Flowing Snowy River Cave near Ft. Stanton, New Mexico. Pictured is cave passage between Plunge Pool and Turtle junction, October 2015.Calcite is actively deposited during such flows. *Photo courtesy of Pete Lindsley.*

Lite Geology

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Issue 45

In this issue...

Water

In this issue of Lite Geology we discuss water and the myriad roles it plays on our planet. Water is important in the creation of fossils, is a critical natural resource, molds geological landforms, and as a key ingredient for life. Our water-themed journey takes readers from the gypsum of White Sands, through the Plains of San Agustin, into Snowy River Cave, down to explore the depths of the earth, up hydrothermal vents into well-maintained greenhouses, and through the minerals, aquifers, and mountains of New Mexico. Our *Through the Handlens feature: Tech Trek at New Mexico Tech* describes the AAUW sponsored Tech Trek program and opportunities for up and coming 8th grade girls to spend two weeks at New Mexico Tech for summer STEM fun!

EARTH BRIEFS

Trackways at White Sands National Monument

Scientists have been investigating remarkable footprint trackways created by extinct animals, including mammoths, ground sloths, dire wolves, saber-toothed cats, and camels, preserved at White Sands National Monument in south-central New Mexico for nearly 40 years, but the richness of the record has been recognized only in the last decade. The tracks are in gypsiferous muds and sands that were deposited along the edge of Pleistocene Lake Otero, a lake that once covered a large area in the western Tularosa Basin during the last Ice Age when the climate was wetter than it is today. Although most of these tracks are estimated to be more than 30,000 years old, two sets of tracks record a younger dramatic event—a stalking or hunting encounter between barefoot humans and ground sloths during the late Pleistocene. Ground sloths were large, lumbering herbivores with long, curved claws that were about six to eight feet tall when they stood up on their hind legs. The tracks were likely formed 10,000 to 15,560 years ago, based on radiocarbon dating of organic material interbedded with the sediment and the known records of sloth extinction and human occupation in the southwestern United States. More than 100 sloth and human tracks have been found at a site located in the northwestern corner of the monument. Analysis of the length and width of the tracks suggests the presence of multiple sloths (at least three) and multiple people. At least ten human tracks are located within sloth trackway way and the orientation of the human and sloth tracks align, suggesting that the humans were deliberately walking in the sloth tracks. In places where the density of human and sloth tracks is high, the sloth trackways show abrupt changes in direction. Certain circular or elliptical sloth tracks with associated claw impressions are thought to represent places where the sloths stood up and turned to face the human pursuers.

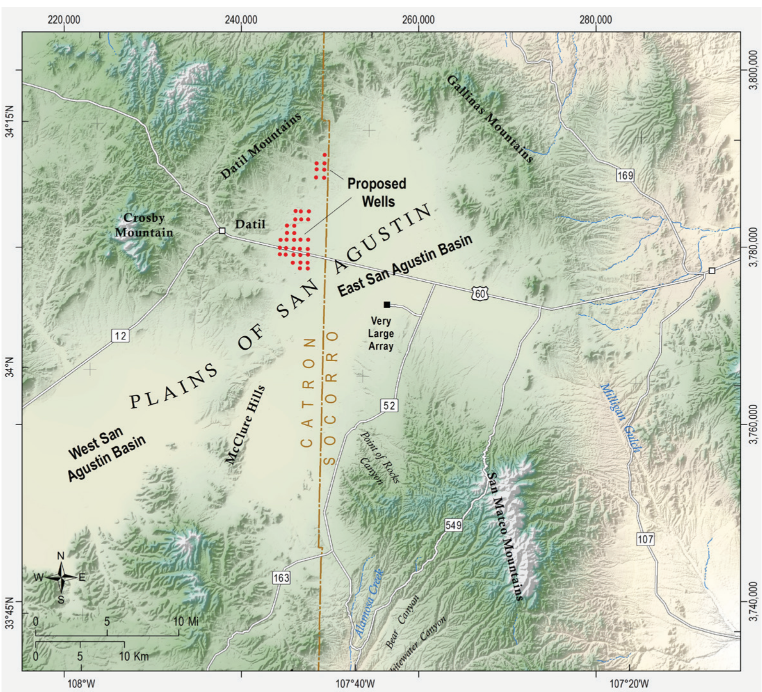
Scientists investigating this site had to answer a very important question: Did these tracks, produced by two very different species, form at the same time? Geologic evidence indicates that they did. The two sets of tracks cut across each other. There is no indication of a time break between formation of the sloth and the human tracks where the sloth tracks are overprinted; no traces of ponded water or sediment infill are recorded and soil moisture conditions did not change between track-forming events. Furthermore, the change in direction of the sloth trackways and signs of defensive behavior by the sloths imply interaction between the groups.

