Sutter Buttes State Park

An Isolated Occurrence?

Features:
Volcanic geomorphology of an oddity

The Sutter Buttes' pristine shape has not been greatly modified by glaciers, subsequent eruptions, massive landslides, or earthquakes. In California, other volcanoes belong to chains or aligned clusters, such as: 1) the Cascade Range, 2) clusters in the Coast Ranges, or 3) along highly deformed rift zones along the eastern edge of the Sierra Nevada. In contrast, the Sutter Buttes volcano is isolated far from other volcanic activity. The origin of the Sutter Buttes has puzzled generations of scientists. At first glance, the buttes seem to align with the great Cascade volcanic chain that includes Mounts Shasta and Lassen; however, that chain actually swings eastward into the Sierra Nevada. The age of the volcanic rocks that make up the buttes more closely corresponds with the northern volcanic fields in the Coast Ranges (the closest of which is to the west at Mount Konocti towering over Clear Lake State Park); but the Sutter Buttes are way off that track—an outlier.

Volcanic Domes

From a distance, the Buttes tower above the flat valley floor rising above the plain like a castle, surrounded by a moat, and built upon a mound or rampart. Ancient landslide deposits mantle the lower slopes of the domes. Along the perimeter of the Buttes,

Why it's important: The Sutter Buttes are the remains of a period of violently active volcanic eruptions between 1.35 and 1.6 million years ago. The origin of the Sutter Buttes has been hotly debated. The volcanic activity has been variously related to the Cascade Range to the North, to the Sonoma volcanics to the south and west, and to plate tectonic interactions deep below the terrestrial crust.

the generally flat-lying sedimentary rocks of the valley were upturned by the upward movement of molten lava from below. Most of the upturned sedimentary rock has been subsequently buried beneath an apron of debris and ash deposits; but where exposed to erosion, the sedimentary rocks erode faster than the harder volcanic rock—leaving a circular trough that resembles a moat. The geologic map of the Sutter Buttes looks like a ten mile diameter dart-board. The bull's eye (one-half mile across) consists of deposits of an extinct lake that occupied the center of a broad (three-mile diameter) volcanic dome. Surrounding the dome is a narrow (less than one-quarter mile wide) circular trench (moat) partially occupied by a dozen or more small domes. This ring is surrounded by a broader (2.5-mile-wide) outer ring of ash and debris flow deposits (rampart). Beyond the outer ring are the generally flat-lying sedimentary rocks of the Sacramento Valley.

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The state park occupies the northeastern quadrant of the Buttes although it does not extend all the way from the central castellated core to the outer ramparts. Beautiful Peace Valley—the centerpiece of the state park—lies within the trough (moat), walled in by steep volcanic domes. In one small outcrop, on Cemetery Hill, the vertically upturned sandstone beds of the valley floor are exposed. Adjacent to the park, North Butte towers over Peace Valley.

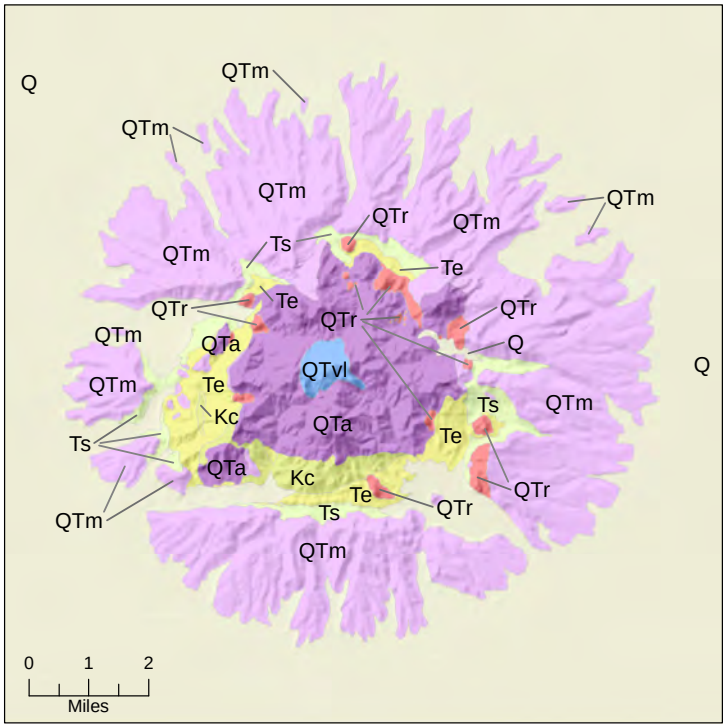
What you can see: Within and surrounding the park are volcanic domes and flows situated anomalously in the center of the Great Valley Geomorphic Province. Peace Valley is an elongate interior valley surrounded by layered accumulations of volcanic flows, ash, and debris.

Landscape Formation

From about 2.5 to 1.4 million years ago, the Sutter Buttes developed as a series of small molten bodies of magma that rose like thick, hot toothpaste through one mile of sedimentary rocks to protrude above the valley floor surface. The molten bodies cooled significantly and mostly crystallized as they ascended. Near the intrusions, the flat-lying sedimentary blanket was tilted to near-vertical as the hot blobs rose. Some molten rock erupted onto the surface leaving hot ash and debris deposits that tilt valley-ward. Chemically, the magma bodies were of two distinct compositions that formed different rock types—andesite and rhyolite. Abundant, glassy quartz crystals in the rhyolite distinguish it from the andesite. Andesite forms the main central dome; while rhyolite forms most of the smaller domes encircling it. How and why two distinctly different magmas extruded to create the Buttes remains a mystery.

Over the roughly 1 million year period of formation and the subsequent 1.4 million years, the forces of erosion have been at work. During the early history of the Buttes, the climate was much wetter as glaciers advanced in the Sierra Nevada and Cascade Ranges. Although the Buttes are high enough to receive snow, there is no evidence of glaciers having been in the Buttes. Episodes of torrential rain washed the ash and debris onto the sloping flanks (rampart) of the Buttes.

Geological Relief Map of Sutter Buttes



Lithology

- Kc, Cretaceous marine deposits
- Q, Quaternary sediments
- QTa, Andesite and dacite domes
- QTm, Rhyolite ramparts
- QTr, Rhyolite domes
- QTvl, Lake bed deposits
- Te, Landslide deposits
- Ts, Tertiary marine and river deposits

Original mapping from Williams and Curtis (1977), and Thamer (1961). New mapping by Brian Hausback. Modified from USGS Fact Sheet 2011-3024, March 2011.

During the earlier period of volcanic activity, the landscape and drainage system was in a state of change. Landslides tumbled off the newly prominent peaks during this period. Old landslide deposits mantle the base of the domes with low-lying hills, peppered with slabs and blocks of rock. An acidic lake at the center of the Buttes received copious volcanic debris and eroded sediments. Eventually, the slopes stabilized and the current radial drainage pattern developed taking water away from the center of the Buttes and toward the Great Valley. Like the volcanism, the central lake is now long extinct. Remnants of the hardened lake deposits (approximately 1,000 feet of re-worked volcanic tuff and ash) have been mapped at the center of the bull's-eye.

Final Thoughts

The modern topography evolved as erosion etched the assemblage of volcanic and sedimentary rocks. The older, weaker sedimentary rocks (sandstone and shale) weathered and eroded quicker than the surrounding new volcanic rock which stands out in sharp relief.

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