

Excerpt from
Geologic Trips, Sierra Nevada

by Ted Konigsmark

ISBN 0-9661316-5-7

GeoPress


All rights reserved. No part of this book may be reproduced without written permission, except for critical articles or reviews.

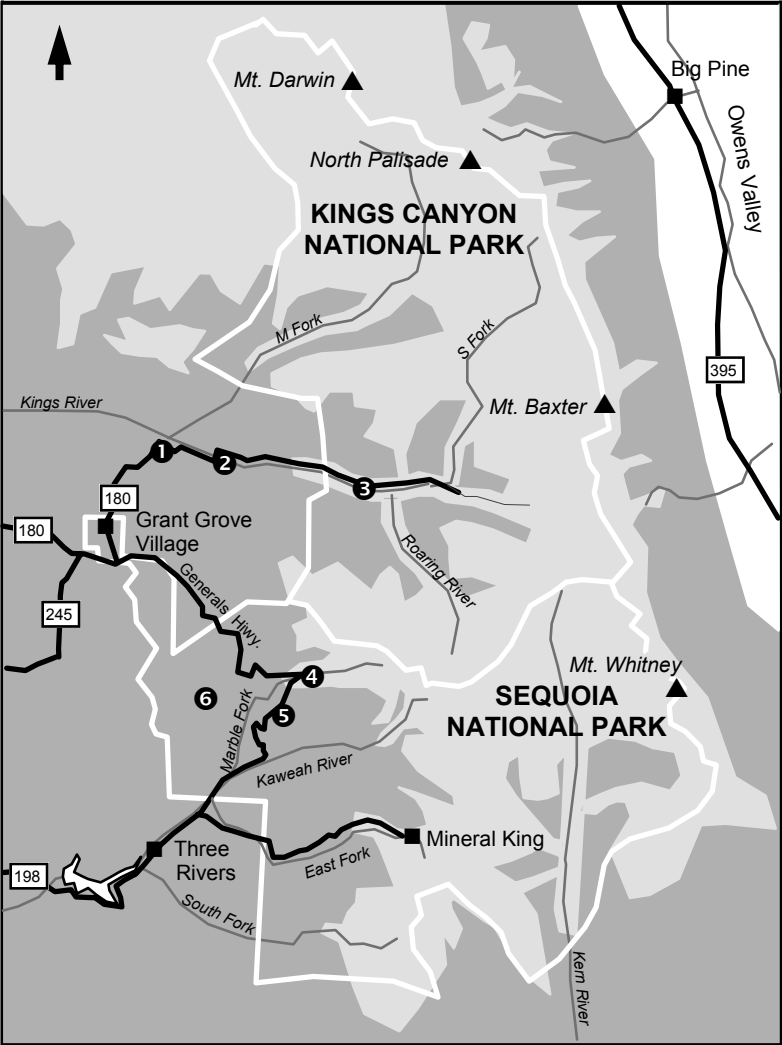
For other geologic trips see:

www.geologictrips.com

Trip 9. SEQUOIA AND KINGS CANYON NATIONAL PARKS

- | | |
|-----------------------|---------------------|
| ① Kings Canyon | ④ Lodgepole Village |
| ② Horseshoe Bend | ⑤ Moro Rock |
| ③ Cedar Grove Village | ⑥ Crystal Cave |

