Montana Geology '05

Jefferson Canyon

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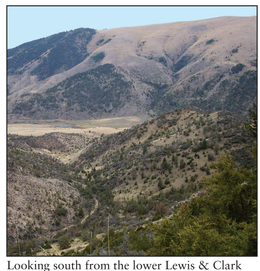
This year's Montana Geology calendar focuses on the geology, scenic beauty, and history of the Jefferson River canyon, situated in the northern Tobacco Root Mountains southeast of Cardwell. The narrow, steep-walled canyon is an abrupt change from the broad valley course of the Jefferson River from Twin Bridges to Cardwell. Rocks are well exposed in the canyon walls and record a geologic history that goes back at least a billion years. Human activity in the canyon has always been greatly influenced by its geology.

The photo above is taken at the western end of the canyon looking south across the river. The red section in the center shows an outcrop of the Amsden Formation, described on the back. Highway 2 and the current Burlington Northern tracks are visible on the near side of the river, and the abandoned Milwaukee Road grade across the river. Halfway up the mountain, running from right to left across the photo, is the Starrets Ditch. Photo by Pete Norbeck, MBMG.

Massive cliffs of Madison Limestone exposed in the Jefferson River canyon. The view is to the west (upstream). Photo by Dick Gibson.

The center ridge is an outcrop of the Quadrant Formation located west (to the right) of the Amsden Formation in the large photo. Notice the abandoned Milwaukee Road grade on the far side of the river. Photo by Dick Gibson.



Looking south from the lower Lewis & Clark Caverns trail, this photo shows the eastern end of Jefferson Canyon. The community of New London was located at the foot of the hills on the far right. Photo by Garrison Smith.

Location

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JEFFERSON CANYON GEOLOGY

THE ROCKS

A major ancient east–west-trending fault, called the Willow Creek Fault, parallels the canyon and has significantly controlled the geologic history of the area. Over a billion years ago the area north of the canyon dropped down deeply along the Willow Creek Fault and filled with a large body of water, which extended from southwestern Montana to southern Alberta and British Columbia. Huge blocks of rock as much as 100 feet long, made up of gneiss, quartzite, and marble, broke off the higher south side of the fault and were buried in muds adjacent to the fault. These rocks are part of the LaHood Formation, part of the Belt Supergroup of rocks, exposed along Montana Highway 2 at the west end of the canyon, near the community of La Hood Park.

Figure 1. Close-up view of the LaHood Formation. Photo by Dick Gibson.

Eventually the sea withdrew, and erosion erased all records of geologic history in the canyon during the interval from deposition of Belt rocks until about 530 million years ago (Cambrian Period of the Paleozoic Era). As the sea again encroached on this part of North America, layers of sandstone, shale, and limestone were laid down over a period of several hundred million years. By the Mississippian Period, around 340 million years ago, much of western North America was covered by a warm, shallow sea, similar to the Gulf Coast of Florida today. The massive cliffs that dominate the narrowest and steepest part of the Jefferson River Canyon are mostly outcrops of Madison Group limestone, which contains abundant small marine fossils.

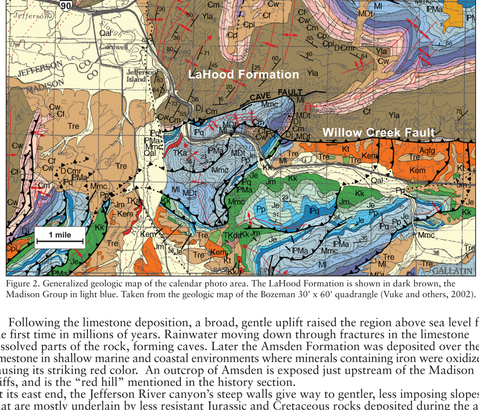

Figure 2. Generalized geologic map of the calendar photo area. The LaHood Formation is shown in dark brown, the Madison Group in light blue. Taken from the geologic map of the Bozeman 30' x 60' quadrangle (Vuke and others, 2002).

