Austin Chalk Do It Yourself Field Trip – McKinney Falls State Park

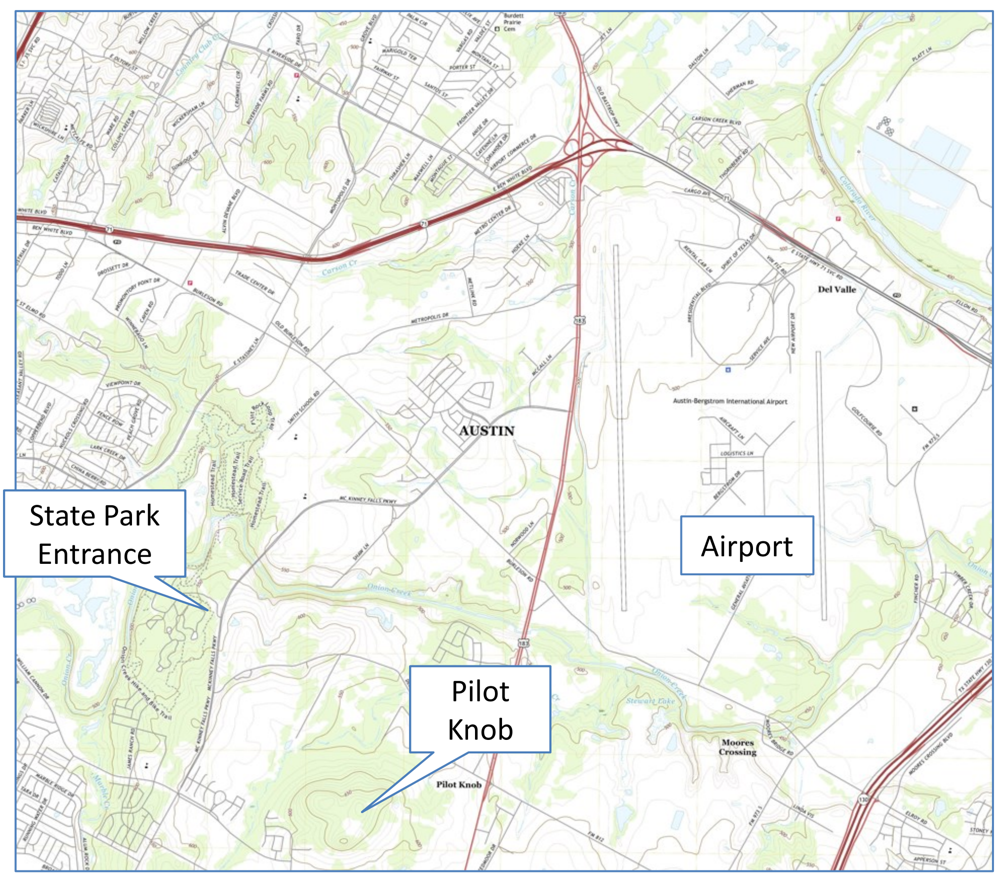
Austin Chalk Overview

The Austin Chalk is a white to gray limestone that can be seen from Dallas to west of San Antonio (https://en.wikipedia.org/wiki/Austin_Chalk https://mrdata.usgs.gov/geology/state/sgmcunit.php?unit=TXKau%3B0) as part of the Balcones Fault Zone (https://www.beg.utexas.edu/geowonders/centtex). It was deposited from about 90 to about 85 million years ago during the Cretaceous period. Below the surface, it extends across large areas of eastern Texas and Louisiana where it forms an important oil and gas reservoir in places (https://austinchalkoilgas.com). The Austin Chalk is a formation that includes two main types of rock: chalk and marl. Chalk is a limestone composed of microscopic plankton fossils, so it formed in an ocean environment. Chalk is dominated by the calcium carbonate mineral calcite. Marl is a mixture of calcite, clay, and silt. Clay and silt are grains of quartz and other silica-based minerals. The chalk formed directly from living organisms in the ocean and the marl formed where clay and silt from the land was mixed into the chalk by rivers and storms.

