Chapter 11

Tremendous Cenozoic Continental Margin Rocks

The ocean floor can be divided into two major areas, the continental margins and the deep ocean basins or abyssal plains. The continental margins make up about 20% of the ocean floor and consist of a continuous band of mainly sedimentary rock that surrounds all continents and large islands (Figure 11.1).

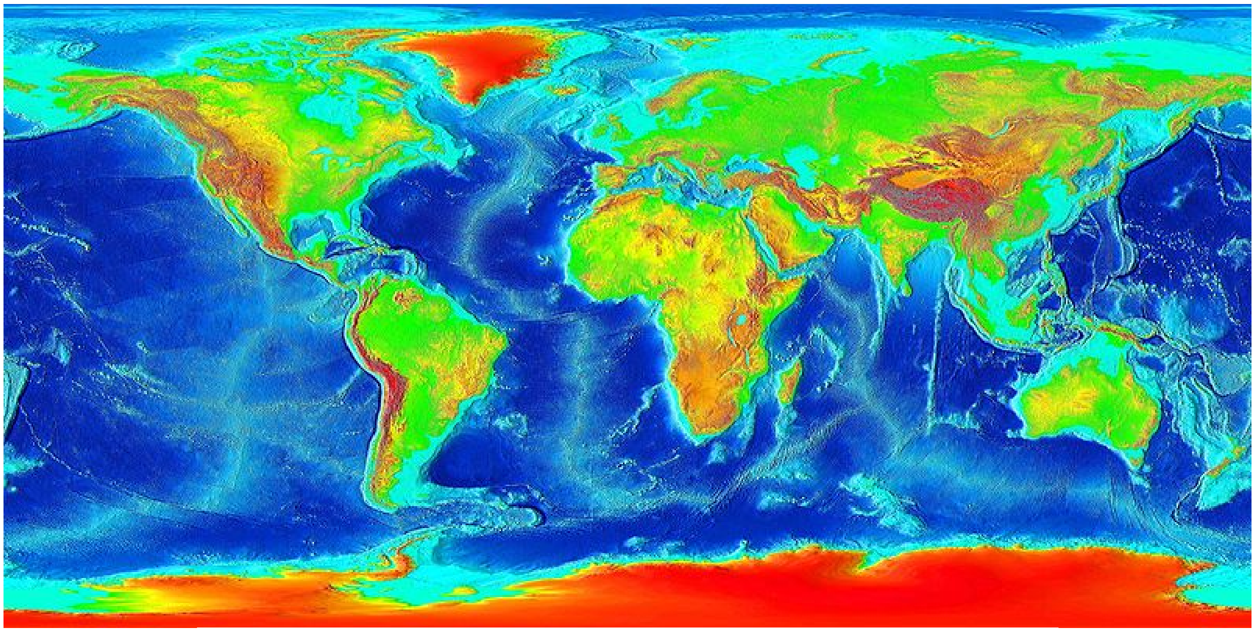

Figure 11.1. The continental margin shown in light blue (from Wikipedia).

The Characteristics of the Continental Margin

There are two types of continental margins: (1) the Atlantic type margin that is generally seismically inactive and (2) the seismically active Pacific type margin.[1] The Atlantic margins are also considered passive margins, and the Pacific margins, active. Figure 11.2 shows typical Atlantic- and Pacific-type margins.

Although there is considerable variety, continental margins consist mainly of a continental shelf and a continental slope. Atlantic margins include the added feature of a continental rise. Pacific margins usually do not possess a continental rise and the slope usually continues down into a deep-sea trench.

The continental shelf is a seaward extension of the continent, or coastal plain, from the shoreline to the shelf break or shelf edge, which is the seaward terminus of the continental shelf and the beginning of the continental slope. The continental shelf dips very gently seaward a slope of at less than 0.1°, with a subdued relief of less than 65 feet (20 m). Relief is the altitude difference between the highest and lowest points of the terrain. In other words, the continental shelf is almost flat with a very slight seaward inclination. Continental shelves continue until the

[1] Kennett, J., 1982. *Marine Geology*, Prentice-Hall, Englewood Cliffs, NJ, pp. 23–30.

edge of the continental slope at a consistent average depth of about 425 feet (130 m), except for Antarctica, which is anomalous because of the depression of the continent caused by the Antarctic Ice Sheet. The continental shelf can range from only a few miles to over 300 miles in width, such as observed off southeast Canada, the Bering Sea off Alaska, and the Arctic Ocean (Figure 11.1). The largest shelf is the Siberian Continental Shelf, 930 miles (1,500 km) wide.

