3. Field Trip to Lexington Reservoir and Loma Prieta Peak Area in the Southern Santa Cruz Mountains

Trip Highlights: San Andreas Rift Valley, Quaternary faults, landslide deposits, Franciscan Complex, serpentinite, stream terrace deposits, Lomitas Fault, Sargent Fault, Cretaceous fossils, deep-sea fan deposits, conglomerate

This field trip examines faults, landslides, rocks, and geologic features in the vicinity of the San Andreas Fault and other faults in the central Santa Cruz Mountains in the vicinity of both Lexington Reservoir and Loma Prieta Peak (fig. 3-1). The field trip begins at Lexington Reservoir Dam at the boat dock parking area. To get to Lexington Reservoir Dam, take Highway 17 south (toward Santa Cruz). Highway 17 enters Los Gatos Creek Canyon about 3 miles (5 km) south of the intersection of highways 85 and 17. Exit at Bear Creek Road located about 5 miles (8 km) south of Highway 85. Cross the overpass and turn left back onto Highway 17 going north. Stay in the right lane and exit onto Alma Bridge Road. Follow Alma Bridge Road across Lexington Reservoir Dam and turn right into the boat dock parking area about 0.6 mile (1 km) from the exit on Highway 17 north. A Santa Clara County Parks day-use parking pass is required to park in the paved lot. The park day use pass is $5. Vehicles can be left here for the day to allow car pooling (the park is patrolled, but as always, take valuables with you).

Detailed geologic maps, cross sections, and descriptions featuring bedrock geology, faults, and landslide information useful for this field-trip area are available on-line at the *USGS San Francisco Bay Region Geology* website [http://sfgeo.wr.usgs.gov/]. McLaughlin and others (2001) have produced geologic maps of the Los Gatos, Laurel, and Loma Prieta 7.5 minute quadrangles that encompass this area. These maps are also consolidated within a research volume on the 1989 Loma

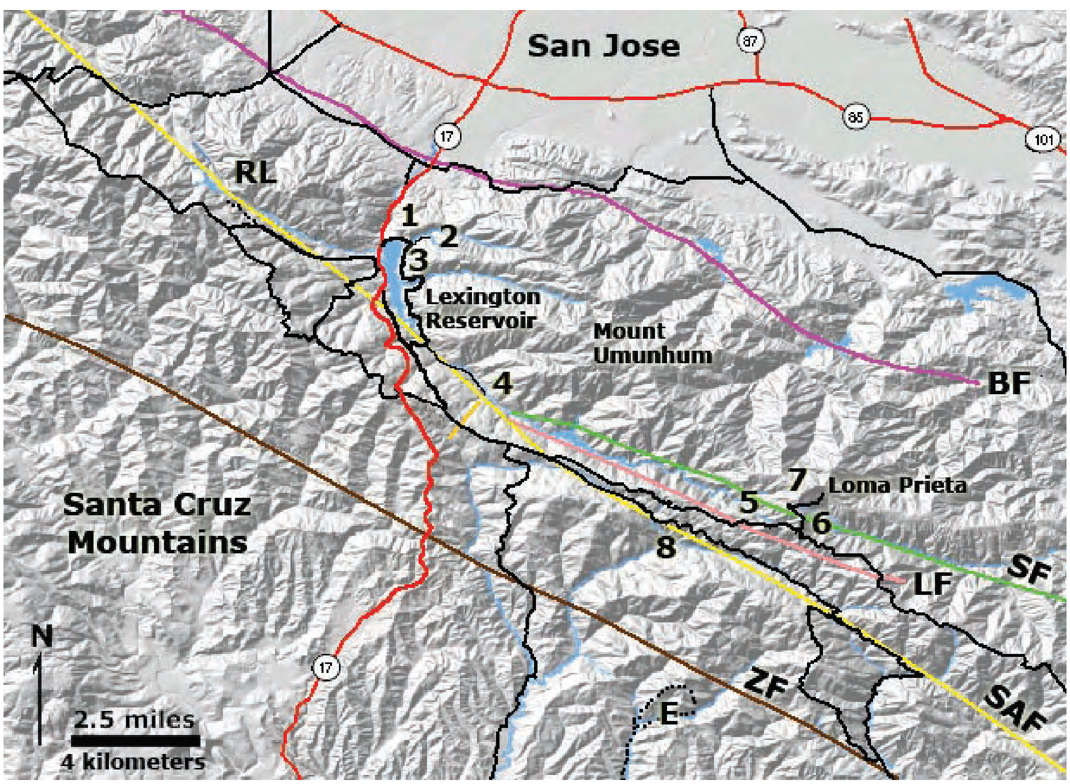

Figure 3-1. Map of the Santa Cruz Mountains between San Jose and Santa Cruz. Numbered stops (1-8) are part of this field trip. Faults shown in colors include the San Andreas Fault (SAF), the Lomitas Fault (LF), the Sargent Fault (SF), the Berrocal Fault (BF), and the Zayente Fault (ZF). Wrights Tunnel is shown in orange (at Stop 4). This map also shows other field-trip options in the vicinity that involve hiking. These include the Big Slump Trail to the epicenter of the 1989 Loma Prieta Earthquake in the Forest of Nisene Marks State Park (E) and a trail to Lake Ranch Reservoir (RL) in Sanborn County Park. The location of Wrights Tunnel is shown in orange at Stop 4.

Prieta earthquake edited by Wells (2004). Wentworth and others (1998) is a regional geologic map of the San Jose 30’ x 60’ quadrangle, and Brabb and others (1997) is a map of Santa Cruz County (see the reference list below).

The Santa Cruz Mountains segment of the San Andreas Fault extends from the San Juan Bautista area northward to Black Mountain. To the south of San Juan Bautista is a creeping segment that extends southward to the Parkfield area in central California. North of Black Mountain is the Peninsula segment that has remained essentially locked since the 1906 earthquake. The Santa Cruz Mountains segment, which experienced between 3 to 6 feet (1 to 2 m) of offset during the 1906 earthquake, was the locus of nearly a dozen magnitude 4-to-5-range earthquakes in the two decades preceding the magnitude 6.9 1989 Loma Prieta earthquake. These earthquakes occurred on the main trace of the San Andreas Fault and on other local faults that splay from the main trace.

Bedrock to the northeast of the San Andreas Fault in this region includes massive slivers or blocks of complexly faulted and folded terranes of the Franciscan Complex and Great Valley Complex. The Sierra Azul Block is an about 2.5 mile (4 to 5 km) wide belt of Great Valley Sequence (Mesozoic and early Tertiary sedimentary rocks) wedged between the San Andreas Fault and a system of ancient faults that roughly parallel the eastern side of the crest of the Sierra Azul Ridge. The northern extent of the Sierra Azul Block is near Wrights Tunnel south of Lexington Reservoir. The New Almaden Block is on the east side of the Sierra Azul Block and consists of Mesozoic age Franciscan Complex (chert, mudrocks, limestone, and basaltic volcanic rocks) and Coast Range Ophiolite (Jurassic-age serpentinized ultramafic rocks) that crop out in a belt extending from Gilroy northward through the Los Gatos-Lexington Reservoir area. Serpentinite exposures at the summit of both Mount Umunhum and Loma Prieta are part of the New Almaden Block. The New Almaden Block is also host to the cinnabar-bearing silica-carbonate deposits and includes the historically largest mercury production district in North America.

Bedrock west of the San Andreas Fault is part of the Santa Cruz Block that consist of late Tertiary marine sedimentary rocks that overlie Salinian crystalline basement rocks (granitoid, diorite, and gabbro that intruded older Paleozoic and Mesozoic metamorphic rocks). These crystalline basement rocks are exposed to the south in the Watsonville-Aromas area and to the northwest on Ben Lomond Mountain.

Road Log From Lexington Reservoir Dam to the Loma Prieta Summit Area

Distance	Description
0.0 mi (0.0 km)	**Stop 1—Lexington Reservoir Dam boat dock parking area** (see description below). Restrooms are available here, albeit primitive. After the stop, turn right when you leave the parking area and continue south on Alma Bridge Road. **Reset your trip mileage odometer to zero** as you leave the boat dock parking area.
0.4 mi (0.6 km)	The entrance to Lexington Quarry is on the left. A large quarry in the Franciscan Complex exposed along the Limekiln Creek valley produces crushed sandstone for construction aggregate.
0.6 mi (1.0 km)	**Stop 2—The Limekiln Trail** (see description below). Parking for about 10 vehicles is available here at the trail head. After the stop, continue south on Alma Bridge Road.
1.6 mi (2.6 km)	**Stop 3—Douglas B. Miller Picnic Area** (see description below). This is both a field-trip stop and lunch stop. Restrooms are available, albeit primitive. After the stop, continue south on Alma Bridge Road.
2.4 mi (3.9 km)	Alma Bridge Road winds into and out of Soda Springs Creek Canyon. Soda Springs road intersects Alma Bridge Road on the left (east). This road winds upward to the summit of Mount Thayer (mostly private land). A significant fire burned much of the hillsides along the east side of Lexington Reservoir in 1985 and threatened or damaged homes in the hills. The mostly chaparral-covered hills were more forested before the fire. The new vegetation is now a significant fire hazard during the dry summer-fall fire season.
4.1 mi (6.6 km)	Intersection of Alma Bridge Road with Aldercroft Heights Road. Turn right (west) on Aldercroft Heights Road. The bridge over Los Gatos Creek is labeled Alma Bridge 1952. **Stop 4—Wrights Tunnel (Optional; see discussion below).** Wrights Tunnel is a historic railroad tunnel that is now abandoned and sealed shut. It was severely damaged by the 1906 earthquake. The tunnel entrance is accessible via a trail between Aldercroft Road and Wright Station Road (to the south) and is downstream of Austrian Dam/Lake Elsman in the upper Los Gatos Creek drainage. Field trips can have access to this area with permission from the San Jose Water Company. Be aware that there is an abundance of poison oak along the trails and near the tunnel. Small dams, dikes, and ruins associated with the old, abandoned train line and station can be seen in the forest and along the trails that follow Los Gatos Creek.
4.6 mi (7.4 km)	An outcrop of serpentinite is visible along the left side of the
4.7 mi (7.6 km)	Intersection of Aldercroft Heights Road with the Old Santa Cruz Highway, turn left (south).
5.2 mi (8.4 km)	Along this section of the Old Santa Cruz Highway the soil along the road cuts changes consistency, becoming increasingly sandy, and redwood groves thrive (regrowth of the older lumbered forest). The change in soil reflects the transition of bedrock, soil, and vegetation across the San Andreas Fault Zone. However, the trace of the fault in not apparent along the highway.

Continued.

6.4 mi (10.3 km)	Mountain Charlie Road is on the right. This is a remnant of an early trail that crossed the Santa Cruz Mountains in the late 18th century connecting Mission Santa Clara with Mission Santa Cruz (probably following existing Indian trails). The trail, and the road system that followed, utilized a low divide along the ridge crest called Patchen Pass. As mining, lumbering, and other regional commerce grew, the need for a road across the mountains led to the establishment of the Santa Cruz Turnpike Company which, in turn, awarded a road-building contract in 1858 to one of the early white settlers in the area, Mountain Charlie McKiernan. This road roughly ran parallel to the modern Highway 17 and still exists as part of Mountain Charlie Road, which intersects Summit Road east of Highway 17. The name Patchen comes from an original settlement located near the summit.
8.4 mi (13.5 km)	Intersection of Old Santa Cruz Highway and Summit Road. Turn left (east) onto Summit Road.
10.2 mi (16.4 km)	Walkway overpass crosses Summit Road at school. This area experience extensive damage to property as a result of numerous surface ruptures from the 1989 Loma Prieta earthquake. Most of the surface ruptures were a result of the gravitational collapse of the mountaintop area during the shaking caused by the earthquake. The combined effects of earthquake shaking and the gravitational pull-apart of the mountain are called ridge-top spreading. All of the visible damage has been repaired and is no longer obvious today. However, the surface rupture effects of the 1989 Loma Prieta earthquake are still visible in remote sections of the Forest of Nisene Marks State Park (see the field-trip discussion in chapter 4).
10.8 mi (17.4 km)	Old School Vineyards are on Right. Summit Road straddles the San Andreas Fault Zone for the next quarter mile, but landscape features do not make the transition apparent.
11.0 mi (17.7 km)	Summit Center Market is on the left. (Food and a restroom are available here.)
11.2 mi (18.0 km)	Soquel-San Jose Road is on the right. To the east of this intersection, Summit Road enters a straight wooded canyon of Laurel Creek that defines the rift valley of the San Andreas Fault. Look for geomorphic features along the road that reveal the trace of the fault.
12.2 mi (19.6 km)	Summit Road ascends into a flat area where a number of sag ponds can be seen along the right side of the road.
12.9 mi (20.8 km)	Intersection of Highland Way and Mount Bache Road. Continue strait onto Mount Bache Road. Highland Way descends into headwaters region of Soquel Creek, which drains a straight valley along the San Andreas Fault (see Stop 8 below). **Be cautious driving on Mount Bache Road**. Although the road is paved, it is windy, narrow, and uneven due to slumping in many places. Vehicles traveling downhill may have more difficulty stopping that those traveling uphill.
13.9 mi (22.4 km)	Mount Bache Road ends where Loma Prieta Avenue comes in from the left and continues uphill. Proceed straight onto Loma Prieta Avenue (continuing south).

