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Geologic Trips, Sierra Nevada

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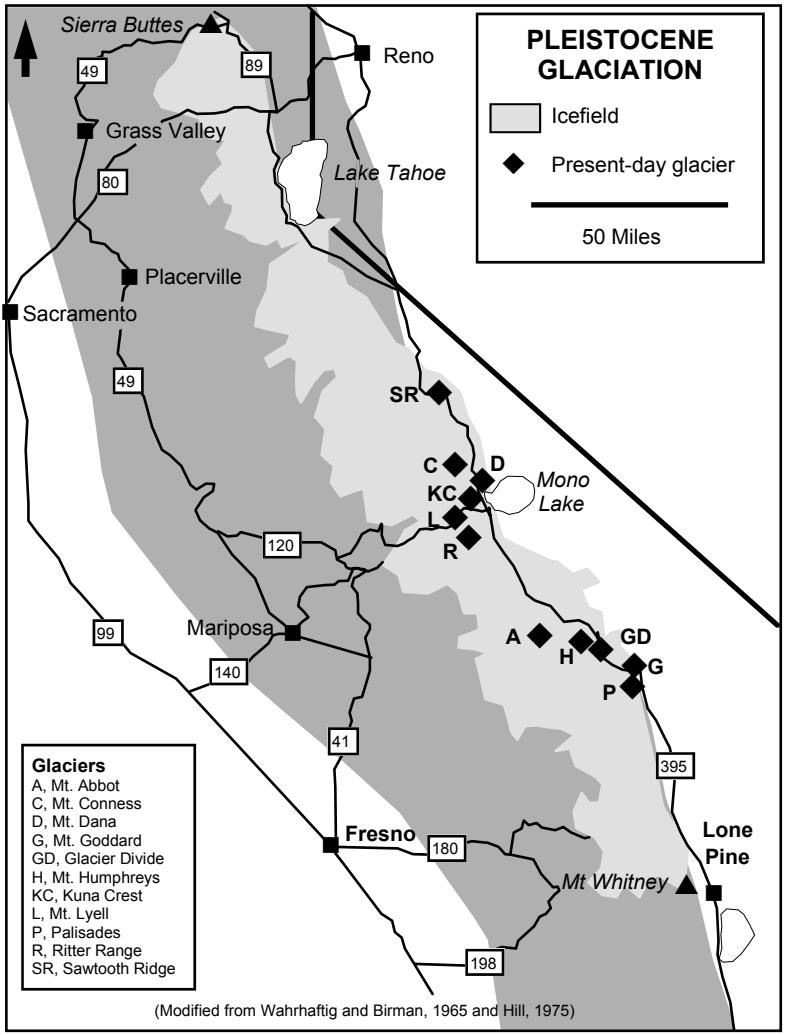


GLACIAL EPISODES Sierra Nevada	
Glacial episode	**Years before present**
Tioga	19,000-26,000
Tahoe	70,000-150,000
Sherwin	about 1,000,000
McGee	about 1,500,000

GLACIATION

During the last two million years, glaciers have covered the high country of the Sierra Nevada a number of times. The glaciers carved mountains into new shapes, deepened and steepened valleys, formed hundreds of lakes and waterfalls, and left mounds of clay, sand, gravel, and boulders scattered throughout the Sierra. Glaciers have had a profound affect on the landscape of the Sierra Nevada, and the results of their work can be seen almost everywhere in the mountains.

Four major episodes of glaciation are generally recognized in the Sierra Nevada. From oldest to youngest, these are the McGee, Sherwin, Tahoe, and Tioga. During each episode, a thick sheet of glacial ice covered the high country from Mt. Whitney north to the Sierra Buttes. The areas that were covered by these icefields have been stripped of their soil cover, leaving fresh rocks exposed. The landscape in these areas is dotted by lakes that were scoured by the ice and punctuated by craggy peaks that once poked through the icefield.

Many rivers of ice spread out from the icefield. To the west, glaciers flowed down the valleys of the Kings, San Joaquin, Merced, Tuolumne, Stanislaus, Mokelumne, American and Yuba Rivers. To the east, the icefield sent tongues of ice over the crest of the Sierra and down many of the steep canyons of the eastern slope, such as Lee Vining Creek, Rush Creek, McGee Creek, and the Truckee River valley.

During each glacial episode, the icefield and the glaciers pulsated with numerous advances and retreats. At the end of each glacial episode, the glaciers retreated up their respective valleys into the icefield, and then the icefield melted. As the glaciers and icefield melted, they deposited mounds of rock that had been carried in and on the ice. These *moraines* of glacial debris have been used to sort out the glacial history of the Sierras. This has been a complex job. The moraines have no fossils, so it is difficult to accurately date the moraines and to correlate the moraines on the east side of the Sierra with those on the west side. In addition, each glacial episode removed and redistributed the earlier moraines. Just bits and pieces of the early moraines remain. Most of the moraines we see today are from the last glacial episode, the Tioga.

