

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

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Peeling back the layers



The Grand Canyon exposes over a billion years of Earth history in its walls.

Nearly twenty years ago I was on a raft trip down the Grand Canyon of the Colorado with my good friend and local historian, Sandy Lydon. The trip was a non-commercial adventure, run by another good friend, local geologist Jerry Weber. Private trips get non-prime time, which in this case meant departure on the 1st of April, and one of the unplanned consequences of leaving that early in the season is that it was snowing during our departure from Lee's Ferry. Interesting things happen when geologists, who tend to think in terms of millions of years, hang out with historians, who tend to think of a few to perhaps several hundred years.

The Grand Canyon provides an exceptional exposure of about two billion years of Earth history that are recorded in the walls of the canyon. Much of the limestone, sandstone and shale exposed in the 5000-foot deep canyon was deposited in an ancient ocean many hundreds of millions of years ago. This region of the Earth wasn't stable throughout this entire period of time, however, and as a result, after sediments filled an ancient ocean, the crust was uplifted or raised by tectonic forces, and erosion took place. The same thing is happening in the Santa Cruz Mountains today every time it rains. The marine sandstones and shales you see exposed in road-cuts along Highway 17 as you commute to work, are gradually being eroded and carried down hill, through the creeks and rivers, to be deposited offshore on the seafloor of Monterey Bay.

While the Earth is about 4.6 billion years old, there is no known place on Earth where sedimentation has been continuous throughout geologic time. Periods of relative stability of the Earth's crust are interrupted by tectonic uplift or subsidence. During the formation of a continent, large sections of the crust are raised out of the shallow seas in which the sedimentary rocks were deposited, subject to erosion, and then often subside again below sea level where deposition of sediment begins again. Activity of this sort produces a buried erosional surface, with older rocks below that are covered with younger sediments. These erosion surfaces, which are called *unconformities*, separate rocks that may be vastly different in age depending upon how much time elapsed between the erosion of the older rocks and the subsequent deposition of younger sediments. We can see this process exposed locally in the seacliffs along West Cliff Drive. The mudstone and sandstone of the Purisima Formation exposed in the cliffs is about 3 to 5 million years old, but is capped or overlain by 5 to 10 feet of sands and gravels that are only 100,000 years old.

When geologist and one-armed Civil War veteran Major John Wesley Powell first ventured down the Grand Canyon with 10 men and 4 boats in 1869, one of the important observations he made was of what he named the *Great Unconformity*. He discovered a section of the canyon where there was a 600 million year gap between the sedimentary rocks below and above the unconformity. Sandy Lydon, a responsible historian, who feels the need to account for every year of the historical record, nearly fell out of the boat when this section of lost geologic time was explained. "How can you geologists just leave out 600 million years of history? And you call this a science?"