Glaciated

 5 Miles

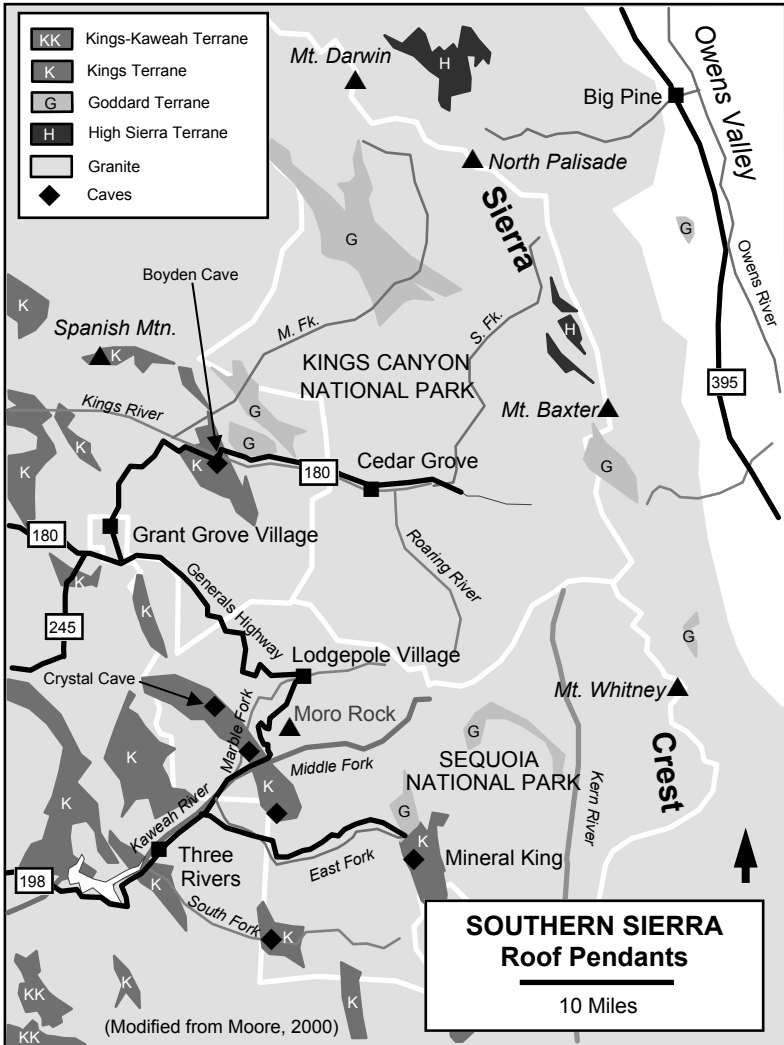


Trip 9
SEQUOIA AND KINGS CANYON
NATIONAL PARKS
The Southern Sierra

Sequoia and Kings Canyon National Parks have the highest and most rugged relief in the entire Sierra Nevada. The area includes Mt. Whitney, the highest mountain in the lower 48 States, and Kings Canyon, one of the deepest canyons in North America. For over 150 miles, there are no roads that cross this part of the Sierra, and the trails that cross the range are rigorous and difficult. This high and harsh topography was formed because the southern part of the Sierra block was uplifted over 8,000 feet during Plio-Pleistocene time, about twice as high as the northern Sierra.

Geologically, the southern Sierra differs from the central and northern Sierra in several other ways as well. Pleistocene glaciation was not extensive in the southern Sierra, compared to the central and northern Sierra. Most of the glaciation in the southern Sierra was confined to the canyons, and the icefield was thin and limited in extent. Thus, glaciers did not remove the thick soil cover from many upland areas. Some of these upland areas now have large groves of giant sequoia. These gigantic trees could not have grown if the soil had been removed by glaciation. Another important difference is that the Western Metamorphic Belt does not extend into the southern Sierra. Instead, the metamorphic rocks in the southern Sierra occur as large roof pendants that lie within the granitic rocks of the Sierra Nevada batholith.

During this geologic trip, you'll drive down into Kings Canyon and gain an appreciation of the work that the rivers and glaciers did in cutting the canyon. You'll also see a large roof pendant of metamorphic rocks exposed in the walls of the canyon. In Sequoia National Park, you'll visit Tokopah Falls, Moro Rock and Crystal Cave, some of the top scenic attractions of the park. Most of the geologic sites on this trip are not accessible in the winter. To see the geology, it is best to visit the area in late spring, summer, or early fall.

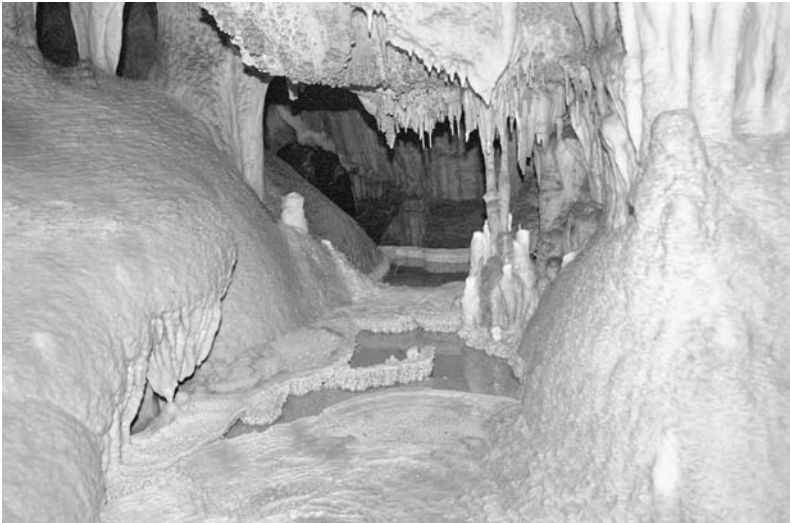


Sequoia and Kings Canyon National Parks are administered together. For park information, visit the parks' website, www.nps.gov/seki or phone 559-565-3341. Some other phone numbers are: Lodgepole Visitor Center, 559-565-3782; Cedar Grove Visitor Center, 559-565-3793; Foothills Visitor Center, 559-565-3135. For more information on the geology of Sequoia and Kings Canyon National Parks, get a copy of *Exploring the Highest Sierra*, by Moore (2000).

Roof Pendants

Although most of the rocks in the southern Sierra are granitic, there are many roof pendants of metamorphic rocks scattered through the granite. Most of the roof pendants are of irregular shape, but in general they are elongated to the northwest. Some are over ten miles long and several miles wide. Although the roof pendants occur in separate patches scattered in the granite, some of the pendants have similar rocks and are obviously related. Based on these similarities, the pendants have been grouped into four terranes:

- 1) The Kings-Kaweah Terrane occurs in the western foothills of the Sierra and is characterized by ophiolites - ultramafic rocks that were once oceanic crust.
- 2) The Kings Terrane is mainly metamorphosed shale, but also includes quartzite and marble. Crystal Cave, Boyden Cavern and many other caves in the southern Sierra are in beds of marble that occur within this terrane.
- 3) The Goddard Terrane is composed largely of metamorphosed volcanic rocks. These are the same metamorphic rocks that occur in the northeastern part of the Alabama Hills.
- 4) The High Sierra Terrane is found along the east side of the Sierra, and includes metamorphosed Paleozoic rocks, mainly schist and marble.



This photo is from Crystal Cave, which occurs in a marble bed in the Sequoia Roof Pendant of the Kings Terrane. There are over 100 caves in the southern Sierra that occur in similar roof pendants.

