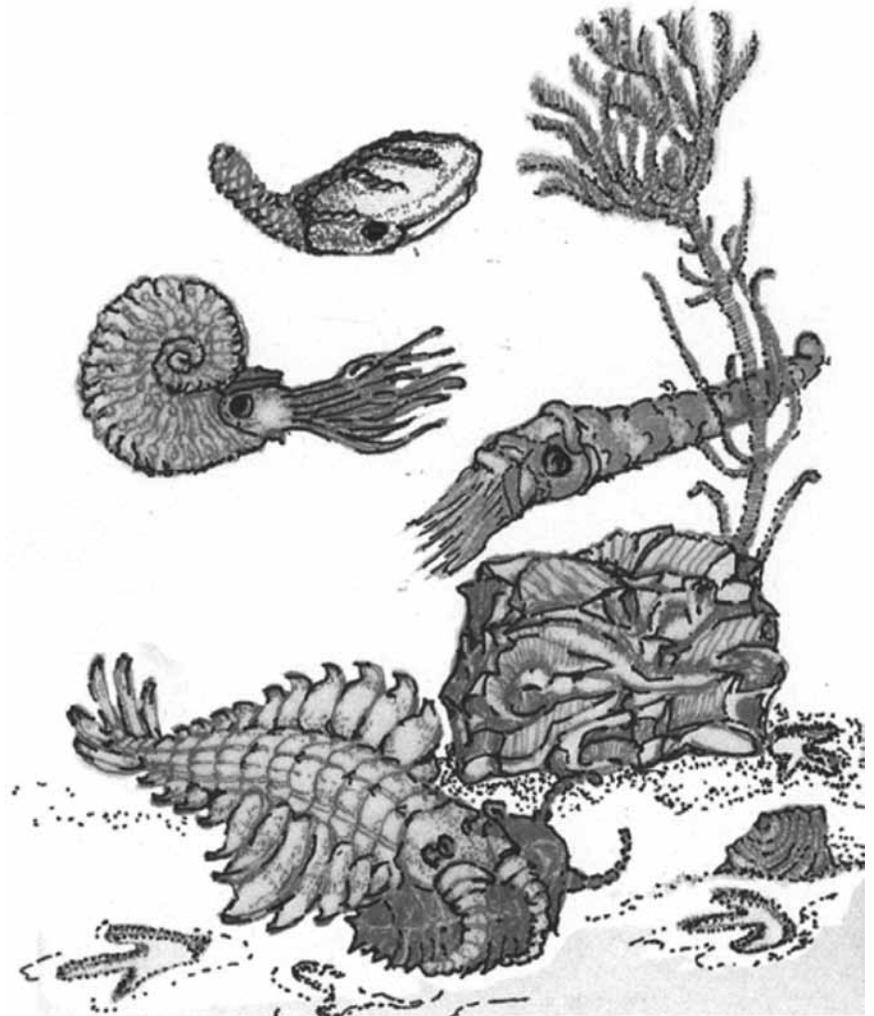


Rocks & Fossils of Fremont County Colorado

Fossils Found in Fremont County
(see page 32 for information)



**FREMONT COUNTY
HERITAGE GUIDE**

About the Cover: In 1915 Fremont County adventurer and entrepreneur Dall DeWeese discovered the fossilized bones of a Diplodocus in Garden Park, which he donated to the new Colorado Museum of Natural History (now Denver Museum of Nature & Science). DeWeese is pictured as he led the 1916 excavation of the Diplodocus which, while too incomplete to mount for display, began the Museum's impressive collection of dinosaur fossils. Photo: used with permission of Denver Museum of Nature and Science.

Rocks and Fossils of Fremont County, Colorado Fremont County Heritage Guide

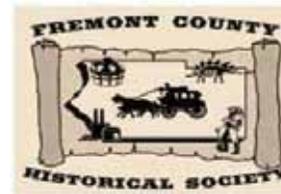
The geologic structure of Fremont County, a determining influence on the settlement, development and economy of the area, has multiple facets that are deeply imbedded in the County's heritage. The purpose of this Guide is to identify and describe the many geological features that make Fremont County unique and to promote a broader understanding of the region. From initial settlement, through the growth of a bustling and robust geologic-resource based economy, Fremont County has produced coal, oil, cement, clay and building stones seen in the state and national Capitols. From the first discovery of dinosaur fossils and other early life forms, through the founding of numerous University Geology Summer Field Camps, Fremont County has provided the setting for the advancement of science. From offering a diverse backdrop for Silent Movies and other filming to a setting that welcomes all to view its dramatic scenic vistas, Fremont County creates experiences last a lifetime.

This Heritage Guide has been compiled by members of the Crossroads Through Time Heritage Park Steering Committee,

located on the Pueblo Community College – Fremont Campus, and Fremont County Stones 'n Bones. Both are all-volunteer organizations, under the umbrella of the Fremont County Historical Society, that cooperate with the Fremont County Heritage Commission to advance understanding of the region's rich geologic and paleontological heritage. Initial printing of the Guide was assisted by a grant from the Colorado Office of Tourism through the Fremont County Tourism Council. Crossroads Co-Chair Harold Taylor led the volunteer team that researched and compiled this Guide with major contributions by Dan Grenard, Cindy Smith and Bob Hickey. Reviewers included Jack Murphy, Curator Emeritus of Geology at the Denver Museum of Nature & Science; Steve Kaverman, Chairman of the Tourism Council; and Margaret Stiles Storm of the Historical Society. Millie Wintz provided maps and graphics, and Jim Nelson coordinated production. Larry Hill of the Tourism Council provided the layout. First published in May 2018. Some photos courtesy of Denver Public Library, Western History Collection.

Overview

Fremont County is where the Arkansas, one of Colorado's seven major rivers, tumbles out of the Southern Rocky Mountains onto the Colorado Piedmont section of the Great Plains. The County's geologic structure determined initial settlement patterns, influenced the location and nature of early development and shaped the economy of the area. The narrow chasm where the Arkansas River flows through the Royal Gorge above Cañon City was a major impediment to exploration and travel west of the Gorge. Originally called the Grand Canyon of the Arkansas, this obstacle was largely responsible for the 1859-60 founding and naming of



Cañon City; initially a supply point for miners drawn by the 1858 Pikes Peak Gold Rush. In the early days of the West, rivers provided a principle route of initial exploration and later development of transportation routes. Not only had this barrier baffled Zebulon Pike in his 1806 search for the headwaters of the Arkansas River, it meant that Cañon City was the last place a wagon-load of goods could travel before being reloaded on pack-mules to reach early mining camps. Joseph Lamb's pack-trains followed old Indian trails up Copper Gulch to Texas Creek, then west along the Arkansas until a wagon road was built along that route in 1874. Oil Creek (now called Fourmile) heading north or Grape Creek heading south were other alternatives.

This hindrance became a major issue between two competing railroad companies seeking to serve the mines at Leadville and provide railroad service to the region. The Denver & Rio Grande (D&RG) and the Atchison, Topeka & Santa Fe (AT&SF) were racing to build tracks, but there was barely room for one set of tracks through the Gorge. Even that required the 1879 construction of a Hanging Bridge over the river to traverse the 175-foot section where the Gorge's 1,250-foot high walls closed to a mere 30-feet of each other. The 1880 resolution of the legal wrangling between the competitors, called the Treaty of Boston, allowed railroad tracks to travel west along the Arkansas River and provided additional access to western Fremont County.

Eastern Fremont County's location over the 66 million year old Late Cretaceous **Cañon City Embayment** (see the Glossary for information on geology terms), resulted in the discovery of high quality coal, first produced in 1847 by a "wheel-barrow" mine near Coal Creek, resulting in the development of the Cañon City Coal Field. The 1860 sales of kerosene and lubricant from an "Oil-Spring" northeast of Cañon City, prompted early commercial efforts that led to the 1881 discovery of the Florence Oil Field – the oldest continually producing oil field in the United States. These coal and oil fields, as well as geologically related clay, cement and building stone that are also part of Fremont County's geological heritage, were caused by the ebb and flow of the shallow Western Interior

Seaway over many millions of years. The abundant sea life, plants and dinosaurs of the Cretaceous period helped set the stage for later discoveries.

Dinosaur fossils discovered in 1876 northeast of Cañon City in Garden Park first propelled Fremont County to prominence as a world-class repository of these scientific specimens. The 1892 identification of what, for the next 80-years, was the world's oldest known vertebrate fossil fish, 450 million years old, by the Director of the U. S. Geological Survey further establish the area's reputation. Additional dinosaur fossils and footprints have been discovered, and in the 1960s the discovery of the Indian Springs trace fossil site added one more important chapter to the region's geologic history. This site was designated a National Natural Landmark in 1979, and it remains the foremost site to observe the tracks of Ordovician creatures that left their tracks on the ocean floor about 450 million years ago (MYA).

Moving west, the highest point in Fremont County is Bushnell Peak at 13,105-feet in the block-faulted Sangre de Cristo range, which makes up the southern portion of the County's western boundary. The prominent Twin Sisters Peaks, featured in the Official Seal of Fremont County, are to the north. The uplift of the Sangre's was coupled with the downward block faulting of the San Luis Valley, southwest of the mountains. This is part of the **Rio Grande Rift** that continues north of Salida and forms the bed of the upper Arkansas River.

To this, add several episodes of volcanic activity, features that resulted from the erosion of the Ancestral Rocky Mountains, uplift of the modern Rockies and Front Range of Colorado as well as the geology associated with the Royal Gorge and the Arkansas River and you have the marvelously complex and picturesque area this Guide will attempt to describe. To place all this in perspective, we begin with the **Geology Time Trail** at the Crossroads Through Time Heritage Park on the Pueblo Community College – Fremont Campus. The tour map and index which follow provide directions.

Cañon City, Florence & Eastern Fremont County
Tour Sites

RF-01: PCC-Fremont Campus; Geology Time Trail

RF-02: Devil's Gap on US-50 West

RF-03: Intersection of US-50 & County Road 3A (Royal Gorge
Access Road)

RF-04: Public Restrooms & Trailheads (Free) at entrance to the
Royal Gorge Bridge & Park (\$)

RF-05: Royal Gorge Bridge & Park; Visitor Center; 4218 County
Road 3A (admission charge and activity fees apply)

RF-06: Skyline Drive Entrance; Gateway of the States

RF-07: Top of Hogback parking area (dinosaur tracks)

RF-08: Second parking area

RF-09: Switchback parking area

RF-10: Floral Avenue parking area

RF-11: Fremont County Admin Building (7th & Greenwood)

RF-12: Royal Gorge Regional Museum & History Center

RF-13: Tunnel Drive Trailhead

GARDEN PARK

RF-14: Cleveland-Delfs Quarry

RF-15: Marsh-Felch Quarry

RF-16: Garden Park School

RF-17: Red Canyon Park

RF-18: Shelf Road Climbing Area

COAL & OIL FIELDS

RF-19: Riverwalk Trail Ash Street parking area

RF-20: Spring Creek Park; Brookside

RF-21: Pathfinder Regional Park

RF-22: Florence City Hall lawn; Oil Well Monument

RF-23: Florence Pioneer Museum and Research Center

RF-24: Tepee Buttes

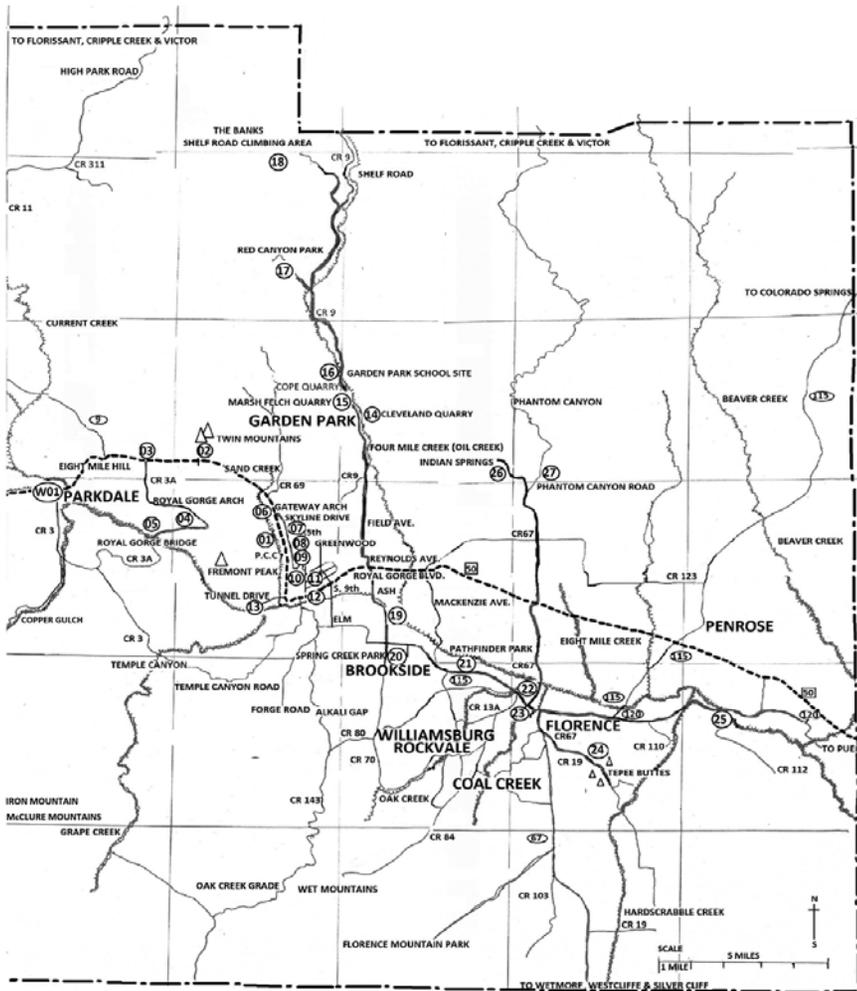
EASTERN FREMONT COUNTY

RF-25: Cement Plant

RF-26: Indian Springs Trace Fossil Site

RF-27: Phantom Canyon Road

For **Western Fremont County**, see the map & index on pg. 46



THE GEOLOGY TIME TRAIL

RF-01: This tour starts at the Geology Time Trail on the Pueblo Community College – Fremont Campus, just off US-50 a little west of Cañon City (Free). Turn off the highway at the sign for PCC-Fremont. Notice the large sculpted rock on the left as you enter the main parking area (more about this after you park). Continue through the main parking area to a parking area northeast of the PCC building. You will see the Stegosaurus sculpture to the south, just below the road.



Park and take the path down the slope to the start of the trail.

This trail, anchored by the Stegosaurus sculpture, illustrates geologic time, with 1 foot on the trail corresponding to 1 million years of geologic time. The stegosaurus dates from 150 million years ago (MYA), so it is 150 feet down the trail. At this scale, once around the loop equals one-half of earth's 4.6 billion year history. The Geology Time Trail was initially conceived in the Fall of 2014 to help educate

students and lifelong learners about deep time. In the photograph looking across US-50, Fountain Formation is directly above the highway, followed by tan Ralston Creek-Bell Ranch Formation, then Morrison Formation and Dakota Formation on top, all discussed later. To the west you see 450 million year old Ordovician rocks and 1.7 billion year old Precambrian rocks. This location readily lends itself as a field laboratory where the earth's geologic history can be laid bare.