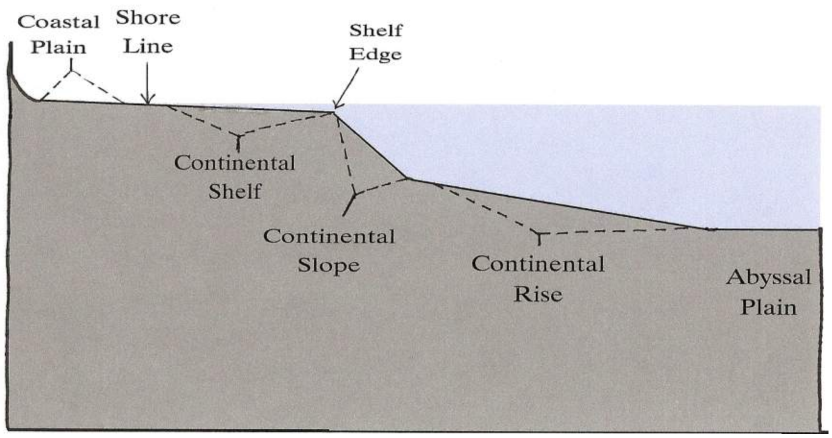

Figure 11.2a. Schematic of an Atlantic type margin (drawn by Mrs. Melanie Richard).

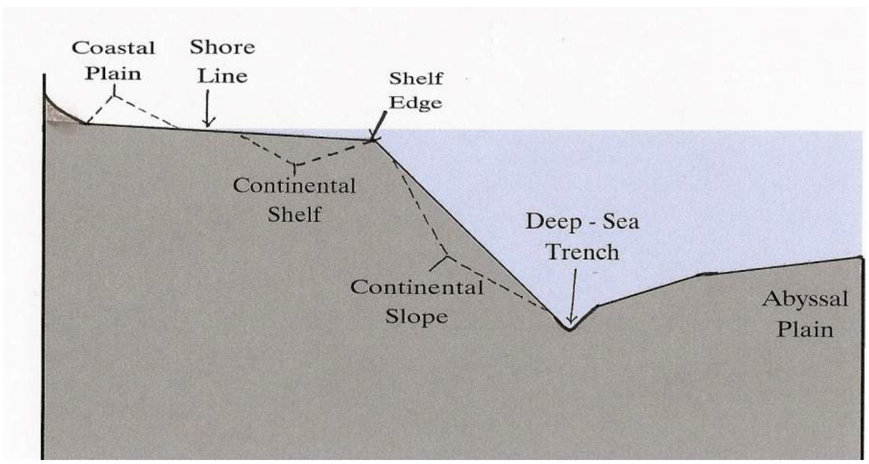

Figure 11.2b. Schematic of a Pacific type margin (drawn by Mrs. Melanie Richard).

Beyond the shelf break, the surface slope suddenly changes seaward from nearly flat to about 4° and drops from 425 feet (130 m) to depths of 4,900 to 11,480 feet (1,500 to 3,500 m). This steep slope is appropriately named the continental slope. If all the water were removed from the oceans, the continental slope would be the *most conspicuous geomorphological boundary on earth*. Continental slopes vary considerably in slope. Some can be much steeper than average with slopes of 35° to 90°. The width of these steep slopes is rather narrow compared to the width of the continental shelf. It is important to note, the wider the continental shelf, the steeper the continental slope. It is expressed as a gradual decline in slope seaward of the continental slope. The continental rise blends into the deep abyssal plains. Figure 11.3 shows the profile of a wide Atlantic type margin, including the continental rise, with a vertical exaggeration of 50/1.

