Field Trip to the Calaveras and San Andreas Faults: Hollister and San Juan Bautista Region

This field trip provides access to well known fault investigation sites in the southern Santa Clara Valley region. Field trips stops include fault scarps and offset manmade and natural landmarks along the Calaveras and San Andreas faults, sag ponds, and bedrock exposures in the Salinian basement complex west of the San Andreas Fault. The field trip begins at the Hollister exit on Highway 101 on Highway 25. **Drivers, please note that the highways are busy along these routes; drive cautiously and defensively**!

Stops 1 to 4 are modified from Harden, D., Stenner, H. M., and Blatz, I., (2001). Stop 5 is a visit to the San Andreas Fault at Mission San Juan Bautista. Stops 6 and 7 involve driving up to Fremont Peak State Park (where camping is available in season). Stops A to C include an optional extension of the field trip to stops along the San Andreas Fault east off Highway 101 along Anzar Road, at a quarry in Aromas, and to the fault at Pajaro Gap.

A very useful resource for this field trip is the Geologic map of the Monterey 30'x60' Quadrangle and adjacent areas, California by Wagner and others (2002). It is available from the California Geological Survey.

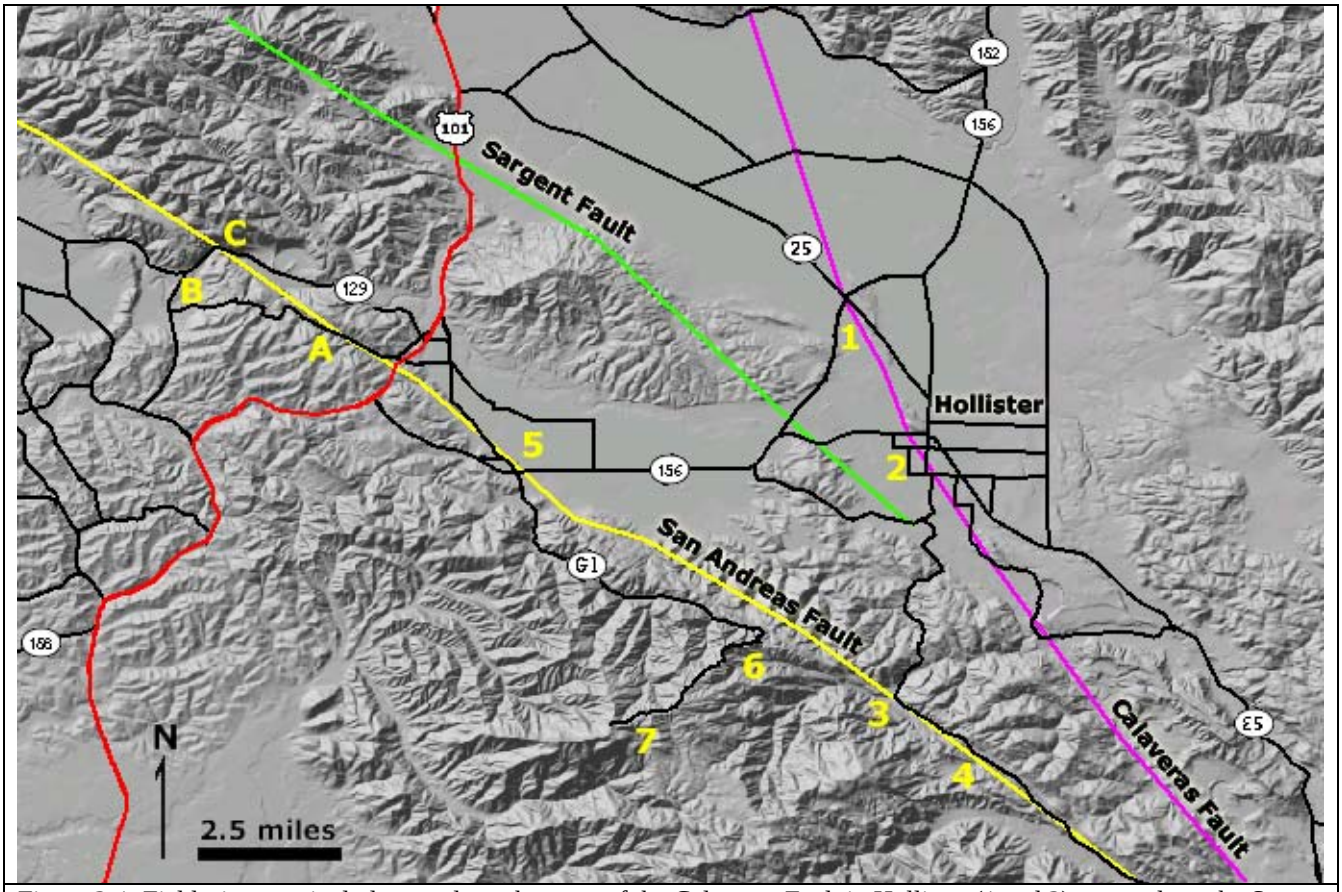

Figure 2-1. Field trip stops include two along the trace of the Calaveras Fault in Hollister (1 and 2), stops along the San Andreas Fault at the Hollister Hill State Vehicular Recreation Area (3), the Cienega Valley (4), the mission at San Juan Bautista (5), and overlook areas along San Juan Canyon Road [G1] (6), and Fremont Peak State Park (7). An option field trip in the vicinity is west of Highway 101 to Anzar Road (A), an active quarry in the Aromas area (B), and Pajaro Gap (C); however, these last stops are not recommended for children, large groups, or at any time other than early on a weekend morning when traffic might be light on Highway 129. Earthquake faults in the vicinity include the San Andreas Fault (yellow), the Calaveras Fault (purple), and the Sargent Fault (green); many other known (and unmapped or unknown) faults exist in the region.