The first sign gives an introduction to the trail, and the second sign celebrates the Royal Gorge, probably carved in the last 5 million years, so it is 5 feet down the trail.

This gives some perspective on geologic time. If you have been to the Royal Gorge, you can get some sense of the time that must have been required to carve that deep canyon. But that was only 5 million years, 5 feet along the trail. Take a look down the trail to the Stegosaurus, 150 feet down the trail, and by the entrance road, barely visible, the marker at 450 million years, when the first fish were swimming in the oceans. Earth's complete geology timeline is twice around this trail. Does that boggle the mind?

It is worth noting here that some geologic events are easier to date than others. When rocks are melted, their atomic composition sets a geologic clock that can be measured with great precision using known rates of radioactive decay. Thus we know that the main constituent rocks of the Royal Gorge are about 1.7 billion years old, and some of the later rocks that squeezed into the cracks and solidified did so about 1.4 billion years ago. Even when rocks are not remelted, sedimentary rocks like limestones and shales can be dated if volcanic events, consisting of recently melted rocks such as volcanic ash, created layers among them.

So rocks can often be dated, but geologic events such as the start of the carving of the Royal Gorge, are more problematic. Sedimentary layers can give some indication of the date when the Arkansas River changed its course, starting the process, but precise dates are still a point of contention.

Across the trail from the marker is a huge block of quarried **Travertine** from a quarry just north of US-50 on the way to the Royal Gorge. This is at the start of the Geology Time Trail because it is likely the

youngest rock here, a relatively recent spring or hot spring deposit. This quarry is on private property, so it cannot be visited without permission. A prominent church in Denver, the Church of the Holy Ghost, was constructed with material from this quarry. The large, sculpted stone you passed entering the parking area was moved here from the same quarry. The stone was either carved to demonstrate its workability or rejected due to flaws and never finished. Today it is a reminder of the many Fremont County quarries that produced distinctive building stone for many historic structures.



Another quarry in that same area produced the conglomerate rock which was used at the Fremont County Administration Building, 615 Macon Avenue, and was also used to create columns used in the Capitol building in Washington D. C. (but were removed during a renovation—current location unknown).

35 MYA – The next sign marks the events which created the wonderful fossils at Florissant Fossil Beds. A huge volcanic debris flow from major volcanic activity between Salida and Florissant created a lake which was about 1 mile wide and 12 miles long. Ash falls from later volcanic activity then preserved the fossils that we can see today. The fine ash, falling onto the lake, captured and preserved insects, leaves and other materials that are still being excavated and



studied. A later debris flow filled the valley with 16 feet of muddy material which preserved the huge tree stumps that can be seen today.

A little later than this, at about 66 million years ago (MYA), a meteorite slammed into the Earth and the dinosaurs went extinct. Another important event, the uplift of the current Rocky Mountains, started about 70 million years ago and continued until about 40 million years ago.

100 MYA – This marker corresponds to one of our region's main attractions, Skyline Drive (see later section). The rocks at the top of Skyline Drive are Dakota Sandstone, which were laid down on the shore of the Western Interior Seaway about 100 million years ago. This rock layer contains dinosaur tracks, worm burrows, ripple marks and impressions of petrified wood. The Western Interior Seaway extended from what is now Canada to the Gulf of Mexico. As time progressed, the seaway expanded, and this region was under water for about 30 million years. Layers of rock to the east of the Skyline Drive hogback, shales and limestones, document this period. Finally, the sea retreated, creating another shoreline sandstone, the Trinidad Formation, which forms cliffs along CO-115 between Cañon City and Florence. Check out the Skyline Drive and Coal Mining sections of this guide for more information.

The retreat of the seaway marked the start of the uplift which created the current Rocky Mountains. Land which was below sea level was uplifted to our current elevation, over 5,000 feet, and the central Rockies were raised even higher. At one time the Western Interior Seaway extended all the way to current Utah, so all of Colorado's 14ers were underwater before the uplift, and they have been weathering away for millions of years. The summits of the Maroon Bells near Aspen and Crestone Peak in the Sangre de Cristo range are sedimentary rock. Quite a change in elevation!

The forces which created the current Rockies are still hotly debated. One prominent theory is that a tectonic plate slid under the western part of North America, staying relatively close to the surface rather than descending at an angle into the deeper parts of the Earth, creating the uplift.

150 MYA – Here we have our Stegosaurus sculpture, celebrating the

Jurassic. Three specimens of Stegosaurus have been found in the Cañon City area. The most recent was airlifted out of the Garden Park area in 1992. Replicas can be seen at the Royal Gorge Regional Museum & History Center, Royal Gorge Dinosaur Experience and the Denver Museum of Nature & Science. Refer to the Garden Park section of this Guide for



more information about the many dinosaur discoveries and the interesting history of the area. Many other dinosaurs have been excavated, including Allosaurus, Camarasaurus, Ceratosaurus and Diplodocus. The photograph shows a Cañon City Stegosaurus now on display at the Denver Museum.

What about the notorious *Tyrannosaurus rex*? Much earlier, about 67 million years ago. None have been discovered at Garden Park, but we do have a meat eater – *Allosaurus*, the sculpture



you see outside the Royal Gorge Regional Museum & History Center. Many dinosaur fossils are recovered from the **Morrison Formation**. You can see the Morrison Formation across US-50 on the slopes of the hogback below Skyline Drive, often in shades of green, red and purple. This formation extends to Morrison, Colorado where it received its name, on to the dinosaur beds of Wyoming, then west to Grand Junction and Utah, including Dinosaur National Monument. It is made up of Jurassic period sedimentary rock. The Jurassic environment was one of relatively flat terrain, where rivers carried sediment and sometimes concentrated the bones of dinosaurs.

Our Stegosaurus sculpture was originally created by Department of Corrections labor about 1995 and was in front of Walmart on the east side of Cañon City for many years. It was relocated to this site in 2014, placed looking toward the dinosaur tracks on Skyline Drive that you will see later and redesigned to look more realistic. It was never intended as a true representation of the animal, just a sculpture to celebrate the local history of dinosaurs in the area.

Two more specimens of interest are between the 150 and 290 MYA markers. The first is tan sandstone that you see between the Fountain and Morrison Formations on the hillside above US-50. This layer is called the **Ralston Creek** or **Bell Ranch** Formation.

The next boulders are really interesting! These are **stromatolites** (like fossilized algae, only much more complicated) 265 million years old from the Lykins Formation. You can see how layers of algae built up, forming rounded masses that were eventually fossilized. Older stromatolites, some more than 3 billion years old, are the oldest fossils known. These were made by a combination of cyanobacteria (blue-green algae) and sediment. They lived when the atmosphere was a toxic mix and produced the oxygen which eventually allowed complex life to develop (like us!).

Some rocks are missing from the geologic record here. There is a big gap in time between the Fountain and the Morrison Formations. For at least some of this interval, Colorado was above sea level and rocks were eroded rather than deposited.

During this period, at about 252 MYA, the greatest extinction event in Earth's history struck. The **Permian extinction**, marks the boundary between the Paleozoic and Mesozoic. It resulted in the extinction of 90 percent of all species – a much more catastrophic extinction than the event which wiped out the dinosaurs.

290 MYA – The **Fountain Formation** dates to about 290 million years ago, when the ancestral Rockies were being torn down by the forces of erosion. If you look at the rocks along the trail, you can see that they consist of rounded, stream worn pebbles. Looking more carefully, you can see evidence of individual events – coarse material deposited as the flood was strongest, and then finer and finer material as the velocity of the water slowed. A large boulder along the trail has very large stones embedded in it, evidence of the force of the water

that was carrying this material. The Fountain Formation has produced some of the most iconic Colorado landmarks, including Garden of the Gods and Red Rocks Amphitheater. It is present around the campus here and it also can be seen at Red Canyon Park north of Cañon



City, Red Rock Canyon Park in Colorado Springs, and in the US-50 road cut directly across US-50 from here.

At Red Rocks Amphitheater in the Denver area, this formation is in direct contact with the ancient 1.7 billion year old **gneiss**, (pronounced: *NICE*) similar to what we see in the Royal Gorge. Here in Cañon City we also have Ordovician rocks, described below, which are not present in the Denver area.

350 MYA – **Williams Canyon Limestone** is rich in calcium carbonate that was deposited in a freshwater environment. It is a mix with similar dolomite rock resulting from magnesium-rich groundwater. The color variations you see result from sedimentary layers that were added over time.

450 MYA -- One of the oldest vertebrate fossils ever discovered was found just west of here in the Ordovician Period Harding Sandstone Quarry. In 1892 Dr. Charles D. Walcott described two fossil fish, **Astraspis** and **Eriptychius**, which held the record as the oldest known vertebrate fossil for more than 80 years until 1977. The original quarry produced blocks of sandstone for building

construction in Cañon City and elsewhere. A quarry operation continues today, producing aggregate and landscape material.

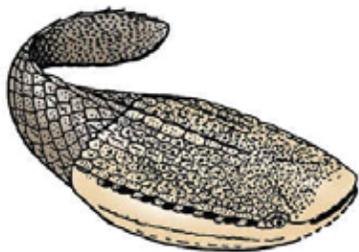
If you look at the rocks beside the trail, you will see small blue flakes. These are fossilized fish scales dating to the same time period. The rocks are **Harding Sandstone**. The photographs show *Astraspis* and a microscopic view of the fish scales.

These rocks were moved here from along US-50 going up Eightmile Hill on the way to the Royal Gorge where they fell by the road. Evidence of a **Great Unconformity** can be seen near this location along the road (we'll point that out along the tour route). 480 MYA Ordovician Manitou Formation rocks directly contact the 1.7 billion year old gneiss, which is prominent in the Royal Gorge. The geologic record viewed here is missing 1.2 million years!

Another local Ordovician location, the Indian Springs Trace Fossil Site, is described later in this Guide. Recognized as a National Natural Landmark, the privately owned Indian Springs Ranch & Campground provides the setting where you can see beautifully detailed tracks that show how animals walked, swam and burrowed on a muddy bottom 450 million years ago.

550 MYA – About 550 million years ago life forms suddenly became more complex. This is called the Cambrian explosion, when life forms transformed from very simple structures into complex animals such as trilobites. While the trilobites are the best known of these creatures, an amazing variety of animals and plants developed during this time. One of them was probably the ancestor of all animals with backbones, others appear to be ancestors of crustaceans and other current life forms, but many have no current descendent. These were evolutionary dead ends.

Many of these amazing creatures were discovered in the Burgess Shale in Canada by Dr. Charles D. Walcott, mentioned previously. Walcott was director of the U.S. Geological Survey from 1894 to 1907 when he became the fourth Secretary of the Smithsonian Institution until his death in 1927. The



specimens in the Burgess Shale show amazing detail, and additional sites there and elsewhere continue to expand our knowledge of Cambrian life. The photograph shows a trilobite from the Burgess Shale.

No Cambrian fossils have been found in Colorado, but an igneous rock of that age is along the trail. This rock is **Syenite** and comes from the McClure Mountain area southwest of Cañon City. It is actually a rather special rock because its properties make it ideal for calibration of radiometric dating procedures. Samples of this rock have gone to laboratories around the world and are used to verify radiometric dating equipment. This syenite has been dated as 523 MYA, but it was intruded into 1.7 billion year old rock.

1000 MYA – About a billion years ago, 1.08 billion to be precise, an upwelling of molten rock cooled below the surface of what is now



Colorado. This **batholith** solidified into what is called Pikes Peak Granite, a huge mass of rock extending from the southern slopes of Mount Evans to Lake George and the Cañon City area. After overlying rocks were eroded, it now forms Pikes Peak.

Two boulders of this granite are along the trail, hauled from the slopes of Pikes Peak with the permission of Pike National Forest. Fossils from this time period, and even much older, have been found, but they are very simple organisms. Nevertheless, they were impacting the planet. They used photosynthesis to create oxygen,

but this oxygen was immediately bonding with other elements, particularly iron, so atmospheric oxygen remained low. After hundreds of millions of years, the oxygen could remain free in the atmosphere, leading to the Cambrian explosion of life.

1700 MYA – This corresponds to the age of the oldest rocks in the area. These rocks are visible west of Cañon City and are most of what you see at the Royal Gorge. The quarry directly to the west is blasting this rock and selling it as aggregate and landscape material. This rock is also visible along the Tunnel Drive Trail, in Bighorn Sheep Canyon and on the way to Cripple Creek.

Most of this rock is classified as **Gneiss**, a banded metamorphic rock that has been remelted and deformed deep within the earth. It can include layers of beautiful mica schist, which sparkles from many parallel flakes of mica. Examples are along the trail.

Some of the rock you see is more recent. Molten igneous rock squeezed into existing cracks in rock and formed the intrusive structures that are now visible within the gneiss. Some of the intrusive rocks were light colored **pegmatites**, others were almost black **gabbro**. Along Tunnel Drive you see **gabbro** intrusives that have veins of pegmatite in them that were intruded more recently, so multiple events created this rock. **Gabbro** is basalt which solidified underground, rather than on the surface. It is almost black in color, the crystal size is much smaller, and it contains virtually no quartz.

Some of the pegmatites have been dated to about 1.4 billion years old. **Pegmatites** are characterized by their large crystal size, 1 inch or larger. Feldspar, quartz, and mica are usually seen in these rocks. Several pegmatite boulders are along the trail at the 1.4 billion year mark, where you can see the large crystals and impressive “books” of mica.



Hopefully, this visit to the Geology Time Trail has helped introduce the rocks and fossils in our region and explain when they occurred in geologic time. What follows in this *Guide* includes many viewing locations where these rocks and fossils were found. Before leaving the PCC-Fremont Campus, you may also wish to visit the **People & Places Trail**, which explores the area's history.

Return to US-50 and turn left (north).

US-50 (*Allow about one day for areas described in this section of the Guide, or break down each area for a more leisurely visit*)

As you leave PCC, going north, the Dakota hogback is to your right, and the Royal Gorge uplift is to your left. *Set your odometer as you drive past the Skyline Drive turnoff, if you wish to use the directions that follow.* As the road veers away from the hogback, it enters an area with several important quarries. Just to the right, on private land, are quarries which were the source of the rose travertine block near the start of the Geology Trail and the conglomerate used in the Fremont County Administration Building. These are not open to the public. The mountains with distinctive ridges are South Twin Mountain and North Twin Mountain. A little beyond, the mountain with the communication towers is Eightmile Mountain (known locally as Eight Mile).

RF-02: *Past milepost 273, 2.5 miles from the turnoff for Skyline Drive, pull off onto a faint road turnout on the right and stop by the gate. If you walk a little up the hill from here you can see where the **great unconformity** mentioned earlier is exposed right next to the road. This roadcut is referred to by local geologists as "Devils Gap," perhaps due to its complexity. Ordovician rocks, strongly layered and red, are directly above the Precambrian rocks, more massive with a coarse pink*



crystalline texture, as seen in the photograph. This is a gap in time of more than 1 billion years. Just east of this turnout is where the Ordovician Harding Sandstone boulders along the Geology Trail were recovered.

