Field-Trip Guide to the Southeastern Foothills of the Santa Cruz Mountains In Santa Clara County, California

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Introduction

This field trip is an introduction to the geology of the southeastern foothills of the Santa Cruz Mountains in southern Santa Clara County. Seven stops include four short hikes to access rock exposures and views of the foothills east of Loma Prieta Peak between Gilroy and San José. Field-trip destinations highlight the dominant rock types of the "Franciscan assemblage" including outcrops of serpentinite, basalt, limestone, ribbon chert, graywacke sandstone, and shale. General discussions include how the rocks formed, and how tectonism and stream erosion have changed the landscape through time. All field trip stops are on public land; most are near reservoir dams of the Santa Clara Valley Water District. In addition, stops include examination of an Ohlone Indian heritage site and the New Almaden Mining Museum.

Fig. 1 is a shaded relief map showing the location of seven stops. Participants are recommended to bring road maps of southern Santa Clara County. Geologic maps available on the Internet of the area are listed in the reference section of this report. Both the Santa Clara Valley Water District and the Santa Clara County Parks and Recreation Department provide brochures and web sites that give additional information about these public lands.

TRAVEL SCHEDULE: Arrival and departure times may vary depending of circumstance and weather.
("*" Means there are restroom facilities - albeit primitive.)

Cars leaves promptly at 9:05am from the loading dock area of SJSU campus.

Arrive at 9:45am: Stop 1 - *Chitactac-Adams County Park on Watsonville Road west of Gilroy. Leave at 10:30am.

Arrive at 10:45am: Stop 2 - *Uvas Reservoir Dam on Uvas Road [Route G8]. Leave at 11:45am.

Arrive at 10:50am: Stop 3 - *Uvas Reservoir Picnic Area. Leave at 12:45pm.

Arrive at 1:00pm: Stop 4 - *Chesbro Reservoir Dam on Oak Glen Avenue. Leave at 1:40pm

Arrive at 1:55pm: Stop 5 - *Calero Reservoir Boat Dock Parking Area.

Arrive at 2:10pm: Stop 6 - *Almaden Mining Museum at Casa Grande on Almaden Road. Leave at 2:45.

Arrive at 3:00pm: Stop 7 - Bald Mountain Overlook Trail on Mt. Umunhum Road. Leave at 4:20 to return to SJSU by 5:00pm.

PLEASE DRIVE CAUTIOUSLY! Some hills are steep, and portions of the road and bridges are narrow. Drivers, please don't be distracted by discussion in the car. Be aware that the roads in the Santa Cruz Mountains are popular with bicyclists and sports-car enthusiasts. Watch out for drunk, distracted or disoriented drivers!

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Road Log

This trips starts on the San José State University campus loading dock for Duncan Hall (home of the SJSU Geology Department). The loading dock drive is just west of the 7th Street Parking Garage on San Salvador Street. This is only temporary parking for gathering trip participants. Day parking is available in the 7th Street Parking Garage at the current price of $2 per day, and parking is generally available on weekends.

Mileage/Notes

From the loading dock, **turn left** on San Salvador Street, then **turn right** on 7th Street (south). **Turn left onto the I-280** on-ramp just south of the highway overpass. **In 1.2 miles, take US Highway 101 South toward Los Angeles**. Be prepared to reset your highway mileage.

0.0 **Reset mileage to 0.0 at the high point on the Highway 101 overpass.** A wide-sweeping view of the northern Santa Clara Valley can be seen from the US 101 overpass.

3.5 Yerba Buena Hills are straight ahead (as seen near the Yuerba Buena Road exit on US Highway 101).

4.5 Pass the sign for Helleyer Park (Helleyer Avenue). US Highway 101 straddles Coyote-Helleyer County Park just south of this exit. Easily-accessible exposures of serpentinite, layered-chert beds in chevron folds, and Silver Creek Gravels (late Tertiary valley fill) occur along the Coyote Creek bike path. Helleyer Park hosts restored riparian habitat and has excellent picnic facilities. Along the next several miles on US Highway 101, blue-green serpentinite exposures can be seen in the hills to the left (beyond areas of recent development).

8.0 Pass the exit for Bernal Road. Bernal Road leads west to the entrance to Santa Teresa County Park. This park provides exceptional views of the Santa Clara Valley and highlights both interesting geology and biology of the Santa Teresa Hills. Part of the hill country is underlain by serpentinite; the soils in these areas, particularly around springs, are habitat to many rare and endangered plant species. Good city planning, environmental concern, and philanthropy have helped save these hills from future development.

8.7 Pass the merge with CA Highway 85. Just past the southern end of the sound wall is a view to the west of Coyote Peak, the highest peak of the Santa Teresa Hills.

9.7 Parkway Lakes, on the right, were formerly gravel pits, and are now groundwater-recharge ponds. The sign "Sure Catch Trout" keeps changing. Sometimes it is just "Sure Catch" - why this is, who knows? In any case, the trout are likely not indigenous. The ponds are part of the network of water infiltration ponds to replenish the aquifers beneath the northern Santa Clara Valley.

10.3 Pass the major power-grid station for San José along US Highway 101. Serpentinite boulders are scattered across the hillsides on the left. This topography is, in-part, a weathering effect related to soil development in areas underlain by serpentinite. Some of the serpentinite has been silicified (chert is very chemically stable and is more resistant to erosion on the surface environment). Areas underlain by this variety of "silicified serpentinite" can be easily recognized on hillsides throughout the South Bay.

13.8 Pass the Coyote Creek Golf Course exit.

14.8 The mountain to the left is called Yerba Buena Ridge. A large, active landfill is on the upper hillsides on the left. On the right are a series of old, overgrown gravel pits that are now wildlife habitat in Coyote Creek County Park.

15.3 A model airplane flying field is on the right (near the line of trees along Coyote Creek). Large gravel bars along Coyote Creek occur in this area. They are a good place to study riparian flora and fauna and to examine the wide variety of rock materials derived from the Diablo Range. From the Monterey Highway (several miles north of Cochrane Road) is an access road that leads to this relatively undeveloped section of Coyote Creek County Park.

15.7 Cliff exposures of late Tertiary valley-fill gravels occur on the hillside at the break in slope on left. These gravels (part of a more widespread deposit called the “Silver Creek Gravels”) represent a period of time when alluvial gravels partially filled the Santa Clara Valley earlier in its geologic development in the late Tertiary. The valley is probably both wider and deeper today than when these gravels (now conglomerate) were deposited along the ancestral Coyote River drainage.

16.1 Pass the bridge over Coyote Creek. Anderson Reservoir Dam can be seen blocking a former gorge through the Yerba Buena Ridge (several miles to the left). This long ridge preserves evidence of the complex geologic history related to the ongoing development of the Calaveras-Hayward fault system and the uplift of the Diablo Range. The hilltops above the dam preserve evidence of a late Tertiary volcanic lava flow that formed early in the development of the San Andreas fault system and the opening of the Santa Clara Valley. These volcanic rocks unconformably overlie highly-deformed Franciscan assemblage rocks, mostly ancient basalt, greenstone [altered basaltic volcanic rocks], serpentinite, chert, shale, and graywacke sandstone. (Graywacke is a fancy name for a “dark, poorly sorted, typically fine-grained, dirty rock.”) Some of the rocks are well-exposed near the reservoir spillway and the boat-ramp areas in Anderson County Park.

17.2 Pass the exit to Cochrane Road.

18.4 El Toro (1420 feet) is the low mountain peak just west of downtown Morgan Hill (400 feet) (fig. 2).

18.8 Pass the exit to East Dunne Avenue (downtown Morgan Hill is to the west). East Dunne Avenue continues east uphill, drops down to a bridge across Anderson Reservoir (flooded Coyote Creek), then continues for another 10 miles to the headquarters at Henry Coe State Park (the second largest state park in California covering ~66,000 acres). Coyote Creek roughly follows a gorge carved along the rift-valley trace of the Calaveras Fault. The high, steep hillsides west of Timber Ridge (the highest ridge in the distance to the southeast) are an indication of how rapidly the Calaveras Fault is changing the landscape. Coyote Creek drains the core of the Diablo Range (to the east) and rather than flowing directly into the Santa Clara Valley it makes a hard right, and follows the chasm of the Calaveras rift valley northward nearly 10 miles before draining west through a narrow gorge that is now home to Anderson Reservoir Dam. Both Anderson and Coyote reservoirs flood portions of the Calaveras Fault rift valley.

