Elephant Butte Lake State Park's namesake "elephant," a volcanic plug intruded into Cretaceous mudstones. *Photo by Colin Cikoski.*

Spring 2019
Issue 44

Lite Geology

In this issue...

The Geology of Southern New Mexico's Parks, Monuments, and Public Lands

This issue of Lite Geology describes the geology found in wilderness areas featured in the upcoming New Mexico Bureau publication: ***The Geology of Southern New Mexico's Parks, Monuments, and Public Lands***. It also highlights southern New Mexico hikes, research, fossil discoveries, historical geology, and visitor information. This issue also details Rockin' Around New Mexico, a geology workshop for K–12 teachers to be held this summer in Socorro at the New Mexico Bureau of Geology and Mineral Resources. Through writing about the beauty of southern New Mexico, we hope to persuade our readers to explore this land and to learn more about it by reading ***The Geology of Southern New Mexico's Parks, Monuments, and Public Lands***, which will be published later this year.

NEW MEXICO BUREAU OF GEOLOGY AND MINERAL RESOURCES
A Research Division of New Mexico Tech
geoinfo.nmt.edu/publications/periodicals/litegeology

Earth Briefs

The Las Cruces Mastodon

A MASTODON SKULL WITH ONE attached tusk was found on private land in Las Cruces near the boundary of the Organ Mountains–Desert Peaks National Monument by a family taking a walk through the desert after several big rainstorms in 2016. Jude Sparks, a 9-year-old boy, found the fossil, which was exposed by erosion related to the storms. A mastodon is an extinct elephant-like creature with primitive high-crowned teeth capable of shredding leaves and tree branches. This particular fossil belongs to a mastodon genus called *Stegomastodon*. The site of the recent Las Cruces discovery is within 2 km of a famous fossil site at the base of Tortugas Mountain, which also contained *Stegomastodon* mouth parts and the remains of two other long-vanished elephant-like animals, *Cuvieronius* and *Mammuthus*. Mammoths are distinguished from mastodons by their teeth; the ridged molars of mammoths are similar to those of modern elephants, and they are well adapted to grazing.

The mastodon fossils near Las Cruces are commonly found in sand and gravel deposited 3.6 to 1.2 million years ago by the ancestral Rio Grande. The ancestral Rio Grande was a dynamic river that meandered laterally across the valley floor between the flanking mountain ranges many times during its long history. Scientists can learn about the landscape at the time that mastodons lived by studying the rocks surrounding the fossils. For example, the recently found mastodon was primarily covered by fluvial (river) sand and gravel, but adjacent floodplain clay deposits suggest that the animal died and was buried near the edge of the river.

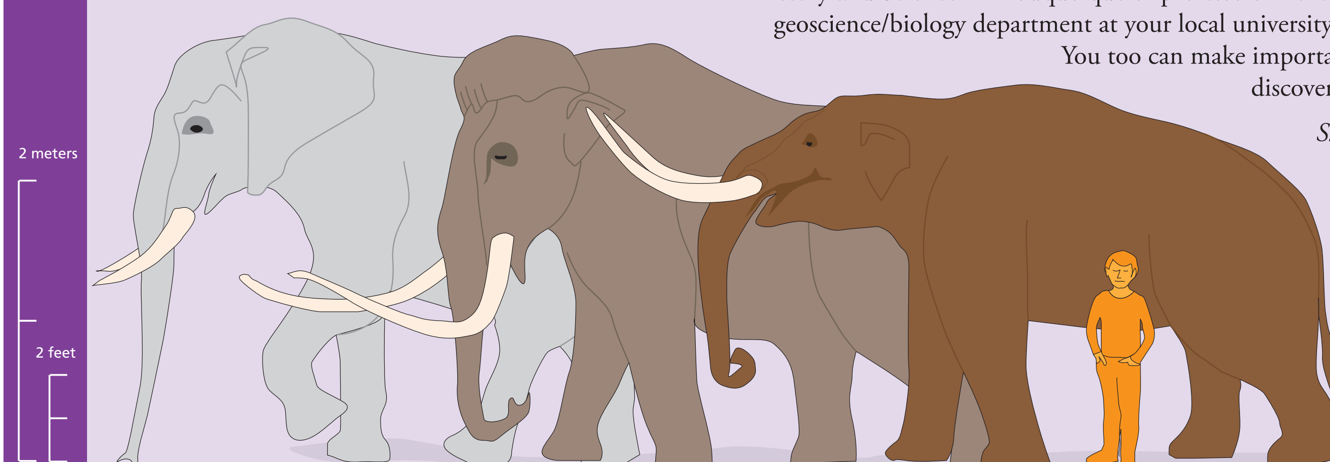
The fossils themselves can reveal vegetation patterns and climatic conditions at the time the mastodons lived. Wear on the teeth (molars) attached to the recently found skull indicates that this mastodon either ate tough vegetation or that the animal had lived a long time and died of old age. The *Stegomastodon* found at the nearby Tortugas site was a slightly more evolved version of the recently found mastodon. The Tortugas mastodon had more complex molars, which has led some researchers to suggest that the eating habits of mastodons were shifting from forest browsing to grazing as climatic conditions became more arid. Although mastodons and mammoths co-existed, the mastodons were eventually replaced by mammoths, which were better adapted to grazing.

Other mastodon fossils have been found in New Mexico, including the skull of a 10 million-year-old mastodon at Elephant Butte Lake in 2014. *Stegomastodon* fossils have been found in Sierra County near Truth or Consequences, in Socorro County in Arroyo de la Parida, and in Grant County near Buckhorn.