Following the limestone deposition, a broad, gentle uplift raised the region above sea level for the first time in millions of years. Rainwater moving down through fractures in the limestone dissolved parts of the rock, forming caves. Later the Amsden Formation was deposited over the limestone in shallow marine and coastal environments where minerals containing iron were oxidized, causing its striking red color. An outcrop of Amsden is exposed just upstream of the Madison cliffs, and is the "red hill" mentioned in the history section.

At its east end, the Jefferson River canyon's steep walls give way to gentler, less imposing slopes that are mostly underlain by less resistant Jurassic and Cretaceous rocks deposited during the age of the dinosaurs. These rocks are both marine and nonmarine, and some came from nearby volcanoes.

FOLDS AND FAULTS

Most rock layers in the Jefferson Canyon are tilted. Because they were originally deposited in horizontal layers, this tilting is evidence for a second major period of tectonic activity. Compressional forces from a collision between the North American and Pacific tectonic plates far to the west of Montana caused complex folding and faulting of the rock layers—in some places, rock layers were even turned upside down. During all this movement, the Willow Creek fault was reactivated as part of a collection of intertwined faults known as the Southwest Montana Transverse Zone. This zone marks a weak area in the earth's crust that will continue to be important as a mechanism for relieving tectonic stresses in the region.

About 5 to 10 million years ago, the Rocky Mountain region began to experience a new period of crustal stress that continues to this day. Rather than compressing, forces began to pull the earth apart across western North America. During this time blocks of earth dropped down to form large valleys, and mountains rose up. This created the topographic contrast between valleys and mountains that we see today, and caused the formation of river canyons. As the northern Tobacco Root Mountains rose, the Jefferson River cut into the rock, forming the Jefferson River canyon.

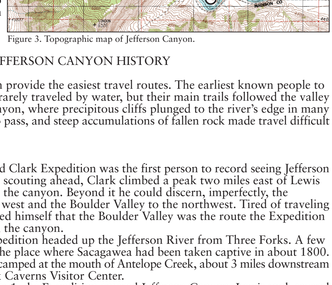

Figure 3. Topographic map of Jefferson Canyon.

JEFFERSON CANYON HISTORY

Rivers, and their valleys, often provide the easiest travel routes. The earliest known people to occupy the Jefferson River basin rarely traveled by water, but their main trails followed the valley bottoms—except in Jefferson Canyon, where precipitous cliffs plunged to the river's edge in many places, leaving little or no room to pass, and steep accumulations of fallen rock made travel difficult and hazardous.

LEWIS AND CLARK

William Clark of the Lewis and Clark Expedition was the first person to record seeing Jefferson Canyon. On July 26, 1805, while scouting ahead, Clark climbed a peak two miles east of Lewis and Clark Caverns, and glimpsed the canyon. Beyond it he could discern, imperfectly, the Cardwell–Whitehall valley to the west and the Boulder Valley to the northwest. Tired of traveling south, Clark erroneously convinced himself that the Boulder Valley was the route the Expedition should take after passing through the canyon.

On July 30th the reunited Expedition headed up the Jefferson River from Three Forks. A few miles from the forks they passed the place where Sacagawea had been taken captive in about 1800. Two evenings later the Expedition camped at the mouth of Antelope Creek, about 3 miles downstream from the current Lewis and Clark Caverns Visitor Center.

Early on the morning of August 1, the Expedition entered Jefferson Canyon. Lewis took several men to scout ahead and, upon Clark's recommendation, trudged north up the mountains to the peak which Clark had climbed on July 26. From Clark's directions Lewis expected to be able to continue northwest to intercept the river, but found that the river Clark hoped to take, the Boulder, was not the main stream. Instead Lewis had to continue west along the ridge crest. After traveling for miles in the heat, with no fresh water, he could see the valleys ahead distinctly, and see that Clark's choice had been wrong. Lewis had climbed the mountain needlessly and gone well out of his way. Lewis's journal entry suggests that he had some misgivings about Clark's heretofore unimpeachable geographical abilities.

