Introduction

Striking beauty, abundant recreational opportunities, historic mining and pioneer locales, and a unique geologic story stretching back over one billion years make Salt Lake County’s Wasatch Front canyons a world-class attraction.

This guide highlights the six canyons open to vehicles. Topical pages present the region’s fascinating geologic history and active processes, while descriptions and maps with road mileage further explain each canyon’s geology.

Enjoy your tours.

William F. Case – Emigration, Parleys, and Mill Creek Canyons
Sandra N. Eldredge – Big Cottonwood Canyon
Mark R. Milligan – City Creek Canyon
Christine Wilkerson – Little Cottonwood Canyon

Driving conditions to be aware of include narrow roads combined with heavy bicycle traffic in City Creek, Emigration, and Mill Creek Canyons, and high-speed highway traffic in Parleys Canyon.

No dogs are allowed in Big Cottonwood, Little Cottonwood, and upper City Creek Canyons because the areas are culinary watersheds.

For other regulations regarding recreation:
- Contact the Salt Lake Ranger District of the Wasatch-Cache National Forest for Mill Creek, Big Cottonwood, and Little Cottonwood Canyons.
- Contact the Salt Lake City Department of Public Utilities for City Creek Canyon.
The central Wasatch Range displays over 1 billion years of Earth history during which oceans repeatedly came and went; mountains rose and wore down and rose again; sand dunes migrated across the lands; and rivers, glaciers, and lakes appeared and disappeared. Although there are some gaps in the rock record (called unconformities) resulting from erosion or no sediment deposition, the canyons in this part of the range display world-class exposures that, together with regional geologic information, provide an excellent outline of the area’s geologic past.

The oldest rocks in this guide are Precambrian-age metamorphic schist and gneiss of the Little Willo Formation at the mouth of Little Cottonwood Canyon. These rocks were metamorphosed some 1.6 billion years ago by intense pressure and heat deep in the Earth’s crust.

Approximately 850 million years ago (mya), continental glaciers abutted the ocean shore, revealed by the Miner Fork Tills found in Big and Little Cottonwood Canyons.

The Cambrian sea retreated as the land rose and an unconformity skips our story ahead about 160 million years to the Devonian, Mississippian, Pennsylvanian, and Permian Periods when an ocean once again covered the area. Fluctuating sea level and sediment input resulted in deposition of a variety of rock types, including limestone, sandstone, and shale (see Descriptions of Map Units for formation names).

No rocks are preserved in the area dating from about 120 million to 50 million years ago. During this time, a mountain-building event called the Sevier Orogeny changed the landscape. Regional-scale plate motions compressed the Earth’s crust in an east-west direction causing the canyons’ rock units to tilt, fold, and move along faults from their original horizontal positions to near their current variety of angles and contortions.

By the end of the Sevier Orogeny, during the Cretaceous Period, abundant sand was deposited on beaches and in the shallow water along the margins of an eastward-encroaching ocean, forming the Tithic Quartzite. As the sea moved farther eastward, this area was under deeper water where mud and silt collected—now preserved as the Ophir Shale.

During the Jurassic Period, sand dunes of the Nugget Sandstone document a sea of a different kind. Similar to the dune areas of the modern Sahara, this ancient sand sea extended through southern Utah where it is preserved as the Nugget’s equivalent—the famous Navajo Sandstone exposed in national parks such as Zion and Capitol Reef.

Beginning about 105 million years ago, Cretaceous rivers flowed northeastward and deposited sediments across a broad coastal plain. These sediments comprise the conglomerate, sandstone, and siltstone of the Kelvin Formation and, where lakes existed, limestone of the Parleys Member.

Next, molten rock spewed out of volcanoes (demonstrated by the volcanic breccia in City Creek Canyon) and some cooled and hardened beneath the surface (intrusive igneous rocks). Today, granitic intrusive rocks form some of the high peaks in Big Cottonwood Canyon and canyon walls of much of Little Cottonwood Canyon.

Crustal extension is still ongoing, from the Wasatch fault westward 400 miles to the Sierra Nevada, and is responsible for creating the Wasatch Range. About 17 million years ago, these mountains started rising along the eastern side of the fault while the adjacent Salt Lake Valley started dropping. This vertical movement along the fault created much of the local landscapes we now see. Lake Bonneville in the valleys and glaciers in the mountains further modified the landscape 30,000 to roughly 10,000 years ago during the Quaternary Period.

The geologic story continues in these mountains today as earthquakes cause them to rise, while landslides, debris flows, and streams erode them down.
Glaciers transport a chaotic mix of huge boulders, rocks, and fine sediment (called glacial till) that is deposited along the sides (lateral moraines) and at the ends (terminal moraines) of glaciers where melting occurs. Moraines are present in the three glaciated canyons.

Glacial erratics are the isolated rocks and boulders carried by glacial ice down from the higher reaches of the canyons. Erratics are often striking contrasts to the material they are resting on, and are evident at the mouth of Little Cottonwood Canyon and in parts of Big Cottonwood Canyon.

Glaciers were at their maximum about 24,000 to 18,000 years ago and dramatically reshaped the higher reaches of Big Cottonwood and Mill Creek Canyons, as well as the entire length of Little Cottonwood Canyon. The other canyons in this guide (City Creek, Emigration, and Parleys) were not glaciated due to their lower elevations and lesser snow accumulation.