Beneath the road a large, rectangular concrete culvert directs water under US-50. If you bushwhack down and into this culvert, you will find many years of graffiti inside, left by dozens of students that were on Geology Field Camps in this area. Fremont County's diverse geology attracts geology students. Many universities have field camps in the area, with others stopping by regularly to study the varied geology.

RF-03: At the turnoff for the Royal Gorge (*Left on CR 3A*), **The Royal Gorge Dinosaur Experience** on the right (\$) (www.dinexp.com/) provides a great chance to see world class replicas of dinosaurs and other fossils. This organization is affiliated with the highly respected Dinosaur Resource Center in Woodland Park. They recently added a replica of a Cañon City Stegosaurus to their displays. Across the highway, the **Gold Mine Rock Shop** sells local rocks and material from around the world.

THE ROYAL GORGE

The road to the Royal Gorge leaves US-50 and travels about 5 miles south to the bridge. This uplifted area is called the Royal Gorge Arch, a north-to-south trending bulge of rocks, like a laccolith dome or an anticline, 6 miles wide by 10 miles long.

As you drive toward the bridge, you can see large quarries to the southeast (left) on CR-383B where the local pegmatites were mined (not open to the public). These large pegmatitic dikes contain unusually large crystals of feldspar, quartz, and both muscovite and biotite mica (as at the Mica Lode Mine). Crystals can grow exceptionally large with a high amount of hydrothermal flow, slow cooling, and lots of room to grow.

RF-04: Closer to the bridge where restrooms are located, hiking trails will take you to the edge of the gorge. Other hiking trails start at the public campground (Free) (turn left on CR-381B) and form a network including one that takes you to the summit of Fremont Peak. The Fremont Adventure Recreation (FAR) website has trail maps. www.joinfar.org/adventureguide.html



RF-05: When you arrive at the Royal Gorge Bridge & Park (\$) (www.royalgorgebridge.com/), the view from the deck at the Visitor Center is spectacular! Not only can you see the rock wall that forms the gorge (morning sun provides the best light), looking east you can see the change in elevation from the Rocky Mountains to the Great Plains. You can also view the bridge.

This is one of the deepest canyons in Colorado (1,250 feet). On the sides of the gorge you can see granite that appears to have intruded up along cleavage planes in the gneiss and schist, creating intrusion columns and granite masses up to hundreds of feet thick. The granite is the lighter colored material. The gneiss is about 1.7

billion years old, the intrusives in the 1.4 billion year range. Age, in this case, refers to the last stage of development. The gneiss is a **metamorphic** rock, created when the original rock was buried, reheated and subjected to tremendous pressure, causing it to melt, flow and recrystallize. The age of the original material that was subjected to these forces is unknown.

The formation of the gorge is hypothesized by some to have started about 5 million years ago. One theory links the gorge to an uplift westward in the Poncha Springs area and the Methodist Mountain complex, deflecting the Arkansas River to its current location, away from its previous course through the San Luis Valley following the Rio Grande Rift.

Cañon City Daily Record publisher Guy U. Hardy helped Cañon City acquire the 5,300 acres of land around the gorge from Congress in 1906 and a road from Cañon City to the gorge was built by prison labor. In 1929, a Texan named Lon Piper formed the Royal Gorge Bridge and Amusement Company, arranged a lease with Cañon City, which continues today, and built the bridge in about seven months at a cost of \$350,000. An incline railroad was also built down a gully near the bridge to reach the bottom of the canyon. The bridge deck is 1,055-feet above the river. This was the world's highest suspension bridge until 2003 – a bridge in China now has the record.

The Royal Gorge Fire of June 2013 destroyed the incline railroad and many of the buildings at the amusement park. While a few planks of the bridge's wooden floor were scorched, it was left intact and the park reopened in January 2014, complete with a new visitor center, awesome deck and updated facilities.

Return to US-50, turn right and travel east toward Cañon City. As you descend the highway from the west, you can clearly see the Skyline Drive ascending the side of the hogback ahead of you.

SKYLINE DRIVE

RF-06: Turn Left into the entrance to Skyline Drive, which is clearly marked along US-50 west of Cañon City. More information about the history of this landmark is in the ***Skyline Drive Heritage Tour***, available for purchase or free download (www.fremontheritage.com/skyline/).

After you turn off US-50, pull off to the side to take a look at the Gateway Arch. This arch was built in 1932 using prison labor, and it includes a rock from every state of the union (at that time).

As you travel up toward the crest of the Drive you will first be driving by Morrison Formation rocks. These are Jurassic rocks, about 150 million years old, and were discussed in the Geology Time Trail section. Many dinosaur discoveries come from this formation, including our own Garden Park discoveries, described in that section of this *Guide*.



These rocks were deposited in swampy lowlands, river channels and floodplains. Some of the layers are bentonite, created from falls of volcanic ash. You can park on several turnouts on the way up to get a closer look. The different layers tell of a landscape that changed over time, creating layers of siltstone and claystone with occasional limestone, sandstone and conglomerate. As you approach the top of the hogback, you transition to Dakota Sandstone, about 100 million years old.

RF-07: Park at the parking area at the top of the hogback and walk back a few hundred feet to see the dinosaur tracks that have been preserved in the Dakota. A group of Ankylosaurs, weighing 6 tons and 39 feet long, walked here when this was a muddy shoreline. A single track was noticed by Bill Kurtz in 1999, and the rest of the trackway was exposed by the Garden



Park Paleontology Society the next year. If you look carefully, a single three-toed track is also present. If you continue to look around, you will see that the Dakota also preserves impressions of petrified wood, ripple marks, and tracks of animals such as worms, shrimp and clams.

Return to the parking area and look southwest. Large quarries are visible below the highest point on the horizon, **Fremont Peak**, which was named (along with the county) for John Charles Fremont. He led several expeditions in the 1840s exploring and mapping the west, from the Oregon Trail to Yosemite to Taos. He was also a Senator from California, Territorial Governor of Arizona and even ran for president. The largest quarry is removing Precambrian rocks for construction and roads.

The area now being quarried was known as the Harding Quarry. This is where, in 1890, Charles D. Walcott visited to view fossils discovered in 1888 by Timothy W. Stanton. Walcott then wrote a paper in 1892 that described a fossil fish, *Astraspis desiderata*, which held the record as the oldest known vertebrate fossil until 1977. This is the **type locality** of the **Harding Sandstone** and **Fremont Limestone** described by Walcott in 1892. The rocks where the fish were found have now been quarried out, but these Ordovician rocks are still visible in the cliffs that line the drainages that drop into Sand Creek, which flows along US-50.

Looking more to the northwest, you can see where US-50 leaves the valley below you and turns more westward. Two important quarries are just north of the highway, a travertine quarry which produced beautiful rose travertine and a conglomerate quarry. These are on private land and cannot be visited without permission. This is the source of the large quarried block of the travertine, seen close to the start of the Geology Trail that was used in the Church of the Holy Ghost in Denver. The conglomerate quarry was the source of



conglomerate used for the Fremont County Administration Building at 615 Macon Avenue in downtown Cañon City. The photograph shows the location of these quarries.

The conglomerate is part of the Fountain Formation, about 290 million years old. The large size of the rounded stones in this conglomerate tells of violent flood events carrying material from the ancestral Rockies. Some of these rounded rocks are pieces of older limestone and contain fossils such as crinoids.

The travertine is much more recent, created when water carrying minerals was exposed at the surface and deposited those minerals in colorful layers. Dating is uncertain, but it is probably under 1 million years old. Geologists call this a **Quaternary surficial deposit**. *Quaternary* is the most recent geologic period. Most rocks we describe in this guide were once beneath the Earth's surface, but this rock is different. It lies exactly where it was formed.

Looking east from the parking area, you can see the broad valley where Cañon City, Florence and Penrose are located. This is the **Cañon City Embayment**, with mountains that are part of the front range uplift to the west and north, and the Wet Mountains to the south. These mountains protect Cañon City from many of the storms that come from the west and the north. Together with the breezes coming down the Arkansas River, this creates the mild climate enjoyed by residents here. The photo of the Embayment was taken north of town from the Island in the Sky trail.



Also to the east, just below the main hogback, two smaller ridges are visible. The larger ridge is the youngest. It is **Niobrara Formation**, mostly limestone, the smaller is the **Greenhorn Limestone**, and between them is the small valley corresponding to the softer **Carlile Shale**. The valley between the Dakota and the Greenhorn Formations corresponds to the **Graneros Shale**. These layers will be discussed in more detail when we get to the bottom of the drive. Just younger than the Niobrara is the **Pierre Shale**, which we will examine on the Riverwalk. It is the surface layer for much of the Cañon City Embayment and includes the interesting Tepee Buttes, all discussed later.

Much of the landscape you see was created by **Differential Erosion** (hard rock like granite erodes away more slowly than softer sedimentary rock such as shale). This helps explain sharp cliff faces, such as those seen at the Royal Gorge, compared to softer slopes such as you will see in the Pierre Shale.

To the south are the **Wet Mountains**, the southern boundary of the Cañon City Embayment.

Now take a look along Skyline Drive to the north. The top of Skyline Drive is all called Dakota Sandstone, but it is not all sandstone. Sandstone beds are below shale layers, then more sandstone, then more shale, then more sandstone, then more shale and so on. This tells the story of a coastline which came and went. The **Western Interior Seaway** deposited sand near the shore, then expanded creating shale in deeper water, then became shallow again producing more sandstone. The cycle repeats many times.

Two hiking trails can be taken from the parking area, the Dakota Ridge Trail and the Old Skyline Drive Trail. The Dakota Ridge Trail follows the top of the ridge and then drops down to the Greenhorn Trail, visible in the gap between the Greenhorn and



Niobrara Formations. It gives beautiful views of the area but is quite steep as it descends off the ridge. The other trail follows the route of the original Skyline Drive, built in 1905 using prison labor. It was originally only for non-motorized traffic—automobiles scared the horses—but automobiles were allowed by 1907. This is an easy trail which also connects with the Greenhorn Trail, directly or via a trail through an old quarry, and along the trail you can see examples of ripple marks and **Liesegangen bands**, or picture sandstone, shown in the photograph. Picture sandstone formed when fluids permeated the sandstone and deposited bands of darker, iron-rich stain. Loop hikes using these trails and returning via Skyline Drive are highly recommended, and signs give more details, or you can visit the Fremont Adventure Recreation website.

Continuing along Skyline Drive from the parking area, the road first stays on the top or west side of the ridge. A little farther along, the road is on the east side, and if you look at the sandstone above the road to the right you can see beautiful ripple marks, evidence of the shoreline environment.

RF-08: Another wide spot in the road is a good place to park and look at the view. The quarry mentioned earlier is more visible here, and if you backtrack along the road you can see more ripple marks with tracks of animals that slithered in the mud 100 million years ago. The road switchbacks



to the left and descends the ridge. At the next switchback there is room to park and look at the rocks.

RF-09: The reddish sandstone here is pockmarked with holes, and these have mineralization in them, **Iron Pyrite** (fool's gold). This is unusual in the Dakota, and the source of the iron is not well understood. The rocks were probably deposited in a stagnant pool.

RF-10: Continue and park in one of the two parking lots below, just before the road exits through the gap in the Niobrara. The Greenhorn trail heads north from here, a wide and easy trail between the Greenhorn and Niobrara limestones. Not too far up the trail you will see two signs explaining some of the geology, and a little farther along is the Bridge Creek Trail, a short trail that highlights the geology of the Greenhorn Limestone. Two large signs give an overview of the Greenhorn, and smaller signs provide examples of **index fossils**, fossils that are used to determine the exact location of a rock in the geologic context. An index fossil is a common, distinctive fossil which only existed for a limited period of time, so when one is found, the surrounding rock must be from that time period.

The trail also has some imported rocks, stone fenceposts that were quarried in Kansas during the early 1900s. These fenceposts were quarried because few trees grew in that area of Kansas, so stone posts were used to string the barbed wire. Why are they here? The same geologic layer which was used to quarry the fence posts (sometimes called the post rock layer) also appears right here. How do we know? Index fossils. As mentioned earlier, these rocks were formed at the bottom of the Western Interior Seaway which extended across much of Kansas. Kansas has produced a wealth of fossils from this seaway, and if you are ever bored driving across Kansas on I-70 (and who isn't?), stop at the Sternberg Museum at Hays for a fossil fix. The museum has the famous "fish within a fish" fossil, a huge fossil fish with another one in its stomach.

Just below the parking area the road goes through the Niobrara Formation and then enters a residential area. If you walk down to this gap in the Niobrara, you will see a brown layer of sandstone, the **Juana Lopez Member**, which extends all the way out to the Comanche National Grasslands south of La Junta. Look at this layer

on the south side of the road and you can see ammonite fossils (please leave these for others to discover, too). The Juana Lopez often contains broken up shells and shark teeth. This layer was deposited in a high energy environment with vigorous waves and currents, so few shells survived intact. South of the parking lot, all of the Niobrara limestone above (east of) the Juana Lopez has been quarried away by prison labor for building stone.

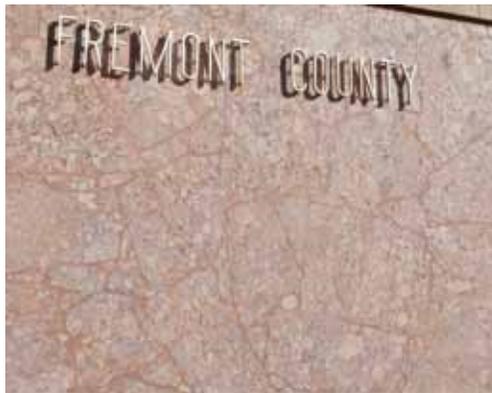
Drive down to the residential area and take 5th Street south for 8-blocks to Greenwood Avenue and turn left for 2-blocks.

FREMONT COUNTY ADMINISTRATION BUILDING

RF-11: The Fremont County Administration Building (*Free. Restrooms are here.*) incorporates natural stone panels on both the interior and exterior walls that were quarried in the nearby Cowan Brothers Quarry that you viewed at stop RF-07. It was dedicated in 1961 and served as the County Courthouse until a new judicial building was built in 1999. Designed by the Denver architectural firm of Nixon & Jones, the building was designated a Fremont County Landmark in 2014. Recently, **Crinoid Fossils** were found in some of the rounded rocks embedded in its walls. A few have been framed for viewing.

South of the Admin Building on Macon & 7th Street you see the First Baptist Church constructed from distinctive, red Harding Sandstone from the Harding Quarry, now the quarry behind PCC.

Continue south on 7th Street



2-blocks to US-50 (Royal Gorge Blvd.). Turn right, then left for the Royal Gorge Regional Museum & History Center at 6th & Royal Gorge Blvd.

ROYAL GORGE REGIONAL MUSEUM & HISTORY CENTER

RF-12: If you are interested in local geology or history, this museum is a must see (*Free, donations encouraged!*). It is located at 6th on US-50, Royal Gorge Blvd. It is open Wednesday through Saturday from 10 a.m. to 4 p.m. at the time of this writing. (www.rgmhc.org/).