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14.4 mi (23.2 km)	Outcrops of steeply dipping and contorted sandstone and shale beds start to appear in cuts along Loma Prieta Avenue (continuing uphill). These are discussed in stops 4 and 5.
16.2 mi (26.0 km)	**Stop 5—Loma Prieta Avenue** (see description below). A parking area is on the right surrounded by large boulders and a gate (do not block the gate—the steep dirt road is used for back country patrols by open space rangers). Additional pulloffs are ahead on either side of the road where Loma Prieta Avenue crosses a narrow divide between the headwaters canyon of Los Gatos Creek on the left (north) and Soquel Creek in the San Andreas Rift Valley on the right (south). After the stop, continue south on Loma Prieta Avenue. The pavement eventually ends, but the graded road is maintained and is suitable for any passenger vehicle.
17.1 mi (27.5 km)	**Stop 6—Intersection of Loma Prieta Avenue with Mount Madonna-Summit Road.** A road to Loma Prieta Peak area is on the left. (See description below.) After the stop, turn left on the road leading to Loma Prieta Peak. (The no-trespassing sign is not enforced in this lower section of the road, however farther along the road gates indicate where private property begins). The road is rough, but is passable up to a large dirt parking area near the intersection of three private roads.
17.3 mi (27.8 km)	Along the route uphill toward Loma Prieta Peak, roadside outcrops of interbedded Late Cretaceous sandstone and shale give way to conglomerate. This, in turn, gives way to exposures of serpentinite of Jurassic age. This transition marks the location of the fault zone of the Sargent Fault (also visible at Stop 7). Intermittent views of the southern Santa Clara Valley are on the right.
17.5 mi (28.2 km)	**Stop 7—Loma Prieta summit parking area** (see description below). A relatively large parking area is located on the left near the intersection of a gated road to Loma Prieta Peak and another unpaved road that leads downhill toward private residences built on the east side of Loma Prieta Peak. A third road (with a gate) leads north along the ridgeline of Sierra Azul ridge. Do not attempt to procede into these areas without permission. After the stop, return down Loma Prieta Avenue to Mt. Bache Road.
23.0 mi (km)	At the Intersection of Mount Bache Road and Highland Way turn left (south). Highland Way descends into the upper valley of Soquel Creek that is also the rift valley of the San Andreas Fault. Highland Way is a road destined for trouble—for much of the next 6 miles the road crosses Quaternary landslide deposits. The rugged condition of sections of the road suggests that parts of the landslide complex are still actively moving. The San Andreas Fault follows the west side of the valley near creek level but buried beneath landslide deposits.
26.0 mi (41.8 km)	**Stop 8—Landslide on Highland Way** (see description below).
26.3 mi (42.3 km)	**End of field trip.** A trail head for the Soquel Demonstration Forest and the Forest of Nisene Marks is on the right (farther south) along Highland Way. Parking is available here for paths that lead to the epicenter area for the Loma Prieta earthquake of 1989. Turn around here and return to Highway 17 using Summit Road. Alternatively, continue south along Highland Way and Buzzard Lagoon Road to get to Santa Cruz-Watsonville area and to Highway 1.

Stop 1—Lexington Reservoir Dam Boat Dock Parking Area

Stop highlights: View of the San Andreas Fault Rift Valley, a range-front thrust fault, Franciscan Complex, graywacke

Lexington Reservoir Dam is located about 1.5 miles (2.4 km) above the mouth of Los Gatos Creek Canyon (at the town of Los Gatos). The dam was renamed the James J. Lenihan Dam in 1997 to honor a former director of the Santa Clara Valley Water District. Two small communities, Lexington and Alma, existed in the upper, broad valley of Los Gatos Creek before the reservoir was constructed. The dam and reservoir were completed in 1952. The dam was built for flood control and to moderate the flow of water to Vasona Reservoir and groundwater-recharge percolation ponds farther downstream in the Campbell area.

Below the dam, Los Gatos Creek Canyon separates El Sereno (the mountain on the west side of the canyon) and St. Joseph's Hill (to the east; it is part of the Sierra Azul Open Space Preserve). A trail system between Los Gatos and the reservoir traverses the canyon and the eastern hillsides. Rocks exposed in the canyon and along the trails include sandstone, conglomerate, chert, basaltic volcanic rocks, and serpentinite and greenstone. The rocks are fragmented into car- to building-sized blocks and mixed together. Where these materials are too small to be differentiated into map units they are collectively assigned to a unit called a *mélange* (meaning mix of rocks). In some areas, belts of similar rock types can be mapped over many miles. The large blocks are bounded by faults that predate or are concurrent with the local development of the San Andreas Fault system in late Tertiary time. One large block of sandstone and mudrock of Cretaceous age is partially exposed in the cut across the road and in the hillsides below the boat-dock parking area.

The view to the southwest across Lexington Reservoir reveals the trace of San Andreas Fault (fig. 3-2). It forms a sidehill bench (a break in the slope) across the hillside on Castle Rock Ridge in the distance. Conifers grow on the uphill, steeper slope on the west side of the fault. The trace of the fault continues north into Lyndon Canyon that separates El Sereno Ridge (on the right) and Castle Rock Ridge (on the left). To the south, the trace of the San Andreas Fault follows upper Los Gatos Creek before ascending over the ridge along Summit Road along the crest of the Santa Cruz Mountains.

In this region of the Santa Cruz Mountains, the rocks east of the San Andreas Fault consist of three groups—the Coast Range Ophiolite, the Franciscan Complex, and the Great Valley Sequence. The Coast Range Ophiolite is comprised of rocks that formed in the ocean's crust during the Jurassic and Cretaceous periods. These rocks have traveled great distances from their place of origin and consist mostly of serpentinized ultramafic rocks and greenstone. The Franciscan Complex contains of a mix of oceanic sedimentary and volcanic rocks of Jurassic to Cretaceous age; this rock assemblage includes pillowed basaltic volcanic rocks, radiolarian chert, mudrocks, sandstone, limestone, and conglomerate. The basalts represent lava flows that probably formed at or near a mid-ocean ridge. These were overlain by open-ocean and continental margin sediments before being accreted onto the edge of the continent through plate-tectonic motion. The Great Valley Sequence consists mostly of sandstone and shale of Cretaceous age deposited in a fore-arc basin developed between an Andean-style volcanic arc and the associated subduction zone to the west. Younger marine sedimentary formations (including the Temblor Sandstone and Monterey Formation of Miocene Age) occur in the Cupertino basin, a great sediment-filled crustal downwarp located beneath the alluvial plain extending eastward from the foothills in the Los Gatos and Saratoga region and extending to San Jose and southern San Francisco Bay.

Rocks on the Santa Cruz (west) side of the San Andreas Fault are part of the Santa Cruz Block, an expansive geologic terrane that consists mostly of sedimentary rocks overlying older Salinian crystalline basement rocks. In the headwaters region of Los Gatos Creek, these rocks consist entirely of marine sedimentary rocks of early Tertiary age (Butano Sandstone of Eocene age and San Lorenzo and Vaqueros Formation mostly of Oligocene age).

In this region, rocks younger than the San Andreas Fault include the Santa Clara Formation of Pliocene to Quaternary age. The Santa Clara Formation consists of stream cobbles, gravel, sandstone, siltstone, and mudstone, and bears freshwater gastropods, pelecypods, and terrestrial plant and vertebrate fossils that are about 3.6 to 0.4 million years old. Younger terrace gravels along stream valleys incorporate a mix of all the above rock-types mentioned.

A walk down to the shore near the boat dock provides a view of Franciscan rocks (to the east) thrust-faulted over steeply dipping gravels of the Quaternary Santa Clara Formation (to the west). The faulted contact is also visible on the far side of the bay of Limekiln Creek: however the outcrop area may not be exposed at high water levels. The thrust fault is part of the Lexington Fault Zone that runs roughly parallel to the mountain front along the east side of the reservoir. The fault system extends from the park's boat dock parking area southward to where it merges with the San Andreas Fault in the vicinity of Wrights Tunnel (see below). Uplift along the thrust fault and other faults are responsible for the high, rugged topography of the Sierra Azul uplands (for geologic maps and additional information, see McLaughlin and others, 2000). Likewise, the broad valley flooded by Lexington Reservoir may be partly due to tectonic downwarping in addition to the erosional downcutting by Los Gatos Creek.

Stop 2—The Limekiln Trail

Stop highlights: An active slump, a fault, serpentinite, sepentinite soil, vegetation contrasts, graywacke and other rocks

The Limekiln Trail climbs to the summit area of El Sombroso, a high point at the north end of the Sierra Azul Ridge. The destination of this stop is a landslide about 0.25 mile

Figure 3-2. Northwest view from the boat-dock parking area showing Lexington Dam and the location of the San Andreas Fault trace (SAF) on the distant hillside west of Highway 17. The fault trace follows a side-hill bench below the upper steep slopes of Castle Rock Ridge on the horizon. The fault continues northward into the valley of Lyndon Canyon.

(0.4 km) uphill from the trail head (fig. 3-3). The trail climbs a moderate grade before leveling out near the slide area. Do not go on the trail if the park police have closed it (park patrol officers will issue tickets).

The lower part of the trail ascends past outcrops of metabasalt, and sandstone and mudrock (also called graywacke) similar to rocks at Stop 1. The landslide occurs along the east side of a fault separating bedrock consisting of sandstone bedrock and serpentinite. The slump provides an excellent observatory of landslide processes, weathering of serpentinite, stream erosion, and vegetation characteristics associated with serpentinite and sandstone bedrock terranes. Phacoids (lenticular-shaped cobbles and blocks) of serpentinite have accumulated in the stream at the toe of the landslide. Many of these phacoids display grooves, gashes, and a smooth surface polish created by grinding and shearing action within the landslide or within a fault zone before being exposed and transported by erosion. The stream also yields boulders of chert, slate, and rounded stream cobbles derived from sources higher on the mountainside.

A belt of barren, gray limestone outcrops is visible on the upper hillsides across Limekiln Creek valley. In addition, groves of manzanita reveal the presence of serpentinite bedrock along the skyline across the valley. Approximately a mile south of the landslide on the opposite side of the valley is the Lexington Quarry, a large active quarry where rock (mostly metasandstone) is mined and processed into aggregate for construction. Geologic maps of the area show a system of southeast-trending faults through the area. One large fault mapped in this area, the Limekiln Fault, basically follows the trace of the stream valley. The fault exposed along the side of the landslide is only a part of the larger fault system. Be sure to examine outcrops in the creek to the right of the landslide. Note shearing features in the faulted bedrock, and observe the chaotic character of debris-flow deposits along the stream banks.

Figure 3-3. An active landslide along the Limekiln Trail causes trail closure during wet seasons. In recent winters the road has been offset by several feet. During dry months the slide area is relatively safe to examine but be aware that rocks and soil in steep slopes may be unstable from recent movement. The landslide formed in deeply weathered serpentinite, but fresh blocks of rock material have accumulated in the stream at the toe of the slump.

Stop 3—Douglas B. Miller Picnic Area

Stop highlights: An unconformity between weathered Quaternary gravels and Franciscan Complex sandstone

The Miller Point Picnic Area is located on a small peninsula in Lexington Reservoir. Besides being an excellent place for a picnic, the park offers an opportunity to examine rocks exposed along the reservoir shoreline. Large blocks of graywacke sandstone stand out on the shore (during low water). Wave erosion at the high water line has exposed an ancient stream terrace deposit consisting of a mix of gravel derived from upland localities (fig. 3-4). At some places along the shore it is possible to see the gravel resting unconformably on an eroded surface of the older graywacke bedrock. The gravel was deposited along the ancestral Los Gatos Creek. The stream has carved about 65 feet (20 m) deeper into the valley since the time the terrace deposits were formed.

The terrace gravel contains an assortment of different rock types, with sandstone being the most abundant. Rock types at the picnic area but not found at the Limekiln Trail stop (above) include conglomerate and volcanic cobbles (clasts derived from the conglomerate) (fig. 3-5). The volcanic clasts are dominantly andesite and possibly dacite—these volcanic rocks are intermediate in composition between more felsic rock (rhyolite) and mafic rock (basalt). The volcanic cobbles display an abundance of phenocrysts (visible crystal mineral grains) surrounded by a finer ground mass. Some of the cobbles may be the intrusive igneous equivalent, granodiorite, which has the same mineral composition of its volcanic form, andesite. Some of the clasts contain xenoliths (pieces of the original host rock that was intruded by the volcanic material). The occurrences of these clasts in the terrace gravels demonstrate how earth materials are recycled (formed, eroded, deposited, exposed, eroded, and deposited again).

The volcanic cobbles are derived from outcrops of Cretaceous-age conglomerate throughout the upper hillsides of the Sierra Azul. It also forms part of the resistant ridge crest on the southwest side of Mount Umunhum and along the ridge south of Loma Prieta Peak and probably elsewhere under the forest cover. Similar gravel deposits can be found around the parking area at Los Trancos, nearly 14 miles (20 km) to the northwest. The offset of these gravels by the San Andreas Fault helps to determine the rate of slip along the fault over time.

Many of the volcanic clasts in the terrace deposit are rotten—they practically crumble in your hands (fig. 3-5). This is a result of chemical weathering of the rocks in the shallow surface environment (processes associated with soil development). The relationship between deposition of the terrace gravels and the motion along faults affecting stream drainages is unclear. However, the occurrence of terrace deposits in upland valleys elsewhere in the Santa Cruz Mountains and in the region is related to erosional valley-broadening periods during the Pleistocene. This is opposed to valley-deepening periods when streams carve downward into their flood plains. During times of high-standing sea level (during interglacial periods), the rise in stream base level tends to allow streams to backfill their channels with sediment. During wetter periods in the West (associated with glaciation), the combined influence of increased stream flow, reduction in sediment supply (due to increased vegetation), and lowered sea level (due to the formation of continental glaciers) induces streams to carve into their flood plains. Incising streams locally leave bench-like, gravel-covered terraces along the valley sides.

Figure 3-4. Stream boulders and gravel of Quaternary-age deposits overlie Cretaceous-age sandstone bedrock along the shore of Lexington Reservoir at Miller Point Picnic Area.

Figure 3-5. A rotten (partial weathered) cobble a mafic volcanic porphyry has an inclusion of gray metasandstone. This cobble was probably derived from the Late Cretaceous-age conglomerate found on Mount Umunhum and Loma Prieta peaks. That conglomerate originally accumulated in the ocean, possibly at the mouth of a deep-ocean canyon offshore of what is today southern California or Mexico. The sediments were consolidated into conglomerate before being transported northward by plate tectonic motion along the San Andreas Fault and fault systems that predate the San Andreas Fault. Similar blocks of conglomerate bearing clasts of mafic volcanic porphyry occur in gravels of the Corte Madera facies of the Santa Clara Formation exposed at the Monte Bello and Los Trancos Preserves nearly 15 miles (25 km) to the north along Skyline Ridge. The measurable offset of the Corte Madera facies provides information about the timing and rate of movement along the San Andreas Fault.

Stop 4—Wrights Tunnel

Stop Highlights: A historic railroad tunnel built through the San Andreas Fault Zone

Wrights Tunnel (fig. 3-6) was constructed by the Southern Pacific Railroad over (and through) the Santa Cruz Mountains. The tunnel took 3 years to build. During construction in 1879, Chinese laborers excavating the tunnel encountered a source of natural gas that exploded and burned, killing 31 people. The completed tunnel was 6,000 feet long and ran between two historic mountain communities (Wrights Station on the east and Laurel on the west). The tunnel passes beneath Summit Road east of Highway 17. The primary income of the railroad was from tourism between the Bay Area and resorts and recreation in Santa Cruz. The peak in use of the train line through

Figure 3-6. View looking out of the west end of Wrights Tunnel toward Los Gatos Creek. The tunnel is now full of leaking cracks that are feeding a small stream flowing from the mouth of the passage.

the Santa Cruz Mountains was in the 1910s and 1920s, before fading as improvements were made to the highway system through the mountains that provided access to the coast by automobile. The tunnel was dynamited shut in 1942 by the U.S. Army out of fear that it might be used by a Japanese invasion force.