Glaciers are moving masses of ice and snow that form when enough snow accumulates to compress the lower layers into ice. Gravity forces the thick, heavy ice to slowly flow downslope. These powerful erosion machines pluck, scrape, and grind rocks from the canyon walls and floors. At their heads, they carve out crescent-shaped rock basins bounded by high, steep walls (cirques). Where two glaciers in adjacent valleys erode both sides of the intervening divide, they form a knife-edged ridge (arête). These features are visible in Big and Little Cottonwood Canyons. The moving masses of ice and rock debris scour the valley bottom and walls, leaving striated, grooved, and polished rock in their wake.

The plowing glaciers deepen and widen the typical "V-shaped" stream valleys (see photo on Mill Creek Canyon map) into wide U-shaped valleys (see photo on Little Cottonwood Canyon map). The U-shape is visible throughout all of Little Cottonwood Canyon and the upper part of Big Cottonwood Canyon. Some tributary canyons end up "hanging" (hanging valleys) above the deeply scoured main canyon. Waterfalls now cascade over these hanging valleys on the south side of Little Cottonwood Canyon.

Lake Bonneville was a huge freshwater lake that existed from approximately 28,000 to 10,000 years ago and covered about 20,000 square miles of western Utah and smaller parts of eastern Nevada and southern Idaho. A shift to a wetter and colder climate triggered its expansion from the location of the present Great Salt Lake to surrounding valleys, reaching a depth of over 1,050 feet. While at its highest level, the lake eroded through a sediment dam at Red Rock Pass in Idaho and catastrophically dropped over 300 feet. Thereafter, a climatic shift to warmer and drier conditions (similar to present) caused Lake Bonneville to shrink, leaving Great Salt Lake as a saline remnant.

Lake Bonneville at its largest extent approximately 15,000 years ago. White areas show glaciers.

Lake Bonneville was a huge freshwater lake that existed from approximately 28,000 to 10,000 years ago and covered about 20,000 square miles of western Utah and smaller parts of eastern Nevada and southern Idaho. A shift to a wetter and colder climate triggered its expansion from the location of the present Great Salt Lake to surrounding valleys, reaching a depth of over 1,050 feet. While at its highest level, the lake eroded through a sediment dam at Red Rock Pass in Idaho and catastrophically dropped over 300 feet. Thereafter, a climatic shift to warmer and drier conditions (similar to present) caused Lake Bonneville to shrink, leaving Great Salt Lake as a saline remnant. The shorelines left by Lake Bonneville can be seen around Salt Lake Valley like rings around a bathtub. These shorelines are both erosional where wave action carved into rock and sediment, and depositional where sediments collected in beaches, spits, bars, and deltas.

Deltas were created where streams flowing down Wasatch Front canyons entered the standing water of Lake Bonneville and then dropped their sediment load. As the lake began to shrink and lake level dropped, streams cut across and through these deltas and redeposited their sediments farther basinward. However, remnants of these deltas can be seen at the mouths of Parleys, Big Cottonwood, and Little Cottonwood Canyons.

Lake Bonneville at its largest extent approximately 15,000 years ago. White areas show glaciers.

Glacial erratics at the mouth of Little Cottonwood Canyon, north side.
Landslides are the downslope movement of a mass of soil and rock, occurring when gravitational forces exceed the strength of materials in a slope. Thus, they are most likely to occur on or near steep slopes and in weak geologic materials. The addition of water in such areas can trigger landslides. All of the canyons in this booklet contain potential landslide conditions, and most show geologic evidence of prehistoric landslides. Historical landslides have occurred in City Creek, Emigration, Parleys, and Mill Creek Canyons (many are too small to show on the maps). At least one landslide in City Creek Canyon was active at the time (2004) of writing this guide.

Landslides can be triggered by:
- rising ground-water levels due to heavy rainfall, rapid snowmelt, consecutive wet years, agricultural or landscape irrigation, roof downspout flow, septic-tank effluent, canal or sewer-line leakage.
- earthquakes.
- grading or erosion that removes material from the base, loads the top, or otherwise alters a landslide or pre-existing slope.

A fault is a break in the Earth’s crust along which slippage or displacement has occurred. Abrupt movement along the fault causes earthquakes. Two types of faults are common in Utah: normal and thrust faults. Of these, many of the normal faults are younger (have moved more recently) and it is the youngest ones – called active faults – that are of most concern for generating future earthquakes.

A fault is a break in the Earth’s crust along which slippage or displacement has occurred. Abrupt movement along the fault causes earthquakes. Two types of faults are common in Utah: normal and thrust faults. Of these, many of the normal faults are younger (have moved more recently) and it is the youngest ones – called active faults – that are of most concern for generating future earthquakes.

Normal Fault
A normal fault results from extensional forces that pull the crust apart. The movement is predominantly vertical; one side moves upward relative to the other moving downward.

The best known normal fault in Utah is the Wasatch fault, which crosses or passes near the mouths of the Wasatch Front canyons. The Wasatch fault, along with many other normal faults in Utah, is capable of generating earthquakes as large as magnitude 7.5.

The Wasatch fault is 240 miles long; most of it traces along the western base of the Wasatch Range. For 17 million years this fault has been active, creating fault scarps when large (magnitude 6.5 and greater) earthquakes rupture the ground surface.

The Wasatch fault scarps are best seen at the mouth of Little Cottonwood Canyon (see photo on canyon description).

Thrust Fault
A thrust fault results from compressional forces that shorten and thicken the crust. The movement is predominantly horizontal; older rock units may be pushed many miles up and over younger rock units.

A local example is the Mt. Raymond thrust fault that trends through Big Cottonwood and Mill Creek Canyons. About 85 million years ago, layers of rocks from the northwest were pushed tens of miles along the thrust plane and now lie atop younger rock layers.

