

Our Ocean Backyard — *Santa Cruz Sentinel* columns by Gary Griggs, Director, Institute of Marine Sciences, UC Santa Cruz.

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Why Marine Terraces?



The lowest marine terrace along the San Mateo County coast.

If you live anywhere in the city of Santa Cruz, chances are quite high that you are living on a marine terrace. This isn't the case if you live downtown on the floodplain, however.

The lowest of these nearly flat stair steps starts at an elevation of about 25 feet along West Cliff Drive, and the 5th or highest terrace reaches an elevation of roughly 850 feet in the hills of Wilder Ranch. The most impressive and extensive set of California coastal terraces are preserved on the Palos Verdes Peninsula, where there are 13 terraces that extend to an elevation of 1300 feet.

Why are these flat terraces so common along California's coast, and are terraces still forming today? The first question requires some explanation, but the second is easier and just requires some observation. If you look at the shoreline from West Cliff at a serious low tide, you will typically see a rocky shelf, covered with all the

tide pool creatures we are all familiar with. This is the modern wave cut platform or marine terrace being formed by wave erosion today.

As waves enter shallow water and break, the larger ones exert considerable pressure or hydraulic impact on the seafloor, weakening, dislodging or breaking up the rock over time. Combined with abrasion, or the washing of sand, gravel or shells across the rock, which works much like sand paper, and also the chemical breakdown of the rocks from constant exposure to sea water (which any coastal resident or boat owner knows is very corrosive), and we have some effective tools for grinding and wearing away the seafloor rock to create a nearly flat terrace.

So, yes, an offshore terrace is forming today, and as long as sea level continues to rise and advance the coastline inland or landward, we will continue cutting a wave cut terrace in the intertidal zone. This process creates a modern terrace, but we still have to preserve these flat benches and explain why they can be hundreds of feet above sea level today.

To create the marine terraces in Santa Cruz, or anywhere along the west coast, requires several concurrent processes: a slow but continuous uplift of the coastline, an oscillating sea level, and bedrock that is weak enough to be easily eroded by waves.

For roughly 100 million years (from about 130 million to 30 million years ago) the edge of what is now California was a place where two massive crustal plates collided. The offshore and thinner oceanic plate (the Farallon Plate) was forced down under the advancing thicker North American plate, which led to gradual uplift of the coast of ancient California, helping to create the Coast Ranges. Some of this slow uplift continues today, slowly lifting up the coastline and terraces in the process.

The second requirement is that sea level rises and falls over time. We know that the Earth's climate has changed constantly over periods of thousands of years because of the variations in our distance from the sun. Simply put, the closer we are to the sun, the warmer the Earth gets; the farther we are away, the cooler it gets. When the Earth is warm, as it is today, ocean water warms and expands and glaciers and ice sheets melt, and sea level rises in response.

At times of high sea level, when the climate is warmer, the wave are doing their job, washing sand back and forth across the intertidal zone, grinding down the bedrock and forming a flat rocky terrace, visible at low tide today.

When the climate cools again, sea level will slowly drop and recede from the shoreline. If the adjacent land is rising, which it has been along most of California's coast for millions of years, a nearly flat marine terrace will gradually be elevated and preserved. Variations in local geological conditions have led to the preservation of up to five terraces in the Santa Cruz area, with Wilder Ranch being a great place to experience them on a mountain bike.