The highlight is an exact replica of the Stegosaurus that was airlifted out of the Garden Park area in 1992. One other replica is on display at the Denver Museum of Nature and Science, and they also have the original, which is not on public display. This important fossil answered many questions about this dinosaur: the arrangement of the plates, the arrangement of the tail spikes, and the presence of protective plates under the neck. Another highlight is the large fossilized tree, also found in the Garden Park area. Other dinosaur displays include huge leg bones, skull replicas, tracks and interactive displays. Other Fremont County fossils are on display, including ammonites, baculites and bivalves. The large fireplace on the second floor has some fascinating rocks, including dinosaur bone. This museum also is great resource for history buffs. There are history displays and a tremendous archive of documents and photos. Just ask the staff for assistance.

The museum building itself has an interesting history. Dedicated as the Cañon City Municipal Building in 1927, the building was strongly influenced by developer, businessman, naturalist, hunter and booster of the area William Dallas (Dall) DeWeese. He



also discovered a Diplodocus in Garden Park.

From the Museum, turn left (west) on US-50 and follow it past the Colorado Territorial Correctional Facility (built in 1871 prior to statehood), around the sharp curve and turn left onto Tunnel Drive.

TUNNEL DRIVE TRAIL (Free, restrooms are here.)

RF-13: This short hike (4-miles, roundtrip) is a great place to get up close to the rocks of the Royal Gorge. The trail starts at the end of Tunnel Drive, on the west side of US-50 between the PCC campus and Cañon City. Park at the end of the drive and take the trail which starts steeply as a paved trail but levels off after a short distance.

Note the historical marker which documents Zebulon Pike's camp in this area.

The rocks you see along this trail are 1.7 billion year old Precambrian rocks, some of the oldest in Colorado. The trail goes through three tunnels in this rock, two short ones and then a longer one. After you exit the third tunnel,



look back and examine the black rocks which are above and to the left of the tunnel. This is **gabbro**, an igneous rock that originated deep in the earth, then intruded and cooled in cracks of the gneiss that makes up most of this Royal Gorge Uplift. When this material cools on the surface, it is called basalt. If you look carefully, you can see chunks of pink rock that were dislodged and carried along as this



molten rock squeezed into the gneiss.

Beautiful examples of banded gneiss are along the trail, as well as another metamorphic rock, mica schist, which sparkles with little crystals of mica. Mica schist usually forms when sedimentary shales or mudstones are subjected to heat and pressure, with the mica lining up perpendicular to that pressure. A similar rock, phyllite, also shows parallel mica flakes, but it is not as strongly metamorphosed (changed by heat, pressure and/or chemistry).

As you continue along the trail you will see many instances of intrusive pegmatites, coarser grained rocks that squeezed into the cracks about 1.4 billion years ago. The surrounding gneiss is about 1.7 billion years old. These pegmatites are characterized by larger crystal sizes than the surrounding gneiss, and they usually contain feldspar, quartz and mica. One of the pegmatites, on a point where the trail goes around a point of land, cutting between rock walls on the right and a remaining point of rock closer to the river, includes crystals of magnetite, an iron mineral which is magnetic. Chunks of magnetite that were magnetically polarized, lodestone, were used for the first compasses.

This route was originally carved into the hillside as a potential irrigation canal, but those plans died when insufficient water rights were available to make the plan economic. After that, the route was used for Cañon City's municipal water supply, and evidence of the original pipe can still be seen along the trail.



Return to US-50 and turn right (east). Go 2.8 miles to Reynolds and turn left (north). The road jogs left, then take the first right and turn north on Field Avenue for 2.3 miles to the junction with Red Canyon Road (CR-9) and continue to the Garden Park area.

Dinosaurs of Garden Park

Ask any youngster to name their favorite dinosaurs and you'll generally get a list that includes Stegosaurus, Diplodocus,

Brachiosaurus and Allosaurus along with other perennial favorites such as Spinosaurus, Triceratops and Tyrannosaurus. Surprisingly, the term dinosaur was hardly in anyone's vocabulary and none of these dinosaurs were known in 1876. Ten years later Stegosaurus, Diplodocus, Allosaurus and others were very well-known based on discoveries in the Garden Park fossil area; Morrison, Colorado; and Como Bluffs, Wyoming,

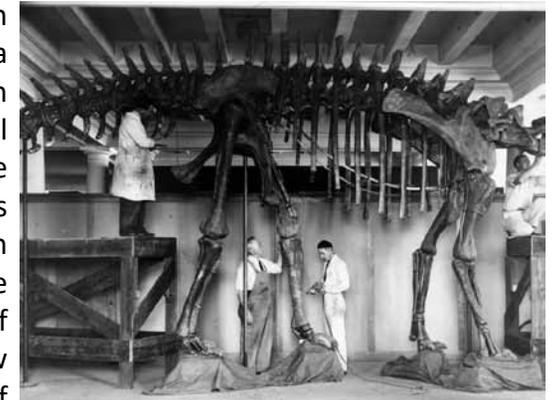
The story of these discoveries originates from an intense rivalry between two great scientists, Professor Othniel Charles Marsh of Yale University in New Haven, Connecticut and Professor Edward Drinker Cope from Philadelphia. Beginning about 1870, hundreds of animals, previously unknown, were discovered in the American West. Up until 1877 none of those discoveries included dinosaurs, but those discoveries spawned curiosity and pioneers were out looking. On January 25, 1877 Henry Felch came walking into the Cañon City Times newspaper office with some very large bones. Five months later, a one room school house teacher named Oramel Lucas arrived at the newspaper office with even larger bones.

Oramel W. Lucas had been attending Oberlin College in Ohio but ran short on funds for tuition and joined family members in Garden Park, becoming the Schoolmaster. In 1877 he noticed fossilized bones and was referred by Oberlin's geology professor to Professors Marsh and Cope. Lucas was soon hard at work for Professor Cope excavating dinosaur bones for the then "get rich" price of 10 cents a pound. Oramel and his brother Ira continued excavating and shipping hundreds of pounds of bones to Cope at his home in Philadelphia, and the news leaked out. Not surprisingly, Professor Marsh heard about it and sent Professor Benjamin Franklin Mudge, his representative in Morrison who was working with a soon-to-be notable geologist named Arthur Lakes, to investigate. Mudge tried valiantly but failed to steal Lucas away from Cope. He then took a different tact; found Marshall Felch, who showed him a site where bones were peeping out of the ground and decided that maybe another site could be just as good. For the time being Marsh's crews continued to work in Como Bluffs, Wyoming, but six years later Felch went to work full time for Professor Marsh in Garden Park.

Marshall P. Felch was a Civil War veteran. He and his wife Amanda, also a Civil War veteran, settled in the Garden Park area in 1871 to operate a farm and were joined by other family members including Marshall's brother Henry. In 1883 the quarry was in full operation and over 270 crates of fossils were sent by railroad to Marsh at the Yale Peabody Museum in New Haven by 1887, when this initial rush ended. The Felch site turned out to be more important than the Cope-Lucas Quarries. It provided virtually complete, articulated skeletons of Allosaurus, Stegosaurus and Ceratosaurus that have been on display at the National Museum of Natural History (Smithsonian) since the early 1900s.

Those early excavations were just the beginning of the Garden Park fossil area's legacy. In

1914, for instance, area developer, businessman and promoter Dall DeWeese and his wife discovered a Diplodocus skeleton in Garden Park. He contacted the Denver Museum of Natural History, now the Denver Museum of



Nature & Science (DMNS), and arranged its excavation in support of the Museum's paleontological research program. In 1992 DMNS paleontologists Ken Carpenter and Bryan Small were leading a field excursion of volunteers in the area when they made an unusual find – the complete skull of a Stegosaurus! This was near the rest of the body which was later excavated and airlifted out. Other discoveries are on display at the Royal Gorge Regional Museum & History Center (RGRMHC).

Did you know that Colorado has a state fossil? It is a Stegosaurus excavated from a location not far from the Marshall-Felch Quarry, pictured



above. The 1936 discovery was made by a group of Cañon City High School students under the direction of their teacher, Frederick Carl Kessler. The Natural History Museum in Denver excavated the skeletal remains and it was placed on display at the Denver Museum in 1939. Kessler led an active science education program at the high school, founded the Cañon City Geology Club in 1928 and was responsible for other discoveries and scientific descriptions of the area. After retiring from teaching in 1949, he became the Curator of the Cañon City Museum, now the Royal Gorge Regional Museum & History Center. The Stegosaurus became the Colorado State Fossil in 1982 at the urging of Denver school students.

It turns out that the Garden Park area is one of the most important Late Jurassic vertebrate localities in North America; the **type locality** of Allosaurus, Camarasaurus, Ceratosaurus, Diplodocus and many other dinosaurs. Not only were dinosaurs found here; but also fish, rhynchocephalians (lizards), crocodiles and mammals.

Today the Garden Park Fossil Area (GPFA) is managed as an *Area of Critical Environmental Concern* by the U.S. Bureau of Land Management. It has also been designated a *National Natural Landmark*, and a *Colorado Natural Area*, by the National Park Service and the State of Colorado respectively. The Garden Park Fossil Area is located approximately 6 miles north of Cañon City along Fremont County Road 9. Further information: www.handsontheland.org/garden-park/

There are two easily accessible fossil sites within the fossil area that are especially worth visiting.

RF-14: Cleveland-Delfs Dinosaur Quarry (Free)

This site is next to CR-9 and it includes a bathroom and picnic area. The site overlooks Fourmile Creek (known earlier as Oil Creek). A brass plaque commemorating the fossil area's National Natural Landmark status with the National Park Service is located near the picnic area. There are three interpretive signs that were updated in 2018. One sign focuses on the Edwin Delfs excavations in the 1950s for the Cleveland Museum of Natural History. The second sign describes the layers of rock known as the **Morrison Formation** which in turn enables us to understand what it was like when the dinosaurs were alive. The third sign describes which museums

received bones from the Garden Park Fossil Area. The bones are not here but they are not gone; in fact they are very well cared for. Some of them are even on display! Further information is available at the RGRMHC.

Delfs' discovery, *Haplocanthosaurus delfsi* (known as Happy), is on display at the Cleveland Museum of Natural History. Nearly half the bones in the 70 foot long, 14 foot high display are real fossil material recovered from this location. This Late Jurassic sauropod was the first of its species ever discovered.



This site is significant for two other reasons. As another sign discusses, it commemorates the December 1806 journey of Zebulon Pike past this exact point during his exploration of land acquired by the United States as part of the 1803 Louisiana Purchase. Also, near here in 1862, the first oil well west of the Mississippi developed from an oil seep the Ute Indians had used. That site was listed on the National Register of Historic Places in February 1996.

RF-15: Marsh-Felch Dinosaur Quarry Overlook Trail (Free).

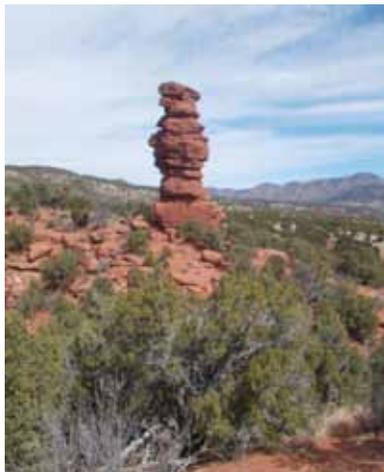
This interpretive trail is a quarter mile north of the Cleveland Quarry along CR-9. Next to the pull-off there is a plaque placed there by the community in 1954. It has some misinformation – see if you can find the mistakes by reading the rest of the signs here, and at the Cleveland-Delfs Quarry! An introduction sign with a trail map is located at the pull-off to help you get oriented. Up around the corner is a sign explaining both the rare plants of today and a tree trunk from the late Jurassic. Both have been discovered nearby! A short distance ahead is a wonderful vantage point where you can see a late Jurassic stream channel in the cliff below the Marsh-Felch Dinosaur Quarry. The sign here describes the “bone wars” story in relation to the Garden Park Fossil Area, the competition between Professor Marsh and Professor Cope. The rest of the trail is less

level and rougher but guides you to an overlook where you look straight across the chasm to the Quarry. The only picture of the site ever taken was from this point in 1888. One sign shares the story of Marshall P. Felch, the disabled Civil War veteran who did some remarkable excavation work, and the second sign explains why so many dinosaur skeletons were found in such a small area. The photo shows the preserved stream bed, as seen from the highway.

If you continue north along CR-9, you will encounter three additional points of interest.

RF-16: First is the Garden Park School site (Free), important when mining camps north of here in the Cripple Creek area were active and needed the fresh vegetables, beef and other food supplied from here via a wagon road. Oramel Lucas taught school in a one room school house that was near this site. The original wooden structure was destroyed by fire and, in 1895, was replaced by this building made of local adobe bricks by area residents. The school closed in 1961 due to consolidation. Today an active restoration effort is underway.

RF-17: A little farther along is Red Canyon Park (Free). This park, owned and operated by the City of Cañon City, is a celebration of red Fountain formation landscape, as shown in the photograph. The distinctive red sandstone formations, carved by nature into unique spires and cliffs, are of 300 MYA **Fountain Formation Sandstone**, the same formation that makes Garden of the Gods in Colorado Springs and Red Rocks Amphitheatre near Denver. The outwash of the Ancestral Rocky



Mountains accumulated into a 1,200-foot thick layer that was solidified by time and pressure into sandstone, turned red by iron oxide, then uplifted, tilted and eroded into magnificent landscapes. Former *Cañon City Daily Record* publisher and congressman Guy U. Hardy aided in the acquisition of this 640-acre park in 1923.

RF-18: Finally, you will come to the BLM managed Shelf Road Climbing Area (\$ for camping), where technical rock climbers ascend the vertical Ordovician Fremont Limestone cliffs. The road then continues to Cripple Creek, where gold is still being mined in a huge open pit operation. The section of the road beyond the climbing area is narrow, with only room for one vehicle in many places. Steep drop-offs on the right side of the road have no guardrails.

Retrace your route, returning south. Continue south on Reynolds/Ash Street. As you cross the river, Reynolds changes names to Ash Street. Continue south past the Parks and Recreation Building on the right and start up the hill. Halfway up the hill you will see a yellow gate on the left and a small parking area on the left just beyond that. If you get to Calihan or Grand streets, you have gone too far. You may want to use Calihan to turn around and go back to the parking area by the yellow gate.

PIERRE SHALE

This is a quick stop to see an outcrop of the Pierre Shale.

RF-19: From the yellow gate the Riverwalk Trail heads east. To the left, notice the wide flood plain of the river with its meander loops edged by gravel bars. These are created as the river moves back and forth. They are more common from here on down the river, since the river is not nearly as steep as it was above Cañon City. To the right you can immediately see **Pierre Shale**. The shale is mostly gray here, with a few bands of harder



material. This harder material can form lenses or continuous layers. The lenses sometimes contain fossils, mostly baculites. The photo is taken a little farther along the trail. The shale here has a more brownish color, and distinct layers of more resistant material can be seen.

A famous Pierre Shale collecting area is Baculite Mesa, just north of Pueblo. This area is privately owned, but local geology and paleontology groups frequently get permission for field trips to the site. Baculites, ammonites, clams, and other fossils can be collected with permission of the owner.

