

Excerpt from  
Geologic Trips, Sierra Nevada

by Ted Konigsmark

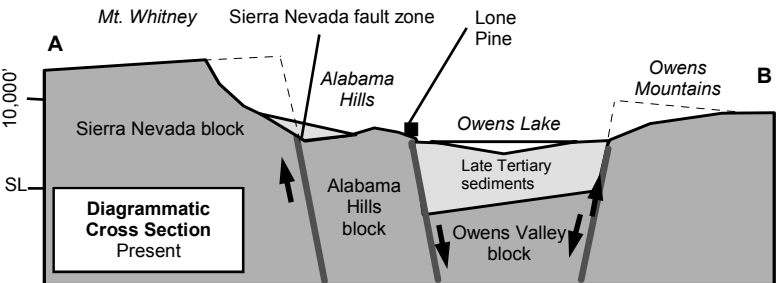
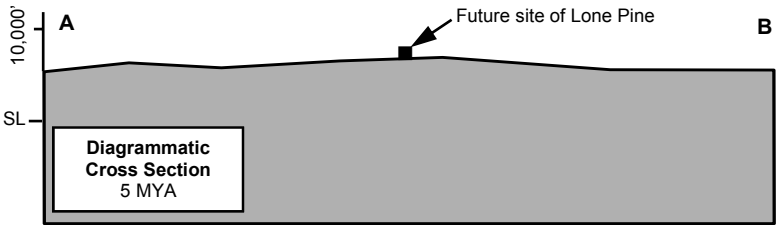
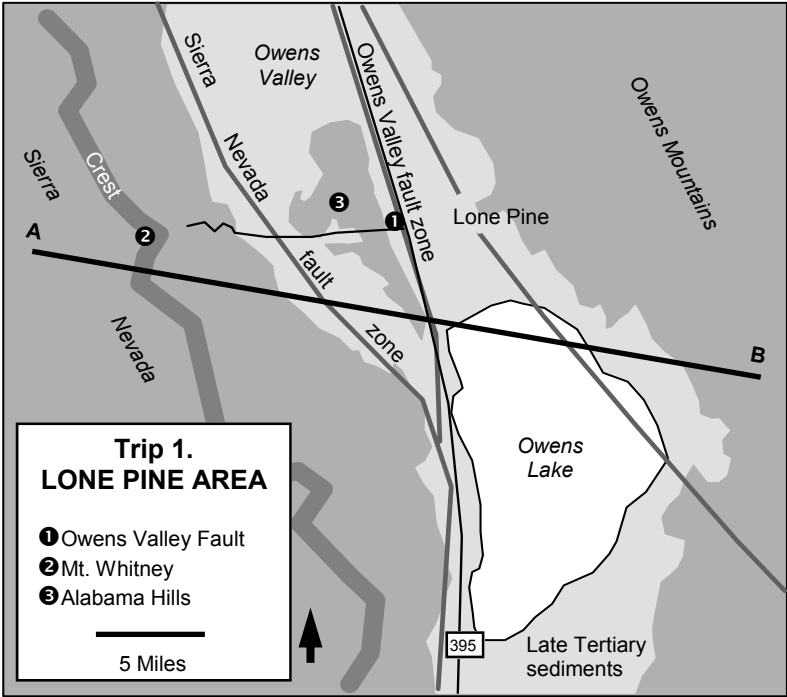
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The upper cross section shows the Lone Pine area prior to uplift of the Sierra Nevada. The lower section shows the present landscape, formed by uplift and tilting of the Sierra Nevada block and subsidence of the Owens Valley block.

**Trip 1**  
**LONE PINE AREA**  
*Uplift of the Sierra Nevada*

The view of Mount Whitney (14,496') from Lone Pine is impressive. The mountain is the highest of several peaks along the steep escarpment of the southern Sierra Nevada. When looking at Mt. Whitney from Lone Pine, it is hard to believe that only five million years ago there was no Sierra Nevada, no Owens Mountains, no Owens Valley, no Owens Lake, and no Mt. Whitney. Instead, there was a low range of hills that extended from the present-day Sierra foothills into western Nevada.