20.1 Pass the exit to Tenant Road. The Hills to the west show bench-like terraces. These are stream terraces (which are different in origin from the sea terraces along the coast). These formed during periods of valley-broadening erosion along with stream sediment deposition that back-filled the Santa Clara Valley (presumably during high-stands in sea level). When sea level fell, the streams carved into the valley. Because the Diablo Range is rising, terraces from each cycle of valley back-filling were left as a step-like surfaces on the hillside. Dating terraces is a method for determining the rate of mountain uplift relative to the valley that remains near sea level.

22.8 Pass exit to San Martin Road. To the west, Timber Ridge overlooks the hidden valley occupied by Coyote Reservoir.

24.1 Lions Peak is the low, grassy bald-topped peak on the right (overlooking northern Gilroy).

26.7 A sign indicating Gilroy’s city limit is on the right.

27.8 **Exit on Leavesley Road** (Highway 152). Turn **right** on Leavesley Road and drive west toward downtown Gilroy.

28.3 **Turn left (south) onto Monterey Highway** after crossing the main valley rail line.

28.7 **Turn right on First Street** (Highway 152 West). St. Mary’s Catholic Church is on the corner. First Street is lined with strip malls for a couple of miles. First Street becomes Hecker Pass Road (the road eventually crosses Hecker Pass in the southern end of the Santa Cruz Mountains). Mt. Madonna County Park (near Hecker Pass) encompasses a heavily forested area along the mountain ridge. The park is known for its captive herd of white fallow deer, redwood forests, hiking trails, picnic areas, and campgrounds.

32.4 Bonfante Gardens Theme Park is on the left. The theme park is nearly 600 acres of theme gardens, rides, and attractions (most with a vegetable theme).The park is the creation of native Santa Clara Valley resident Michael Bonfante, who sold a successful grocery store chain to realize his dream of creating the theme park.

33.6 **Turn right on Watsonville Road (Route G8)**. A sign indicates the direction "to Morgan Hill." The road follows the west side of the broad stream valley for Uvas Creek.

34.7 Redwood Retreat Road (to the left) follows the valley of Little Arthur Creek.

34.8 A bridge crosses the stream just south of the confluence of Uvas Creek and Little Arthur Creek.

34.9 **STOP 1: Chitactac-Adams County Park.** This stop focuses on examining massive outcrops of the middle Tertiary Temblor Sandstone (figs. 3 and 4), local Native American archeology and history, and stream valley development. See the "Stop 1" discussion below.

Reset mileage to 0.0 when leaving the park.

1.2 Pass Day Road. Kirigin Cellars vineyards fill the low valley to the east. There is no stream currently draining this broad valley. It was probably the ancestral path of Uvas Creek before stream capture occurred when a tributary of Little Arthur Creek carved through its headwater area, diverting Uvas Creek into the current valley between Chitactac-Adams County Park and Day Road.

1.4 From this location, look to the northwest across the vineyards and you can see why the mountain in the distance is called "Twin Peaks" (fig. 5). Twin Peaks is actually a long ridge that divides Uvas Creek Valley on the west, from "Paradise Valley" (Llagas Creek Valley) on the east. Note the high peak of Loma Prieta in the distance, nearly 15 miles away looking westward up Uvas Creek Valley. Note the steep "V-shaped" valley of Uvas Creek in contrast to the broad valley we've just driven through.

2.4 **Turn left onto Uvas Road** (continuing on Route G8). Watsonville Road continues northward to Morgan Hill through a broad valley (Hayes Valley) that has lost its stream to stream capture. At one time in the Pleistocene, the ancestral Llagas Creek or ancestral Uvas Creek may have flowed through this valley. To the west, Hayes Valley joins the Santa Clara Valley and is drained by a small tributary of Llagas Creek.

3.1 Uvas Pines RV Park on the flood plain adjacent Uvas Creek. **Be cautious crossing the narrow bridge over Uvas Creek.**

4.3 **STOP 2: Uvas Reservoir Dam**. This stop is to examine pillow basalt and other rock outcrops exposed in the dam spillway and along the exposed shore (see figs. 7 to 9). See the "Stop 2" description below.

4.8 **STOP 3: Uvas Reservoir boat dock parking area** on right. This is the designated lunch stop, and includes an examination of limestone outcrops and red soil exposures near the parking area along the shore (fig. 10). See the "Stop 3" discussion below.

Reset mileage to 0.0 before leaving the parking lot.

0.3 Cross a causeway across a western arm of Uvas Reservoir. This is the flooded valley of Carnadero Creek. The creek drains Eastman Canyon to the southwest. Croy Ridge is the mountain in the headwaters of this valley to the west.

2.6 In this region the road follows an elevated terrace roughly 10 meters above the modern stream. The horse pastures in this region are littered with scattered boulders and outcrops of serpentinite and chert. Large outcrops of metachert and serpentinite that rise above the grassy landscape are called "knockers."

3.1 **Be cautious crossing a narrow bridge over Uvas Creek.** Uvas Creek drains from its headwater region in the Santa Cruz Mountains to the southwest. The road continues to follow the valley of Little Uvas Creek.

3.6 A scenic palm tree patch on the left.

3.7 Croy Road (on left) leads to Uvas Canyon County Park in the headwater area of Uvas Creek. This park has a beautiful trail system and hosts numerous waterfalls that are a tremendous display after spring rains. One trail leads to the high ridge crest that forms the backbone of the Santa Cruz Mountains. Summit Road follows this ridge, but because of land disputes and landslides, the road no longer is continuous along this ridge.

3.9 **Be cautious crossing a narrow bridge over Little Uvas Creek.** Little Uvas Canyon Road is to the left.

4.1 The beautiful valley of Garcia Cañada is on the left. Serpentinite and chert boulders and knockers are abundant on the hillsides in this area.

4.3 Here the road (Route G8 north) follows another abandoned stream valley left behind by stream capture. The stream that carved Cañada Garcia (the valley on the left) probably used to flow into Uvas Creek Valley. A tributary of Llagas Creek carved into the divide, capturing the stream, leaving a dry valley connecting Uvas Creek Valley and Llagas Creek Valley at the northwestern end of Twin Peaks ridge.

5.4 **Turn right on Oak Glen Road** (toward Chesbro Reservoir) and cross the bridge over Llagas Creek.

6.1 Pass the Quail Canyon Inn (at upper end of Chesbro Reservoir). The hillsides in this area and westward also display an abundance of serpentinite knockers.

7.1 Pass Willow Springs Road (on north). Willow Springs Road follows a valley that doesn't contain a stream to match the size of the valley. The valley cuts through the hills and connects to the broader Santa Clara Valley (Coyote Creek portion) a couple of miles north of Morgan Hill. This may have been an ancestral drainage of Llagas Creek (the creek that feeds Chesbro Reservoir). The channel may have been abandoned by stream-capture processes as the modern Llagas Creek carved backward into its headwater region, capturing the stream, and creating the modern, expanded drainage system. This stream capture was probably influenced by strike-slip faulting and resulting uplift and rotation of tectonic blocks in this portion of the Santa Cruz Mountains.

7.4 On the left, a recent excavation into the hillside exposed highly-fractured graywacke.

7.6 Red chert crops out in several places along the north side of the road. It weathers to a dark-red soil.

8.1 **STOP 4: Chesbro Reservoir boat dock parking area.** This stop is to examine serpentinite exposed around the reservoir and discuss aspects of the geologic history and landscape in this area (figs. 11 and 12). See "Stop 4" discussion below.

Reset mileage to 0.0 before leaving the parking lot.

2.7 Return westward to Uvas Road (County G8). **Turn right on Uvas Road** (Route G8 north). Here Uvas Road continues north along the upper valley of Llagas Creek. Note the abundant serpentinite outcrops along the road in this area.

3.7 **Be cautious crossing the narrow bridge over Llagas Creek**. Driving northward on Route G8, you are entering the region known as the "Cinnabar Hills" – known for the scattered abundance of cinnabar (HgS) – mercury ore – that was prospected for and mined in the this region. On the hillsides near the bridge are a number of prospects dug in search of cinnabar that occurs in association with calci-silicate veins in altered serpentinite host rock throughout this area.

4.2 The broad valley of Llagas Creek on the left (in contrast to the more narrow, gorge-like valley we passed through between Oak Glen Road and here).

4.9 Casa Loma Road (on left) follows Llagas Creek into its headwater basin area on the eastern flank of Loma Prieta. Uvas Road changes its name to McKean Road (but maintains its Route G8 title). McKean Road winds over a low divide and drops into the valley drained by the headwaters of Arroyo Calero (Calero Creek).

6.6 Cinnabar Hills Golf Course is on the right.

6.7 Calero County Park road is on the left. Calero Park offers many miles of hiking and horse trails (no mountain bikes). Trails lead far into the hills reaching the barren grassy hilltops (called the Bald Peaks), and beyond to Loma Prieta. Much of this undeveloped land was recently added to the ever-expanding Sierra Azul Open Space Preserve.