Above the shale is a layer of rounded stones and cobbles, described as the **Louviere Alluvium** (Bull Lake Glaciation) on the geologic map of the area, about 85 feet above the current level of the river. Dates are somewhat uncertain, but this glaciation was probably between 200,000 and 130,000 years ago.

Extrapolation is fraught with problems. Rates of erosion are never constant, influenced by river flows and topography. But if the river dropped 85 feet in 200,000 years, the 1,250-foot depth of the Royal Gorge might have been carved in about 3 million years. No respected geologist would promote this estimation, but it is still interesting.

This is a particularly beautiful section of the Riverwalk, and if you take the time to continue east you will see huge cottonwoods along the river and an irrigation channel along the walk. Additional exposures of the Pierre Shale show a more brownish color, and more layers of more resistant shale, more like a sandstone. The walk ends at MacKenzie Avenue and, if you look across MacKenzie toward the left, you will see an old oil well which still occasionally pumps oil from below.

Continue on Ash south past CO-115, go east (left) on Pinion Avenue, and then south (right) on Spring Street to Spring Creek Park, on your right.

RF-20: Spring Creek Park (Free). Restrooms and a picnic area are located here, along with interpretive information about the mine here which once produced tons of coal daily. Trails in this area show where coal mining and processing took place. Trails traverse the Vermejo formation and some more recent river deposits.

Signposts along the trail point out what remains of the mine, including the base where a huge steam engine once provided power to the mine, as shown in the photograph.

COAL AND OIL

Coal & Oil Production

was historically important in the Florence area, due to material deposited here during the ebb and flow of the Western Interior Seaway in the Cretaceous Period between 70 and 100 million years ago. **Coal** was found in the *Vermejo Formation* in 1860 and more than 20 mines were operating in the early 1900s, with much of the production going to Colorado Fuel & Iron in Pueblo.

The region south of CO-115 between Cañon City and Florence was the center of coal mining and oil production. The coal mines are all closed now, and most are on private property and not open to the public. This stop at Brookside has provided an introduction to the operations.

Return to CO-115 and turn right to Florence

As you drive on CO-115 between Cañon City and Florence, the top layer of rock exposed on the south side of the highway is Trinidad Sandstone.



Side Trip: Another exposure of the Trinidad, along with the Vermejo and the youngest Raton sandstone, can be seen at historic **Alkali Gap**. This is the gap that Oak Creek Grade goes through about two and a half miles south of Elm Avenue (going up 9th Street from US-50, bear right at the traffic circle onto Elm for 1-block, then left on CR-143). As you proceed through this gap, you first see Raton, then Vermejo, and then Trinidad formations. A little farther along the road are the remains of an old coal mine. The Cotter Corporation Uranium Mill, now closed and a EPA Superfund Site, is located nearby.

RF-21: Pathfinder Regional Park

(Free) Restrooms and picnic area are on the left as you travel toward Florence. The large metal sculpture in the roundabout as you enter the park is of John C. Fremont, known as the *Great Pathfinder* for his western exploration.

Looking southwest from the main parking area on the left of the roundabout you get a good view of the edge of the **Cañon City Coal Field**. Across the Arkansas River to



the north you see a prominent local geologic feature known as **Castle Rock** (not to be confused with the Town of Castle Rock between Denver and Colorado Springs). This prominent landmark is largely composed of Trinidad Sandstone, with some Vermejo higher up, and it is topped with old river alluvium. (*for the best view of Castle Rock, drive toward the boat ramp and fishing area on the river*)

Coal: As mentioned above, coal mining was historically an important economic activity in Fremont County. The first coal production here was in 1847, when George Lewis began removing small quantities of coal from an outcropping, expanding the operation to a small coal pit later that year. That mine went through several owners, finally purchased by the Denver & Rio Grande Railroad in 1871 because of the high quality of its coal. Coal mining flourished, driven

by the demands of railroads and the steel industry in Pueblo. As many as 185 mines operated during the years, although some may have been counted more than once because of change in name or ownership, producing a total of 48 million tons of coal. Peak activity was between the 1890s and 1940s, dwindling to just six active mines in 1978. The last coal mine closed in 2000; the result of market conditions and operating costs. There is still coal in the ground.

The coal was mined from the Vermejo Formation, corresponding to a time when the great western seaway was in retreat. As the sea retreated, the underwater Pierre Shale gave way to the beach sands of the Trinidad Sandstone, then the Vermejo with coal seams, and the Raton Formation.

Seven different coal seams were mined from the Vermejo. These ranged from the Rockvale seam, just above the Trinidad, to the Brookside seam, several hundred feet higher. No coal was mined in the upper part of the Vermejo.

Geologically, the mining district is a large syncline where the rocks are deformed downward like a trough. In the middle of this trough, the Raton formation is at the surface. Moving away from the center, the Vermejo is exposed, and that is where most of the mine entrances were located. The mines themselves extended deep into the hillside. The Southfield mine, the last to close in Fremont County, extended almost a mile from the entrance to the working face.

Oil: In 1881 Alexander Cassidy, who had been involved in unsuccessfully trying to expand the scale of the Garden Park oil well mentioned earlier, struck oil while drilling for water near Florence. The **Florence Oil Field** became the second oldest in the U.S. and first in Colorado with 500 wells producing 15 million barrels of oil between 1890 and 1920. The field is unusual in that it is a *Syncline* (downfold or trough) where oil collects at the bottom of the **Cañon City Embayment** in fractures of the *Pierre Shale*, rather than being trapped at the top of an *Anticline* (upfold) which is a more classic configuration for an oilfield. Oil production continues today with 30,000 barrels produced from over 20 active wells in 2016. At its peak, the oilfield covered 25 square miles. During the 1920s,

Florence had 25 oil companies, seven gold ore processing mills (processing Cripple Creek ore), three railroads, more than two dozen coal mines and a cement plant. Today, many antique shops dot the historic downtown.

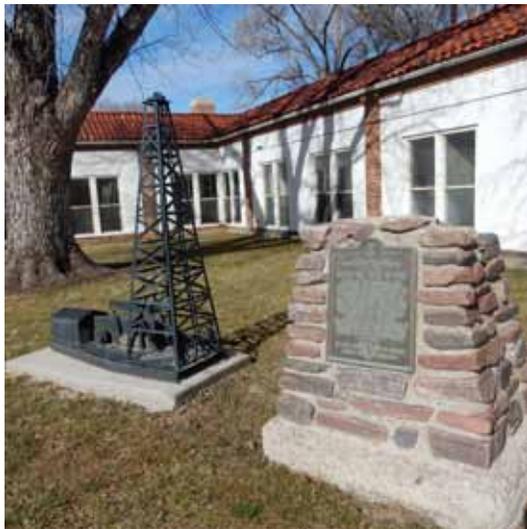


For further information, see the *Downtown Florence Heritage Guide* www.fremontheritage.com/florence-colorado/ and *Coal Camps of Fremont County Heritage Guide* www.fremontheritage.com/wp-content/uploads/2017/11/Coal-Camps-Online.pdf.

Return to CO-115, turn left and drive toward Florence.

RF-22: Oil Well Monument, Florence City Hall lawn. Travel to

Florence on CO-115 and stop at City Hall on 600 West Third Street. Here you see a plaque and oil well sculpture commemorating Florence's peak as an Oil Field. The **Florence Historical Archive**, a resource for researching the history of Florence and vicinity, is also located here. For further information, contact



(719) 429-5515 or www.facebook.com/Florence-Historical-Archive-432771616926733/.

Continue on CO-115 through Downtown Florence and turn right at the stoplight on Pikes Peak Avenue to 100 Pikes Peak Avenue.

RF-23: The **Florence Pioneer Museum and Research Center** has a large display map of coal mines and oil wells which shows the location and extent of the production of each. It also has extensive historic information on the Florence area. www.florencepioneermuseum.org/



TEPEE BUTTES

RF-24: Just south of Florence are examples of tepee buttes, a geologic formation in the Pierre Shale. *To see these formations, travel east on CO-115 from downtown Florence to the stoplight on CO-67. Travel south (right) for about one-half mile, turn east on the paved Bear Paw Drive, which soon becomes gravel Siloam Road (CR-19), and go two and a half miles from CO-67.* One butte is on the north side of the road here, and if you drive about another half mile, two small buttes are on the south side. These are on private property and can only be visited with permission. Local geology and paleontology clubs sometimes offer field trips.

These conical hills occur from Florence to Pueblo (near Baculite Mesa) and all the way out onto the eastern plains as far as Boone and north to South Dakota. There used to be one in the northern part of Cañon City, but it has been leveled. These formations, mostly limestone, are much more resistant to weathering than the surrounding shale. They were created when methane seeps developed at the bottom of the Western Interior Seaway. The seeps created a micro-environment rich in life. In particular, fossil clams, *Nymhalucina occidentalis*, did so well in these conditions that their shells can be found by the hundreds. This clam species is only found near these Tepee Buttes; it is not found anywhere else in the world! This rich environment also supported baculites, ammonites, gastropods, bivalves and other genera.

Retrace your route to downtown Florence.

EASTERN FREMONT COUNTY (Allow about one day for the areas included in this section, depending on how far you go in Phantom

Canyon Road.)

From the intersection of CO-67 and CO-115 travel east on CO-115 for about 2-miles to the intersection with CO-120 and bear right. Travel about 3.5 miles to the Portland area of Fremont County.

Beyond oil and coal, other vestiges of the Western Interior Seaway remain in the area and can be seen in Eastern Fremont County. East of Florence along CO-120 a large limestone quarry has provided the raw materials for cement manufacturing for over 100-years.

RF-25: Locally occurring limestone and gypsum have been manufactured into Cement at **Portland** (named for the Isle of Portland off the coast of England where the process originated) since the early 1900s. **LafargeHolcim** is the current operator of the large limestone quarry and cement manufacturing plant about 5 miles east of Florence. Using limestone and other products from this quarry and gypsum and calcium quarried near Howard, west of Cañon City, cement is made by crushing the material, then heating it to 2,700 degrees Fahrenheit in a large rotary kiln. Colorado Industrialist Charles Boettcher and John Thatcher of Pueblo incorporated Portland Cement Company (later called Ideal Cement) in 1901, which expanded production of an existing cement plant.



INDIAN SPRINGS TRACE FOSSIL SITE (\$)

RF-26: *Tours of this site must be arranged in advance by calling (719) 372-3907. Return to CO-115 and to CO-67, Pikes Peak Avenue. Turn north (right) at the stoplight. Follow CO-67 across US-50 and*

*continue on CO-67 another 3.5 miles and turn left. After 1.4 miles you will come to the **Indian Springs Ranch & Campground** office, where the tours begin. www.indianspringsranchcampground.com/ The Indian Springs Ranch Campground is a historic working ranch that has built a campground and facilities in the central part of the ranch. The site was founded by the ranch's patriarch, Bennie C. Thorson (now deceased), who found the trace fossils and contacted Professor William A. Fischer of Colorado College in Colorado Springs. The Thorsons and Dr. Fischer worked extensively on the 10-acre site for five field seasons before scientific results were published. Bennie's daughter Carly has carried on the family tradition of preserving and presenting this remarkable site. About 450-million years ago, this was a shallow muddy sea where trilobites and many other animals slithered and crawled across the sea bed, leaving their tracks, which have been beautifully preserved. The site was designated as a National Natural Landmark in 1980.*



PHANTOM CANYON ROAD (Alternative to Shelf Road for access to Cripple Creek)

RF-27: Phantom Canyon Road, also part of the Gold Belt Scenic Byway, was initially constructed in 1892 by Florence area businessmen up Eightmile Creek to compete with the Cañon City & Cripple Creek Toll Road, now Shelf Road. Originally a free road, the roadbed was converted into the Florence & Cripple Creek Railroad in 1894 to bring Cripple Creek ore to Florence for processing. Dropping from 9,500 feet near Victor to 5,500 feet at the bottom, the rail line was plagued by floods and washouts. Due to damage and declining ore production the railroad closed in 1915 and by fall, 1918 the State Highway Department completed the present Phantom Canyon Highway. It is a generally well-maintained dirt road with two tunnels, several bridges and spectacular views,

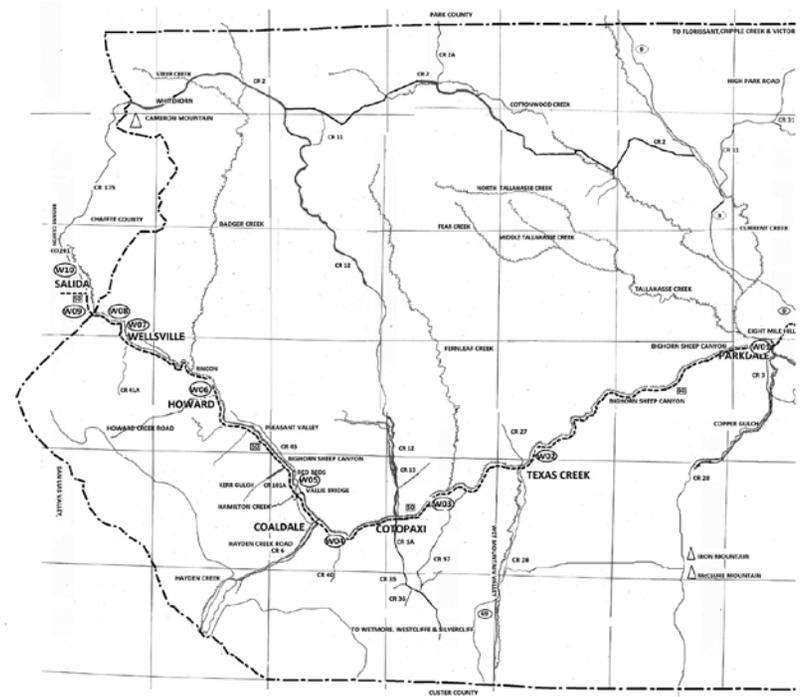
although still plagued by washouts due to flooding (local inquiry is suggested before taking this drive). Geologically, the canyon cuts through Precambrian igneous and metamorphic rock with many faults, folds and unconformities. The photo is of the old Adelaide Station on the Florence & Cripple Creek Railroad.



The Phantom Canyon Road continues to the Cripple Creek/Victor area where Newmont Mining operates a large, open-pit gold and silver mine. www.newmont.com/operations-and-projects/north-america/cripple-creek-and-victor-us/overview/default.aspx While vehicles longer than 25 feet are prohibited due to hairpin turns and narrow width in places, it is less arduous than Shelf Road. *Note: for a paved alternative to get to Cripple Creek/Victor, take CO-9 right off US-50 past the Royal Gorge entrance road, then follow the paved High Park Road (Teller County Road 11).*

WESTERN FREMONT COUNTY *(allow about one day to enjoy this portion of Fremont County's outstanding geology)*

Western Fremont County



Tour Sites

- RF-W01: Parkdale Recreation Site
- RF-W02: Approaching Texas Creek, right pull-off (MP254)
- RF-W03: Approaching Cotopaxi (MP249)
- RF-W04: Approaching Coaldale (MP243)
- RF-W05: Vallie Bridge (on CR-45) (MP239)
- RF-W06: Howard Creek Road (CR-4)
- RF-W07: West of Howard (MP233)
- RF-W08: Wellsville (MP228-226)
- RF-W09: Salida East Recreation Site (MP224)
- RF-W10: Salida Area – Northwest

BIGHORN SHEEP CANYON: *Beginning at the PCC-Fremont Campus, follow US-50 West.*

US-50 climbs Eight Mile Hill past where the Royal Gorge access road branches off to the south, then drops down to Parkdale where it crosses the Arkansas River. Bighorn Sheep Canyon is the name given to the Arkansas River Canyon between Salida and the Royal Gorge Canyon. Named for the Colorado State Mammal, the Rocky Mountain Bighorn Sheep, you may see a group grazing beside the road. The presence of these stunning animals was noted by Zebulon Pike in his 1806 journal. As you descend the hill, you can see evidence of the extreme deformation here, as the layers change from nearly vertical to horizontal.