About five million years ago, these low hills began to be broken by a series of northwest trending faults. During the next five million years, the Sierra Nevada was uplifted and tilted westward along these faults. Uplift was greatest in the south, near Lone Pine, and decreased northward. As the Sierra block was uplifted, the crust to the east of the faults subsided, forming a number of basins to the east of the Sierra, including the Owens Valley, Mono Valley, and Lake Tahoe basins.

The series of faults along which the Sierra Nevada was uplifted and the adjacent basins subsided is referred to as the Frontal fault system. Nowhere can the effect of the uplift be better seen than at Lone Pine. Here, the Frontal fault system is split into two major fault zones, the Sierra Nevada fault zone and the Owens Valley fault zone. The Sierra Nevada block has been uplifted about 10,000 feet along the Sierra Nevada fault zone and the Owens Valley block has been dropped over 5,000 feet along the Owens Valley fault zone. The Alabama Hills lie between these two fault zones. The Alabama Hills block represents a sliver of the earth's crust that was neither uplifted with the Sierra Nevada block nor down-dropped with the Owens Valley block. As the Sierra block was uplifted, it began to be eroded. The higher the uplift, the greater the erosion. Many of these erosion products were deposited as sedimentary rocks in the sinking Owens Valley block.

During this trip, you'll take a look at recent faulting along the Owens Valley fault zone, drive across the Sierra Nevada fault zone on the way to Whitney Portal, and investigate how and why the unusual scenic features of the Alabama Hills were formed.

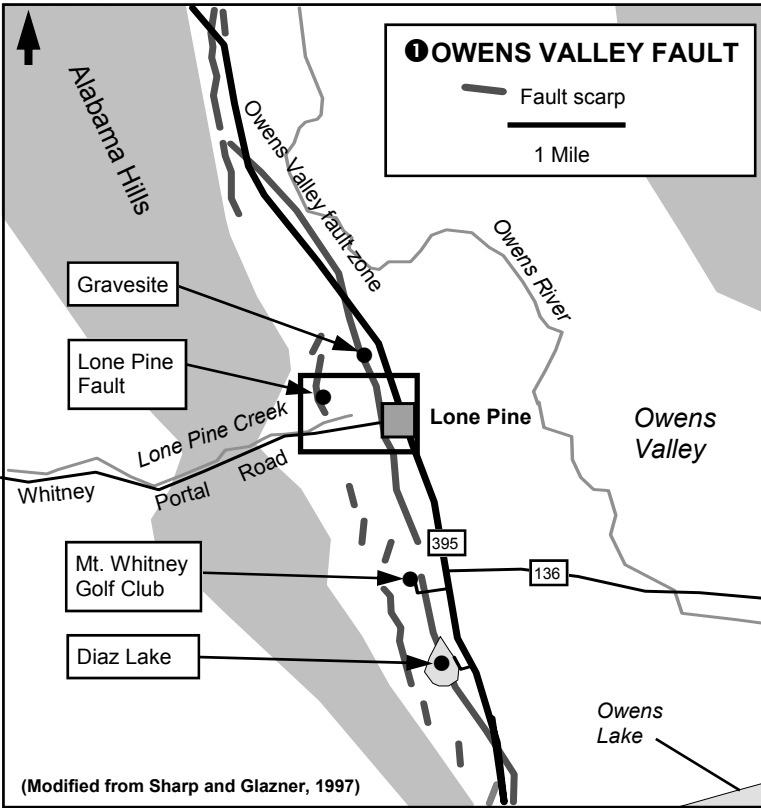
### ① **Owens Valley Fault**

The Owens Valley fault zone goes through the town of Lone Pine. The Alabama Hills are on the west side of the fault and Owens Valley is on the east side. Owens Valley has subsided about 5,000 feet along this fault zone during the last five million years. The fault is active, and the movement is still going on, as evidenced by a number of recent small fault scarps along the fault zone. Some of these scarps were formed as recently as 1872, when the town of Lone Pine was destroyed by the Owens Valley earthquake. This M8.0 earthquake was one of the largest earthquakes ever recorded in California, and was about the same magnitude as the 1906 San Francisco earthquake. Of the 300 residents in Lone Pine at the time of the earthquake, 23 were killed by collapsing homes and buildings. During the earthquake, the ground was ruptured for a distance of over 100 miles and left a series of discontinuous scarps between Olancha and Big Pine.