Each fossil that is found sheds new light on our understanding of the change in animal lifestyles and environmental conditions through time. So, the next time that you are out walking the family dog along an arroyo after a summer thunderstorm, watch for bones protruding from the walls or floor of the arroyo. If you spot something, take a photo, get a GPS coordinate, and leave it in place, then contact the curators at the Museum of Natural History and Science in Albuquerque or professors in the geoscience/biology department at your local university. You too can make important discoveries!

Shari Kelley

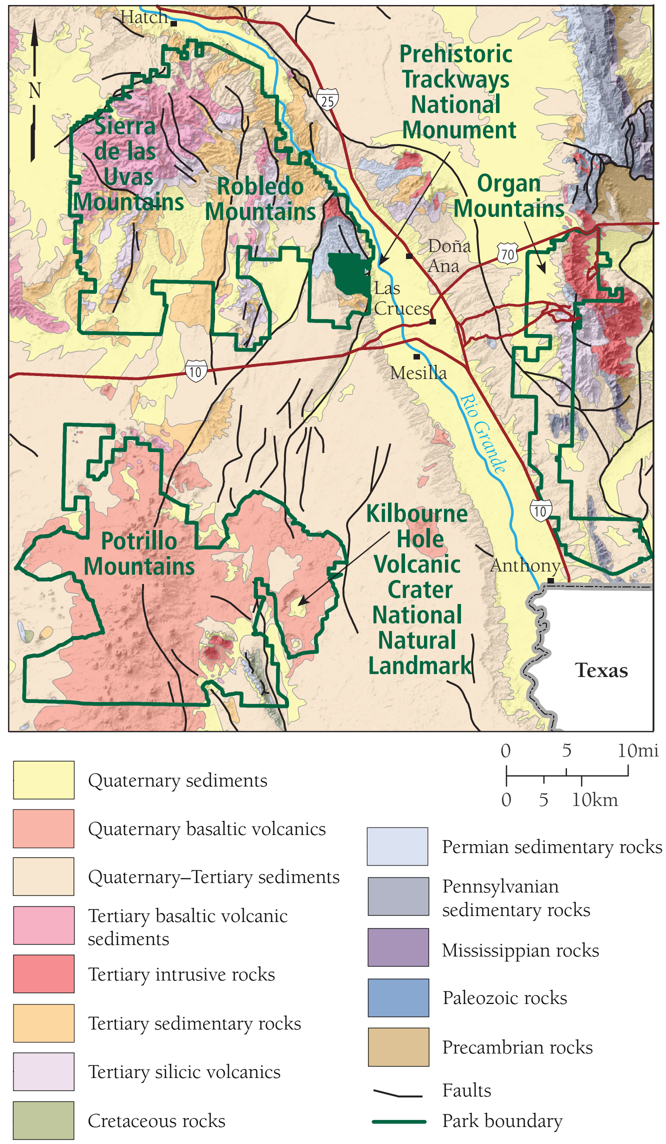
Jude Sparks with the *Stegomaston* fossil. Note the wear on the teeth. *Photo courtesy of Peter Houde, biology professor at New Mexico State University, who was in charge of excavating the fossil.*



African savanna elephant (*Loxodonta africana*) | Woolly mammoth (*Mammuthus primigenius*) | American mastodon (*Mammut americanum*) | Jude Sparks (*Homo sapiens*) | *Illustration modified from Encyclopedia Britannica.*

Organ Mountains–Desert Peaks and Prehistoric Trackways National Monuments

Established in 2014, Organ Mountains–Desert Peaks National Monument covers nearly 500,000 acres of diverse terrain and geology around the city of Las Cruces. This article covers three parts of the park, as well as the adjacent Prehistoric Trackways National Monument. Both parks are administered by the Bureau of Land Management, with visitor information at:
www.blm.gov/visit/omdp
www.blm.gov/visit/ptnm



Quartz monzonite forming the jagged spires of Organ Needles.
Photo by of Matt Zimmerer.

THE ORGAN MOUNTAINS form the famously jagged skyline east of Las Cruces. The diverse suite of rocks encountered in the Organs represents a complex geologic history. The earliest part of this history involved orogenic (mountain-building) events and sediment deposition as volcanic arcs converged with the proto-North American continent. These events are represented by 1.4 billion-year-old granites exposed on the northwestern flank of Baylor Peak, although they occur more extensively in the southernmost San Andres Mountains north of San Augustin Pass.

Hundreds of millions of years passed during which uplift and erosion removed rocks formed after the granites. During the Paleozoic Era, from about 500 to 250 million years ago, a thick succession of carbonates (limestone and dolomite) and interbedded shale, sandstone, and conglomerate was deposited across southern New Mexico in shallow seas and coastal settings. The aptly named Bishop Cap at the southern end of the Organ Mountains consists of rocks deposited during this interval.

The Laramide Orogeny, occurring from 80 to 40 million years ago, resulted in the old Precambrian granite and Paleozoic rocks being thrust upward into folds and fault-bounded blocks, including Bishop Cap. Caldera-forming eruptions in the Organ Mountains about 36 million years ago resulted in deposition of three ash-flow tuffs. These deposits formed from incandescent clouds of gas and ash, which flowed rapidly across the ground surface. Each caldera was superimposed on the former one, meaning that today only the structure of the youngest caldera is well preserved. The tuffs can be observed at La Cueva, Soledad Canyon, and in staggering 2,000-foot cliffs surrounding Dripping Springs.

Another granite-like rock called monzonite formed as magma collected at a depth of about three miles during caldera formation and for 10 million years afterward, composing the Organ batholith. This rock is lighter in color and less eroded than the Precambrian granites.

Pennsylvanian limestones at Bishop Cap.
Photo courtesy of Spencer Lucas.

Dramatic cliffs of ash-flow tuff at Dripping Springs.
Photo by of Matt Zimmerer.

Several monzonites are well exposed along the crest and eastern part of the range, as viewed from Aguirre Springs and the Pine Creek Loop Trail.