Was this interaction related to hunting or were the people just curious about the sloths? The fossilized remains of a sloth carcass have not been found, but conditions for preserving fossil bone in this environment were not ideal. Maybe the hunt was unsuccessful. We will leave it to your imagination to fill in the details of the story of this chance meeting that occurred along the shores of a long-gone watering hole. We are fortunate that the evidence for this encounter was protected by the shifting sands of the Tularosa Basin.

Shari Kelley

Groundwater under the eastern San Agustin Plains

In 2007, a foreign-owned company applied to the Office of the State Engineer (OSE) to pump 54,000 acre-feet of water from a sparsely populated place called the San Agustin Plains, 50 miles west of Socorro, and pipe it nearly 150 miles north to the greater Albuquerque Metropolitan Area. The people of the San Agustin Plains, known for their frontier individualism, came together in strong, united opposition of the project, forming the San Agustin Plains Water Coalition. Other regional land managers joined with the land-owners in formally protesting the application. Three applications have been made, protested and then declined by the OSE, with the final being declined in 2018.



Overview map of San Agustin Plains, showing proposed well field (red dots) and the different basins of the Plains.

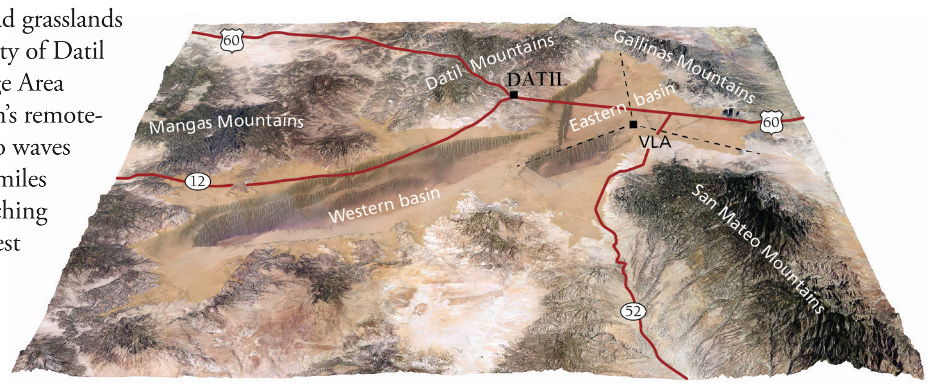
Surrounded by low, rugged mountains, the broad grasslands are home to scattered ranches, the small community of Datil (population 54), and the Karl G. Jansky Very Large Area (VLA). The VLA was put here because of the basin's remoteness—the VLA's measurements of interstellar radio waves are overwhelmed by cell phone radio waves a few miles away. The Plains consist of two closed basins stretching northeast-southwest for nearly 60 miles. The longest basin is the western arm of the Plains. The eastern Plains, separated from the western Plains by low hills, is underlain by three small grabens, or fault-bounded bedrock lows: the C-N, the North, and the White Lake grabens. In the Plains, these lows have been filled by sediment eroded from the surrounding mountains.

The scant population of the Plains was caused by physical and social drivers. The basin has no perennial springs or streams. The surrounding, mineral-poor mountains are cut by narrow valleys and canyons, complicating travel despite their low relief. This resource-limited landscape and the mobility of the different indigenous Apache bands made this one of the last regions of the conterminous U.S.A. to be colonized. The settler families that came into the region in the late 19th and early 20th century mostly founded ranches dependent on stock tanks filled by windmills and occasional flows in arroyos.

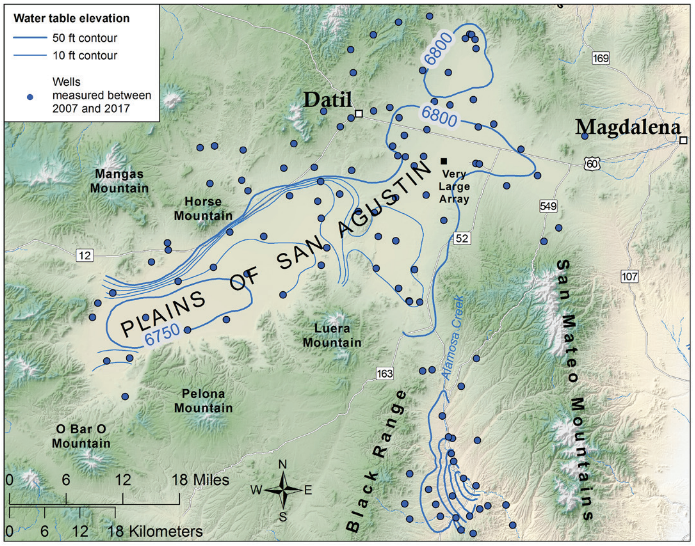
The hydrogeology of the Plains has been little studied, because of its remoteness and emptiness. The Plains were once filled by Ice Age lakes prompting archaeological and paleoenvironmental studies that discovered world-class archaeological finds of dry caves with the earliest specimens of maize in New Mexico. But in terms of hydrogeology, only three major studies have been conducted. All three studies build on each other and find largely consistent results.