Landslides are the downslope movement of a mass of soil and rock, occurring when gravitational forces exceed the strength of materials in a slope. Thus, they are most likely to occur on or near steep slopes and in weak geologic materials. The addition of water in such areas can trigger landslides. All of the canyons in this booklet contain potential landslide conditions, and most show geologic evidence of prehistoric landslides. Historical landslides have occurred in City Creek, Emigration, Parleys, and Mill Creek Canyons (many are too small to show on the maps). At least one landslide in City Creek Canyon was active at the time (2004) of writing this guide.
Prospectors searching for riches have scrambled throughout the canyons and mountains along the Wasatch Front for over a hundred years. The richest mineralization is in Big and Little Cottonwood Canyons due to the heat of igneous intrusions that drove mineral-rich fluids and created ore deposits.

**Big and Little Cottonwood Canyons**

Although silver-lead ore was first discovered along the Wasatch Front in Little Cottonwood Canyon in 1864, major mining in the canyon did not begin until 1868 with the discovery of rich ore at the Emma mine, located north of Alta. Soon after, prospectors spread northward into Big Cottonwood Canyon. Mining in these two canyons produced mostly silver and lead with minor quantities of copper, zinc, and gold. Both areas prospered in the late 1800s and early 1900s, and mining continued in the canyons until the 1960s.

Alta, the largest mining town in Little Cottonwood Canyon, flourished in the 1870s and had thousands of inhabitants, twenty-six saloons, seven restaurants, two drug stores, and even a Chinese laundry. The former town of Argenta, located midway up Big Cottonwood Canyon, was that canyon’s major mining town and had up to 200 inhabitants.

**Mouth of Little Cottonwood Canyon (Little Willow area)**

Claims were staked north of the mouth of Little Cottonwood Canyon (Little Willow area) as early as 1870 and farmers were rumored to have found gold nuggets in streams, but not until the 1890s did this area experience increased activity by prospectors. Minor gold deposits were discovered, but no major ore bodies were ever found, even though thousands of feet of tunnels and shafts were dug. Minor sporadic gold production continued until 1946.

**Mill Creek Canyon**

Although recorded as being part of the Big Cottonwood mining area, a few prospects and mines were located on the Mill Creek Canyon side of the ridge line between the two canyons. These small prospects yielded some lead and silver, and one report indicated some gold and copper.

**City Creek Canyon**

Most of the mining activity in City Creek Canyon took place between 1870 and 1880 in the upper part of the canyon, and extended over the ridge into Davis County. Small quantities of lead and iron were produced with minor amounts of silver, gold, copper, and zinc.

Stone from canyons along the Wasatch Front has been used for construction since the onset of pioneer settlement in 1847, probably beginning with cobbles gathered from City Creek Canyon to build stone walls.

**Emigration Canyon**

During the mid-1800s through the early 1900s, numerous buildings in Salt Lake City were constructed using Nugget Sandstone from several quarries located within the Wasatch Range. In upper Emigration Canyon, blocks of both white- and red-colored Nugget Sandstone were quarried at the Brigham Fork Quarry. Wagons hauled the stone out initially, until the electric Emigration Canyon Railroad was built in 1907. A decade later concrete had become the desired foundation material and the railroad was dismantled.

**Parleys Canyon**

Excavation of the Twin Creek Limestone from the rock quarries located along the north side of Interstate 15 in Parleys Canyon began in the late
**Little Cottonwood Canyon**

The Temple Quarry, located at the mouth of Little Cottonwood Canyon, was established in 1881 to excavate quartz monzonite, a granite-like rock, to build the Salt Lake LDS Temple. Working in pairs, skilled workmen equipped with a sledgehammer and a hand-held drill bit cut the stone from enormous boulders at the canyon’s base. At first hauled to the city by ox teams, the blocks later traveled by rail cars after completion of a railroad track to the quarry in 1873. Several other buildings in Salt Lake City were also built of this stone, including Utah’s Capitol and Salt Lake City’s Saltair. Deer Valley and Park City’s ski resort were also built of Little Cottonwood Canyon granite.

The stone for this new construction was quarried from loose boulders farther up the canyon.

*Church of Jesus Christ of Latter-Day Saints*

---

### IGNEOUS ROCKS

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Granodiorite</td>
<td>Intrusive, contains medium to large mineral crystals of quartz, feldspar, and biotite.</td>
</tr>
<tr>
<td>Diorite (intrusive)</td>
<td>Contains red, dark-colored dikes and sills in Big Cottonwood Canyon.</td>
</tr>
<tr>
<td>Volcanic Breccia</td>
<td>Contains angular particles of volcanic (extrusive, andesitic) rock up to 16 inches in diameter in a fine-grained matrix.</td>
</tr>
</tbody>
</table>

### SEDIMENTARY ROCKS

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conglomerate</td>
<td>Contains rounded, pebble-to-larger size rock fragments.</td>
</tr>
<tr>
<td>Limestone</td>
<td>Is composed mostly of calcium carbonate.</td>
</tr>
</tbody>
</table>

### METAMORPHIC ROCKS

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quartzite</td>
<td>Metamorphosed quartz-rich sandstone.</td>
</tr>
</tbody>
</table>

---

**Rocks Discussed in this Guide**

- **Quartz Monzonite**: Intrusive, granitic rock that solidifies on (extrusive) or within (intrusive) the Earth’s crust.
- **Conglomerate**: Contains rounded, pebble-to-larger size rock fragments. Red, white, and brown conglomerate is found in Emigration & Parleys Canyons.
- **Dolomite**: Similar to limestone except that it has less calcium and more magnesium. Gray and white dolomite is found in Little Cottonwood Canyon.
- **Siltstone**: Fine-grained rock that solidifies on (extrusive) or within (intrusive) the Earth’s crust.