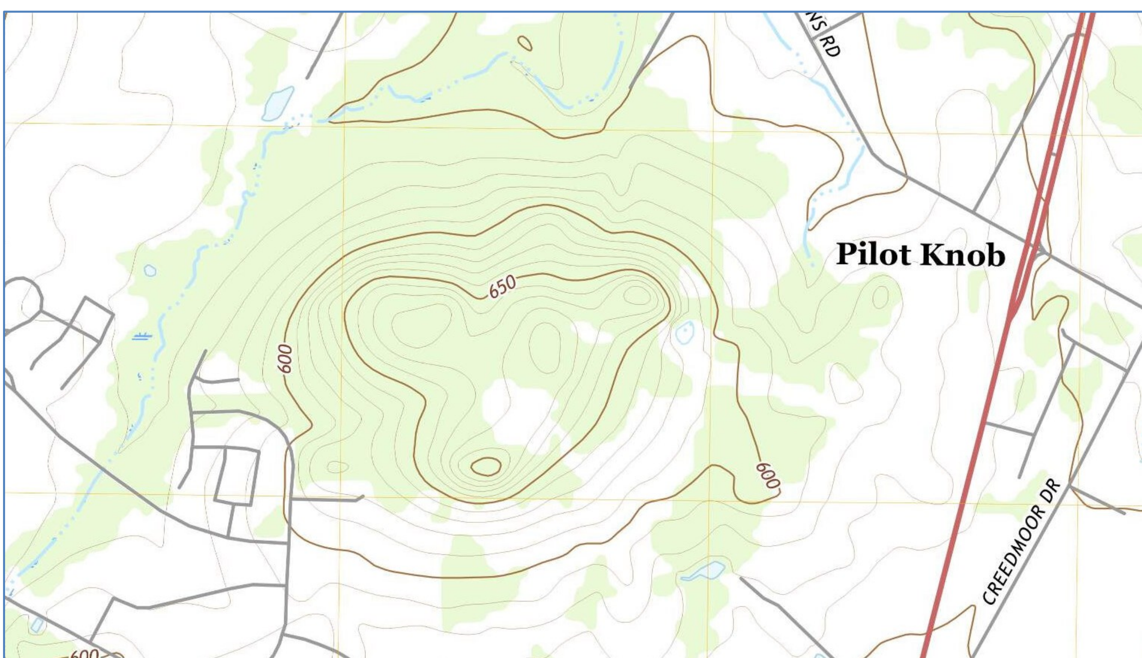
McKinney Falls State Park

McKinney Falls State Park has some unique and fascinating Austin Chalk outcrops because the rocks there were influence by a nearby volcano, Pilot Knob. It may seem strange to think about volcanoes in central Texas, but several existed from Uvalde to Austin during the later part of Austin Chalk deposition. Today, Pilot Knob is a small hill just south of the park. For more information, find D. L. Parker's discussion (Chapter 4) in the University of Texas Student Geological Society's *"Guidebook to the Geology of Travis County"* published in 1977.

