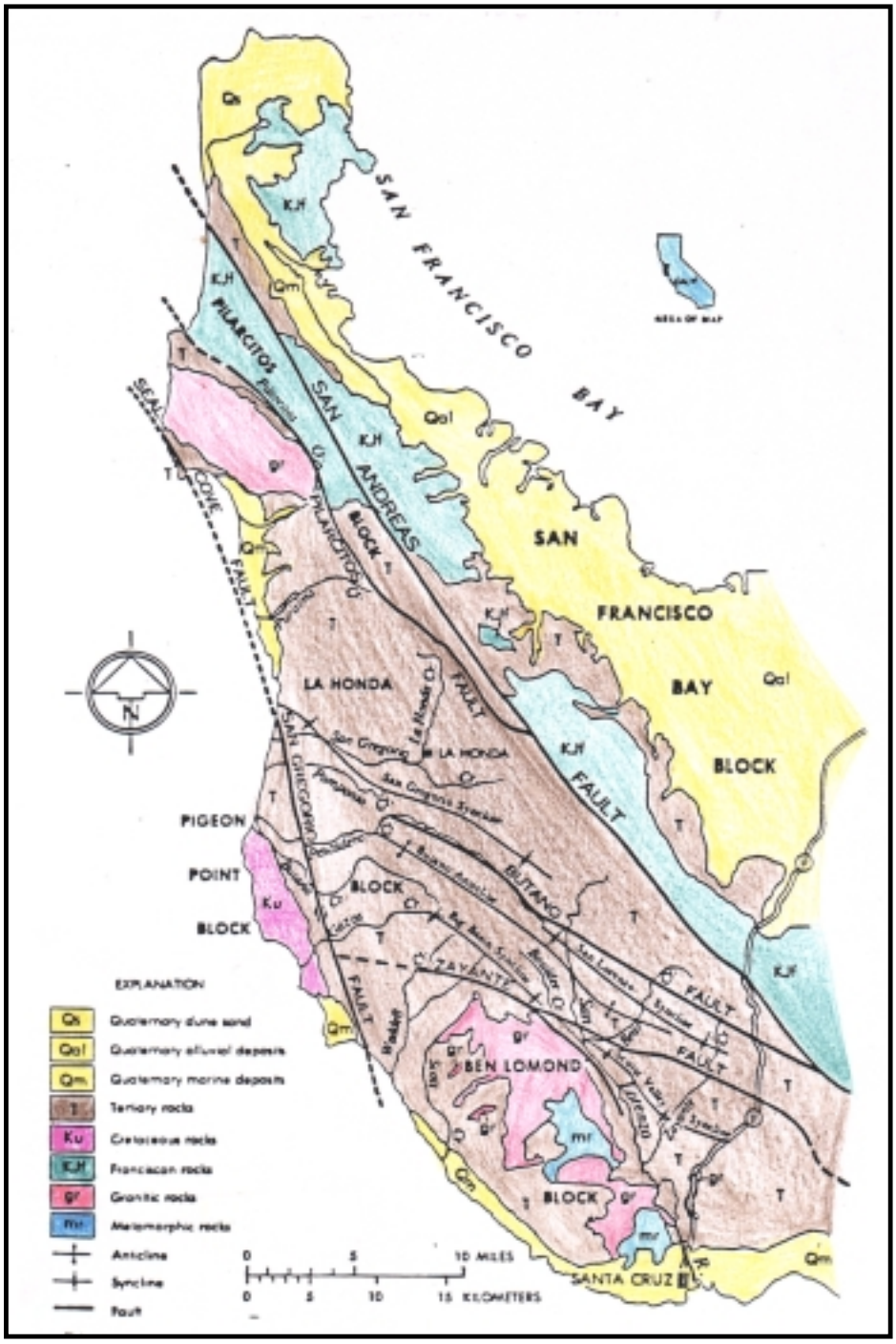
Geology of Monterey Bay Region
MLML MS 274
Field Trip 6
Examination of the Purisima and Santa Cruz Mudstone Formations
Of
Coastal Santa Cruz

Template 9: Geologic Map of Santa Cruz Region



Map by Roger Lewis, Modified from Cummings, et al., (1962)

