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Geology 41

Instructor Wiese

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Submarine Canyons

Under the ocean there is a different world compared to the land we humans are living. The landscape underwater is spectacular meanwhile explorable. One of the features cannot be found on solid ground is submarine canyon. Submarine canyon is steep-sided, V-shaped valley that is formed at outer edge of continental shelf and continue across the slope. Meanwhile at its lower end usually leads to an abyssal fan (submarine fan), a fan-shaped, big pile of sediment lying on the sea floor. Fig 1 shows a typical submarine canyon and an abyssal fan.

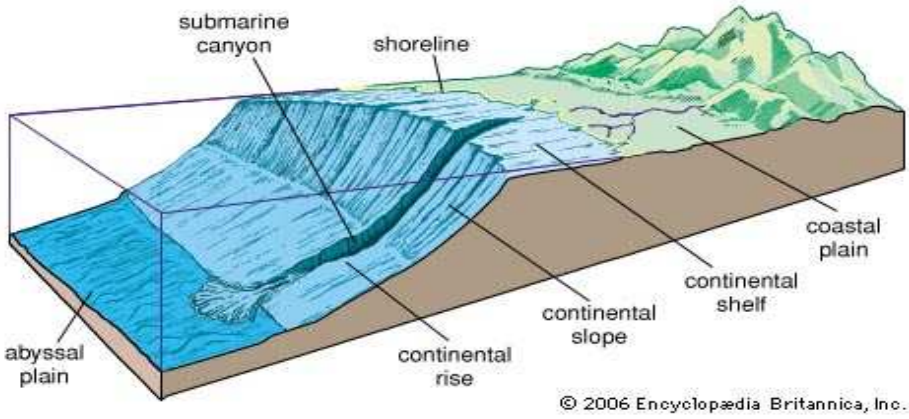

Figure 1: Continental margin: elements of the continental margin

Formation

When submarine canyons are first discovered, geologists proposed they were eroded by rivers during the Pleistocene Epoch, when glaciers started accumulated on land and lowered the sea level around 150 meters. However, this hypothesis cannot explain the deeper portions of submarine canyons that cut into lower continental slopes at depths of a kilometer or more. Therefore, submarine canyons must be formed underwater and associated with a submarine mechanism.

Geologists subsequently realized that turbidity currents are those who did the work. Turbidity currents are created when loose, wet sediment tumbles down the slope resembles a submarine landslide. The movement can be caused by an earthquake or simply by gravity on the slope when sediment overloads. Mixture of water and sediment is denser than water, it flows down the shelf and slope like a turbulent. A turbidity current can reach a speed greater than 100 kilometers per hour and a distance up to 700 kilometers. With this speed and range turbidity current has tremendous erosive power. Once a turbidity current cut a crack into the shelf and slope, the following currents could take up the chance and deepen the crack. Over time, the currents erode a submarine canyon on the shelf and slope. Turbidity currents slow down once they reach the sea floor and the sediment starts to accumulate to form the abyssal fan.