In and near Lone Pine, you can see several of the fault scarps that were formed during the 1872 earthquake. We'll visit several of these scarps. However, don't expect to see a fresh scarp and fresh rocks. In the 130 years since the earthquake, most of the scarps have been covered by grass, rocks and shrubs, and some have been modified by man. Nonetheless, the linear trend and general shape of the scarps is evident. Although many of these scarps are only a few feet high and may not be impressive, keep in mind that many small offsets like this can add up to a large amount of uplift given a long period of time. Assuming an average rate of uplift of only 2.4 inches per century, the Sierra block would be uplifted 10,000 feet in five million years.

It takes a huge break, probably through the entire earth's crust, to cause an earthquake as large as the 1872 Owens Valley earthquake. A break of this magnitude would normally extend laterally for tens of miles, and the rocks along the break would be offset from several feet to as much as twenty or thirty feet. Earthquakes of this size are very effective in releasing stress along a fault. It usually takes a long time for stress to build up and cause another major earthquake, perhaps several decades to several hundred years. It is virtually certain that another large earthquake will eventually occur in the Lone Pine area, but no one really knows when that will happen.

→Mt. Whitney, in the center of the photo, is the highest point along the crest of the Sierra Nevada. The Sierra crest represents the eroded eastern edge of the large west-tilted Sierra Nevada fault block.



**Diaz Lake:** *From the junction of Hwy. 130 and Hwy. 395 go 1 mi. S on Hwy. 395; turn W into the Diaz Lake Recreational Area.*

Diaz Lake is a popular recreational area, with boating, fishing, water sports, picnic grounds, camping, and trails. The lake and the surrounding area is owned by the Los Angeles Department of Water and Power and is leased as a recreational facility by Inyo County. The Los Angeles Aqueduct lies immediately west of the lake along the base of the Alabama Hills.

The lake is named for the Diaz family, who had established and operated a successful cattle ranch here in the late 1860's. Prior to the 1872 Owens Valley earthquake, this part of the ranch was a spring-fed wetland with cattails and reeds. During the earthquake, the ground on the east side of the fault dropped 20 feet. New springs developed and fed into this depression to form Diaz Lake. Down-dropped blocks like this are common along major fault zones and reflect minor surface adjustments to very deep movement along the fault zone.



Diaz Lake lies within the Owens Valley fault zone, and was formed when this area subsided 20 feet during the 1872 Owens Valley earthquake. The Alabama Hills can be seen on the far side of the lake and the Sierra crest in the distance.

For information, maps, and books on the Owens Valley, Death Valley, eastern Sierra, and Yosemite, drop by the Interagency Visitor Center 1.5 miles south of Lone Pine at the intersection of Highways 395 and 136 (760-876-6222).

**Mt. Whitney Golf Club** - *The Mt. Whitney Golf Club is on the W side of Hwy. 395 near the junction with Hwy. 130; follow the entrance road to the clubhouse.*

The Mt. Whitney Golf Club is in the Owens Valley fault zone just north of Diaz Lake. One of the fault scarps formed during the 1872 earthquake goes through the golf course. Although the scarp has been modified by development at the golf course, it can still be seen as a low north-trending embankment that runs along the western side of the golf course. The clubhouse and the tee for hole six are on the top of the east-facing scarp and most of the remainder of the golf course is on the downdropped block. During the earthquake, the ground to the east of the scarp dropped about 15 feet. The road to the clubhouse climbs the fault scarp, and a remnant of the unmodified scarp can be seen on the south side of the road as it crosses the scarp.



This view looks north along the Owens Valley fault scarp at the Mt. Whitney Golf Club. The clubhouse, at the left side of the photo, is on the top of the scarp and the low area at the right is at the base of the scarp. The large tree is on the gentle slope of the fault scarp. The fault scarp was formed during the 1872 Owens Valley earthquake.