Mileage	Description
0.0	Exit from Highway 101 south onto Highway 25 south toward Hollister. **Reset mileage** to zero**.** **Be cautious at this busy intersection while turning left!** The Hollister area has experienced extensive development during the housing boom of the 1990s. However, numerous farms are still actively providing strawberries, garlic, tomatoes, salad greens, and seed nurseries for flowers.
8.5	Traffic light at intersection of Route 156.
9.0	**STOP 1 (rolling stop) - Pressure ridges along the Calaveras Fault** (see stop description below). The landscape features seen here are best viewed by slowly driving from this point onward into Hollister. However, be cautious of traffic behind you! A small, dirt section -boundary road on the right offers a photo stop, however, do not attempt to stop if farm vehicles are present, or if the ground is wet. Keep out where posted and do not walk in crop fields.
11.0	A water tank on the right is built on a pressure ridge along the Calaveras Fault.
11.5	At a stoplight, Highway 25 becomes San Benito Avenue. Continue south into downtown Hollister. Prepare to turn right on 6th Street. Proceed west for two blocks to Dunne Park on the corner of 6th Street and West Street.
12.3	**STOP 2 - Dunne Park** (see stop description below). Restrooms are available here. Offset from fault creep along the trace of the Calaveras Fault can be observed throughout the neighborhood around the park. After the stop, proceed east on 6th Street. **Reset mileage** at corner of 6th Street and San Benito Avenue.
0.5	Downtown Hollister.
0.7	San Benito Avenue becomes Nash Road; continue straight at the light following signs to the Hollister Hills State Vehicular Recreation Area.
1.6	Turn right (west) at stop sign (Union Road). Cross the bridge over the San Benito River.
1.7	Immediately after crossing the bridge, turn left (south) on Cienega Road.
3.2	Stop sign. Continue to the right on Cienega Road. The road winds uphill through an area affected by active landslides in Tertiary sedimentary rocks.
6.5	Cross Bird Creek.
7.0	Turn right at Hollister Hills State Vehicular Recreation Park. The San Andreas Fault runs through the valley on the left.
7.1	Pass the park ranger station. A day-use fee per vehicle may be required. Proceed on the unpaved road into the park.
7.8	Turn a sharp left and proceed uphill to the picnic tables on the south end of Radio Ridge.
7.9	**STOP 3 - Radio Ridge** (see stop description below). Restrooms are available at this stop. After this stop, return past the ranger station to the park entrance.
8.8	Park entrance. Turn right (south on Cienega Road).
9.9	Vineyard School, on the right, is built on the San Andreas Fault.
10.6	A sag pond along the fault is on the right. A local oral history account is that this pond drained after the 1906 earthquake.
10.8	**STOP 4 - DeRose Winery** (see stop description below). The winery building was built on the San Andreas Fault and is slowly being torn apart by ongoing fault creep. After the stop, return north toward Hollister on Cienega Road. **Reset the mileage** to zero.
6.0	Bear left at the "Y" intersection and continue on Cienega Road.
7.5	Turn left (west) onto Union Road.
11.1	Turn left (west) onto Highway 156.
15.2	Turn right onto The Alemeda into the town of San Jan Bautista. The San Juan Bautista Mission is one block to the right of The Alameda in downtown. Turn right on Washington Street and start looking for parking. There are many excellent restaurants along The Alameda. Field-trip planners might consider ample time to enjoy a meal and a tour of the mission area.
15.5	**STOP 5 - San Juan Bautista State Historical Park** (see stop description below).

STOP 1 (rolling stop) - Pressure Ridges Along the Calaveras Fault Near Hollister

Stop highlights: fault scarps, pressure ridges, and sag ponds along the Calaveras Fault System

Low linear escarpments reveal the main fault trace of the Calaveras Fault and other splay faults throughout the Hollister area. Examples of these pressure ridges and fault scarps can be seen along Highway 25 between the intersection of Highway 152 and downtown Hollister (figs. 1 and 2). (Driving warning: Highway 25 is a busy highway, and it is not recommended to stop along the road, particularly if more than one vehicle is involved.)

The Calaveras Fault is part of the greater San Andreas Fault System in the San Francisco Bay region. The Calaveras Fault splays away from the San Andreas Fault about 10 miles south of Hollister near the town of Paicines, California. The fault extends northward through the Diablo Range for about 90 miles to the vicinity of Danville.

The southern segment of the Calaveras Fault (between Paicines and San Felipe Lake along Highway 152) is one of the fastest creeping fault segments in the San Francisco Bay region. Historic surface measurements show that the fault is creeping in the range of 11 to 19 mm per year (Kelson and others, 2004). Geophysical investigations show that as much as 174 kilometers of offset has occurred along the Calaveras Fault in the past 12 million years. This translates to roughly 13.7 mm of offset per year (McLaughlin, and others, 1996). Strike-slip deformation is partitioned between the northern Calaveras, the Hayward, and other faults that splay from the central segment of the Calaveras Fault in the vicinity of Calaveras Reservoir.