---

**Portland Cement Company quarry excavation site in Parleys Canyon, 1912. Photo courtesy of Utah Historical Society.**
City Creek Canyon is the northernmost canyon in Salt Lake County and the closest to downtown Salt Lake City. Due to this proximity, City Creek heavily influenced the development of Utah’s capitol city. City Creek provided water for drinking, crop irrigation, and power to run grist, saw, turning, cording, and woolen mills. To this day, City Creek supplies water to Salt Lake City. However, with the water come geologic hazards such as floods, debris flows, and landslides. In 1983 for example, the creek flooded its banks in Memory Grove Park and thousands of volunteers slung sandbags along State Street to channel the racing water.

Three roads are located in City Creek Canyon. Bonneville Boulevard is a one-way road that wraps around the lower canyon from 11th Avenue on the east to 500 North on the west. Canyon Road parallels the lowermost reaches of City Creek and is closed to motor vehicles. City Creek Canyon Road follows the creek upstream of the intersection with Bonneville Boulevard.

In the lower part of the canyon are three debris catchment basins designed to prevent debris flows from reaching downtown. Upstream at mile 3.0 on City Creek Canyon Road, a good example of a prehistoric debris-flow deposit can be seen.

Along Bonneville Boulevard you can see at least two active landslides (miles 0.5 and 0.6), outcrops of both fine- and coarse-grained Lake Bonneville sediments (miles 0.4 and 1.0, respectively), and the remains of an ancient debris flow of volcanic (andesitic) rock and mud (mile 0.9). This volcanic rock came from a volcano that violently erupted some 35 to 39 million years ago, probably in the vicinity of either Little Cottonwood Canyon, Park City (about 25 miles southeast), or Bingham Canyon (about 25 miles southwest). Upstream of Bonneville Boulevard at mile 1.2 on City Creek Canyon Road, the canyon topography changes from relatively narrow and steep to broad and more rolling. This change reflects a transition of the bedrock from conglomerate that can stand as steep slopes, to weathered volcanic rock (similar to that seen at mile 0.9 on Bonneville Boulevard) that is unstable on steep slopes and has formed a large landslide. This prehistoric landslide appears to have crossed the creek and may have temporarily dammed it. Landslide dams are unstable and can fail catastrophically, releasing a flood of water.

A second major change in the canyon is found at mile 4.5 where the road crosses the presumably inactive Rudy’s Flat fault, transitioning from the near-horizontally bedded, less than 40-million-year-old conglomerate to near-vertical, 300- to 400-million-year-old limestone beds that form large fins. This limestone was originally deposited in horizontal layers in an ancient ocean and later tilted to near vertical during the Sevier mountain-building event.
carved their way through Emigration Canyon on their way to California. To clear the canyon’s trees and brush for the wagon passage required so much work that by the time the party reached the narrow, highly thicket-ed gorge at the canyon mouth they were so frustrated that, in desperation, they pulled the wagons over a ridge to bypass the gorge. The Donner Hill monument (mile 0.7) commemorates this effort.

In 1847, Mormon pioneers followed the Donner Party trail but cleared a way through the thicket instead of going over Donner Hill. Trail markers show the “Pioneer Trail” from Little Dell Reservoir, across Little Mountain Summit and into Emigration Canyon.

Wagons were unable to pass through Parleys Canyon until 1850 when Parley Pratt cleared the last three miles through a deep, winding gorge with a rough bottom. Stagecoaches began to use the canyon in 1858 and the Pony Express in 1860, but the services were dropped by 1869 when the Transcontinental Railroad was completed.

This Is The Place Heritage Park is situated on the north side of Sunnyside Avenue near the mouth of Emigration Canyon to commemorate pioneer emigration. It is a fitting start to the Emigration and Parleys (named after Mormon pioneer Parley Pratt) Canyons geologic road log. The route climbs up Emigration Canyon Road to Little Mountain Summit, descends to SR-65 and I-80, and ends at the mouth of Parleys Canyon.

The roads pass through sedimentary rocks of Triassic, Jurassic, and Cretaceous ages. Much of the route is in the Jurassic Twin Creek Limestone, which includes oolitic, sandy, silty, fossiliferous, massive, and/or shaley (some intensely shattered) limestone. The formation also consists of small amounts of red siltstone and shale. The red shale at mile 0.9 may be a remnant of an ancient soil or erosion surface.

The next unit encountered in Emigration Canyon is the Jurassic Preuss Sandstone, which consists of chocolate-brown sandstone and fine-grained brown and white conglomerate. In places near Little Mountain Summit, the river-deposited sandstone shows cross-beds and drag-marks made by driftwood or other objects.

The white limestone portion of the Cretaceous Kelvin Formation, which was probably deposited in shallow lakes near a source of sand and fine-grained gravel, locally contains scattered black pebbles.

The Triassic Ankareh Formation can be seen at the mouth of Parleys Canyon where the red and white rock layers are steeply tilted on the southeast flank of the Parleys Canyon syncline. The red rocks on the north side of the canyon mouth contain mud cracks and small ripple marks, which were created by shallow water that gently lapped back and forth across a mud flat that occasionally dried up. The large ripple marks on the white quartz conglomerate indicate energetic currents in stream channels.

The rocks of Emigration and Parleys Canyons are folded into northeast-trending troughs (Emigration and Parleys Canyons synclines) on either side of a folded ridge (Spring Canyon anticline). The rocks were gently to intensely folded and faulted during the Sevier Orogeny 120 to 50 million years ago in this area.

