Torrey Pines SB and Torrey Pines SNR

National Natural Landmark 1977 | State Beach and State Natural Reserve

Crumbling Cliffs

Features/Processes: Coastal geomorphology and geobotany, with concretions and fossils

Along the beachfront in the southern reserve area, a dramatic cliff face towers over the Pacific Ocean. This cliff face exposes a thick stack of sedimentary rocks that span a great period of time from Middle Eocene (roughly 49 million years before present) to the Pleistocene (120,000 years ago). Eocene deposits are relatively rare throughout the west and so these deposits help fill a huge knowledge gap in the geologic record. The rocks in the sea cliffs represent a former bay that was uplifted long ago. They also reveal where the ocean invaded the land, producing a similar environment to what today exists between the sandy beach and Los Peñasquitos Marsh Natural Preserve to the east.

Why it's important: Torrey Pines State Natural Reserve preserves habitat for North America's rarest and most geographically restricted pine tree species. Several natural processes interact to form the habitat for the pines. The reserve and beach are perfect places for visitors to see vestiges of past environments and their continuing influence on the landscape and to envision the dynamics of shoreline processes.

The pines prefer the sandy soils on the coastal bluffs and ravines within the Reserve. The pines were once more widespread during a different climate regime. Another population of Torrey Pine exists in two small groves on Santa Catalina Island. These populations of rare pines are thought to be hold-outs from the Ice Ages. They are literally losing precious ground to rapid erosion of the sandy slopes they occupy.

These cliffs of sedimentary rocks are relatively weak and prone to landslides especially as they are attacked and undercut along the beach by waves. Although a hazard, landslides replenish the beaches with new sand. While a slumped mass remains on the beach, it buffers the steep cliff from wave attack. The waves sweep away the mass and again attack the cliffs eventually triggering another landslide. The sand is carried into a current called the Oceanside Littoral Cell. Researchers estimate that about half of the natural sand load in the Oceanside Littoral Cell has been eliminated due to the construction of dams, the loss from gravel mining, and the urbanization of southern California. This has resulted in accelerated beach loss (and in places accelerated bluff retreat) along the affected coastline.

What you can see: Majestic, towering sea cliffs sliced by ocean wave erosion and hammered by pounding waves. The Torrey Sandstone and underlying Del Mar Formation comprise the majority of the sea cliff edifice; the Quaternary marine terraces on top were deposited after tens of millions of years of erosion. The sea cliffs reveal beautiful shapes and patterns of soft sediment deformation, formed when the sands were below sea level and saturated with water. A gigantic landslide south of Flat Rock deformed the cliff into a stair-step like shape. Marble-sized iron oxide concretions mantle some of the terrace surfaces.

The Embayment

During the Eocene, a great embayment of the Pacific Ocean into the North American continent existed from Carlsbad in the north, to Baja in the south, and east beyond Poway. Sediments of the Del Mar Formation and Torrey Sandstone deposited in this embayment. The Del Mar Formation is yellowish-green claystone that formed in a lagoon-like environment similar to, but much larger than, the Los Penasquitos lagoon. Near the top of the Del Mar in the vicinity of Flat Rock is a layer of fossilized oyster shells called a “coquina.” The Torrey Sandstone is light brown sandstone that likely formed as a barrier beach west of a lagoon. The sand barrier in front of the Los Penasquitos Lagoon provides a small example.

What we see today in map view is that the lagoon and the sand spit are adjacent to each other. However, in the cliff face at Razor Point is something entirely different. The two rock types, yellowish-green claystone (Del Mar Formation), and light brown sandstone (Torrey Sandstone), are actually stacked on top of, but not adjacent to each other. What does this mean? This can be explained by understanding how deposits proceed inland as ocean level rises relative to a land mass. Geologists call this a transgression, when sea level rose and the beach front and lagoon both migrated inland. The two strata were deposited simultaneously, yet if you cut a vertical cliff face into them you see the older lagoon deposits under the younger beach sand deposits.

Much has happened since then. The fine-grained sediment deposited in the lagoon and the sands deposited along the barrier beaches have undergone lithification. This means that they have turned into rock, as the original air and water was pressed out and the sediment was squeezed by overlying deposits under the force of gravity.

Since Eocene time, sea level has risen and fallen many times and other rocks in the area record these events. During one highstand approximately 700,000 years ago, the sea cut a marine terrace into the Torrey Sandstone upon which the Linda Vista Formation was deposited. The Linda Vista is a distinctive, rusted color sandstone, with abundant marble- and pea-sized iron stones.

Along the coastal bluffs at Razor Point, a much younger deposit called the Bay Point Formation rests on top of the Linda Vista Formation. This deposit was laid down during a period when the glaciers had mostly melted, and sea level had risen. This period is called the Sangamon interglacial and it started roughly 120,000 years before present. The Bay Point Formation contains marine fossils at its base, but gradually becomes terrestrial (or dry land) sandy deposits near the top. Because the Bay Point Formation is roughly 48 million years younger than the Eocene rocks on which it rests, it erodes differently and has a characteristic red hue due to weathering and oxidation of iron and magnesium-bearing minerals. Because of its youthful age, it has not yet consolidated and turned to rock, so it erodes by rilling and forms badland topography.

Final Thoughts

The shoreline cliffs at Torrey Pines both provide solitude from the nearby urban environment and reveal a unique chapter of the geologic past that lies beneath the metropolis of San Diego.

Written by Jeremy Lancaster, California Geological Survey
Photos: Mike Fuller

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