Figure 2-2. Escarpment and linear ridge (pressure ridge) on the Calaveras Fault along the east side of Highway 25 north of downtown Hollister.

Figure 2-3. A sag pond and low linear scarp along a second strand the Calaveras Fault of the west side of Highway 25 north of downtown Hollister. This view was taken in the same location as the image above.

STOP 2 - Dunne Park, Hollister

Stop highlights: creeping trace of the Calaveras Fault; offset curbs, walls, buildings, and other damaged infrastructure

The Hollister region experienced damage from both the 1906 and 1989 earthquakes. The town also experienced minor damage from earthquakes on the Calaveras Fault: the 1979 Coyote Lake earthquake (M = 5.8) and the 1874 Morgan Hill earthquake (M = 6.3).

The Calaveras Fault runs through the urban heart of Hollister. Dozens of residential homes are built on, or immediately adjacent to, the active creeping trace of the fault, and damage from fault motion can be traced from block to block both north and south of Dunne Park. Cracks and offset sidewalks, curbs, walls, and buildings can be seen along every street and alley.

Although local residents are probably accustomed to people observing fault damage, it is extremely important to warn field trip participants not to walk on lawns, photograph homes or people, and to limit walking to public sidewalks, alleys, or streets. California laws relating to earthquake damage and repair to existing homes along active faults have put an extra financial burden on residents along the fault zone; some are quite vocal and deserve respect for their opinions. All the homes in this neighborhood were built before modern earthquake laws were enacted.

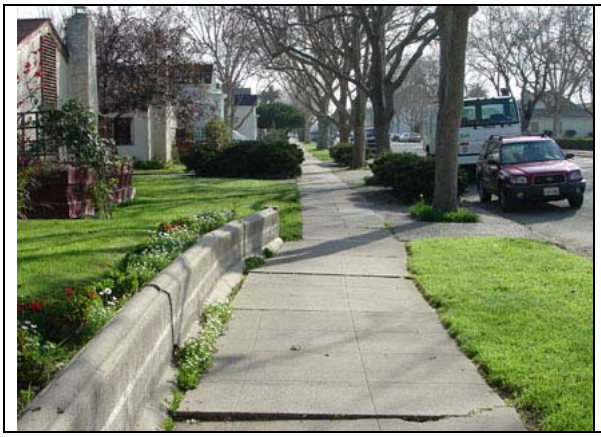

Figure 2-4. View looking east along an offset wall and sidewalk on 6th Street in Hollister adjacent to Dunne Park. The park itself preserves a low hill that is a scarp of the Calaveras Fault. The low area within the park west of the scarp was partly a sag pond prior to development of the area.

STOP 3 - Hollister Hills State Vehicular Recreation Area

Stop highlights: rift valley of the San Andreas Fault, an offset stream, shutter ridges, and vegetation and bedrock contrasts on opposite sides of the fault

The Hollister Hills State Vehicular Recreation Area consists of 6,627 acres dedicated to off road vehicle activities. The north section of the park has over 60 miles of trails for to motorcycles, and the southern section is limited to 4-wheel-drive vehicles. It is operated by the State Department of Parks and Recreation. An entrance fee is required to use the park (field trip planners might call in advance to inquire about educational group access waver).

The park straddles the San Andreas Fault. Radio Ridge is a low linear hill in the middle of the broader linear valley of Bird Creek. A picnic area on the ridge provides views of the surrounding landscape. The steep, chaparral-covered slopes on the southwest side of the valley are underlain by crystalline basement rocks (granitic plutonic rocks of Mesozoic age, and of Paleozoic and Mesozoic gneiss, schist, and marble of the Fremont Peak area that predate the granitoid intrusions).

The northeast side of the valley is dominated by oak woodlands and grasslands. The bedrock in this area consists of late Tertiary (Miocene and Pliocene) sedimentary rocks of marine and non-marine origin. Both fossil shell material and lignite occur amongst beds of sandstone, shale, and mudrocks mostly of the Pliocene age Etchegoin Formation.

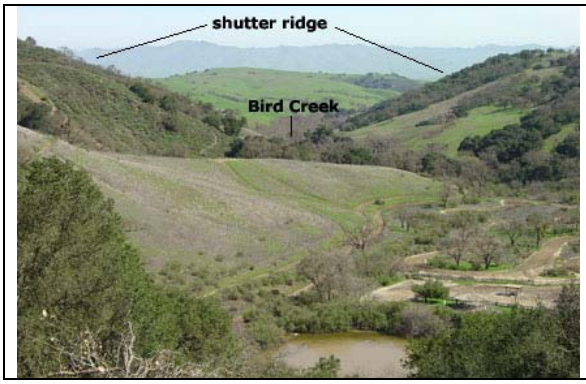

Figure 2-5. This view is looking east from Radio Ridge to the gap where Bird Creek (an fault offset stream) cuts through a shutter ridge and drains toward the Hollister valley. Bird Creek follows the straight valley of the San Andreas rift.

Figure 2-6. This view is looking toward the southeast from Radio Ridge up the San Andreas Rift Valley. The active trace of the San Andreas Fault runs along the right side of the grassy area in the valley.