Wrights Tunnel was damaged by the 1906 earthquake (fig. 3-7). The fault rupture offset the tunnel about 400 feet inside the Wrights Station entrance. It took 2 years to rebuild the tunnel. Between 3.5 and 5 feet (1 to 2 m) of right-lateral offset were reported on a strand of the San Andreas Fault in the tunnel (Prentice and Schwartz, 1991); however, analysis of historical documents show that the tunnel was offset a total of at least 5.6-5.9 feet (1.7-1.8 m) (Prentice and Ponti, 1997); the main trace of the San Andreas Fault has been mapped east of the trail entrance (McLaughlin and others, 2001). Some early reports suggest as much as 4 feet (1.2 m) of vertical offset may have occurred. However, modern re-evaluation suggests that the fault zone is about 0.25 mile wide and that a total of 6 feet (2 m) of offset occurred in the vicinity of Wrights Tunnel. The geologic map of Los Gatos quadrangle (USGS Miscellaneous Field Investigation Map 2373) shows that the main trace of the San Andreas Fault is inferred to cross Los Gatos Creek several hundred feet northeast of the east tunnel entrance. Most of the mapped cracks that were recorded from the 1989 Loma Prieta earthquake occurred outside of the zone of faulting that occurred in 1906 in Wrights Tunnel.

Figure 3-7. Damage to the railroad track between Wrights Station (near the tunnel) and Alma caused by the 1906 earthquake. Both historic settlements and the rail line no longer exist. The gravel road now follows the rail path. The photograph is from an unspecified source reproduced by Iacopi (1969).

Please note that there is limited parking and trail access to Wrights Tunnel, and poison ivy is abundant everywhere. The tunnel is closed, and permission for group access to the area is required from the San Jose Water Company.

Stop 5—Loma Prieta Avenue

Stop highlights: Views of the San Andreas Rift Valley and Monterey Bay, Cretaceous fossils, conglomerate, turbidites

A parking area is on the right surrounded by large boulders and a gate (do not block the gate—the steep dirt road is used for backcountry patrols by open space rangers). Additional pulloffs are ahead on either side of the road where Loma Prieta Avenue crosses a narrow divide between the headwaters canyon of Los Gatos Creek on the left (north) and Soquel Creek Canyon in the San Andreas Rift Valley on the right (south). This stop involves a short walk along Loma Prieta Avenue to examine roadside outcrops and the regional landscape. Loma Prieta Peak (covered with radio antennas) is visible on the north side of the road across the headwaters valley of Los Gatos Creek.

On the south side of the road the slope descends steeply into the linear valley of the headwaters region of Soquel Creek (fig. 3-8). The linear character of Soquel Creek canyon reflects the location of the San Andreas Fault. The forested ridge on the opposite side of the canyon is part of the Forest of Nisene Marks (the location of the epicenter of the 1989 Loma Prieta earthquake). The more distant views along the saddle area include a sweeping view to the south toward Monterey Bay and Monterey Peninsula and the Santa Cruz urban coastal corridor.

Other than a few scattered homes and some radio towers, the upland area around Loma Prieta Peak is relatively wild country. The isolated country is prime mountain lion habitat. The west- and south-facing slopes tend to have chaparral to mixed shrub-deciduous forest (particularly bay laurel), whereas the wetter, cooler north- and east-facing slopes are forested with mixed evergreen (spruce-pine-redwoods). However, the character of the bedrock and derivative soil plays an important role in supporting different types of vegetation. Loma Prieta receives the greatest amount of rainfall annually in the South Bay region—on average, mixed precipitation is equivalent to about 60 inches of rainfall.

Figure 3-8. View looking south at the Loma Prieta Road (LPA) saddle area. The rift valley of the San Andreas Fault (SAF) is developed in the headwaters of Soquel Creek (which flows to the right). To the south of a divide in the rift valley is Corralitos Creek that flows south into the Watsonville area (W). A linear ridge and a change in vegetation mark the location of the Lomitas Fault (LF). Seen in the distance are Monterey Bay (MB), and the Santa Lucia Range (SLR), which at the northern end becomes the Monterey Peninsula.

Vegetation and topography reveal the trace of the Lomitas Fault along the hillside about 600 feet (200 m) below the south side of the road (fig 3-9). On the north side of the road, the Sargent Fault follows the valley of Los Gatos Creek (see Stop 6 discussion). Both faults merge with the San Andreas Fault in the area between Wrights Tunnel and Austrian Dam in the upper Los Gatos Creek canyon.

Figure 3-9. Vegetation changes and topography reveal the trace of Lomitas Fault (LF) below the saddle area along Loma Prieta Avenue. Raised relief on the south side of the fault suggests that the Loma Prieta Peak side of the fault dropped relative to the opposite side. However, the fault probably shares the right-lateral motion of the San Andreas Fault and other faults in the region. The valley of Soquel Creek is on the upper right. The stream drains into the ocean in the Capitola neighborhood of Santa Cruz.

Road cuts along Loma Prieta Avenue expose Late Cretaceous age marine sedimentary rocks. The alternating sandstone and shale beds are called turbidites. Turbidites form from sediment-bearing underwater landslides (turbidity currents) that roll down the Continental Slope and spread out on the deep ocean floor. The heavier sand is deposited first (forming sandstone) and the finer silt and clay settle out later (forming mudstone and shale). Turbidites are characterized by graded bedding, moderate sorting, and well-developed primary structures (including traces that reveal current orientation, bedding lamination, and bioturbation features from organisms that fed or lived in the sediment). These deep ocean sediments are now exposed in many areas throughout the Santa Cruz Mountains. The turbidite sandstone and mudstone cut by the construction of Loma Prieta Avenue near the parking area display exceptional examples of spheroidal weathering (the early stages of chemical weathering of freshly fractured rock).

In the middle of the saddle area are outcrops bearing massive sandstone, conglomerate, and fossiliferous marl (bearing oysters, corals, calcisponges, and other invertebrates and trace fossils) (figs. 3-10 and 3-11). The conglomerate bears mafic-mineral bearing volcanic clasts (andesite and dacite) in a fine sandy matrix. These conglomerate beds are likely the source of the deposits seen at the Miller Point Picnic Area (Stop 3). The occurrence of the oyster-bearing beds is unusual. Modern oysters live in brackish, shallow-water environments just as they probably did in Cretaceous time. How this deposit arrived at its location amongst deep-water deposits can only be speculated (perhaps carried down slope as a great submarine landslide after an earthquake, massive storm, or giant tsunami impacted the coast). Elder (1991) provides more information about the paleontology of this site.

Stop 6—Intersection of Loma Prieta Avenue with Mount Madonna-Summit Road

Stop highlights: Cretaceous turbidites, conglomerate, views of the southern Santa Cruz Mountains region

A parking area near the intersection of Loma Prieta Avenue and Mount Madonna-Summit Road is the best place to examine the turbidite beds (alternating sandstone and shale layers). An optional walk (or drive) is to continue along Mount Madonna-Summit Road to examine folds in the sandstone and shale and conglomerate (fig. 3-12). A view of the straight valley of Uvas Creek Canyon and the more distant Santa Clara Valley in the vicinity of Morgan Hill (near El Toro Peak) is approximate 0.2 miles south of the intersection. **Warning: Be cautious of traffic while walking, especially near blind bends in the road.**

Stop 7—Loma Prieta Summit Area

Stop highlights: Views of the Sargent Fault Zone, Sierra Azul Ridge, Mount Umunhum, serpentinite

Figure 3-10. A layer of conglomerate between beds of sandstone. The largest clasts of volcanic rock and sandstone are at the base of the graded bed, suggesting that rock hammer handle is in the direction of the top of the unit. Much more massive beds of conglomerate occur throughout the area along Loma Prieta Avenue and Mount Madonna Summit Road. Conglomerate beds also occur in the western Mount Umunhum summit area.

Stop 7 is along the road to the Loma Prieta Peak summit area (fig. 3-13). An old sign near the intersection of Loma Prieta Avenue and Mount Madonna-Summit Road warns travelers to “keep out.” However, the road is passable to the intersection of three gated roads farther along the route. Proceed up the road for 0.6 miles to a large circular parking area. Along the way, pay attention to the scenery and bedrock changes in

Figure 3-11. Small oysters and calcisponges in a fine mudrock groundmass occur in an outcrop area near the center of the saddle area along Loma Prieta Avenue. Like the conglomerate beds, the oyster shells and other fossil material were probably deposited in a submarine-fan channel far offshore (in a setting perhaps similar to the bottom of submarine Monterey Canyon today). Today, oysters thrive in brackish estuary and nearshore waters but cannot tolerate predation or environmental conditions typical of open-ocean marine waters. These fossil oysters probably lived in a similar habitat.

Figure 3-12. This road cut along Mount Madonna-Summit Road displays sandstone and shale beds (turbidites) and conglomerate cross cut by folds and minor fault offset.

the road cuts. Drivers should pay attention for potholes, but the road is passable for any vehicle. Unfortunately, much of the summit area of Loma Prieta and the passage along Sierra Azul Ridge to Mount Umunhum are closed to the public, although field trips have been granted permission to enter in the past.

Along the route, the road crosses the Sargent Fault (fig. 3-14). The fault is indicated by the transition from conglomerate, sandstone, and shale (turbidites) to serpentinite, as is visible in roadside outcrops. Small pull outs along the route provide scenic vistas to the south and east of the Santa Clara Valley and the foothill country and canyons east of the crest of the Santa Cruz Mountains. The Sargent Fault is considered an earthquake fault—showing active recent seismicity and having

Figure 3-13. Serpentinite forms the core of Loma Prieta Peak. The chaparral- and manzanita-covered mountain top is privately owned, and space is leased for radio towers. The area is closed to public access. This view is from along the road to Stop 7.

Figure 3-14. This view is looking south along the straight canyon of upper Uvas Creek from along the road to Stop 7. The valley follows the trace of the Sargent Fault southward to the Gilroy area and on to Hollister where it intersects the Calaveras Fault. Mount Madonna-Summit Road follows the ridge on the right.

association with damaging earthquakes in historic times in the Gilroy and Hollister region. The fault intersects the San Andreas Fault near Elsman Reservoir (upstream of Wrights Tunnel) and connects with the Calaveras Fault in the vicinity of Hollister. Like all major faults in the area, it displays evidence of right-lateral (dextral) offset. However, evidence of some vertical component offset is suggested by exposures of the fault scarp along the Los Gatos Creek Canyon. The west side of the fault (toward the creek) appears to be raised as much as 200 feet (60 m) relative to the Loma Prieta and Sierra Azul Ridge side of the fault. This perspective is best seen from near the Stop 7 parking area (fig. 3-15).

Figure 3-16. View looking north toward Sierra Azul Ridge and Mount Umunhum. The low section along the ridge is underlain by early Tertiary carbonaceous shale and sandstone (containing land plant material). The higher section of the ridge consists of Cretaceous-age conglomerate. The eastern peak of Mount Umunhum (near the large cement-block-shaped structure of an abandoned military radar facility) consists of a complex mix of rocks, mostly serpentinite, associated with the Coast Range Ophiolite.

The Stop 7 parking area also provides an opportunity to view the crest of the Santa Cruz Mountains extending north to the Mount Umunhum summit area and beyond (fig. 3-16). It also is an excellent location to examine serpentinite outcrops (fig. 3-17).

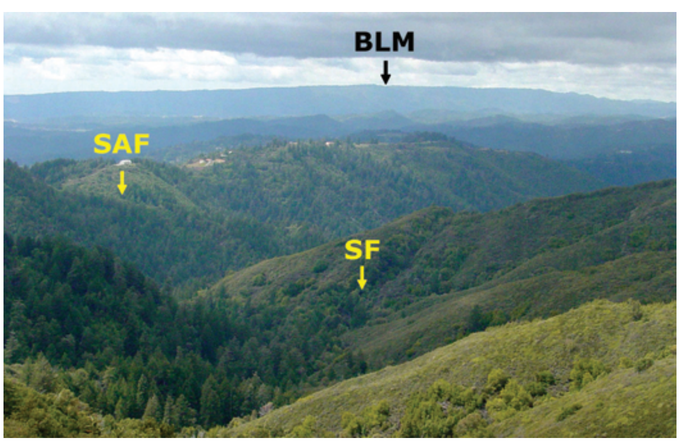

Figure 3-15. View looking west from the Stop 7 parking area. The linear scarp of the Sargent Fault (SF) is highlighted by a line of coniferous forest on its northwest-facing slope. The location where the trace of the San Andreas Fault (SAF) crosses the ridge along Summit Road is visible on the opposite side of Los Gatos Creek Canyon. Ben Lomond Mountain (BLM) is the long, gentle ridge on the western horizon.

Figure 3-17. This view shows part of a large serpentinite block near the Stop 6 parking area. The rock reveals aspects of how mantle rock is converted to serpentinite. Pink crystalline masses are relatively unaltered ultramafic rock (harzburgite and peridotite). These are surrounded by black serpentinized material (resulting in the loss of crystalline texture). The blue veins are asbestoid minerals (mostly crysotile) and magnesium hydroxide-rich minerals. Surficial weathering converts these minerals to magnesium-rich clay soil.

Stop 8—Landslide on Highland Way

Stop highlights: Landslides, Tertiary sandstone and shale, San Andreas Rift Valley

Along Highland Way, about 3 miles (5 km) west of the intersection of Summit Road, are a series of landslides that have frequently closed the road to through traffic. The road was most recently closed by massive landslides that occurred in January of 1997 with additional activity the following year (fig. 3-18). The road has since been repaired, but the fresh landslide escarpments are still visible (even after construction repairs have smoothed out the typically chaotic landscape of a slide area). The steep, forested landscape throughout this area displays abundant evidence of landslide activity—both active slides and other more ancient slides that are probably dormant. A combination of factors makes this area prone to landslides, including:

- long, steep slopes;
- bedrock consisting of sedimentary rock (mostly shale and highly fractured sandstone);
- a seasonally wet period;
- mountain climatic conditions that promote organic activity and associated weathering;
- rapidly down-cutting streams that undermine slopes;
- human activity—particularly their preponderance to cut slopes to build roads; and
- frequent landslide trigger mechanisms, including earth quakes and major storms.