For information about Lone Pine, Owens Lake, the Alabama Hills, and nearby areas, visit the Lone Pine Chamber of Commerce, 126 S. Main St., Lone Pine (760-876-4444)

**Lone Pine Fault** - From the junction of Hwy. 395 and Whitney Portal Rd. go 0.6 mi. W on Whitney Portal Rd.; park at the information pullout on the right side of the road; hike back 0.1 mi. to the gravel road just W of the L. A. Aqueduct; go N 0.1 mi. on this road, turn right on the narrow dirt road just beyond Lone Pine Creek; continue on this road for 0.1 mi. to the base of the fault scarp; the scarp lies immediately W and continues N for 0.5 mi.; the dirt road runs between the fault scarp and the L. A. Aqueduct.

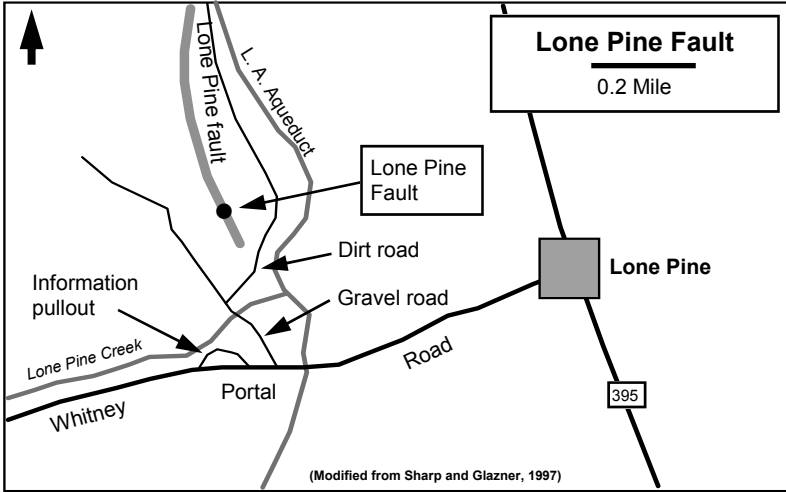
The Lone Pine fault is one of several faults that lie within the Owens Valley fault zone. This fault has a well-developed scarp just north of Lone Pine Creek and immediately west of the Los Angeles Aqueduct. The east-facing scarp is 15 feet high and trends north. The scarp offsets an alluvial fan with large boulders, and the boulders are exposed on the face of the scarp. This scarp was probably formed during several different earthquakes along the Lone Pine fault. The latest movement was during the 1872 Owens Valley earthquake, when the east side of the fault moved down an estimated eight feet and the west side of the block moved north several feet.

**Gravesite** - Drive N on Hwy. 395 to the sign marking the north entrance to Lone Pine; the gravesite is on the W side of Hwy. 395 immediately S of the sign.

The plaque at this locality marks the common gravesite for the victims of the 1872 earthquake. The gravesite is on the top of a scarp along the Owens Valley fault and Highway 395 is at the base of the scarp. The scarp continues north from the gravesite, and can be seen as an east-facing scarp on the west side of the highway for several miles to the north of Lone Pine.







↑ The boulder-covered Lone Pine fault scarp on the left side of the photo extends north for about half a mile.

← The steep boulder-covered slope in this photo is the east face of the Lone Pine fault scarp near Lone Pine Creek. The fault cuts through an alluvial fan, exposing the boulders in the fan. The Alabama Hills are in the middle ground on the right and the crest of the Sierra Nevada is in the distance.

## ② *Mt. Whitney*

Mt. Whitney lies 13 miles west of Lone Pine, and is the highest point along the steep eastern escarpment of the Sierra Nevada. This escarpment is a deeply eroded fault scarp that was formed by faulting along the Sierra Nevada fault zone. During the last five million years, the Sierra block was uplifted over 10,000 feet along this fault zone. The Sierra Nevada fault zone is not exposed along Whitney Portal Road, but lies along the mountain front where it is buried by alluvium that has washed down from the eroding fault scarp.