STOP 4 - DeRose Winery

Stop highlights: offset drainage ditch and building on the San Andreas Fault, sag ponds, San Andreas Rift Valley

The DeRose Winery claims to be the "oldest existing winery in California." A French immigrant, Theophile Vaché established a vineyard in Cienega Valley and began selling wine in San Juan Bautista starting in 1854. Cienega means "marsh" in Spanish and the valley is appropriately named after the natural sag ponds that exist along the San Andreas Fault in the valley. The vineyard has a long history of wine production and has survived several changes in ownership, major earthquakes, and the age of prohibition.

From 1953 to the early 1980s the vineyard was owned and managed by Almaden Vineyards. The company expanded to produce nearly 3,500 acres of grapes in the area, but later in this period the company changed its production focus, and most of the vineyards were abandoned.

The DeRose and Cedolini families, and a business partner, Ernie Miller, purchased the winery in 1988. The families claim their ancestors have been making wine for over 10 generations. With a modest start using existing vines, the owners began producing zinfandel, cabernet, and pinot grape wines. Today the vineyard produces about 5,000 cases of wine annually under the DeRose Vineyards label amongst which include award-winning zinfandel, negrette, cabernet franc and viognier wines. The vineyard's cellar covers about 4 acres with a capacity of 37,000 fifty-nine gallon barrels.

The large production facility has an interesting history because it was built directly on the trace of the creeping section of the San Andreas Fault. Evidence of damage to the building and infrastructure along the trace of the fault are clearly visible. Perhaps of greatest significance is an offset cement-lined channel that was built in the late 19th century. It now displays about a meter of right lateral offset. The vineyard building itself is offset by the fault. Cracks in the parking area, and offset walls and bent boards can be seen on both sides of the building. Wine tasting and a tour of the facility may be arranged by calling the vineyards in advance. The site is now a national landmark. For more information see: http://www.derosewine.com/.

Figure 2-7. This cement-lined drainage ditch on the south side of the DeRose Vineyards shows offset from creep along the San Andreas Fault. The drain was probably constructed before the 1906 earthquake.

STOP 5 - San Juan Bautista

Stop highlights: escarpment of the San Andreas Fault, a historic Catholic mission damaged by the 1906 earthquake

The location chosen to build the San Juan Bautista Mission couldn't have been better in the eyes of the Franciscan fathers when they founded it on June 24, 1797. A low ridge above the broad floodplain of the San Benito River would provide a commanding view of agricultural activities. In time the mission and settlement would host commerce traffic along the El Camino Real (the King's Highway) that passed along the base of the hill next to the mission site. This is the highway that connected all of the California missions, and later served as one of California's major stage and wagon roads. The town site had great potential to become a significant population center in California. However, many things happened over the course of time that prevented the town from growing. To begin with, little did they know that the straight hill next to the mission site was the escarpment of the San Andreas Fault!

Figure 2-8. The San Juan Bautista Mission. The trace of the San Andreas Fault runs along the foot of a historic grandstand (painted green) along the "El Camino Real" (at the base of the stairs). The historic road runs along the San Andreas Fault scarp through the northeast side of town.

The onset of trouble began before the mission was even built. In October, 1798 the shaking from an earthquake was so bad that the missionaries slept outside for the whole month. As many as six strong earthquakes occurred in a single day, leaving many huge cracks in the ground and damaged newly constructed buildings. Shortly afterward, a newly constructed church building was destroyed by an earthquake in 1803. However, the town population was growing quickly. The modern mission was designed to accommodate a thousand people and, they hoped, to withstand significant earthquake shaking. The developing mission experienced its next damaging earthquakes in 1836 and 1838. The 1836 Hayward earthquake may have actually had its epicenter along the San Andreas Fault near San Juan Bautista! The 1838 earthquake occurred along the Peninsula section of the San Andreas Fault.

In the period before the 1849 Gold Rush, the town of San Juan Bautista had a population of several hundred Californios (Spanish descendants) and a large Native American population. The San Juan Valley was the home of the Mutsun Indians. At one time some 1,200 Indians lived and worked at this mission (as many as 5,000 Mutsun Indians are buried in the town cemetery). The Gold Rush brought a flood of northern European and English-speaking settlers to the region. However, these new immigrants largely avoided the Spanish-speaking town and established Hollister that would soon eclipse San Juan Bautista as the economic center of San Benito County. The transition happened on the heals of disaster.

In 1869 a smallpox outbreak occurred. A local resident observed that a guest at a San Juan Bautista town meeting had symptoms of the disease. They immediately tried to quarantine the sick person but it was too late. The entire community was soon quarantined with Marshall Law rules; if someone attempted to flee they would be shot. When the outbreak was over, nearly a third of the town's residents were dead, and a community of Native Americans (laborers) nearby was completely wiped out by the disease. Six month later, a fire swept through much of the downtown area. The combination of the two event crippled the town for years.

Then the 1906 earthquake struck. The mission was nearly destroyed along with many of the business buildings and residents throughout the town.The next crushing blow came when the town was bypassed by the railroad (that went, instead, through Hollister). In addition, much of the land around could not be developed for fear of flooding of the nearby San Benito River.

In 1949, the Hearst Foundation financed efforts to restore the mission to its original form. However, repair of damage to the mission from the 1906 earthquake was not completed until the 1970s. In contrast, the 1989 earthquake only caused minor damage. However, in many respects the historic town has been "saved" by its misfortune. Today the town retains much of its historic architecture, culture, and charm. It has a thriving restaurant and shopping district on The Alameda (3rd Street), and the active historic Catholic mission and museum area on 2nd Street are part of the San Juan Bautista State Historical Park.