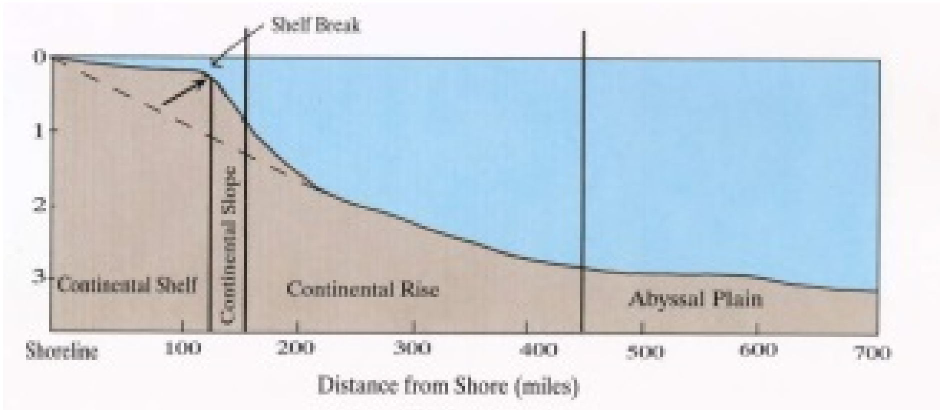

Figure 11.3. Principal features of an Atlantic-type margin with depths in miles and a vertical exaggeration of about 1/50 (drawn by Mrs. Melanie Richard). Note the dashed line, which represents the slope that should occur by normal wind driven currents in the ocean today.

The sedimentary rocks along the continental margin can be extremely thick (Figure 11.4), over 12 miles (20 km) deep in places. Near and along the continental margin there are many buried rifts or basins that were caused by extension and subsidence.

The sedimentary rocks making up the continental margin possess a generally sheet-like geometry, separated by minor unconformities, and sedimentary rocks that dip more steeply seaward (Figure 11.5). The shallowest strata on seismic profiles are generally parallel with the surface of the continental shelf, slope, and rise.[2] The dip of the sedimentary rocks is steeper where they are buried deeper.[3] Geomorphologist Lester King commented:

> We note that all the formations drilled [along the continental shelf] dip offshore. The oldest and deepest formations dip at several degrees, the youngest and upper most dip at less than one degree.[4]

Nonetheless, the seaward slope of the continental shelf sedimentary rocks is still slight, even deep within the sedimentary wedge.

Although few uniformitarian scientists address this issue, the continental shelf and slope are mysterious geomorphological features for the uniformitarian paradigm. Natural process would favor a gradual descent to the ocean depths. There really should be no continental shelf or slope, as shown by the dashed line on Figure 11.3. King described the problem:

> There arises, however, the question as to what marine agency was responsible for the leveling of the shelf in early Cenozoic time, a leveling that was preserved, with minor modification, until the offshore canyon cutting of Quaternary time? Briefly *the shelf is too wide, and towards the outer edge too deep*, to have been controlled by normal wind-generated waves of the ocean surface (emphasis mine).[5]

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[2] Uchupi, E. and K.O. Emery, 1967. Structure of continental margin off Atlantic coast of United States. *AAPG Bulletin* 51 (2):223–234.

[3] Steckler, M.S., G.S. Mountain, K.G. Miller, and N. Christie-Blick, 1999. Reconstruction of Tertiary progradation and clinoform development on the New Jersey passive margin by 2-D backstripping. *Marine Geology* 154:399–420.

[4] King, L.C., 1982. *The Natal Monocline*, second revised edition. University of Natal Press, Pietermaritzburg, South Africa, p. 45.

[5] King, L.C., 1983. *Wandering Continents and Spreading Sea Floors on an Expanding Earth,* John Wiley and Sons, New York, NY, p. 199.