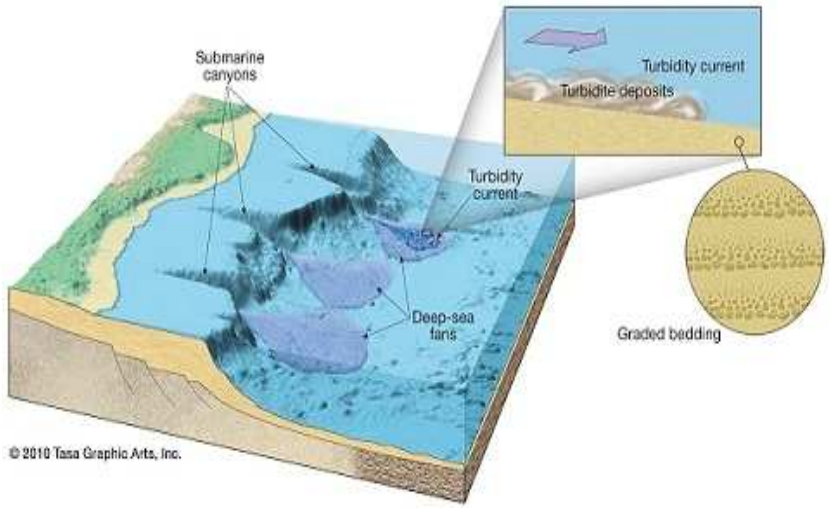

Figure 2: Turbidity Current Deposits


Figure 3: Turbidite Flow

Sand Migration

Submarine canyon plays an important role in sand migration since it is formed primarily by the mechanism of the sediment. Most submarine canyons and fans are located near the mouth of large rivers because the rivers provide large amount of sediment needed to generate turbidity currents, which also explains where does the sand from the river travel after it reach the mouth of a river. The arrows in figure 4 next page demonstrate a fine movement of sediments when they leave the river.

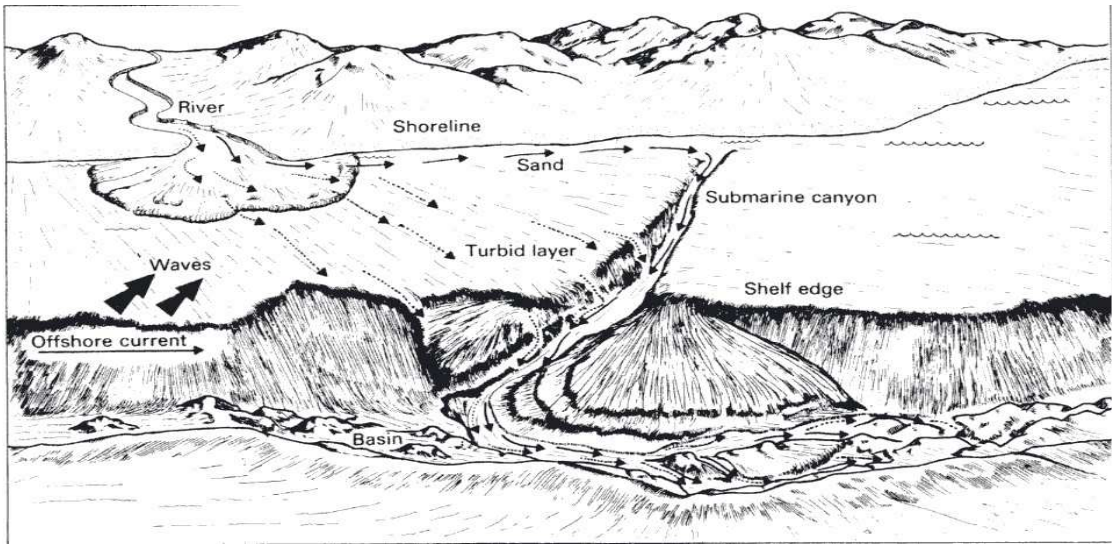

Figure 4: Sediment Movement

The sediments travel along the coastline to the right because of the wave. Notice the wave is not striking the coast perpendicularly (and true for almost all coastal waves, they approach zigzag to the coast), the sediments thus are brought to the right along the coastline which is called longshore drift. The drift is then ceased by a headland or groynes made by man, the sediments are forced to deposit on continental shelf and slope. As they deposit, turbidity currents can be formed and so do submarine canyons. Finally they will reach the abyssal fan and accumulate.

Submarine Canyons near San Francisco

One of the submarine canyons near San Francisco would be the Monterey Submarine Canyon.