Road log for Field Trip 6: Coastal Santa Cruz

Stop	Miles	Cumulative
Moss Landing	0	0
STOP 1 Capitola Beach (Purisima Formation)	21	21
STOP 2 West Santa Cruz Contact	9	30
STOP 3 Tar Sands (Coast Road)	7	37
STOP 4 Santa Cruz Mudstone (Coast Road)	0.3	37.3
STOP 5 Mountain Road (Purisima Formation)	15.7	53
Back to Moss Landing	32	85

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Monterey Bay is a crescent-shaped bay located northwest of the fertile Salinas Valley. Tucked into the northern part of the bay is the town of Santa Cruz. It is known for its generally mild, Mediterranean-like climate, laid back lifestyle, excellent surfing, well-developed marine terraces, and beautiful coastline. On this field trip, the focus is on the present day coastline and coastal deposits of the past.

Not only is the Santa Cruz coastline an excellent area to study the marine geology of the past, but it is an excellent area to study how coastal processes effect humans and vice versa. Retreating cliff faces at Capitola Beach and rip-rap protected cliffs at Steamer Lane provide dramatic examples of the constant pressure exerted by waves along this coastline

You will examine two marine deposits, the Purisima Formation and the Santa Cruz Mudstone, deposited from the late middle Miocene to the Pliocene. These formations represent two different marine depositional environments that offer clues about oceanographic conditions, marine life, and sea level changes of the past.

Leave Moss Landing and head north on Highway 1 to Capitola Beach. Exit the freeway, go left on Park Avenue and left on Central Avenue and then turn left to Capitola Avenue (look for available parking spots, if you can find one). If you have to, take Capitola Road and turn right up the hill on Wharf Road and park on top of the terrace, there are usually parking spots here. Walk back down towards the beach and go left (south) past the esplanade to observe the cliffs south of the city beach and sewer plant.

STOP – 1 Capitola Beach (Purisima Formation - 21 miles)

Examine the cliffs as you walk down the beach and note the talus clasts that have fallen onto the beach sands. The exposure is the Pliocene Purisima Formation described by Cummings et al., (1962) as a buff-yellow to light brown and gray, fine-grained sandstone and siltstone. They report that the formation is dated at 3 -1 Ma. The formation contains intense concentrations of fossilized mollusk coquinas ranging from 3-20 cm in thickness (Fig. 77 next page). These are interbedded with thin to thick argillitic sandstone beds and thin phosphatic silt and mudstone beds. The alternating fine to coarse-grained bedding is believed to reflect transgressive and regressive periods associated with uplift due to wrench tectonics and sea level changes (Clark et al., 1979). Look for faulting within the formation and see if you can locate slickensides that are preserved in some of the fractures (Fig. 76 next page).

Fig. 76: Fault bounded mollusk coquina and medium to thick sandstone beds of the lower Purisima at Capitola Beach.

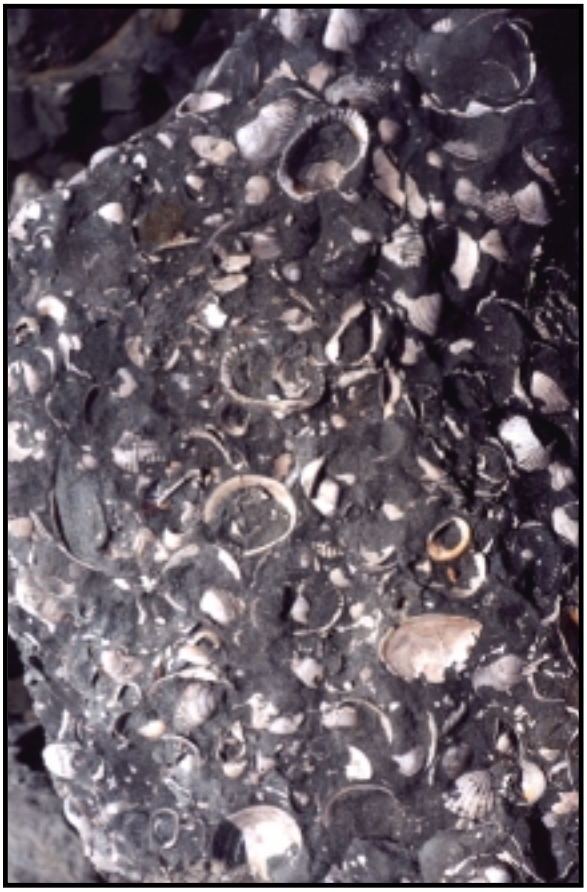

Fig. 77: Close-up of mollusk coquina bed.