First, the Plains are hydrologically connected to the surrounding mountains. The aquifers in the mountains are made of shallow alluvial sediments filling canyon bottoms and of locally fractured volcanic ash-flow rocks that can be connected on length scales of 100s of yards to miles. Water infiltrates into these aquifers and then drains down and out into the Plains. In the Plains, the sediment filling the basins, or basin-fill, makes up the aquifer. This sediment is composed primarily of sand and gravelly sand deposited by past ephemeral streams, which transitions downstream to clay-silt and fine sand. Groundwater levels are too deep (10s to 100s of feet) for recharge to infiltrate from the surface in the Plains themselves.

Second, the groundwater in the San Agustin Plains is flowing steadily but slowly, as seen in the constant, low



This figure shows what the San Agustin Plains would look like if we removed the basin-fill sediment. It allows visualization of the depth-to-bedrock and the locations of grabens. The depth-to-bedrock is interpreted using wells and geophysics.



Water table elevation contours in San Agustin Plains and Upper Alamosa Creek measured in wells between 2007 and 2017.

slope of the water table elevations.

The groundwater table elevation slope (2 feet/mile) is comparable to the slope of the Rio Grande (3 feet/mile) between Belen and San Antonio. However, the water table in the North graben, where the proposed development is located, is flat. This implies that not only is the aquifer in this region at a steady-state, but that groundwater actively flows through these aquifers.

Third, the Plains slowly drain from their southwestern corner into the Gila River watershed. Our study concluded that little to no groundwater is draining from the San Agustin Plains into the upper Alamosa Creek and then into the Rio Grande watershed—the divide between the Plains and Alamosa Creek is full of low permeability rock and the waters of the Plains and Alamosa Creek are isotopically and chemically distinct. Preliminary groundwater radiocarbon dates show that recharge is entering the Plains over the course of thousands of years while the groundwater along the axis of the Plains is between 10,000 and 15,000 years old.

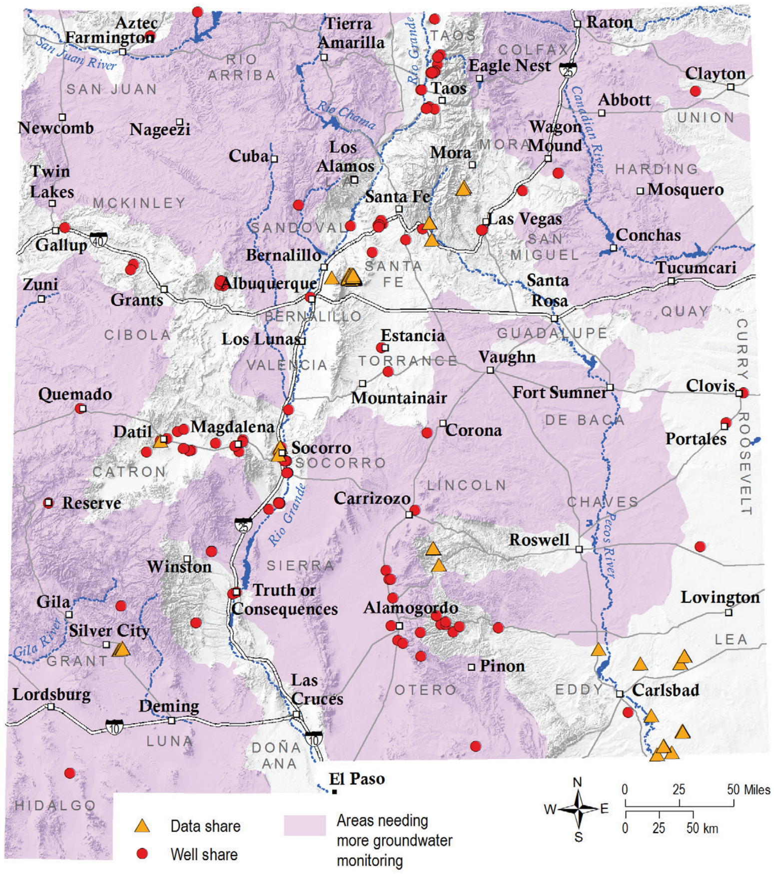
The San Agustin Plains are controversial, both hydrologically and socially, and with minimal data the Plains have challenged researchers to find answers. We know that the water is flowing very slowly but steadily, and that the Plains are underlain by distinct grabens that make the basin-fill aquifer and underlying bedrock floor uneven—which would affect groundwater flow paths and rates. We know that over geologic time the Plains are draining into the Gila River watershed. But questions remain on the rates of groundwater movement and what that implies about the effects of a proposed interbasin water transfer project on groundwater in the Plains.