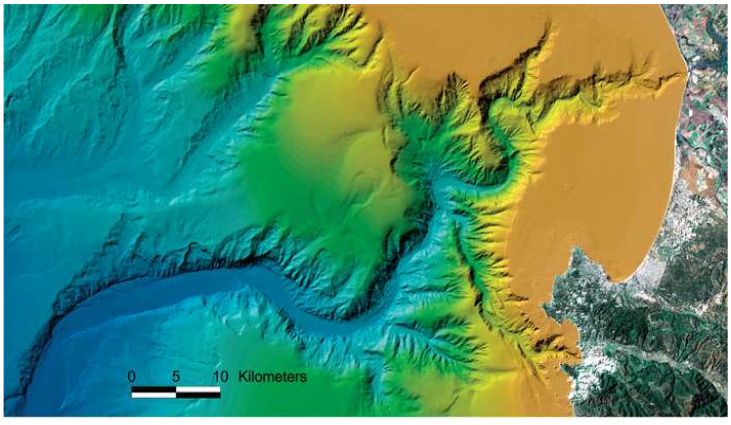

Figure 5: Monterey Submarine Canyon

Figure 6 shows the longshore drift direction along California coast which is going South. It leads to the other submarine canyons in Southern California: the Hueneme canyon, Santa Monica canyon and Redondo canyon. Figure 7, 8 and 9 show the location of them.

