

A CRACK SPREADS ACROSS CALIFORNIA — 25 MILLION YEARS AGO

About 65 million years ago, the tectonics of the North American western margin (coastline) between Northern California and Baja, Mexico began a radical change. Prior to that date, it had been a convergent plate boundary, with an active subduction zone. By about 65 million years ago, the Farallon plate had entirely subducted under the North American plate, which was now overrunning a seafloor spreading center. The plate boundary began turning into a transform boundary separating the Pacific and the North American plates. Over the next 35-40 million years, this transform plate boundary developed into the **San Andreas Fault System (SAFS)**. Now the SAFS accommodates transform motion that connects seafloor spreading centers off Northern California and in the Gulf of California.

The San Andreas Fault is the main fault within the SAFS. It can be clearly traced through many parts of California. It is a right-lateral transform fault, which means that if you imagine standing on either side of the fault and looking across to the opposite side, it seems to you that the people and objects on the opposite side are moving to your right. The SAFS separates two halves of continental crust, one embedded in the North American plate, the other now part of the Pacific plate. The North American Plate side is moving south, and the Pacific Plate side is moving north. Los Angeles sits on the Pacific Plate. San Francisco sits on the North American Plate. About 25 million years in the future, if movement continues in the same direction, Los Angeles will be a suburb of San Francisco (or vice versa). Although these plates mostly slide past each other, there is still a small amount of compression and hence crustal uplift between them.

Movement along the SAFS occurs at an average rate of 5 cm/yr (about as fast as your fingernails grow). Instead of a continuous movement, however, stress usually builds on locked segments of the fault, until it reaches a breaking point, when the built-up energy is released in a sudden earthquake. Historic evidence shows that the SAFS experiences a magnitude 8 or larger earthquake every 50 years or so, somewhere along its 500-km length.

Within the San Francisco Bay Area, two large strands of the SAFS are the Hayward Fault in the East Bay (it lies along the western edge of the East Bay Hills) and the San Andreas Fault in the West Bay (it lies along the eastern edge of the Santa Cruz Mountains). The small amount of compression associated with these faults is the cause of these coastal hills. The San Andreas Fault leaves the coast at Mussel Rock south of Fort Funston. It hits land again north in Bolinas, where it cuts across Point Reyes and then goes back offshore.



Plate Tectonic map of the western margin of North America. Notice that the San Andreas Fault connects offset portions of the Juan de Fuca ridge to the north with offset portions of the East Pacific Rise in the Gulf of California (or Sea of Cortez). There is still active subduction of the Juan de Fuca Plate in Northern California, Oregon, and Washington. In California, the San Andreas Fault System cuts through the continental plate, transferring some of the continental crust to the Pacific Plate, which is moving north towards Alaska and the subduction zones of the Aleutian Islands. © Prentice Hall Publishing