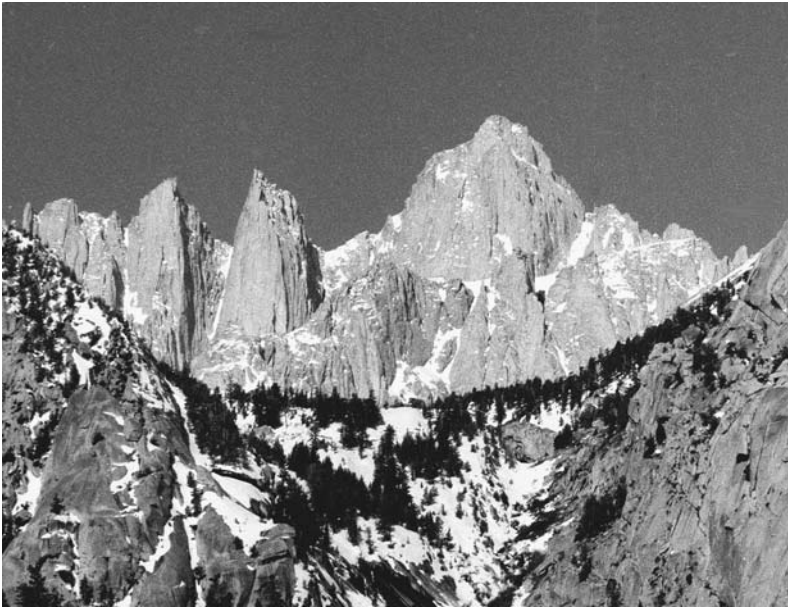
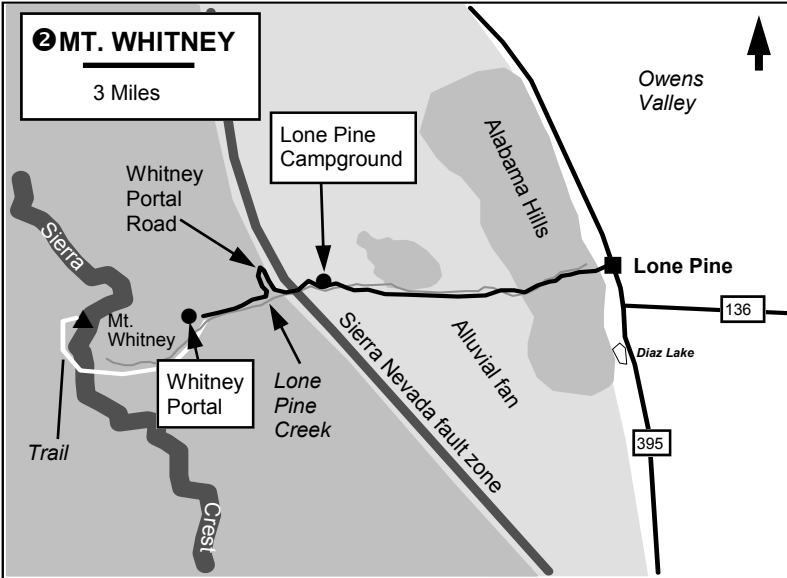
Although you cannot see the other side of Mt. Whitney from here, the west slope of the mountain is quite different. It slopes gently to the west and is part of the old Miocene pre-uplift land surface that has been preserved. The westward tilt of the surface records the westward tilting of the Sierra Nevada block during uplift. This low-relief west-tilted surface occurs along the west side of many peaks along the Sierra crest.

### ***Lone Pine Campground*** - From Lone Pine go 8 mi. W on Whitney Portal Rd.

The Lone Pine Campground is near the top of the large alluvial fan that extends from the Sierra Nevada mountain front to the Alabama Hills. The alluvial fan rises 3,000 feet as you climb up Whitney Portal Road from the Alabama Hills. The fan is composed of rocks and debris that have eroded from the uplifted Sierra block to the west. Note the many large granite boulders on the upper part of the fan that have eroded from the fault scarp.