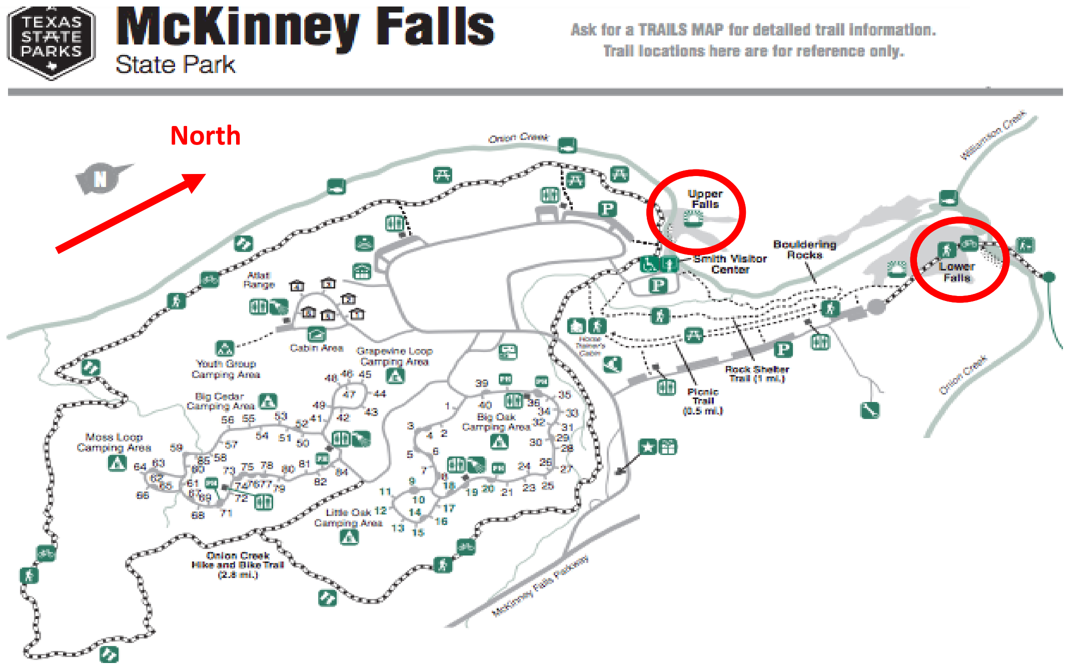
The Pilot Knob volcano was recognized when dark-colored igneous rocks were found there. Further geologic work showed that the volcano erupted on the sea floor where the hot rock created a series of steam explosions. The result was a crater with a rim that was higher than the surrounding sea floor. Eventually, with continued eruptions, the crater rim built up to sea level and created islands. Geologists know this because there are deposits of volcanic ash that can only form when a volcano erupts into air. The ash settled on the beaches and shallow water around the volcano where waves worked it into sandstone and clay layers.