Figure 2-9. A brass plate on the San Juan Bautista Mission grounds commemorates the 100th anniversary of the U.S. Geological Survey. The original exhibit contained a USGS seismograph and seven stops along the "El Camino Real Earthquake Walk." Only this brass plaque remains today.

A trip to the mission plaza and grounds offers an excellent view of the San Andreas Fault escarpment along the northeast side of the mission. Modern offset on the fault can be seen in several locations. A white fence probably constructed in the early 1970s on either side of El Camino Real at the foot of the stairs near the mission is offset by about 3 inches (either due to ongoing creep along the fault or to poor alignment of the fence!). In addition, a visible break in a wall can be seen outside of the Faultline Restaurant just southeast of the mission.

Sources: http://missions.bgmm.com/bautista and http://www.sanjuanbautista.com/history.html.

Trip to Fremont Peak State Park (Optional Trip Extension)

Mileage	Description
0.0	At the intersection of The Alameda (in San Juan Bautista) and Highway 156, proceed south on San Juan Canyon Road following signs to Fremont Peak State Park. (The Alameda becomes San Juan Canyon Road south of the intersection.). The drive is about 11 miles. Reset trip mileage to zero at the intersection of Highway 156 and San Juan Canyon Road (The Alemeda in San Juan Bautista).
0.2	Bear to the left to stay on San Juan Canyon Road. The road to the right is the Old Stage Road that connects San Juan Bautista to Salinas Valley. A sign at the intersection state that the distance to Fremont Peak is 11 miles. Large barren outcrops of marine sandstone of Miocene age (Temblor Sandstone) crop out in the hills on both sides of the road. Pyroclastic volcanic rocks of Miocene age are mapped in the area but are not visible along the road.
5.0	A private picnic area owned by the Church of Jesus Christ of Later Day Saints (Mormon) is on the right. The picnic area is adjacent to a large abandoned "granite" quarry in the Salinian basement complex. Tailing from the quarry operations can be seen near the mouth of San Juan Canyon.
7.0	The road begins to ascend from San Juan Canyon. It passes very close to the San Andreas Fault Zone near the eastern-most point along the route, but nothing is apparent in the forested landscape except perhaps the character of the low divide to the left of the road where the fault crosses a saddle between drainage divides. Bird Creek drainage is to the south.
8.5	**STOP 6 - Overlooks along San Juan Canyon** Road (see stop description below). Several small pull offs are available along both sides of the road. The road ascends along a ridgeline that provides views of Bird Creek Valley to the east and Peak Canyon (with the Mormon camp quarry)

	to the west. After the stop continue uphill (west).
11.2	**Fremont Peak State Park** (see stop description below). Restrooms and camping are available here. Camp sites must be reserved in advance of the trip. After the stop, return to San Juan Bautista by the same route.

STOP 6 - San Juan Canyon Road

Stop Highlights: Views of the rift valley of the San Andreas Fault, weathered granite, an abandoned granite quarry

San Juan Canyon Road runs south from downtown San Juan Bautista (across from where The Alameda intersects Highway 156). The road follows the historic stage route for a short distance before veering off to the left. At one time this area was the historic Indian village where over a thousand people may have lived. That village vanished after a smallpox outbreak in 1869 that completely annihilated the population. No obvious trace of the Indian village remains.

San Juan Canyon Road extends for 11 miles to near the summit of Gavilan Peak (now Fremont Peak in Fremont Peak State Park). The name, Gavilan, has been relegated to the entire range extending south from the San Juan Bautista area to the Pinnacles to the south. Most of the range is a great massif of Salinian crystalline basement (Mesozoic age granitic rocks that have intruded older Paleozoic and Mesozoic metamorphic rocks). The Gavilan Range (also spelled *Gabilan*) is on the west side of the San Andreas Fault.

Near where the road enters San Juan Canyon, piles of abandoned gravel in the fields to the right side of the road are reminders of past mining activity in the area. Salinian granitic rocks and marble were mined locally for aggregate and probably cement. A large abandoned quarry is in the vicinity of a Mormon camp along the road. It is in the vicinity of the Mormon camp where the road crosses the Vergeles Fault. The fault splays from the San Andreas Fault near where San Juan Canyon road makes a steep bend to the south and ascends from the valley along a ridgeline leading to Fremont Peak. The Vergeles Fault extends westward across the northern flank of the Gavilan Range and vanishes under the cover of Quaternary sediments along the Pajaro River Valley to the west of Highway 101.

While driving up San Juan Canyon Road the bedrock and vegetation changes as it crosses the Vergeles Fault. North of the fault the bedrock consists of Miocene-age volcanic rocks (not exposed due to weathering and plant cover) and older Tertiary sedimentary rocks. Massive outcrops of Vaqueros Sandstone (Oligocene age) occur throughout the hillsides along side of the road. These are the same rocks that crop out along Rocks Road and along Highway 101 south and west of San Juan Bautista (and at Castle Rock State Park in the Santa Cruz Mountains). In this section of the canyon, the hillsides are covered with a mixed oak and evergreen forest. On the south side of the Vergeles Fault the bedrock consists of weathered granitic rocks that are dominantly covered with chaparral on the upland south- and west-facing slopes.