RF-W01: Parkdale Recreation Site near mile 267 (\$) *This is one of many facilities operated by the Arkansas River Headwaters Recreation Area (AHRA), a Colorado State Park managed in cooperation with BLM and the Forest Service. Day Passes may be purchased here; Annual Passes are available from Colorado Parks & Wildlife. The park stretches from Leadville to Pueblo Lake and includes restrooms, river access, interpretive signs, picnic areas and campgrounds at several sites along the road. www.cpw.state.co.us/placestogo/parks/ArkansasHeadwatersRecreationArea*

Once again, we see Mesozoic rocks here; the Mesozoic Morrison, Dakota, Graneros, Greenhorn, Carlisle and Niobrara Formation rocks. These were trapped by the violent Front Range uplift and now lie on top of the basement rock. This patch is significantly faulted and folded with wedges of the formations tilting at weird angles, even vertical and overturned. South of the highway you can see a hogback that was abruptly cut off by a perpendicular fault line. This hogback is bounded on the west by the Ilse Fault and on the east by an unnamed fault.

To the east and south, we have the continuation of the Front Range uplift in the ridges seen in the distance (the Wet Mountains to the south). The large quarry you see is currently operated by **Martin Marietta Materials** and produces aggregate, gravel and granite for shipment by railroad. The area has historically produced silica for glass making and fire clay for bricks, etc.

As you continue west, the canyon is walled by Precambrian rocks

more than a billion years old. These are mixed granites and metamorphic (gneiss and schist) basement rocks of the Precambrian period uplifted from deep in the earth's crust by the Front Range uplift event. As you travel west, notice the veins of lighter colored intruded granitic material, surrounded by the darker, banded gneiss and schist, and the occasional black gabbro intrusives. These rocks have probably been uplifted around 10,000 feet, almost 2 miles, from their previous depth.

RF-W02: At mile 255 you can see some of the oldest rock exposed in Bighorn Sheep Canyon, thought to be 1.8 billion years old, the **Texas Creek Meta-sediment deposits**. There is an unsigned pull-off and river access past mile 255 on the north side of the highway at the west end of the curve on the highway. The formation can be seen to the north and west on the bend across the river at the pull-off with much younger granitic crust sitting above it to the north. There is a good outcrop of the meta-sediment in the pull-off area off the highway on the south side of the river, readily accessible from a vehicle. In this outcrop, the meta-sediment even has **porphyroblasts** (a large mineral crystal in metamorphic rock that has grown in a finer groundmass) of garnet.

At Texas Creek, CO-69 turns off to the left and goes up the Wet Mountain Valley. The old railroad grade you see here was once a branch of the D&RG that served mines in the Rosita/Querida area at Westcliffe.

RF-W03: The less-steep walled area to the right between mile 249 and 248 displays a fine example of the primary way in which granitic rocks erode – **spheroidal erosion** with some spalling erosion as well. There are no better examples of these rounded remnants along this entire stretch of highway.

At Cotopaxi, CR-1A turns off to the left and connects with CO-69. CR-12 takes off to the south, becoming a dirt road through a mountainous area, eventually connecting with east-west running CR-2 that provides access to Salida to the west (make local inquiry at the Cotopaxi store before attempting this route). The Cotopaxi Mine was an important part of the rich history of the community and western Fremont County and is described in another guide.

www.fremontheritage.com/western-fremont-county/. Early day prospector Henry Thomas (Gold Tom) discovered the mine in the late 1870s. It was later developed by Emanuel Saltiel and others. This **Precambrian Skarn** deposit, like many such sulfide deposits in Colorado, was enticing because of its gold, copper and zinc ore. The low amount of precious metal obtained, however, meant that it never became a consistent producer despite efforts by several owners.



Just after mile 243 at the intersection with CR-39, the Arkansas River and highway take an abrupt bend and enter straight into the hard granitic and metamorphic west wall of the Front Range uplift, turning from southeasterly to northeasterly. The river west of this point was cutting through softer sedimentary rock all the way from just west of Wellsville, but now cuts through much harder rock. This presents a real geologic conundrum – why did the river not just continue southeasterly into the Wet Mountain Valley using a sedimentary rock course? There is no answer at this point and the question is being studied.

At Coaldale, the rocks change. At mile 242 you can see sedimentary rocks being quarried across the broad valley. South of Coaldale, on the east slopes of the Sangre de Cristo Mountains, we can see the rotated crustal blocks east of the Rio Grande Rift valley (San Luis Valley). These blocks form the east horst (uplifted block) of the rift. Limestone and gypsum cliffs can be seen – the limestone being the Leadville Formation of the Upper Mississippian Period.

Hayden Creek Road (CR-6) turns off to the left at about mile 241. LafargeHolcim operates a Gypsum quarry here to support the cement plant at Portland, near Florence. This historic quarry operated from 1907 to 1990 and was reactivated in 2006. Kit Carson's nephew, Dudley, was killed by falling rock when he worked here in 1916 and is buried in the Coaldale Cemetery at the turnoff

to the quarry. Farther up Hayden Creek Road was Barnes City, the site of an unsuccessful mining effort (or successful scam) by the Montezuma Gold Mining & Milling Corporation in the early 1900s. The site, designated a historical landmark by the Heritage Commission, is on private property and no buildings remain.

RF-W05: At Vallie Bridge after mile 240, we find a mixture of limestone (both Mississippian and Pennsylvanian, about 300 million years old), conglomerates and shale. If you pull off US-50 and cross the bridge, you can see these layers tilted to almost vertical. Also, these beds are tilted toward the east, rather than to the west as most of the sedimentary rocks we will see along the highway. All of these sediments were bent up severely to the east by the collision of the abrupt uplift of the Front Range just to the east at the Pleasant Valley Fault, which the river follows here. It is thought that the uplift along this thrust (reverse) fault caught and bent the east end of the horst up at the very noticeable high angle.



At mile 238 you enter the Redbeds, red sandstone and mudstone deposits, up to 20,000 feet thick. The Redbeds correspond to the Fountain Formation seen closer to Cañon City, both created when the ancestral Rockies were being eroded. The Cañon City formation was closer to the ancestral Rockies, so it is a coarse conglomerate compared to the finer grained rocks found here. The extreme thickness of these Redbeds has never been adequately explained. The layers above the Redbeds have been eroded away, but more recent activity from three separate volcanic complexes has taken place. The visible results are extensive, complex and not easily explained. An important distinction to keep in mind is that the Sangre de Cristo range is uplifted – not volcanic.

At Kerr Gulch, CR-101A turns off to the southwest (left) and enters BLM managed land. The old Kerr Quarry (private, no access) is here. This quarry produced rhyolite building stone for the First Church of Christ (Scientist) and the Kerr residence in Denver. Carpenter Ridge Tuff age 27.4 MYA and Fish Canyon Tuff at 27.8 MYA are visible here.



RF-W06: Howard Creek Road (CR-4) turns off to the left. Colorado Fuel & Iron (CF&I) operated a limestone quarry here to provide flux, called the “Howard Special,” for their Pueblo steel mill. The company town of Calcite was located there, served by a D&RG rail spur, and active from 1903 to 1929. Today only a few foundations remain. Western Fremont Historical Society has further information on Calcite www.westfremonthistory.com/. They also operate a History Center in the Old Howard Church.

RF-W07: Between west Howard and Rincon Campground, after mile 233, you drive through a volcanic ash flow, with the flow mostly visible on the north wall of the canyon. From the west Howard vantage point, you can look east and view the ash flow on the south side of the canyon, making a significant hill just to the south of the highway. At mile 231 you are back in the Redbeds.

RF-W08: A great variety of layers are visible in the Wellsville area, mile 226. To the east behind the community of Wellsville and to the north and west, Ordovician to Devonian to Mississippian sedimentary rock layers are visible on the top of the Precambrian Basement igneous rocks. You can see the white/gray (Leadville Limestone) Mississippian layer, brown, white, yellow-to-pink (Dyer Dolomite and Parting Quartzite) Devonian layers, and gray/brown (Manitou, Fremont Limestones along reddish Harding Sandstone) Ordovician layers. The limestones and shales of these ages verify that Colorado was under water for many millions of years before

the uplift which caused the ancestral Rockies.

To the east and southeast behind Wellsville on the canyon wall, notice the severe faulting and folding of the layers of sedimentary rock. This indicates severe movements of the crust and pressures on the rock after sedimentation, causing the rock layers to warp, crack, fold and tilt at weird angles. The Wellsville thrust fault (a low-angle reverse fault) has thrust Ordovician Fremont Limestone over the Devonian Parting Sandstone layers to the east.

North of Wellsville is the largest deposit of Travertine in Colorado that produced stone for use in the Denver City & County Building, buildings in Washington, D.C. and other locations. Blocks as large as 100 tons have been shipped. While the dimension stone quarry is no longer operating, a nearby limestone/gypsum quarry produces agricultural amendments for the U. S. Soil Conditioning Company plant here. It is visible on the hills near the plant.



Entering Chaffee County.

RF-W09: Salida East Recreation Site, mile 224. To the immediate east of Salida, a small lava flow covers the basement Precambrian rocks and is visible across the river.

RF-W10: To the Northwest of Salida, you see a large opening up of the Rio Grande Rift valley (**graben** or down-dropped block fault). This valley was caused by significant spreading of the earth’s crust, and the rift runs primarily north/south from at least the very southern Wyoming border, north of Steamboat Springs and North Park, well into Mexico to the south. Unlike the rift grabens to the north of Granite and south of Poncha Pass, the bottom of the graben here is severely sloped down from east to west. A graben

sloped like this is called a half-graben and it is caused here by the series of north/south running faults parallel to the rift on its east side from Salida to the Buffalo Peaks area. The depth of fill on top of this slanted bottom goes from approximately 3,000 feet on the Salida side to 15,000 feet on the Poncha Springs side and these depths are consistent to where the rift pinches together north of Buena Vista. The Rio Grande Rift valley south of Poncha Pass (the San Luis Valley) contains up to 15,000 feet of fill.

North of Salida, the Arkansas River follows the Rio Grande Rift from its headwaters at 12,525-feet south of Fremont Pass, northeast of Leadville. It is the rifting that created the path for the river (the river did not create this valley!). Along the east margin of the rift and localized mostly to that margin, there is much evidence of volcanic activity north to the Buena Vista area. Area volcanic activity includes Tenderfoot Hill (the hill with the "S" on it), as well as Big Baldy Mountain and Waugh Mountain to the northeast. To the Northwest, much of the Precambrian basement rock that you see exposed is beautiful tan granitic rock. This is how Browns Canyon got its name.

Side Trip to Cameron Mountain

Cameron Mountain, northeast of Salida, is home to many old quarries of **Salida Blue**, a stunning Cretaceous granite quarried locally and found throughout the United States as headstones in cemeteries. This is a Late Tertiary intrusion of Whitehorn Granodiorite, age dated at 70 MYA, which provided the resource for a hefty local industry in the 1920s. Unusually fine grained, deep blue, and hard, this granite takes a fine polish. It is also very recent geologically; it was still forming during the **Laramide Orogeny** (the uplift of the current Rocky Mountains) and the formation of the Rio Grande Rift.

In the 1890s the towns of Whitehorn and Turret sprang-up in response to the prospects of gold in this area. Professor Arthur Lakes described the area in 1904, but gold production was scant, and the school district closed in 1909 with the post office closed in 1918. CF&I operated an Iron Mine here from 1882 – 1900. This is mix of public and private land and permission must be obtained to enter the private property. More information is available in the Cemeteries

of Fremont County Heritage Guide www.fremontheritage.com/wp-content/uploads/2017/04/cemetariesonline.pdf.

Getting There: From Salida, head northwest on CO-291. At the Hospital turn right (north) on Ute Trail (Chaffee County Road 175 which becomes Fremont County Road 2) in about 16 miles. Local inquiry is suggested. If you followed the road north of Cotopaxi to Salida, you have already been here.

As you return to Cañon City from Salida, consider following CR-1A and CO-69 south from Cotopaxi (turn right, by the store). This will take you through the Wet Mountain Valley past Westcliffe and Silver Cliff and through a piece of the Pike-San Isabel National Forest on CO-96. You will pass the historic Hardscrabble area and Wetmore, then head toward Florence on CO-67.

Optional Side Trips

Florissant Fossil Beds National Monument, Thirty-Nine Mile Volcanic Field, Guffy Gorge, Cripple Creek, Victor

To reach these locations from Cañon City head west from town past the turnoff to the Royal Gorge, turn right (north) on CO-9 then bear right in about 8.5 miles onto High Park Road (Teller County Road 11). Turn left on Teller County Road 1 for Florissant Fossil Beds or right for the Cripple Creek/Victor area.

Suggested Hiking Trails

The Island in the Sky trail at Oil Well Flats has great views and great examples of Dakota Sandstone.

Redemption and Hard Time trails in the South Canyon trails show lots of interesting geology, including another example of the great unconformity and dinosaur tracks in the slot canyon (a trail not shown on the map, just past the slot, makes a loop hike possible). In Ecology Park you can go through the water gap in the hogback for another great view of the Dakota.

Trails in the Royal Gorge area provide great views, especially the difficult hike to the top of Fremont Peak.

Mentioned earlier in the guide, Tunnel Drive and the Hogbacks area provide excellent hikes with lots of geology.