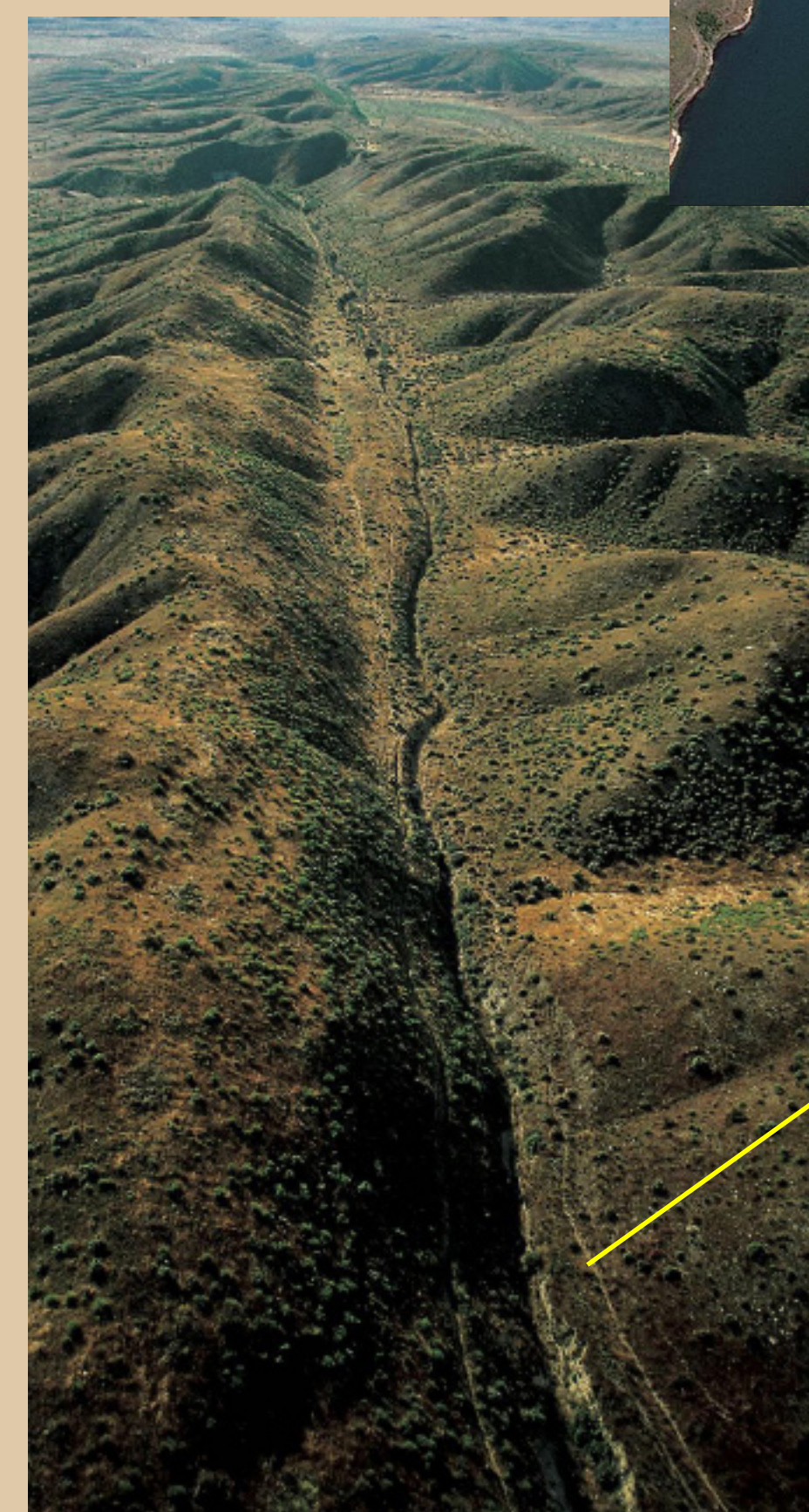
Images of the San Andreas Fault as it cuts across California