The most recent geologic history of the Organ Mountains is marked by faulting related to the Rio Grande rift and associated basin subsidence. The Jornada and Mesilla basins west of the Organs filled with sandy and gravelly deposits of the Camp Rice Formation during the last five million years. Faulting, westward tilting of the Organ Mountains fault block, and subsequent erosion resulted in the spectacular topography of the range and excellent exposures of the rocks described above.

POTRILLO MOUNTAINS AND KILBOURNE HOLE—The southwestern part of Organ Mountains–Desert Peaks National Monument includes the Potrillo Mountains and volcanic field about 30 miles southwest of Las Cruces. In contrast to the geologic era-spanning rocks of the Organ Mountains, most rocks in the Desert Peaks area are less than 1 to 1.5 million years old, with the exception of an Oligocene volcanic dome at Mount Riley–Cox Peak and Permian and Cretaceous sedimentary rocks in the East Potrillo Mountains.

The West Potrillo Mountains cover much of the southwestern part of the monument just north of the International Border, forming a broad volcanic field with numerous basaltic cones and flows. The western margin of this field is roughly coincident with the western margin of the Rio Grande rift. Indeed, these basaltic features, thought to have erupted at least 900,000 years ago, cover an aggradational surface on the basin-filling Camp Rice Formation. The volcanic field itself is also rift-related, as stretching of the crust facilitated migration of magma toward the surface.

One of the most fascinating features of this part of the monument is Kilbourne Hole, a classic example of a maar (volcanic crater) formed when magma interacts with groundwater during eruption. The interaction of hot magma with cold groundwater created a steam explosion, which excavated a deep, cone-shaped crater at Kilbourne Hole some 45,000 years ago. This process played out over the course of 1 to 10 years and formed an explosion breccia containing xenoliths (Greek: "strange rocks") of the underlying Afton Basalt and of peridotites containing green olivine, black pyroxene, and apple-green chrome diopside. The peridotites were carried upward by magma from more than 30 miles deep in the Earth's mantle.

Kilbourne Hole is a volcanic maar, with the East Potrillo Mountains in the distance at the upper right. *Photo courtesy of Akanawa, Wikimedia.*

The Kilbourne Hole explosion breccia is overlain by grayish surge deposits with beautiful cross stratification. The surge deposits, nearly 100-feet thick in places, formed from a series of small explosive eruptions in the already excavated vent. Turbulent clouds, comprising fragments of fresh magma, Afton Basalt, and Camp Rice sediments, deposited the cross-bedded surge beds. Also visible are bedding sags caused by the impact of large blocks of Afton Basalt, which were blown high into the sky by the eruption and then fell into the surge deposits.

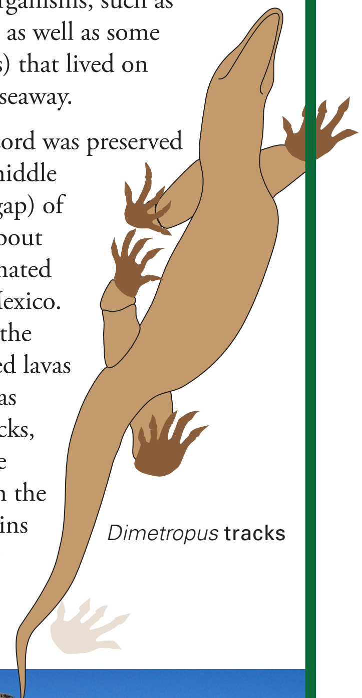
Lower Hueco Group in Prehistoric Trackways National Monument, marine limestones of the early Permian tropical sea that covered southern New Mexico. *Photo courtesy of Spencer Lucas.*

ROBLEDO MOUNTAINS AND PREHISTORIC TRACKWAYS—The Robledo Mountains and neighboring Sierra de las Uvas represent the northwestern unit of Organ Mountains–Desert Peaks National Monument. Tucked within this unit, just west of the town of Doña Ana and the Rio Grande, is Prehistoric Trackways National Monument, established by Congress in 2009. The Robledo Mountains are a fault block in the Rio Grande rift cored by Paleozoic sedimentary rocks with lesser exposures of Eocene volcaniclastic rocks. This range forms the western border of the Rio Grande valley northwest of Las Cruces.

Just after 300 million years ago, during the early Permian, New Mexico was located along the western shoreline of the supercontinent Pangea near the equator. This shoreline fluctuated from near Las Cruces northward for about 35 miles and was the seaward termination of rivers flowing from the Ancestral Rocky mountains. The shoreline and shallow-marine environment are represented by rocks of the Hueco Group, a succession of limestones, shales, red siltstones, and sandstones. Low-gradient river floodplains followed the shoreline as the seas retreated.

The Hueco Group contains a diverse assemblage of plant and animal fossils, from petrified tree trunks to marine shelled creatures to tracks and trails of ancient crustaceans and other arthropods, amphibians, and reptiles that give Prehistoric Trackways its name. Footprints and other impressions belong to a unique class of fossils called ichnofossils, or trace fossils. Trace fossils of plants, arthropods, amphibians, and reptiles attest to a diverse food chain and ecosystem comprising forested river floodplains and tidal flats not easily imagined in today's desert environment. There are also abundant fossils of marine-dwelling organisms, such as brachiopods, bryozoans, and crinoids, as well as some bivalves (clams) and gastropods (snails) that lived on the shallow, sunlit floor of the Hueco seaway.

After the early Permian, no rock record was preserved in the Robledo Mountains until the middle Eocene—an unconformity (geologic gap) of nearly 250 million years. Beginning about 40 million years ago, volcanism dominated the landscape of southwestern New Mexico. The eruptions of large volcanoes, and the rivers that flowed from them, deposited lavas and laharic (volcanic mudflow) breccias of the Palm Park Formation. These rocks, as well as a flow-banded rhyolite dome and a basaltic plug, are well exposed in the southern part of the Robledo Mountains between Picacho Mountain and the Robledo Mountains Off-Highway Vehicle (OHV) Trail System.