The bedrock exposed in the slide area is interbedded quartz-rich to arkosic sandstone, and shale of early Tertiary age (Eocene Mount Madonna Sandstone; deposited between 34 to 56 million years ago). On the west side of Soquel Creek valley the bedrock is a mudstone of late Tertiary age (Purisima Formation; of Pliocene age, about 3 million years). Marine fossils in the Purisima Formation demonstrate that the Santa Cruz Mountains have risen from below sea level to more than 3,000 feet (1 km) high in roughly 3 million years. In addition, another 10,000 to 13,000 feet (3 to 4 km) of rock has probably been eroded from the crest of the Santa Cruz Mountains in the past 5 million years (McLaughlin and others, 2001).

Many trees in the Soquel State Demonstration Forest (across the valley) were damaged or fell in the 1989 Loma Prieta earthquake. The magnitude 6.9 earthquake occurred on Tuesday, October 17, 1989, at 5:04 p.m. PDT. The epicenter of that quake was located at 37°02'N, 120°53'W, approximately 4 miles (6.5 km) south of the Highland Way slide area in the heart of the Forest of Nisene Marks State Park (see chapter 4). The depth of the main shock was approximately 11.5 miles (18.5 km) below the surface. The fault plane is not vertical, but rather, it dips steeply at a high angle toward the southwest (NcNutt and Toppozada, 1990). The earthquake produced little physical evidence of right-lateral offset on the surface, however the earthquake initiated numerous slope failures and slump-related ground ruptures throughout the Santa Cruz Mountains, particularly along the Summit Road corridor. Near the epicenter, uplift of about 22 inches (55 cm) resulted, whereas east of the fault subsidence occurred in the order of about 6 inches (15 cm) for the area around Loma Prieta peak. Within several miles distance from these areas, the measurable elevation offset diminishes to being negligible.

Figure 3-18. The Highland Way landslide is part of an extensive landslide complex that extends along the east side of the San Andreas Rift Valley in the upper Soquel Creek watershed. Highland Way cuts across the landslide complex and has experienced many landslide-related problems, with the latest massive landslide taking place in January, 1997 which closed the road for several years. Extensive work was conducted to remove dead trees and loose rock before the road could be repaired. This looser material is derived from Tertiary rock which consists of dark, hard, siliceous marine shale with interbedded arkosic sandstone. This sequence of marine strata forms a belt along the eastern side of the San Andreas Rift Valley for many miles extending to the south from the Highland Way landslide area.

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4. Big Slide Trail, Forest of Nisene Marks State Park

Trip highlights: Epicenter of the 1989 Loma Prieta earthquake, landslides, fissures, sag ponds, deranged forest

The magnitude 7.0 Loma Prieta earthquake of October 17, 1989 occurred at 4:15 pm and lasted between 10 and 15 seconds. The epicenter was located in the Forest of Nisene Marks State Park (located about midway between Loma Prieta Peak and downtown Santa Cruz) (see fig. 3-1). The hypocenter (the point at depth where the rupture started) occurred at a depth of 11 miles (18 km), located approximately 4 miles (6 km) west of the surface trace of the San Andreas Fault (the fault plane dips at an angle of about 75 degrees to the west). The rupture of the earthquake propagated through the southern Santa Cruz Mountains for a distance of about 25 miles (40 km) in the area east of Highway 17. It was estimated that as much as 6.2 feet (about 2 m) of horizontal right-lateral displacement and 4.2 feet (1.3 m) of vertical (reverse) displacement occurred, with uplift on the west side relative to the east side of the fault. Debate still continues among scientists on whether the 1989 Loma Prieta earthquake actually occurred within the San Andreas Fault Zone (McNutt and Sydnor, 1990; Wells, 2004).

It is fortunate that the epicenter of this large earthquake happened in such a remote area within the Forest of Nisene Marks State Park. The hike to the epicenter region of the 1989 Loma Prieta earthquake is both long and strenuous, but the rewards are a multitude of views of a damaged landscape and a forest that is recovering from the effects of the earthquake. Shaking from the magnitude 6.9 Loma Prieta earthquake created numerous surface ruptures, sag ponds, and slumps that are still largely visible (figs. 4-1 to 4-3). The most impressive geomorphic features are along the Big Slide Trail that descends from China Ridge into the canyon of Aptos Creek.

Figure 4-1. This pond formed at the head of a great slump along the Big Slide Trail.

Figure 4-2. The landscape reveals many clues to the severity of the 1989 Loma Prieta earthquake. Many trees fell during the earthquake, and whole groves of trees have bent trunks from having adjusted themselves back to a vertical direction after the ground surface rotated in areas of deep-seated slumps.

Starting from the Aptos Creek Road (Santa Cruz) park entrance, park at the picnic area trail head and follow the Aptos Creek Fire Road uphill for about 4 miles (6.5 km). The hike involves an elevation gain of about 1,000 feet (300 m). The Big Slide Trail intersects the fire road on the right. This narrow trail descends gradually at first through a "deranged

Figure 4-3. One of many fissures that opened along the Big Slide Trail during the 1989 Loma Prieta earthquake.

Figure 4-4. The park sign was installed along the Aptos Creek Trail at the location of epicenter of the 1989 Loma Prieta earthquake. This sign is located about one mile east of the intersection of the Aptos Creek Trail with the Aptos Road (trail).

forest" or "drunken forest" (trees lean in unusual ways in many places; fig. 4-2). The trail then descends steeply into Aptos Creek Canyon in an area affected by massive landslides initiated, in part, by the earthquake. Continue downhill along the Aptos Creek Trail to return to the fire road. A sign marking the location of the epicenter is along the Aptos Creek Trail about 0.6 miles (1 km) east of the fire road intersection (fig. 4-4). The complete loop hike is about 11 miles (18 km). Note that the rugged Big Slide and Aptos Creek trails are inaccessible to bicycles. It is advisable to call about trail conditions before starting the hike during the rainy season.

The Forest of Nisene Marks was heavily lumbered, mostly to make charcoal for baking local marble into lime (for cement) in the late 19th to early 20th century. Wood and lime from the Santa Cruz area were used in the rebuilding of San Francisco after the 1906 earthquake and fire. Local lime was also used in the construction of the Grand Coulee Dam in Washington.

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5. Lyndon Canyon and Lake Ranch Reservoir, Sanborn County Park

Trip highlights: San Andreas Rift Valley, Lake Ranch Reservoir (site of 1906 earthquake damage)

The hike to Lake Ranch Reservoir via Black Road is a scenic and easy walk (an unusual flat hike in the Santa Cruz Mountains). The trail basically follows the scarp of the San Andreas Fault to Lake Ranch Reservoir, a modified sag pond that straddles the pass between Lyndon Canyon on the south and Sanborn Creek on the north (fig. 5-1). The lake has two dams, one on each of the drainages at opposite ends of the lake. The hike, and the drive to get there, offers views of the San Andreas Rift Valley and provides a wilderness-like feel for a park relatively close to the greater urban San Jose area.

To get there take Highway 17 south toward Santa Cruz. Exit at Bear Creek Road about 3 miles (5 km) south of Los Gatos. At the top of the highway ramp continue straight (north) along the highway frontage road about 0.2 miles (0.3 km) and turn left (north) on Black Road. Black Road winds northward (uphill) and eventually connects with Skyline Boulevard (Highway 35) that runs along the crest of the northern Santa Cruz Mountains. About 2 miles (3 km) south of the intersection with the frontage road, Black Road crosses and then basically follows the San Andreas Fault Zone for a couple of miles. Although the landscape has been heavily modified by past and recent human activity, it is still possible to pick out landscape features that probably reveal the trace of the fault. Look for sag ponds (wet areas with cattails), isolated hills and linear ridges, straight stream valleys, steep escarpments (fault scarps), and changes in vegetation.

The trailhead for the John Nicholas Trail to Lake Ranch Reservoir is located about 6 miles (10 km) from the intersection of Black Mountain and the frontage road along Highway 17. The trailhead is located by a small parking area on the north side of the road about a mile downhill from the inter-

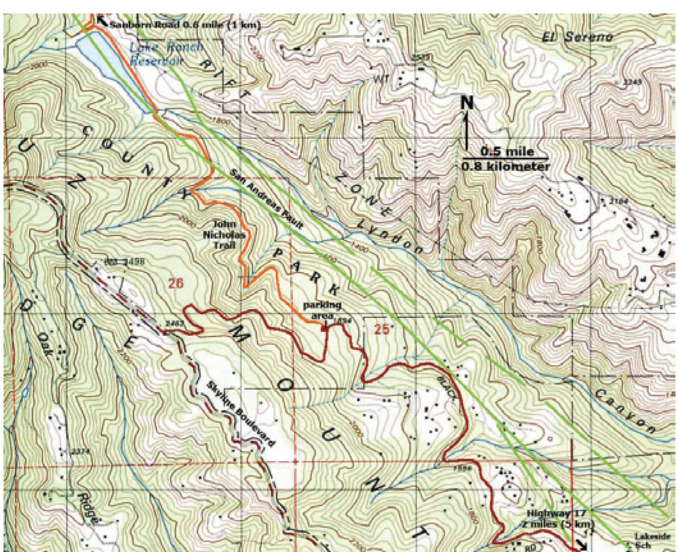

Figure 5-1. Map showing the location of the Lyndon Canyon-Ranch Lake Trail.

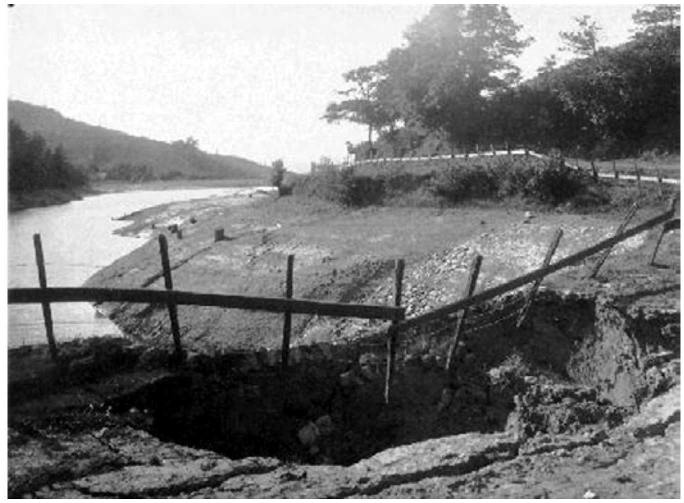

Figure 5-2. Ranch Lake as it appeared shortly after the 1906 San Francisco earthquake. Ground failure in the foreground is the result of slumping of the earthen dam at the south end of the lake. Local lore is that a large quantity of water splashed out of the lake as a result of the earthquake. Note the high water line that existed at the time of the earthquake. Also note the comparative lack of forest in the photo as compared to the modern image below. The main trace of the fault runs along the base of the hill on the left, but the whole lake is within the fault zone. (Photograph from Lawson, 1908.)

Figure 5-3. Ranch Lake as it appears today. The lake was originally used as a reservoir, but was abandoned after the 1906 earthquake for fear of flood disaster should the dam rupture during an earthquake. After nearly 100 years coniferous forests have returned to the hillsides west of the fault. Oak, bay laurel, madrone, and chaparral dominate the hillsides east of the fault. The difference in vegetation reflects both hillslope orientation (west-facing slopes tend to be warmer and dryer) and soil characteristics (bedrock characteristics influences soil development and moisture retention).

section with Skyline Boulevard. The hike to Lake Ranch Reservoir is 1.4 miles (2.2 km). The trail basically follows the uphill side of the San Andreas Fault scarp that follows Lyndon Canyon Creek (and is responsible for its linear valley). About 0.5 mile along the trail are two large redwoods that escaped the era of heavy lumbering of this region of the Santa Cruz Mountains at the close of the 19th century. A small spring-fed stream flowing past the redwoods produces a slight sulfur smell ("rotten eggs").

The trace of the San Andreas crosses through low earthen dams at both ends of Lake Ranch Reservoir. The area experienced surface rupture during the magnitude 7.9 1906 San Francisco earthquake (fig. 5.2). An additional 0.5 mile takes you to the south end of the lake where one of the headwater tributaries of Sanborn Creek descends from Castle Rock Ridge on the west. This stream probably flowed into Lyndon Canyon Creek in the past, but migration of Castle Rock Ridge northward (on the west side of the fault) relative to El Sereno Ridge (on east side of the fault) resulted in the formation of the straight valley of Lyndon Canyon Creek and then stream capture of the headwater stream by Sanborn Creek. Comparison of the photograph taken in 1906 with a recent photograph (figs. 5-2 and 5-3) demonstrate just how heavily lumbered the area was about the time of the 1906 earthquake.

Lake Ranch Reservoir is also accessible from a relatively steep trail that starts at the end of Sanborn Road about a mile south of the main entrance of Sanborn County Park (see chapter 6). This route climbs steeply up an access road to the reservoir for a distance of about 1 mile (1.6 km) before it reaches the northern impoundment of the dam. Parking is limited near the trailhead area at Sanborn Road.

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6. Earthquake Trail, Sanborn County Park: A Geology Hike Along the San Andreas Fault

Trip Highlights: San Andreas Fault, fault scarps, shutter ridges, sag ponds, landslides, fractured walls, offset streams, offset alluvial fan

Sanborn County Park straddles a section of the San Andreas Fault Zone where it passes through the Santa Cruz Mountains in Santa Clara County, California (fig. 6-1). This chapter is a guide to the Sanborn Earthquake Trail, a moderately strenuous hiking route that is 2.5 miles (4 km) long and leads through hilly terrain covered with a mixed redwood, Douglas fir, and oak woodlands and grasslands within the park and on other public land. The park area experienced strong earthquake shaking during the magnitude 7.9 1906 San Francisco earthquake and the magnitude 6.9 1989 Loma Prieta earthquake. The trail provides access to a variety of geomorphic features associated with the fault zone, including deflected streams, shutter ridges, sag ponds, fault scarps, and other fault-related landforms. Most of these landscape features are developed on an old alluvial fan system along streams draining from a high ridgeline eastward into the rift valley along the San Andreas Fault Zone. Other ongoing surface processes affecting the forested landscape include landslides, debris flows, floods, giant tree falls, and other forms of mass wasting and erosion, as well as both prehistoric and modern human activity that have left an imprint on the landscape. The route follows established park trails including the route of the biology-oriented Sanborn Nature Trail.