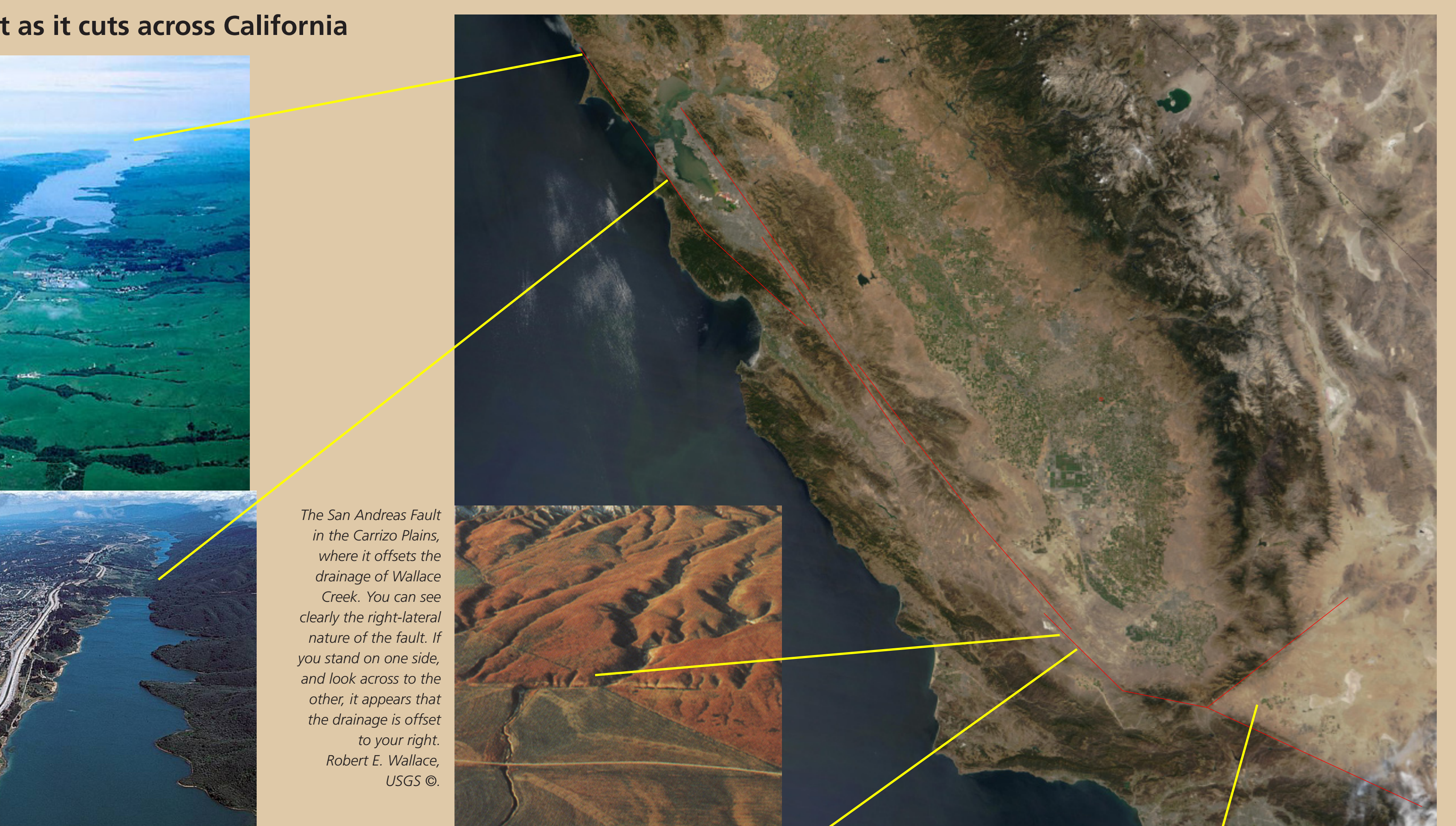
Tomales Bay — North of San Francisco along Highway 1 (the image looks north). Tomales Bay has the shape it does because it has formed along the fault (waves have easily eroded the fault-gauged sediments). © Prentice Hall Publishing



