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

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Solving a Mystery–How Old Are The Terraces?

Fossil clamshells preserved in the first terrace near Santa Barbara.

Driving almost anywhere in Santa Cruz takes you across a marine terrace. If you are on Mission Street, Soquel Drive, 41st Avenue, West or East Cliff, you are navigating along the first or lowest terrace. We know this was old seafloor sometime in the geologic past, but when?

Dating the first terrace, or any of the higher terraces, is more complicated than it might initially seem, and it took a number of years to answer the question. If you walk out across the modern intertidal terrace today, at a serious low tide, there are lots of animals living in the nooks and crannies, attached to the rocks, and still and others that bore into the rocks. The organisms with shells, like clams or snails, are the kinds of things that if preserved on older terraces would give us something that could be dated.

In order to preserve this modern terrace, sea level needs to drop. That's not going to happen anytime soon, however, because the climate is warming and sea level is

going the other way; it's rising. But in the geologic past, sea level did drop during the cool periods or ice ages, when roughly 10 million cubic miles of seawater was transferred to the continents as glaciers and ice sheets.

As sea level was lowered, the beaches migrated seaward and the low tide terrace was gradually covered by beach sand, dune sand in places, or even stream deposits.

Those intertidal organisms that couldn't migrate with the ocean, the clams that had bored into the rock, were trapped. They were buried by the advancing beach, died, and some were preserved. Today there are places along the outer edge of the modern seacliff, in Santa Cruz and elsewhere, where these ancient clamshells can be found.

Where uplifted marine terraces occur in more tropical environments, corals have been preserved. So the age of these fossil clams or corals represents the time of the formation of each of these coastal terraces.

The challenge for coastal geologists was to figure out a way to date these fossils shells. The most obvious answer was to utilize carbon-14, which is used to date all kinds of organic material, stuff like ancient cloth, charcoal, bone or shells. Unfortunately, because carbon-14 decays relatively quickly compared to other longer-lived isotopes, it is only useful on material less than about 50,000 years old. When shells were first dated from the lowest marine terrace in California, they were discovered to be too old to contain carbon-14. So this was a dead end.

Scientists next tried other some dating techniques, one of which, the decay of natural occurring uranium to the element thorium, didn't work well on clams, but did on coral. It turns out that there are solitary corals preserved on the terraces of southern California and Baja California, which provided consistent and reliable dates.

The lowest terrace in southern California was dated at about 100,000 years old. This was an important breakthrough and provided for correlations with the lowest terrace elsewhere along the state's coastline.

A sequence of over 20 uplifted terraces were discovered 45 years ago on the tropical island of Papua New Guinea. Like California, Papua New Guinea, lies at the juncture of two tectonic plates where the island is being raised out of the sea, preserving all of these terraces.

Being able to date fossil coral on the higher terraces in New Guinea, which equate to times of warmer climate when sea levels were higher, combined with other paleoclimate records from deep-sea sediments enabled us to piece together the ages of the higher Santa Cruz terraces.

We believe that the lowest terrace (West Cliff and East Cliff) is about 100,000 years old, and the second terrace (traversed by Western Drive) is about 230,000 years old. The third stair step (on Wilder Ranch) is about 350,000 years old, and the fourth, also exposed on Wilde, about 490,000 years old. All of these were formed well before humans were here to watch the process.