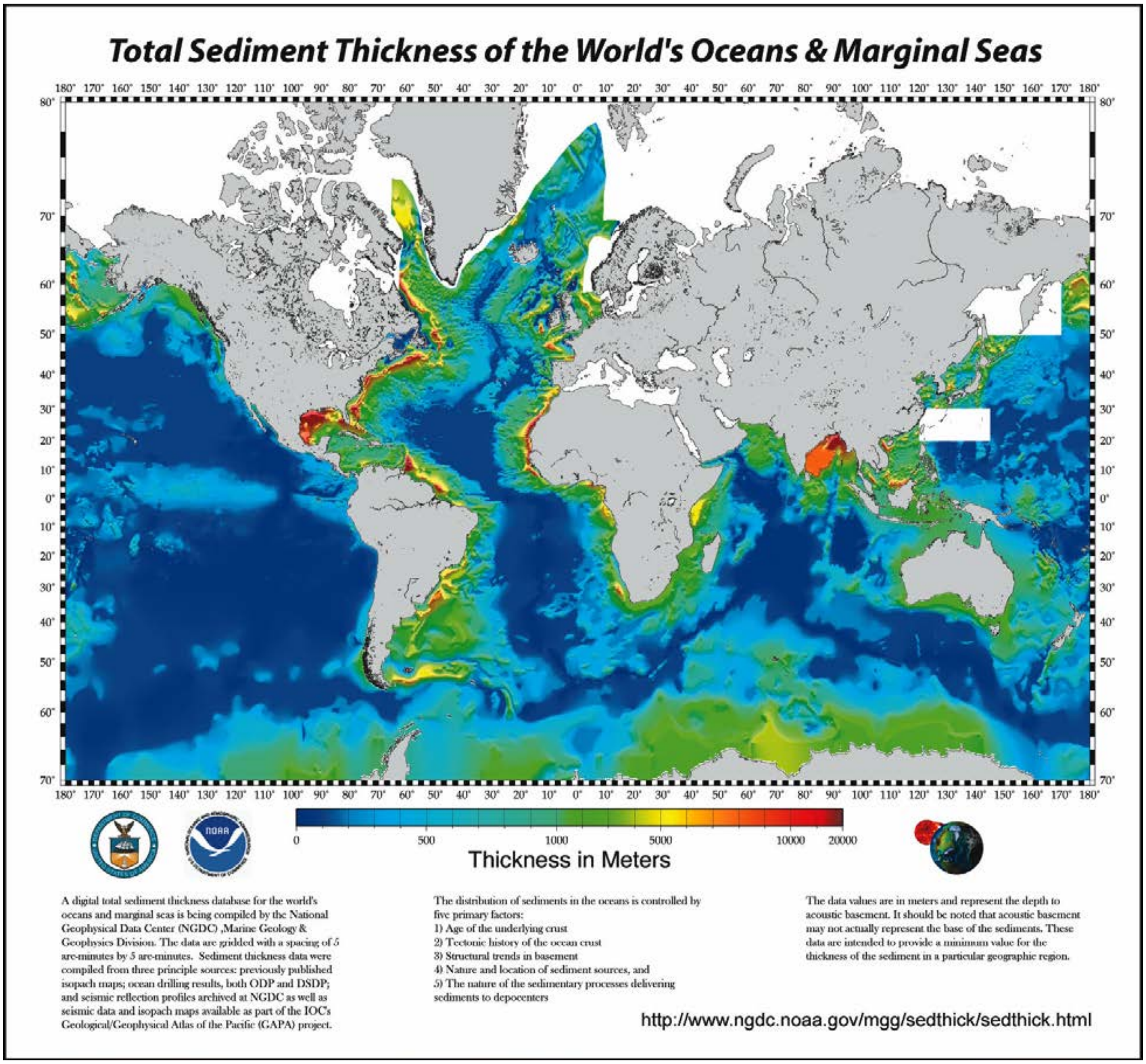

Figure 11.4. Depth of sedimentary rocks along the continental margin (courtesy of NOAA). The deepest sedimentary rocks are in the northern Gulf of Mexico, off the east coast of North America, and in the Bay of Bengal. There is no data from the Arctic Ocean, but the sedimentary rocks are very thick along this margin.

This defies the uniformitarian principle upon which most of geological interpretations are based. [6] Even before King pointed out that the continental margin represents an unusual profile, Hedberg had stated "…there is considerable controversy as to the origin in detail of continental slopes. It seems evident that there is no unique answer."[7]

At the time King wrote these words, many scientists thought that submarine canyons were cut into the continental shelves, and the slopes are young features which formed when the sea level was lower, during the "Quaternary" Ice Age. However, researchers now realize submarine canyons had to have taken much more time to erode than their paradigm allowed.

[6] Oard, M.J., Earth's Surface Shaped by Genesis Flood Runoff Volume I: Tectonics and Erosion. http://michael.oards.net/GenesisFloodRunoff.htm.

[7] Hedberg, H.D., 1970. Continental margins from viewpoint of the petroleum geologist. *AAPG Bulletin* 54(1):11.