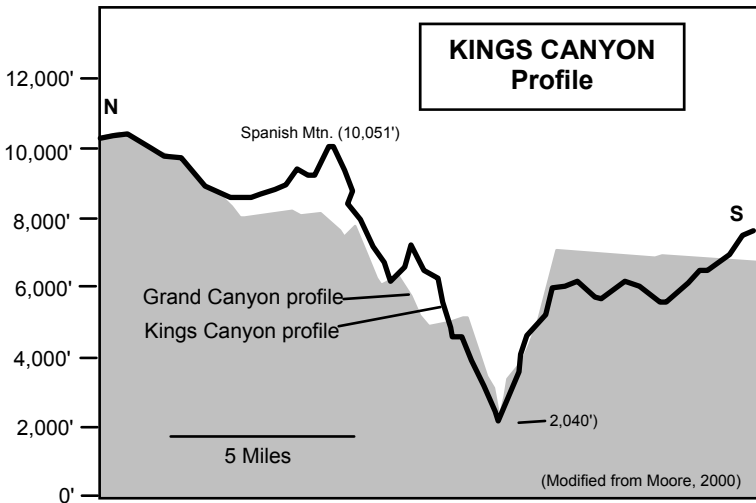
❶ Kings Canyon

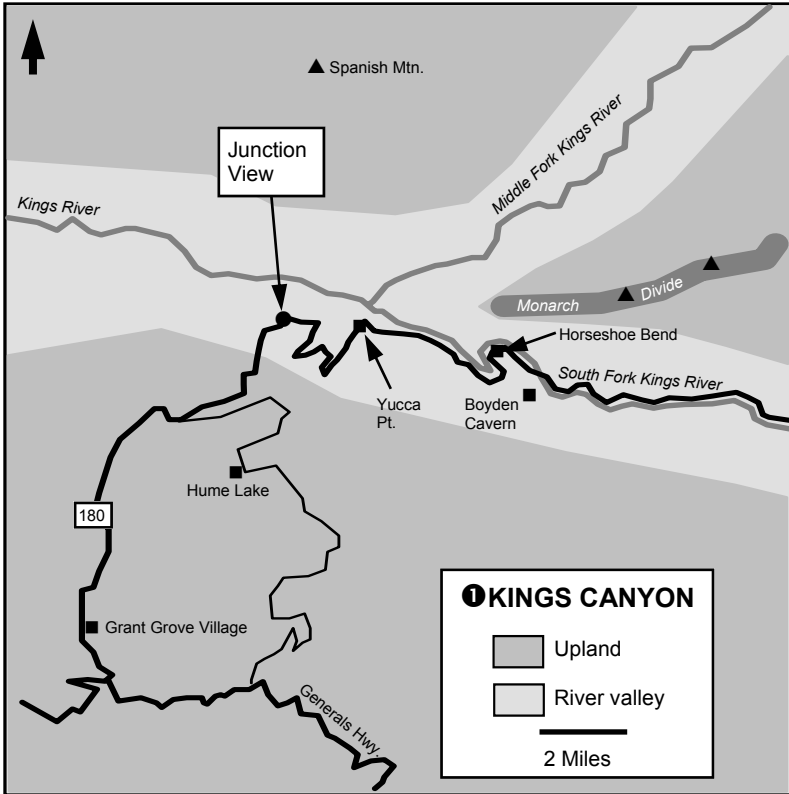
Kings Canyon is one of the deepest canyons on the North American continent. The bottom of the canyon lies from 4,000 to 8,000 feet below the surrounding topography, compared to 4,000 to 6,000 feet for the Grand Canyon. Kings Canyon attained this great depth due to the very high uplift of the southern Sierra during the Plio-Pleistocene. This rapid and high uplift gave the Kings River the power to cut its deep valley.

Junction View - From Grant Village go 14 mi. E on Hwy. 180 to the turnout for Junction View.

From Junction View, you can see where the Middle and South Forks join to form the Kings River. These rivers are in the steep, rugged, V-shaped canyons that were cut during the Plio-Pleistocene uplift of the Sierra Nevada. The bottom of the canyon is 8,000 feet below the top of Spanish Mountain, which lies five miles northwest of the river junction. Pleistocene glaciers did not reach this part of Kings Canyon, so all of the canyon downcutting was by rivers.

Three miles further east on Highway 180, Yucca Point provides a closer view of this same river junction. The rocks from Grant Grove to Yucca Point are granite and are part of the Sierra Nevada batholith. However, immediately east of Yucca Point, Highway 180 begins to traverse through the metamorphic rocks of the Boyden Cave Roof Pendant. These metamorphic rocks provide some dramatic scenery in the vicinity of Horseshoe Bend, where the South Fork of the Kings River slices through the roof pendant, and exposes the roof pendant in the steep walls of the canyon.





View from Yucca Point looking northwest across Kings Canyon. The Kings River is in the bottom center of the photo. This part of the Kings Canyon is V-shaped, and has not been modified by glaciers.