Dimetropus tracks

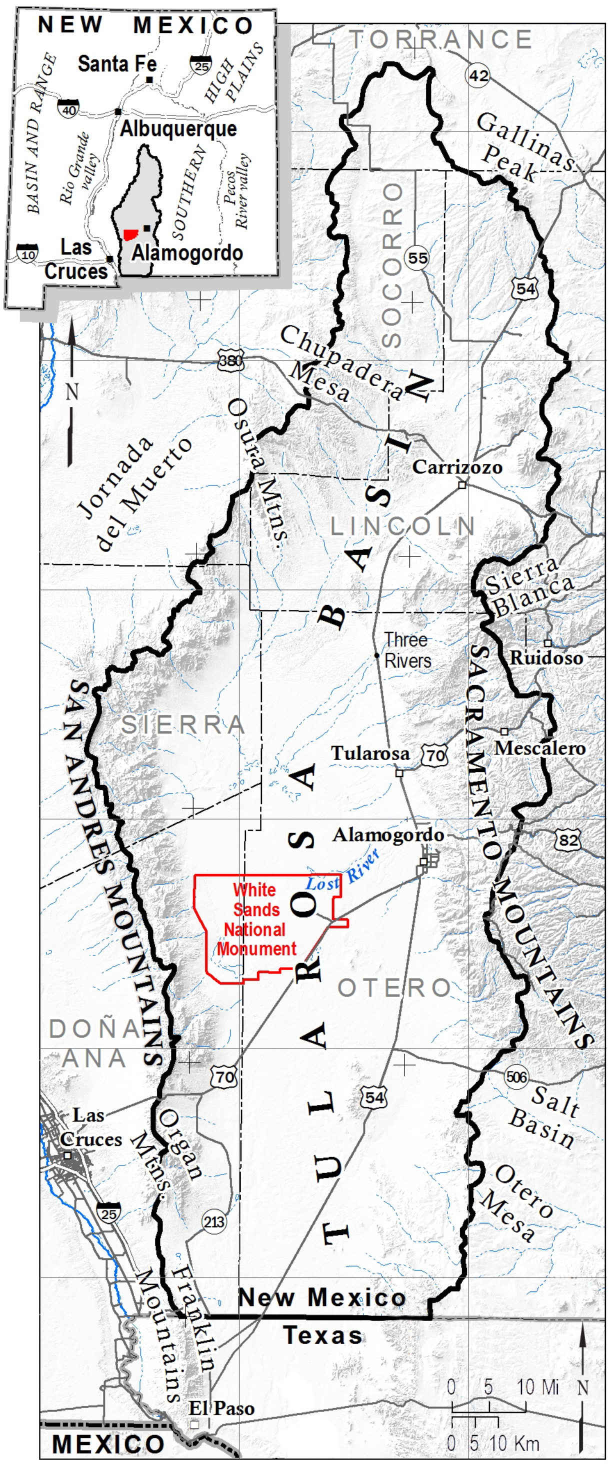
Red layers of the Hueco Group that yield trace fossils and give Prehistoric Trackways National Monument its name. *Photo courtesy of Spencer Lucas.*

NOTES ON VISITING THE NATIONAL MONUMENTS—*The Organ Mountains–Desert Peaks and Prehistoric Trackways national monuments offer abundant opportunities for hiking, climbing, mountain biking, camping, and horseback riding. Camping can be found at Aguirre Springs and at Leasburg Dam State Park near the Robledo Mountains. The Robledo Mountains OHV and Shane's Super Trail (SST) trail system near Prehistoric Trackways offer challenging terrain for OHVs and mountain bikers (the SST system is for non-motorized uses only). Note that rocks lying on the monuments may be collected by visitors, but collection of fossils is prohibited. Please contact the Bureau of Land Management (BLM) Las Cruces District Office for more information at (575) 525-4300.*

Nelia Dunbar, Spencer Lucas, Matt Zimmerer, and Andy Jochems

How the White Sands Dune Field in Southern New Mexico Won the Geologic Lottery

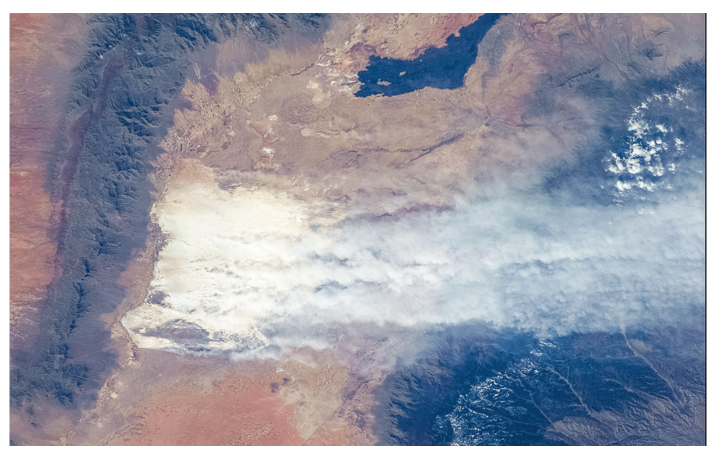
White Sands National Monument is located in the Tularosa Basin in southern New Mexico.
www.nps.gov/whsa



THE WHITE SANDS NATIONAL MONUMENT includes a part of the largest gypsum dune field in the world—approximately 275 square miles! The contrast of the white sand dunes against the backdrop of New Mexico's desert mountains results in a surreal landscape that is truly unique.