**Pioneer history**

Emigration and Parleys Canyons have provided access to the Salt Lake Valley since pioneer times in the mid 1800s. In 1846, the Donner Party carved their way through Emigration Canyon on their way to California. To clear the canyon’s trees and brush for the wagon passage required so much work that by the time the party reached the narrow, highly thicket-ed gorge at the canyon mouth they were so frustrated that, in desperation, they pulled the wagons over a ridge to bypass the gorge. The Donner Hill monument (mile 0.7) commemorates this effort.

In 1847, Mormon pioneers followed the Donner Party trail but cleared a way through the thicket instead of going over Donner Hill. Trail markers show the “Pioneer Trail” from Little Dell Reservoir, across Little Mountain Summit and into Emigration Canyon.

Wagons were unable to pass through Parleys Canyon until 1850 when Parley Pratt cleared the last three miles through a deep, winding gorge with a rough bottom. Stagecoaches began to use the canyon in 1858 and the Pony Express in 1860, but the services were dropped by 1869 when the Transcontinental Railroad was completed.
Mill Creek Canyon contains Mississippian- to Triassic-age marine and shoreline marine rocks and Jurassic-age sand-dune rocks. The following descriptions begin with the oldest rocks.

The oldest rocks in Mill Creek Canyon are visible from the road only by looking through the trees toward the south ridge skyline. These rocks are part of the Mississippian- and Pennsylvanian-age formations including Deseret and Round Valley Limestones and Humbug and Doughnut Formations, and are combined into one unit on the map.

The Pennsylvanian Weber Quartzite, originally a sandy marine beach, is common in the canyon particularly at its western end and mouth. Locally, the brown quartzite was dramatically folded and crushed by thrust faulting during the Sevier Orogeny about 85 million years ago.

The Permian Park City Formation is a dark gray limestone that contains fossil shells (brachiopods) in Rattlesnake Gulch at mile 0.7. The best exposure of the Park City Formation is in a road cut at mile 4.8, near the White Bridge Picnic Area.

The Triassic Woodside Shale is a reddish siltstone and fine-grained sandstone deposited in layers up to several inches thick. The Woodside Shale is exposed in road cuts partly covered by vegetation near mile 6.8 and the Clover Springs Picnic Area.

The Triassic Thaynes Formation contains abundant marine fossils such as corals, shells, and other marine animal parts on trails north of Camp Tracy scout camp. The most visible feature of this gray limestone is a massive limestone ridge that juts above vegetation on the north side of the canyon. The massive limestone meets the road at mile 5.5 where the road makes a sharp turn to the southeast.

The Triassic Ankareh Formation and Jurassic Nugget Sandstone are the youngest bedrock units in this canyon. They are seen near the northernmost ridge skyline of the canyon, and red Nugget Sandstone boulders are in debris-flow gravel near mile 4.8.

During the recent Ice Age, glaciers carved some of the upper Mill Creek tributaries and deposited moraines, such as the one seen at mile 7.1. Glaciers did not flow down the main canyon, thus, the canyon maintains the characteristic "V-shape" caused by stream erosion (see photo on map).
This tour begins 1 billion years ago when the area was a tidal environment at an ocean shoreline. The tidal environment is preserved in the now-tilted layers of quartzite and shale that make up the canyon walls for the first 6 miles. In some areas, the shale is metamorphosed into argillite or slate. Traveling farther up the canyon, you progress through times when different ancient seas covered the area; the sediments left on the ocean shore and floors are now the 600- to 100-million-year-old sandstone (and quartzite), shale, and limestone. Fingers of magma intruded up through these rocks about 70 million years ago, and can be seen between miles 7.3 and 8.3 where the red- to dark-colored intrusions contrast with the white limestone and marble. These intrusions are called dikes when they cut perpendicular through the limestone/marble layers or sills when they parallel the bedding.

The head of the canyon reveals 35-million-year-old igneous activity where a large body of magma intruded into the surrounding rock and, while beneath the Earth’s surface, then cooled and hardened into a gray granitic rock called granodiorite. Millions of years later, after the overlying softer sedimentary rocks eroded, the granodiorite was exposed and now makes up the peaks surrounding Brighton.

About 30,000 to 8,000 years ago, Brighton was buried under hundreds of feet of glacial ice. The main glacier flowed down the canyon 5 miles where it abruptly ended at Reynolds Flat (mile 9.0). At this point you can see an obvious difference in topography: a narrow, twisting canyon below Reynolds Flat and an open, straight canyon above. This illustrates a classic example of a river-carved “V-shaped” canyon (below Reynolds Flat) and a glacier-carved “U-shaped” canyon.

Tidal Rhythmites
One-billion-year-old records of the rhythm of ancient ocean tides

One of the best documented and oldest known records worldwide of tidal rhythmites is in Big Cottonwood Canyon. Discovered in the 1990s, this record is enthusiastically being researched, in large part to provide clues to ancient lunar cycles. Yearly, monthly, and even daily and semi-daily tides are recorded in the black shale of the 850-million to 1-billion-year-old Big Cottonwood Formation. Within the shale are thin, alternating layers of light-colored sand and dark-colored silt and clay. The sand was carried by peak (strong, dominant) flows and the silt and clay by slack (weaker, subordinate) waters at changing tides. Thus, these thin individual bands record daily tides and can be counted much like we count tree rings.

Because the gravitational pull of the moon and the sun cause tides, the length of an ancient day and lunar month can be determined from these tidal rhythmites. Long ago, the moon took less time to orbit the Earth, the Earth was spinning faster, and thus the days were shorter and there were more of them in a year. These records in stone indicate that one billion years ago, a day on Earth lasted only 18 hours, there were 13-plus months in a year, and about 481 days in a year!