How to get to Sanborn County Park: From the north (San Francisco), take I-280 south toward San Jose. Exit to California Highway 85 south and proceed 3.5 miles (6 km) to the De Anza Boulevard exit. Bear right onto De Anza Boulevard

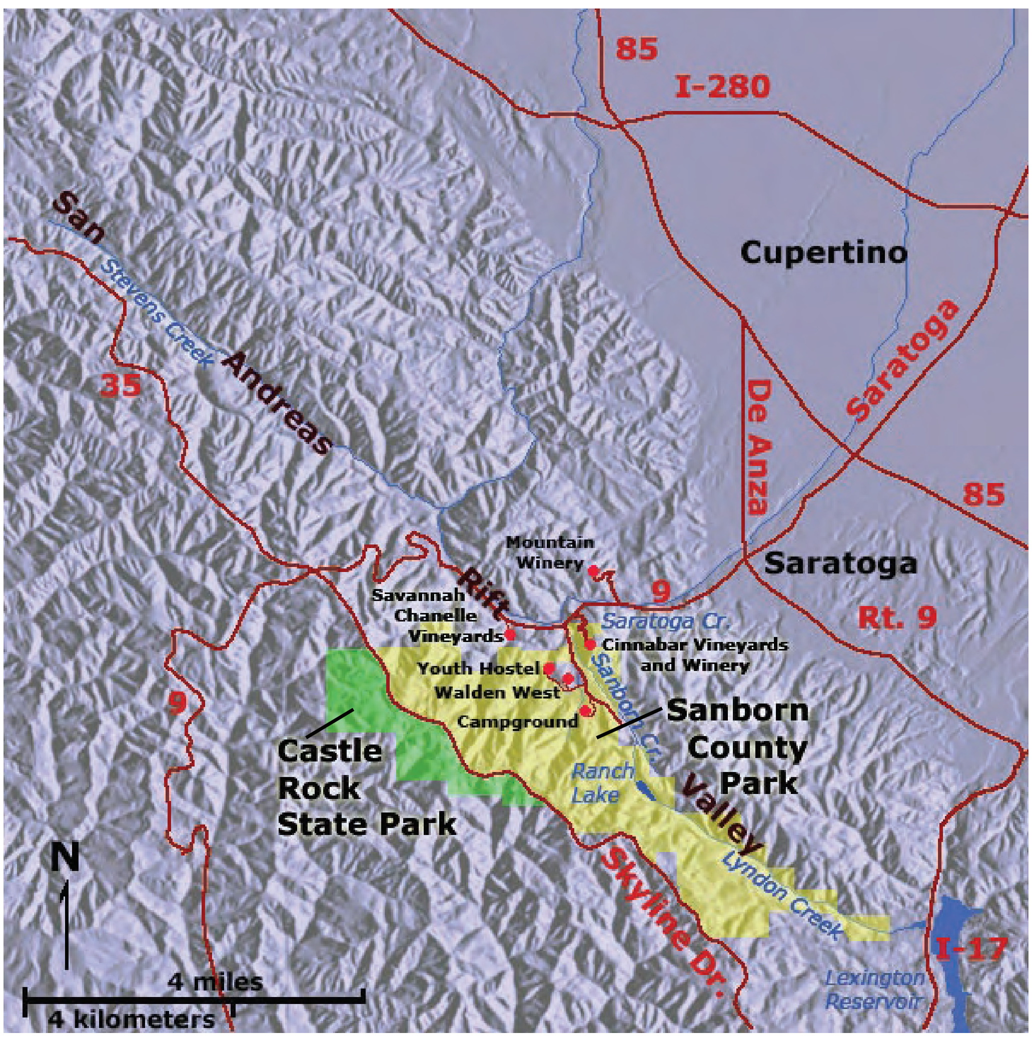

Figure 6-1. Map of the Sanborn County Park vicinity near Saratoga, California.

and proceed south 4 miles (7 km) to the intersection of Highway 9 in downtown Saratoga. From the south (San Jose), take California Highway 85 north and then take Highway 9 west to the town of Saratoga. Proceed west on Highway 9 (also called Big Basin Way or Congress Springs Road) through downtown Saratoga and proceed up Saratoga Canyon for about 3 miles (5 km). Turn left on Sanborn Road. Proceed 1 mile (1.6 km) to the entrance to Sanborn County Park on the right. A day-use fee ($5) is required for each vehicle entering the park. After passing the Entrance Station follow the main park road uphill to the RV Campground parking area. If day-use parking spaces are not available in the RV area use the day-use parking lot just below the RV campground. Field-trip participants should gather near the trailhead to the walk-in campground near the RV campground restroom facility.

Warnings for hikers: Please be aware that poison oak, ticks, rattlesnakes, mountain lions, or other natural hazards can be encountered in the park (as anywhere in the Santa Cruz Mountains). Rattlesnakes are generally harmless unless provoked (fig. 6-2). Simply take another route if you encounter one, and warn others in the area to be aware. Rattlesnakes are most likely to be seen near water sources on hot summer days. All wildlife in the park is protected. Slick trails, falling branches from trees, and stream flooding may be potential hazards during storms. Pets and smoking are not allowed on park trails. Bring some water on the hike.

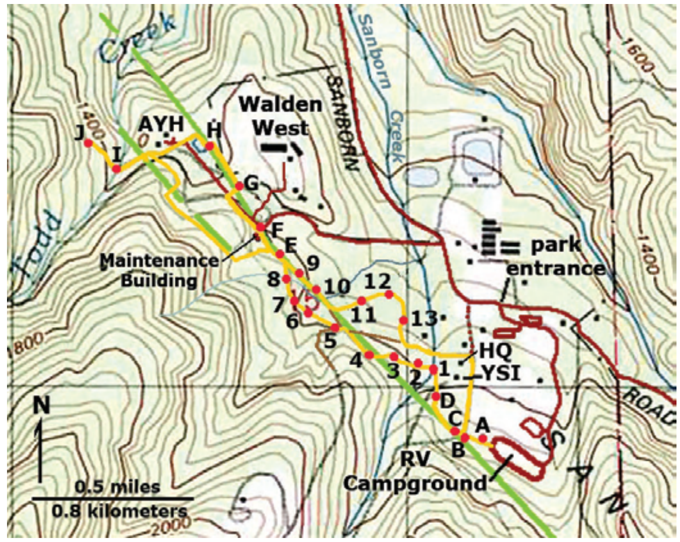

Figure 6-3. Map of a portion of Sanborn County Park with the route of the Earthquake Trail shown in gold with numbered and lettered stops in orange. Stops are organized as both letters (A-J) and numbers (1-13). The letter stops of the Earthquake Trail were added to incorporate the preexisting numbered stops of the already established Sanborn Nature Trail. Each of the stops is marked by a lettered- or numbered-trail stop post. The trace of the San Andreas Fault is shown in green. Park access roads are shown in red. The base map is a U.S. Geological Survey topographic map showing elevation contour lines in feet. The hike begins at a kiosk with park rules and regulations near the RV campground restrooms. AYH, American Youth Hostel; HQ, park headquarters; YSI, Youth Science Institute.

Sanborn Earthquake Hike—Geology Field-trip Route

Figure 6-3 shows the route of the recommended hike. Numbered and lettered dots on the map show the general location where stops for observation are located. However, field-trip participants should be on the lookout for wildlife and additional natural features not mentioned in the text. The complete field-trip hike described below typically takes 4 to 5 hours with a mixed group of people of all ages. This includes time for discussion and a picnic in the park after the walk

Figure 6-2. A western diamondback rattlesnake warms itself in the morning sun on a Sanborn County Park trail.

Stop A is located near several large sandstone boulders about 100 feet (30 m) downhill of the intersection of two paved trails near the RV campground restroom facility. This first stop is located at the edge of the large field that provides one of the best views of the park vicinity. Landscape features visible from this location include:

The San Andreas Fault: It may not be evident to most people who visit Sanborn County Park that they are, in fact, in the San Andreas Fault Zone. The fault passes through this portion of the Santa Cruz Mountains in and around Sanborn Park. The San Andreas Fault extends from great depths estimated from seismic data to be in the range of about 9 to 12 miles (15 to 20 km) under the Santa Cruz Mountains (Jachens and Griscom, 2004). As the fault zone approaches the surface it splays into a complex system of both parallel and interconnecting faults. The San Andreas, Hayward, Calaveras, and other earthquake faults are all part of the greater San Andreas Fault system (fig. 6-4). In the San Francisco Bay region, the

San Andreas Fault system displays a total offset of about 286 miles (460 km), but only about 87 miles (140 km) of this offset occurred along the San Andreas Fault in the central Santa Cruz Mountains, the rest of the offset occurred on the Hayward and Calaveras Faults in the East Bay region and on other regional faults (Dickinson, 1997; Graymer, 2002).

The San Andreas Fault is not perfectly straight. In places, such as in the Santa Cruz Mountains, the fault trace bends slightly to the left. This bend causes uneven forces throughout the crust and results in the ongoing uplift of the Santa Cruz Mountains. Gradual changes in elevation are occurring continuously throughout the Coast Ranges, both upward and downward with the build up of pressure and its release during episodic earthquakes. Fission track studies and other data demonstrate that rock in the Santa Cruz Mountains has risen approximately 2 miles (3.2 km) over the past 4.7 million years (a rate of about 0.6 mm per year) (Bürgmann and others, 1994). Since the highest elevations in the Santa Cruz Mountains are only slightly higher than 0.63 mile (1 km), the rate of erosion of the mountain uplands is therefore about 0.4 mm per year. However, uplift and erosion factors are complex, and they are neither uniform nor synchronous throughout the Santa Cruz Mountains.

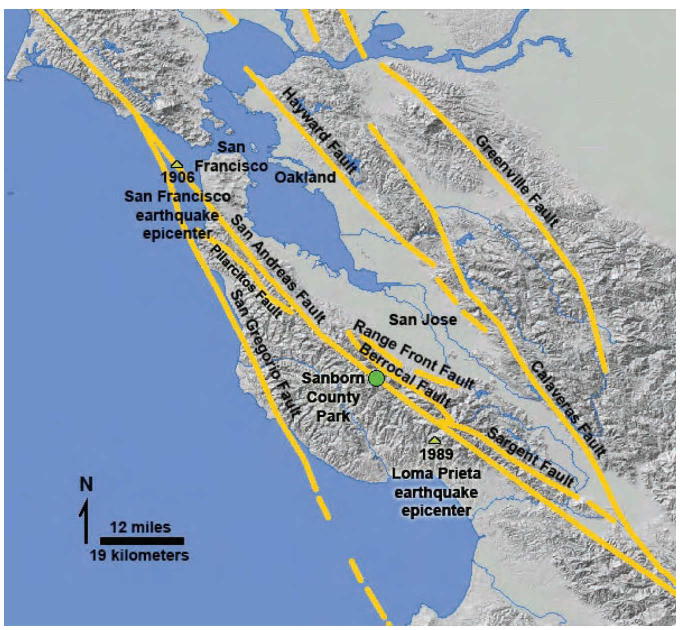

Figure 6-4. The San Andreas Fault system in the San Francisco Bay region. The San Andreas Fault is a relatively new geologic feature in the San Francisco Bay region. It began forming in the south central California region about 28 million years ago but propagated through the Bay Area region only about 10 to 6 million years ago (Elder, 2001). Prior to the San Andreas Fault, a completely different continental margin configuration existed in California. Traditionally, the San Andreas Fault has been used to separate the North American Plate on the east and the Pacific Plate on the west in California. The offset along the San Andreas Fault is a strike-slip fault with right-lateral offset, such that the west side (the Pacific Plate) is moving northward relative to the east side (the North American Plate). (A USGS publication entitled *This Dynamic Earth* provides an introduction to plate tectonics theory; it is on-line at http://pubs.usgs.gov/publications/text/dynamic.html.)

The San Andreas Rift Valley: Sanborn Creek is a headwaters tributary of the greater Saratoga Creek watershed that drains along Highway 9 into Saratoga. Over time, streams have carved a canyon that follows the zone of crustal weakness associated with the San Andreas Fault Zone. The combination of stream erosion and movement along different faults near the surface has resulted in the formation of the San Andreas Rift Valley; it is both a “geologic-structural” valley, and “surface-erosional” valley. The landscape is a reflection of two totally different geologic processes—(1) tectonic forces affecting the Earth’s crust below ground and raising the land surface and (2) the combination of erosional and depositional processes occurring at the land surface. However, the structural forces are, in part, controlling how and where erosion and deposition are occurring in the park area. The combined headwater valleys of Sanborn Creek, Lyndon Creek (to the south), and Saratoga and Stevens Creek define the trace of the San Andreas Rift Valley in the central Santa Cruz Mountains (see fig. 6-1).

The gap in the hills to the south of the campground marks the location of the active trace of the San Andreas Fault. The steep slope above the RV campground is a fault line scarp. However, in most places on the steep slope the fault is covered by colluvium and does not show an obvious surface expression to point to its exact location on the slope. Note that the exact fault location is not always easy to see. In most places, the surface expression of the San Andreas Fault is complex. Slumping and landsliding occur along the fault in many areas where it crosses slopes. In addition to the main (or active) trace of the San Andreas Fault, there are many other faults in the area, some of which display evidence of recent movement.

Bedrock Geology: Figure 6-5 is a portion of a geologic map showing the Sanborn County Park area (Brabb and others, 2000). The bedrock west of the San Andreas Fault consists of Tertiary-age sedimentary rocks (roughly 40 to 30 million years) that probably overlie more ancient Salinian granitic basement rocks at depths of about 4 miles (6 km) below Castle Rock Ridge. On the hillsides to the east of the San Andreas Rift Valley (toward Saratoga) the bedrock consists of oceanic basement rocks and associated younger sedimentary rocks (Coast Range Ophiolite and Franciscan Complex, roughly 165 to 120 million years old). With the uplift of the Santa Cruz Mountains, erosion of bedrock on the mountainsides on both sides of the San Andreas Fault contributed sediments that partially filled in the San Andreas Rift Valley. Figure 6-6 is a generalized geologic cross section across the park area between two mountain ridges that border the rift valley—Castle Rock Ridge on the west and El Sereno on the east.

Alluvial Fans: The sloping fields in the main park area are part of a system of alluvial fans associated with streams draining from Castle Rock Ridge to the west. Over thousands of years, sediments eroded from the steep slopes above were deposited on the more level slope in the valley below. Alluvium is unconsolidated material on the land surface, including soil, boulders, and sediments deposited by wind and water. An alluvial fan is a wedge-shaped accumulation of stream-deposited sediments that spreads out into a valley from a canyon source area, such as in a valley along a fault-bounded highland area. Where many alluvial fans join together along a mountain front the result is a broad, apron-like, sloping, alluvium-covered surface called a bajada. Much of Sanborn Park is located on an old alluvial fan complex (or bajada) that is currently being incised by streams. The surface of the fan is highly irregular from stream erosion and from offset along the the San Andreas Fault which cuts across the alluvial surface.

