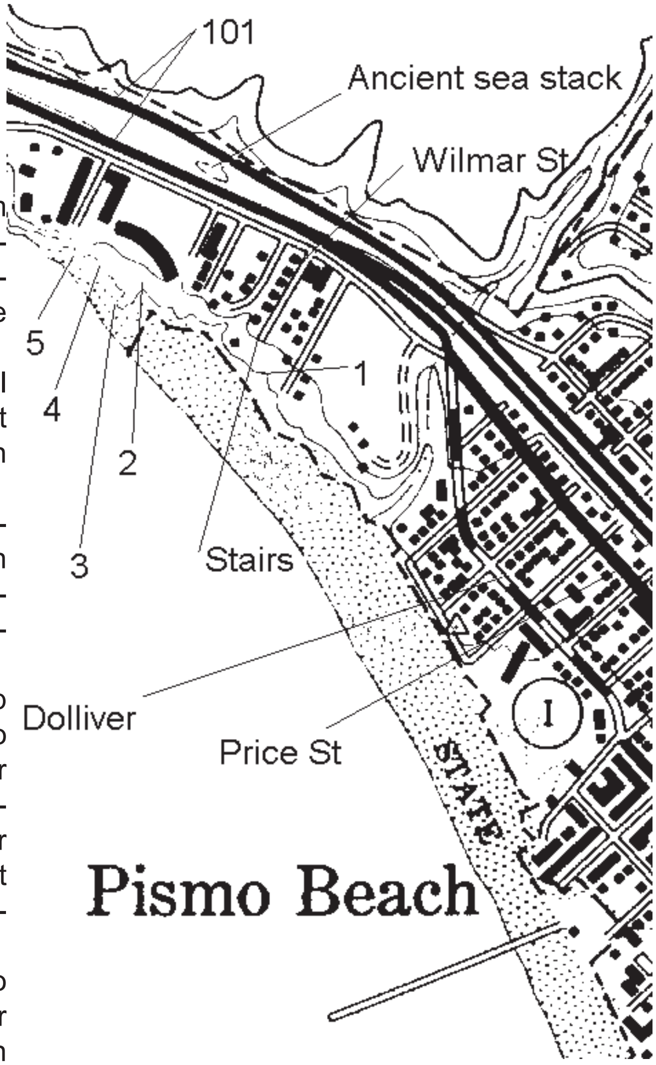
Pismo Beach, CA Beach Geology Walk, Self Guided



This walk is about a one-hour round trip to and from the base of the Wilmar Street beach access stairs (assuming you stop a bit to read/study). The text and images below will guide you along your way, explaining the geological features that you'll visit.

This walk is best done at low tide, otherwise you'll get wet (to varying degrees) trying to go around the point at #3. Tide books may be found at the Pismo Beach Chamber of Commerce and online.

Pismo Beach is in San Luis Obispo County, California - about half-way between Los Angeles and San Francisco along Highways 1 and 101 that hug the Pacific coast. We're about 90 miles north of Santa Barbara.

We'll reference very local locations using the map shown here. Wilmar Street is just out of downtown Pismo Beach to the north along Price Street. Turn down Wilmar Street toward the ocean; at the end there is (limited) parking. Also, at the cliff's "edge" are a flight of stairs (over 100!) that take you down to the beach. You can also get to this spot (base of these stairs) by a short walk northward along the beach from the Pismo pier.

The geologic story of the rocks you are about to see began about 180 million years ago (mya) when our "area" was considerably farther south on the globe than it is today, at a longitude about equal to San Diego's (or even closer to the equator some would say). At that time, the coastline was inland near the Sierra Nevada Mountains, which probably looked then like the Ande's do today. This was an area of continental collision, where the Pacific plate was going down under the North American plate, a process known as subduction. You could picture the Pacific plate as an escalator going down... This process caused a great deal of ocean crust material to "pile up," and provided much of the force needed to create the Sierras.

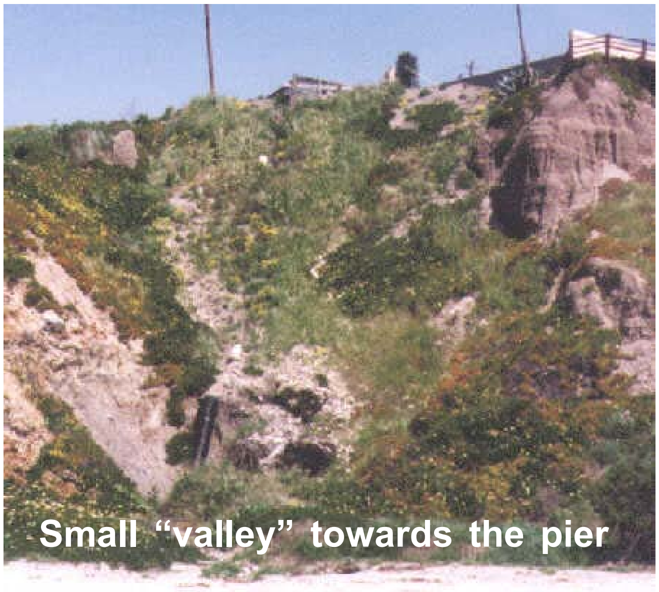
Then for reasons not yet clear, the area of subduction jumped from where the Sierras are today to roughly where today's Coast Range is. With subduction going on in this area, there was volcanism, mountain building, granite implacement, and "piling up" of ocean crust "debris." This jump left a large section of oceanic crust abandoned in between that we know today as the Great Valley of California.