(Information supplied by Marjorie A. Chan, University of Utah and Allen W. Archer, Kansas State University.)
This road tour begins at a Salt Lake County geologic view park, located just north of the intersection of Wasatch Boulevard and Little Cottonwood Road. From here you can view evidence of prospectors seeking riches, glaciers creeping down the canyon, and earthquakes rupturing the ground.

North of the canyon mouth are mine dumps located in the oldest rocks (> 1.6 billion years) in the canyon: the schist and gneiss of the Little Willow Formation. Prospectors mined minor gold deposits within this formation.

A massive glacier carved the canyon into its classic U-shape over thousands of years beginning about 30,000 years ago. This 12-mile-long glacier, the longest and largest in the Wasatch Range, stretched from Albion Basin down to Lake Bonneville’s shores. The boulder-strewn ridge on the south of the canyon mouth is the left-lateral moraine; the right-lateral moraine is pushed up against the hillside on the north. As you drive up the canyon, additional glacial evidence can be seen: hanging valleys between miles 4.6 and 6.3 on the south side of the canyon, and moraine remnants.

Repeated large earthquakes in the past tens of thousands of years created the long, steep slope cutting across the canyon mouth. In this area, the Wasatch fault contains some of the largest geologically recent fault scarps in Utah.

The darker rocks at the mouth of the canyon, together with the darker (shale) and lighter brown (quartzite) rock layers along most of the northern ridge line up to Snowbird, were deposited as clay and sand in a marine tidal environment 1 billion to 850 million years ago. Unconformably abutting these oceanic deposits (near mile 8.6) is a dark-colored rock unit called glacial till that contains a hodgepodge of boulders, cobbles, and pebbles abandoned by continental glaciers around 850 million years ago. The light-colored quartz monzonite (granite) that forms the majority of the canyon walls intruded as magma and hardened underground about 31 to 30 million years ago.

The buff-colored quartzite, brown shale, and black and white limestone seen in the upper third of the canyon record the advances and retreats of multiple, long-lasting oceans present between 540 and 330 million years ago. Originally layered horizontally from oldest to youngest, these rock layers have been disarrayed by folding, tilting, and faulting.

Located at the head and along the eastern ridge line of the canyon is another intrusive igneous rock. This magma body intruded about 35 to 33 million years ago and hardened into a granite-like rock called granodiorite. Both intrusives in this canyon aided in creating the rich mineralization found in Little Cottonwood mines. Numerous mine dumps dot the mountainsides surrounding Alta, evoking images of the once-lively mining district.
**Geologic Map Symbols**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alluvium</td>
<td>Includes gravel, sand, silt, and clay deposited at the base of steep slopes.</td>
</tr>
<tr>
<td>Talus</td>
<td>Arch-like rock debris deposited at the base of slopes.</td>
</tr>
<tr>
<td>Conglomerate</td>
<td>Rounded pebbles and cobbles, often in a sandy matrix.</td>
</tr>
<tr>
<td>Limestone</td>
<td>Pale to dark gray, may weather to brown. Some beds may be fossiliferous.</td>
</tr>
<tr>
<td>Dolomite</td>
<td>Pale to dark gray. Includes Gardison Limestone, Deseret Limestone, Humbug Formation, and Doughnut Formation.</td>
</tr>
<tr>
<td>Quartz Monzonite</td>
<td>Intrusive igneous rock, light gray (30-31 million years old).</td>
</tr>
<tr>
<td>Granodiorite</td>
<td>Intrusive igneous rock, light to dark gray (33-36 million years old). Includes Alta and Clayton stocks.</td>
</tr>
<tr>
<td>Conglomerate</td>
<td>Rounded pebbles and cobbles of gray limestone, tan quartzite, and sandstone.</td>
</tr>
<tr>
<td>Volcanic Breccia</td>
<td>Rock (andesite) surrounded by an andesitic matrix. Clasts are up to 16 inches across.</td>
</tr>
<tr>
<td>Ophir Shale</td>
<td>Gray to nearly black. Includes Marlind Limestone.</td>
</tr>
<tr>
<td>Mutual Formation</td>
<td>Gray shale and quartzite. Includes Mineral Fork Tillite.</td>
</tr>
<tr>
<td>Big Cottonwood Formation</td>
<td>Light gray sandstone and conglomerate. Includes Brake Rock and Black Rock Quartzite.</td>
</tr>
<tr>
<td>Mutual Formation</td>
<td>Light gray sandstone and conglomerate. Includes Brake Rock and Black Rock Quartzite.</td>
</tr>
</tbody>
</table>

**Additional Information**

- Alluvium and Talus: Includes gravel, sand, silt, and clay deposited at the base of steep slopes.
- Conglomerate: Rounded pebbles and cobbles, often in a sandy matrix. Locally includes wind-blown silt and sand.
- Volcanic Breccia: Rock (andesite) surrounded by an andesitic matrix. Clasts are up to 16 inches across. Probably deposited as a mudflow of volcanic material some 35 to 39 million years ago.
- Ophir Shale: Gray to nearly black. Includes Marlind Limestone.
- Big Cottonwood Formation: Light gray sandstone and conglomerate. Includes Brake Rock and Black Rock Quartzite.
Layered sand and gravel deposited in high-energy shallow waters of Lake Bonneville. Contrast this to the quiet-water fine-grained sediments seen across the canyon and the clay-rich chaotic debris-flow deposits found in the canyon bottom (mile 3.0).

Layered silt and sand deposited approximately 15,000 years ago in quiet waters of Lake Bonneville.

Angular clasts of andesitic volcanic rock in a fine-grained matrix. Deposited as a debris flow approximately 26 to 39 million years ago, well before the formation of City Creek Canyon. (Seen in road cut, but too limited to map.)