📍 **Horseshoe Bend**

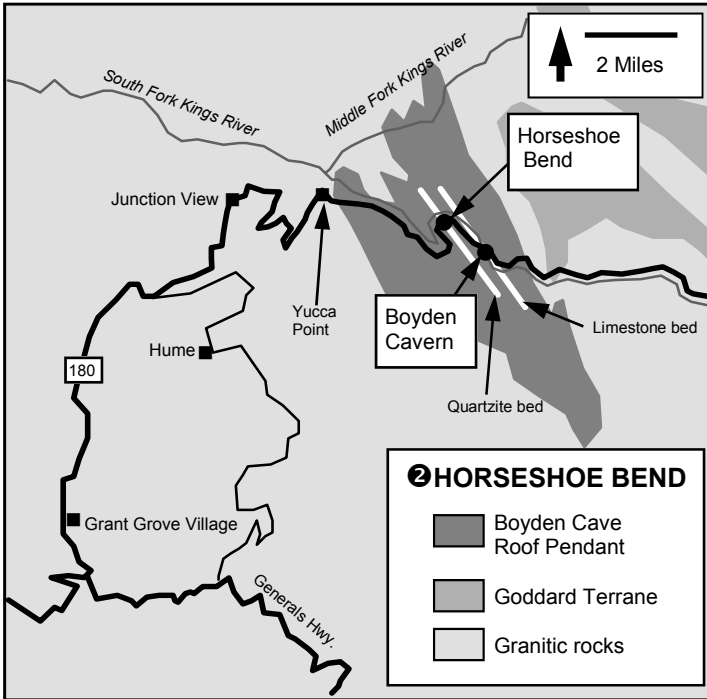
From Yucca Point to two miles east of Boyden Cavern, the South Fork of the Kings River cuts through the Boyden Cave Roof Pendant, one of the large roof pendants of the Kings Terrane. The roof pendant consists of slate, quartzite, marble and schist. Sparse fossils, mainly crinoids and ammonites of Jurassic age, have been found in some of these rocks. Excellent exposures of the roof pendant can be seen along the river, in roadcuts along the highway, and in the canyon slopes above the river. One of the best places to see these rocks is at Horseshoe Bend.

Horseshoe Bend – *From Junction View go 8 mi. E on Hwy. 180 to the pullout for Horseshoe Bend.*

At Horseshoe Bend, the South Fork of the Kings River makes a horseshoe-shaped detour as it cuts across a thick bed of very hard quartzite in the Boyden Cave Roof Pendant. The quartzite bed is about 3,600 feet thick, is layered, and the layers are near-vertical. The quartzite was formed by metamorphism of a thick bed of quartz sandstone. Faint cross bedding and graded bedding can be seen in some of the sandstone beds. The sandstone is thought to have been formed in a shallow water tidal environment or perhaps as a channel in a deeper water fan system. Age dating from zircons in the sandstone indicates that the sandstone was sourced from a pre-Cambrian continental mass. The location of this continent is unknown. Looking northwest from the turnout, the rocks of the Boyden Cave Roof Pendant are exposed in several steep ridges on the southern slope of Monarch Divide. The ridges of quartzite appear as dark reddish-brown cliffs. The gray cliffs and spires are formed from beds of marble, and the brown areas of subdued relief are schist.

Boyden Cavern - *From Horseshoe Bend, continue 1 mi. E on Hwy. 180; park in the Boyden Cavern parking area just E of the bridge across the S. Fork of the Kings River. Private; open May through Oct.; visit by guided tour (45 min); 209-736-2708.*

Boyden Cavern is in a thick layer of marble that lies within the Boyden Cave Roof Pendant. This blue-gray marble is exposed in the parking area for Boyden Cavern and in the channel of the South Fork of the Kings River in the vicinity of the bridge. The marble is a massive, vertically-layered unit about 2,000 feet thick. The entrance to Boyden Cavern is in a cliff in the lower part of the river canyon on the south side of the river. The cave has many of the decorations normally associated with limestone caves, including draperies, stalactites, and stalagmites. Boyden Cavern is one of many small-to-moderate-sized caves that occur within the limestone and marble of the Kings Terrane.



At Horseshoe Bend, Highway 180 bends around a thick bed of quartzite in the Boyden Cave Roof Pendant. The highway is in the notch in the shadow at the lower right. The quartzite bed forms a steep cliff on the opposite wall of the valley. The ridge at the upper right is marble.

③ Cedar Grove Village

During the Pleistocene glacial episodes, glaciers extended down the South Fork of the Kings River as far as Cedar Grove Village. These glaciers modified the upper portion of the Kings Canyon to form a typical U-shaped glacial valley, similar to Yosemite Valley. The glaciated part of the Kings Canyon is wide and has steep walls, waterfalls, and meadows. The granitic rocks along the sides of the valley were scraped, plucked and polished by the glaciers, forming a variety of waterfalls, steep cliffs, and granitic domes and spires. The glaciers, however, were neither as thick nor extensive as the glaciers in Yosemite Valley. Thus, the glacial features in Kings Canyon, although impressive, are not quite as spectacular as those in Yosemite Valley.

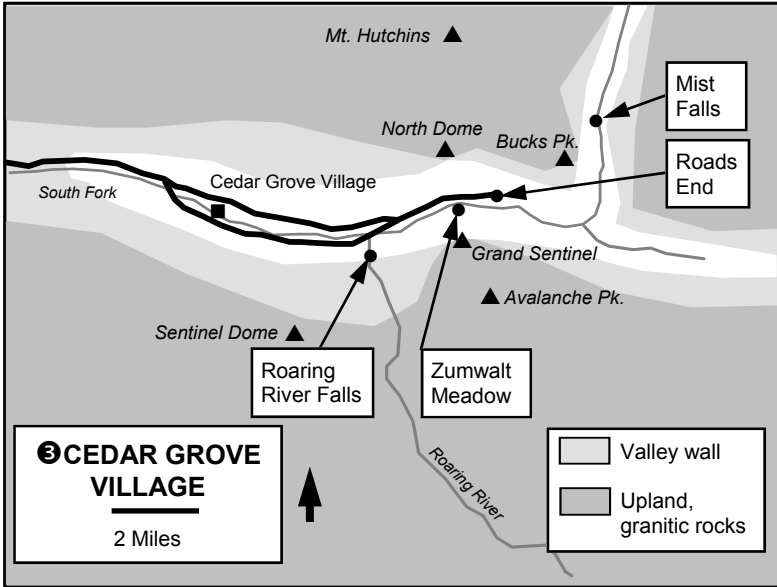
Roaring River Falls - From Cedar Grove Village drive 3 mi. E on Hwy. 180; park in the Roaring River Falls turnout on the E side of Roaring River across the bridge; hike 200 yards to the viewpoint.