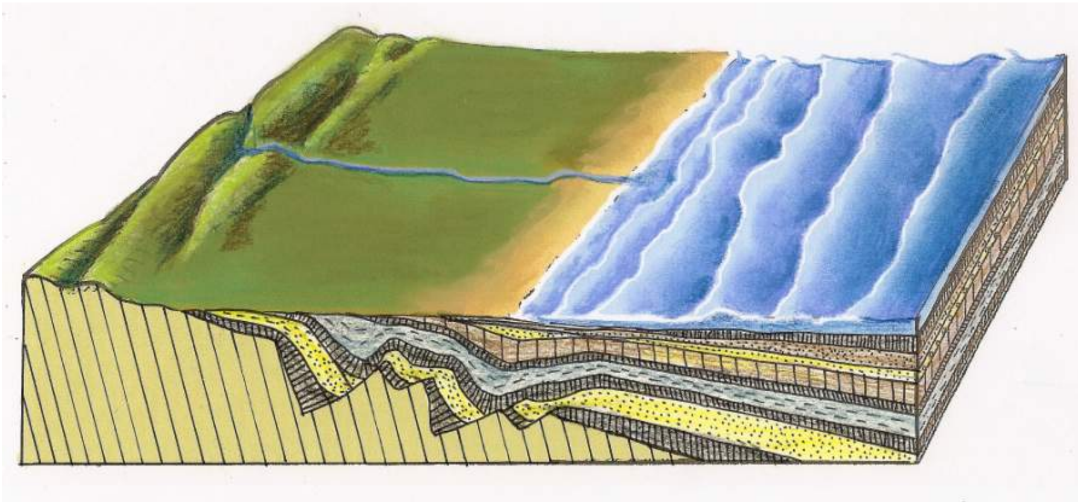

Figure 11.5. Seaward thickening wedge of sedimentary rocks (drawn by Mrs. Melanie Richard).

The Genesis Flood Formed the Continental Margin

Since continental shelves and slopes are continuous around all of the continents, and the sedimentary rocks are sheet-like, sheet deposition during Flood runoff seems like the only reasonable mechanism to account for the continental margin. Sheet deposition would correspond with the first half of the Retreating Stage of the Flood in Walker's model.[8] Sheet deposition from currents moving off of the uplifting continents is supported by the seismic profiles of continental shelves where many layers are generally planar over large areas (Figure 11.5). Strong currents are implied by sheet deposition. Sometimes, the dip of the strata increases *seaward*, forming what are called unconformities and delta-like features. This signifies a local velocity increase with the depositional current flowing *offshore* and not parallel to the shoreline as would be expected from wind generated currents that occur today. Hedberg states: "Reflection profiling has shown that many slopes in their present form are the result of prograding sedimentation."[7] This prograding wedge of sedimentation is generally perpendicular to the coast, implying currents moved directly off the continents along the entire edge of all the continents, not as the typical parallel shore currents we observe today.

Continental slopes likely signify the edge of seaward sheet flow deposition. This would be analogous to the edge of a river delta, the top of the delta representing the continental shelf. The delta can serve as an analog for the continental margin Flood formation, if the sediments do not spread laterally along the shore. A good example is the recently-formed delta of the Colorado River which meets Lake Mead in the narrow Lower Granite Gorge of Grand Canyon (Figure 11.6). The delta formed as the lake was filling. There were no along the shore currents to spread the sediments since they were deposited in a narrow gorge. The illustration shows the top of the delta has a slight lake ward slope until it reaches the steep drop off. Compare the Colorado River delta feature to the edge of the continents and the large islands. This gives a glimpse of how the continental shelf and slope would have formed rapidly when wide Flood sheet currents flowed off of the rising continents. Figure 11.7 is a schematic of the Flood formation of the continental margin.

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[8] Walker, T., 1994. A Biblical geological model. In, Walsh, R.E. (editor), *Proceedings of the Third International Conference on Creationism*, technical symposium sessions, Creation Science Fellowship, Pittsburgh, PA, pp. 581–592.