Stop 6 is located along the road approximately 8.5 miles from Highway 156 on San Juan Canyon Road. Vehicles can pull off on the right side of the road onto two unpaved spur roads. Vistas are seen on both sides of the road in this area where the road follows the ridge line. On the west side of the road the view encompasses the abandoned quarry near the Mormon picnic area and the region around the southern Santa Cruz Mountains in the distance. This hard rock quarry produced granitic aggregate and stone. The dominant rock type included granodiorite, and garnet-bearing granitoid gneiss and schist. On the south side of the road the view encompasses the headwater region of Bird Creek in the Hollister Hills State Vehicular Recreation Area. The trace of the San Andreas Fault can be seen down the valley where the vegetation changes from chaparral (covering weathered granitic bedrock) to oak woodlands and grasslands growing on latest Tertiary-age sedimentary rocks on the east side of the fault. The trace of the fault extends into a rift valley southward into the Cienega Valley region.

Continue uphill; note the character of the weathered granitic bedrock and the light-colored quartz and aplite veins that protrude from the weathered rock. Also note the vegetation change where the road crosses from bedrock consisting of weathered granite to bedrock dominated by marble and other ancient metamorphic rocks.

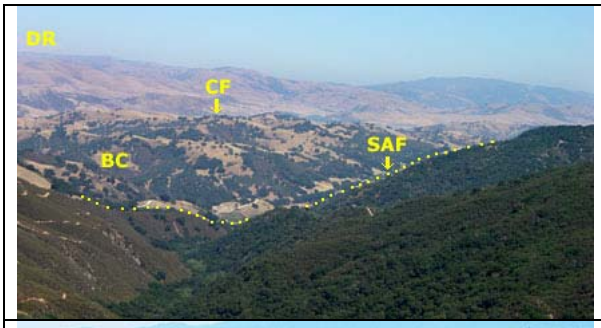

Figure 2-10. View of the San Andreas Rift Valley in the vicinity of Bird Creek in the Hollister Hills State Vehicular Recreational Area. SAF is the San Andreas Fault. BC is the offset gap of Bird Creek Canyon. CF is the San Benito River valley and the location of the Calaveras Fault. DR indicates the Diablo Range in the southern of Quien Sabe Range southeast of Hollister.

Figure 2-11. An abandoned granite quarry near the Mormon camp on San Juan Canyon Road. The rock is mostly granitoid gneiss with some schist and intrusive dikes.

STOP 7 - Fremont Peak State Park

Stop highlights: Vistas of Salinas and Santa Clara valleys, Monterey Bay, Salinian Basement marble, lead mines

In 1846, Captain John C. Fremont and his company of U.S. "surveyors" climbed Gavilan Peak and built a hasty fortification of earth and logs, expecting stiff resistance from Mexican Californios. The peak area was known for its wide view of the region and small-scale lead mining activity. Fremont and his men had been allowed to spend the winter in California under the condition that they stay away from coastal settlements in the region. Fremont chose to ignore this decree, and reports reached the Mexican California governor, Jose Maria Castro, who was already concerned by the flood of non-Spanish speaking people into the region. The governor sent troops to remove Fremont and his men. While waiting for the arrival of troops, the defenders raised the United States flag over their fortification (the first time recorded in California). However, after several days of "not-so-diplomatic" negotiation, a battle still did not materialize. Probably more because of their limited supplies of food and water, Fremont and his men grudgingly decided to break camp and head for Oregon.

Today, Gavilan Peak is called Fremont Peak and the summit area is incorporated into Fremont Peak State Park. The name, Gavilan, is now applied to the range extending from about Highway 101 southward to the Pinacles National Monument area. Trails lead to the craggy summit of the mountain, and the park maintains a public campground (make reservations well in advance!). A radio facility is operated on one of the lesser peaks in the summit area. Also, the Fremont Peak Observatory Association maintains an observatory in the park. Many amateur astronomers come to the peak on the new moon each month.

Fremont Peak offers some interesting geologic observations. The summit area consists of a ridge of marble and dolomite that display interesting textural characteristics which are a source of long-standing discussions. The primary questions focus on whether the texture of the marble is a result of primary sedimentary structures or of secondary metamorphic foliation. Early investigations suggested that the marble preserves calcitic crinoid column fragments of Paleozoic age. Other reports suggested that the rock is of Cretaceous age (closer to the age it underwent metamorphic alteration and intrusion). The rock was ultimately derived from the southern California region where both Paleozoic carbonate rocks and Mesozoic intrusive rocks occur. The rock migrated northward along the San Andreas Fault and possibly other fault systems that predate the San Andreas. Fissures in the marble around the ridge top preserve cavernous travertine deposits and some cerussite (lead carbonate) deposits that were the target of early, small-scale mining operations. Prospect pits, shafts, and tunnels are scattered throughout the mountain top (mostly on nearby private land). It

is recommended to stay out of the mines due to their instability, and the potential of disturbing bats, rattlesnakes, and other varmints that access them.

Figure 2-12. Fremont Peak is 3,169 feet in elevation. This north-facing view shows part of a marble outcrop in the foreground. The chaparral ecosystem in the midground overlies weathered granitic basement. The grasslands behind cover Tertiary sedimentary and volcanic rock north of the Vergeles Fault. SJB is San Juan Bautista SAF shows the linear escarpment of the San Andreas Fault. SH show the Sargent Hills. LP is Loma Prieta Peak where the San Andreas Fault crosses its southern (left) flank.

