Malibu Creek State Park

Conejo Volcanics

Features/Process:
Volcanology of an uplifted Miocene ocean basin, and pillow basalts

Crossing the central section of Malibu Creek State Park are tilted layers of the Conejo volcanic rocks that form prominent east to west aligned ridges. These include Brent's Mountain and Goats Butte. The exposures of the Conejo volcanic rocks contain abundant clues that reveal the geologic history of the area. During the Miocene Epoch, the Conejo Volcanics were extruded onto the sea floor from approximately 17.4 to 15.9 million years before present. The types of volcanic rocks that comprise the Conejo Volcanics are lava (basaltic and andesitic) flows, pillow basalts, tuff, and volcanic breccias. These rocks are exposed in the road cuts, cliffs, ridges, and valleys—they are generally dark brown to dark reddish brown in color. Some of these rocks contain abundant vesicles which were air bubbles or pockets trapped in the lava as it cooled.

Why it's important: Malibu Creek State Park contains excellent exposures of the Conejo Volcanics that cover large portions of the modern Santa Monica Mountains of the Transverse Ranges geomorphic province. The Conejo Volcanics are one of several Miocene volcanic fields along the California coast that erupted in response to a major reorientation of the tectonic plate boundary between the North American tectonic plate, the subducting Monterey microplate, and the better-known Farallon plate. The reorientation caused local areas of extension and crustal thinning. The molten rocks below the thin oceanic crust ascended through the crust along fractures to the surface and erupted as volcanic rocks.

Limestone with oyster shells and other marine fossils formed within the submarine volcanic field. Submarine eruptions of basaltic lava typically produce pillow-shaped structures called pillow basalts. Although the pillows were later broken into multitudes of pieces (breccia); vestiges of these underwater forms remain recognizable. Later in the eruptive life of the volcanic field, the region was elevated above sea level as evidenced by pieces of petrified wood in the later lava deposits.

Why They Formed?

The Conejo Volcanics formed when the eastern Pacific oceanic tectonic plate and the Monterey microplate were subducted beneath the North American tectonic plate, causing upward and lateral land surface swelling (dilation) and then extension (deflation). Many basins formed along the continental margin due to extensional

faulting, and these basins then filled with sediment. That accumulated sediment is now visible as sandstone, siltstone and pebbly sandstone. Volcanic vents occurred along the bottom and on the margins of the basins as magma rose along faults and zones of weakness in the crust. As the basins continued to fill with sediment, they were also filled with layers of volcanic rock in the form of basalt flows, pillow basalts, submarine ash (tuff), and volcanic mudflows. The rocks formed from these diverse processes are now considered part of the Topanga Group.

Photo: Jeremy Lancaster

What you can see: Volcanic pillow basalts which formed on the ocean floor.

Pillow Basalts and Breccias

As basaltic lava oozes from fissures and contacts cold seawater, a crust forms around the blob of extruded lava. As pressure builds, the crust breaks and more fresh lava extrudes like toothpaste squeezed from a tube. Each extrusion of lava has an irregular lower surface and a smooth, convex upper surface, superficially resembling a pillow. Further eruptions cause hot lava to break out and form more "pillows." This pillow texture is common in underwater basaltic flows and is diagnostic of an underwater eruption environment. If underwater eruptions are continuously repeated, a thick sequence of pillows may be formed.

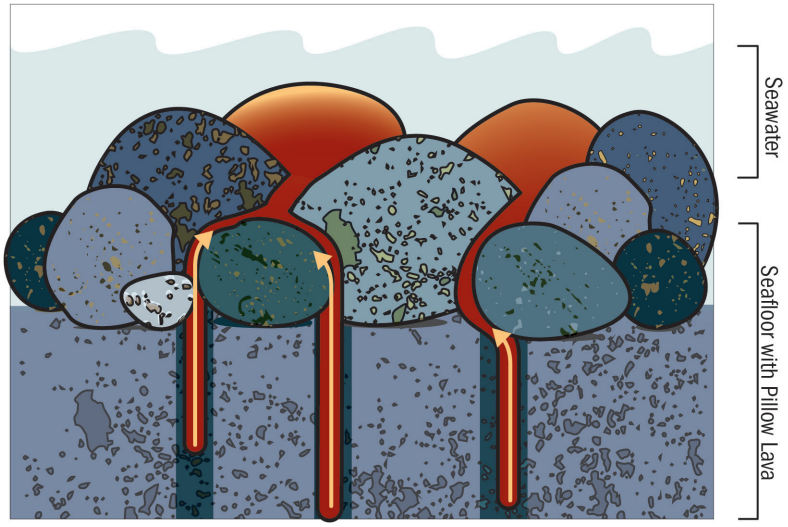

Illustration: A. Carney

Between episodes of lava eruptions of pillow basalts other biological activity occurred on the sea floor. Marine organisms likely thrived upon and congregated around these pillow basalts and associated hot spots. The Conejo Volcanics contain beds of volcanic sandstone with fossils.

What is a Pillow Basalt Breccia?

Sometimes pillow basalts will be erupted into a relatively quiet environment and the pillow structures are preserved intact. In other areas, the pillows may be broken or otherwise deformed by later earth movements. Most of the pillow basalts in Malibu Creek State Park are pillow basalt breccias. A breccia is a type of rock that contains very angular, broken fragments in a matrix of finer grained material. Pillow basalt breccias tell us that something catastrophic occurred on the sea floor, such as a submarine landslide.

Periods of quiet do not last forever on the sea floor where volcanic activity is intermittently active. Because of the extension along the continental margin during Miocene time, portions of the sea floor would commonly drop downward to form basins. As a result, steep slopes formed along the margins of these basins and became areas where sediment from the continent was deposited underwater. Submarine landslides were commonplace along these steep underwater slopes and deposited material in the basin bottoms. Eventually, thick sequences of pillow basalts, volcanic sands, and other sediment were caught up in these landslides. The outcome is simple to picture: a thick sequence of pillows are broken up, deformed and then re-deposited on the ocean floor as slide debris. The uniform stack of pillows then becomes a breccia, with only very little original pillow structure remaining.

Final Thoughts

This land is being squeezed in a tectonic vise with the continental plate on one side and the oceanic plate on the other. The effects are apparent on so many scales, ranging from fragmented rocks to tilted beds of marine deposits being thrust forward and upward during powerful earthquakes.

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