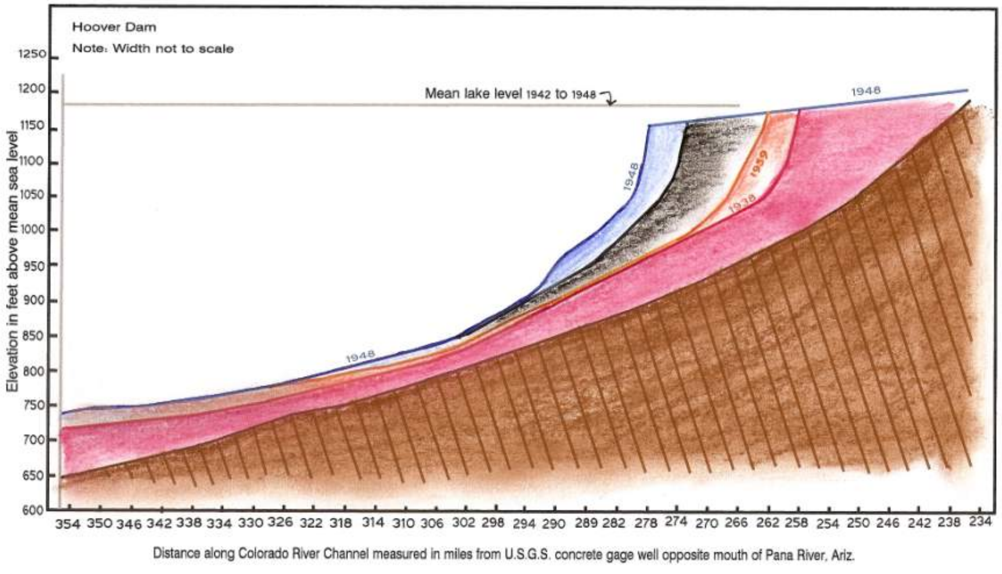

Figure 11.6. The yearly prograding Colorado River delta into Lake Mead in the Lower Granite Gorge of Grand Canyon as the lake was filling (redrawn from Kostic et al., 2002 by Mrs. Melanie Richard).

The continental margin contains a large proportion of Cenozoic sedimentary rocks. The rest are from the upper half of the Mesozoic. Off the central East Coast of the United States, it has been estimated that out of a total volume of 237,000 mi^3 (1.34 million km^3) of sedimentary rocks, about 30% are Cenozoic.[9] The very thick continental margin in the northern Gulf of Mexico is filled with about 7.5 miles (12 km) of Cenozoic sedimentary rocks.[10]

The central Argentine continental margin, 95 to 310 miles (150 to 500 km) wide, contains one of the thickest accumulations of sedimentary rocks in the world.[11,12] Based on the inferred age of the sedimentary rocks, around 50 to 75% of the sediments are dated as Cenozoic. The Mediterranean Sea margin off Israel has a maximum of about 3 miles (5 km) of Cenozoic sedimentary rocks, which appear to be about 50% of the margin sedimentary rocks.[13] Two basins on the South China Sea continental margin contain Cenozoic sedimentary rocks greater than 6.2

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[9] Poag, C.W., 1992. U.S. middle Atlantic continental rise: provenance, dispersal, and deposition of Jurassic to Quaternary sediments. In, Poag, C.W. and P.C. de Graciansky (editors), *Geological Evolution of Atlantic Continental Rises*, Van Nostrand Reinhold, New York, NY, pp. 100–156.

[10] Bally, A.W. 1989. Phanerozoic basins of North America; in: Bally, A.W. and A.R. Palmer (Eds.), *The Geology of North America—An Overview*, The Geology of North America, volume A, Geological Society of America, Boulder, CO, pp. 397–446.

[11] Hinz, K., S. Neben, B. Schreckenberger, H.A. Roeser, M. Block, K. Goncalves de Souza, and H. Meyer, 1999. The Argentine continental margin north of 48°S: sedimentary successions, volcanic activity during breakup. *Marine and Petroleum Geology* 16:1–25.

[12] Gruetzner, J., G. Uenzelmann-Neben, and D. Franke, 2012. Variations in sediment transport at the central Argentine continental margin during the Cenozoic. *Geochemistry, Geophysics, Geosystems* 13*:1–15.*

[13] Steinberg, J., Z. Gvirtzman, Y. Folkman, and Z. Garfunkel, 2011. Origin and nature of the rapid late Tertiary filling of the Levant Basin. *Geology* 39:355–358.