The White Sands dune field is also exceptional from a geologic perspective. Sand grains in almost all other dune fields in the world typically dominated by silica (SiO_2), with a mix of other minerals of low solubility (not easily dissolved by water) that are eroded by fluvial (river or stream), alluvial (deposits left by flowing water), coastal, or lacustrine (associated with lakes) systems. The sand that makes up the white dunes at White Sands National Monument is instead dominated by gypsum (calcium sulfate, $CaSO_4$), which is much more soluble than silica. Very few gypsum dune fields exist in the world, and the dune field at White Sands National Monument is by far the largest. The second largest gypsum dune field, located in northern Mexico near the town of Cuatro Ciénegas, encompasses about three square miles.

Aerial view of White Sands National Monument. The rising of the very shallow water table results in flooding during periods of high rainfall. *Photo courtesy of the National Park Service.*



A windstorm carrying gypsum-rich dust northeast from White Sands National Monument as seen from the crest of the Sacramento Mountains near Sunspot. The photograph taken from the International Space Station in late Feburary, 2012, shows that this dust can be carried as a visible plume for hundreds of miles, well into west Texas.

A delicate balance of environmental factors is required for such a huge amount of gypsum to accumulate as sand. The formation of a gypsum dune field requires:

1) A source of gypsum—Gypsum is a common mineral found in sedimentary rocks. The gypsum from White Sands National Monument likely came from the Yeso Formation in the Sacramento Mountains to the east of the monument. The Yeso Formation is about 260 million-years-old and is made up of sandstone, siltstone, and limestone deposited along the margins of an ancient ocean.
2) Gypsum transport—Because gypsum is relatively soluble, calcium and sulfate are common ions found in rivers, streams, and groundwater. Gypsum from the rocks in the nearby mountains was dissolved by rain and snowmelt and transported to the Tularosa Basin by streams and groundwater flow.
3) Gypsum accumulation—Gypsum is a common mineral found in evaporites, which are rocks formed by the evaporation of water. Over 20,000 years ago, a large lake in the Tularosa Basin slowly evaporated, leaving hundreds of feet of evaporites that primarily comprise gypsum. Over the last 6,000 years, wind has eroded the evaporites at the surface and transported it as sand-sized grains to accumulate as dunes.
4) Dune stability—This is the tricky part. An arid climate is required to preserve the dunes because too much fresh rainwater can dissolve soluble gypsum sand. The groundwater table at White Sands is very shallow (1 to 3 feet below the surface in the inter-dunal areas). This water effectively cements the buried gypsum and the base of the dunes in place. This groundwater is very high in dissolved minerals, including gypsum. If this was not the case, the gypsum sand would be dissolved by the groundwater. The stability of the dune field also depends on a sufficient amount of source sand that results in a deposition rate that is equal to the rate of deflation of the dunes (sand being removed from the dunes by wind). Currently, scientists do not fully understand all the factors that contribute to the long-term stability of the White Sands dune field.

White Sands is open every day except for December 25th. Hours vary depending on the season and can be found on the National Parks website at www.nps.gov/whsa/planyourvisit/hours.htm. The monument may close unexpectedly due to inclement weather. White Sands may also close for up to three hours due to missile tests on the nearby White Sands Missile Range. Visitors are encouraged to call 575-479-6124 the day before arrival to inquire about closures. We highly recommend that you visit White Sands National Monument so you can personally experience this one-of-a-kind geologic wonder.

Talon Newton and Ethan Mamer

Catwalk National Recreation Trail

For a delightful walk beside hidden pools and splashing waterfalls, visit the Catwalk National Recreational Trail. The trail takes you back in time when the lure of gold brought miners from all over the world, to work the mines high up the canyon hillsides of the rugged Mogollon Mountains.

www.newmexico.org/places-to-go/regions-cities/southwest/catwalk/

LONG BEFORE THE MINERS ARRIVED,

the land was shaped by silicic lavas and tuffs erupted from volcanoes. 40 to 24 million years ago, domes and calderas coalesced to form the Mogollon–Datil volcanic field. The Mogollon–Datil volcanic field rises abruptly from the floodplain south of Glenwood, includes the Gila Wilderness, and encompasses the Mogollon Mountains.

Whitewater Creek at the Catwalk. *Photo by Peter Scholle.*

In 1875, Captain Cooney discovered gold in the Mogollon Mountains. It was not until the mid-1880s after the surrender of Apache Chief Geronimo, however, that mining began in earnest, and for a few short years the town of Mogollon grew into a rip-roaring mining camp. Further south, gold was discovered above Whitewater Canyon, one of the larger and longest canyons in the Mogollon Mountains. Whitewater Creek emerges from the mountains through a tight box canyon, squeezed between the 100-foot cliffs of the Cooney Tuff. The Cooney Tuff erupted from one of the oldest major caldera-forming centers in the Mogollon Range at around 34 million years ago. Massive boulders clog the roaring stream, creating a series of falls and plunge pools.

In 1893, John T. Graham constructed an ore processing mill where the rugged canyon ended and the stream enters a wide gentle valley; here the small town of Graham, also known as Whitewater, grew up around the mill. The stream frequently dried up at the mill site, but there was always a good supply of water farther

The restored Catwalk in Whitewater Canyon. *Photo by Peter Scholle.*

upstream. The town also required water, so a 4-inch pipeline was constructed, reaching about three miles up the canyon. Built at the same time as the mill, pipeline anchor holes were drilled into the canyon walls—sometimes 20 feet above the canyon floor—to hold support timbers and iron bars. In 1897, a second larger pipeline (18 inches in diameter) was built to supply water to run a larger generator. The larger pipeline was in constant need of maintenance, and workman who had to walk the pipe dubbed it the "Cat Walk." Within 10 years, the boom was over, and the town dissolved away. Today, all that remains to mark the site of the once-thriving community is a remnant of the mill walls still clinging to the west side of the canyon, near the entrance to the Catwalk.