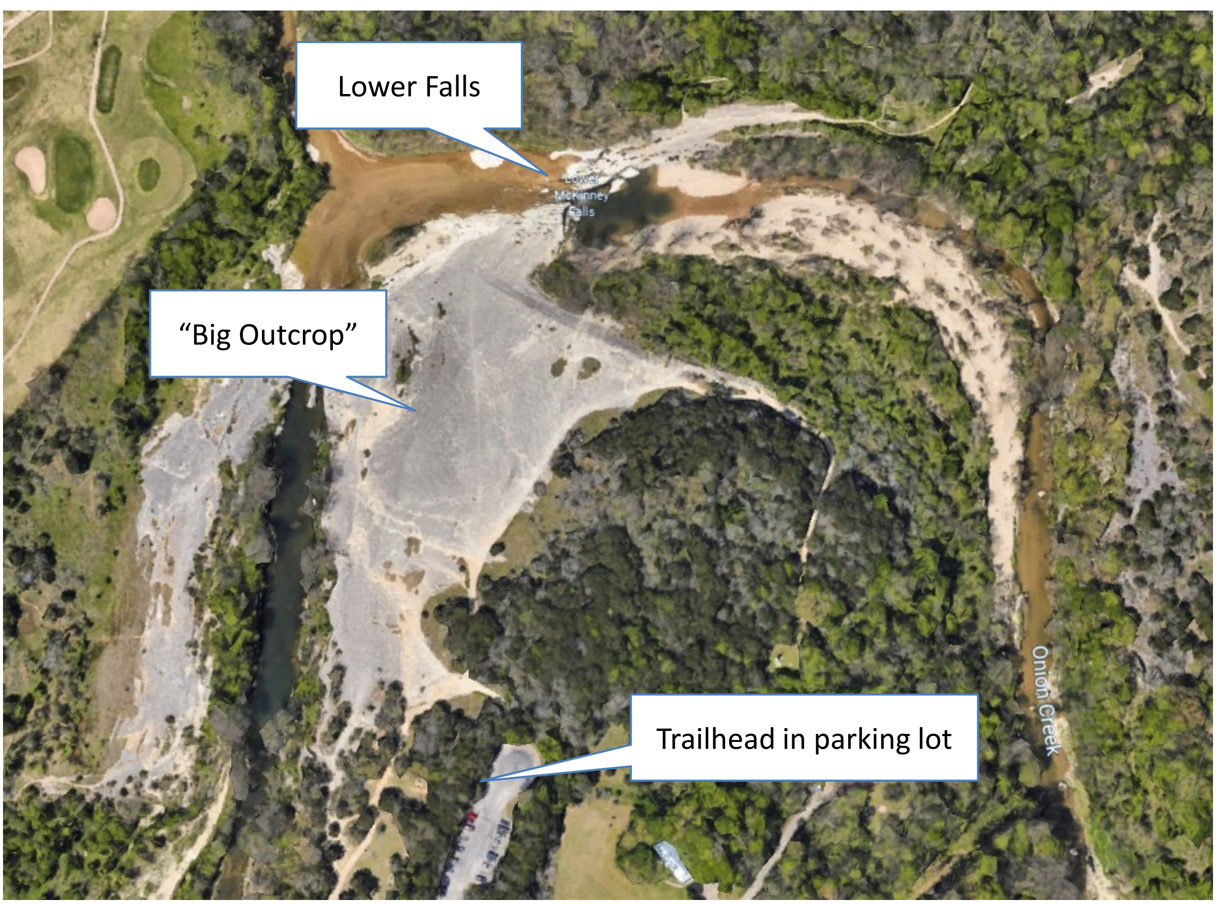


This is the view of Pilot Knob looking east from McKinney Falls Parkway just south of the state park.



The contour interval of this map is 10 feet so by counting contours, starting from the creek on the west, you can see that Pilot Knob rises 140 feet in the view of the photo above.





Note that the official state park map does not have north at the top. This image from Google Earth does have north at the top. The following photos are arranged to begin at the lower falls and then walk back across the area I call the "Big Outcrop".

Interesting Things to See

The lower falls are a great place to make observations of the rocks. First, you can see that the falls are a cliff with two major layers: a thick grey layer hanging over a darker-colored layer that has thinner layers within. Overhangs like this are caused when a creek or river can remove a lower layer faster than the upper layer, so we wonder if the darker layer is softer. By carefully climbing along the boulders at the south end of the falls, you can reach the dark layer and see if you think it is softer. You'll get a view like the photo below.

Geologist William (Bill) R. Morris is standing next to the darker layer. You can see that the upper grey layer does not have obvious internal layering, but the darker layer looks much more complicated. It has an upper half with prominent thin layers and a lower half (at Bill's elbow) that has a smooth appearance. The smooth-looking layer is very soft, so the creek easily washes it away to make the overhang. This layer is a greenish clay that formed from the volcanic ash. The layer just above it is a sandstone composed of minerals that are typical from volcanic eruptions. The sandstone formed as waves near the shore of the crater washed away the clay to leave sand on the sea floor.

This photo shows the boundary between the upper grey layer and the darker layer. Notice that the change in the rock types is very abrupt suggesting that there was a big change in the environment. One explanation for the change will be presented below.

Here, with more detail, you can see that the darker layer is composed of smaller layers. The lowest layer is the clay with the smooth appearance. There is a middle layer that has a chaotic appearance and seems to change thickness across the photo. The highest part has thin layers that extend across the entire photo.

Here is a detailed view of the same layers. Here the middle chaotic layer looks like it is just part of the lower clay. More study would be needed to decide how the middle layer formed. The clay layer formed when clay was able to settle out on the sea floor during a time of low wave energy. The upper layer looks like sandpaper, so we know it is a sandstone. It formed when wave energy was high enough to wash away the clay leaving only sand on the sea floor.

These photos provide additional details about the smaller internal layers within the darker layer. Notice that the clay layer has white cracks running through it. These formed as open cracks after the clay turned into rock. The white material is the mineral calcite. The calcite was deposited by water with concentrated calcium carbonate. There is a layer of sandstone below the clay that has the appearance of coarse sandpaper. The grains of sand in this layer are bigger than those in the uppermost sandstone beds.

Now let's turn our attention to the upper grey layer. It is very different from the darker layer below. The color is lighter and there is no sign of clay or sandstone. If you look very closely and long enough, you will see that it is composed of broken fossils and very small crystals. This is a limestone that formed once the eruptions ended and the environment became a normal sea floor. Most of the broken fossils are oysters which are common elsewhere in the Austin Chalk.

