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San Francisco and the Bay Area

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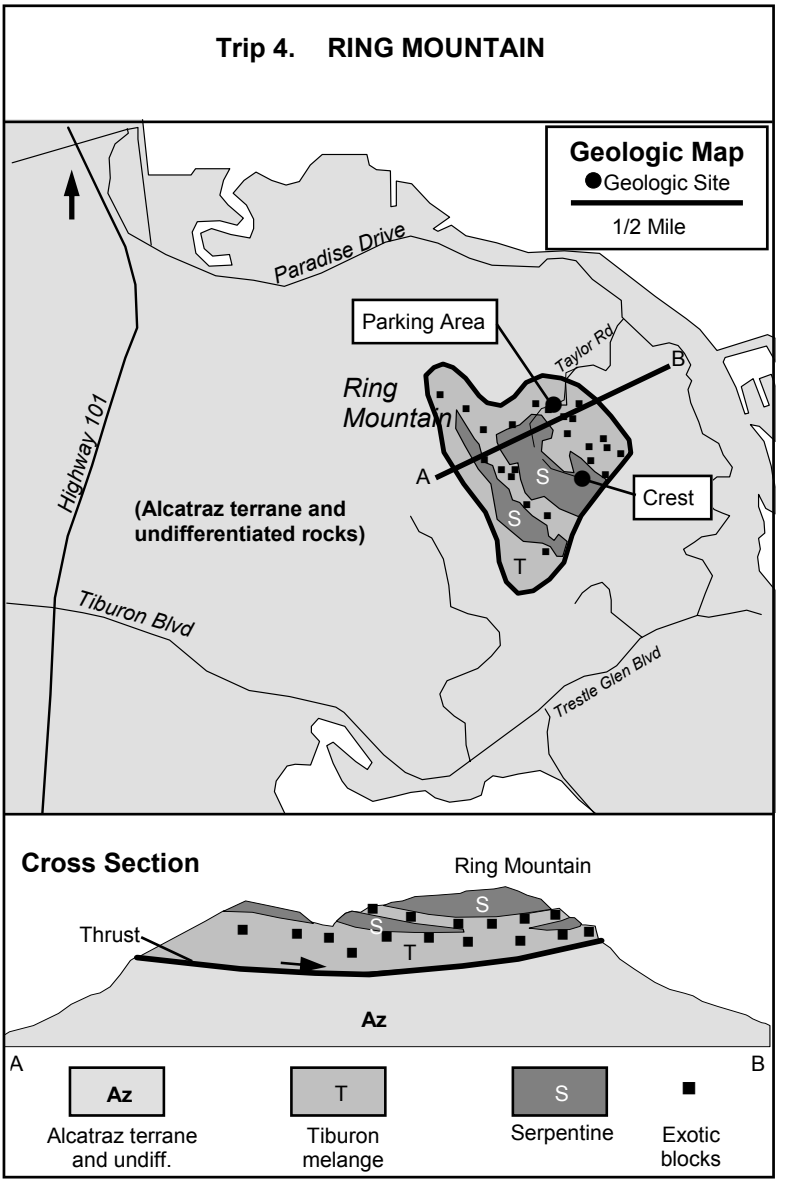
Trip 4. RING MOUNTAIN



The crest of Ring Mountain is formed from thick layers of serpentine. The Tiburon melange, below the serpentine, contains large exotic blocks of unusual metamorphic rocks. The Tiburon melange was thrust over the Alcatraz terrane, which is exposed at the base of Ring Mountain.

Trip 4.

RING MOUNTAIN

Exotic Blocks - Thermometers in the Subduction Zone

Ring Mountain is geologically similar to Angel Island in that Franciscan metamorphic rocks have been thrust over unmetamorphosed rocks of the Alcatraz terrane. The Alcatraz terrane can be found on the lower slopes of Ring Mountain, whereas metamorphosed rocks and serpentine occur on the upper slopes and crest. The metamorphosed rocks at Ring Mountain occur as large boulders, or e*xotic blocks*, in the Tiburon melange. These exotic blocks are of special interest to geologists because they have acted like digital thermometers that have been inserted into the bowels of the Franciscan subduction zone, and thus provide a record of temperatures and pressures in the subduction zone.