Alex Rinehart & Dan Koning

Collaborative Groundwater Monitoring Network with the New Mexico Bureau of Geology and Mineral Resources

We use water every day. Most of us don't think about where our water comes from every time we turn on the tap. In many parts of our state, we rely heavily on groundwater. Groundwater can be found in aquifers where pore spaces or fractures exist in the subsurface rock material and where these pores or fractures are well connected. Some of our aquifers in New Mexico are large and productive, such as in the sand and gravel basin-fill beneath Albuquerque; others are broken up by faults or volcanic rocks and have low productivity, such as in some of our high mountain regions.

Taking groundwater depth measurements, as shown here, in domestic wells is best done using a specially made steel tape, which has 1 ft markings all along it. The tape works much like the dipstick in motor oil. *Photo by Bonnie Frey.*



Map of wells participating in the New Mexico Collaborative Groundwater Monitoring Network. As you can see, we have a lot of empty areas to fill in!

You can think of our surface water (lakes, rivers, and streams) as our checking account, while our groundwater is our savings account. We hope to have groundwater in times of need, when surface water flows are reduced or unavailable. We have many ways to measure our surface water and track that balance, but providing an accurate account balance for groundwater is far more difficult. Additionally, many regions, well owners, and water systems struggle to understand the extent and volume of their groundwater resource. One way we can evaluate our groundwater savings account is to measure and track static groundwater levels in wells. Aquifers ignore boundaries, such as county lines or fence lines; therefore a regionally comprehensive dataset with many wells is needed to help us holistically describe and quantify our groundwater resources. Groundwater-level data is a fundamental dataset that helps us understand where the groundwater exists, which way it's moving, and trends over time. Community water providers rely on these data to better understand and secure their water future.

The Aquifer Mapping Program at the New Mexico Bureau of Geology and Mineral Resources is working to address the need for tracking our groundwater account balance, especially in rural communities. Through a public-private partnership between the New Mexico-based charitable Healy Foundation, we are working around the state to build a Collaborative Groundwater Monitoring Network. The collaborative groundwater monitoring network aims to address three primary goals: (1) to provide New Mexicans with an awareness of our groundwater resources, (2) to provide a public dataset on groundwater, and (3) to use groundwater-level data to describe and define our aquifers. This program is free to all participants!

Water level measurements are especially needed in areas of the state where no other monitoring occurs. The map shows the approximate locations of the current water level monitoring networks, including the network maintained cooperatively through the NM Office of the State Engineer and the U.S. Geological Survey. Having water-level data that track the annual or seasonal trends over time can provide useful data for seeking funding for additional wells, or for simply tracking the groundwater account balance. Water-level data may also indicate problems with a well that occur as well infrastructure begins to age and deteriorate.

These valuable data are provided through our online interactive map at https://maps.nmt.edu/. Check out this online data-rich map and play around with some of the different features on display there by clicking on the boxes and drop down menus!

Stacy Timmons & Angela Lucero

Snowy River Passage, Fort Stanton Cave, New Mexico

Almost all caves throughout the world, with the exception of lava tubes, are primarily produced by interactions between rocks and water. Rocks (mainly limestone and evaporites) are dissolved by water to form cave passages. Subsequently, rain and snowmelt percolates into these passages from above, depositing minerals in the cave to form beautiful decorative speleothems, such as stalagmites and stalactites. Many caves are connected to the surface by streams that deposit and erode sediments within the cave passages. Features in caves, such as speleothems, sediment deposits, and stream morphology are related to the local hydrogeology. The amount and timing of water input that drives many of these processes depends on the temporal and spatial distribution of precipitation. Therefore, most caves contain a record of past climate to some degree. Scientists study features in caves to understand how the climate has changed over the last hundreds to thousands of years.

Fort Stanton Cave, located in Lincoln County in an area once known as the Fort Stanton Military Reservation, is one of the longest caves in New Mexico with over 30 miles of mapped passage.

Snowy River Springs. *Photo courtesy of Pete Lindsley.*

The known extent of the cave has increased greatly since 2001 when cave explorers discovered Snowy River Passage. Over the last 18 years, cavers have mapped well over 10 miles of the Snowy River Passage, and there is no end in sight. In 2009, about 25,080 acres surrounding Fort Stanton Cave was set aside as a National Conservation area to protect, conserve, and enhance the unique and nationally important historic, cultural, scientific, archaeological, natural, and educational subterranean cave resources of the Fort Stanton-Snowy River cave system.