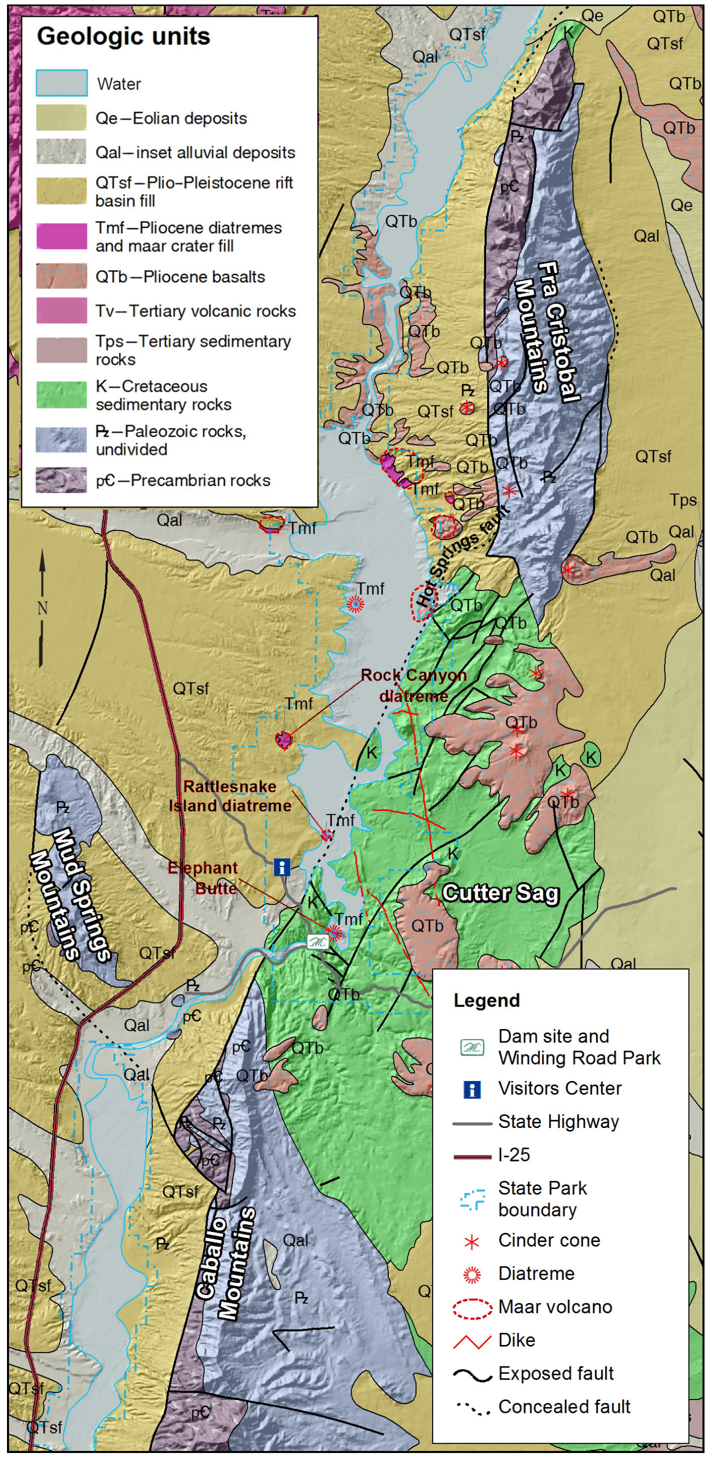
The suspended walkway, or "Catwalk," named for the former pipeline, was installed in the 1930s by Civilian Conservation Corps workers. In September, 2013, the Catwalk was destroyed when torrential rains inundated Whitewater Canyon. The canyon had been left vulnerable by the devastating 2012 Whitewater–Baldy Complex Fire—the largest fire in New Mexico's history. The Catwalk was rebuilt, with the help of Light Detection and Ranging (LIDAR) to precisely map the positions of new wall anchors and prefabricated 12 to 20 foot steel walkway sections. Construction took six months, and the newly restored Catwalk opened to the public on Memorial Day, 2016.

The Catwalk Recreation Area is a day-use area and is open from sunrise to sunset. A parking fee of three dollars per vehicle is paid at a self-pay station in the parking lot. Camping is available elsewhere in the Glenwood area. Beyond the developed trail, more rigorous trails lead into the Gila Wilderness. Consult with the Forest Service before venturing beyond the Catwalk Trail area.

Maureen Wilks

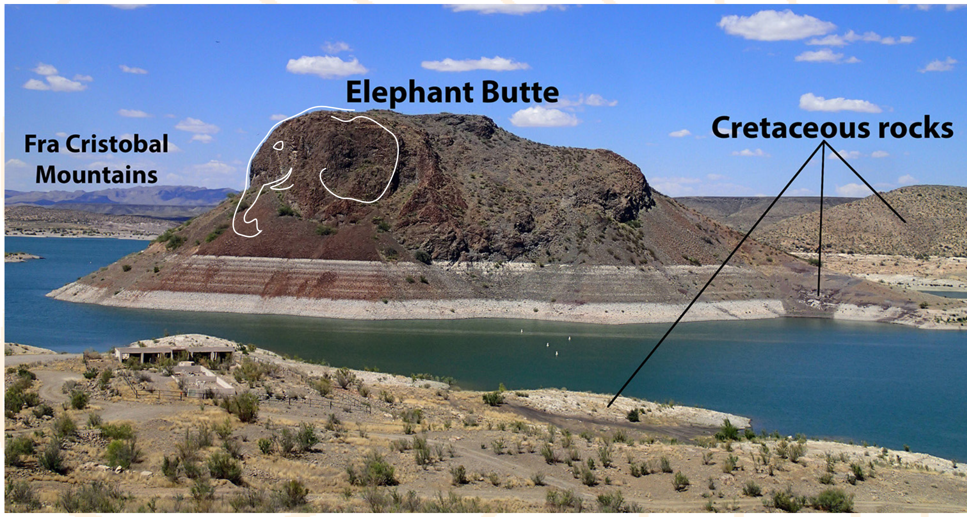
Elephant Butte Lake State Park

WHEN CRITICAL WATER SHORTAGES IN THE 1880s necessitated the development of a large reservoir in southern New Mexico, the deep and narrow bedrock walls of Elephant Butte Canyon provided a uniquely ideal foundation. Completed in 1916, Elephant Butte Dam was the largest irrigation dam in the nation, a 301-foot-tall, 1,674-foot-wide