The trip to Ring Mountain can be easily done from San Francisco in half a day. During the trip you will go to the parking area at the end of Taylor Road, where you will examine some exotic blocks. You will then follow a short trail to the crest of the mountain where you will see the thick slab of serpentine that forms the flat top of the mountain.

Ring Mountain lies within the Ring Mountain Preserve and is administered by The Nature Conservancy (Phone 415-435-6465). There are many unusual plants on the preserve that grow there because of the serpentine soils. You can see many of these plants on the 1.5-mile self-guided loop trail into the preserve that leaves from the parking area on Paradise Drive, 0.8 miles west of Taylor Road.

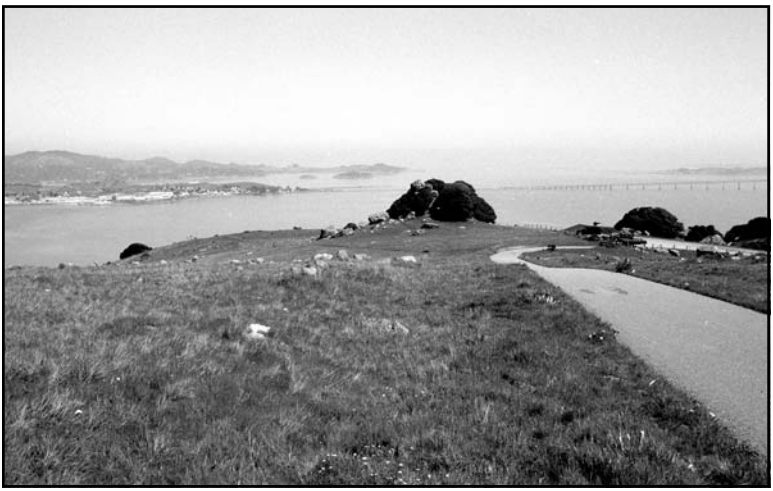
Taylor Road

To get to Taylor Road, go north on Highway 101 from the Golden Gate Bridge to the Paradise Drive exit 7.0 miles north of the Golden Gate Bridge. Turn right on Paradise Drive and keep sharply to the right to stay on Paradise Drive. Continue east 2.3 miles to Taylor Road, turn right on Taylor Road and go 0.5 miles to the end of Taylor Road. Turn right into the public parking area at the end of the road and park. This parking area is the first geologic site and the paved fire road from the parking area goes to the geologic site at the crest of the mountain.

●*Parking Area*

In and adjacent to the parking area at the end of Taylor Road there are a number of large isolated boulders of varying size. Some of these boulders are a foot or so across, and some the size of a small house. These boulders are exotic blocks in the Tiburon melange. The soft clay of the Tiburon melange has been washed away and left the exotic blocks on the surface of the ground likes plums in a plum pudding. The clay that forms the matrix of the melange consists of rocks that were ground into a fine powder by the thrusting action within the subduction zone. You will not see any good exposures of this clay since it is too soft to form outcrops.

Take a good look at the exotic blocks in and near the parking area. You will find that some of the blocks have grooves that were formed as the blocks rubbed against other rocks during their wanderings in the subduction zone. Other blocks have a rind of chlorite, talc, or other minerals. These minerals are slippery and served as a lubricant as the blocks were squeezed through the melange. Most of the blocks sparkle from flakes of mica that were formed during metamorphism. Almost all of the blocks appear to have rough, platy layers. This layering, called schistosity, formed during metamorphism as the different minerals segregated into layers.



The large exotic block (center) is adjacent to the parking lot at the end of Taylor Road. The fire road (right) leads to good exposures of serpentine at the crest of the mountain.

The exotic blocks at Ring Mountain offer one of the best places in the Coast Ranges for the study of Franciscan metamorphism because of the wide variety of metamorphic rocks found in the blocks. Some of the more common metamorphic rocks include amphibolites, eclogites, and blueschists. The amphibolites have dark elongated crystals, sometimes up to two inches long. The blueschists appear as very dark blue layers within the schists. The eclogites have small red crystals of garnet.