Snowy River Passage is characterized by a snow-white calcite formation that covers the streambed floor for its entire length, making it the world's longest cave formation. As far as we know, no other known cave in the world exhibits this beautiful and unusual feature. The calcite deposit, which overlies stream sediments (gravels, sand, and silt), is several centimeters thick and made up of dark and light bands or layers that represent different depositional or flooding events. The bottom layer was determined to be approximately 800 years old. Since its discovery, Snowy River Passage has flooded several times in response to above-average monsoon rainfall and spring snowmelt. The water is very clear, with virtually no suspended sediments, indicating that the water is not coming directly from a stream or lake on the surface. Thin layers of calcite are deposited during each flood event. Sediments that were deposited prior to Snowy River Formation, indicate that in the past (greater than 800 years ago), there were one or more cave entrances that provided a direct connection between Snowy River Passage and water on the surface. Cavers and scientists are currently studying the hydrogeology of Fort Stanton Cave and Snowy River Passage. Understanding today's hydrogeologic system will help to predict future flood events in the passage so that cave explorers will not get stranded in far reaches of the cave. Studying current and past hydrogeologic processes and interactions between the cave and the surface is necessary to extract valuable information about how the climate has changed over the last hundreds to thousands of years.

Talon Newton

Tiny crystal calcite "balls" deposited on a stainless steel staff gauge in Snow River. *Photo courtesy of Pete Lindsley.*

Calcite lines on the wall mark ancient water lines on the side of the cave not far from Turtle Junction and just a few feet above today's high water mark on Snowy River. November 04, 2017. *Photo courtesy of Pete Lindsley.*

No water, no granite. No granite, no continents. No continents, no land mammals.

Water is essential for life to thrive on this planet. It is necessary for our bodies to function. In fact, the average human adult male is approximately 60% water and the average adult female is approximately 50%. Without it, we couldn't grow crops, keep livestock, or wash our food (or our bodies, for that matter). Water has also advanced civilization. We use water to power our modern-day lives. Sixty percent of U.S electricity is from power plants that use hot water and steam turbines to drive electricity generators.

Without water, life on earth would never have begun. Water acted as a medium in which organic compounds could mix with one another, and water facilitated the formation of the planet's first life forms, possibly even protecting them from the sun's radiation. Scientists continue to explore possible locations for the origin of life, including tide pools, hot springs, and deep-sea hydrothermal vents.

Sugarloaf Peak in the Organ Mountains. *Photo by Matt Zimmerer.*

We do know that around 400 to 350 million years ago, in the Devonian era, the first vertebrate animals, tetrapods (four footed animals) climbed out of the sea and began to colonize swampy land. To achieve this historic landmark there had to be land to climb up and on to. And water was crucial in the formation of this land.

An outcrop showing highly irregular bands of lighter and darker minerals. The bands are wavy because of convection currents in the once-liquid magma chamber. *Photo by Matt Zimmerer*

These are types of granitoids (rocks with quartz, plagioclase, and K-feldspar). Granite is actually a very specific combination of the three minerals. The two samples in the middle are the most closely related to granite. *Photo by Matt Zimmerer.*

Oceanic crust, which covers 70% of the Earth's surface, is erupted at mid-oceanic ridges. Below the ridges magma chambers act as heat sources for convective systems which cycle hot seawater through fractures in the crust, resulting in deep and widespread hydration of seafloor basalts. As the oceanic crust spreads away from the ridges it cools and becomes denser than the underlying rocks and eventually sinks back into the mantle at subduction zones. At a depth of about 60 km the presence of water in the hydrated basalts lowers the melting point of the region, allowing silica-rich, less dense magmas to rise towards the surface, forming volcanoes and large intrusive granite bodies. Over time, these coalesced into the building blocks of continental crust. Collision of tectonic plates has uplifted and exposed large granite intrusions like the Sierra Nevada batholith, which forms the core of the Sierra Nevada in California.

View from the top of the Organ Mountains looking east. Much of the Organ Mountains are composed of granites and syenites (a rock very similar to granite, but with less quartz). These types of rocks typically weather into angular slabs like those in the photo. *Photo by Matt Zimmerer.*

Continental crust is too buoyant to return to the mantle. That's why it is, on average, so old. When continents collide, the crust can thicken to almost 100 km, but that is temporary because it soon spreads out again. The relatively thin skin of limestones and other sedimentary rocks tend to stay on the continents, or in the ocean, rather than return to the mantle. Even the sand and clay that is washed off into the sea returns to the continents on the conveyor belt of the oceanic crust. Continents are truly permanent, self-sustaining features of the Earth's surface and have allowed land-life to evolve from marine life and humans to colonize every continent.

Maureen Wilks

Rock Glaciers of New Mexico

It's hard to imagine today but alpine glaciers extended into New Mexico's mountain ranges during the last Ice Age, leaving behind prominent topographical features and deposits in the Sangre de Cristo Mountains, Jemez Mountains, and even as far south as Sierra Blanca near Ruidoso. Bodies of glacial ice were active on the east side of Santa Fe Baldy as recently as 15,000 years ago—essentially an instant on geologic timescales. Striking head valleys (cirques) surrounded by knife-like ridges (arêtes) in the Sangre de Cristos testify to the awesome land-sculpting powers of extinct glaciers.