### ***Whitney Portal*** - From the Lone Pine Campground drive 5 mi. W to the end of Whitney Portal Rd. If you wish to go to the summit of Mt. Whitney, a permit is required. From Whitney Portal, the summit is a strenuous 21.4-mi. round-trip hike along the rugged Mt. Whitney Trail.

Just west of the Lone Pine Campground, Whitney Portal Road leaves the alluvial fan along the mountain front and begins its steep climb up the eroded fault scarp of the Sierra Nevada fault zone. Along the road there are many exposures of medium gray granodiorite with dark xenoliths. This granodiorite is part of the Whitney Intrusive Suite, a large granitic intrusion that extends from here through Mt. Whitney to Roads End in Kings Canyon National Park. The steep east face of Mt. Whitney has a large number of vertical indentations that give this side of the mountain a fluted appearance. These indentations are formed by intersecting vertical joints in the granodiorite. The granodiorite breaks into blocks along these joints, aided by the freeze and thaw action of water. This type of erosion is common in the High Sierra where rocks are jointed, and where there is water and freezing temperatures.



The steep butresses on the east face of Mt. Whitney are formed by intersecting vertical joints in the granite. This photo was taken from near Whitney Portal.

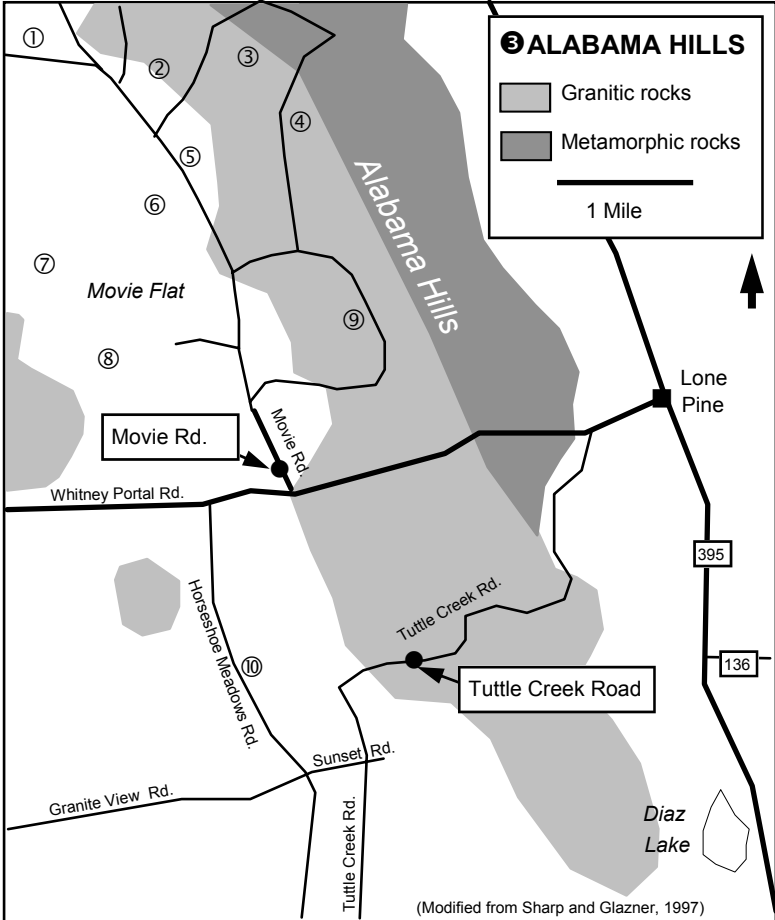
### ③ **Alabama Hills**

The Alabama Hills are famous for the scenic rounded rocks that have formed the backdrop for some 200 movies and many television programs. The rocks of the Alabama Hills are the same granitic and metamorphic rocks that occur in the Sierra Nevada. However, the granite in the Alabama Hills is not clean and fresh like the granite in the High Sierra, but is deeply weathered and crumbles easily. The granite is cut by a number of joints, and the deep weathering of the granite along these joints has given the Alabama Hills their striking scenery.