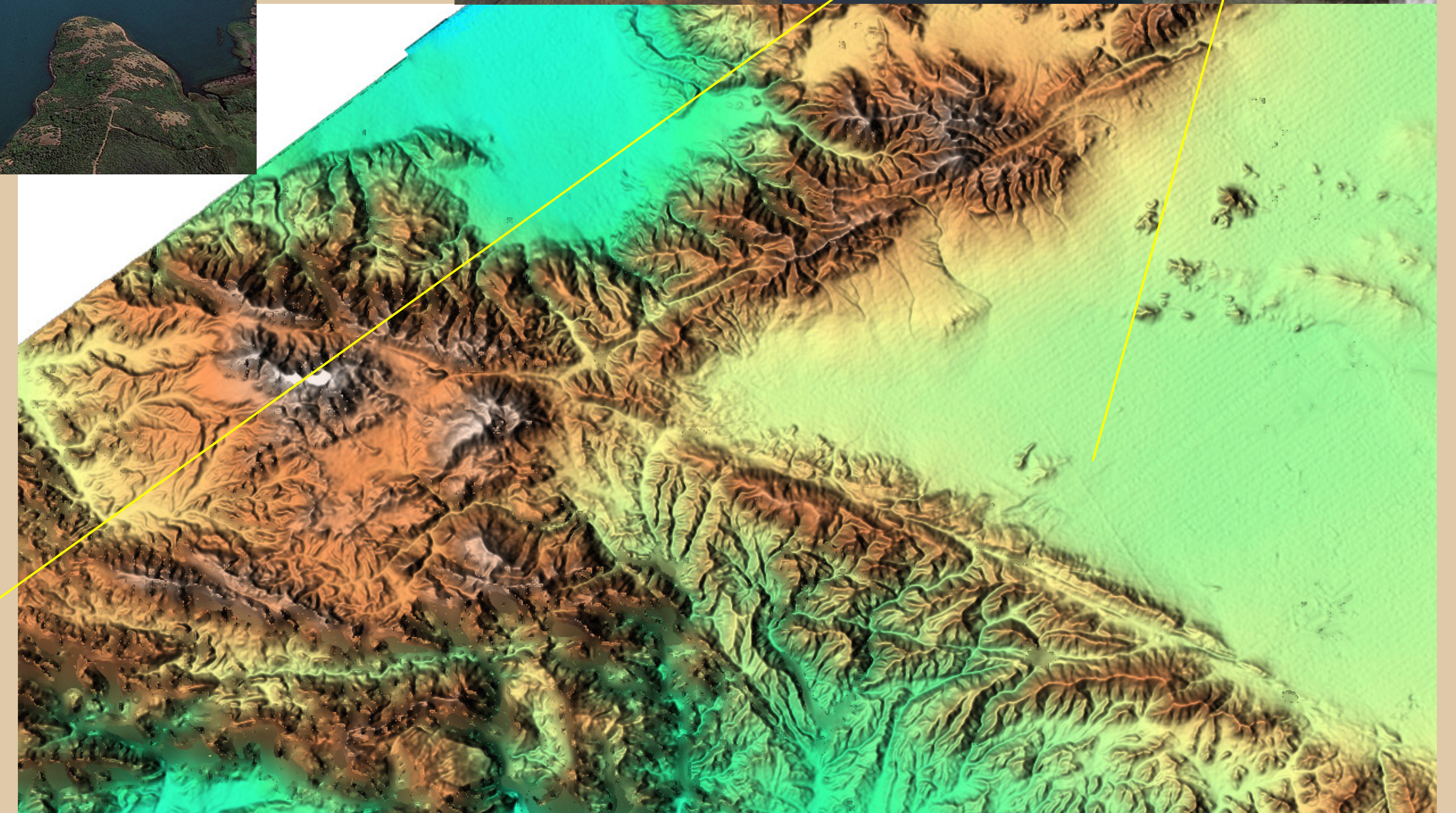
Crystal Springs Reservoir — just south of San Francisco and west along Highway 280 (the image looks south). The reservoir formed here along the fault trace in a small depression formed by fault movement. © Prentice Hall Publishing



The San Andreas Fault cuts through the Temblor Mountains at the edge of the Carrizo Plains and leaves this deep scar. © Yann Arthus-Bertrand.



The San Andreas Fault in the Carrizo Plains, where it offsets the drainage of Wallace Creek. You can see clearly the right-lateral nature of the fault. If you stand on one side, and look across to the other, it appears that the drainage is offset to your right. Robert E. Wallace, USGS ©