Furrowed and pitted rock glacier surface in the southern San Mateo Mountains, New Mexico. Vicks Peak (left) stands at 10,252 feet above sea level. *Photo by Andy Jochems.*

Even more surprising is that ice could *still* be driving landscape processes in mountains around our state! But it's much more subtle than during the last Ice Age. No, you won't find glaciers filling entire mountain valleys in New Mexico. Instead, the ice is hidden beneath piles of rock debris in mountainous head valleys, forming features suitably called rock glaciers.

Rock glaciers are periglacial mass-movement landforms consisting of rock debris with subsurface ice. The term "periglacial" traditionally refers to geomorphic processes that take place adjacent to past or existing glaciers, but is now used to describe processes occurring in cold climates with or without large glacial ice bodies. Active rock glaciers are usually found in areas with permafrost (permanently frozen ground), although some may occur in temperate climates where their debris-laden surfaces prevent melting of the underlying ice.

The coarse, angular debris that mantles rock glaciers is derived from mass wasting of cliffs, upslope scree or talus deposits, or landslides. Rock glaciers are thought to move in several different ways: deformation of internal ice (permafrost creep), pushing by the weight of upslope talus deposits, or interactions between permafrost and groundwater (basal sliding). Gradual downslope movement and internal melting of ice results in an overall tongue or lobate shape with complex furrowed and pitted surfaces as well as steep frontal and side slopes.

Rock glaciers are potentially useful features for understanding past climate because temperatures must have been lower and/or precipitation higher in order for them to have contained year-round ice. Oxygen and hydrogen isotopes from ice cores within rock glaciers show promise for more specific paleoclimatic interpretations.

Most of the rock glaciers in New Mexico are relict features and likely no longer contain ice, especially in southern ranges like the San Mateo and Capitan Mountains. Most occur at elevations above 8,500–9,000 feet. There is no way to directly date these landforms but the majority are probably younger than about 35,000 years old, based on their prominent relief and lack of vegetation and soils. A few rock glaciers in the Sangre de Cristo Mountains lie at high elevations with low average temperatures that could preserve subsurface ice year-round—they may remain active to this day!

Andy Jochems

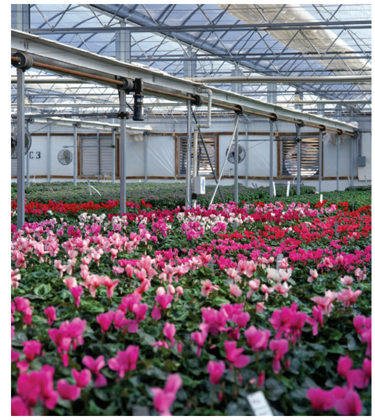
Rock glacier west of Pueblo Peak in Taos County (arrow points to frontal slope). View is to the southeast. *Image courtesy of Google Earth.*

Geothermal Greenhouse Heating in New Mexico

A portion of the Masson Radium Springs Farm geothermal greenhouse complex is shown, looking south across the Rio Grande toward the Robledo Mountains. *Photo courtesy of Jim Witcher.*

Geothermal energy, an abundant resource in New Mexico, has important cost savings potential in the agriculture sector for greenhouses. New Mexico has some of the best solar for plant growth in the United States; and combined with good transportation that is co-located with geothermal resources, there is potential for significant greenhouse growth in the future. Geothermal greenhouses also show promise to conserve valuable water, while maintaining or increasing agricultural income.

Greenhouse crops grow in a controlled environment and take maximum advantage of sunlight for growth through photosynthesis and for daytime heat in winter. During the day in summer, evaporative cooling may be used. At night, the transparent cover of a greenhouse will allow heat to radiate outward almost as though no roof existed. As a result, all greenhouses are heated to optimal conditions for plants at night, even on many summer nights, and on winter days when solar heating is limited. Conventional greenhouses use a fossil fuel boiler. In this case, natural gas is burned to heat water in a boiler. Circulation of boiler hot water through pipes and radiators heats air in the greenhouse. The hot water circulation system is a closed loop that continually returns water to be reheated by the boiler for additional heating passes through the greenhouse.



A crop of Cyclamen is showing red and pink flowers. The louvered fans on the far wall draw air across wetted pads behind the viewer for cooling of solar heating during daytime. *Photo courtesy of Jim Witcher.*

Hot geothermal water from production wells is piped into the exchanger room as the heat source for a closed-loop fresh water heating system. The very efficient plate and frame heat exchanger is the square red equipment on the far left. The red tank on the right is for accommodating thermal expansion of the closed-loop heating system fluids when the system is brought on line in late afternoon and evening for night time heating. The blue objects are pumps for circulating hot-fresh water from the heat exchanger via the silver insulated pipes. *Photo courtesy of Jim Witcher.*

Greenhouses require enormous amounts of heat even in the mild winter climate of the southern New Mexico deserts and an acre of greenhouse will require at least 4.5 billion Btu of heat during a year. Wholesale or commercial natural gas is typically sold in units of 1,000 cubic feet or 1 Mcf, which is the same as a million Btu or 1 MMBtu. Over the last decade, the cost for 1 MMBtu of natural gas has varied from roughly \$3 to \$15. The large cost variation is difficult for many high energy demand businesses and makes planning very uncertain.