The granite of the Alabama Hills is typically cut by three sets of joints, two vertical and one near horizontal. If all three sets of joints are well-developed and equally-spaced, they cut the granite into cubes. However, in most areas, the joints are irregular and discontinuous. Some joints are wide-spaced and others close-spaced. In some places, vertical joints are dominant. In other places, horizontal joints are dominant. These irregular and discontinuous joints cleave the granite into a variety of slabs, spires, ledges, and blocks.

The joints provide pathways along which the granite has been subjected to weathering and decomposition. Much of the weathering probably took place prior to uplift of the Sierra Nevada. At that time, this area had heavy rainfall and the granite was covered by thick soil and vegetation. Under these humid conditions, the joints were wet much of the time and the granite along the joint surfaces rapidly disintegrated into quartz grains and clay. The sharp edges and corners of the jointed blocks were rounded more rapidly than the flat surfaces because the edges and corners had more surfaces that were subjected to decomposition. In this manner, cubes of granite were rounded into boulders, spires were rounded into columns, and slabs and ledges developed curved edges.

When the Sierra Nevada block was uplifted during Plio-Pleistocene time, the Alabama Hills came into the rain shadow of the new mountains and the climate of the Alabama Hills became arid. Under these arid conditions, the soil cover was removed from the granite, the joints were cleaned out, and the rounded rocks were exposed in their full glory. The rocks were no longer buried under a deep cover of soil and vegetation. Since the Alabama Hills were not uplifted with the Sierra Nevada, they were never subjected to glaciation. If the Alabama Hills had been glaciated, the glaciers would have cleaned off the loose decomposed rocks and left fresh clean granite like you see in the High Sierra.



**Movie Locations**

- ① Stuntman Canyon
- ② "Rawhide" (Susan Hayward and Tyrone Power)
- ③ Hopalong Cassidy (Ambush Rock)
- ④ Gene Autrey Rock
- ⑤ "Lone Ranger" Canyon
- ⑥ Area used by Gene Autrey and Roy Rogers
- ⑦ "How the West Was Won" Cinerama
- ⑧ "High Sierra" (Humphrey Bogart)
- ⑨ "Yellow Sky" (Gregory Peck)
- ⑩ "Gunga Din"

**Movie Road** - From Lone Pine, go W on Whitney Portal Rd. 3 mi. to Movie Rd.; turn right and drive 0.5 mi. to Movie Flat.

Only the first part of Movie Road is paved. After that, it becomes a good gravel road. Dozens of dirt roads branch from this road, leading to many scenic locations. If you are interested in movie locations, get one of the guidebooks available locally. With these guides, you can find the locations of specific scenes from your favorite movies.

When looking at a specific rock outcrop in the Alabama Hills, try to identify which joints formed the feature. If one set of vertical joints dominate, you will see vertical slabs. Spires and columns are formed from intersecting vertical joints. Rounded boulders and blocks form where vertical and horizontal joints are all well-developed. Ledges form where there are good horizontal joints. Also, note that the surface of the granite is rough and that the grains of quartz and feldspar easily rub off the decomposing granite. These coarse grains form the sandy floor of Movie Flat.

**Tuttle Creek Road** - From Movie Rd. go W on Whitney Portal Rd. 1 mi.; turn S on Horseshoe Meadows Rd.; go 2 mi. and turn E on Sunset Rd.; go 0.2 mi. and turn left on Tuttle Creek Rd.; follow Tuttle Creek Rd. back to Whitney Portal Rd.

Narrow, winding Tuttle Creek Road follows Tuttle Creek as it cuts across the southern part of the Alabama Hills. From this road, there are many excellent views of odd-shaped jointed and rounded granite. Some of these picturesque rocks have been given names such as The Owl, Polar Bear, Walrus, Eagle, The Bishop, Peter's Pumpkin, and Cougar. Local guidebooks will identify this cast of characters.



The rounded granitic rocks of the Alabama Hills are in the foreground and Mt. Whitney in the center background.



The vertical joints are well-developed in this granite in the Alabama Hills. Note the rough texture on the surface of the weathered granite in the left foreground.



These large granite monoliths in the Alabama Hills are formed from wide-spaced intersecting vertical and horizontal joints. Note the individual for scale.