One of three debris basins in the lower reaches of City Creek Canyon. These basins are designed to reduce flooding threats to downtown Salt Lake City by catching debris and mud flows.

This house lies just above an active landslide’s uppermost boundary, or main scarp (light-colored cliff face).

These prehistoric landslide deposits are significant in that they may have temporarily dammed the creek. Landslide dams are unstable and can fail catastrophically, releasing impounded water as destructive floods. Although this area could potentially pose a threat downstream to downtown Salt Lake City, no historical movement has been observed on these landslides.

Concrete barrier buttressing the toe of a small landslide.

Looking up canyon, once-horizontal rock layers are tilted to near vertical and now form resistant fins on the mountainside.

Down-canyon view shows horizontal layers of a conglomerate that is less than 40 million years old. The sand, pebbles, and cobbles eroded from this conglomerate have been re-deposited down canyon in stream channel alluvium (not mapped), alluvial fans (Qal), and the shallow waters of ancient Lake Bonneville (Qlb).

Layered sand and gravel deposited in high-energy shallow waters of Lake Bonneville. Contrast this to the quiet-water fine-grained sediments seen across the canyon and the clay-rich chaotic debris-flow deposits found in the canyon bottom (mile 3.0).

Layered sand and gravel deposited in high-energy shallow waters of Lake Bonneville. Contrast this to the quiet-water fine-grained sediments seen across the canyon and the clay-rich chaotic debris-flow deposits found in the canyon bottom (mile 3.0).

Layered sand and gravel deposited in high-energy shallow waters of Lake Bonneville. Contrast this to the quiet-water fine-grained sediments seen across the canyon and the clay-rich chaotic debris-flow deposits found in the canyon bottom (mile 3.0).

Layered sand and gravel deposited in high-energy shallow waters of Lake Bonneville. Contrast this to the quiet-water fine-grained sediments seen across the canyon and the clay-rich chaotic debris-flow deposits found in the canyon bottom (mile 3.0).
Emigration and Lower Parleys Canyons

17 miles
(mileage begins at This Is The Place Heritage Park at the mouth of Emigration Canyon)

View eastward into Emigration Canyon showing shoreline deposits of Lake Bonneville at left foreground and under buildings.

View northward of a young alluvial fan deposit that flowed out of Badger Hollow.

View northward of chocolate-brown Jurassic Preuss Sandstone.

Panoramic view to the northeast of the Cretaceous Kelvin Formation red sandstone, and conglomerate and white limestone of the Parleys Member of the Kelvin Formation.

Northward view of highly folded Jurassic Twin Creek Limestone and Nugget Sandstone exposed in landscape-rock and crushed-stone quarries.

Westward view toward the mouth of Parleys Canyon showing the orange Jurassic Nugget Sandstone.

Eastward view of the tilted white and red layers of the Ankareh Formation on the southeast flank of Parleys Canyon syncline. Photo by Ari Menon.

Fossiliferous limestone, oolitic limestone, and red siltstone of the Jurassic Twin Creek Limestone on the north side of the road.

Map modified from: "Fabric of the Mount Aire quadrangle, Salt Lake County and Fabric of the Sugar House quadrangle, Salt Lake County" (Crittenden, M.D., 1965: USGS Map GQ-379 and GQ-380, 1:24,000); "Geologic map of the pre-Quaternary rocks of the Salt Lake City North quadrangle, Salt Lake County" (Van Horn, R., 1981: USGS Map I-1330, 1:24,000); and "Surficial geologic map of the Salt Lake City segment and parts of adjacent segments of the Wasatch fault zone, Davis, Salt Lake, and Utah Counties" (Personius, S.F., and Scott W. E., 1992: USGS Map I-2106, 1:50,000).

See p. 23 for description of map units.
Mouth of Mill Creek Canyon, a typical "V" shaped stream valley.

Pennsylvanian-age Weber Quartzite. View up canyon.

Permian-age Park City Formation limestone. View down canyon.

Massive limestone ridge of the Triassic-age Thaynes Formation. View down canyon.

Triassic-age Woodside Shale on the south side of the road.

Quaternary-age glacial moraine, deposited by a glacier from Alexander Basin, on the south side of the road.

Map modified from Geology of the Mount Aire quadrangle, Salt Lake County and Geology of the Sugar House quadrangle, Salt Lake County (Crittenden, M.D., 1965: USGS Map GQ-379 and GQ-380, 1:24,000); and Geology of the Park City West quadrangle, Salt Lake County (Crittenden, M.D., and others, 1966: Map GQ-535, 1:24,000). See p. 23 for description of map units.
Big Cottonwood Canyon

15 miles

(mileage begins at road junction with Wasatch Blvd)

Tilted layers of reddish-brown quartzite and black to purple green shale (pCbc), remnants of tidal environments, dominate the first 6 miles. Originally deposited as flat-lying sediments, these now steeply tilted rock layers provide good views of ripple marks and mud cracks. These now steeply tilted rock layers provide good views of ripple marks and mud cracks.

Ripple marks

5.7 water power

The Wasatch fault forms the steep 60-foot break in slope above Wasatch Boulevard.

Glacial outwash was carried by the creek into Lake Bonneville - forming a delta-like feature (escarpment marked on map). Delta on south side of creek is a very gently sloping terrace. View up Mill D South Fork shows glacial arête on the ridge line.

Boulders (1 to 3 foot diameter) in a silty matrix (glacial till). Transported by a glacier about 13,000 years ago. Large angular boulders make up part of the talus at Stairs Gulch.