Masson Farms of New Mexico, Incorporated north of Las Cruces at Radium Springs, uses geothermal for significant savings to heat 24 acres of greenhouse, the largest in New Mexico and one of the largest geothermal greenhouses in the nation. Geothermal heating for the Masson Farms greenhouse costs less than \$0.50 per MMBtu for the expense of electricity to operate the well and circulation pumps, maintenance, and to pay well drilling costs. There is no variable and unpredictable fuel cost. For comparison, with a current natural gas cost of \$3.50 per MMBtu and boiler inefficiency added, the annual geothermal savings is more than \$432,000.

At Radium Springs, 199° F water is pumped from a depth of 650 to 800 feet with a geothermal production well. The geothermal water is piped to a heat exchanger where the heat in salty geothermal water is transferred to fresh water. The salty geothermal water with heat removed is then injected back into the reservoir with a different well. Hot fresh water at 180° F is circulated through bare piping in the closed-loop greenhouse heating system and returned to the heat exchanger for geothermal reheating in the continuous heating cycle.

James C. Witcher

2018 Tech Trek campers learn about missing geologic time and angular unconformities at San Lorenzo Canyon. *Photo by Cynthia Connolly.*

Through the Hand lens: Tech Trek

Tech Trek is an American Association of University Women (AAUW) initiated, seven-day academic summer camp devoted to immersing 60 female, up-coming 8th grade students in a variety of STEM disciplines. The New Mexico Tech Trek program has mentored over 300 New Mexico girls since 2015. Program participants are nominated by their 7th grade science teachers and are chosen by the Tech Trek committee, based on essay performance and interviewer comments. Tech Trek attendees are housed in the NMT dorms and attend classes designed to enhance appreciation of a wide array of science disciplines. Last year the Bureau of Geology and Mineral Resources (NMBGMR) offered a geology tour of San Lorenzo Canyon and educational activities at our Mineral Museum.

This summer, with generous support from Haliburton, NMBGMR geologists Dana and Peter Scholle, Ron Broadhead, Bonnie Frey, Lynn Heizler, Shari Kelley, and Nels Iverson created a workshop with activities designed to showcase the effects of porosity and permeability on geology at a range of scales. All 60 Tech Trek campers traveled to the Quebradas Scenic Byway to study porosity and permeability in Pennsylvanian–Permian sedimentary rocks. Groups of 30 took the trip on two separate days to allow greater interaction with geologists. Tech Trek staff then selected eight girls to participate in an extended geology workshop in which campers studied reservoir rocks at the NMBGMR petroleum core library, examined thin sections with petrographic microscopes, and inspected samples at the sub-micron level with an electron microprobe. All Tech Trek campers also toured the education classroom and Mineral Museum at the New Mexico Bureau of Geology.

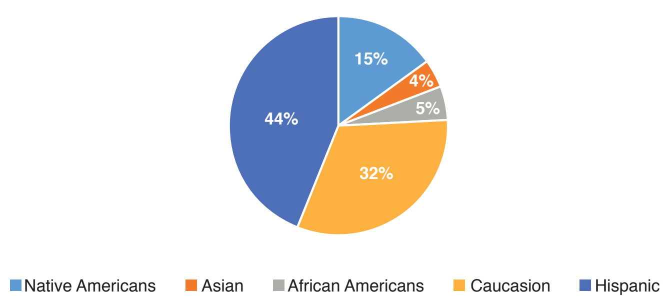
Tech Trek participants learn about San Lorenzo Canyon from geologists Nels Iverson, Virginia McLemore, Nelia Dunbar, Chloe Bonamicci, Shari Kelley, and Bonnie Frey. *Photo by Cynthia Connolly.*

The AAUW Tech Trek strongly supports diversity in education. In 2019, 60 girls represented 51 different schools, (13 new to Tech Trek), 19 counties, and various ethnic and racial backgrounds. This year Tech Trek had 44% Hispanic, 32% Caucasian, 15% Native American, 5% African American, and 4% Asian American campers enroll. In partnership with the AAUW and Halliburton, the NMBGMR provided Tech Trek students with a rigorous STEM experience taught by mostly female mentors to demonstrate that women do belong in science and in the workplace.

