

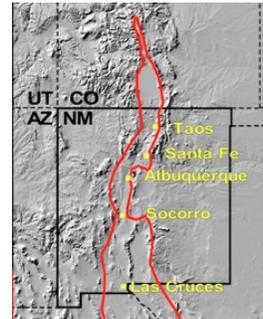
## BRIEF GUIDE TO THE GEOLOGY OF THE METROPOLITAN ALBUQUERQUE REGION

- Albuquerque is located in a dynamic geological landscape.
- The best way to understand the geology of Albuquerque is to divide it into four components. Each of these components is actually a part of a single geological story, the Rio Grande rift.

### Rio Grande Rift

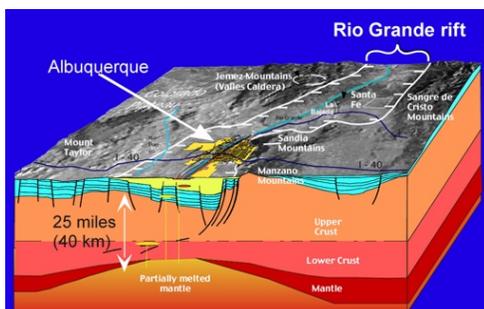
#### Description

- A **rift** is an area where the Earth's crust is thinning and pulling apart.
- The Rio Grande rift is one of only five young continental rifts in the world. It is not a plate boundary; it is located within a plate. The other geologically young continental rifts are the East African rift valley, Lake Baikal (Russia), the Rhine graben (Germany), and a rift beneath the ice of Antarctica.
- The Rio Grande rift extends in a series of connected basins (depressions) from the southern Colorado down the center of our state into northern Mexico. *Rio Grande Rift*
- The basins are filled with sediment and rock debris, eroded from surrounding mountains and carried by rivers, and layers of volcanic ash and lava flows.
- Most of the basins contain geologically young volcanism; volcanoes can more easily erupt where the Earth's crust is thinning and fracturing.



#### Formation

- The Rio Grande rift began to form about 20 to 25 million years ago at the same time that the Basin and Range began to form; both were due to a change in movements by the North American and Pacific tectonic plates, far to our west.
- The location of the rift, in the middle of our state, appears to be due to interaction between the Basin and Range and Colorado Plateau Provinces, and perhaps due to a small plate that moved beneath New Mexico about 20 to 50 million years ago.
- The Rio Grande rift is being monitored by geophysical instruments; it is considered still active.
- We don't know if the rift will continue to form. It could continue to open or, as Earth's plates change movement, it could just stop forming. Since it is located in the interior of a thick continental plate, it is unlikely that it will become a new plate boundary or ocean-front property.



### Albuquerque-Belen Basin

- Albuquerque is located in the *Albuquerque-Belen Basin* of the rift. The East Mountains, Placitas, and Rio Rancho are all located just outside the basin.
- The Albuquerque-Belen Basin is about 24 miles (40 km) wide, 100 miles long (160 km), and extends from the Sandias on the east margin to the area around Tohajiili to the west and the Sierra Ladrones to the southwest.
- The basin contains ~20,000 feet (6,000 meters) of loosely consolidated sediment, geologists call this the Santa Fe Formation. The rock layers visible at Sandia Crest were once continuous with rock layers that are now tens of thousands of feet (thousands of meters) below our city.
- The **faults** that define the rift boundary occur along the base of the Sandias on the east, and in a series of steps (including "9-Mile Hill") that extend from the rift center to the western margin.

## Rio Grande – Great River

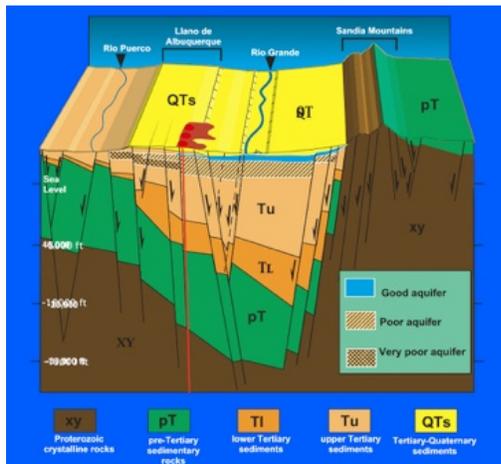
### Description

- Unlike many other rivers, the Rio Grande did not initially erode its valley, but instead followed the low area of the rift. The Rio Grande became a through-going river about 3 to 4 million years ago.
- The river meandered across the area where Albuquerque is today, and generally deposited sediment and filled the rift basin; stream gravel *Rio Grande*



from the river have been found as far east as Eubank.