Stop B is located at the intersection of trails near a park information kiosk just north of the campground restrooms.

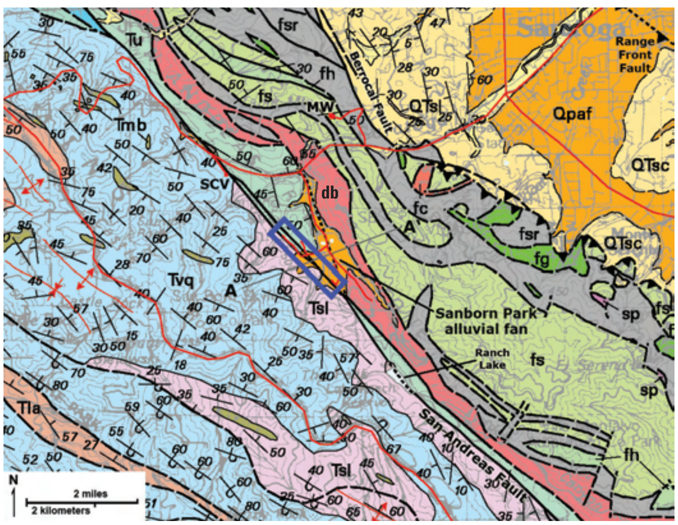

Figure 6-5. Geologic map of the area encompassing Sanborn County Park (from Brabb and others, 2000). The blue box at the center of the figure shows the Earthquake Hike field area in Sanborn County Park. SCV is the Savannah-Chanelle Vineyards; MW is the Mountain Winery. Map units include; Qpaf, Quaternary (Pleistocene) alluvial fan deposits; QTsc, Santa Clara Formation (gravel, sand, and mud of Pliocene and early Quaternary age); QTsl, lake beds. Franciscan Complex (undivided) and other rocks east of the San Andreas Fault include: fsr, sheared rock (mélange); fg, greenstone; fh, argillite and shale, some sandstone; fs, sandstone; fc, chert; sp, serpentinite; db, diabase and gabbro (Coast Range Ophiolite); Tu, Unnamed Tertiary mudstone, shale, argillite and sandstone (Eocene?). Tertiary marine sedimentary rocks west of the San Andreas Fault include: Tla, Lambert Shale (lower Miocene and Oligocene); Tmb, Mindego Basalt and related volcanic rocks (lower Miocene and Oligocene); Tvq, Vaqueros Sandstone (lower Miocene and Oligocene); and Tsl, San Lorenzo Formation (Oligocene and upper and middle Eocene), consisting mostly of shale and mudstone. A to A′ shows the location of a geologic cross section illustrated in figure 6-6. Line symbols with associated numbers represent the strike direction and dip angle of mapped rock units. Map modified from Brabb and others, 2000.

Note the abrupt change in slope near the kiosk and trail-intersection area. This break-in-slope at the top of the alluvial fan is the fault-line scarp of the San Andreas Fault. Three low pyramid-topped posts with red bands just south of the Stop B post mark the most likely location of the San Andreas Fault. Whether or not there was surface rupture here from the 1906 earthquake is uncertain because no reports from the 1906 were made at this location. However, there almost certainly was surface rupture, if not exactly where the posts are, then very close by. Without a recent major earthquake, or trenching, the exact locations of faults in this area are not clearly visible. Surface erosional processes have erased evidence of surface rupture along the fault trace. There could be more than one seismically active strand of the fault in this valley.

The amount of surface rupture in the southern Santa Cruz Mountains caused by the Great San Francisco earthquake of April 18, 1906, is uncertain but probably varied between 3 to 10 feet (1 to 3 m) of right-lateral offset. The best reported observation was 5 feet (1.5 m) of right-lateral offset in Wrights Tunnel (south of Lexington Reservoir) (Prentice and Schwartz, 1991); however, analysis of historical documents show that the tunnel was offset a total of at least 5.6-5.9 feet (1.7-1.8 m) (Prentice and Ponti, 1997); the main trace of the San Andreas Fault has been mapped east of the trail entrance (McLaughlin and others, 2001). Many of the ground ruptures in the southern Santa Cruz Mountains found after both the 1906 and 1989 earthquakes were a result of landslides induced by ground shaking (Prentice and Schwartz, 1991). Nearly all the trails, roads, and manmade structures in the park area were constructed after the 1906 earthquake.

The greatest offset reported the 1906 earthquake occurred well north of the SF Bay region, with 16 feet (5 m) of right-lateral offset well documented near Point Arena, and 20 feet (6 m) reported near Point Reyes. Some reports of greater offsets were reported, but these measurements, including those at Point Reyes are uncertain, and may include non-tectonic

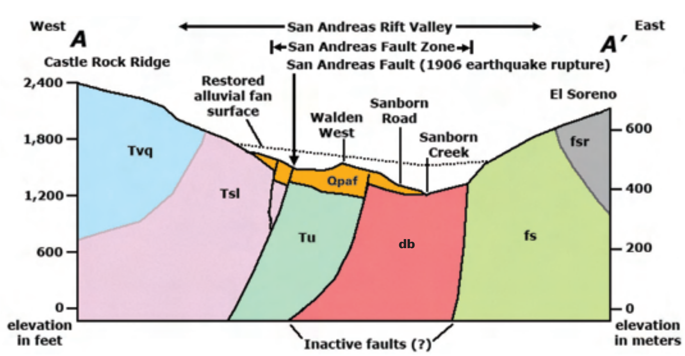

Figure 6-6. Generalized geologic cross section of the San Andreas Rift Valley between Castle Rock Ridge and El Sereno (ridge). The location of the cross section is shown as A to A′ on figure 6-5. The subsurface character of the faults and bedrock are inferred from mapped features in the surrounding area. The diagram also illustrates the differences in the use of the terms San Andreas Fault, San Andreas Fault Zone, and San Andreas Rift Valley. See figure 6-5 for abbreviations.

displacement due to ground shaking and lateral spreading, or by slumping. Southward into the Santa Cruz Mountains, the amount of offset reported after the 1906 earthquake diminished to about 1.2 meter (4 ft) near Watsonville, to almost nothing observable on the surface south of San Juan Bautista, although tremendous seismic shaking was reported over a much greater region extending far to the south in the vicinity of Pinnacles National Park. Subsurface rupture along the fault probably extended well beyond the region of surface rupture (http://quake.wr.usgs.gov/info/1906/offset.html; Gilbert and others, 1907; Lawson, 1908).

Stop C marks the beginning of a narrow path that leads downhill along the escarpment of the San Andreas Fault into the drainage of Sanborn Creek. The escarpment marks the west side of the San Andreas Fault. On the east side of the fault near the trail intersection is a large water tank constructed by the Santa Clara County Water District that was built for irrigation and emergency purposes in the park. The tank was constructed in 2003 on a small hill on the east side of the fault.

This undeveloped section of the trail is inaccessible when wet. If the trail is closed, proceed down and pick up the route at the Visitor Center/Youth Science Institute (YSI) and continue on the hike from there.

The trail leads several hundred feet downhill through a grove of small redwoods. The ecosystem around Sanborn Park includes redwood and Douglas fir forests in the cooler, wetter valleys and north- and east-facing slopes, whereas chaparral and shrub oak dominate the higher, dry west-facing slopes. Large redwood stumps along the trail and throughout the park show that the area was heavily lumbered in the late 19th century.

Keep looking to the north through the gaps in the forest to where Sanborn Creek descends off of the escarpment of the San Andreas Fault. Just north of an “artificial” waterfall created by a pipe diversion of Sanborn Creek, the natural stream has been deflected where it encounters the fault. It makes a sharp turn and flows northwestward along the fault for some distance before turning right to resume its initial eastward downstream course in its incised valley. The bend in the stream is due to stream capture as the western (uphill) side of the San Andreas Fault moved northward relative to the alluvial fan (downhill) side of the fault. Over time, the stream has continued to flow in its current channel resulting in a dog-leg shaped path of the stream channel called an deflected drainage. This zigzag-shaped bend shows that the course of Sanborn Creek has been affected by the right-lateral relative motion along the San Andreas Fault. Much of the landscape geomorphology in Sanborn Park is related to the formation of offset drainages and stream capture along the San Andreas Fault.

Stop D is located near some very large boulders where the narrow path intersects a larger park trail. Some springs are located nearby in a low area to the south of the stream. Springs are common along fault zones because faults and fractures serve as fluid-migration pathways. Whether these springs are related to a fault is uncertain.

How did the large boulders get here? The boulders are derived from the Vaqueros Sandstone or the San Lorenzo Formation. Both of these sedimentary rock formations occur as bedrock in the hillsides to the west and above Sanborn Park. The Vaqueros Sandstone is the dominant cliff-forming unit in Castle Rock State Park, located along the ridge west of Sanborn Park. These large blocks of sandstone were carried downslope onto the alluvial fan by rock falls, landslides, or debris flows from the upland areas to the west, If they were transported by a landslide or debris flow, the smaller rock fragments and mud would have surrounded these boulders, but must have long since eroded away. Large boulders are a typical occurrence on the upper portion of alluvial fans. Another possible explanation is that the huge boulders were dislodged during a large earthquake on the San Andreas Fault and rolled down the steep slope and across the fault.

The Vaqueros Sandstone (lower Miocene and Oligocene, roughly 20 to 30 million years old) consists of light-gray to buff, fine- to medium-grained, locally coarse-grained arkosic (feldspar mineral-bearing) sandstone interbedded with olive- and dark-gray to red and brown mudstone and shale. Sandstone beds are commonly from 1 to 10 feet (0.3 to 3 m) thick and mudstone and shale beds are as much as 10 feet (3 m) thick. In the region, the Vaqueros Sandstone varies from several feet to as much as 2,300 feet (700 m) in thickness (Brabb and others, 2000). The formation consists of sediments that were probably deposited in a shallow marine shelf environment, offshore of a river mouth that was probably far to the south (possibly in southern California). These sediments, now rock, where transported northward to their present location by movement along the San Andreas Fault system.

The San Lorenzo Formation (Oligocene and upper and middle Eocene, roughly 30-to-50 million years old) consists of dark-gray to red and brown shale, mudstone and siltstone, with local interbedded layers of sandstone, and is about 1,800 feet (550 m) thick. Within the upper part of this formation are large, elongate carbonate concretions. The presence of shale indicates that the formation represents materials deposited in somewhat deeper water, a setting farther offshore than the younger Vaqueros sediments.

Volcanic rocks are present in the hillsides west of the fault with outcrops and boulders scattered throughout the Santa Cruz Mountains. The Mindego Basalt (Miocene and Oligocene) includes both extrusive and intrusive volcanic rocks that range in color from dark-gray to orange-brown to greenish gray breccia, tuff, pillow lavas, and flows. The intrusive rocks tend to be coarsely crystalline. Radiometric dates of selected samples yielded an age of about 20.2 (+/-1.2) million years (Brabb and others, 2000).

Along the San Andreas Fault, these rock units are highly fractured and mixed together. Cobbles and boulders of basalt can be found in the alluvial sediments along streams in the park area. Fossils are not common in either the Vaqueros or San Lorenzo formations locally. Collectively, the rocks on the west side of the fault in Sanborn Park are between 20 and 50 million years old, whereas the rocks on the east side of the fault are much older. The later belong to the Franciscan Complex, a mix of ancient marine sediments and oceanic crustal rocks that formed in the mid- to late-Mesozoic era, roughly between 200 to 100 million years ago (Elder, 2001). Franciscan rocks are not exposed along this field-trip route.

Continue downhill and then bear to the right, avoiding the private residence (a post with an arrow marks the route). Proceed downhill; once you get to the paved road, take the wooden bridge across a small pond and then proceed uphill to the left to the Visitor Center (Youth Science Institute building near the Park Office).

Local legend says that the shaking caused by the 1906 earthquake caused much of the water to splash out of the pond in this area. Note that much of the landscape here has been modified since the earthquake. A significant portion of the water in Lake Ranch Reservoir (at the south end of the park) was also reported to have splashed out during the earthquake (see chapter 5). The reservoir lies in a modified natural sag pond along the San Andreas Fault in the natural upland saddle between the drainages of Sanborn Creek (on the north) and Lyndon Creek (canyon to the south).

Nature Center /Youth Science Institute—Optional Stop

Park maps and brochures are available at the Nature Center/Youth Science Institute (YSI). Several displays highlighting local Native American (Ohlone) culture and history are located on the outside patio area of the Nature Center. A number of artifacts are on display. Other exhibits include live animals that populate the Santa Cruz Mountains, earthquake and geology displays, an insect zoo, and a garden featuring native plants and plants used by Native Americans. The YSI is an educational institution that conducts a variety of prekindergarten to high school and teenage group programs, after school science classes, and summer science camps (with similar programs at Vasona and Alum Rock County Parks).

Geology Along the Sanborn Nature Trail

From the Nature Center/YSI, the Earthquake Hike follows the same route of the Sanborn Nature Trail. Biology-oriented nature-trail brochures are available from the park office and at the Nature Center/YSI. Near the Visitor Center, a sign points to the "Peterson Memorial Trail, San Andreas Trail, and Walden West." Follow the trail downhill past some big blocks of sandstone to a recently renovated stage area. The bridge across Sanborn Creek is at Stop 1 on the Nature Trail route.

Stop 1 along the nature trail is devoted to a coastal redwood, the California State tree. Coastal redwoods can grow more than 320 feet (100 m) high and can live more than 2,000 years. The red bark of the redwoods contains a resin that helps protect them from fire. They also are able to reproduce through their root system when cut down or damaged by fire. Most of the redwoods in the park are younger than a century because the area was heavily lumbered in the late 1800s. The remnants of old logging trails are still visible in many places. These road scars can now serve as a measure of landscape change and forest recovery over time, and many now serve as hiking trails through the park.

At the wooden bridge, note the incised character of the stream valley (Sanborn Creek, a tributary of Saratoga Creek along Highway 9). Also note the abundance of large sandstone boulders in the creek bed. Signs describe the creek bed area as a "restoration area" to repair damage from past heavy foot traffic off the trails. The small stream has cut down into an older surface of the alluvial fan. Note that near Stop 1 a narrow flood plain forms the floor of this stream gorge and that the small stream is limited to an irregular channel incised into this flood plain. The floodplain can be completely covered during floods or especially when debris flows occur.

Proceed steeply uphill from the bridge along the Nature Trail. From here, the trail follows ascends the alluvial fan along the north side of the incised ravine of Sanborn Creek and includes stops 2, 3, and 4.

