to the origins of modern humans, roughly 200,000 years ago.

“It’s important to understand the history of oxygen on Earth,’’ says Beukes. “It’s where we come from.’’
Winter in the South African Highveld paints with a palette of golds and reds, dusty browns and shades of pale pink. An arid grassland at once reminiscent of the American Midwest and Southwest, the landscape is dotted with striking clusters of green — trees growing along the slopes of the region’s undulating hills.

Often, these trees betray a secret. Attracted by moisture, they grow atop a meshwork of underground caves that, millions of years ago, provided water, cover and shade to early peoples in a part of the world now called the Cradle of Humankind.

It was in one of these caves, in 2013, where a team led by Anthropology professor John Hawks, and his South African collaborator, Lee Berger, made a remarkable discovery: a brand new human ancestor they named Homo naledi. The Cradle of Humankind, located 30 miles northwest of Johannesburg, is rich in fossil-bearing caves, including Swartkrans, Sterkfontein and Rising Star, where Homo naledi was excavated by an international team of six women, including one from UW–Madison, PhD student Alia Gurtov.

It is one of the most important places in the world for the study of human origins. “The origins of humankind, of humanity, is an African story,” says Travis Pickering, who is also a professor of Anthropology at UW–Madison and has spent most of his career studying fossils in South Africa. He is part of a team that recently put on display one of the most complete skeletons of a human ancestor ever found, a human cousin named Little Foot. Pickering leads an undergraduate field school at Swartkrans each summer.

“Every one of these big discoveries is coming out of this tiny area,” says Hawks. But, he notes, “This kind of cave exploration is a difficult beast.”

All in the family

In 1947, a paleontologist named Robert Broom and his apprentice, a young scientist named John Robinson, discovered a skull at the Sterkfontein Caves. The Sterkfontein Caves are known for their vast holdings of early hominin fossils, some dating back 2.3 million years.

Homo naledi was discovered in the Rising Star Cave, and in 2013, an international team of six women — including one from UW–Madison — worked to excavate the fossils.
Sterkfontein cave that would help establish Africa as a critical place for the study of human origins. They named their find Mrs. Ples, representative of another human cousin called *Australopithecus africanus*, which lived millions of years ago.

The two scientists and Mrs. Ples became part of the fabric of the human evolution story in South Africa. Robinson would ultimately become a professor at UW–Madison and his legacy would live on as other scientists continued to make finds in the Cradle of Humankind, building upon his discoveries.

Since then, the discovery of many more human ancestors has made clear that our concept of evolution as a linear pathway where one species evolves into another simply isn’t true, says Hawks.

He envisions humanity’s origins more like a river delta, with waterways weaving in and out of a channel that radiates outward. Multiple species lived and adapted and died on the landscape simultaneously.

“The exciting thing is, we’re charting this course through unknown territory and we have the privilege of knowing there is more to discover,” Hawks says.

**Sharing knowledge, making connections**

Hawks is dedicated to sharing this knowledge in new ways. He and Berger, professor of anthropology at the University of the Witwatersrand, involved more than 100 early- and mid-career scientists in recovering, analyzing, cataloging and making *Homo naledi*’s data accessible to other scientists.

They keep fieldwork brief and efficient. Scans of the bones are made public so others can study them virtually or 3D print them. Hawks routinely shares findings from the field on social media and teaches undergraduate courses to UW–Madison students virtually, giving lectures from cave entrances and other unique anthropological sites.

Today, *Homo naledi* is on display at Maropeng, a museum in the Cradle of Humankind dedicated to human origins. Designed like a cave, the exhibit takes visitors through “chambers” where they learn how *Homo naledi* was discovered, the teamwork involved in its study and the fossil’s place in the evolutionary story.

In July of 2017, Hawks was visiting the exhibit before the museum opened for the day. He was still in the final chamber where *Homo naledi* rests when the first tour group came through with questions about these ancient humans: How old are they? What other animals were around when they lived? Did *Homo naledi* get cavities?

**A search for truth**

There is something indescribable about standing in these caves where people who came before us went about their lives. Here, scientists are tracing the history of our species, condensing millions of years of physical, social and intellectual developments that have led us to the now—a moment when scientists have the power to unravel the mysteries of the universe we inhabit and the planet beneath our feet.

“We are all connected by our curiosity about our origins,” says Pickering. “There is a fellowship in that that I find heartening.”

[origins.wisc.edu](http://origins.wisc.edu)