Roaring River is a hanging valley that tumbles down a steep narrow granite gorge and then drops 80 feet into a deep pool. This granite is part of the North Mountain unit, a small pluton about three miles in diameter.

Zumwalt Meadow - The parking area for Zumwalt Meadow is 2 mi. E of Roaring River Falls; take the self-guided 1.5 mi. loop tour.

Zumwalt Meadow was formed in the same way as the flat floor of Yosemite Valley. The process began when the South Fork was dammed by a glacial moraine, causing a lake to form behind the dam. Over time, the lake was filled with sediment and then plants grew on the sediments. Take the short Zumwalt Meadow Trail for information on the plant life of the meadow and for excellent views of the river, meadow, North Dome, and Grand Sentinel. Part of the trail crosses a talus slope on the south side of the valley and provides a good opportunity to see the granitic rocks that make up the valley wall. This granite has many dark, sharp-edged xenoliths, which are probably pieces of the roof rock that fell into the granite magma.

Grand Sentinel (8,504') is on the south side of the valley, and rises 3,500 feet above Zumwalt Meadows. The rock that forms Grand Sentinel is part of the Lookout Peak Granodiorite, and is characterized by large twinned potassium feldspar crystals. The spires and ledges that give Grand Sentinel its unique character are shaped by vertical and sloping joints that cut through the granite. The sheer face of North Dome (8,717'), across the valley from Grand Sentinel, was shaped by the valley glaciers. The top of the dome lies back from the valley wall.



The giant granitic monolith of Grand Sentinel (8,504') dominates the east end of Kings Canyon as it rises nearly 3,500 feet above Zumwalt Meadow.

Roads End - *From Zumwalt Meadows go 1 mi. E on Hwy. 180 to Roads End.*

At Roads End, the highway splits into a one-way loop and crosses through a small ridge. This ridge is a recessional moraine, and is composed of unconsolidated and non-stratified boulders, sand, silt, and clay. The moraine was deposited during retreat of the last glacier that flowed down the South Fork of the Kings River. The boulders in the moraine provide a convenient sample of the rocks that the glacier passed through on its trip to Roads End. Many of these boulders came from the Paradise Granodiorite. The rocks of the Paradise Granodiorite are easily identified because they have large potassium-feldspar phenocrysts that are filled with concentrically arranged inclusions of biotite, hornblende, and plagioclase.

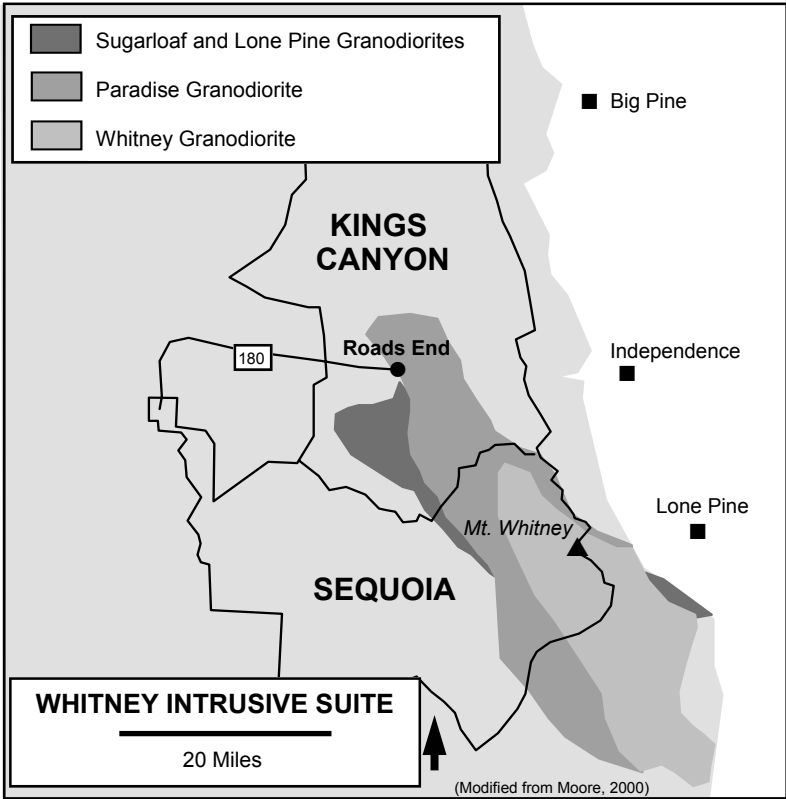
The Paradise Granodiorite is a part of the very large Whitney Intrusive Suite, which extends from here to the southeast for fifty miles. Mt. Whitney lies in the Whitney Granodiorite in the core of the pluton. This suite of rocks is similar in composition, size and age to the Tuolumne Intrusive Suite at Tuolumne Meadows.

The Whitney Intrusive Suite is thought to have formed from a single very large granodiorite intrusion. The edges of the pluton cooled and crystallized first, forming the Lone Pine and Sugarloaf Granodiorites. Next, the Paradise Granodiorite, which was still hot and molten, rose through the solidified wall rocks of the Lone Pine and Sugarloaf Granodiorites. After the Paradise Granodiorite solidified, the still-hot Whitney Granodiorite, in the core of the pluton, rose through the Paradise Granodiorite. The Whitney Granodiorite contains giant crystals of potassium feldspar, similar to the Cathedral Peak Granodiorite of the Tuolumne Meadows.