Shari Kelley (center with whiteboard) and fellow geologists describe the geologic history of the Quebradas. *Photo by Cynthia Connolly.*

Bonnie Frey takes a "chemistry moment" to describe the chemistry associated with oxidation spots on Abo Formation rocks. *Photo by Cynthia Connolly.*

Tech Trek 2019 Ethnic Demographics



Through our website, educators, students, and all who are interested in geology have access to lesson plans and teaching resources. In the long term, the NMBGMR hopes to foster a relationship with the AAUW Tech Trek program to create a culture of activity-based learning as a way to increase gender diversity in the workplace. Find out more about Tech Trek at techtrek-nm.aauw.net and geology-themed educator resources at geoinfo.nmt.edu.

Cynthia Connolly

Teacher Activity:

Albuquerque Water Web

by Angela Lucero

All water drops and game signs can be found at:
geoinfo.nmt.edu/repository/index.cfml?rid=20190003

ASSEMBLY/PREP-WORK:

1. Print out enough water drops for each player/team. We suggest using bright blue paper and laminating them if you plan to reuse them.

2. Print out ABQ_waterweb_square.pdf. For single use, we suggest printing them on regular paper and taping them to the wall around your classroom. For repeated use, we suggest laminating them and mounting them to 12"x12" pavers with strong duct tape. The pavers can be placed outside.

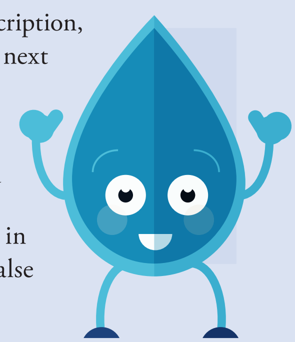
3. The game is more fun if you take the time to place the stations in a way that players have to look around for their next sign. For example, try not to put "Clouds" right next to "Rain" or "Snow"—make them search for the sign they want!

HOW TO PLAY:

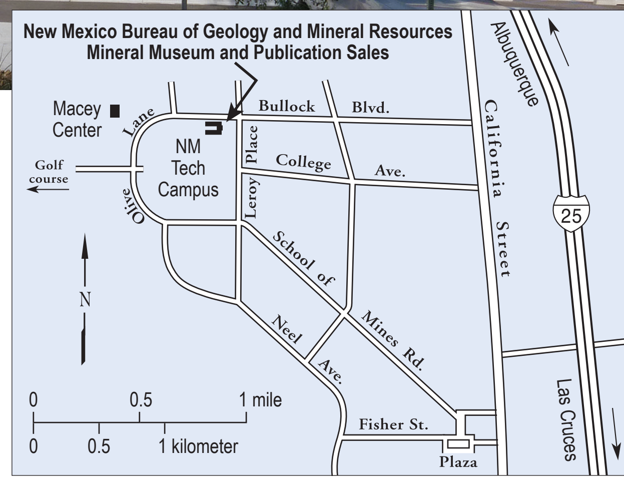
1. Each player or team gets one water drop. It tells them which station to start at and where they need to finish. Younger students would benefit from having a reading buddy on their team to read the text out loud.

2. All players start at the "Cloud" station. After reading the description, they must decide where to go next from the options presented.

3. Repeat until the player successfully gets to the "ABQ Tap Water"—Read, decide, move. Players may get caught in small loops but there are no false or dead-end options.



Please contact Angela Lucero at: angela.lucero@nmt.edu with any questions, concerns, or requests to make this game local to your community!



The Mineral Museum and Publication Sales Office are housed in the Bureau of Geology and Mineral Resources on the New Mexico Tech campus in Socorro, at the corner of Leroy Place and Bullock Boulevard. Visitor parking on the east side of the building provides convenient access.

Hours, excluding New Mexico Tech holidays, are: Monday through Friday, 9 a.m. to 5 p.m. and Saturday through Sunday, 10 a.m. to 3 p.m.

MINERAL MUSEUM

The Bureau's mineralogical collection contains more than 16,000 specimens from New Mexico, the United States, and around the world, along with mining artifacts and fossils. About 5,000 minerals are on display at a time. We like to show off our home state's minerals, as well as give students an idea of how minerals end up in products we use every day. For teachers, students, and other groups, we offer free tours of the museum. Museum staff can also identify minerals or rocks for visitors. Please call ahead to ensure someone will be available. For more information on the museum, please visit our website at:

geoinfo.nmt.edu/museum/

Senior Mineralogist and Museum Director:

DR. VIRGIL W. LUETH

(575) 835-5140, virgil.lueth@nmt.edu

Museum Curator: KELSEY MCNAMARA

To schedule a museum tour, contact Kelsey:
(575) 835-5418, kelsey.mcnamara@nmt.edu

Education Outreach: CYNTHIA CONNOLLY

(575) 835-5264, cynthia.connolly@nmt.edu

801 Leroy Place
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A wide selection of resources for teachers is available, including publications on New Mexico's geology. Many are written for the amateur geologist and general public.

We offer:

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