behemoth that today restrains New Mexico's largest body of water and provides hydropower and water resources to the region. More than 100 years later, Elephant Butte Lake continues to be a unique location, an oasis in a picturesque desert setting, perfect for boating and escaping the heat at New Mexico's most popular state park.

The Lake lies in the Engle basin of the Rio Grande rift along the west side of the Fra Cristobal Mountains and the Cutter Sag, the latter being a region of low bedrock hills that connect the Fra Cristobal and Caballo mountains. This modern topography is principally the result of Rio Grande rift crustal stretching; each mountain range is a footwall uplift, wheras the Engle basin is a down-dropped "half-graben" that subsequently filled with alluvial (river-lain) sediment washed out of the rising mountains, as well as brought into the area by the Rio Grande.



Elephant Butte is all that remains of a 2 to 3 million year old volcano that erupted through Cretaceous rocks of the Cutter Sag. Purplish rocks at the base of the butte are Cretaceous mudstones. *Photo by Colin Cikoski.*

Thinly banded brown-to-greenish gray slopes downstream of the dam are underlain by Crevasse Canyon Formation sandstones (thin ledges) and mudstones (unexposed slopes). Outhouse for scale. *Photo by Colin Cikoski.*

Cretaceous river channels carried boulders up to 2 feet in diameter from mountains far to the southwest that now form conglomerates exposed at Winding Road Park. *Photo by Colin Cikoski.*

Elephant Butte itself is a volcanic plug, the exposed throat of an approximately 2 to 3 million-year-old volcano that erupted through about 66 to 70 million-year-old mudstones of the McRae Formation. Several volcanic vent rocks are exposed within the park boundaries, including at Rattlesnake Island, Rock Canyon, and Three Sisters Point, most of which are diatremes consisting mainly of basaltic ash and lapilli mixed with Rio Grande sands and pebbles excavated from the walls of the vent. Some vent rocks also contain xenoliths, clasts of rocks from as deep as 35 km below the surface that were entrained in the rising basaltic magma and carried to the surface.

Elephant Butte Canyon is carved into latest Cretaceous to earliest Tertiary (95 to 60 million-year-old) sedimentary rocks of the Crevasse Canyon and McRae formations, each consisting of mudstones, sandstones, and conglomerates laid down by ancient river systems. The older Crevasse Canyon Formation mainly consists of greenish-gray mudstones and thin light-brown sandstones, wheras the younger McRae consists of reddish-brown to purplish mudstones, sandstones, and conglomerates containing large rounded cobbles and boulders of mostly andesitic volcanic rock. Petrified wood and dinosaur fossils found in these rocks, including a *Tyrannosaurus Rrex* jaw, indicate the river plain was shaded by massive trees and stalked by gargantuan beasts.

Today, the area is better known for hot summer days and lake lounging than for dinosaurs and volcanoes. The park's exciting geologic past, however, can still be enjoyed in between swims, particularly at Winding Road Park, where visitors can discover Cretaceous rocks, and at Rock Canyon Marina where they will find volcanic rocks.

Colin Cikoski

Through the Hand Lens: Rockin' Around New Mexico 2019 Socorro

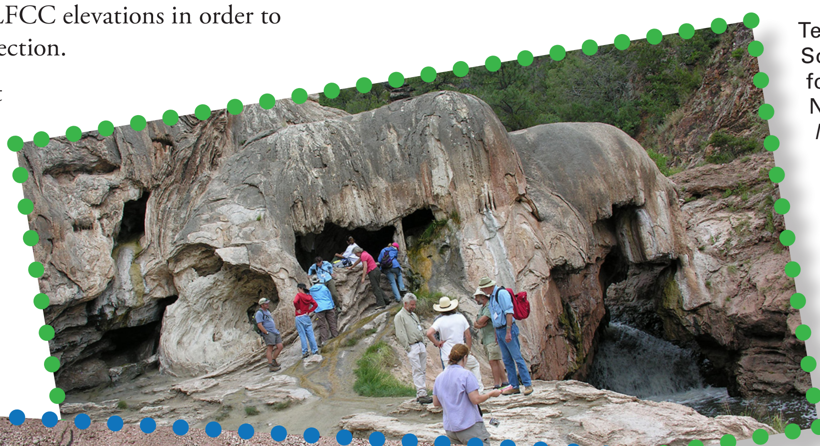
Rockin' Around New Mexico 2019 (or "Rockin") is a three-day geology workshop for K–12 teachers, coordinated by the New Mexico Bureau of Geology and Mineral Resources (NMBGMR), New Mexico Tech (NMT), and the New Mexico Department of Homeland Security and Emergency Management (NMDHSEM). The 2019 Rockin' will be held on Wednesday, July 10th, through Friday, July 12th, in Socorro, New Mexico. The theme for this year's Rockin' will be "Water: Past, present, and future." The Rockin' Around New Mexico workshop is taught by NMT geology professors and NMBGMR staff and features both fieldwork and classroom studies of geology. Mornings will be spent in the field, and afternoons will consist of in-class presentations and activities. Lessons can be taken back to the K–12 classrooms to inspire youth to appreciate the world around them and hopefully eventually pursue a career in geology. Prior knowledge of geology is not required to take the workshop.

