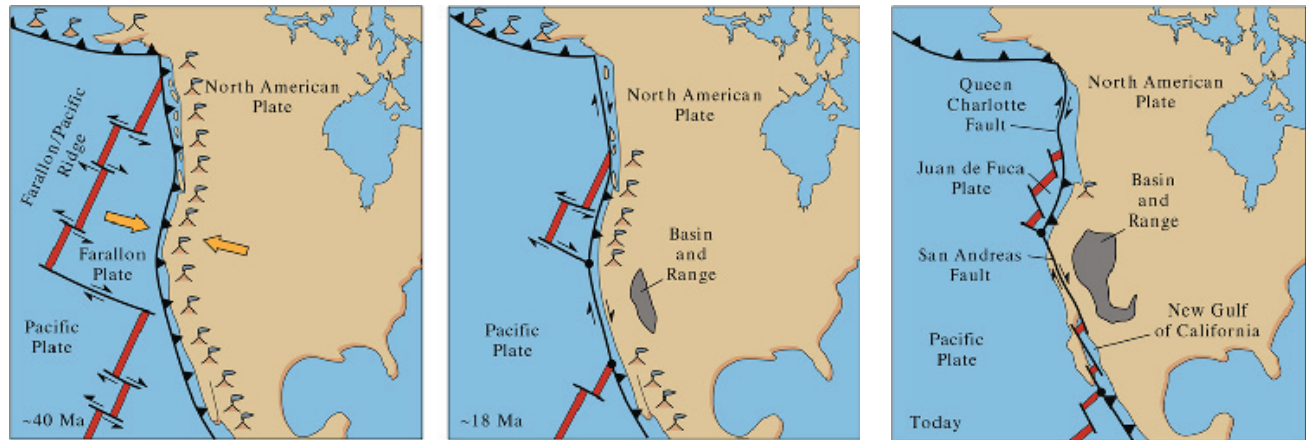


# ERTH15 Beach Walk Summary (November 2006)

## General Geotectonic Setting

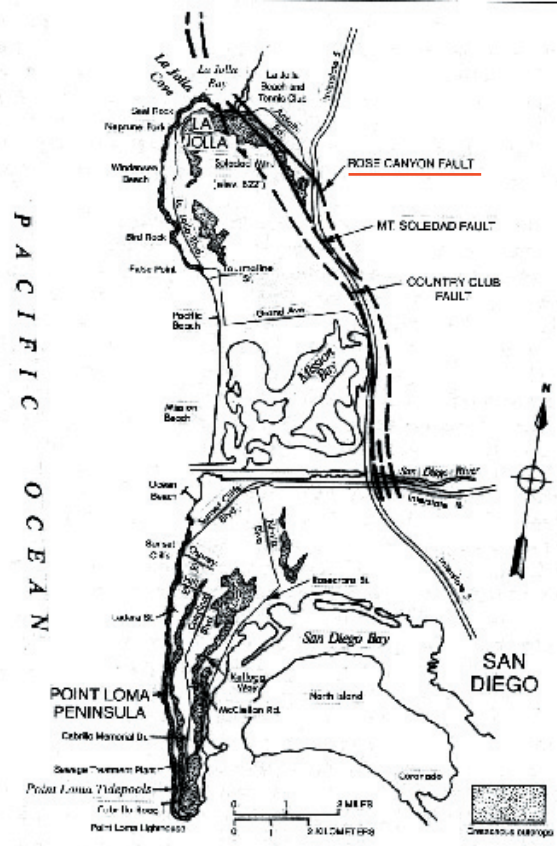
- 40 Mio yrs ago, San Diego was on the North American Plate. It was below sea level on the continental shelf and slope and faced the subducting Rivera Plate (whose trailing parts are now further south)
- 18 Mio yrs ago, San Diego was still on the North American plate facing the subduction of the Rivera Plate but further north, subduction was replaced by a strike-slip environment. The Gulf of California/Sea of Cortes opened, bringing Tertiary volcanism to the county and causing San Diego to jump plates.
- Today, San Diego is on the Pacific Plate and moves northward relative to the rest of the continent.



from: "Earth, Portrait of a Planet" by Stephen Marshak

## La Jolla, South of the Pier

The Rose Canyon Fault is one of San Diego's active faults. The Rose Canyon Fault is partially hidden beneath the city's sediments so its total length is unknown. It can be traced from north of San Diego Bay along I-5 before it turns northwest and goes offshore just north of Mt. Soledad by the La Jolla Beach and Tennis club. The RCF continues for at least 25km. Trench work revealed that there has been about 1-2mm/yr of right-lateral slip throughout the last 8000 years. We don't know if this slip occurred during many small earthquakes or a few large earthquakes due to poor historical records. There were two large magnitude 6 (or greater) events in 1800 and 1862 which could have happened on the RCF or one of the faults off-shore.