This brings us to about 20-25 million years ago, when the Morro's ("The 7 Sisters") formed. These are the peaks that dot Los Osos Valley: Bishop's Peak, San Luis Peak, etc. including Morro Rock. Actually, there are really 9 of these peaks. There is one further out to sea that would look very much like Morro Rock only it's always submerged. And there is another one at the other end, near the San Luis Obispo airport, that is considerably smaller though nicely cone-shaped. All of these peaks are volcanic necks, the rock that solidified in the "piping" of the volcano after it quieted down. The cones have long since been eroded away.

Out to the east in our county at about this same time (20-25 mya), the San Andreas Fault began to form as the North American plate rode over the center of the Pacific plate, its ridge. It is during this march westward of the North American plate and the forming of the fault that those of us on this side of the San Andreas finally became residents of the Pacific plate, and we remain so today. Pillow lavas (billowy dark rocks) visible along the cliff just off the parking lot at the farthest Avila pier were formed at the Pacific ridge by upwelling magma that hit the cold oceanfloor water and cooled instantly into these "pillow"-shaped rocks. We see them today having been "saved" by the scraping off process as the ridge "went down" to subduction.

Ancient sea stack by Marie Callenders

Right in front of Marie Callender's (along Price Street just north of downtown Pismo Beach) there is a large rock formation that stands between the north and south bound lanes of Highway 101. (The picture at right views the rock from the south.) This is the **ancient sea stack** labelled on the map. A sea stack is any "hunk" of rock that sticks up out of a beach area, left high and dry as erosion removed all the material that once surrounded it. At one time, the tidal zone and beach of the ocean was about where the highway is today, and the waves would have sometimes lapped up against the foothills that today serve as a backdrop for Pismo Beach. The rock that makes up this ancient sea stack is called a tuff, made from what was originally volcanic ash (more on that to come...).



Small "valley" towards the pier

For a brief stop at #1 on the map, we head back towards the Pismo pier from the base of the Wilmar Street beach access stairs, but not very far at all. Here, looking back at the cliff, you'll see an indention, a s**mall "valley"** in the cliff face (to the left of the overhanging deck and running past the black, round drainage tube towards the bottom) that goes to a point at the top well back from the base. This is the Wilmar Street Fault. The area has been more readily eroded than other parts of the cliff in the area due to the crushing of the rock materials by movement along the fault.

This fault is considered inactive in that it shows no evidence of movement within the last 100,000 years or so. From here, it runs inland to the other side of the highway, turns southward, and crosses the Huasna Valley about halfway between Arroyo Grande and Lopez Dam.

On the way now to #2, stop a moment just north of the Wilmar stairs to visit the white rock that makes up the cliff in this area. Pick up a small piece lying on the beach and crush it in your hand. Notice how powdery it is, and if you look very closely at the individual grains, you'll notice that they are angular. This rock is a tuff (yes, just like the ancient sea stack discussed above). It was made from ancient volcanic ash that landed on the ocean and settled to the bottom building up over many years. This ash was eventually buried to depths sufficient to produce temperatures and pressures necessary to petrify it into the tuff, was later uplifted, and the erosion exposed it for us to see today. There was enough ash generated to ultimately create tuff hundreds of feet thick in this area.

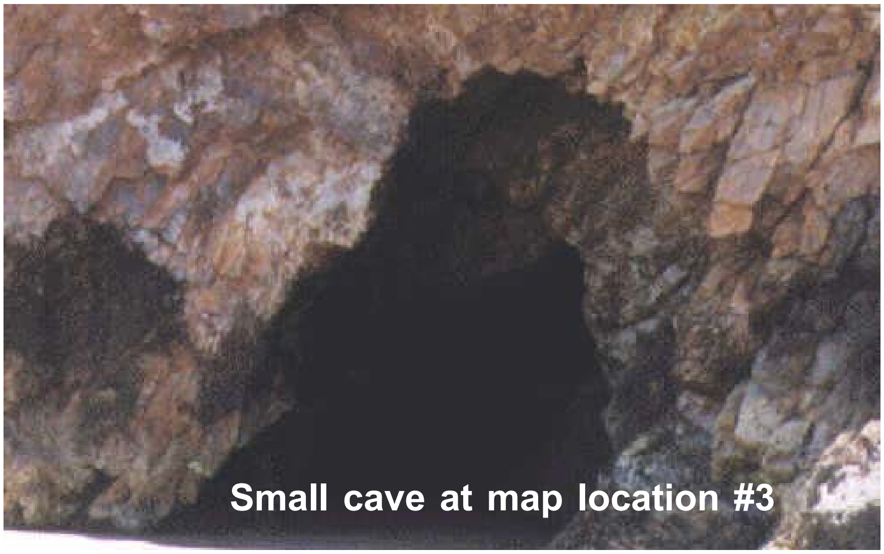
Moving north along the beach to #2, we come to a **set of stairs** leading up to one of the motels at the top of the cliff. About 30 feet up the stairs, flanked by pine trees, you'll see a rock face that is full of holes ranging in size from quite small to a couple of inches in diameter. These holes were

Holes in rock face near top

made by a rock-eating clam called a pholad. It lives its entire life cycle in the rock. Today, you can find holes just like these in the tide pools, sometimes with the clam still in them!


