WHITE POINT AND FORRESTAL QUARRY FIELD TRIP

Directions: Drive down Western Avenue from 25th St toward the ocean. Although the entrance is to the left on Paseo Del Mar, we will park and turn to the right (west) on Paseo Del Mar and park and meet at 8:30AM. If the weather is bad, I will call students to cancel the trip. Bring a hat and be prepared for some short walks.
Equipment: Compasses, hand lenses, pick hammers and safety goggles, and hard hats.
Preparation: Plate Tectonics, Rocks and Minerals, Folds and Faults, Local Geologic History and Local Geography.

Beginning our story...(overlooking the White Point shoreline)...

1. Over geologic time, the plate boundaries in a region can change, and in any one region there can be a variety of plate margins. Today, there is a convergent boundary along the western coast of Mexico, a spreading zone in Baja California, the transform margin of the San Andreas Fault System, another convergent margin along the Oregon coast, another transform margin in Canada, and in Alaska there is a convergent margin.

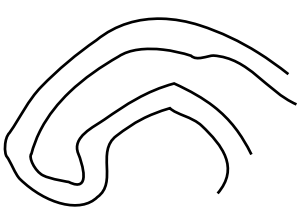
200 my ago the coastline was eastward and this spot was lower and underwater. That coastline was part of a convergent plate boundary. As the oceanic plate slid under the North American plate, sediment and rock were scraped off the subducting plate and piled up against the continental plate. The coast ranges are evidence of that accretionary wedge where shale and diatomite have been uplifted from the submarine trench and exposed. A volcanic arc or mountain chain was formed. The Sierra Nevada Mountains are evidence of that magmatic arc today. The volcanoes that “sat” on top have been eroded away. The Sierra granite, diorite, and gabbro that rise up today originally underlay the volcanoes.

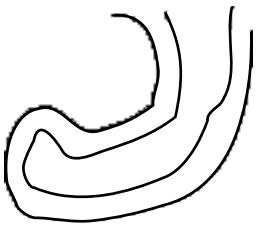
2. 25 my ago (the beginning of the Miocene) the California that we know originated. The relative motion of the two plates became a sideways or transform system. Deep cracks or faults formed. Modern Sierra Nevada, the nearby Transverse Range, and the Peninsular Ranges down south were uplifted along dip-slip faults. Other fault-blocks sank and some were carried sideways. What we see west of the San Andreas fault was over 400 km south 25 my ago.

3. The San Andreas was and is a right-lateral fault with a “bend”. When the bend was right (looking northward), the Los Angeles basin was formed by this “releasing” bend. The sedimentary rocks were deposited to a depth of 6 or 7 miles, mostly by submarine landslides from the continent. There were other coastal basins formed (Ventura Basin and the Santa Maria Basin near San Luis Obispo). The Monterey Formation is the name given to the rocks formed in the coastal basins. It was extremely biologically rich and was the source of our oil or petroleum. Evidence of this extensional phase is in front of us as we gaze at the shoreline here. The black outcrops along the shoreline are part of a basalt sill indication of a thinning crust and magmatic intrusion. Notice the concrete wall of an ocean swimming pool, part of a Japanese-American resort up until the 1930’s when the Long Beach earthquake closed up most of the hot springs which heated the pool.

4. Then 5 my ago there was a change from an off shore transform boundary to one inland (the San Andreas fault) which resulted in a “restraining” bend. As we look northward today, the bend is to the left. Now instead of a hole being formed, we had the San Gabriel and Santa Monica mountains being formed. The Palos Verdes fault has a left bend and a movement one-tenth that of the San Andreas. The peninsula is also about one-tenth as high as the San Gabriel mountains.

Hiking down the ramp (so we don’t have to pay for parking!), we get to an overturned fold. Before discussing this, turn toward the ocean and ask which way does the shoreline run. Pass out the compasses and (1) adjust for a 15º angle of declination. (2) Take a bearing on Catalina Island or a distant boat. Show both ways to take find a compass heading. (3) How might one determine one’s location with a map and two prominent points? (4) Explain how to use the clinometer by sighting on a cliff top. (5) Go over how to make strike and dip measurements.
5. The axis of a fold is a line running thru the “core” of the fold. The fold is due to the compressional forces caused by the “restraining” bend in the transform plate margin. The compressional force is perpendicular to the fold axis. The “ok” definition of an anticline is an “upfold” with a syncline being a “downfold”. The better definition works even if the fold is overturned. In a syncline the younger rock is at the core, while in an anticline the older rock is at the core. First try to determine the axis of the fold. The lower grayish strata appear to be pointing southward (remember Catalina’s bearing?), but take a closer look at the core layers in the middle.The orientation of the axis is more east-west which would correspond to an overall north-south compressional force that the Los Angeles basin is still experiencing. As you drove down Western Avenue you may recall you were driving down a canyon. Water still drains out although man-made storm drains divert most of the water. Is this an over-turned anticline or an overturned syncline? Actually we can’t tell without knowing the relative age of the core rocks, but we think it looks like an overturned syncline. Notice the smaller “parasitic” or tiny folds off to the right. The term is relative, this large, distinctive fold can also be considered a parasitic fold of the larger, broad fold of the peninsula. The strata should be highly fractured. The fractures would be parallel features, farther apart in the thicker layers. Besides the overall compressive force, some of the fracturing would be due to the slippage between layers.