Mist Falls - *The Mist Falls trail leaves from the Roads End permit station; 8 mi. RT; moderately strenuous.*

This trail follows the glaciated valley of the South Fork of the Kings River. At Mist Falls, the river washes down a 300-foot steep ledge of polished granite and then plummets 45 feet to form the falls. The granite is part of the Paradise Granodiorite, and is hard with few joints. The granite was polished by glaciers during Pleistocene glaciation.

→North Dome as seen from Roads End. The top of North Dome lies back from the canyon rim.



④ **Lodgepole Village**

Lodgepole Village is in the valley of the Marble Fork of the Kaweah River at an elevation of 6,720 feet. The highest and least accessible part of the Sierra Nevada lies in Sequoia National Park to the east of Lodgepole Village. Although the direct distance from Lodgepole Village to Mt. Whitney is only 23 miles, the trail distance is at least 50 miles, and the trail would involve crossing the Great Western Divide, the deep Kern River Valley, and several other major passes and valleys.

During the Pleistocene glacial episodes, glaciers flowed down Marble Fork from the High Sierra and left a number of lateral and recessional moraines in and around Lodgepole Village. Glacial deposits of Tioga age, deposited during the last glacial episode, now cover the central part of the valley. Older moraines of Tahoe age lie at higher elevations along the flanks of the valley for a mile or so west of Lodgepole Village. The road to Wolverton crosses the Tahoe moraine.

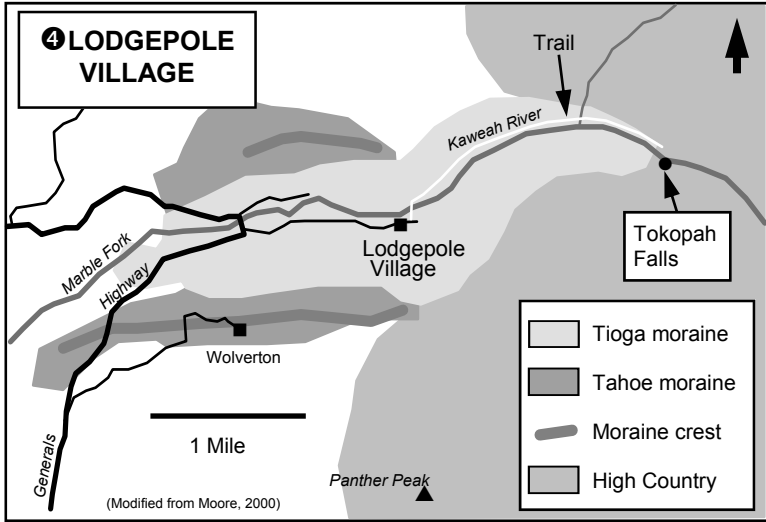
The glacial deposits in the Lodgepole area mark the western extent of the glaciers that flowed down the Marble Fork. Further west, the Marble Fork enters a steep V-shaped river valley and descends rapidly to join the Middle Fork of the Kaweah River at the Potwisha Campground, over 4,000 feet below Lodgepole Village.

East of Lodgepole Village, the Marble Fork flows through a typical U-shaped glacial valley with steep walls of granite. The floor of this valley rises gently to the east for two miles and then ends abruptly in a steep granite slope that leads to the Sierra High Country. Tokopah Falls tumbles nearly 1,000 feet down this steep granite slope.

Tokopah Falls – *The trail to Tokopah Falls begins at the Lodgepole Campground; 3.5 mi. RT; moderate.*

The trail to Tokopah Falls goes east along the glaciated valley of the Marble Fork of the Kaweah River. The granite along the valley walls has been grooved and polished by the glaciers. Tokopah Falls lies at the end of the valley. The slope down which the falls tumble is made up of a number of ledges and cliffs that were formed by vertical and sub-horizontal joints in the hard granite. The glaciers that flowed down the valley plucked and quarried the granite along these joints.

The Lodgepole Visitor Center at Lodgepole Village has excellent exhibits on the history, geology and forest life of Sequoia.



Tokopah Falls cascade down the steep slope that lies at the head of the Marble Fork of the Kaweah River.