ADDITIONAL RESOURCES

U. S. Bureau of Land Management (BLM), Royal Gorge Field Office, **U. S. Forest Service (USFS)** San Carlos Ranger District, San Isabel National Forest, Joint Office; 3028 E. Main Street, Cañon City, Colorado 81212; (719) 269-8500. Office Hours Monday – Friday 8 a.m. – 4:30 p.m.; Maps and informational brochures available, information on local conditions.

www.blm.gov/visit/garden-park-fossil-area

www.handsontheland.org/garden-park/

Royal Gorge Regional Museum & History Center, 612 Royal Gorge Blvd., Cañon City, CO 81212; (719) 269-9036; Hours, Wed – Sat, 10 a.m. – 4 p.m.; Fossils, historic objects, area research and photographs. www.rgmhc.org/

Cañon City Chamber of Commerce, 403 Royal Gorge Blvd., Cañon City, CO 81212; (719) 275-2331 or 1-800-876-7922; Area information and brochures. Visitor Center. www.canoncity.com/

Florence Pioneer Museum and Research Center, 100 Pikes Peak Avenue, Florence, CO 81226; (719) 784-1904; Hours, Tues – Fri 1 p.m. – 4 p.m.; Saturday 10 a.m. – 3 p.m.; Large display map of Coal Mines and Oil Wells, historic objects, area research. www.florencepioneermuseum.org/

Florence Historical Archive, 600 West Third Street, a resource for researching the history of Florence and vicinity. For further information, contact (719) 372-1648 or www.facebook.com/Florence-Historical-Archive-432771616926733

Florence, Colorado Chamber of Commerce, 116 N. Pikes Peak Avenue, Florence, CO 81226; (719) 784-3544. Area information and brochures. www.finditinflorence.com/

Western Fremont Historical Society (WFHS), Mailing Address: P.O. Box 181, Howard, CO 81233; History Center Address: 0070 CR-56, Howard, CO 81233; Hours: The History Center is open during Society programs and by appointment. During the months of April through October, the center is open the last Sunday of each month (1:00-4 p.m.); <http://westfremonthistory.com/>

Fremont Adventure Recreation (FAR), is a group of outdoor recreation enthusiasts that publishes an annual *Recreation & Trail Guide to the Royal Gorge Region, Colorado*. The guide includes

detailed maps and information on area hiking, biking, rock climbing, fishing, boating, fossil discovery and geology. Printed copies of the guide are available from FAR sponsors or the group's website for \$5.00 or can be downloaded free. The website has further information on the region www.joinfar.org/.

Fremont County Heritage. Several organizations jointly sponsor a website with heritage related information. Groups include the Fremont County Historical Society, Heritage Commission, Friends of the Museum, Stones 'n Bones and Crossroads Through Time Heritage Park. www.fremontheritage.com/. For the Geology Time Trail go to www.fremontheritage.com/crossroads-through-time/.

Royal Gorge Region Official Visitor Website: Comprehensive site for area visitor information www.royalgorgeregion.com/

Western Interior Paleontological Society (WIPS), is an organization dedicated to scientific, educational, and charitable activities related to paleontology, the study of fossils. Monthly meetings are held in Denver at the Denver Museum of Nature & Science, field trips, volunteer activities and a biennial symposium.

www.westernpaleo.org

Cañon City Geology Club (CCGC), is an educational club dedicated to increasing and promoting the Earth Sciences pertaining to minerals, gems, rocks, artifacts and fossils. Monthly meetings are held along with field trips and classes.

www.canoncitygeologyclub.com

Arkansas Headwater Recreation Area (AHRA), is a Colorado State Park resulting from cooperative efforts by BLM, the U.S. Forest Service and others. AHRA's Salida Visitor Center Is Open five days A Week, Monday Through Friday, 8 Am-5 Pm. Closed Saturday And Sunday. Located at 307 West Sackett Avenue, Salida, CO 81201. Phone 719-539-7289. www.cpw.state.co.us/placestogo/parks/ArkansasHeadwatersRecreationArea

GLOSSARY OF GEOLOGIC TERMS

Alluvial: a fan-shaped deposit of unconsolidated sediment deposited by a stream when the slope of the fall of the stream suddenly begins to flatten.

Andesite: Volcanic extrusive igneous rock having a makeup between that of granitic (felsic) and basaltic ferromagnesian (mafic) rocks.

Basalt: an extrusive igneous rock made up of fine crystals containing abundant dark, dense ferromagnesian minerals and low in silica, the volcanic equivalent of gabbro.

Batholith: a large mass of intrusive igneous rock that formed when magma was emplaced at depth in the crust, crystallized, and was subsequently exposed.

Biotite (Mica): a form of the potassium aluminum silicate mica group with the addition of iron and magnesium to its chemical composition, making it blackish in color.

Block fault: a fracture in rock where a section of rock has dropped, usually because of the spreading of the earth's crust. The block is called a graben, and will have faults on both sides.

Breccia: a rock composed of angular (not smoothed) fragments included in a matrix. Formed as rocks grind together during faulting or by violent volcanic events.

Cañon City Embayment: originally formed by the Western Interior Seaway and now located between two Laramide uplifts, the Front Range and the Wet Mountains. These structures are spectacularly displayed within the area.

Concretion: A rounded structure in a sedimentary rock caused by a change in the local chemistry, creating a different degree of hardness of the material. Concretions sometimes form around fossils.

Conglomerate: a sedimentary rock consisting of two types: rounded, gravel-sized inclusions called just conglomerate or angular inclusions called **breccia**.

Cross-bedding: sedimentary rock in which layers are inclined at an angle to the main bedding.

Differential Erosion: different types of rock erodes at different rates. Harder rock erodes more slowly than softer rock. Hard rock generally erodes into cliffs (vertical faces), while softer rock erodes into slopes. The relatively faster rate of erosion that occurs in softer sedimentary rock layers that lay beneath harder, overlying layers, effectively removes the foundation of layers above it; causing fractured layers to fall.

Dike: a tabular-shaped intrusive igneous feature that cuts more vertically through surrounding rock.

Extrusive Igneous Rock: igneous rock from magma that cooled very quickly as it rose from the earth to the Earth's surface or into water (also called **Volcanic Rock**).

Fault: a crack or break in the Earth's crust along which movement is taking place or has taken place in the past.

Foliation: a linear arrangement of textural features of metamorphic rock (gneiss) giving the rock a layered appearance.

Gabbro: the intrusive equivalent of basalt, very dark green to black in color and composed primarily of the heavy-metal (iron, magnesium, manganese and calcium) dense minerals hornblende, olivine, pyroxene and calcium feldspar.

Gneiss: metamorphic rock where dark and light silicate materials have separated into distinct bands that may have even been twisted (**Folded Gneiss**) by high degrees of pressure and temperature.

Graben: a valley formed by the downward displacement of a fault-bounded block of earth's crust (see **Rift**).

Granite: igneous rock composed mostly of the light-metal (aluminum, potassium, sodium, and silicon) and low density silicate mineral crystals of the minerals quartz, feldspars (usually more orthoclase than plagioclase), mica, and hornblende.

Granitic (Granite Family): granite-like igneous rock composed of light-metal silicate minerals (quartz, feldspars, and micas) and, generally, more (by percentage) heavy-metal denser silicate minerals (from iron, magnesium, manganese, and calcium) than in granite.

Gypsum: a very common sulfate salt mineral of calcium, developing primarily in sedimentary rocks of chemical (evaporate) origin.

Hornblende: a heavy metal igneous iron/magnesium silicate mineral of the amphibole family that is a building block in the formation of igneous rocks.

Horst: an elongated uplifted block of earth's crust bounded by faults (see **Rift**).

Igneous rock: rock formed by the crystallization of molten magma, either within the Earth's crust or at the surface.

Inclusion: a piece of one rock unit contained within another.

Intrusions: magma that has forced its way into cracks, faults, and fissures in previously solidified crustal rock, often found as dikes and sills.

Intrusive Igneous Rock: igneous rock from magma that cooled, crystallized, and solidified below the surface of the earth.

Laccolith: a massive igneous body, more lense-shaped, intruded between preexisting strata.

Lava: magma that reaches Earth's surface.

Lenticular: lense-shaped

Limestone Rock: a sedimentary rock primarily composed of the mineral calcite (calcium carbonate) formed by either inorganic means or biochemical processes (primarily exoskeletal remains).

Lithification (lithified): the process generally by cementation or compaction of converting sediments to solid rock.

Mafic: derived from magnesium, and ferrous and ferric for iron, rocks containing a high percentage of **ferromagnesian** and other heavy metal silicate minerals.

Magma: a body of molten rock found at depth in the earth (usually from the mantle), including any dissolved gases, rock, and crystals.

Metamorphism: changes in the composition and texture of solidified rock due to high temperature (yet below the melting point of the minerals contained in the rock) and/or pressure after initial solidification or previous metamorphism.

Mineral: a naturally occurring inorganic crystalline material with a unique chemical structure (chemical equation).

Muscovite: the basic potassium aluminum silicate mica group, usually white or colorless to an aluminum-looking color when thick.

Orthoclase (a Feldspar Group): potassium aluminum silicates sometimes with considerable sodium.

Pegmatite: a very course-grained igneous rock (typically granite) commonly found as a dike associated with a large mass of plutonic rock that has smaller crystals. Crystallization in a hydrothermal-rich environment is believed to be responsible for the very large crystals.

Phyllite: a type of dense, hard, crystallization metamorphic rock resulting from the continued medium-grade regional metamorphism on slate under compressive stress producing a wavy to crinkly foliation with visible mica flakes in parallel planes and a pronounced silky sheen.

Plagioclase (a Feldspar Group): a series of mixtures of sodium and calcium aluminum silicates.

Plate Tectonics: a theory that proposes the Earth's outer layer (the Lithosphere) is composed of individual large plates of crust that move about on the mantle layer below and interact in various ways with one another.

Porphyritic Texture: an igneous rock texture characterized by two distinctively different crystal sizes: the larger crystals called **phenocrysts** and the matrix of smaller crystals termed the **groundmass**.

Precambrian or Proterozoic/Archean/Hadean Basement Rocks: all rocks formed before the Paleozoic period when sediments were laid down with the first explosion of fossils of life forms.

Quartz: the rock consisting purely of the mineral silicon dioxide, one of the family of **silicate** minerals.

Quartzite: a very hard metamorphic or sedimentary rock formed from quartz sandstone.

Pumice: a volcanic rock that forms when large amounts of gas escape through lava to generate a frothy mass.

Redbeds: refers to a combination of layers of rock in earth's strata that commonly take on a red appearance as a group.

Rift: a portion of the Earth's crust where spreading (or separation) is occurring or has occurred and where, in continental crust, elongated blocks of the crust (called **horsts**) parallel to and on both sides of the rift rotate and uplift while the area between the uplifts (called a **graben**) forms a valley by downward displacement along the uplifting fault-bounded crustal blocks. Continental rifts are thought to be often caused by remote plate tectonic activity below the crust.

Sandstone: sedimentary rocks in which sand-sized grains predominate. See **Sedimentary Rock**.

Schist: a type of metamorphic rock that is course grained with a planar arrangement of platy materials like mica, where the crystals grow many times larger than usual and the quartz and feldspar crystals deform to flat or lens-shaped grains.

Sediment: unconsolidated particles created by the weathering and erosion of rock, by chemical precipitation from solution in water, or from the secretion of organisms, and transported by water, wind, or glaciers.

Sedimentary Rock: rock formed from the mechanical and chemical weathered products of preexisting rocks that have been transported, deposited, and lithified.

Shale: sedimentary rocks in which silt- and clay-sized particles predominate. See **Sedimentary Rock**.

Siltstones - Mudstone: clay minerals derived from the decomposition of feldspars with silt-size (microscopic) grains of quartz and flakes of mica. **Shale** is compacted, harder, and thinly laminated while **mudstone** is less compacted,

breaks apart more easily and erodes more deeply.

Silica: the mineral quartz, one of the family of **silicate** minerals.

Silicate: any of the numerous minerals having the silicon-oxygen tetrahedron as their basic structure (a structure composed of four oxygen atoms surrounding a silicon atom, the basic building block of silicate minerals).

Sill: a tabular igneous body intruded more horizontally or parallel to the layering of existing rock.

Skarn: coarse-grained metamorphic rocks composed of calcium-iron-magnesium-manganese-aluminum silicate minerals (commonly referred to as “calcsilicate” minerals) that form by replacement of carbonate-bearing rocks (in most cases) during contact or regional metamorphism and metasomatism. The majority of the world’s major skarn deposits are thought to be related to hydrothermal systems.

Slate: a type of dense, hard, microscopic crystalline metamorphic rock of weak luster resulting from a low-grade regional metamorphism of mudstone or shale producing a foliation by alignment of mica flakes in parallel planes along which the rock splits readily into thin sheets.

Spheroidal Erosion: a weathering process that tends to produce a spherical shape for an initially blocky shape, especially evident in the erosion of granitic rocks.

Stromatolites: the first fossils ever, they are mounds formed in shallow marine waters by matted layers of dirt and cyanobacteria (often called blue-green algae, but not really algae at all). The bacteria extract carbon dioxide from the water and, through photosynthesis, produce oxygen. Without the oxygen-generating stromatolite, life as we know it wouldn’t exist.

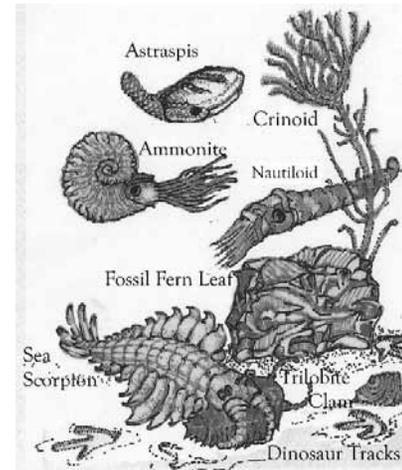
Syenite: a granitic rock, like granite but with little quartz, a high concentration of plagioclase feldspar for the feldspar component mostly as late magmatic replacement of potassium feldspar, and may contain some leucite, nepheline, and sodalite (similar to the feldspars but containing less silica).

Tectonics: large-scale geologic processes that deform the Earth’s crust (like Plate Tectonics) through crustal movements.

Travertine: formed of calcium carbonate from the evaporation of water that has percolated through Limestone.