## La Jolla Shores

The buildings of La Jolla shores sit on the floodplain of a (long-gone river) in the San Clemente Canyon (SR-52). The sediments of La Jolla Shores carry large amounts of water, making it susceptible to liquefaction during an earthquake on the RCF. Other areas prone to liquefaction are Mission Bay and Lindbergh Field airport.



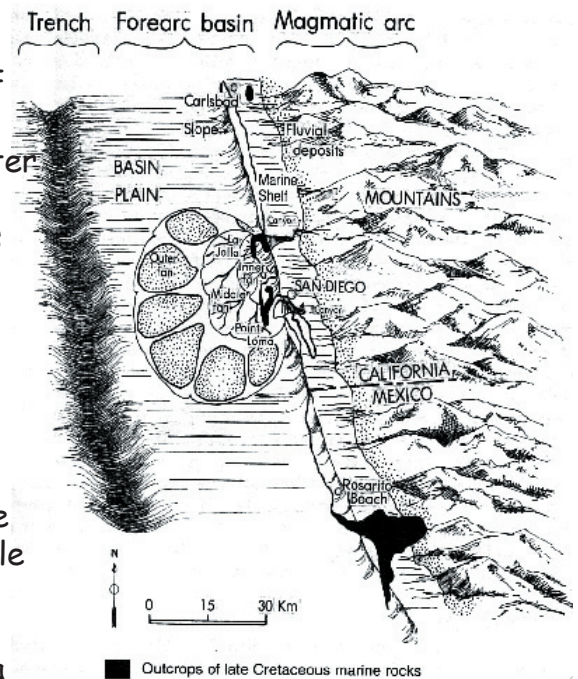
La Jolla Shores 1930 viewed from Mt. Soledad

## Ancient Geological Environment in La Jolla

In ancient geologic times, the coastal strip in front of San Diego's mountains was quite narrow and most of La Jolla was located either on the shelf in shallow water or down the slope. On a submarine fluvial (river) fan. So most of the sediments found along La Jolla's cliffs are submarine in origin.

## The Sediments along Scripps Beach

The sediment profile of San Diego's sediments is quite complicated but only two sedimentary layers are visible along the Scripps beach. The lower one is the 50Mio year old Ardath shale, a fine grained (much finer than sand) greyish rock. At the Scripps beach, it reaches a few m above the beach sand, while at Blacks beach it reaches higher into the cliffs. The Ardath shale was deposited in a quiet marine environment either on the shelf or near the end of a submarine fan where small particles were able to settle. Above lie the sandstones of the slightly younger (47Mio yrs) Scripps formation. The sandstones were deposited on the submarine fan, some of it in a relatively quiet environment (horizontal layering) but most along the Scripps and Blacks beach in a turbulent high-energy environment such as a submarine canyon. The geometry of the canyon may have changed over time and the river changed its delta, cutting into already formed horizontal layers. The corresponding cliffs are very unstable.



from:  
"The Rise and Fall of San Diego County"  
by Patrick Abbott

## The Unstable Cliffs of Scripps Beach

There are numerous factors that contribute to the relatively quick retreat of La Jolla's cliffs.

- 1) The Ardath shale is a relatively weak layer that erodes more easily than the Scripps Sandstone above. Waves pounding at the cliff therefore cut into the Ardath shale causing undercuts. The overhanging cliff eventually loses its support and fails, causing a rock fall. Earthquakes pose an added risk because they can trigger such rock falls.
- 2) The Scripps sandstone is much more permeable to rain than the Ardath Shale. Water therefore easily penetrates through the sandstone but then accumulates on the Ardath Shale. The boundary between the two formations serves as a glide horizon for the mass above. The water lubricates this glide horizon increasing the risk for slumps. Slumping happens quite often and some can be quite large. The Torrey Pines slide in 1949 was 600m long.
- 3) In addition to rain irrigation also adds to the risk of slumps. In fact, there are quite a few cases of houses near cliff edges along Scripps and Blacks Beach that lost their backyards (or some of it) during the "dry" season.
- 4) The cliffs are relatively bare of vegetation that could prevent near-surface erosion. During every rainstorm, a little bit of cliff is therefore carried away by rain.
- 5) On a small scale but not to be neglected animal activity such as burrowing squirrels also contribute to cliff erosion.
- 6) The U.S. Marine Fisheries Building (three-story concrete building at the end of Scripps Beach) sits on a fault. Numerous slumps have occurred on the cliff just west of the building and the cliff is retreating at an alarming rate. It is only a matter of time that parts of the building slides down the cliff.