Figure 2-13. An old lead mine in the marble of Fremont Peak. Note that the barren bushes in and around the mine are poison oak.

Trip to the Anzar Road and Pajaro Gap (Optional Field Trip Extension)

Mileage	Description
0.0	This trip begins at San Juan Bautista Mission. Follow 2nd Street west from the mission.
0.4	Bear right on Monterey (proceed one block).
0.5	Bear left on San Juan Road. The escarpment of the San Andreas Fault vanishes in the fields northwest of the mission, but emerges again along the low hills on the west side of San Juan Road.
2.4	Turn left on Anzar Road. The hill slope on the left side of the road is probably a fault scarp within system of local faults associated with the San Andreas Fault Zone.
3.6	Overpass of Highway 101.
3.7	Intersection of Anzar Road and Searles Road (frontage road for Highway 101). Continue straight on Anzar Road. **Note:** To get to Stop A from Highway 101, exit at Highway 129 (toward Watsonville. (This exit is 40.9 miles south of the intersection of Highway 85 and Highway 101 in south San Jose.) Once off the highway ramp, proceed south on Searles Road. (Searles Road runs parallel to Highway 101 south). Proceed south on Searles Road 0.7 miles to the intersection with Anzar Road. Turn right (west) on Anzar Road. Cracks in Searles Road located several hundred feet south of the intersection with Anzar Road are probably a result of fault creep along the San Andreas Fault. **Reset mileage** to zero at the intersection of Searles and Anzar roads. Begin rolling Stop A here.
0.0	**STOP A - Anzar Road** (rolling stop)

0.5	A sign along Anzar Road says: Stevens Creek Quarry, Williams Pit: (408)253-2512; Plant #2 - (831)623-9555
1.1	Cross Canyon Road. Note the forested, cliffy slope on the left side of the fault and the grass-covered slope on the right. Cattails mark the location of springs and sag ponds along the fault zone.
1.5	A small abandoned quarry on the left.
1.9	Anzar Lake is on the left. This is one of the largest sag ponds on the San Andreas Fault in the region. The east side of the rift valley is forested with eucalyptus.
2.4	Forest Road on right. The road bends to the left (south) and ascends a hill into the eucalyptus grove along the west side of the San Andreas rift zone. The landscape in this region is underlain by Pliocene marine sediments and Quaternary alluvial (non-marine) sediments. These sediments overly the granitic basement rocks.
2.8	The road crosses a large conveyor belt that carries crushed rock from the granite quarry to the processing plant and railroad terminal.
3.1	Cole Road to left; bear to the right.
3.5	Intersection of Anzar Road with Carr Avenue and Aromitas Road. (Aromitas is an unpaved shortcut to Stop B). However, continue west on Carr Avenue. The road crosses a low divide and descends into the village of Aromas.
5.2	Turn right onto Carpenteria Road.
5.4	Intersection of Carpenteria and Blohm Avenue. Continue straight on Carpenteria. (Gas and food can be purchased in the small "downtown" area at the crossroads).
5.6	Turn right on Quarry Road just before the railroad tracks.
6.1	Intersection of Aromitas Road and Quarry Road. Proceed north into the quarry.
6.4	**Stop B - Aromas Granite Quarry** (see description below). Stop at the quarry entrance station before proceeding. Permission is required to enter the quarry, and mining activity may prevent access to the main pit. It is advisable to call for tour permission well in advance. After the stop, return to the intersection of Quarry Road and Carpenteria. Turn right (north) on Carpenteria and proceed across the railroad tracks. **Reset the mileage** to zero.
0.6	Turn right (east) on Highway 129. Highway 129 follows the valley of the Pajaro River.
1.4	**STOP C - San Andreas Fault at Pajaro Gap (rolling stop)** (see stop description below). **Please note!** Due to fast and heavy traffic on Highway 129, groups should not plan to stop at the bend in the road where the fault crosses the road. Rather, proceed to a small pull off on the right near the Crittenden Railroad Bridge.
1.8	**STOP C (continued) - Crittenden Railroad Bridge** (see stop description below). An unpaved road on the right leads to a small parking area next to the Crittenden Railroad Bridge over the Pajaro River. The original railroad bridge was heavily damaged by the 1906 earthquake. **Please Note!** Do not attempt to walk on the bridge or the railroad tracks! Trains blaze through this area at high speeds and the sound of their approach may be muffled by highway noise. After the stop, continue east on Highway 129.
4.3	Intersection of Highway 129 and Highway 101 and Searles Road. End of field trip.

STOP A (rolling stop) - San Andreas Fault Along Anzar Road

Stop highlights: Fault scarp along the San Andreas Fault, bedrock and vegetation contrasts, sag ponds

Anzar Road follows the San Andreas Rift Valley and provides views of some exceptional geomorphic features. The granitic basement rock exposed on the west side of the rift valley forms a steep escarpment covered with mixed oak and evergreen forests. Late Tertiary and Quaternary sediments on the east side of the fault are covered in grasslands. Sag ponds are common along this quiet rural road; Anzar Lake near the northeast end of the valley is particularly impressive. West of Anzar Lake the road ascends out of the rift valley through a scenic eucalyptus forest. There are no parking spaces

along this road, but ample visibility along the straight valley and the general lack of rural traffic shouldn't make stopping a concern for a picture break.