7.3 Bailey Road is on the right. Bailey Road crosses a low, narrow divide at the southern end of the Santa Teresa Hills.

7.2 **Stop 5: Calero Reservoir boat dock and picnic area** are on the left. According to sports fisherman, the fishing is very good in Calero Reservoir (fig. 13). This is, in part, because you are not allowed to eat the fish because of the high mercury content of the water. Large naturally-occurring pockets of cinnabar (mostly unmined) occur in the hillsides around this reservoir. See the Stop 5 discussion below.

11.6 **Turn left on Harry Road** and cross the bridge over Alamitos Creek. (Note: Just a block to the right on Harry Road is the southern terminus of Almaden Expressway which continues Route G8.)

12.0 **Turn left on Almaden Road**. Almaden Road follows the gorge of Alamitos Creek. The stream drains the region encompassing much of the northern flank of Loma Prieta.

13.8 **STOP 6: New Almaden Mining Museum at Casa Grande.** Turn **left** into the parking lot and park at the far end of the building next to the entrance of the mining museum. This stop is to visit the museum and discuss the geology and mining history of the New Almaden Mining District. See "Stop 6" discussion below.

Reset mileage to 0.0 before leaving the parking lot.

0.3 Almaden-Quicksilver County Park trailhead parking is on the right. Almaden Road winds through the old Almaden mining community. Many of the buildings standing here were miners' homes and service community businesses.

0.9 **Warning:** A slump has removed part of the road here. Proceed cautiously past the stop sign.

1.3 Approaching Almaden Reservoir Dam. Note large outcrops of graywacke and both "fresh" and "altered" serpentinite on the right. Cinnabar-host rock (called *calci-silicate rock*) occurs primarily along faults, fissures, and fractures along the margins of serpentinite bodies in this area. Some of the large blocks used to keep cars from parking on the dam are calci-silicate rock containing cinnabar. The mountain on the north side of the valley is called Mine Hill, and has yielded the majority of the mercury ore found in the region. Looking west from the dam is an excellent view of Bald Mountain. Almaden Dam (and Reservoir) is one of six original systems approved for construction by voters in the May, 1934 bond election. Construction of the dam systems began that same year. Water in the reservoir has high concentrations of mercury and is both unsafe for swimming or fishing, and is therefore inaccessible to the public. There is no parking along the road.

2.2 **Turn right on Hicks Road**.

3.9 **Turn left on Mt. Umunhum Road** (the road sign is missing).

6.9 Large exposures of ribbon chert, (inter-bedded marine chert and shale) are on the left. Some beds display tight folding (see fig. 14). It is best to examine these on the way back down the hill.

7.5 **STOP 7: Bald Mountain Overlook.** Park near the gate, but be sure not to block the turn-around area by the gate. It is best to park facing down hill along the guard rail. Walk out the path to the leading to the east to the overlook on Bald Mountain. This overlook provides one of the most stunning views of the South Bay and the New Almaden Mining District (figs. 15 to 20). See the "Stop 7" discussion below.

Reset Mileage to 0.0 before proceeding down hill. PLEASE BE CAUTIOUS! USE LOW GEAR GOING DOWNHILL TO SAVE YOUR BRAKES.

0.6 If time allows, stop to examine the ribbon chert outcrops. Be sure to park so that cars traveling both ways can see you.

3.6 **Turn left on Hicks Road**.

4.2 Landslides in the serpentinite are visible on the hillsides of Mine Hill across the valley to the right. The road is dropping into the valley of Guadelupe Creek. On the map, the creek follows a very straight course for several miles, suggesting that the valley is fault-controlled. The USGS Map shows numerous faults in the area, basically trending in the same direction of the valley.

5.1 A great boulder of graywacke sandstone sits in the middle of Guadelupe Reservoir on the right (fig. 21). Guadalupe Dam, completed in 1935, impounds Guadelupe Creek several miles upstream from the confluence with Alamitos Creek. The reservoir and dam are part of the Santa Clara Valley Water District water system that was approved for construction by voters in the May 1934 bond election. The name, Guadelupe, is derived from the patron saint of Catholic Mexico, the Virgin of Guadalupe, and was an extremely popular Spanish place name in early California. The Guadelupe River was named by the de Anza expedition on March 30, 1776, "Rio de Nuestra Señora de Guadalupe,"(River of Our Lady of Guadelupe) in honor of the principal patron saint of the de Anza expedition (Source: http://scvwd.dist.ca.us>.**)**

6.1 Similar outcropping of graywacke sandstone occurs on the left along the side of road just south of Guadelupe Reservoir Dam.

8.9 Pass Shannon Road (to the left). Shannon Road follows the fault-rift valley of the Shannon Fault, one of the earthquake fault subsidiaries of the greater San Andreas Fault System.

9.9 **Field trip ends here.** The fastest route back to SJSU is to turn right on Camden, then immediately to the left on Coleman. Take Coleman for several miles, and turn left on Santa Teresa Avenue. Get onto Highway 87 (toward downtown), then take I-280 East to the 7th Street exit.

STOP DESCRIPTIONS

STOP 1: Chitactac-Adams County Park

At this stop, be sure to browse the exhibit hall near the parking area. The exhibit provides detailed cultural and historical interpretations of the site and the Ohlone Culture. Take the short loop walk along Uvas Creek and examine scenic and unusual outcrops of the Temblor Sandstone. **Be aware that poison oak can be found at all stops! Other hazards include ticks and rattlesnakes.** Please, don't hurt the snakes!

Archeological and Cultural History

Ohlone Indian villages may have existed at this site near the confluence of Little Arthur Creek and Uvas Creek for thousands of years prior to the arrival of the Spanish missionaries. Archaeological evidence indicates that Mutsun Ohlone Indians had inhabited this site for over 3,000 years. Radiocarbon dating of site materials have yielded habitation dates of between 1,700 and 2,700 B.P. (before present). The four acre park site is part of a larger area of pre-contact habitation extending across Uvas and Little Arthur creeks. The village was called Chitactac by the Mutsun Ohlone people (source: http://claraweb.co.santa-clara.ca.us/parks/prkpages/chitacch.htm).

According to park literature, the site contains a number of petroglyphs and over 75 bedrock mortars. Petroglyphs are images carved into a rock surface. Two types of petroglyphs are found at this site: cupules and cup-and-ring (concentric circles with center depression) (see fig. 3). Their meaning and age are unknown. Throughout the site are numerous bedrock mortars. Mortars are stone bowls used with a pestle (a cylindrical rock hand tool used to mash or pound), and were used to process food (nuts, seeds, and possibly meat and fish). These round mortar holes can be seen on sandstone outcrops throughout the site. The number of mortar holes suggests that the site may have supported about a several hundred people at one time.

Geology

The bedrock exposed throughout the park is called the Temblor Sandstone (see figs. 3 and 4). The sandstone has physical similarities with outcrops nearby that have yielded marine fossils that indicate an age of middle Miocene to Oligocene: ~20-30 Million years old. The rock consists of a uniform, medium-grained, quartz-rich sand, and generally lacks bedding structures. It is similar to bioturbated beach and exposed shallow-marine sand that occurs along the Monterey Bay coastline today. The sand is tightly cemented and displays an abundance of healed cracks or fractures. The occurrence of these outcrops reveals part of the geologic story of the region: this middle Tertiary marine sand was first deposited, then survived burial (and cementation), transport by tectonic forces, uplift, and exposure in what is now the Santa Cruz Mountains. The sandstone is much younger than the Franciscan graywacke sandstone that we will be seeing later on the trip. The Temblor Sandstone was deposited during a period when an coastal embayment of the ocean flooded over an ancient eroded surface of Franciscan rocks long before the formation of the modern Santa Cruz Mountains.

The parking area rests on a terrace roughly 25 meters above the current stream level. This terrace is part of a greater elevated Pleistocene-age floodplain that extends across the combined valleys of Uvas Creek and nearby Little Arthur Creek (to the south). The valley to the north of Chitactac Park is quite narrow by comparison. Approximately a mile to the north along Watsonville Road, the valley broadens again near Day Road. There is currently no stream of any size that flows in the valley north of Day Road, or in another broad valley about a mile east of the park. In the past, ancestral streams of Uvas Creek and Little Arthur Creek probably flowed through these valleys. However, with the combined effects of tectonic uplift, faulting, and headwater erosion, stream capture occurred resulting in the formation of the modern Uvas Creek drainage. This pattern repeats itself throughout the foothills between Morgan Hill and Gilroy involving Uvas and Llagas creeks, and their tributaries.