Other features of interest in this locality include large fossilized bones of unknown marine mammals preserved in some of the talus boulders and lithified sandstone on the beach (Fig.78 below).

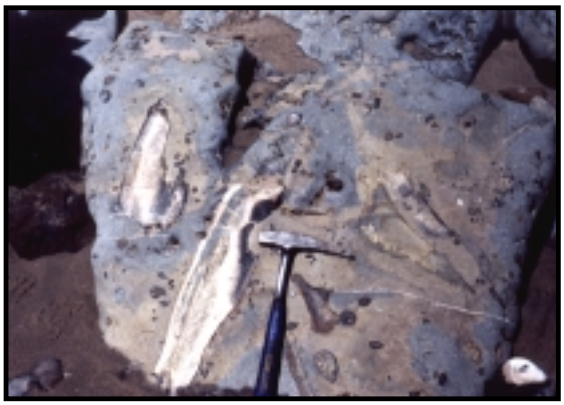

Fig. 78: Fossilized bone in rock outcrop at Capitola Beach.

Fig. 79: Fresh water seeping from porous beds of the Purisima Formation at Capitola Beach.

The fine-grained sand and silty nature of the Purisima, combined with the presence of disturbed fossilized mollusk shells, suggests a shallow water, neritic marine depositional environment. The shells

preserved in the coquinas are usually found in non-living positions. This is suggestive of periodic high-energy storm events capable of excavating the mollusks from their normally shallow habitats and preserving them into aggregate beds further offshore.

In addition to the Purisima Formation, Capitola Beach is also an excellent beach to study near-shore coastal processes and hazards. At the top of the cliff, above the Purisima Formation, note the foundations and crumbling walls constructed too close to the edge of the retreating cliff (Fig. 80 below).

Fig. 80: Retreating cliff due to undercutting by wave erosion at Capitola Beach.

Construction of jetties and harbors to the north of Capitola disrupted littoral drift, decreasing the sand supply to Capitola and other beaches to the south resulting in erosion and cliff retreat. Another important factor of cliff erosion here is fresh water sapping (Fig. 79 previous page). Observe the porosity of the Purisima Formation where water is seeping out of the cliff. This serves to weaken the competancy of the cliffs making them more susceptible to wave erosion. The Purisima Formation extends seaward beneath the continental shelf to the Monterey Canyon, where they are exposed in the walls.

Walk back to the cars and head out to Highway 1. From Wharf Road turn onto Soquel Wharf Road. Turn right on Porter Street and then head north on Mission Street Highway 1. Turn left on Swift Street and then left on West Cliff Drive. Park at the intersection of West Cliff Drive and Fair Avenue and walk down to wave cut platforms below.

STOP- 2 West Santa Cruz: Purisima Formation and Santa Cruz Mudstone contact (30 miles)

The cliff at this stop is composed of the Purisima Formation, while the platform bench is composed of Miocene age Santa Cruz Mudstone. The contact between the Purisima and the Santa Cruz Mudstone is an erosional unconformity (Aiello et al., 1999). The Santa Cruz Mudstone, described by Clark et al. (1979) is a thin to medium bedded pale-yellow-brown siliceous mudstone that locally grades to siltstone. The fine-grained siliceous nature of the Santa Cruz Mudstone implies organic deposition in a quiescent, deep-water environment. The siliceous Santa Cruz Mudstone is generally harder and more resistant to wave action than the Purisima Formation, as evidenced by the retreating cliff face of the Purisima and the wave cut platform of the more resistant mudstone. Aiello et al. (1999) describe the authigenic carbonate pipes and bedding parallel slabs composed of low magnesium calcite found in the white to yellow inner bedded slabs here (Fig. 81 below). The carbonates are interpreted to have formed by fresh water fluid seeps during the Miocene period.

Fig. 81: Bedding parallel carbonate slabs in Santa Cruz Mudstone at West Cliff Drive.

Turn around on West Cliff Drive and turn then right at Natural Bridges State Park. On Swanton Avenue turn left on Delaware Avenue, right on Natural Bridges and then left on Mission to Highway 1. Drive north on Highway 1 to Coast Road and turn right.