Stop 2 is located on a flat area, (possibly an old stream terrace) above the incised valley of Sanborn Creek. This stop in the Sanborn Nature Trail guide points out the differences between a redwood and a Douglas fir. Both trees are used for lumber. However, Douglas firs are also currently farmed as Christmas trees throughout the Santa Cruz Mountains.

Stop 3 is a good area to examine the character of the old alluvial fan surface. Note the gentle slope to the east and the abundance of rock material on the surface between the trees. All the material beneath the surface is poorly consolidated alluvium deposited by stream processes, landslides, slumps, debris flows, floods, rockfalls, and creep from the hill slope above before the modern forest developed. Erosion has removed most of the finer sediment from around the largest boulders resulting in their concentration on the surface of the old alluvial fan.

Stop 4 is located where the trail approaches the steep escarpment at the top of the Alluvial fan. Note, however, that there is no stream at the head of the fan! The source of the alluvial fan sediments has been displaced to the northwest by motion on the San Andreas Fault. The fault probably crosses the trail at a notch on the south side of the trail where the park has posted a sign designating an area closed for restoration. While walking along the trail beyond this point, note how some of the small drainages were abandoned as the streams' headwater areas moved northwestward over time relative to the alluvial fan. Past great earthquakes in this area have produced surface displacements measurable in many feet. Such shifts in ground motion assist "stream capture" or "stream deflection" and results in the development of new drainages and the abandonment of others.

Stop 5 is located at the intersection of the Nature Trail and the Peterson Memorial Trail. In the Nature Trail guide Stop 5 is a good location to learn to differentiate Blackberry plants from Poison Oak. Both plants have has leaves with 3 rounded or oak-like leaflets. However, Poison Oak is an upright shrub or climbing vine with drooping leaves. Small white flowers in the spring give way to white berries in loose clusters along the stem in the summer to fall seasons. In the fall the leaves can turn bright red. Blackberries and other berries are easy to confuse with Poison Oak because they are also shrub size and have leaves consisting of 3 leaflets. However, berries have stiff protective hairs on the leaves, stems, and the branches, and some have thorns. A simple phrase to remember the difference between the two plants is “Leaves of three, let it be. If it’s hairy, it’s a berry.”

Poison oak is abundant everywhere in the Santa Cruz Mountains. Although the plant foliage is most toxic, the barren branches, fallen leaves in winter months, and soil around the plants still can cause serious reactions in some people. Smoke from burning brush can carry the toxic resins. Simply washing laundry may not be enough to remove toxic resins from clothing, although for most people this is sufficient. The best solution to the poison oak problem is to learn to recognize and avoid the plant in all seasons.

In the vicinity of the trail intersection, note that the Peterson Memorial Trail to the right (downhill) follows an incised valley that does not have an actively flowing stream (fig. 6-7). This valley is an example of an abandoned stream—cut off from its headwater area due to motion along the fault.

Follow the Patterson Memorial Trail uphill a short distance to where the Nature Trail continues on the right. After the trail intersection, the Nature Trail traverses part of the fault scarp of the San Andreas Fault. Although most of the relative displacement along the fault is horizontal, right-lateral, strike-slip motion, part of the motion is also vertical in this area (contributing to the uplift of the Santa Cruz Mountains). In general, for every 10 feet the west side of the fault moves northward, the Santa Cruz Mountains also rise about 1 foot. It is also important to note that relative motion is not uniform everywhere along the fault (or faults), which adds to the complexity of the evolving landscape. In most places the trace of the fault is not easy to see except relatively soon after a major earthquake when surface rupture along the fault is commonly visible. Erosion and shifting surface sediments typically mask the traces of surface rupture within a few years.

Stop 6 is at a massive stump of a redwood harvested in the 1800s. This tree was about 1,000 years old and probably about 260 feet (80 m) high when it was cut. During its lifetime the tree probably experienced several major earthquakes, and in the course of its lifetime the land it occupied probably moved as much as 56 feet (17 m) northwestward relative to the opposite side of the fault! (This estimate is based on right-lateral slip rates along the local section of the San Andreas Fault by McLaughlin and others, 1999.)

Stop 7 is near the location of a large Douglas fir that fell during a storm in 1995. Note the abundance of rock material tangled in its decaying roots. This fallen tree is a testament to the erosional forces created by biological activity. The hummocky character of the forest landscape is partly a result of tree falls in the past. Other forces affecting the hillside are the constant seasonal wetting and drying, causing clays in the soil to expand and contract and gradually causing materials to

Figure 6-7. A park trail near Stop 4 follows a beheaded stream channel formed by right-lateral fault motion and stream capture. Unlike at Stop 1, there is currently no active stream channel to match the size of this valley. The escarpment of San Andreas Fault is to the right.

Figure 6-8. A stump of a great redwood harvested in the late 19th century. Note the offspring of the original tree on the uphill side of the stump. The tree was probably about 1,000 years old when it was harvested. Three youngsters for scale.

creep down slope. During colder periods in the past, freezing and thawing of the land surface probably also generated significant amounts of ground movement and supply of sediment to the alluvial fan. Combined with the force of gravity, weathered rock and soil migrates down slope over time, these processes are collectively called mass wasting.

Stop 8 is by a small wooden bridge over another small stream that crosses a strand of the San Andreas Fault. Many of the small streams in this area tend to dissipate as they approach and cross the fault. The flat area downslope is in part an ephemeral sag pond. A sag pond is a fault-related low area where water may accumulate because (1) sedimentation cannot keep pace with the tectonic forces warping the landscape downward or (2) erosion cannot keep pace with uplift blocking a drainage outlet. Between Stop 8 and the next stop (Stop E) notice the abundance of large boulders scattered on the surface throughout the forest. These massive boulders were transported downslope by rockfalls, landslides, or debris flows from the eastern mountain front of Skyline Ridge and deposited on the alluvial fan surface.

Figure 6-9. A fairy ring of redwoods at Stop E. After a mature redwood dies or is cut down, offspring chutes may sprout from the parent tree's roots. The original stump gradually rots away, leaving a ring of trees around the perimeter of the parent tree. There are several large and developing fairy rings along the trail route.

Northern Sanborn County Park Area

At the trail intersection beyond Stop 8, leave the Nature Trail temporarily. Turn left and proceed northward along the trail toward Walden West and the American Youth Hostel (Welch Hurst House). From this point the trail basically follows the trace of the San Andreas Fault. (**Note:** Do not follow the "San Andreas Trail"—this trail does not follow the San Andreas Fault, but instead leads uphill to the Skyline Boulevard area near Castle Rock State Park; a lower section of this trail is part of an optional return route after Stop J described below).

Stop E is located near two large "fairy rings" on the right side of the trail (fig. 6-9). These circular groves of redwoods formed when a large "parent" tree died (or was cut) and a ring of new trees sprouted around the base of the missing tree. Also note the low rocky linear ridge along the right side of the trail as you approach the park maintenance buildings (on the left). This is a "shutter ridge" formed by strike-slip motion along the San Andreas Fault (fig. 6-10).

Stop F is located at the intersection of the trail with the paved road. The road splits here to the park maintenance area, Walden West, and continues northwestward to the American Youth Hostel. The San Andreas Fault passes through this vicinity. Take time to look at the stone walls and stream culverts in this area. One of the pillars just downhill of the intersection displays a date of 1955 with a geology pick commemorating Vernon Pick, a successful Utah uranium prospector who temporarily owned this land.

Look for recent cracks, fractures, and right-lateral offsets in the stone walls that may be a result of earthquake damage (an example is shown in fig. 6-11). However, not all damage to the walls and culverts in this area may be from earthquakes; some could be from slumping, tree-root breakage, or other causes related to gravity-driven "mass-wasting creep." Earthquake shaking can cause ground ruptures that are not tectonic. This segment of the San Andreas Fault is considered "locked" since the 1906 earthquake, unlike other faults in the region that show evidence of slow movement or "creep." Different segments of the regional fault system are "locked" or "creeping" and although all fault segments are potential sites for

Figure 6-10. The trail follows a shutter ridge along the San Andreas Fault between Stops E and F near the Sanborn County Park maintenance facility. The shutter ride is on the right side of the trail. The slope to the left is part of the old alluvial fan along the mountain front of Castle Rock Ridge.

Figure 6-11. This culvert built by Vernon Pick in 1955 displays evidence of right-lateral displacement, possibly from ground motion (creep) along the San Andreas Fault. The arrows on this image show where to look for fractures and offset. Fractures and traces of offset are visible at both ends of the culvert.

large damaging earthquakes, the locked segments are locations where pressure will be released in potentially large, damaging earthquakes in the future (as has often occurred in the past). The Sanborn County Park area experienced heavy shaking during the 1989 Loma Prieta earthquake, but no fault surface rupture was observed in the vicinity.

Mr. Pick named the land Walden West and for a time developed an underground uranium ore testing facility and bomb shelter farther up the road (this underground structure was later abandoned and sealed off for public safety concerns). Local legend says that shortly after building his laboratory Mr. Pick chose to abandon his homestead to seek tax-exempt freedom outside of the United States. The County then purchased the land in 1977 for inclusion in Sanborn County Park. Walden West is an outdoor education and summer day camp under the direction of the Santa Clara County Department of Education.

Figure 6-12. The trace of the San Andreas Fault runs through an abandoned field near Walden West. In the past, the field was a sag pond that was drained and used as an orchard. In the more distant past, Todd Creek drained across this area before stream capture occurred and altered the stream's path to its modern drainage to the north of the field. The headwater valley of Todd Creek can be seen in the top of this image.

Downhill from the intersection, the road follows a stream valley that was once been the channel of Todd Creek—another case of an abandoned channel and stream capture due to offset along the fault. Because of more recent stream capture, Todd Creek now drains north of the large field below Walden West (located on the hilltop on the right). The broad field area was once the floodplain of Todd Creek, and in the past was partially occupied by a natural sag pond that has been modified and enlarged (fig. 12, see also figure 17 below). Since the 1906 earthquake, this field was drained and used as an orchard. The intersection at the south end of the field basically marks a stream divide between headwater areas of Sanborn Creek (to the south) and Todd Creek (to the north). As you will see as you continue the hike, Todd Creek has captured the stream drainage around this former sag pond area.

Stop G is in the field along the road leading to the American Youth Hostel. Follow the dirt trail from the stop G sign post out to a line of three red pyramid-topped posts. The three posts mark the known location of the San Andreas Fault.

An exploratory trench was dug in this location by the USGS to help characterize past earthquake activity of the San Andreas Fault. Although the trench exposed the trace of the fault, unfortunately, agricultural activity in the field in the last century had disrupted the surficial deposits that might have provided information about the frequency of earthquakes in this area over the past few centuries. This information can be used to make judgments about the frequency of future earthquakes along the fault. The difference between a "fault" and an "earthquake fault" or "active fault" is that the latter shows evidence of fault movement during the Holocene (the current geologic epoch that began roughly 11,500 years ago following the last ice age of the Pleistocene Epoch). Not all faults are in the San Francisco Bay region are considered active faults.

Stop H is located farther down the trail at an intersection with another trail connecting the playing fields at Walden West to a pond surrounded by a redwood forest. Note the drop from the field to the creek below. Although this area has been heavily modified over the years, it still reflects the character of the natural sag pond that existed here in the past. The trace of the San Andreas Fault runs through this pond area. The Stop H area provides a reasonable view to the north across the valley of Saratoga Creek and northwest along the trend of the San Andreas Rift Valley toward Table Mountain and the more distant grass-covered peak of Black Mountain located within the Monte Bello Open Space Preserve. Note the abundance of chaparral growing on the south facing slopes of Table Mountain.

Continue along the trail around the pond. Turn right on the paved road toward the American Youth Hostel.

The American Youth Hostel is a log-style house with a large hexagonal central room that was originally named Welch-Hurst House and was built in 1908 as a summer home for the Honorable Judge James Welch and his family. In 1955, the Welch Hurst House and surrounding lands were sold to Mr. Vernon Pick. When the house and land was later sold to the county, renovation costs were considered too high and the house was slated for demolition. However, the Santa Clara Valley hostelling club saved and renovated the building through a grassroots collective effort beginning in 1979. The Sanborn Park Hostel is now listed on the National Registry of Historic Places (http://www.sanbornparkhostel.org/about.html).

A large fairy ring of redwood trees is the location of a picnic ground in front of Welch-Hurst House. The building is made of native sandstone from the Vaqueros and San Lorenzo formations. Note the large round concretions used as monument caps near the front door of the house. Concretions are abundant in the San Lorenzo Formation. Also note the large prehistoric mortar hole carved in the large sandstone slab incorporated into the front right side of the path leading to the front of the house. Other mortar holes used for grinding acorns and other food products by Native Americans are present in several of the large boulders along a short trail behind the hostel building.

Continue around the left (west) side of the Hostel building. Follow the stairs or path down to the low flat area next to the building that is currently used as a volleyball court. Note that the Hostel building is built on a low straight ridge covered with blocky alluvium. The building is situated on an old terrace of Todd Creek just west of the trace of the fault. The low flat area occupied by the volleyball court represents an old stream meander of Todd Creek after being captured in its current drainage configuration, but before the incision of the modern gorge north of the Welch-Hurst House.

Continue west across the flat area and follow the old road downhill (to the west).

Stop I is located at a bridge over Todd Creek. Todd Creek has a steep drainage profile relative to Sanborn Creek. The creek has rapidly carved downward into the older alluvial fan deposits that once filled this portion of the San Andreas Rift Valley to a relatively higher level than exists today. Note the size of the large boulders in the creek and exposed in the steep hillsides along the creek and the road (fig. 6-13). These blocks are not bedrock, but rather, are materials that moved down the slope by mass movement in the past (landslides, rockfalls, debris flows, creep). Some of the large boulders near the bridge contain concretions.

Continue west along the trail for a couple hundred feet to the next stop.

Stop J is located near a precipitous drop off where a landslide has taken away part of the old road. The poorly consolidated sediments of the alluvial fan are prone to landslides in areas of steep stream incision. Use caution when approaching the escarpment! From the trail above the slump escarpment it is possible to see the layered beds of alluvial sediments. Note the tree roots exposed in the surface soil profile. The lack of trees in the landslide area reflects that much of this hillside fell away in a massive landslide event that happened during the particularly wet winter of 1995. Also note that very little sediment remains in the toe area of the landslide. Much of the landslide material probably moved downstream in the form of a debris flow. Numerous other slumps and landslides occur throughout the hillsides in this vicinity.