STOP 2: Uvas Reservoir Dam

Uvas Reservoir was constructed in 1957 as part of the South Santa Clara Valley Water Conservation District. The dam impounds both Uvas Creek and Carnadero Creek (a smaller tributary that drains from Eastman Canyon to the west) (see fig. 7). A causeway for Uvas Road was constructed across the flooded portion of Carnadero Creek. *Carnadero* means "butchering place" in Spanish. *Uvas* means "grapes" in Spanish. Early settlers utilized the abundance of wild grapes in the area, and in 1842 the Mexican Governor Alvarado to Lorenzo Pineda granted much of the surrounding land to Rancho Las Uvas. Today, the lower valley has numerous grape vineyards and wineries (including Solis Winery, Sarah's Winery, Thomas Kruse Winery, Fortino Winery, Hecker Pass Winery, and Kirigin Cellars).

The chaparral-covered mountain on the north side of Uvas Reservoir is called Twin Peaks (you can see the two peaks from the south end of the valley, but not here; see fig. 5). In contrast, the north-facing mountainside on the opposite side of the road is more densely vegetated, reflecting the cooler, moister conditions on the shady side of the mountain. Standing on the center of the dam it is apparent that Uvas Creek follows a "straight valley,"which is a clue that there may be a major fault here. The geologic map of the area shows a significant fault running along the hillsides on the east side of the reservoir, but not up the main valley of the reservoir. Quaternary alluvium (flood-plain deposits) and the reservoir may possibly mask a fault trace in the valley. Uvas Reservoir dam was built in this location (replacing an earlier "Gilroy Waterworks" dam) to take advantage of the narrow gorge of Uvas Canyon in this section of the valley.

The Franciscan Assemblage

The bedrock around Uvas Reservoir are a *mélange* (a great chaotic mix) of different rocks ranging in age from Early Jurassic to Eocene, representing a time span over 150 million years ending roughly 50 million years ago. Similar rocks are exposed throughout the Coast Ranges of California and are collectively named the Franciscan assemblage (or Franciscan Group, Franciscan Series, or Franciscan Complex, depending on preferences of various geologists through time). The word "assemblage" is appropriate because rocks that are included in the Franciscan originally formed in a variety of geologic settings later to be brought together and mixed along a convergent plate boundary (see fig. 6). General rock types that occur in the Franciscan assemblage include ultramafic gabbro, serpentinite, basaltic volcanic rocks, limestone (and dolostone), ribbon chert, shale, graywacke (mudstone and sandstone), serpentinite, and other materials. As the variety of rocks suggests, the origin of the Franciscan assemblage is complex; a short interpretation of its geologic history follows.

The oldest Franciscan assemblage rocks include gabbro (original mantle and oceanic crust). In most places, this original rock has been completely altered to serpentinite. These rocks occur in association with pillow basalt that is inferred to have formed on a mid-ocean ridge or associated undersea volcanoes. On top of some of these volcanos, or on shallow ocean platforms, calcareous limey sediments accumulated (forming limestone similar to what is found forming on modern guyots or atolls). Through time, plate tectonic motion transported new oceanic crust into a deeper water setting where radiolarian ooze was deposited. Exposures of ribbon chert in the Santa Cruz Mountains are inferred to have formed from deep-sea ooze deposited between the Early Jurassic to the middle Cretaceous. The youngest and most common rocks in the Franciscan assemblage are graywacke mudstone, sandstone, and conglomerate. These sedimentary rocks frequently occur interbedded with shale and are interpreted as sediments having been derived from a volcanic arc and deposited via turbidity currents into a trench or deep water marginal basin offshore.

The chaotic mix of rocks of the Franciscan assemblage completes the geologic history, involving plate-tectonics (crustal formation, migration, subduction, and accretion). Serpentinite forms from the metamorphic alteration and/or remelting of rocks of ultramafic composition (typical of lower oceanic crust or even Earth's mantle). In the process of subduction and continental accretion, oceanic sediments and crust broken into bits ranging from hand specimens to mountain-sized blocks. These rocks were jumbled and crushed into one another, especially along major continental margin fault zones that formed, faded, and reformed through time. Serpentinite is unusual in that it is less dense in composition that its original host (rock consisting mostly of dunite and pyroxenite). Through time serpentinite migrates towards the surface along faults or forming plugs (or intrusions) that inject upward into the surrounding host rock.

The complexity of the Franciscan assemblage is linked to the origin and history of its rock components. In many places, individual rock types occur as mappable units, however, in many areas it is simply too complexly broken, sheared, and altered, and is most simply mapped as a mélange.

A Walk to the Bottom of the Spillway

This stop involves less than a mile walk to the bottom of the spillway and return to the parking area near the dam. Note the variety of rock exposures along the shoreline. Nearly every rock type of the Franciscan assemblage can be found within a mile radius of the Uvas Reservoir Dam. On the shore near the south end of the dam blocks and boulders of graywacke sandstone, volcanic breccia, limestone, and other rock litter the shoreline. Examine the shoreline and note that different rock-types that occur in pod-shaped masses or as a chaotic mix. This is classic mélange typical of the Franciscan assemblage.

Pillow Basalt

Cross the dam and turn right. Follow the path down to the spot where the concrete spillway ends (see figs. 8 and 9). In the creek are exposures of relatively unaltered “pillow basalt” - pillow-shaped pods of basalt formed from the rapid cooling of basaltic lava on the sea floor. Each pillow displays a chilled crust from the molten lava coming in contact with the cold ocean water. Radiometric determinations suggest these rocks formed in the Lower Cretaceous (between 100-130 million years ago). Note that some of the basaltic lava preserves vesicles (gas bubbles) and that in some places, gray, limey mudrock or limestone (or dolostone) fills in around some of the pillows. Both occurrences suggest that the lava formed in relatively shallow ocean depths, probably on a submarine volcano. Under greater ocean depths the confining pressure would prevent gas vesicles from forming in the lava. In addition, calcareous sediments are not preserved in deep ocean settings; organic pelagic remains containing calcium carbonate dissolve rapidly in cold marine water under pressure.

In some locations around the spillway exposure, the basaltic lava has also been partially altered to greenstone. (Greenstone is a field name for a dark-green altered or metamorphosed basic volcanic rock containing the minerals chlorite, epidote, or actinolite.) The rock is also broken by fractures that are filled primarily by calcium carbonate (possibly derived from the recrystallization of the original limey ocean sediment). The outcrop is broken by several small faults, one of which displays apparent offset of the overlying soil profile. This exposure is on the north side of the cut about 100 feet south of the end of the cement spillway. Be sure to check out the composition of the stream gravel in patches along the shore. Gravel bars provide a glimpse of the various rock types derived from in the drainage area. Some of the gravel is reworked from older stream channel and floodplain deposits, now preserved as terraces, and are exposed along the hillsides below the dam.

STOP 3: Uvas Reservoir Boat Dock Parking Area

A hill rises out of the reservoir about one-half mile west of Uvas Reservoir dam. A parking area for the boat dock and a small picnic area are located on a flat divide area between the hill and the mountainside west of the road. This flat area probably represents a terrace where Carnadero Creek used to flow before stream capture rerouted the stream into Uvas Creek in its current valley (now flooded below the causeway about a quarter mile to the west).

Limestone and Dolostone

Exposures of light-colored rock and a deep-red soil (called *terra rossa*) occur along the shoreline of a bay just east of the parking area (see fig. 10). These rocks (white, pink, and gray) consist of limestone and dolostone. Limestone forms mostly from the remains of organisms that have calcareous skeletons, including algae, mollusks, corals, and other shelled invertebrates. It is likely that the majority of limestone in the Bay Area originally formed in shallow to moderate ocean depths (such as on the flanks of submarine volcanoes). The original calcareous sediments formed from the buildup of calcareous plankton remains and excrement of swimming organisms (animal plankton, mollusks, arthropods, echinoderms, and fish). Calcite ($CaCO_3$) is the primary mineral material in lime mud. In the process of conversion from lime mud to limestone, most of the original organic material and texture is destroyed and replaced by recrystallized calcite. Some of the limestone is converted to dolostone (a rock in which the dominant mineral is dolomite [$CaMg(CO_3)_2$]). The mineral conversion from calcite to dolomite results in a slight loss in volume, so dolomite tend to be more porous than limestone. Therefore, it can take up other mineral compounds, typically iron minerals, silica or organic compounds that contribute to its red, gray, or even black appearance. In this locality, the limestone is white, whereas the dolostone tends to be pink and gray. In some places, the limestone occurs interbedded with radiolarian chert.