- About 100,000 years ago, the river eroded the modern outer valley (Coors to I-25), resulting in a flood plain and Albuquerque's north and south valleys.
- At the end of the last **Ice Age**, about 10,000 years ago, the river eroded the modern, narrow inner valley and river channel currently crossed by bridges, and today's bosque (or riparian) forest was created.
- To prevent floods within the inner valley, during the twentieth century, the river was engineered to follow a fixed course. Sediment carried by the river and deposited along its bottom has raised the modern riverbed above the surrounding inner valley.
- Although the river is controlled, runoff from large mountain rains can still flood the inner valley because Albuquerque is built on a slope of debris that has eroded off the Sandias. An extensive network of arroyos and diversion channels diverts runoff to the north and south.



### Albuquerque's Water

- Much of the current water supply for Albuquerque comes from water trapped within the sediments of the Rio Grande rift. The groundwater is in a layer of sand and gravel that is called an **aquifer**. When you drink aquifer water, you are mostly drinking water that was collected thousands of years ago.
- Only the blue area shown beneath the surface in the cross-section to the left is usable, good-quality water. This aquifer ranges in thickness from 500 to 1500 feet (150 to 460 meters) and is located at the very top of the thick deposit of sediment within the Albuquerque basin.
- The top of the aquifer is called the **water table**; the depth to the water table in the Albuquerque area ranges from less than 15 feet (5 meters) near the river to more than 1,000 feet (300 meters) near the Sandia Mts.
- The usefulness of the aquifer decreases with depth, due to the decrease in **permeability** (the ability of the water to flow through the rocks) and increased concentration of dissolved minerals.
- In 2004, Albuquerque was pumping about 10 million gallons (38 million liters) of water each day out of the Albuquerque aquifer, and groundwater was being 'mined' out of the aquifer faster than the aquifer could be recharged. The San Juan-Chama River Water Project is designed to decrease the amount of groundwater and increase the amount of river water in Albuquerque's water supply.
- Albuquerque is also doing a good job at conservation efforts. In 1995, water usage was 251 gal/person/day for the city. In 2019, that number had decreased to 121 gal/person/day.

## Sandia Mountains

### Description:

- The Sandia Mountains are geologically very young mountains, but they contain old Proterozoic (Precambrian) and Late-Paleozoic rocks.
- They are not part of the Rocky Mountains. Geologically, they formed in a completely different way and much more recently than did the Rockies.



*Sandia Mountains*

### Formation

- As the rift formed, movement on the rift boundary faults caused the Sandia Mountains to lift up and tilt toward the east, like a trap door. This is called a **fault block** mountain. As recently as 5 to 10 million years ago, the Sandias began to take on their present-day appearance.
- The Sandias, the Manzanita and Manzano Mountains, and Los Sierras de los Piños (east of Socorro) are all part of the same uplift, and mark the eastern margin of the rift. Tijeras Canyon, which separates two of the ranges (Sandias and Manzanitas), is an old fault zone that predates the modern mountains and has been reactivated many times. This fault zone has moved in a horizontal or shearing motion – very appropriate for a canyon with the Spanish name “scissors.”
- Because geologists believe that the rift is still active, they assume that the mountains at the rift margin are also still forming. This mountain-building activity is probably intermittent movement along the rift marginal faults.
- Microquakes occur frequently in the Albuquerque basin and may be a signal of this movement. The geological record of old, large earthquakes is visible in scarps that can be seen along the Rincon Ridge of the Sandias and along the base of the Manzanitas. The stairs that visitors climb from the parking lot to the base of the Sandia Tram marks one of the faults. Geological evidence shows that the Rincon Ridge fault and Hubble Springs fault (along the base of the Manzanitas) have moved within the past tens of thousands of years.