Many of the metamorphic minerals in these rocks, like lawsonite, glaucophane and garnet, form only under very specific conditions of pressure and temperature. Some of the minerals also provide a record of when the metamorphism occurred, based on the rate of decay of radioactive isotopes in the minerals. Using the age, temperature and pressure information from these minerals, it is possible for specialized geologists to reconstruct the pressure-temperature history of the Franciscan subduction zone.

On the basis of the age, temperature and pressure information from the blocks, subduction of the Franciscan is thought to have begun in early Jurassic time, about 175 million years ago. At the beginning of subduction, sedimentary and igneous rocks on the Farallon plate were metamorphosed at high temperatures as they were brought into the subduction zone and carried below the North American plate. Some of the weaker rocks in the subduction zone were crushed to form the clay melange while some of the very hard metamorphic rocks were broken into pieces and remained as large, hard blocks within the melange. With continuing subduction, the rocks in the subduction zone cooled because of the influx of the cool, wet rocks from the sea floor of the Farallon plate. Some of the blocks in the melange continued to be carried to greater depths in the cooler subduction zone. Glaucophane and lawsonite were formed under these low temperature-high pressure conditions by chemical alteration of the original amphiboles and feldspars. About 65 million years ago subduction ended, and the Coast Ranges were uplifted and eroded. Eventually this uplift and erosion brought the exotic blocks to the surface, where they now lie scattered on the landscape as if placed in a large rock garden.

Exotic blocks with high-grade metamorphic minerals like the blocks at Ring Mountain are widespread in the Franciscan of the Coast Ranges, but make up less that one percent of the Franciscan. These blocks have also been referred to as knockers, tectonic blocks, or high-grade blocks.

The grooves in this exotic block near the parking area were formed as the block was squeezed through the Tiburon melange while the block was in the Franciscan subduction zone.

Most of the exotic blocks are schistose; that is, they appear platy on broken surfaces. Most of these fresh broken surfaces are covered by sparkling flakes of mica. A lizard conveniently provides scale.

●*Crest*

Continue on the path to the crest of Ring Mountain. The round-trip hike is about half a mile. You will be on the Tiburon melange during most of the hike and see more exotic blocks along the road. As you approach the flat top of the mountain you will see that the crest is formed from two thick sub-horizontal layers of light yellow-brown serpentine. These layers represent coherent pieces of the ocean crust of the Farallon plate that were incorporated into the Tiburon melange. For more detail on how the serpentine was formed refer to the Fort Point locality on the geologic trip to San Francisco. Also refer to the discussion of spreading centers under Plate Tectonics.

The serpentine on the crest of Ring Mountain resists weathering and forms hard blocky outcrops. On fresh exposures, the rock is pale green, sometimes with dark specks about the size of small peas. These dark specks are remnants of pyroxene crystals that have been altered to serpentine.

In places, some large blocks of this serpentine have broken off and are slowly sliding down the side of the mountain, lubricated by the soft and slippery clay of the underlying Tiburon melange. Rainwater accumulates in fractures in the serpentine and makes its way down to the contact between the serpentine and the clay. Putting water along this contact zone is like putting wax on the runners of a ski.

Soils formed from serpentine are characterized by anomalous plant life. This is due to the composition of serpentine. Serpentine is mainly an iron and magnesium silicate. There is almost no aluminum, so no clay soil is formed and the soil is thin and gravelly. The serpentine also has toxic amounts of magnesium, nickel, chromium and cobalt, and is low in plant nutrients such as potassium, sodium, calcium, and phosphorus.

Most common plants avoid serpentine. However, a few hardy and specialized plants thrive under these conditions. Some of the unusual plants at Ring Mountain include Tiburon Indian paintbrush, Oakland Star tulip, and the very rare Tiburon Mariposa lily, whose only natural occurrence is at Ring Mountain. The Tiburon Mariposa lily is abundant at Ring Mountain and is found especially among the blocky serpentine boulders and outcrops where there are springs and where the lily is protected from grazing. The plant is about two feet high and blooms in May and June with cinnamon-and-yellow flowers.