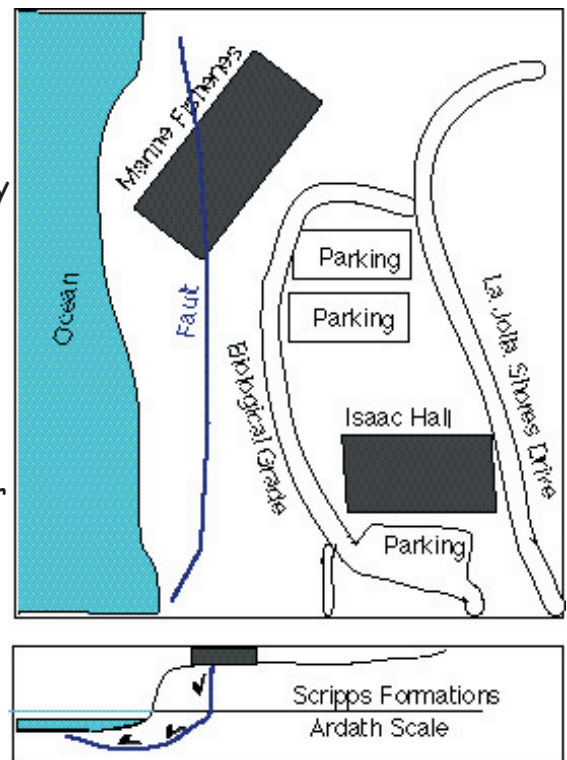
## La Jolla Shores, Ocean Currents and the Seasons

Unlike other beaches in San Diego county (e.g. Coronado Beach), the beaches just north of La Jolla do not have to be replenished with sand. The California Current that flows south along the shore deposits the sand at Blacks (just north of Scripps), Scripps and La Jolla Shores beaches before it gets diverted westward down along a submarine canyon (west of the La Jolla Beach and Tennis Club). In seafloor maps, the canyon can be traced into the San Diego Trough, 40 km off-shore. There, a new, large sediment fan is forming. The sand on Scripps beach comes with the long-shore drift, a process that transports the sand in a saw-tooth fashion. Waves come in obliquely from the north, bringing the sand. They go out perpendicular to the beach, taking out the sand, come back in obliquely, and so on. Sand coming from the north, is dumped in northern river estuaries (e.g. San Diego River) and picked up by the California Current.

In winter, great storms coming from the north, create large surf with strong waves taking the sand off-shore. These waves are stronger than the California Current so the latter cannot replenish the lost sand. In some winters with heavy storms, Scripps beach gets stripped completely of its sand which returns in the following spring. The last such winter was the El Niño winter of 97/98.

## How can We Protect the Cliffs?

- 1) Boulders (rip-rap) in undercuts reduces some of the energy with which waves pound at the cliffs (seen at the beach beneath IGPP).
- 2) Seawalls (a few m high but some are substantially higher) protect the houses behind them because they also prevent undersuts (e.g. Hubbs Hall and houses along Paseo Grande).
- 3) Buildings like the U.S. Fisheries needs proper anchoring in the rocks beneath (if at all possible).
- 4) Deep-rooting vegetation slows down surface erosion.
- 5) A better control of backyard irrigation, together with adequate landscaping (i.e. no plants that need a lot of water).



## The Controversy On Building Seawalls

Lately, the seawalls in Solana Beach and along other stretches of the local beaches have been a point of heated discussion. Some want to protect the cliffs with seawalls, while some do not want them. Proponents of the seawalls are mainly residents with houses near the cliff tops. Opponents argue that the beach is eventually strips of its beach sand. Recent studies suggest that local beaches get only about 50% of their sand from rivers further north through the California Current. The rest comes from local cliff collapse. Seawalls that protect the cliffs would cut off this source of beach sand.

Also, seawalls are only temporary fixes. Seawalls protect cliffs from the direct impact by waves but the waves start to erode the beach near the base of the seawalls, especially during strong storms when the surf is high. At the same time, the beach has not had its supply of local sand from beach collapse so the beach sand has also diminished. Eventually, the seawalls lose their support and need to be replaced.