Although fossils are scarce in the limestone, they have been found in the vicinity. Marine mollusk (ammonite) and echinoderm (sea urchin) fossils suggest that limestone in the Franciscan assemblage is Late Cretaceous, ranging in age between ~90 and 65 million years.

Terra rossa is a reddish-brown residual soil found over limestone bedrock. Terra rossa is typically found in karst areas (limestone bearing caverns), and is especially common under conditions of Mediterranean-type climate. The low elevation areas of the coastal regions of central California (ideal for growing grapes) provide classic Mediterranean climate.

STOP 4: Chesbro Reservoir Boat Dock Parking Area

A local doctor, Elmer J. Chesbro, was the president of the Santa Clara Valley Water Conservation District at the time of the construction of Chesbro Dam and Reservoir in 1955 (see fig. 11). Chesbro Reservoir impounds Llagas Creek. The reservoir floods land that was originally part of two land grants from the Mexican Governor Figueroa in 1834: Rancho Ojo de Agua de la Coche ("Pig Spring") and Rancho San Francisco de las Llagas ("St. Francis of the Wounds"). The ranchos were later acquired by an early settler of the Santa Clara Valley named Martin Murphy. The water from the reservoir is used to recharge groundwater aquifers in the Santa Clara Valley. (Source: Santa Clara County Parks & Recreation brochure.)

We will be examining exposures around the parking area, along the road, and around the dam spillway. Boulders of many of the different Franciscan assemblage rocks are conveniently on display around the boat dock parking area. Boulders around the margin of the boat-dock parking area include examples of graywacke sandstone, metasandstone, greenstone (metabasalt), serpentinite, red chert, and chert breccia. These rocks occur in scattered pod-like masses (a classic mélange) exposed along the shoreline of Chesbro Reservoir.

A short walk to the dam (0.2 miles) provides opportunity to view exceptional exposures of serpentinite in road cuts and in excavations along dam path (see fig. 12). Don't stand along the road because of the hazard of speeding cars. Instead, the safer place to examine the serpentinite is along the dam path. Some of the serpentinite displays *slickensides*, a linear fracture pattern caused by fault shearing motion between rock surfaces. The hillsides near the dam adjacent to Oak Glen Road is host to a dense Pajaro Manzanita forest. These plants are well adapted to the dry conditions on the south-facing slope and to the serpentinite soil.

From the opposite end of the dam you can see the back of El Toro, the peak overlooking Morgan Hill. Downstream from the reservoir, Llagas Creek flows through Paradise Valley and enters the Santa Clara Valley a couple of miles south of Morgan Hill. On the north side of the spillway is a landslide formed in the weathered serpentinite. Note the bluish-green to black color of the residual soil; the soil is rich in the clay mineral, montmorillonite.

Serpentinite

Serpentinite is a rock consisting almost entirely of serpentine-group minerals. The typically green serpentinite that occurs in relative abundance throughout Franciscan rocks in the Coastal Ranges consists dominantly of *antigorite* (a typically green mineral with a dull, earthy, or frothy texture, but has a soft, soapy feel on some fresh surfaces that may display a conchoidal fracture pattern), *lizardite* (white to pale gray-green with a platy or scaly texture, typically found on exposed surfaces of antigorite masses), *chrysotile* (white, pale green to bluish-green, fibrous to frothy-textured masses, commonly occurring in fractures on weathered surfaces), and accessory minerals including chlorite, talc, magnetite, magnesite, and other minerals. Serpentinite is considered greenschist, a metamorphic facies associated with low temperature, low pressure conditions relative to other grades of metamorphic rocks. Higher pressure metamorphic grades of serpentinite contain *glaucophane* (a pale bluish-gray to black serpentine mineral that occurs in fibrous to felted aggregate masses). Higher temperature and pressure metamorphic grades contain garnets, pyroxene- and amphibole-minerals and are grouped into a metamorphic class called *eclogite*.

The origin of serpentinite is inferred to be an metamorphic alteration product of mantle rock or oceanic crustal rock. The original rock (protolith) includes gabbroic crystalline rock of ultramafic composition including *peridotite* (rock rich in the olivine-group of minerals) and *pyroxenite* (rock dominated by pyroxene-group minerals). The protoliths for most blocky serpentinite in the region are two types of peridotite including *harzburgite* (a rock consisting of 70-75% olivine, 20-30% pyroxene minerals, and a trace of chromium spinel as an accessory mineral) and the less common form, *dunite* (a rock consisting almost entirely of olivine with only traces of pyroxene). In some exposures, the original protolith has basically escaped whole-scale conversion to serpentinite, and the rock preserves relict mantle lineations or foliations (oriented mineral grains) inferred to represent the original asthenospheric flow-banded texture that formed in association with upper mantle convection near a spreading center. Weathered surfaces of harzburgite have a yellowish to reddish brown color and a rough, irregular "hob nail" appearance due to the differential weathering of the olivine and pyroxene (after Coleman, 1994).

The occurrence of serpentinite fits into the plate-tectonic model for the origin of the Franciscan assemblage. The formation of serpentinite from a mantle protolith involves a fluid-rich, low-temperature, low pressure metamorphic environment. The mantle rock becomes incorporated into oceanic crustal rock at a spreading center and gradually is converted to serpentinite through exposure to brines (modified seawater) that gradually cycles through the ocean crust over time. These briney fluids migrate into the oceanic crust along faults and fractures with pumping pressure driven by mantle heat convection near the spreading center, and later by the increasing confining pressure as oceanic crust is forced downward into a subduction zone along a continental margin. Geologists give the name "ophiolite" to a sequence of mantle-derived crystalline ultramafic rock and their basaltic volcanic derivatives formed at or near a spreading center. The conversion of peridotite to serpentinite involves a density change of approximately 22 percent (serpentinite is less dense). This density conversion and the corresponding soft, textural characteristics of the serpentinite explains why serpentinite migrates to the surface, flowing upward plastically like salt (or in molten form) along faults and other zones of weakness in the crust. Serpentinite occurs in many of the highest points around the South Bay including on Loma Prieta, Mt. Umunhum, and Mount Wilson (in Henry Coe State Park). Serpentinite in the Bay Area is inferred to be equivalent to the Coast Range Ophiolite, a piece of oceanic crust and mantle that underlies the Cretaceous and Tertiary sedimentary *Great Valley Sequence* throughout much of central California.

Landscape with serpentinite bedrock tends to have thin or absent soil cover. Serpentinite soil tends to have low levels in all major plant nutrients (particularly calcium), and tend to be rich in magnesium, chromium and nickel - elements that are probably toxic to many plants. Certain plants are endemic to serpentinite soils in California including *Quercus durata* (Leather Oak) and *Garrya congdonii* (Silk Tassel Bush). Many plants that grow on serpentinite will grow on non-serpentinite soils, but they tend to be crowded out by other species, particularly non-native grasses. However, many non-native grasses and other plants tend not to grow well on serpentinite soil. A common plant that tolerates serpentinite soil in chaparral and coastal sage scrub habitats is the *Arctostaphylos pajaroensis* (Pajaro Manzanita) (see fig. 13).

Stop 5 - Calero Reservoir

If time allows, stop at the Calero Reservoir boat dock parking area to have a look at the "groundwater" exhibit. Calera, or calero, is the Spanish word for a limestone quarry (or lime kiln). The Calera Limestone is a Late Cretaceous limestone unit that crops out intermittently throughout the Bay Area, and has been mined extensively, including in the vicinity before Calero Reservoir was constructed. A small indentation on the shoreline across from the boat dock parking area is the only remaining evidence of a limestone quarry that existed here before the reservoir was constructed.

In 1935, the Santa Clara Valley Water Conservation District obtained land for the proposed Calero Reservoir from the Newman Brothers. The brothers had operated a ranch since they purchased the land in 1905 from its previous owners, the Bailey family, who owned much of what was then known as Calero Valley and used the land to raise stock, grow orchards, and farm. Calero Reservoir is one of six original reservoir systems approved for construction by voters in the May 1934 bond election. The other five include Almaden, Guadalupe, Coyote, Stevens Creek, and Vasona reservoirs. Construction of the dam systems began that same year (source: http://scvwd.dist.ca.us>). Most of the land around the reservoir and in the hills beyond are part of Calero County Park.

Calero Dam impounds Arroyo Calero, a tributary of Alamitos Creek (see fig. 13). Alamitos Creek is impounded upstream from the confluence with Arroyo Calero by Almaden Reservoir. Alamitos Creek gets its name for the Spanish word for "poplars" or "cottonwoods." Downstream, Alamitos Creek joins Guadelupe Creek to become the Guadelupe River which flows through downtown San José and eventually into San Francisco Bay at Alviso. Calero Reservoir Dam serves, in part, as a groundwater recharge area for the aquifer beneath the valley below. Other infiltration ponds can be seen along the Almaden Expressway in south San José.