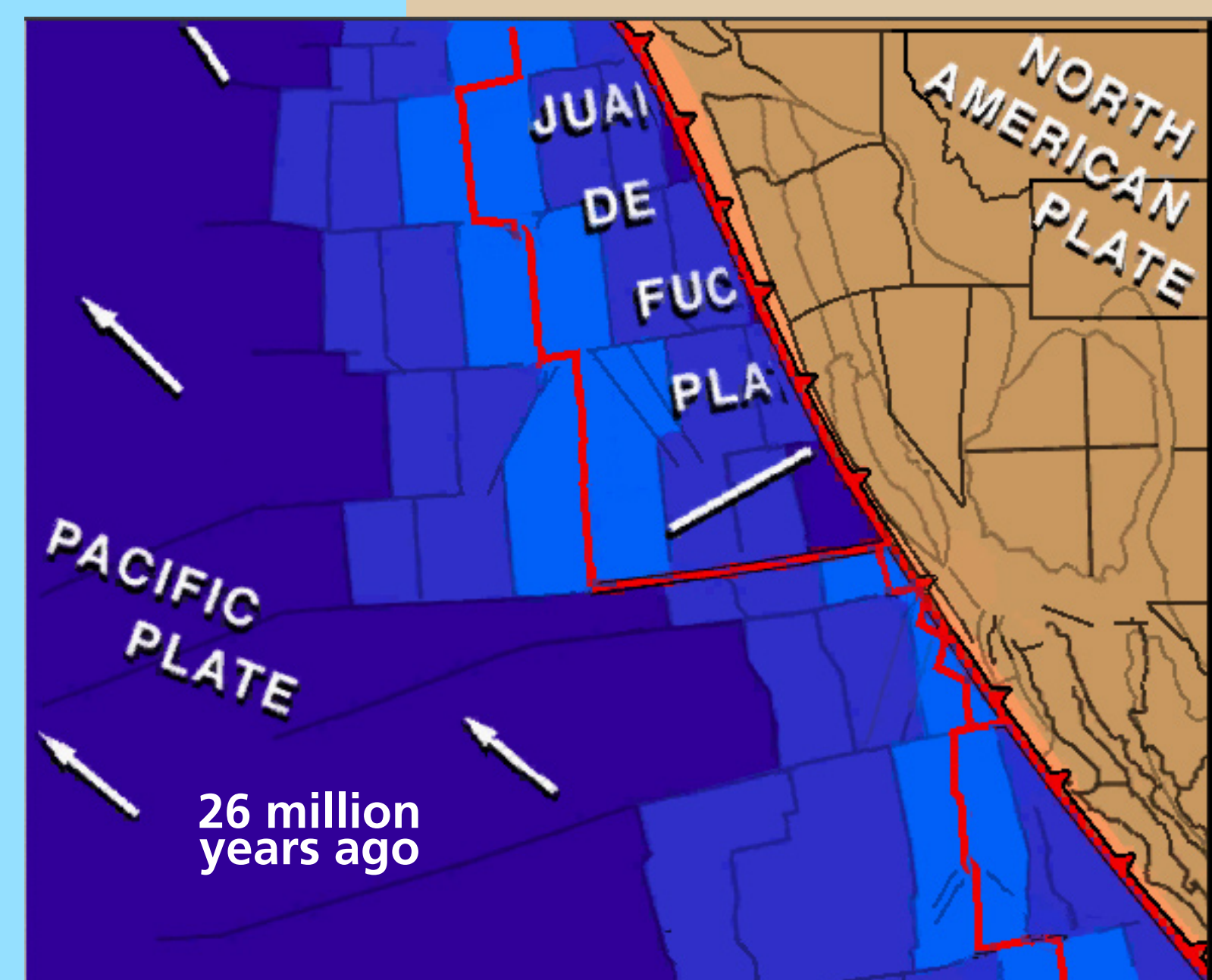


Satellite image of the Mojave Desert. The San Andreas Fault takes a huge bend east here, creating the southern border of the desert and heading toward the Salton Sea. The Garlock Fault meets the San Andreas at about a 30 degree angle and creates the northern border of the desert. (Look for the < pattern in the image.) Header image: San Andreas Fault as it cuts across the San Francisco peninsula, the Golden Gate entrance to San Francisco Bay, and Point Reyes. USGS.