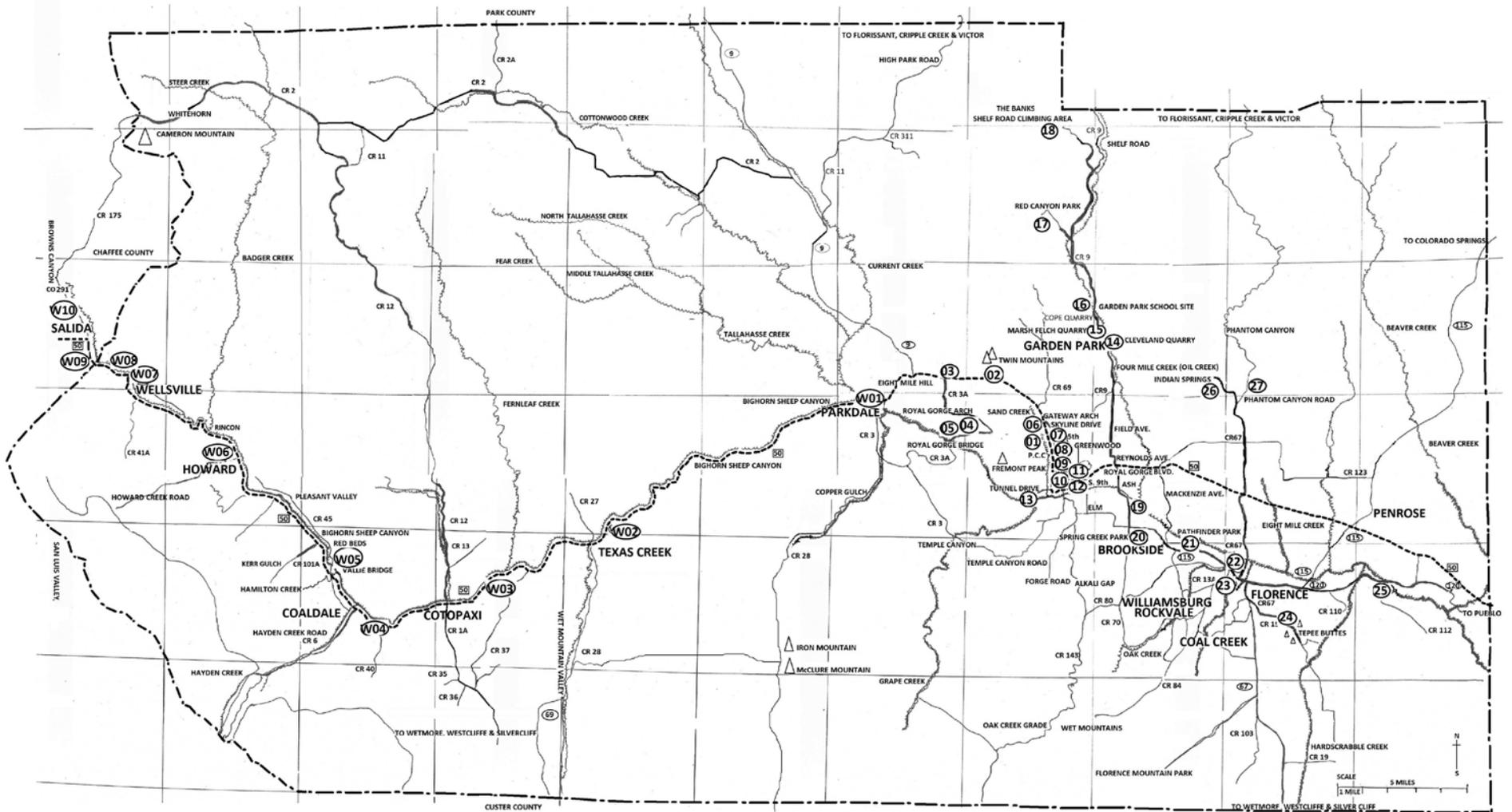
Volcanic Rock: rock that forms from magma that extrudes from the earth’s crust and cools quickly (see **Extrusive Igneous Rock**), resulting in primarily an aphanitic crystal texture.

Weathering: the disintegration and decomposition of rock at or near the surface of the Earth. See **Mechanical Weathering** and **Chemical Weathering**.

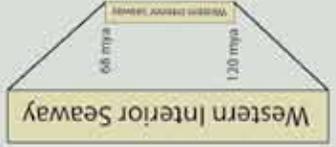
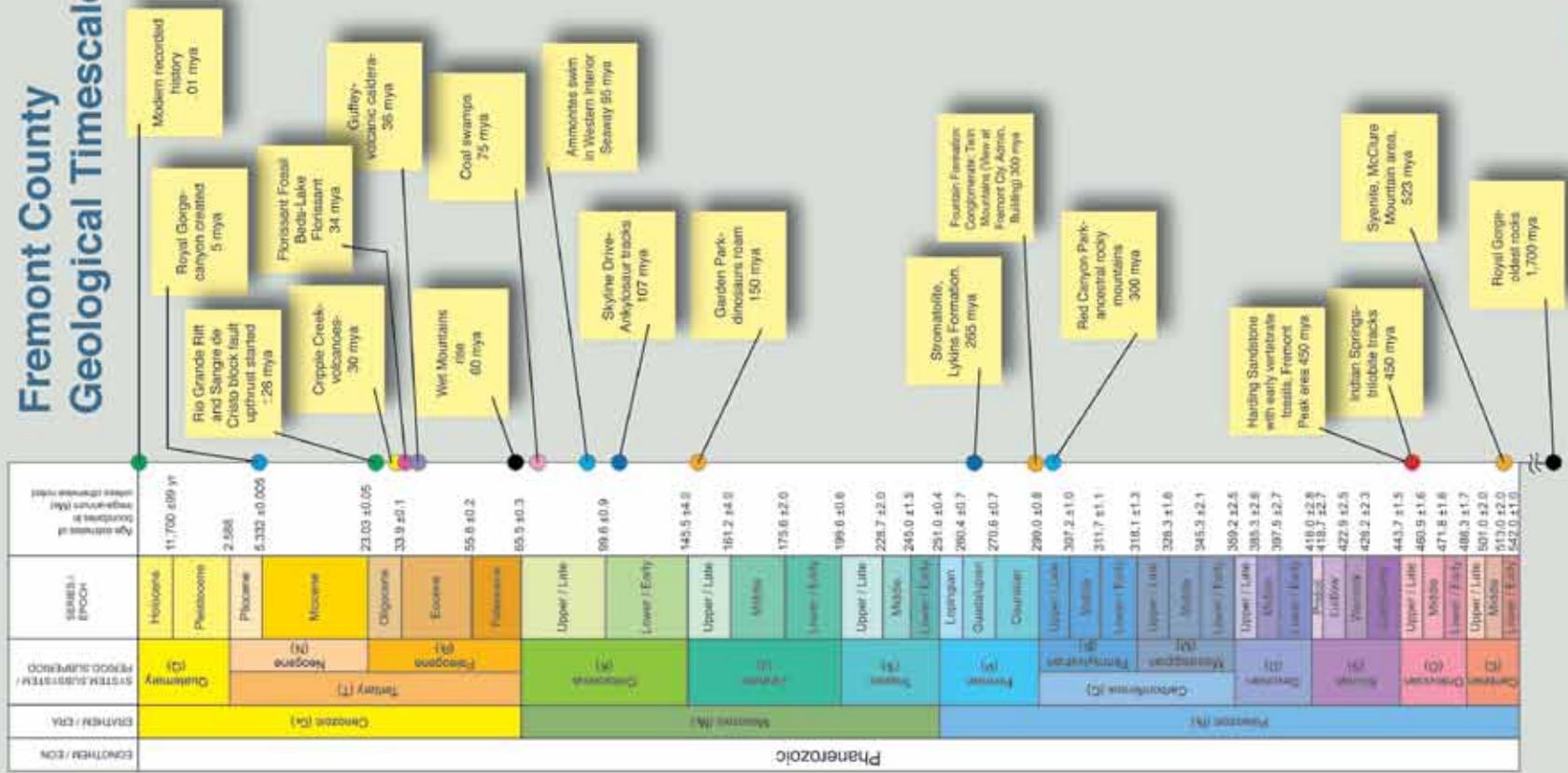


This is one of eight Guides available at Museums, visitor locations and online at: www.fremontheritage.com/self-guided-heritage-tours-2
Skyline Drive
Downtown Cañon City
Downtown Florence
Western Fremont County
Historic Howard
Cemeteries of Fremont County
Coal Camps of Fremont County

Rocks & Fossils of Fremont County



Fremont County Geological Timescale



Some of these dates are based on dates in the world. There are different ways of dating rocks and geology is always advancing through research and new techniques. Dating is provided to the best of our knowledge. Some dates are based on the best available data.



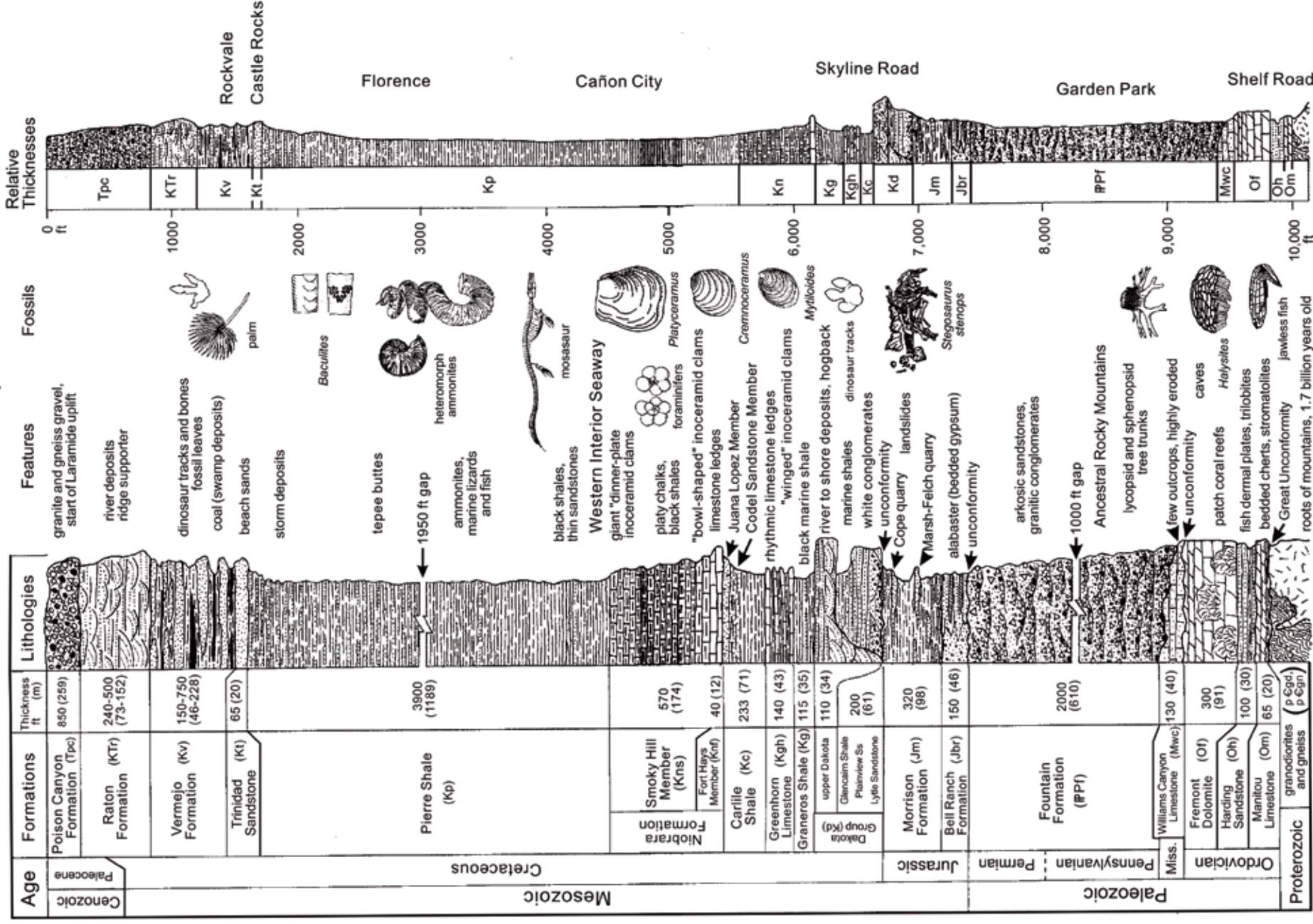
www.westernpaleo.org



www.fremontheritage.com



Rocks of the Cañon City Basin



Geologic Time Scale, Formations and Major Happenings in/around Fremont County, CO

ERA	mya	Period	Epoch	Formation	(Natural Resource/Other)	Major Geologic Events
C E N O Z O I C	2.6	Quarternary	Holocene Pleistocene	Recent Alluvium	(Sand and Gravel)	Continued down-cutting and a period of mountain glaciation. Many sand and gravel deposits formed in county.
				Pinedale and Bull Lake Glaciation		
				Verdos and Rocky Flat Alluvium		
				Nussabaum Alluvium	(Sand and Gravel)	
				Dry Union Formation		
				Sante Fe Formation		
				Waugh Mountain Andesite		
				Gribbles Park Tuff		
				Thirtynine Mile Andesite	(Cripple Creek Gold)	
				Talahassee Creek Conglomerate	(Uranium)	
Wall Mountain Tuff						
Echo Park Alluvium	(Uranium)	Laramide Orogeny at beginning of Period (65 mya) produced much of the present day Rocky Mts. Thick sediments deposited between grabens. Eocene erosional surface formed followed by major volcanism. Neogen Orogeny at end of Period uplifts Sangre de Cristos, continued volcanism. Regional uplift late in period starts down-cutting of Royal Gorge and removal of older sediments - present day geography shaped.				
*Poison Canyon and Raton Formation						
*Vermejo Fm	(Coal and Fossils)					
*Trinidad SS	(Coal and Fossils)					
*Pierre Shale	(Oil/Gas and Fossils)					
Whitehorn Granodiorite						
*Niobrara Formation	("Portland Type" limestone)					
*Carlile Shale						
*Greenhorn LS and Graneros Shale						
*Dakota Sandstone	(Skyline Drive/Dinosaur tracks)					
*Morrison Formation	(Major Dinosaur discoveries)					
*Ralston Creek Formation	(Gypsum)	Swampy lowlands of dinosaurs turn to beach deposits, followed by deepening of sea. Last Great Inland Sea to cover Colorado deposits limestone and shale. Uplift returns and seas disappear at end of Period with new deltas and swamps forming extensive coal deposits. End of period marks the K-T boundary and disappearance of the dinosaurs.				
*Lykins Formation	(Stromatolites)					
**Sangre de Cristo Formation	(Coaldale Gypsum)					
**Mintrun Formation						
**Belden Formation						
*Fountain Formation	(Red Canyon Park)					
*Williams Canyon LS						
**Leadville LS						
**Dyer Dolomite						
**Parting Formation - Chaffee County						
		Uplift and erosion - no sediments deposited				
		Fremont Limestone	(Shelf Road Rock Climbing)	Sea deepens and covers most of Colorado, deposition of sandstones and limestones.		
		Harding Sandstone	(Old fish scale fossils)			
		Manitou LS/Dolomite	(Quarried, decorative rock)			
		Syenite Intrusions				
		Sawatch Sandstone	(Eroded from Fremont County)			
			Lippilian Interval			
			400 my of quiet tectonics and extensive erosion. Development of flat surface for Paleozoic sediments.			
			Pikes Peak Granite, Silver Plum Intrusions Boulder Creek Intrusives, Idaho Springs Metamorphic Complex (Micas, Feldspars, Pegmatite, Crushed Aggregate)			
				Minor intrusions and slow encroachment of sea - very little deposition		
P A L E O Z O I C	540	Cambrium				Sea deepens over most of Western US
P E R M I A N	299	Permian				Ancestral Rockies formed west of present mountains - thick sediments deposited in between mountain ranges
P E N N S Y L V A N I A N	323	Pennsylvanian				Sea deepens over most of Western US
M I S S I S S I P P I A N	354	Mississippian				Sea deepens over most of Western US
D E V O N I A N	418	Devonian				Sea deepens over most of Western US
S I L L U R I A N	444	Silurian				Sea deepens over most of Western US
O R D O V I C I A N	485	Ordovician				Sea deepens over most of Western US
C A M B R I U M	540	Cambrium				Sea deepens over most of Western US
P R O T E R O Z O I C	2500	Proterozoic "first life"				Sea deepens over most of Western US
A R C H E A N	4000	Archean "old life"				Sea deepens over most of Western US
H A D E A N	4600	Hadean "no life"				Sea deepens over most of Western US

*Major Formation of Cañon City Embayment - found only in Eastern Fremont County and part of Colorado Piedmont/Plains Province

**Major Formation found only in Western Fremont County - part of Southern Rocky Mountain Province

Courtesy of Steve Wolfe; adapted from Masters Thesis - UCCS, 1991 *The Natural History of Fremont County, Colorado*