Don't Eat the Fish!

An abundance of naturally occurring cinnabar exists in the hills around Calero Reservoir. Although mining operations have significantly contributed, much of the mercury “pollution”in South Bay reservoirs is essentially natural! However, large volumes of contaminated materials were contributed to the watersheds in the Cinnabar Hills region by human activity. Huge tailing piles, poor refining practices, and indiscriminate dumping of contaminated wastes have released large volumes of mercury into the environment. Calero, Almaden, and Guadelupe Reservoirs are all posted with signs warning people not to eat the fish. This creates somewhat of a paradoxical situation: Calero Reservoir has an abundance of large, old fish because anglers throw them back. As a result, sport fishing in the reservoir remains quite popular.

A common question that follows is: “If the reservoir waters are contaminated with mercury, then why is it used as drinking water?” The water in these South Bay reservoirs is used primarily for groundwater recharge operations. When mercury-contaminated water seeps into the ground, it flows through the sediments of the aquifer, and metallic cation exchange reactions take place involving rock-water interactions with clay minerals. This takes mercury out of solution and releases more soluble elements, particularly potassium, sodium, calcium, and iron. In addition, by the time the water reaches the extraction wells for the city water supply, it has been diluted with other water sources to the point that mercury concentrations are considered within “safe” government-standard toleration limits.

STOP 6: New Almaden Mining Museum at Casa Grande

Native Americans utilized the red cinnabar ore in the hillsides of the Santa Cruz Mountains (they unknowingly used it as body paint, medicine, and jewelry, unaware of its toxicity). Two prospectors, Luis Chabolla and Antonio Sunol, first worked the ore from the Santa Cruz Mountain foothills in 1824 (making it the site of the first mining in California). Early prospectors thought it might be silver ore, but it wasn’t recognized as an economic resource for quicksilver until 1845 when Native Americans brought Andres Castillero to exposures of the cinnabar deposit in the area now known as the Almaden Hills. Castillero was granted mineral rights on Dec. 30, and mining soon began in earnest. The mine was first named the Santa Clara or Chaboya's mine. In 1848 the name "New Almaden" was adopted (*almaden* in Spanish means “mine” or “mineral”), named after the famous mercury-producing mines in Spain. New Almaden became the largest mercury-producing mine in the Americas.

Tabulations from mining reports show that total production of mercury from the New Almaden Mining District was 38,940,000 kg, or about 1,130,000 flasks of mercury (a flask is a cylindrical metal container that holds 76 pounds of liquid mercury). Company data show cumulative mercury production from the incorporated mines: 18% by 1860, 43% by 1870, 60% by 1880, 88% by 1890, and 96% by 1900. Twentieth Century production accounts for less than 4% of all reported production. The period of greatest production were the five years immediately following the Civil War, accounting for about 16% of mines’ total output (Source: Cox, 1994). The majority of the mercury went to gold extraction processes in the Sierra Nevada foothills region.

About 95% of the mercury ore was processed at a single plant named “La Hacienda De Benficio” located on an 11 acre site along Alamitos Creek about a half mile north of the Casa Grande Museum (at the trail head parking area for Almaden Quicksilver County Park). A great environmental clean-up took place at the original refinery, but a great volume of the material found its way down the watershed into the flood plain deposits throughout southern San José.

The majority of the cinnabar deposits in the New Almaden area occur in intensely sheared and altered serpentinite in association with calci-silicate veins. The altered serpentinite has an orange to rust-red appearance (from iron-oxide minerals) streaked with white and yellow vein-filled fractures. The cinnabar ore ranges in color from bright to dark red, to brown. Examples are on display in the museum, but cinnabar is a relatively common occurrence throughout the Almaden Hills region. Red rocks containing cinnabar can be found as park or yard ornaments throughout San José and represent a potential health hazard, especially to children.

The New Almaden Quicksilver Mining Museum is located at 21350 Almaden Road. The museum is part of Casa Grande, a historic building with a opera theater. Exhibits in the museum include numerous photographs, mining equipment, memorabilia, ore samples, documents, and interpretive history displays that provide an excellent review of life in this important mining district. The exhibits include the blacksmith workings, history of the mines, geology and mine workings, living conditions of three communities at the mines during the heyday (1845-1912) and modern day mining until 1976. The New Almaden Quicksilver Mining Museum is open year round Fridays, Saturdays and Sundays from 10:00 AM to 4:00 PM except for major holidays. Guided tours are available by request for groups of 35 or less. Call in advance for reservations. No fees are required. The museum also provides walking tour brochures to this historic mining area and village. More information about the mining history and activities can be found at the Almaden Quicksilver County Park Website: <http://claraweb.co.santa-clara.ca.us/parks_old/park_pages/aq.html> Perhaps the best source of information about geology and mine production history is a report by Edgar H. Bailey and Donald L. Everhart (1964), US Geological Survey Professional Paper 206.

Ribbon Chert

Along Mt. Umunhum Road about one-half mile below the terminal gate are excellent exposures of Jurassic-age ribbon chert (see fig. 14). If time allows, examination of these outcrops is recommended on the way down the mountain (parking is somewhat safer).

Ribbon chert represents a deposit of very deep water siliceous radiolarian ooze that accumulated on the ocean bottom far away from any sources of volcanism or terrestrial sediment sources. Ribbon chert of similar age and occurrence are exposed and perhaps best known throughout the Marin Headlands (Elder, 2001). Ribbon chert occurs as nearly uniform beds of chert (typically 1-3 inches thick) with thin shale partings inbetween. The chert preserves microfossils called *radiolarians*, a group of microscopic organisms characterized by siliceous skeletons that lived in a marine pelagic environment. When these organisms die, they sink into the deep ocean and are incorporated in the siliceous ooze on the seabed. Chert is the rock formed from the recrystallization of siliceous ooze. The intervening shale is possibly wind-blown dust derived from distant continental landmasses. Whether these shale layers represent periodic cycles of greater dust input or periods when organic productivity in the ocean abated (or both) is unclear. Their regular pattern, however, implies some kind of cyclic oceanic-atmospheric system conditions. Studying equivalent ribbon chert in the Marin Headlands, Murchey (1984) determined that radiolarians preserved in the chert display characteristics of warm tropical to subtropical waters. Red, oxidized radiolarian ooze are associated with highly productive ocean upwelling zones just north and south of the equator. The general lack of land-derived sediments suggests that the chert formed far offshore, possibly more than 1,000 miles compared to the extent of land-derived sediments found in modern ocean basins. Age determinations from radiolarians found in the Marin Headlands suggest that the oldest chert formed nearly 200 million years ago (Early Jurassic), whereas the youngest reflect an age of about 100 million years (early-Late Cretaceous). The occurrence of ribbon chert in the Franciscan assemblage supports the model that ocean crust carrying a coating of marine sediments was eventually accreted onto the convergent continental margin of western North America. The missing volume of oceanic crust implies that perhaps thousands of miles of oceanic crust were incorporated back into the mantle through subduction.

STOP 7: Bald Mountain Overlook

Bald Mountain is accessible from Mt. Umunhum Road, a narrow, steep winding road that splits from Hicks Road several miles southwest of New Almaden (see fig. 15). An easy quarter-mile walk begins at the barricade gate on Umunhum Road (not far beyond this gate the road enters private property). Be sure to park away from the gate as to leave room for vehicles to turn around. It is recommended to park on the downhill side of the road (the road is not posted). The trail begins near the gate and leads east toward the grassy hilltop of Bald Mountain. Along the trail, be sure to examine the exposures of interbedded graywacke sandstone and shale.

Graywacke

Graywacke is an old term for a "dark, poorly-sorted, fine-grained dirty rock" (mudstone, sandstone, or conglomerate). Considering volume percentage, graywacke is perhaps the dominant rock type of the Franciscan assemblage. It typically occurs in association with shale or argillite. It occurs as massive beds or interbedded with shale or other sedimentary beds. In most places in the Santa Cruz Mountains, graywacke is a relatively soft, crumbly rock that weathers easily into a brown, muddy soil. These deposits are probably Late Cretaceous in age (representing deep-water turbidity-current deposits). They are all part of the mélange of highly sheared and jumbled blocks that make up the Franciscan assemblage. In contrast to chert or limestone, the sediments that make up graywacke are continentally derived. During the late Mesozoic Era, erosion of the ancestral volcanoes that formed the Sierra Nevada volcanic chain was probably the primary source of graywacke sediments in the Coastal Ranges.