Meanwhile, back in the canyon, Clark's party struggled upstream. Clark recorded: *the rocks ragged, some very dark and other parts light rock; the light rock is sand stone.* Lewis, who saw the canyon only from the lower end and from above on the ridge, wrote: *the lower part of this rock is of the black granite before mentioned*[1] *and the upper part is a light colored freestone*[2]*; the cliffs continue for 9 miles and approach the river very closely on either side.*

Food had been scarce for the past few days, and the men's exertions against the river had fatigued them. By midday Clark's hungry party neared the upper end of the canyon. Several bighorn sheep trod the cliffs above the river. .food on the hoof! In Sergeant John Ordway's words: *About noon Captain Clark killed a mountain sheep out of a flock on the side of a reddish hill on [the] larboard.*[3] *He shot it [from] across the river and the rest of the flock ran up the cliffs which were nearly steep.*[4] *The one killed rolled down some distance when it fell. We got it and dined hearty on it.*

The party then continued upstream, towing the canoes. A short distance upstream at a rapid below an island, the tow line of Clark's canoe broke and the canoe nearly capsized. After repairing the rope, the party went on upstream. About a mile farther they reached a large creek which Clark named Fraziers Creek for one of the party; it is now called South Boulder River. As the "reddish hill" on the west side of the river was just downstream from the rapids and island, we can pinpoint where Clark shot the bighorn. The rock that forms the reddish outcrop is part of the Amsden Formation, of Pennsylvanian age.

Three-quarters of a mile upstream from the mouth of South Boulder River, Clark's party emerged from Jefferson Canyon about where La Hood now stands.

[1]Described on July 31. The rock there, however, was not granite either, but limestone of the Madison Group.
[2]A rock that splits easily into layers.
[3]To your left as you face the front of a boat. The canoes were heading upstream nearly north; hence the hill was west or southwest of the river.
[4]Ordway commonly used the word "steep" in this construction to mean "vertical" or "perpendicular."

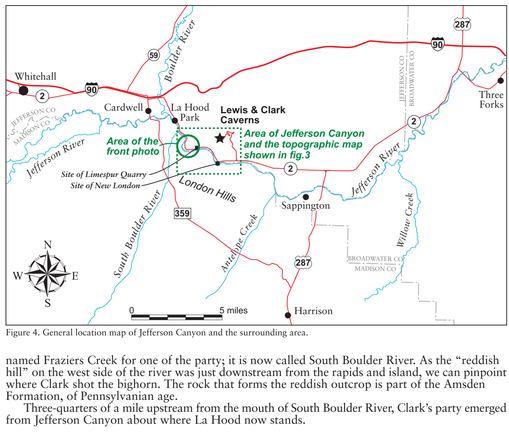

Figure 4. General location map of Jefferson Canyon and the surrounding area.

THE RAILROAD AND MINING

Except for occasional nomadic hunters, trappers, and, after 1862, a few gold seekers, Jefferson Canyon saw little traffic until 1881. In that year the Utah & Northern Railroad (Union Pacific), building a line from Dillon to Butte, began grading a roadbed through Jefferson Canyon for a possible line to Helena; plans altered and work stopped on the roadbed in 1882. In 1889, the Northern Pacific Railroad decided to build a spur from its main line east of Three Forks to Butte.

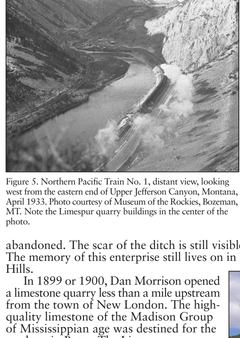

Figure 5. Northern Pacific Train No. 1, distant view, looking west from the eastern end of Upper Jefferson Canyon, Montana, April 1933. Photo courtesy of Museum of the Rockies, Bozeman, MT. Note the Limespur quarry buildings in the center of the photo.