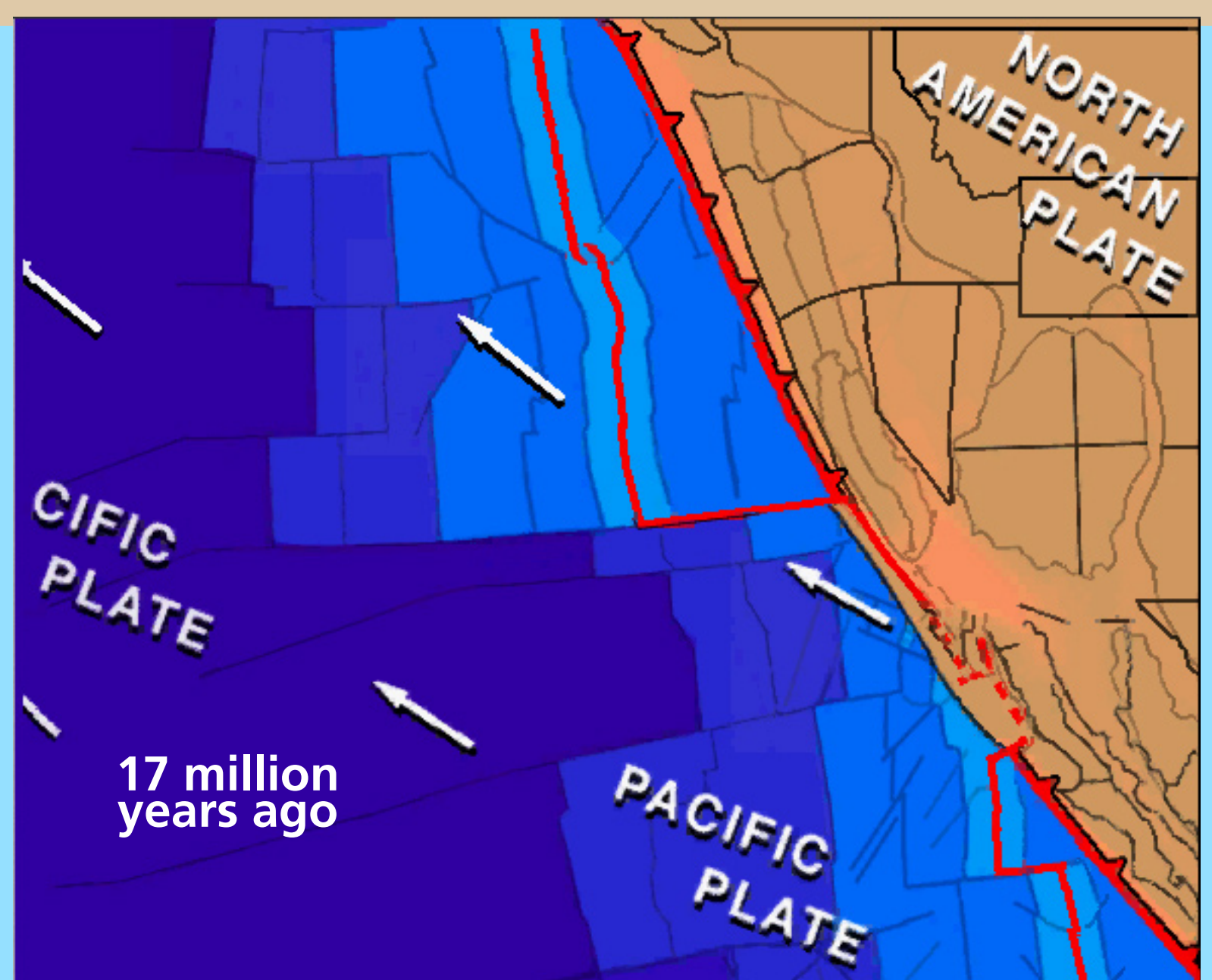
Time-lapse images of the formation of the San Andreas Fault



