Our Ocean Backyard — *Santa Cruz Sentinel* columns by Gary Griggs, Director, Institute of Marine Sciences, UC Santa Cruz.

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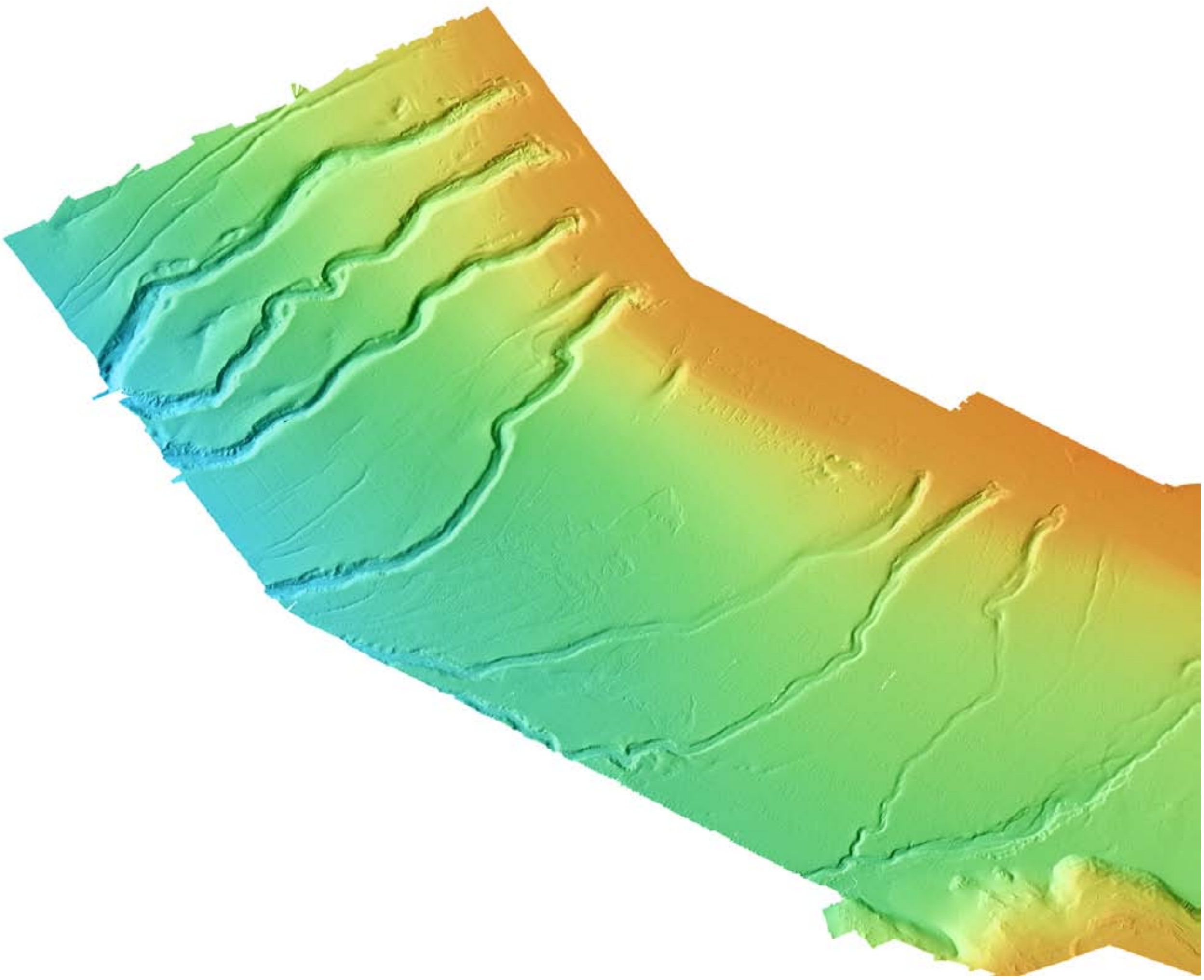
Why submarine canyons?



The continental slope along the coast of west of Santa Barbara is cut by a series of parallel submarine canyons.

In 1929, there was a large earthquake in the Grand Banks area off Nova Scotia that provided the evidence need to confirm the existence and ultimately, the importance of turbidity currents to submarine canyon formation. Hard to believe, but in 1929 we had no cell phones or satellites to relay phone calls, so long underwater cables had been strung along the seafloor to connect phone lines in North America with Europe. In the minutes immediately following the earthquake there was a welldocumented cut-off in communications as these cables progressively failed proceeding down slope away from the earthquake's epicenter. It appeared to the scientists who studied these cable failures that a flow of sediments along the sea floor, or turbidity current, had been generated by the earthquake and had sequentially broken the telephone cables as it progressed down slope to the deep sea. The confirming evidence was obtained when oceanographic vessels subsequently cored the sea floor in the area and found graded sands at the surface as evidence of the passage of the turbidity current.

Putting together these and other observations has produced a coherent picture of how submarine canyons have formed. It turns out that both terrestrial and underwater processes are involved. We need to have at least a portion of the continental shelf exposed to initiate the cutting of a submarine canyon, which happens where a river discharges. As sea level drops during a glacial period, the shoreline retreats and the river continues to erode its channel across the shelf in order to reach the ocean. At least half of all of the submarine canyons studied lie directly offshore from rivers, providing good evidence for the role of rivers in the initiation of many submarine canyons.

With each rise in sea level, the river retreats back across the shelf where it discharges at the new shoreline. With the next drop in sea level, the river will again work its way across the shelf, further deepening its channel. The river's sediment load will now be discharged at the outer edge of the shelf where it will accumulate until it becomes unstable, and then, either from an earthquake or some other mechanism, the sediment will cascade down the steeper continental slope as a turbidity current. Abrasion by the coarser sand and gravel will gradually deepen the canyon, while the finer silt and clay may be deposited along the banks of the canyon as natural levees, similar to a river in flood stage. Thus a submarine canyon can grow by both eroding its channel downward, and by constructing natural levees upward.

An essential process maintaining those submarine canyons along the California coast today is the active transport of littoral sand from the beaches into the canyon heads. Most of California's littoral cells terminate in submarine canyons. As waves from the northwest drive littoral drift southward, the sand at the end of each cell is carried offshore into the head of a submarine canyon. Hundreds of thousands of cubic yards of beach sand is funneled down into each these canyon heads every year, to ultimately be carried by turbidity currents down to the deep sea floor 10,000 to 12,000 feet below.