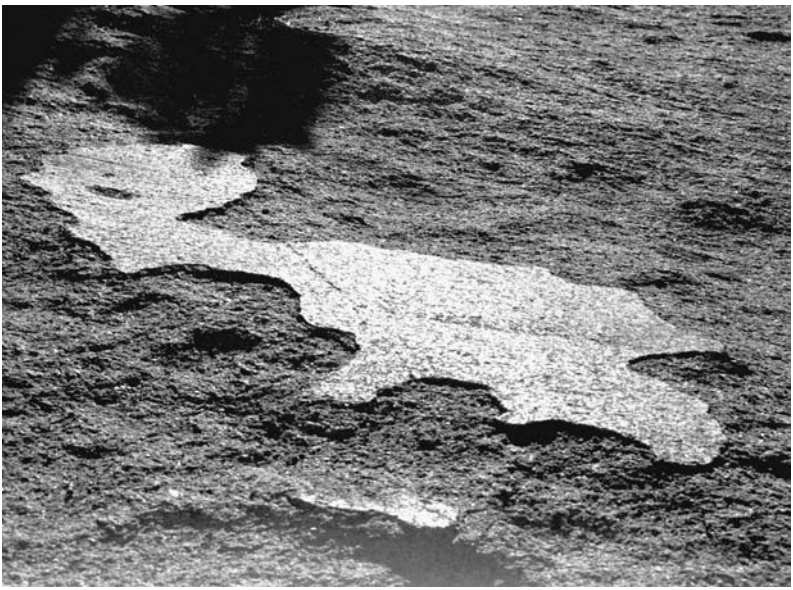
Glacial Erosion and Deposition

A glacier is like a thick river of ice moving slowly down a valley at several inches to several feet per day. The glacier is fed by snow that accumulates in an *icefield* at the head of the valley. The snow turns into ice as it is buried by new snow. Over time, the ice in the icefield can accumulate to thickness of up to several thousand feet. After reaching a critical thickness, the ice flows from the icefield under its own weight, like cold molasses. As the glacier moves down the valley, it scrapes the rocks along the floor and walls of the valley. If the rocks are soft, it gouges out the rocks and leaves indentations in the floor and walls of the valley. If the rocks are hard, the glacier polishes and smoothes the rough edges of the rocks. If the rocks are hard and jointed, the glacier quarries the jointed blocks. As the rocks are removed along the path of the glacier, the walls of the valley become steeper and the floor of the valley becomes wider, giving the valley a "U" shape. As the sides of the valley are steepened, the lower courses of tributary rivers are cut off, leaving the truncated valleys hanging from the sides of the main valley. If some of the rocks in the glaciated valley are soft and some are hard, the glacier will remove the soft rocks, leaving a depression in the valley floor that may later be filled by a lake. Some glacial valleys have a staircase of benches formed when the glacier quarried rocks along vertical and horizontal joints. Other valleys have a chain of lakes, where the lake basins have been cut from the softer rocks. Glaciers on the flanks of the higher mountains carve amphitheaters, called *cirques*. Small lakes, called *tarns*, are commonly scooped out of the rocks at the base of the cirque.

As the glacier scrapes and cuts into the rocks in its path, it carries the rock that has been removed and deposits the rock where the ice melts. The rocks left behind by the glacier are of many different sizes, including clay, silt, sand, gravel, and boulders. Rocks deposited by a glacier are referred to as *till*. Some till ends up in piles of rocks deposited at the end of the glacier or along the sides of the glacier. These piles of till are called *moraines*. *Lateral moraines* are formed along the sides of the glacier. The rocks deposited at the end of the glacier are called *terminal moraines*. Successive piles of till deposited at the end of the glacier while it is retreating are called *recessional moraines*. During retreat, a glacier is simply melting faster than it is advancing. *Medial moraines* form where two valley glaciers join and their lateral moraines coalesce. Terminal and recessional moraines can dam the water in the valley, forming a moraine-dammed lake. Large boulders carried by the glacier and left behind after the glacier melted are called *erratics*.

By the end of the last glacial episode, the Tioga, all of the glaciers in the Sierra Nevada had completely melted. Since then, there have been several periods during which small glaciers have formed on the higher peaks. These glaciers have advanced and retreated during historic time, in response to variations in historic climate.

Presently, there are about 80 glaciers in the Sierra Nevada. These are all on the east or northeast sides of mountain peaks and at elevations greater than 10,500 feet. The largest of these is the Palisade glacier, which covers about one-fourth of a square mile. Another well-known glacier is the Mt. Dana glacier on the northeast side of Mt. Dana south of Tioga Pass.



The polish on this granite at Olmstead Point was formed during Pleistocene glaciation when a thick icefield moved across this area. Most of the polish has been destroyed by weathering in the 10,000 years since glaciers melted, but some patches like this remain. Striations on the polished surface indicate the direction of ice movement. This patch is about a foot long.