### Rocks and Time

- The Sandias are dominantly **granite**, especially visible on their west face. About 1.4 billion years ago, one or two large **plutons** (bodies of magma) cooled deep beneath the surface to form the granite.
- To the south and north of the mountain are even older **metamorphic** rocks that predate the intrusion of the granite, and are about 1.6 billion years old. These metamorphic rocks include



*Sandia Crest*

- rocks in Tijeras Canyon (**gneiss, greenstone, and quartzite**) and the **schist** of the Rincon Ridge. • Visible at Sandia Crest is the layered **limestone, shale, and sandstone** containing fossils of organisms that lived in the shallow sea that covered much of New Mexico about 320 million years ago. Fossils found in the Madera Formation limestone include **brachiopods, crinoids, corals, and bryozoans**. Above the limestone, tilted to the east and eroded so that it is visible only on the east slope of the Sandias, are sedimentary rocks (**sandstone, limestone, and siltstone**) from the Permian, Triassic, Jurassic and Cretaceous Periods.
- When you look at the mountains, the granite below and the layered light-colored limestone are distinctively different. The line between them (a **geological contact**) represents almost one billion years of missing rock layers. This gap in rock layers and in time is called the **Great Unconformity**; and it marks a mystery. What happened in the Albuquerque area during this missing geological history during the time from the Late Precambrian to the Middle Paleozoic?

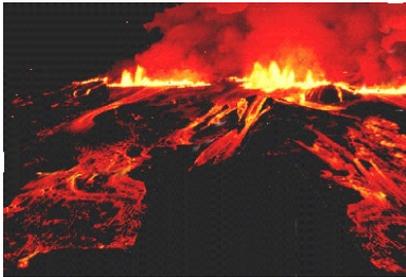


*JA, Black, & Vulcan*

## Albuquerque Volcanoes

### Description:

- Only a few American metropolitan areas have geologically young volcanoes nearby. The Albuquerque Volcanoes are a local treasure.
- The volcanoes may be on the west side of the city, but they actually mark the center of the Rio Grande rift. Geophysical instruments show the mantle is up-warped slightly beneath the center.
- From south to north, they are named JA Cone (after the old St. Josephs of Albuquerque College), Black Cone, Vulcan (the largest), Butte, and Bond. There once was a sixth volcano, between Black and Vulcan, but it was almost totally dismantled by a cinder quarry operation.
- Increased usage of the west mesa and expansion of Albuquerque in the 1970s led to a public effort to protect the volcanoes. Currently, the volcanoes are jointly managed by the Albuquerque Open Space Division and the National Park Service.
- The volcanoes are actually part of a line of more than a dozen small volcanoes from Bernalillo to Belen that erupted within the rift. Small cinder cones, located west of Belen and Los Lunas, called the Cat Hills, are similar to the Albuquerque Volcanoes, but slightly younger in age.



### Formation

- The Albuquerque Volcanoes are around 200,000 years old. They probably erupted continuously over a period of months to years and might have looked like this image when they erupted.
- They are a type of volcano called **cinder** or **scoria cones**. They were formed by eruption of molten magma from vertical cracks (called **dikes**) oriented north-south. This type of eruption is known as a **fissure eruption**; it is very unusual in the Southwest.
- The eruption probably began as a long line of fire, similar to Hawaiian fissure eruptions, which “focused” into several simultaneous eruption spots that became the volcanoes. The individual volcanoes built themselves by eruption of ash, cinder, and spatter with a final “coating” of lava.
- Cinder cones commonly have one or more associated lava flows, and in this case, a series of lava flows moved down gradient to the east toward the river. The flows erupted onto the easily eroded sands of the Santa Fe Formation, and as the soft material eroded, the margins of the lava flows crumbled to form the **escarpment** of Petroglyph National Monument.

### Rocks and Volcanic Features

- Cinder/scoria cones tend to erupt only once, so the current volcanoes will probably not erupt again; however, new cinder cones could form along the fissure line. Earthquake swarms beneath the Albuquerque volcanoes (one swarm occurred in the 1970s) may indicate fault readjustments.
- The volcanoes and lava flows are **basalt**, a volcanic rock high in calcium and low in silica, sodium and potassium, and composed of **olivine**, **pyroxene**, **magnetite**, and **feldspar** minerals.
- Warm air is sometimes felt at cave-like openings formed in the spatter that built the volcanoes. This is actually ambient (average temperature) air trapped just beneath the surface. The air will feel cool on hot days and warm on colder days.
- There are some short segments of lava tubes within the lava flows, visible along the escarpment at Petroglyph National Monument.

**For questions about this Brief Guide, contact:** *Jayne Aubele, Geologist and Educator, New Mexico Museum of Natural History and Science, email: [jayne.aubele@state.nm.us](mailto:jayne.aubele@state.nm.us)*