Scientists from the Los Alamos National Laboratory, and New Mexico Bureau of Geology geologists, describe the landscape of the Valles Caldera in the Jemez Mountains during the 2007 Rockin' Around New Mexico. *Photos by Lynn Heizler.*

DURING THIS ROCKIN' AROUND NEW MEXICO, we will take a field trip to the Bosque del Apache to discover how the U.S. Bureau of Reclamation is changing the course of the Rio Grande and what it plans to accomplish with this move. Teachers will also learn about the "Save Our Bosque" task force and NMBGMR monitoring of riparian recovery after the Tiffany Fire of 2017. Teachers will participate in these efforts by measuring in situ water levels, dissolved oxygen, pH, and oxidation-reduction potential. Teachers will also survey the relative surface elevation of the river and Low Flow Conveyance Channel (LFCC). In class, teachers will use collected and archived data to graph relative river and LFCC elevations in order to determine groundwater-flow direction.

On day two, teachers will visit the Quebradas backcountry, east of Socorro, to explore the Chupadera copper mine area and then walk over to Bursum Springs (also known as Ojo de Amado). On this hike, we will cross a preserved coastal lake of Pennsylvanian age (300+ million years) and will continue past this ancient shoreline and a coastal lagoon. These features are recognized by observing the stratigraphic positioning of rock types and fossils. This walk is about a mile and a half long over rough terrain. (Participants that have trouble hiking this far can be driven from the mine to the springs). Teachers will also learn about the ancient groundwater processes that created the copper deposits and will observe a modern artesian spring. In-class lessons include growing copper sulfate crystals and water-related activities.

Day three will consist of earthquake-related presentations, demonstrations, and activities, including a "Shake Out" earthquake practice drill. Bureau Geologist Dr. Alex Rinehart will discuss the dangers of liquefaction in New Mexico, and a speaker from the NMDHSEM will relate the importance of preparing for earthquakes. All teacher participants will receive a t-shirt, a notebook with resources, books describing the geology of Socorro, and collected rock samples.



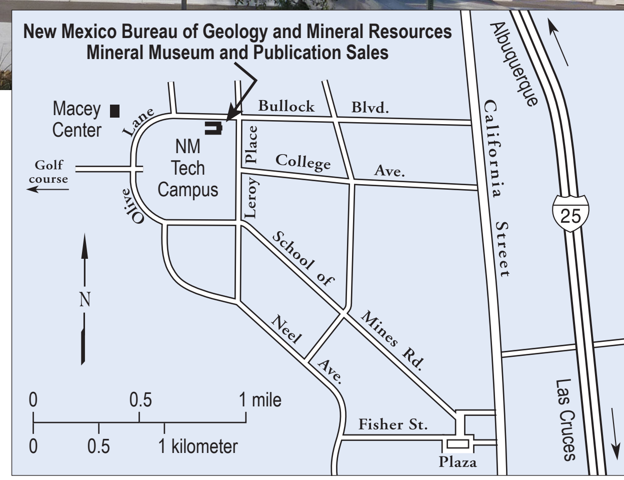
Teachers investigate the Soda Dam travertine formation, Jemez Mountains, New Mexico. *Photo by NMBGMR staff.*

Teachers sieve pumice to identify ash flow and ash fall. *Photo by Lynn Heizler.*

PARTICIPATION IN ROCKIN' can be part of the Master in Science Teaching Program (MST) for credit (MST–540) or can be taken as a non-credit elective for professional development. Enrollment charges for MST–540 include 20 percent of the tuition cost for one credit hour of New Mexico Tech graduate-level instruction. Travel to Socorro, lodging, breakfasts, and dinners will initially be paid by the teacher but will be reimbursed through the NMDHSEM. Teachers that wish to take Rockin' for professional development must pay a $40 fee and expenses for travel, lodging, breakfasts, and dinners. All of these costs will be reimbursed by the NMDHSEM. For information about this opportunity for MST credit, call Megha Khandelwal at (575) 835-5470 or email megha.khandelwal@nmt.edu. To take Rockin' for non-credit professional development, call Cynthia Connolly at (575) 835-5264 or email cynthia.connolly@nmt.edu. Class size is limited to 30 teachers, so register today!

Cynthia Connolly

Rockin' Around New Mexico teachers survey Cero Grande fire damage of 2000 in the Jemez Mountains. *Photo by Lynn Heizler.*



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 pm. 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

PUBLICATION SALES OFFICE

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:

- Popular and educational geologic publications
- Topographic maps for the entire state of New Mexico
- Geologic maps for selected areas of New Mexico
- U.S. Forest Service maps
- Jewelry and children's science exploration kits

Teachers are given a 20 percent discount on Bureau of Geology and Mineral Resources and New Mexico Geological Society publications. Phone orders, please call (575) 835-5490. For more information, visit our website at: **geoinfo.nmt.edu/publications**

LITE GEOLOGY CREDITS

Managing editor: Cynthia Connolly
Editorial assistance: Belinda Harrison, Shari Kelley, and Jennifer Eoff
Layout & graphics: Brigitte Felix and Stephanie Chavez
Web design: Stephanie Chavez
Web support: Adam Read
Editorial board: Lynn Heizler, Gretchen Hoffman, Andy Jochems, Shari Kelley, Dan Koning, Virgil Lueth, Dave Love, Kelsey McNamara, Ethan Mamer, Stacy Timmons, Maureen Wilks

801 Leroy Place
Socorro, NM 87801-4750
(575) 835-5490