STOP – 3 Tar Sands (37 miles)

At this stop, petroleum enriched tar sands have been injected into the overlying Santa Cruz Mudstone forced by the upward mobility of buoyant gasses. The tar sands range from very hard dense compacted sand to weathered and fissile exposures at some surfaces (Figs. 82 and 83 next page). This hydrocarbon source was probably formed in an anoxic basin containing the underlying siliceous Santa Margarita Sandstone (Stanley 1990; Phillips, 1990). The Santa Cruz Mudstone acts as a stratigraphic trap,

structurally controlling the rise of the tar sands here (Phillips, 1990). The asphalt pits mined above this stop were used to pave some of the first streets in San Francisco.

Fig. 82: Asphalt-rich sandstone with a non-hydrocarbon infused sandstone inclusion.

Fig. 83: Roger Lewis closely inspects the asphalt sands.

Return south on Highway 1 for another 0.3 of a mile to the next Coast Road intersection on the right-hand side of the road.

STOP 4 – Santa Cruz Mudstone (37.3 miles)

This stop provides a good exposure of the thinly bedded Santa Cruz Mudstone. There are visually contrasting lithologic similarities contrasting the Santa Cruz Mudstone and the Monterey Formation (Figs 84 and 85 below). However, the Santa Cruz Mudstone is an upper Miocene deposit while the Monterey Formation, further south, is dated as lower Miocene (Clark et al., 1979). The Santa Cruz Mudstone also contains fine-grained mud and silt from terrigenous inputs, in addition to the diatomaceous grains. This contrasts with the almost pure diatomaceous Monterey Formation and the opal-A to opal C-T transition of sediment grains to porcellanite and chert. You may also find dolomitic concretion pods at this site.

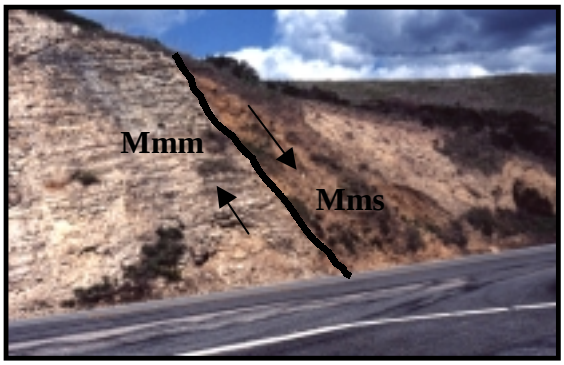

Fig. 84: Santa Cruz Mudstone in fault contact with Miocene San Lorenzo Formation.

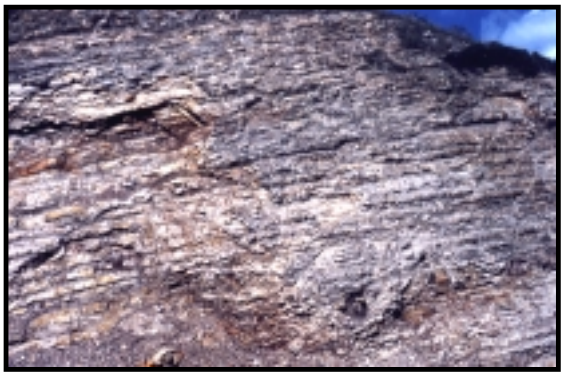

Fig. 85: Santa Cruz Mudstone beds at Stop 4.

Drive south on Highway 1. Turn right on Grant (Water Street) then left onto Market Street. Market turns into Branciforte Drive. Next, turn right on Mountain View Road then right on Rodeo Gulch Road

STOP – 5 Rodeo Gulch Road: upper Purisima Formation (53 miles)

This stop features cross trough bedding, conglomerate lenses, and channel fill structures of the upper Purisma Formation member of approximately 1 Ma (Clark et al., 1979) (Figs. 86 and 87 below). This exposure is an example of the tectonic uplift that has taken place in the Monterey Bay since this unit was deposited during the early Pliocene. The nearshore beach deposit here is about 330 m above the shallow shelf deposits of the lower Purisma Formation, which lie at sea level in Santa Cruz and Capitola.

Fig. 86: Coarse grained pebble rich sands of the upper Purisima Formation at Stop 5.

Fig. 87: Large cross trough beds at Stop 5.

Turn around to Mountain View Road and turn right. It turns into Laurel Glenn Road, then to Soquel-San Jose Road. This eventually reaches Highway, where you will take the southbound onramp.

Return to Moss Landing (85 miles).