Gaviota State Park

Miocene Monterey Formation

The Monterey Formation visible at Gaviota State Park is a major source of petroleum in southern California. Prior to the arrival of the Europeans, the Chumash people used tar that seeped from these rocks to waterproof their ocean-going canoes. The tar seeps barely suggested the vast underground reservoirs of petroleum that were eventually discovered.

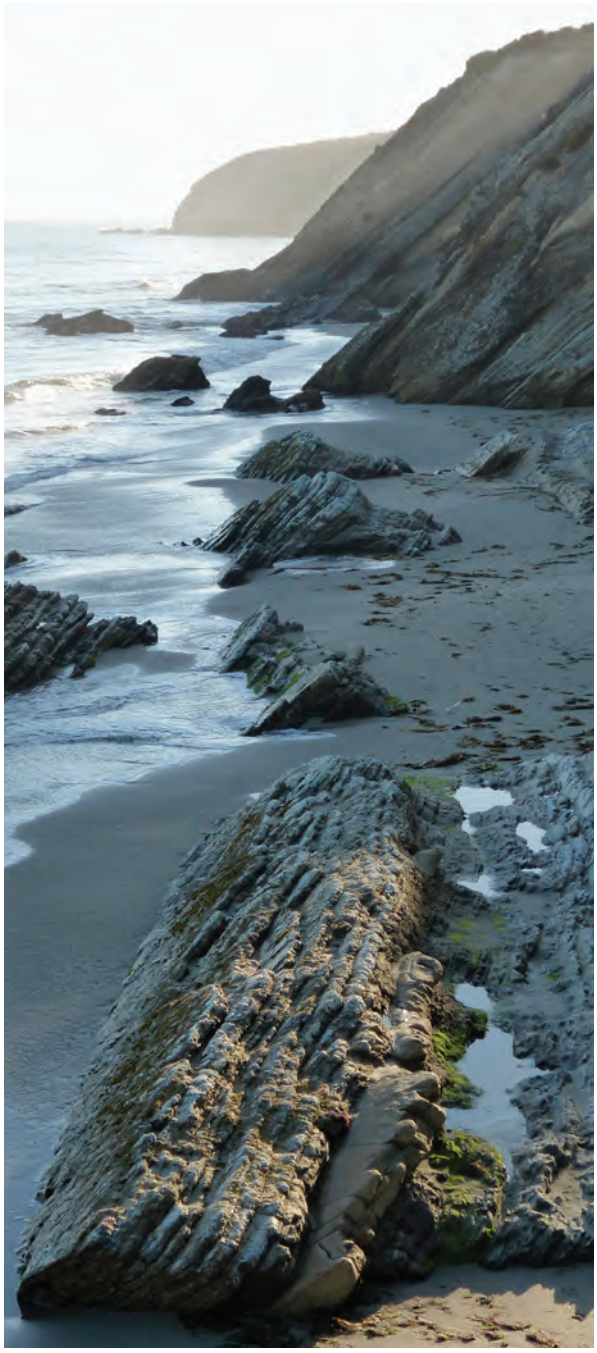
Features:
Sedimentology of an uplifted Miocene ocean basin, and fossils

Strikingly different from the rich source rocks are the thick layers of diatomaceous sediment (deposits of diatoms—the "skeletal" remains of microscopic plankton). Abundant microscopic pores make the material very lightweight and ideal for filtering impurities out of various solutions. Once used for refining sugar and beer, diatomite is better known for its uses in swimming pool filters and as filler to reduce the weight of concrete. There are over 300 other industrial uses.

Why it's important: The coastal bluffs at Gaviota State Park reveal a 500-foot thick cross-section of the geographically extensive Monterey Formation. Offshore and inland, petroleum geologists have extensively explored underground for oil reservoirs within this rock sequence and probed its depths to understand the genesis of this important oil source.

The naturally cemented, bluff faces resist wave erosion and are tilted to display multiple layers like the pages of a book. The geologic layers contain some nicely preserved fossils—even the complete skeleton of a halibut-like fish.

During the Miocene (5 to 23 million years ago), the precursor sediments of the Monterey Formation were deposited in deep quiet waters far offshore from the present onshore location. Enormous quantities of diatomaceous skeletons rained down through the oceanic water column to settle on the ocean floor. Layer upon layer buried the previous extensive deposits. The diatomaceous ooze of planktonic debris was compressed over time into shale layers that are cumulatively as thick as 3,000 to 6,000 feet. These rocks now extend from Point Arena (Mendocino County), north of San Francisco Bay, to Dana Point in southern Orange County.



Thin layers are visible in the diatomaceous shale, which give it a platy appearance. The texture indicates deposition in quiet water far from sources of other (such as land-derived) sediment. About 20 million years ago, dynamics between the movements of the tectonic plates stretched the crust which consequently subsided, oceanic basins formed along the continental margin. These basins filled with sediment until around six million years ago. Subsequently, the deposits were compressed against the continent and uplifted along with the surrounding region.

Volcanoes to the east were erupting as the Monterey Formation was forming; large quantities of ash were deposited on the ocean surface and trickled down to the ocean floor. This is reflected in the submarine ash beds (tuff) at the base of the Monterey Formation. Because of its thickness and persistence in the region, this tuff unit is known to geologists as the Obispo tuff member of the Monterey Formation.

Fossils

The Monterey Formation contains fossils in the vicinity of the park. Fish scales are common along bedding planes, and some complete fish skeletons (halibut-type fish) have been found. Whale bones and plant fossils have also been discovered among the layers of the rocks. The microscopic diatoms make up the bulk of the Monterey. Of course, being microscopic, the beauty and variety of the fossilized plankton are best appreciated under a microscope where thousands of elegant shapes can be seen.

What you can see: Fossil-rich, tilted shale and diatomite beds formed on the ocean floor millions of years ago.

Dip Slope Bedding

The multiple layers of the Monterey shale are beds of material deposited on the ocean floor in a nearly horizontal position, and subsequently deeply buried and compressed. Since the time of deposition, the layers have been folded and the once-horizontal beds are now tilted. West of the pier, the tilted beds are at the same angle as the slope face, so the cliff face angle is the same inclination as the tilted beds. Along cross-fractures, the layers break, giving the appearance of pages of a book—frozen in stone.

By measuring the geometry of layers in the subsurface and determining how and when the rocks were deformed in their journey from deep ocean basin to the Santa Ynez Mountains, we are led to a deeper understanding and appreciation for the powerful and relentless tectonic forces involved.

Interesting Unique Layers

The conglomerates (cemented layers of cobbles within the formation) exposed in the bluffs include many interesting features. Some of the conglomerates are impregnated with natural tar. Some of the conglomerates contain pebbles made of phosphate minerals.

Layers of volcanic ash are found here and there. An 18-inch-thick layer of volcanic ash lies 500 yards west of Canada del Cementario. To the east for three miles, the layers are intensely folded due to deformation that occurred while the sediments were still soft and plastic. The soft sediment deformation may have developed from the slumping off the edge of the continental shelf and down the continental slope to the deep ocean floor.

Final Thoughts

Being economically important, the Monterey Formation has elicited a great deal of study over the last hundred or so years. Despite extensive research, many questions of its origin remain.

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Prepared by California Geological Survey, Department of Conservation | www.conservation.ca.gov/cgs
for California State Parks | www.parks.ca.gov

Geological Gems of California State Parks, Special Report 230 – Fuller, M., Brown, S., Wills, C. and Short, W., editors, 2015 Geological Gems of California, California Geological Survey under Interagency Agreement C01718011 with California State Parks.