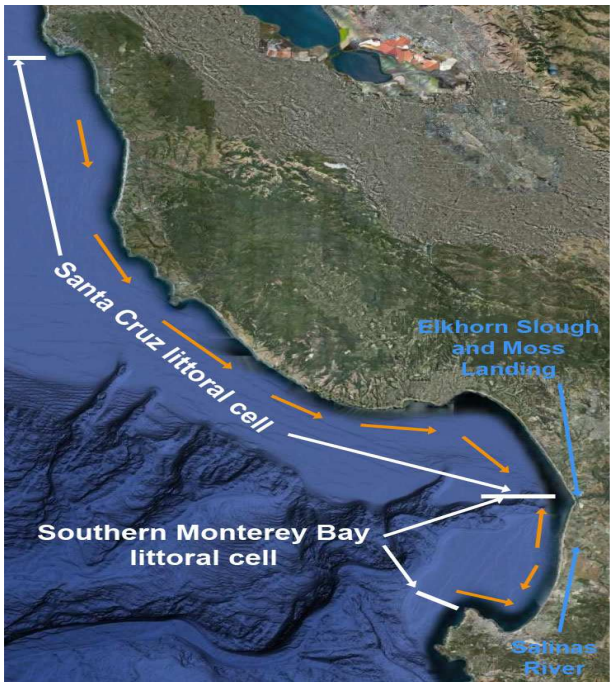

Figure 6: Littoral Cell

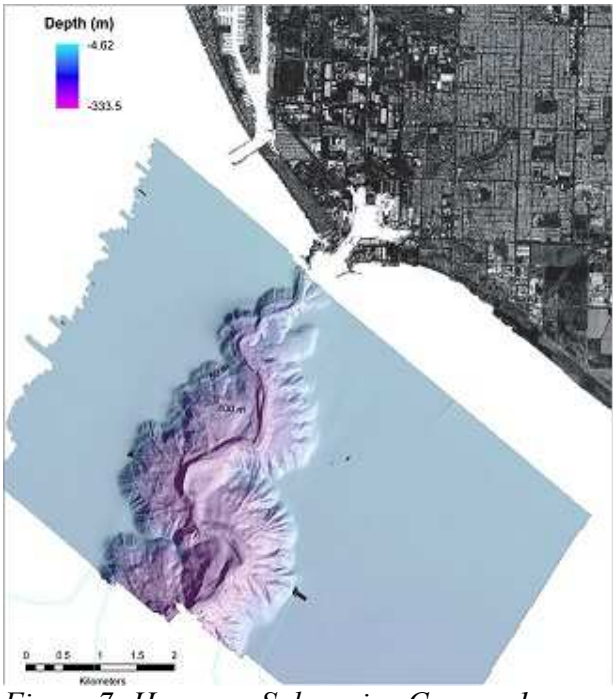

Figure 7: Hueneme Submarine Canyon 1

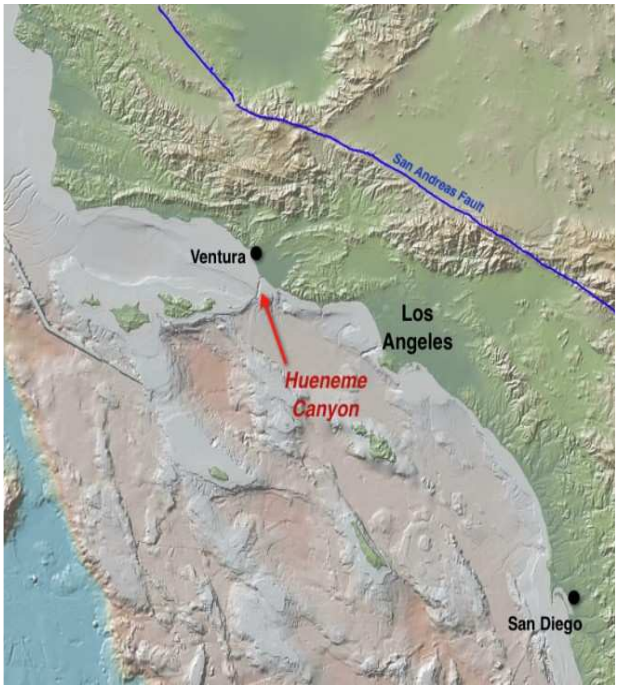

Figure 8: Hueneme Submarine Canyon 2

Figure 9: Santa Monica Bay

One of the submarine canyons being mentioned in the field trip guideline is Pioneer Submarine Canyon. It is said that the sediments in the Pioneer Submarine are being brought by the longshore drift from Ocean Beach. This idea can be proven by the direction of the longshore drift which simply goes southward along the coastline. As a result the sediments deposit on the continental shelf and help contributing the Pioneer Submarine Canyon. Figure 10 shows the three-dimensional picture of the canyon.

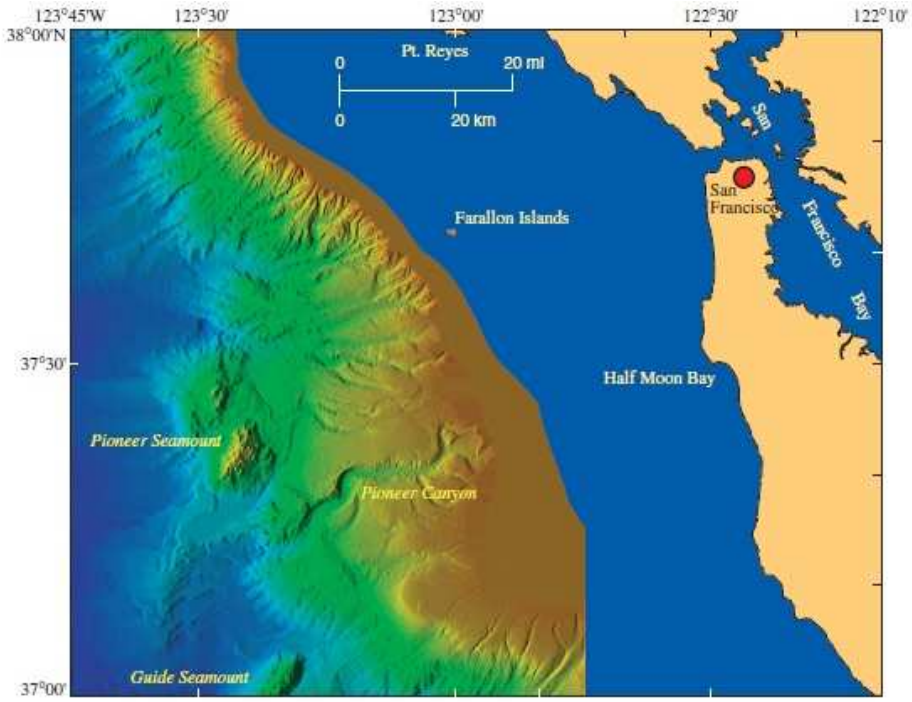

Figure 10: Pioneer Submarine Canyon

In the field trip coming up we are going to visit the beaches along the coastline. While the paper allows me to understand the transportation of sediment, I believe the trip will give me a totally different method to experience the journey of sand migration by devoting myself physically in the trip.

Pictures Credits

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