Return along the old road (trail) to the intersection with the paved road. Bear to the right, and then bear to the left past the gate onto the route of the San Andreas Trail. Follow this trail back to the vicinity of the Park Maintenance Building near Stop 8 on the Sanborn Nature Trail.

Along the San Andreas Trail look for landscape features that might display evidence of faulting and stream offset. The San Andreas Fault Zone is complex; in many places it is represented by multiple parallel and interconnecting faults. The landscape features, including linear scarps and the sag ponds, suggest that there may be several active fault traces within the vicinity. Note that although the landscape has been heavily modified by recent human activity, it still reflects the geomorphic profile of an alluvial fan, similar to the area near the RV campground area. It is likely that these flat areas were once aligned but have since been offset by movement along the fault.

Figure 6-13. Colluvium (boulders and soil) partly held in place by tree roots along the trail by Todd Creek near Stop I. The colluvium is derived from older alluvial deposits that are being exhumed by erosion along the eastern flank of Castle Rock Ridge.

Sanborn Nature Trail (continued)

The San Andreas Trail descends off an elevated portion of the alluvial terrace and follows a small stream down hill to an intersection with the Nature Trail near Stop E. Turn right on the Nature Trail (south toward Park Headquarters). Bear to the right and continue along the Nature Trail to Stop 9. Note that the trail follows the trace of the San Andreas Fault southward. Note the sag area along the trail on the right (the sag area is typically dry in the summer).

Stop 9 is near what appears to be an abandoned stream cut through the shutter ridge along the San Andreas Fault on the east side of the trail. At Stop 9, the Sanborn Nature Trail guide discusses how the leaves, flowers, and fruit of the California buckeye are poisonous to humans and animals. However, buckeye nuts were prepared as food by the Ohlone Indians when acorn supplies were low. Buckeye nuts are rich in starch, but are not suitable for food because they contain a poisonous glucoside, aesculin, which can cause severe gastroenteritis, depression, hyperexcitability, dilated pupils, and coma. The Native Americans roasted the nuts among hot stones, peeled and mashed them, and leached them with water for several days. This treatment apparently removed the toxic aesculin. Buckeyes can be particularly hazardous to pets (especially to dogs that chew sticks of buckeye wood).

Stop 10 is located near another gap in the shutter ridge. This one, however, looks like it was modified by human activity. Stop 10 provides an opportunity to examine the curved trunks of trees along the deflected stream drainage. The trees are adjusting to the slow creep of surface materials down the slope into the creek bed. Just south of the trees with curved trunks the stream curves to the left and cuts through the shutter ridge (fig. 6-14). The Nature Trail crosses a small bridge and then bears to the left at a trail intersection.

Stop 11 in the Sanborn Nature Trail guide is a location to examine a Pacific madrone tree. Unfortunately, the specimen to be examined is now dead, but there are many others in the vicinity. Madrone trees have a multitude of uses. The fruit (berries) are an important food source for many species of mammals and birds. The Ohlone Indians ate the berries both raw and cooked. Early European settlers preferred to use charcoal derived from madrone wood in the manufacture of gunpowder. Both Native Americans and early settlers used tea brewed from its bark, leaves, and roots of the madrone tree as relief for stomachaches and treatment for colds; this tea was also used topically as an astringent (useful against inflammation and to stop bleeding). Today, madrone is primarily used as an evergreen ornamental plant. Its hard wood resembles black cherry and is used as furniture paneling, flooring, tobacco pipes, and other novelties, in addition to firewood.

Stop 12 is a large boulder (locally called "Ghost Rock") along the Sanborn Nature Trail that displays tafoni-style weathering (fig. 6-15). Tafoni forms on rocks exposed at the surface for long periods of time, such as these boulders resting on an old surface of the alluvial fan. When precipitation soaks into porous sandstone, some of the mineral cement dissolves. As the rock dries out, capillary action brings moisture along with dissolved minerals to the surface. As the water evaporates, the minerals precipitate. In this manner, the rocks actually break down from the inside out as this weathering process removes the mineral cement below the surface. The wind and rain help to sculpt away the softer rock, leaving the more resistant, tightly cemented surface rock behind. Tafoni-style weathering is responsible for the unusual character of the massive Vaqueros Sandstone outcrops in Castle Rock State Park on the ridge west and above Sanborn County Park and along Skyline Boulevard. Local legend is that Ghost Rock may have

Figure 6-14. View along the Nature Trail between Stops 10 and 11. A small stream channel follows the trace of the San Andreas Fault before it cuts through the shutter ridge on the east side of the fault. Note the curved trunks of the large Ponderosa pines in the distance near a small bridge over the creek. The trees in the foreground are redwoods.

Figure 6-15. "Ghost Rock" is located at Stop 12 along the Nature Trail. The "mouth" is a typical example of taphoni-style weathering. The two "eyes" may be Native American grinding mortar holes in a rock that was later set upright into its current position.

been set up to appear as it does. The two "eyes" look similar to small grinding mortars elsewhere in the park area.

Stop 13 in the Sanborn Nature Trail guide describes the dusky-footed woodrat, a common pack rat in woodland and chaparral habitats throughout California. Woodrats gather litter from the forest floor to build small lean-to-style middens, typically under brush or in the pockets of tree stumps. Woodrats will gather whatever catches their eye, including garbage, and incorporate it into their middens.

The hiking trail ends near restrooms near the Park Office area and lower parking area. Additional stops at local winery and vineyards that provide views of the San Andreas Rift Valley in the vicinity of Sanborn County Park are described below.

Alternate Stop—Savannah-Chanelle Winery and Vineyards

Stop highlights: San Andreas Fault, shutter ridge, sidehill bench

The driveway and parking associated with the winery area and the tasting room are built right within the San Andreas Fault Zone, and geomorphic features associated with active faulting are well developed (fig. 6-16). A good view of the grounds is possible from a picnic area a shorth walk uphill from the parking area. This vista point provides a view along the trace of the fault to the south toward Sanborn County Park.

This is a privately owned business, open to the public during business hours (11 am to 5 pm daily). From Sanborn park return north along Sanborn Road to Highway 9 and turn left (south). The driveway to the winery is on the left about 0.7 mile (1.2 km) south of Sanborn Road. Turn into the vineyards and proceed to the parking area in front of the tasting room.

The San Andreas Fault crosses Highway 9 near the driveway to the Savannah-Chanelle Winery and Vineyards (see fig. 6-1). The large home near the tasting room building was built on top of a shutter ridge associated with the fault. The trace of the fault follows a hillside bench along Sanborn Creek Valley along the lower eastern flank of Castle Rock Ridge (to the west). The bedrock in the hills consists of Eocene and Oligocene age marine sandstone and shale, whereas Quaternary alluvial-fan deposits underlie the bench and lowlands in the valley along Sanborn Creek. Rocks of Mesozoic age underlie the forests on El Sereno Ridge on the opposite side of the valley (east of the San Andreas Fault).

Figure 6-16. The Savannah-Chanelle Vineyards straddles the San Andreas Fault north of Sanborn County Park. The fault line passes through the parking area at the wine tasting room. The yellow dashed line in this image shows the approximate location of the fault and arrows show relative movement. This view is looking southeast from the winery's picnic area across the trace of the fault and the valley of Sanborn Creek (within the San Andreas Rift Valley). The mixed redwood and Douglas fir forest on the right is along McElroy Creek. McElroy Creek drains off of Castle Rock Ridge and displays displacement by stream capture where it crosses the fault near the vineyard. The grape vineyards in the foreground on the left are on a shutter ridge on the east side of the fault. The Cinnabar Vineyards are on El Soreno Ridge in the distance on the east side of the San Andreas Rift Valley.

Alternate Stop—Cinnabar Vineyards and Winery

Stop highlights: San Andreas Fault, rift valley, vegetation contrast, offset streams

This stop provides excellent views of the San Andreas Rift Valley to the west and to the Santa Clara Valley to the east. Cinnabar Vineyards and Winery is located on the north end of El Sereno Ridge on the east side of the San Andreas Rift Valley near Sanborn County Park. This is a privately owned business that is open to the public only for special events. However, special arrangements can be made for groups to visit. The driveway leading to the mountaintop winery begins on Highway 9 about 2.5 miles (4 km) south of downtown Saratoga (see fig. 6-1). Be very careful driving up to the mountaintop in that the narrow single-lane road is locally very steep and winding.

The mountaintop setting provides spectacular views of Santa Clara Valley around San Jose to the east and the rift valley and Castle Rock Ridge to the west (fig. 6-17). Unobstructed views extend to the south where the San Andreas Fault passes beneath Lake Ranch Reservoir in the saddle between upper Sanborn Creek Valley and Lyndon Creek Valley (see chapter 5). The fault zone near Walden West and the Savannah-Chanelle Vineyards are clearly visible. To the north, a stark vegetation contrast highlights the difference of soil, bedrock, and climate conditions on opposite sides of the rift valley in the vicinity of Saratoga Gap where the San Andreas Fault crosses a low saddle between the Saratoga Creek and upper Steven Creek drainages.

It should be noted that despite the name Cinnabar there are no mercury mines or ore deposits associated with the vineyard, even though North America's largest historical mercury mining district is located only a few miles south in the New Almaden region of the eastern foothills of the Santa Cruz Mountains.

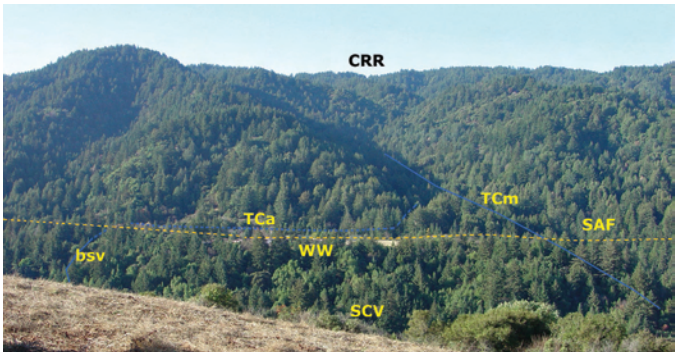

Figure 6-17. This view from the Cinnabar Winery shows part of the rift valley of the San Andreas Fault at Sanborn County Park. Open fields around Walden West (WW) are on a low shutter ridge on the east side of the San Andreas Fault (SAF). The modern drainage of Todd Creek (TCm) drains down a steep canyon off of Castle Rock Ridge (CRR). In the past, Todd Creek (TCa) used to flow south before cutting through the shutter ridge at Walden West before draining into Sanborn Creek Valley (SCV). The driveway leading to Walden West follows the beheaded-stream valley (bsv) of ancestral Todd Creek.

Alternate Stop—The Mountain Winery

Stop highlights: Vistas of the San Andreas Rift Valley, southern San Francisco Bay, Berrocal Fault

This stop provides vistas of the San Andreas Rift Valley in the vicinity of Sanborn County Park and unobstructed views of the entire South Bay region. The Mountain Winery is located on Pierce Road off of Highway 9 (Congress Springs Road) about 2 miles (3 km) south of downtown Saratoga (see fig. 6-1). From Highway 9, proceed uphill (to the west) about 0.2 miles (0.3 km) and the gated entrance to the Mountain Winery grounds is on the left. Unfortunately, the lower gates to the winery on are typically closed and access is limited to guests of events held at the facility or during open-air concerts which are scheduled from the late spring to early fall. It is worth inquiring in advance to see if the facility will be open to the public.

Paul Masson purchased a scenic mountaintop near Saratoga in 1901 and began clearing the land for vineyards and construction of what would become the historic Paul Masson Winery building. The Great San Francisco Earthquake of 1906 caused considerable damage to the new winery and widespread destruction throughout the communities in the South Bay. Paul Masson salvaged a 12th century Spanish front portal from St. Patrick's Cathedral in San Jose that was destroyed in the 1906 earthquake. He incorporated the arched doorway into the rebuilt winery building (now part of the concert stage). During the Prohibition Era most wineries in California were closed, but Paul Masson's Mountain Winery survived with a permit for production of sacramental wines. The winery building became a California Registered Historic Landmark and was placed on the National Registry of Historic Places in 1960. The mountaintop setting of the facilities provides spectacular views of the surrounding region including unrivaled sunset and evening views of the South Bay region.

The mountaintop setting of the Mountain Winery provides views to the west of the San Andreas Rift Valley around Sanborn County Park (fig. 6-18). The view looking west from the lower parking area of the Mountain Winery provides a good orientation to the vicinity of the Earthquake Hike route in Sanborn County Park described above. The geomorphology associated with the east side of the San Andreas Fault is highlighted by the vineyards of the Savannah Chanelle Winery and the grass-covered fields around Walden West School. The upland drainages of Sanborn and Todd Creeks are also visible on the steep, forested, eastern escarpment of Skyline Ridge.

The view looking to the east from both the lower parking area and the Mountain Winery's patio dining area encompasses the South Bay region, including the nearby eastern foothills to the Santa Cruz Mountains near Saratoga. A straight valley and adjacent ridge roughly 0.6 mile (1 km) east of the Mountain Winery follows the trace of the Berrocal Fault (see figs. 6-4 and 6-5). A thrust fault system known as the Range Front Fault (or Monte Vista Fault) runs along the base of the foothills near Interstate 280 and California Highway 85 in Saratoga. These faults are part of the San Andreas Fault system and may actually merge with the main fault zone at depth. Both the Berrocal and the Range Front Fault systems are considered to be potential earthquake-generating faults. The foothills around Saratoga are structurally complex, having numerous faults and folds that cut both older bedrock and younger, overlying alluvial sediments.

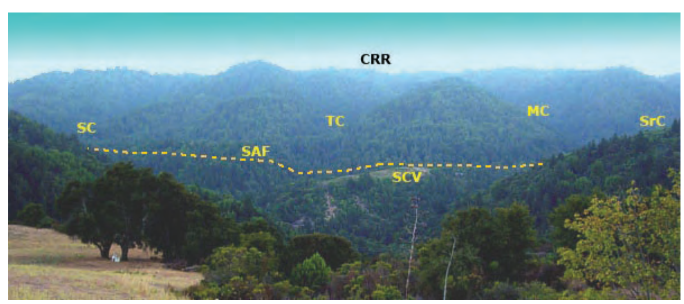

Figure 6-18. This view is looking west from the Mountain Winery parking area toward Castle Rock Ridge (CRR) and the rift valley of the San Andreas Fault (SAF). The Savannah-Chanelle Vineyards (SCV) is near the center of the image. On the east flank of the ridge, McElroy Creek (MC) drainage is to the right of the vineyard. Todd Creek (TC) is to the left of center, and Sanborn Creek (SC) is to the far left (south). Saratoga Creek (SrC) comes in from the upper right and drains to the lower left.

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