⑤ **Moro Rock**

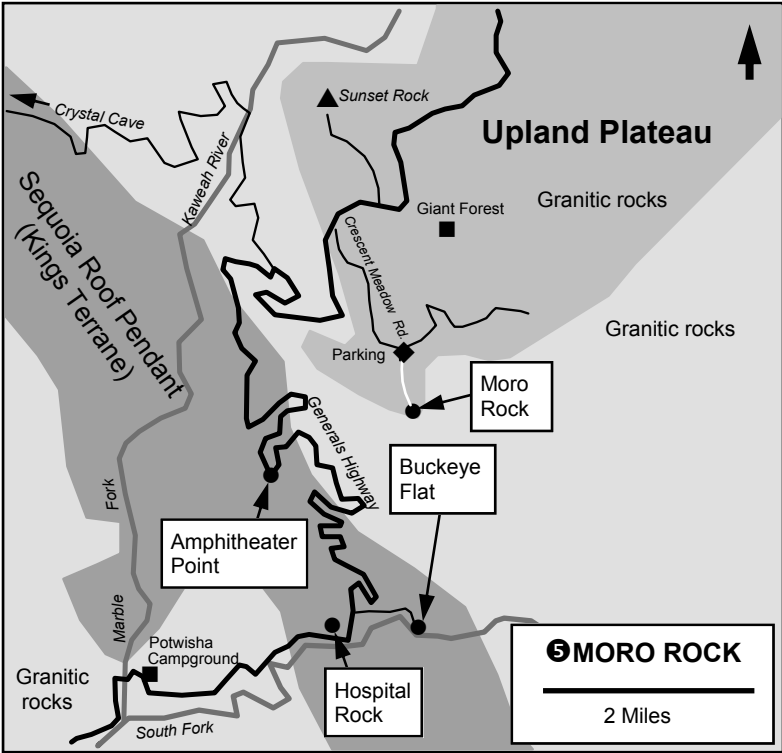
From Lodgepole Village to Moro Rock, Generals Highway traverses a heavily forested, rugged, upland plateau that lies at an elevation of about 6,500 feet. To the southwest, this plateau is being rapidly dissected by the Kaweah River and its tributaries. The drop from the edge of the plateau to the Kaweah River valley at the base of the plateau is about 3,000 to 4,000 feet. One of the most spectacular places to see this drop is from the top of Moro Rock, which is situated at the southwest edge of the plateau. From Moro Rock to Hospital Rock, which is at the base of the plateau, there is a drop of 4,000 feet. In a straight line, this distance is two miles. The Generals Highway takes a more leisurely ten miles as it winds its way down the grade from Moro Rock to Hospital Rock.

The steep grade on Generals Highway from the upland plateau to Hospital Rock lies along the contact between two vastly different types of basement rock. Moro Rock and the plateau on the east side of the contact are underlain by granitic rocks of the Sierra Nevada batholith. In contrast, the rocks on the west side of the contact are metamorphic rocks that are part of the large Sequoia Roof Pendant of the Kings Terrane. These rocks are mainly slate, schist, quartzite, and marble. As Generals Highway twists and turns down the grade, it is sometimes in the granitic rocks on the east side of the contact and sometimes in the metamorphic rocks on the west side of the contact. You will see the granite during the trip to Moro Rock. The metamorphic rocks are well exposed at Amphitheater Point and at Buckeye Flat near Hospital Rock.

Forests cover much of the western part of Sequoia National Park. Most of the upland area from Lodgepole Village to Moro Rock was never glaciated, so the deep soil cover was preserved and the area was able to support large trees. Giant Forest, immediately north of Moro Rock, has some of the largest trees on the face of the earth.

Moro Rock - From Lodgepole Village drive S on Generals Highway 4 mi. to Giant Forest Village; turn left on Crescent Meadow Rd.; drive 1.5 mi. to the parking area.

Moro Rock is an imposing granitic dome at the southern edge of Giant Forest. The top of the dome is easily accessible by a 400-step stairway. Because of its sensitive design and the craftsmanship of its construction, this stairway was entered into the National Register of Historic Places in 1978. Moro Rock was formed from a hard sparsely-jointed granitic rock called the Giant Forest Granodiorite. This rock is the oldest unit of the Sequoia Intrusive Suite, and is characterized by its dark color and high content of hornblende and sphene. The sphene occurs as wedge-shaped honey-brown crystals.



The summit of Moro Rock is easily accessible by a 400-step stairway and path. The large blocks are slabs of granite that are exfoliating from Moro Rock.

Moro Rock got its rounded shape from exfoliating shells of granodiorite. Like Sentinel Dome in Yosemite, Moro Rock was never covered by glaciers. From the top of Moro Rock, looking east, you can see the Middle Fork of the Kaweah River leading up to the Great Western Divide in the High Country of the Sierra Nevada. To the south are Castle Rocks, and to the southwest the main valley of the Kaweah River.

Amphitheater Point - *On Generals Highway, 5 mi. S of Crescent Meadow Rd.*

There are good exposures of the schist of the Kings Terrane in the roadcuts at Amphitheater Point. The schist is medium brown, foliated, and stands in near-vertical beds. Prior to metamorphism, these beds were sandstone and shale.

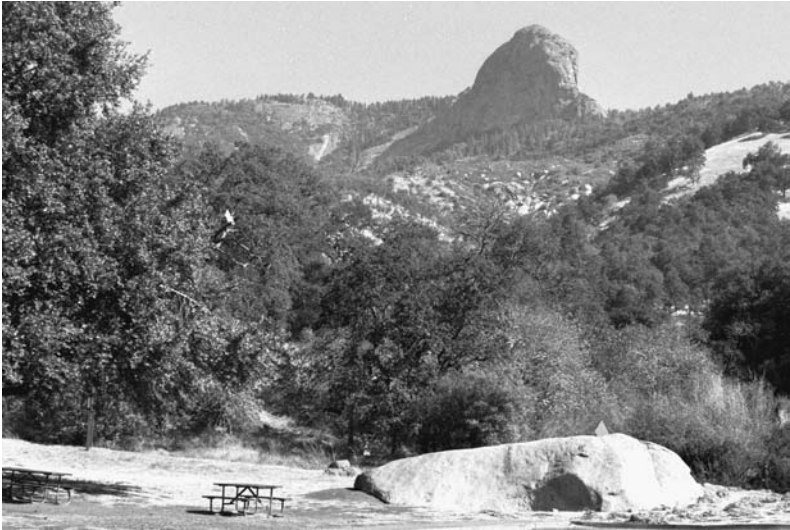
Hospital Rock - *On Generals Highway 5 mi. S of Amphitheater Pt.; park at the picnic area; follow the signs to Hospital Rock, across the Highway from the picnic area.*

Hospital Rock is a large granite boulder that has a flat surface with pictographs painted by Native Americans. The flat surface was formed when the boulder cracked along a joint surface. However, there is one additional problem. The bedrock in the vicinity of Hospital Rock is not granite, but consists of the metamorphic rocks of the Sequoia Roof Pendant. This large granite boulder is therefore not in place, but came here from somewhere else.