Another thing to notice is the layering. The upper picture shows a horizontal crack separating the limestone into two thick parts. The crack is a surface that probably formed when large storm waves scoured the sea floor. The upper part of the limestone has a surface below the woman that slopes to the right. This surface shows us the original slope of the sea floor surface and suggests that this area was a beach. The middle photo is a close-up of the sloping surface.

This photo shows a large oyster fossil on the surface of the ground. Look for it as you leave the area around the south end of the falls where the above photos were taken. Please do not damage it. Collecting or damaging rocks in a state park is unlawful. There are not many large fossils in the Austin Chalk here so this is a special thing to see and should be preserved for everyone.

These photos show the area I called the "Big Outcrop" on the air photo above. You can climb it easily as you make your way back to the parking area. I think I see multiple scoop-shaped surfaces in this outcrop (see red lines below). If they are real, then they might have formed where water returned to the ocean after it had been piled up on the beach by waves. This return of water is how rip currents form. Rip currents might have eroded the bottom to make the scoops. Further work would be needed to see if I am right.

This view is from the upper falls looking downstream. The limestone, sandstone and clay that we saw at the lower falls is well exposed here but it's a little trickier to get down to see them.

Sequence of Events That Formed the Falls

So far, the discussion has been about making observations and thinking about what they mean individually. Now let's talk about how the observations fit together to tell the big picture story.

Two really big observations are the place to start: the Austin Chalk here is unique among the Austin-area outcrops and the park is right next door to an ancient volcano that was active during deposition of the chalk elsewhere. Because of these local differences the Austin Chalk here is a limestone composed of broken shells from sea life that lived in shallow water instead of chalk and marl made from clay and plankton debris that geologists believe formed in deeper water. The volcano provided the sandstones and clay so those kind of rocks are not found in most Austin Chalk outcrops. There were smaller outcrops of these rocks where other igneous rocks affected the Austin Chalk but most of these have been covered by development of the city. If you want to know more about igneous rocks in the city, I highly recommend "*Cretaceous Volcanism in the Austin Area, Texas"* by Keith Young, S. Christopher Caran and Thomas E. Ewing published by Austin Geologic Society as Guidebook 4 in 1981.

The big picture story of the rocks at McKinney Falls begins with plankton debris settling to the floor of a shallow that covered the entire Austin area. This time of typical Austin Chalk formation was interrupted by underwater steam explosions by hot liquid rock entering the sea floor from the vent of the Pilot Knob volcano. This created a crater in the existing chalk sediment. With continued eruptions, the volcano grew high enough to form islands surrounded by shallow water where waves could wash the volcanic debris to make layered sandy sediments. When the volcano grew above sea level the subsequent eruptions created big ash clouds that settled out on the sea floor. The ash would become clay in the sea water. Continued wave action and eruptions built up the final layers of sandstone and claystone.

When the volcano stopped erupting, there was no more source of sand and clay, so the sea water returned to its pre-volcanic condition with one big change: the area around the Pilot Knob island had beaches and nearby shallow water. This is not the kind of place that plankton live so the limestone formed from broken shells of oysters and similar animals that live in shallow water that is agitated by waves.

Fast forward to the more recent past when Onion Creek formed. As water continued to flow down Onion Creek, all the rocks above the Austin Chalk were removed by erosion. When the stream started flowing on the limestone in the falls area, it began to seep into the layer of sandstone and clay below and remove it. Once enough of the softer layer was removed, great blocks of the limestone fell into the stream creating rapids and the area where the sandstone and clay were being removed migrated upstream. The point where the limestone layer has not broken into blocks is the waterfall.

Of course, a trip to McKinney Falls State Park has much to offer in addition to great rocks. Your trip can be greatly enhanced by getting a copy of Jay Raney's 1997 short book *"Down to Earth at McKinney Falls State Park, Texas"* published by the Bureau of Economic Geology. This is an excellent guide to the history of the park, the plants and animals, and to the rocks. I learned a lot from it and the other publications mentioned above.