Silver Springs and Argenta (mile 7) were two mining towns in the 1870s, complete with stores and hotels.

The Wasatch fault forms the steep 60-foot break in slope above Wasatch Boulevard.

Red to dark-colored dikes and sills contrast with the light-colored limestone and marble along the road between miles 7.3 and 8.3.

The immense volume of material that glaciers carried is evident as moraines (seen as hills or ridges) and the scattered white granite boulders transported from the canyon’s upper portions. Moraines are visible at Reynolds Flat (the largest one is in this photo and marked on map), and as a one-mile-long, 280-foot-high aspen-covered ridge along the northeast side of the road below Brighton (marked on map).

Transported by a glacier about 13,000 years ago. Large angular boulders make up part of the talus at Stairs Gulch.

Glacial outwash was carried by the creek into Lake Bonneville - forming a delta-like feature (escarpment marked on map). Delta on south side of creek is a very gently sloping terrace. View up Mill D South Fork shows glacial arête on the ridge line.

Boulders (1 to 3 foot diameter) in a silty matrix (glacial till). Transported by a glacier about 13,000 years ago. Large angular boulders make up part of the talus at Stairs Gulch.

Silver Springs and Argenta (mile 7) were two mining towns in the 1870s, complete with stores and hotels.

The Wasatch fault forms the steep 60-foot break in slope above Wasatch Boulevard.

Glacial outwash was carried by the creek into Lake Bonneville - forming a delta-like feature (escarpment marked on map). Delta on south side of creek is a very gently sloping terrace. View up Mill D South Fork shows glacial arête on the ridge line.

Boulders (1 to 3 foot diameter) in a silty matrix (glacial till). Transported by a glacier about 13,000 years ago. Large angular boulders make up part of the talus at Stairs Gulch.

Silver Springs and Argenta (mile 7) were two mining towns in the 1870s, complete with stores and hotels.

The Wasatch fault forms the steep 60-foot break in slope above Wasatch Boulevard.

Glacial outwash was carried by the creek into Lake Bonneville - forming a delta-like feature (escarpment marked on map). Delta on south side of creek is a very gently sloping terrace. View up Mill D South Fork shows glacial arête on the ridge line.

Boulders (1 to 3 foot diameter) in a silty matrix (glacial till). Transported by a glacier about 13,000 years ago. Large angular boulders make up part of the talus at Stairs Gulch.

Silver Springs and Argenta (mile 7) were two mining towns in the 1870s, complete with stores and hotels.

The Wasatch fault forms the steep 60-foot break in slope above Wasatch Boulevard.

Glacial outwash was carried by the creek into Lake Bonneville - forming a delta-like feature (escarpment marked on map). Delta on south side of creek is a very gently sloping terrace. View up Mill D South Fork shows glacial arête on the ridge line.

Boulders (1 to 3 foot diameter) in a silty matrix (glacial till). Transported by a glacier about 13,000 years ago. Large angular boulders make up part of the talus at Stairs Gulch.

Silver Springs and Argenta (mile 7) were two mining towns in the 1870s, complete with stores and hotels.

The Wasatch fault forms the steep 60-foot break in slope above Wasatch Boulevard.

Glacial outwash was carried by the creek into Lake Bonneville - forming a delta-like feature (escarpment marked on map). Delta on south side of creek is a very gently sloping terrace. View up Mill D South Fork shows glacial arête on the ridge line.

Boulders (1 to 3 foot diameter) in a silty matrix (glacial till). Transported by a glacier about 13,000 years ago. Large angular boulders make up part of the talus at Stairs Gulch.

Silver Springs and Argenta (mile 7) were two mining towns in the 1870s, complete with stores and hotels.

The Wasatch fault forms the steep 60-foot break in slope above Wasatch Boulevard.

Glacial outwash was carried by the creek into Lake Bonneville - forming a delta-like feature (escarpment marked on map). Delta on south side of creek is a very gently sloping terrace. View up Mill D South Fork shows glacial arête on the ridge line.

Boulders (1 to 3 foot diameter) in a silty matrix (glacial till). Transported by a glacier about 13,000 years ago. Large angular boulders make up part of the talus at Stairs Gulch.

Silver Springs and Argenta (mile 7) were two mining towns in the 1870s, complete with stores and hotels.

The Wasatch fault forms the steep 60-foot break in slope above Wasatch Boulevard.

Glacial outwash was carried by the creek into Lake Bonneville - forming a delta-like feature (escarpment marked on map). Delta on south side of creek is a very gently sloping terrace. View up Mill D South Fork shows glacial arête on the ridge line.

Boulders (1 to 3 foot diameter) in a silty matrix (glacial till). Transported by a glacier about 13,000 years ago. Large angular boulders make up part of the talus at Stairs Gulch.

Silver Springs and Argenta (mile 7) were two mining towns in the 1870s, complete with stores and hotels.

The Wasatch fault forms the steep 60-foot break in slope above Wasatch Boulevard.

Glacial outwash was carried by the creek into Lake Bonneville - forming a delta-like feature (escarpment marked on map). Delta on south side of creek is a very gently sloping terrace. View up Mill D South Fork shows glacial arête on the ridge line.

Boulders (1 to 3 foot diameter) in a silty matrix (glacial till). Transported by a glacier about 13,000 years ago. Large angular boulders make up part of the talus at Stairs Gulch.

Silver Springs and Argenta (mile 7) were two mining towns in the 1870s, complete with stores and hotels.
Glaciers plowed along the entire length of Little Cottonwood Canyon, carving out its distinctive U-shape. View down canyon.

Large, white granitic boulder (glacial erratic) sitting on darker rock high on hillside indicates a glacier thickness of at least 650 feet.