Hospital Rock was once part of an exfoliation slab on Moro Rock. When the slab broke loose, it shattered into a number of pieces and the pieces tumbled down the steep slope of the Kaweah River valley as an avalanche. The avalanche left Hospital Rock at this locality. Other granitic boulders from this and other avalanches occur in the Hospital Rock area and clog several of the gulches along Generals Highway from Deer Ridge to Hospital Rock.

Buckeye Flat - *Take the gravel road that goes E from Hospital Rock; drive 2 mi. to the campground; take the trail to the river between campsites 23 and 25.*

At Buckeye Flat, the metamorphic rocks of the Sequoia Roof Pendant are exposed along the Middle Fork of the Kaweah River. These rocks are mainly dark gray slate, phyllite and schist. The rocks are highly deformed, so that the rock layers dip steeply and some are twisted into tight folds. Prior to metamorphism, these rocks were mud and shale. A number of granodiorite boulders are scattered around Buckeye Flat. These boulders arrived here as avalanches from Moro Rock, similar to Hospital Rock.



This photo, from Hospital Rock, shows Moro Rock on the horizon. The large rock at the far end of the parking lot is one of many pieces of granite in this area that have broken from Moro Rock and rolled into this area in large avalanches.



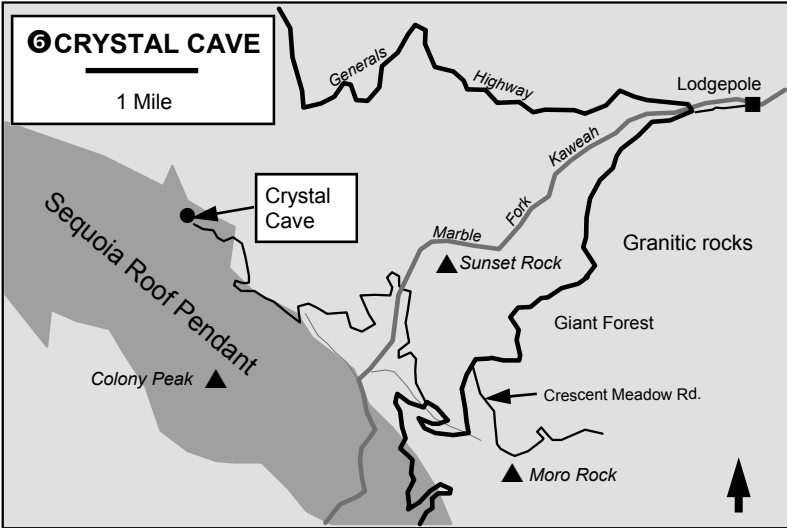
Hospital Rock is a part of an exfoliated slab of granite that tumbled down the steep slope from Moro Rock. Pictographs drawn by Native Americans can be seen on the flat overhanging surface of the broken rock.

⑥ **Crystal Cave**

There are approximately 100 caves in Sequoia and Kings Canyon National Parks. Of these, Crystal Cave is the most popular, and the only one that is open to the public. All of these caves occur in beds of marble that lie within roof pendants of the Kings Terrane. The marble is usually interbedded with quartzite and schist. No one knows where the roof pendants of the Kings Terrane came from nor how they got to the southern Sierra. However, we do have some clues as to how and when the rocks in the roof pendants were formed. The marble of the Kings Terrane began its life as limestone in a shallow warm-water sea. Fossils indicate that the limestone was deposited during late Triassic to early Jurassic time. The sea was near a continent that shed sandstones into the sea from time to time. These sandstones now form the beds of quartzite that are interbedded with the marble. The rocks of the Kings Terrane could not have been in the foothills of the southern Sierra when they were formed, since great thickness of volcanic and volcanoclastic rocks were being deposited in the Sierra at that time. It appears likely that the rocks of the Kings Terrane were brought into this area by large transform faults during late Mesozoic or early Tertiary time, probably from the south.

Crystal Cave - *From the Crescent Meadow Rd. turnoff to Moro Rock, go S on Generals Highway 2 mi. to the turnoff to Crystal Cave; turn right and drive 7 mi. on the twisting access road to the parking area; hike 0.5 mi. to the cave entrance. Visit is by guided tour only; seasonal; tickets for tours must be purchased in advance at the Lodgepole or Foothills Visitor Center.*

The bed of marble that is the host for Crystal Cave forms a 700-foot wide ridge between Yucca Creek and Cascade Creek. The cave was formed by water that flowed from Yucca Creek into a pit in the floor of the creek. From the pit, the water flowed through a series of sub-horizontal joints in the marble until it emerged on the other side of the ridge and flowed into Cascade Creek. As the water followed these joints, the weak acid in the water dissolved the marble along the joints to form sub-horizontal passages. From time to time, the water level would drop, and a new set of passages would form at a lower level. When this happened, surface water seeping through the joints in the marble would begin decorating the higher passages with the many limestone forms typical of caves. As a result of this process, Crystal Cave has several large sub-horizontal rooms at different levels, and these rooms have a variety of cave forms, including stalactites, stalagmites, pillars, draperies, flowstone, and shields. The different forms were created by the many ways that water moves across the irregular surfaces of the cave passages.



The entrance to Crystal Cave is just above Cascade Creek, which lies at the lower left. This cave is open to the public and is the most popular cave in Sequoia National Park.