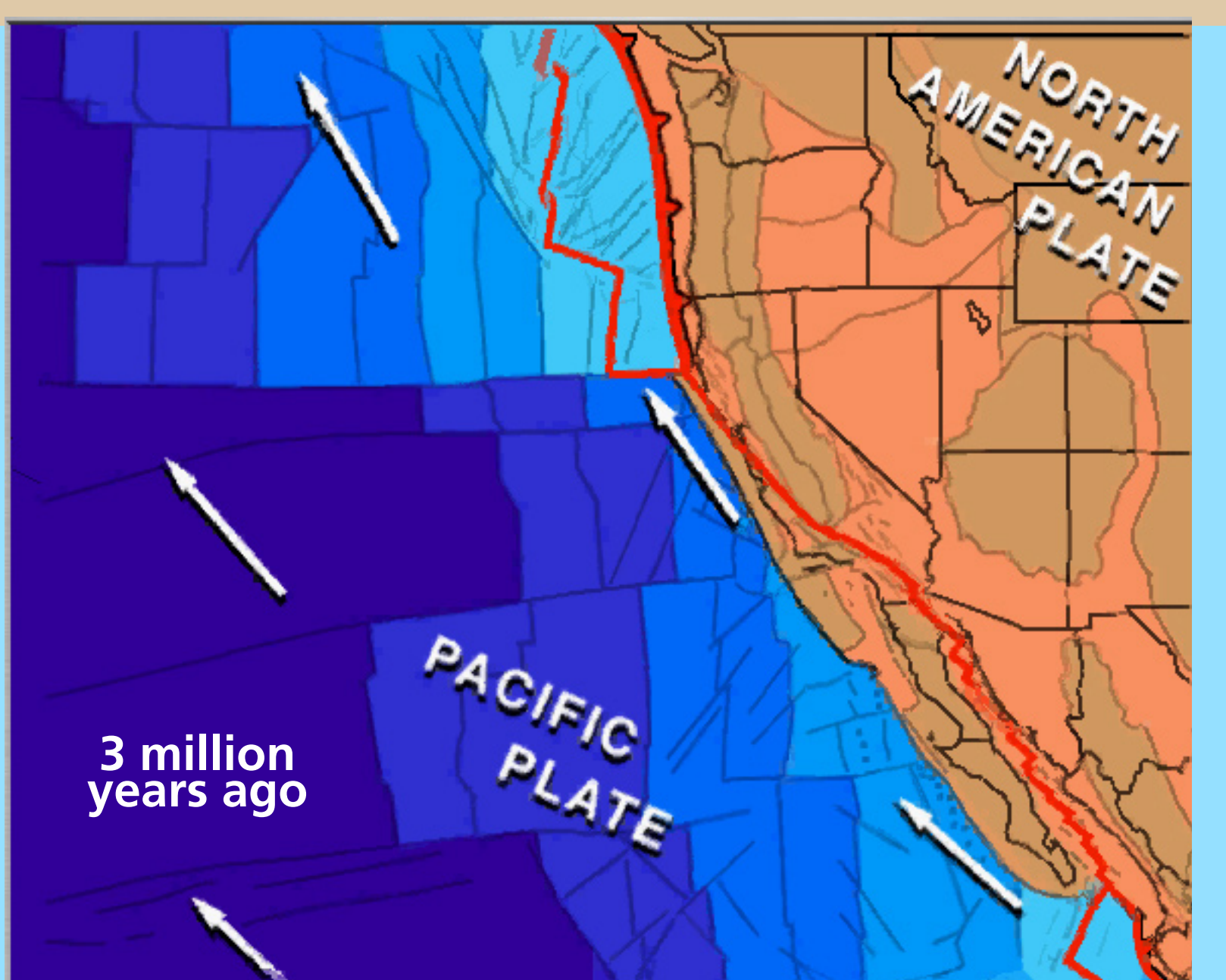
38 Million Years Ago — The East Pacific Rise (shown in red) is an offshore spreading center where new ocean crust is forming. Once the new crust forms, it is pushed both east and west away from the center. The ocean crust that moves east is part of the Farallon Plate and where it collides with the North American Plate, it sinks into the Franciscan subduction zone. Sediments and islands on the subducting plate are scraped off and accreted to the edge of North America, creating an assemblage of rocks known as the Franciscan Assemblage Terranes. The entire spreading center is slowly getting closer and closer to the North American plate, where the entire center will eventually subduct. © U.C. Santa Barbara



26 Million Years Ago — The East Pacific Rise spreading center reaches the Franciscan subduction zone. Subduction stops where the Pacific plate enters the subduction zone because the Pacific plate is moving away from the subduction zone. Part of the North American plate attaches to the Pacific plate and begins to move northwest. It is at this point that the subduction zone begins to change into a transform plate boundary to accommodate the motion of the offset spreading centers that still exist to the north and south. The San Andreas fault forms and becomes the boundary between the Pacific and North American plates. The western edge of the fault moves north with the Pacific plate at about 5 cm/yr relative to the rest of North America. © U.C. Santa Barbara



17 Million Years Ago — Baja, California in Mexico is broken off the mainland and transferred to the Pacific Plate. The East Pacific Rise begins opening up the Sea of Cortez. © U.C. Santa Barbara



3 Million Years Ago — The East Pacific Rise has opened up the Sea of Cortez and Baja, California has migrated north along with the Los Angeles Basin. © U.C. Santa Barbara