A new source of coal had been found in Red Lodge, and the new NP route could bring that superior coal straight to the hungry smelters of Butte. After some dramatic right-of-way face-offs between NP and UP workmen in the canyon in March 1889, the two railroads reached a settlement. The UP was paid for its work, and the NP built its line to Butte, completing the route in 1890.

About this time, prospectors discovered placer gold in the deposits on the south side of the Jefferson River, about a mile and a half upstream from the current Lewis and Clark Caverns Visitor Center. The principal gold-bearing gravels were a hundred feet or more above the river. Instead of pumping water up from the river to wash the gravels, miners dug a ditch, called the Starrets Ditch, to supply the water. The ditch was about six miles long and took water from South Boulder River and tributaries along the west side of the mountain that forms the upper end of Jefferson Canyon. The water then went through a tunnel and entered the canyon more than 200 feet above the river. Miners excavated the ditch into the limestone where feasible, while carpenters built flumes to span the numerous ravines. The ditch snaked along the southern cliffs, descending gradually until it reached the workings near the community named New London, in honor of English investors. The workings and community faltered and went "ghost" by the early 1900s, and the ditch was abandoned. The scar of the ditch is still visible (see front photo), but the flumes have collapsed. The memory of this enterprise still lives on in the name of the mountains to the south: the London Hills.

In 1899 or 1900, Dan Morrison opened a limestone quarry less than a mile upstream from the town of New London. The high-quality limestone of the Madison Group of Mississippian age was destined for the smelters in Butte. The Limespur quarry operated almost continuously until 1935.

In 1906 the Square Deal Gold Company began operating a small dredge on the Jefferson River near the Limespur quarry. The dredge worked for about 12 days before litigation with the Northern Pacific Railroad caused all operations to be suspended, and the dredge was moored to the river's south bank. It remained there until the spring of 1907, when flood waters swept it about 9 miles downstream to the Sappington bridge. The dredge became lodged against the piers and finally was dynamited.

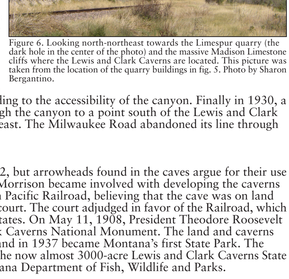

Figure 6. Looking north-northeast towards the Limespur quarry (the dark hole in the center of the photo) and the massive Madison Limestone cliffs where the Lewis and Clark Caverns are located. This picture was taken from the location of the quarry buildings in fig. 5. Photo by Sharon Bergantino.

The Chicago, Milwaukee and St. Paul Railroad built its line through the canyon on the south side of the river in 1908, adding to the accessibility of the canyon. Finally in 1930, a road was completed from La Hood through the canyon to a point south of the Lewis and Clark Caverns, where it joined a road from the east. The Milwaukee Road abandoned its line through the canyon in the 1980s.

LEWIS AND CLARK CAVERNS

The caverns were "discovered" in 1892, but arrowheads found in the caves argue for their use by earlier inhabitants. About 1898, Dan Morrison became involved with developing the caverns for tourism. Soon after that, the Northern Pacific Railroad, believing that the cave was on land granted to the railroad, took Morrison to court. The court adjudged in favor of the Railroad, which then turned the land back to the United States. On May 11, 1908, President Theodore Roosevelt set aside 160 acres as the Lewis and Clark Caverns National Monument. The land and caverns passed to the State of Montana in 1932, and in 1937 became Montana's first State Park. The caverns, which are the main attraction of the now almost 3000-acre Lewis and Clark Caverns State Park, currently are managed by the Montana Department of Fish, Wildlife and Parks.

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Montana Bureau of Mines and Geology

Montana Tech of The University of Montana

http://www.mbmg.mtech.edu

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The Montana Bureau of Mines and Geology (MBMG) was established in 1919 as a public service agency and research entity for the State of Montana, *to conduct and publish investigations of Montana geology, including mineral and fuel resources, geologic mapping, and ground-water quality and quantity.* In accordance with the enabling act, MBMG conducts research and provides information but has no regulatory functions.

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