6. With the rising basalt intruding into wet and mucky sediments, there resulted a great deal of chemical alteration. This hydrothermal activity would be comparable to that near Mount Lassen or Yellowstone Park where water flows. Sulfur compounds, quartz, and gypsum are some of the minerals produced by the many chemical reactions. Moving in towards the rock formation, we attempt to take strike-dip measurements on clean planar surfaces of the outcrop on the left side. (The strike would be perpendicular to a water drip down the face of a flat surface. Use the straight edge of the compass and remember to keep the compass flat.) Here you should be able to easily spot the sulfur. Those with hardhats can move up against the fold and observe the fractures in the layers including their alignment and spacing. The thick grayer layers are shale hardened with silica. This is known as Palos Verdes Stone. Notice a thin oil rich layer. The tar is all that remains of the oil or petroleum. The gasoline and kerosene have evaporated leaving only the tar which is used to pave streets. The white powdery material is gypsum. The gypsum was originally formed hydrothermally, but now it is being leached out and weathered. A stratigrapher studies all the information given by these layers. A rough time line might estimate that 1meter of sedimentary rock is laid down every 1,000 years.

7. At the top of the bluff, take time to discuss the Palos Verdes Marine terraces. We're standing on the 1st terrace, called the 100,000 year old terrace. Below we can see that the shoreline will become another terrace and if we look westward up the coast we can see the terrace feature. For 2 my the Pleistocene glaciations have occured. Sea levels can vary up to 100m between glacial and interglacial periods. Now suppose the PV fault causes an uplift of 1 or 2 meters every 1,000 years. In 50,000 years the uplift would be 50 to 100m. Now when the ice sheets melt, the water may rise back to the same level but the peninsula is 100m higher and a new terrace is formed. There have been 4 or 5 major melts and 4 or 5 major terraces. You will read that there are about a dozen terraces which reflect the dozen or so glacial and interglacial periods. Why are there no marine terraces elsewhere along the coast? First of all the other areas do not have their own PV fault and secondly Palos Verdes has little rainfall and hence little erosion. Malibu would have its terraces wiped-out.

Drive west up the coast on Paseo Del Mar and turn right uphill at Anchovy Street. Turn left at the signal on 25th St and continue down the drive for a few minutes. A bright blue sign on the right will include “Forrestal Drive”. Turn right up this road and continue thru the gated road (if it’s open). The road forks down and to the left toward the old Ladera Linda Elementary School.

8. The first stop is a fault to the right of the higher road. The Forrestal Quarry mined basalt for road and railroad beds. North of the peninsula the Madrona Marsh is a rather sad remnant of a marshland which stretched from the South Bay to the Los Angeles Harbor area. In the rainy season, Indians could paddle their boats continuously from Redondo Beach to Cabrillo Beach. The quarry closed in the 1950’s. The basalt in this area is not black. It is mainly rust-colored, but you will see many other colors - as in Yellowstone Park, this is evidence of the high degree of chemical alteration associated with hydrothermal activity. A real rock (you can’t pick it up and throw it) lies right in the middle of the path. In it one can see numerous mineral veins. In the cracks, dolomite crystals formed long ago. Hike up along a short but steep drainage channel. Observe the rocks on the ground for minerals and colors. Look to the right at the fault. How can we tell that we’re looking at a “thrust” fault? Was this fault most likely created during the extensional or compressional period? Notice the igneous layer or sill has no stratification. Those with hard hats can climb up to the face of the fault to observe the groundup rock (called fault gouge) between the standing and hanging walls. If we could get between them, we would find the surfaces themselves are actually smooth. Notice the large dolomite crystals in the cracks or fissure. The numerous fractures are probably due to the rapid cooling as the volcanic sills spread laterally into the wet, sandy layers.

9. Back down at the road move further west to the intersection. (The paved roads were part of a larger plan to develop the area into residential housing.) Looking up above the quarry road or manmade terrace, we can observe the igneous and sedimentary layers again. Try to locate two faults with 10 to 20 feet of displacement. Are these normal faults or reverse faults? Were they created before the last fault that we observed or after?

10. Northwest of this point is a small hill with sedimentary rock containing marine fossils. This is Altimera Shale or PV stone. With pick hammers and safety goggles we can separate the strata and often observe many fish scale fossils. A few shark’s teeth fossils have also been found there along with fossil kelp. Be careful climbing up high, where the ground is unstable. The people down below have to watch out for the rocks which may come tumbling down.