Figure 2-14. Anzar Lake is a large sag pond in the San Andreas Rift Valley along Anzar Road.

STOP B - Aromas Quarry

Stop highlights: Salinian basement complex, granodiorite, the Logan Gabbro, active granite quarry operations

The Aromas "Granite" Quarry area is a popular destination for field trips. Advanced access arrangements, hard hats, and boots are required to tour the quarry (access is forbidden during blasting and heavy mining activity). There is no true granite being mined in the quarry. The Jurassic age rock consists of coarse crystalline gabbro and diorite (crystals of light-colored plagioclase feldspar and dark-colored clinopyroxene, hornblende, and amphibole give the rock a "salt and pepper" texture). Veins of some granodiorite and granitoid rock are also present. (The older Logan Quarry is just over the hill and is known for its gabbro; the local outcrop belt of this crystalline bedrock is called the Logan Gabbro). The rock is blasted, crushed, and sorted for use as aggregate and can be found in construction sites and rail lines throughout the region. A thin cover of Pliocene marine fossil-bearing sediments can be seen unconformably overlying the high walls of the quarry.

The Logan Gabbro has been correlated with equivalent exposures of gabbroic rocks at Gold Hill (south of Parkfield) and Eagles Rest Peak in the Tehachapi Mountains in Southern California (an offset distance of about 320 kilometers along the San Andreas Fault).

Figure 2.15. The main active pit at the Aromas "Granite" Quarry.

STOP C - The San Andreas Fault at Pajaro Gap and Chittenden Bridge

Stop highlights: San Andreas Fault, bedrock and vegetation contrasts, Santa Cruz Mudstone, riparian habitat, springs

Please note: This stop is not recommended for groups of more than a few people because of the dangerous traffic on the road. Groups should proceed to "STOP C (continued)" described below for a safer and more casual examination of the area. However, if you do stop please pull off to the right beyond the guard rail, and pull ahead as far as possible to leave ample room and time for northbound drivers to see cars parked alongside the highway. Please note that

as on all roadside stops, group leaders or individuals standing along this busy highway could be cited if proper precaution in not taken to ensure public safety.

Pajaro Gap is the narrow river passage between the southern Santa Clara Valley and the Monterey-Santa Cruz coastal plain region. The passage defines the southern end of the Santa Cruz Mountains. The Gavilan Range is to the south and east. The Pajaro River is usually a small spring-fed stream except during infrequent winter floods. Most of its headwater tributaries have been modified or diverted to support agricultural activities, groundwater recharge, municipal uses, and flood control. The river is the main drainage of the southern Santa Clara Valley and a large portion of the central Diablo Range. Its main tributary is the San Benito River that drains the San Andreas Rift Valley south of San Juan Bautista. West of the gap the river flows to Monterey Bay through the Pajaro Valley, the agricultural region around Watsonville.

Figure 2-16. The San Andreas Fault is poorly exposed crosses Highway 129. Landslides and plants have covered the fault zone (near the bend-in-road sign). The outcrop directly behind the car is weathered granitic rock; the outcrop on the right side of the image is sheared and weathered Miocene marine mudrocks (Santa Cruz Mudstone).

Figure 2-17. Beds of Santa Cruz Mudstone are gently dipping to the northeast towards Santa Clara Valley.

Figure 2-18. A drain pipe in the Santa Cruz Mudstone near the fault zone is a source of sulfur-rich water. Sulfur and mineral springs are common along faults throughout the region. **Warning!** Do not attempt to have field trip participants cross the road to examine the springs or outcrops. There isn't enough room to stand next to the road. Rather, a single individual might carefully cross the road and fill a water jug. However, the rotten-egg smelling water is not safe to drink. Cattails grow in abundance near the springs.

STOP C (continued)

A small access road to the Crittenden Railroad Bridge is about 0.4 mile north of where the San Andreas Fault crosses Highway 129. This is a much safer place to park and observe aspects of the landscape around Pajaro Gap. However, be

cautious of broken glass and other material abandoned here. A good overlook view is next to the railroad bridge (**WARNING! Do not walk on the rails or the bridge**; it is both unsafe and illegal. Trains can pass through this area at unexpected high speed and their approach can be masked by highway noise.)

The trace of the San Andreas Fault is revealed on the hillside above Pajaro Gap by both a change in vegetation and a change in slope. Older "granite" quarry operations are visible on the east side of the river south of the railroad bridge. An outcrop of Santa Cruz Mudstone next to the bridge parking area is a much safer place to examine the rock than along the highway.

Figure 2-19. Mt. Pajaro is to the right (elevation 1,578 feet). A eucalyptus forest grows on the west side of the San Andreas Fault on the weathered granitic bedrock. Chaparral dominates the steep hillsides east of the fault where the soil is composed of weathered Tertiary sedimentary rocks. A riparian forest community dominates the narrow floodplain of the Pajaro River.

Figure 2-20. The original railroad bridge over the Pajaro River was heavily damaged by the 1906 earthquake. The bridge straddles a strand of the San Andreas Fault, which caused minor rotational offset of the bridge during the 1906 earthquake. The area also experienced heavy shaking during the 1989 earthquake. Piles of gravel from the Logan Quarry are in the distance.

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