In the Bay Area, older graywacke units are considered part of the Franciscan assemblage. In the Diablo Range east of San José (such as in the Alum Rock Park and Henry Coe), older graywacke sediments are mostly metamorphosed (to metasandstone and even schist). These older rocks probably range in age from Late Jurassic to Early Cretaceous. Some of the graywacke deposits in the Santa Cruz Mountains yield fossils of Late Jurassic age, however, most of the less consolidated graywacke deposits in the Santa Cruz Mountains are probably somewhat younger: Late Cretaceous or early Tertiary (equivalent to the Great Valley Sequence that flanks portions of the Diablo Range). The graywacke deposits represent marine deposited sediments.

An alternating pattern of graywacke sandstone and interbedded shale is the tell-tale pattern of deep-water sedimentation via turbidity currents. Turbidity currents are bottom-flowing currents laden with suspended sediments, moving swiftly down a subaqueous slope (such as the continental rise or in a submarine canyon). When the turbidity current reaches the bottom of the slope it and spreads horizontally across the seabed. Without barriers, these currents can travel dozens to even hundreds of miles across the ocean basin (depending on size, speed, and other characteristics). As the turbidity flow loses its momentum, the denser sediments are deposited first (gravel and sand), whereas silt and clay settle out later. A sequence of turbidity currents may produce a stacked series of alternating sand and mud deposits (becoming alternating sandstone and shale beds).

Bald Mountain Overlook

The destination of the walk is the north end of an unmarked loop trail on the north side of the summit of Bald Mountain (this destination is fairly apparent as you approach the north side of the summit facing Alamitos Creek Valley with a view of Almaden Reservoir; it is a popular picnic destination although there are no tables). The overlook provides one of the most scenic publicly accessible views of the Santa Clara Valley from the west side of the valley, including spectacular views of Loma Prieta, Mt. Umunhum, Mine Hill (in New Almaden Quicksilver County Park), the Alamitos Creek Valley, the Santa Teresa Hills, the distant Yerba Buena Ridge, the Diablo Range, and the entire San José region on a clear day. Prominent landscape features visible from Bald Mountain are described below.

Mt. Umunhum

"Umunhum" is the Ohlone Indian word for "hummingbird." The "blockhouse" that resides at the 3,486 foot summit of Mt. Umunhum is a relict of the "Cold War" missile complex and until recently was on land owned by the U.S. Air Force. In 2001, the land was acquired and added to the Sierra Azul Open Space Preserve. Until environmental restoration is complete, Mt. Umunhum will remains off-limits to the public. A large cliffy exposure on the northeast face of Mt. Umunhum is one of the best Bay Area exposures of the Coast Range Ophiolite (fig. 16). The Coast Range Ophiolite is a piece of Middle Jurassic oceanic crust and mantle that is also known to underlie the rocks of the Great Valley throughout central California. The original oceanic crust has largely been converted to serpentinite and with extensive faulting and diapiric injection upward, some of it is migrated to its current exposures on the Earth's surface, including this exposure on the face of Mt. Umunhum and the extensive outcrop areas throughout the Santa Cruz Mountain foothills and elsewhere.

Loma Prieta

Loma Prieta (Spanish for "black mountain") stands above the southern end of the Sierra Azul (Spanish for "blue mountain"). The Sierra Azul is actually a steep-sided ridge that runs along the crest of the Santa Cruz Mountains (including Loma Prieta and Mt. Umunhum, and two lower peaks to the north, Mt. Thayer and El Sombroso). The high ridge separates the Santa Clara Valley around San José from the San Andreas Rift valley to the southwest. Loma Prieta (3,806 feet) is the highest point in the Santa Cruz Mountains (see fig. 17). Its summit consists of a serpentinite diapiric plug (Coast Range Ophiolite) surrounded on the east by middle Tertiary Temblor Sandstone on the east, and by Late Cretaceous sedimentary rocks (shale, mudstone, graywacke sandstone, and conglomerate - Great Valley Sequence equivalent rocks) on the west. The peak is host to a privately-owned radio tower operation.

Mine Hill

Mine Hill is the high point on the north side of the Alamitos Creek Valley (home to the town of New Almaden and the Almaden Reservoir). The Bald Mountain overlook provides perhaps the best view of remnant landscape changes resulting from the mining activity in the New Almaden area. Most visible is the environmental restoration effort to mitigate the mine tailings pile below the main shaft entrance of the San Cristobal Mine near the summit of Mine Hill (see figs. 18 to 20). From the overlook on Bald Mountain it is possible to see numerous landslides (some generated by mining activity) exposing weathered serpentinite bedrock on the flanks of Mine Hill. On the east side of a fault that runs along the south side of Mine Hill is a great block that preserves a series of Early Cretaceous basaltic lava flows. Resistant volcanic layers and some intervening sedimentary beds stand out as large bands streaking across the sparsely vegetated hillside on the south flank of Mine Hill and are is striking contrast to the serpentinite on the hills in the distance.

Santa Clara Valley

The Santa Clara Valley is a southward extension of the valley occupied by San Francisco Bay. It extends from San José southward through the Morgan Hill and Gilroy, and broadens in the region around Hollister. To the south, the valley closes between the merge of the Diablo and Gabilan ranges. (The San Benito River follows the San Andreas Rift Valley to the south.) The Santa Teresa Hills rise out of the Santa Clara Valley on the south side of San José. The Santa Clara Valley is most easily described as a graben between two larger horst blocks, the Diablo Range on the east, and the Santa Cruz Mountains on the west. However, this explanation isn't quite accurate without emphasizing the effective offset along the Calaveras and San Andreas Fault Systems. The combined right-lateral offset of the fault systems may be several hundred miles since the greater San Andreas Fault System began to develop in middle Tertiary time. The existence of the Santa Clara Valley is partially explained by a great bend in the San Andreas Fault System where the rocks of the Santa Cruz Mountains are being pulled north and west away from the crustal block defining the Diablo Range on the east. This northwest relative motion between the Santa Cruz Mountains and the Diablo Range is causing the intervening landscape to drop relative to the mountain ranges on either side. The actual depth of the alluvial-filled valley beneath the surface ranges from several hundred feet to possibly many thousands of feet (under the "Cupertino Basin" on the west side of the valley). The Santa Clara Valley is broken by numerous fault systems that are generally poorly understood in relation to overall geologic history and earthquake potential. At one time in the Miocene, the Calaveras Fault and the San Andreas Fault probably represented a single great fault. However, the complexity of the rocks and structure throughout the region suggest that numerous large faults have evolved, peaked in activity, ceased activity, and became reactivated or become incorporated into other fault systems through time. The massive inactive faults that occur along the serpentinite bodies in the Mine Hill area and throughout the mélange belts throughout the Santa Cruz Mountain's eastern foothills are a testament of this changing, complex history. Current seismic activity suggests that the majority of active earthquake fault activity and creep motion is limited to the modern San Andreas Fault on the west, and the Calaveras/Hayward Fault System on the east side of the greater Santa Clara Valley.