Modern-day sea stack

Pholads can't live high and dry like this rock face is today. This clam "condo project" had to be in the tidal zone during the period of time that these pholads lived. The ocean waters were their only source of nutrients. Evidently, the land has risen and/or sea level has lowered since then (probably both: the rocks/land in this area are actively uplifting, and sea level has been at one of its highest points recently because we are between ice ages).


Small cave at map location #3

As you approached #2, you got a good look at a **modern day sea stack** (pictured above). Sea stacks are created by a process known as differential erosion. The rock surrounding the sea stack was less resistant to the erosional forces of the tides and rain and was therefore eroded away, whereas the rock that remains resisted those same forces. There are sea stacks all along the cliffs in Pismo Beach, particularly along Ocean Boulevard.

At #3, you'll see a **small cave** as you go around the point. This cave was created by the same differential erosion as the sea stack, only in reverse. In this case, the surrounding material was more resistant and thus remains, and the "inside" was eroded away by the tides, etc.

You'll notice that the rock in this area is different now - it's yellow. If you try to break off a piece or crush a piece of this yellow rock, you'll find that it is considerably tougher than the white rock. Interestingly, this rock is a tuff, too. It differs from the white tuff, however, in that it was exposed to a secondary process that the white tuff was not. This extra process brought another mineral (mordenite) into the picture which acted much like a glue and made this rock not only the color it is, but also gave it its added strength.


Stops #4 and #5

From a distance, we see **stops #4 and #5** in the same picture. To the left (#5) is a dike (brown vertical feature in the white tuff), and to the right (#4) is a fault (where white meets yellow).

The dike at #5

The dike (#5) is a tabular igneous rock formation that "cuts across the grain" of the host rock body created when a magma (liquid rock) injects itself at depth into a crack or other plane of weakness in that host rock (in this case, the tuff). A sill is the equivalent tabular feature that goes "with the grain" of its host body. Dikes are often thought of as vertical and sills as horizontal, although that's technically not necessarily true. Upon close examination, you'll note that the dike itself (the center 8 feet or so) is fine grained and dark. Geologists refer to fine-grained, dark, igneous rock as a gabbro.

On either side of the gabbro itself, there is another rock type. It is darker, and it has in some cases (especially on the left side) resisted erosion even better than the gabbro. The "wall" on the left is made of this other material called hornfels. Hornsfel is a rock type created typically by contact metamorphism - when a rock is subjected to great temperatures and pressures (such as a hot liquid body of rock). It is, in this case, metamorphosed tuff. You can see that the metamorphism was very limited indeed, fading away to no change at all about 10 feet (or less) from the dike.

If you walk up onto the gabbro "bench" and go to where it heads upward, look at the center (roughly) of the dike. You'll see lighter-colored patches of rock material that don't look like the rest of the dike. These look more like pieces of the hornfels (the wall). And in fact, that's what they are, pieces of the wall that were scraped off as the igneous body flowed in, and drifted towards the center of the dike (the gabbro). These are generically called xenoliths ("foreign inclusion"), as they "don't belong."

Second fault at #4

Our last stop (#4) is our **second fault** of the trip. Here, the yellow tuff has been brought into contact with the white tuff through movement along a fault. The yellow tuff is the older of the two, and was the one brought "up" relative to the white.

While looking closely at some rocks near the fault line, you may see slickenslides. These are parallel grooves carved in the rocks as they ground past each other.

While standing at this fault, look back toward the Pismo pier. You won't be able to see the pier because of the yellow tuff point (#3) that projects out toward the ocean. Near the base of that projection, you'll see an indention in the yellow tuff that is vertical in nature, dark, fine-grained... Sound familiar - yes. It's a piece of the same dike (#5)! Only this time it's in the yellow tuff, and it doesn't quite line up with the other section.

Now we have enough information to "put it all together." First came the yellow tuff, then the white tuff on top of that. Then the dike intruded both the yellow and the white tuff. Then lastly, the fault "cut" the tuffs and the dike, causing the dike to be offset and bringing the yellow tuff in contact with the white tuff.

Many thanks to Professors Paul Bauer and Jeff Grover at Cuesta College for their California Geology course and field trips. I enjoyed them thoroughly, and from them got most of the information for this self-guided walk. I'd also like to acknowledge Cal Poly Professor David Chipping's local geology guide, which can be purchased at the Cal Poly bookstore (last I checked...). The photographs are my own.