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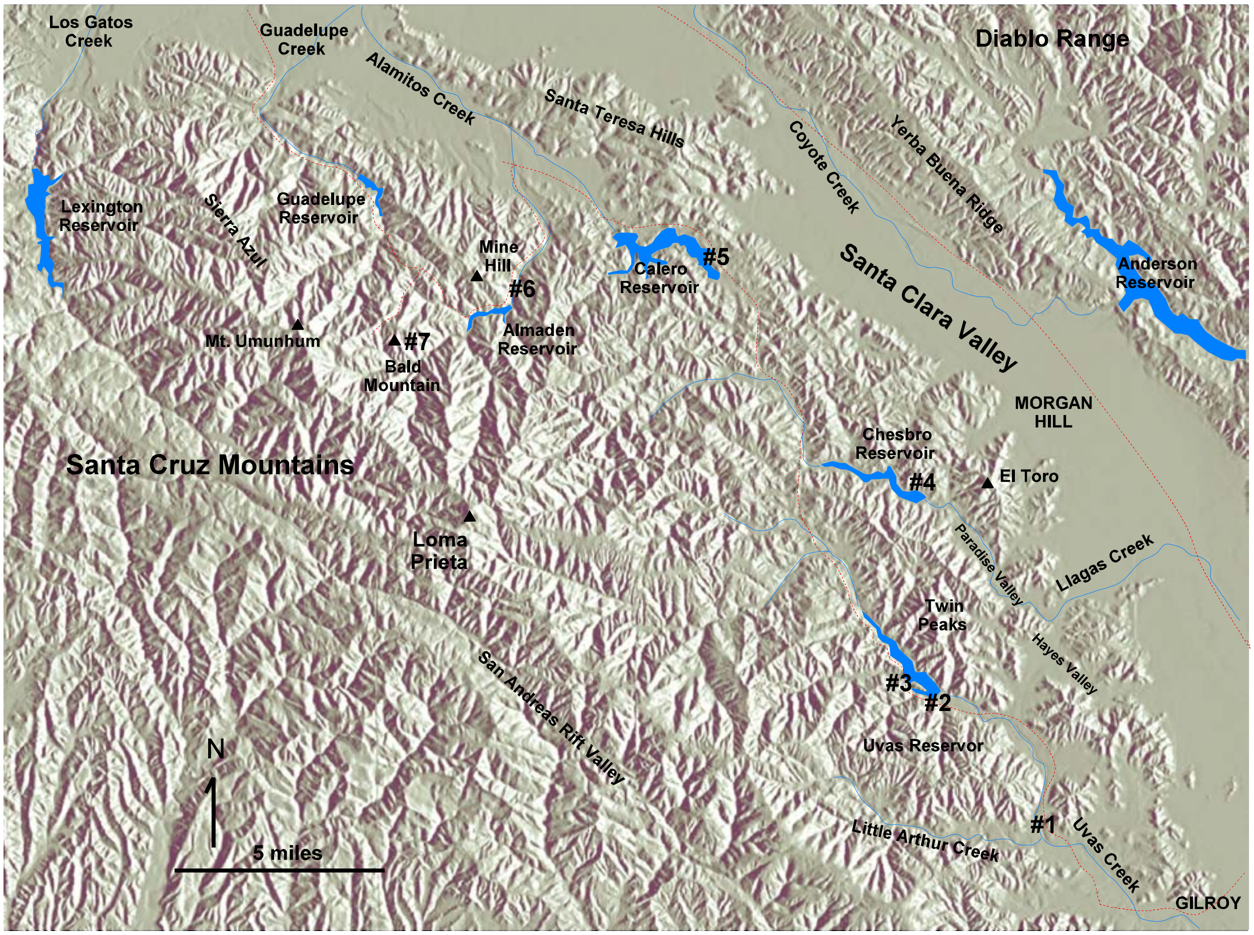

Figure 1. A shaded relief map showing the locations of field-trip stops.

Figure 2. El Toro rises above Morgan Hill in the Santa Clara Valley. The dark ridge behind to the left of El Toro is the ridge of Twin Peaks. the distant crest of the Santa Cruz Mountains includes the Sierra Azul Ridge, with high points Loma Prieta (on left) and Mt. Umunhum (on right).

Figure 3. Indian mortars and a spiral petroglyph carved into an outcrop of Temblor Sandstone.

Figure 4. Outcrop along Uvas Creek.

Figure 5. View of Twin Peaks ridge looking northwest near the intersection of Day Road and Watsonville Road. The valley to the left is that of Uvas Creek. Watsonville Road continues across the divide on the right through an abandoned stream valley (Hayes Valley) and later follows the stream valley of Llagas Creek (Paradise Valley).

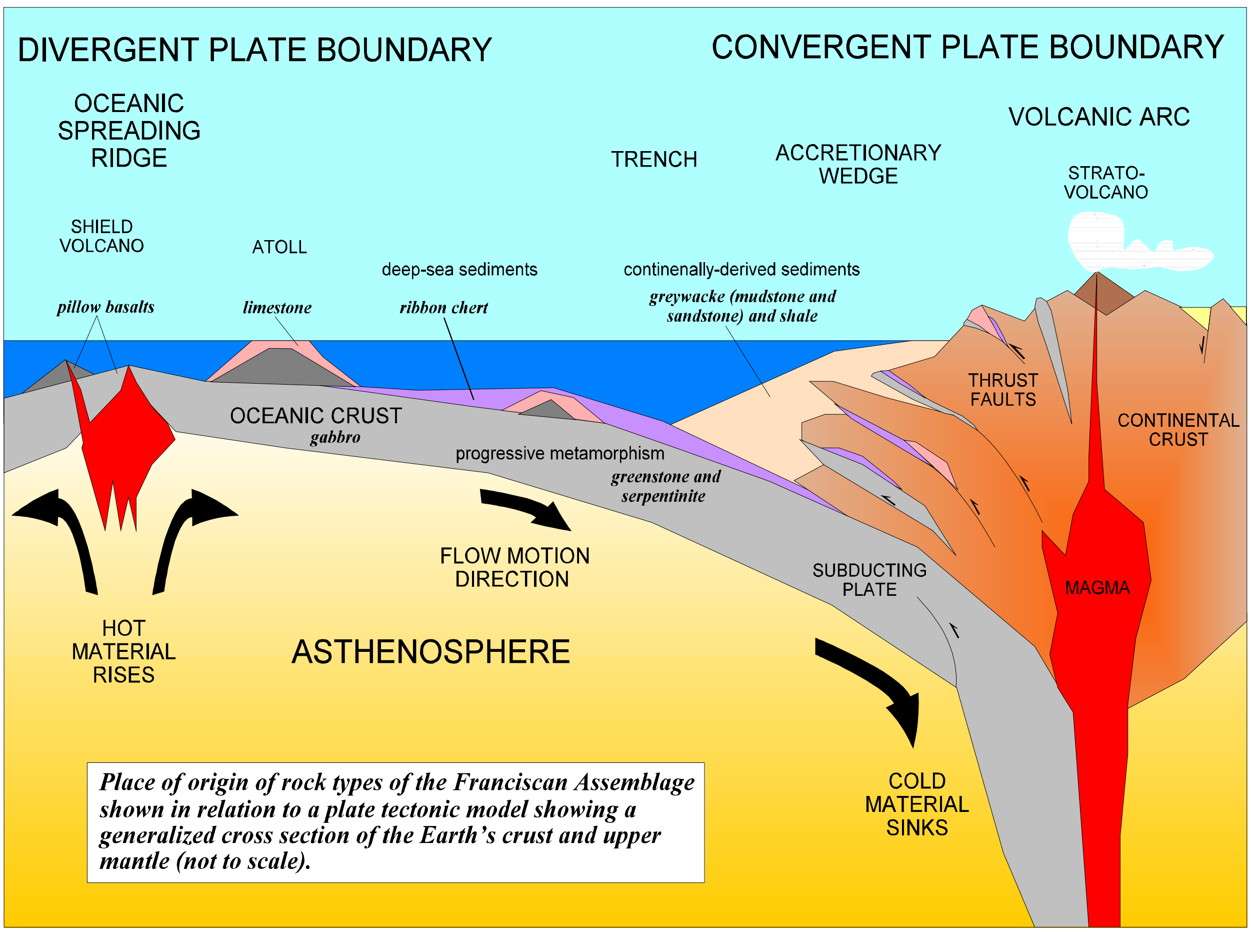

Figure 6. Places of origin of the different rock types of the Franciscan assemblage.

Figure 7. Uvas Reservoir fills the valleys of Carnadero Creek (left) and the "straight valley" of Uvas Creek (right). Stream capture diverted Carnadero Creek to a new route beyond the ridge now surrounded by reservoir.

Figure 8. Outcrops below Uvas Dam spillway.

Figure 9. Pillow basalt.

Figure 10. Limestone outcrops with terra rossa (red soil) along the shore of Uvas Reservoir near the boat dock parking area.

Figure 11. Chesbro Reservoir Dam with a Pajaro Manzanita grove in the foreground.

Figure 12. Serpentinite outcrop near Chesbro Reservoir Dam.

Figure 13. Calero Reservoir and dam as viewed from the western hillsides. The Santa Teresa Hills are in the distance (east).

Figure 14. Ribbon chert layers exposed along Mt. Umunhum Road on Bald Mountain.

Figure 15. The grassy top of Bald Mountain stands out in front of the Sierra Azul Ridge. Mt. Umunhum is on the right. The picture was taken from the top of Mine Hill facing south.

Figure 16. Mt. Umunhum (with the blockhouse on top) displays steep, rocky serpentinite cliffs on its eastern face.

Figure 17. Loma Prieta peak "kissed by clouds" (view facing south from Mine Hill).

Figure 18. Eastward facing view from Bald Mountain of Mine Hill (Cristobal Mine area) displaying scars of cinnabar mining. The Santa Clara Valley and Mt. Hamilton in the Diablo Range in the distance.

Figure 19. The Cristobal Mine of the New Almaden Mining District on top of Mine Hill.

Figure 20. Almaden Reservoir highlights the Alamitos Creek Valley. Mine Hill is on the left. In the distance across the valley are the grass-covered Yerba Buena Ridge and the forested Diablo Range. This east facing view is from the overlook on Bald Mountain.

Figure 21. A large block of graywacke sandstone rises from the south end of Guadelupe Reservoir.