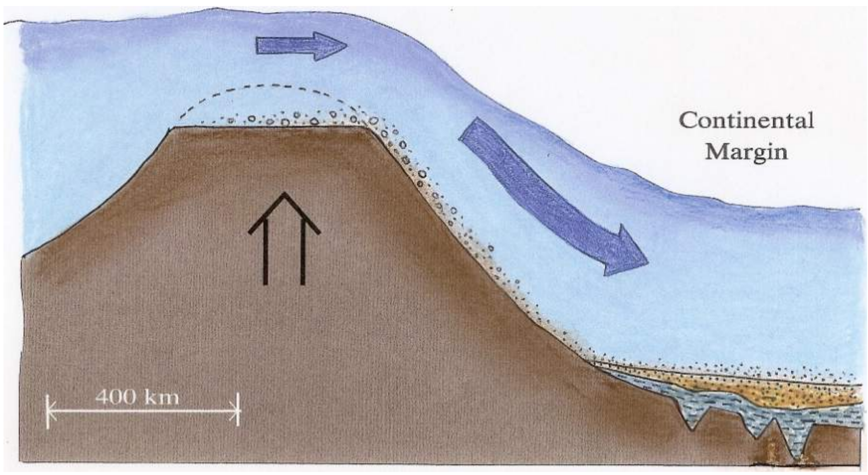
miles (10 km) thick![14] It appears that about 40% of the continental margin sedimentary rocks off the west coast of South Africa are from the Cenozoic.[15]

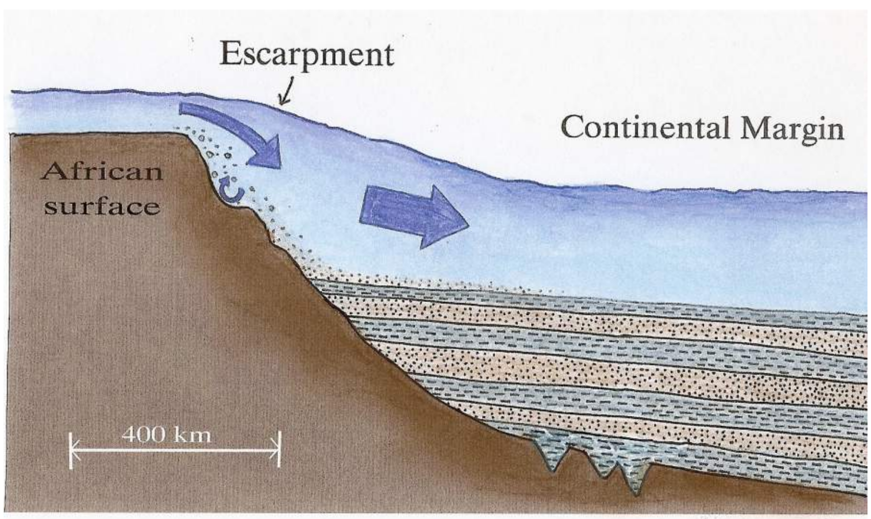
Although these estimates are based mostly on fossil dating, they are representative of a large, thick sheet of Cenozoic sedimentary rocks ringing all of the continents with a thick blanket.

Very Late Cenozoic Flood/Post-Flood Boundary Based on Continental Margins

Sediment were flowing perpendicular off the continents and were deposited as a sheet tens of thousands of feet thick at the continental margin. Since a large proportion of this rock is from the Cenozoic, it means that this sheet flow continued into the Cenozoic. How is it possible this catastrophic activity took place after the Flood? The evidence strongly indicates the Flood/post-Flood boundary is in the very late Cenozoic on continental margin areas of the world.

Those who believe in post-Flood catastrophism must explain the many thousands of feet of Cenozoic sheet deposition by sheet currents flowing perpendicular to the shoreline *after* the Flood. This would imply continents flooded after the Flood, a highly unlikely scenario.





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[14] Xie, X., R. Dietmar Müller, J. Ren, T. Jiang, and C. Zhang, 2008. Stratigraphic architecture and evolution of the continental slopoe system in offshore Hainan, northern South China Sea. *Marine Geology* 247:129–144.

[15] Wigley, R.A. and J.S. Compton, 2006. Late Cenozoic evolution of the outer continental shelf at the head of the Cap Canyon, South Africa. *Marine Geology* 226:1–23.

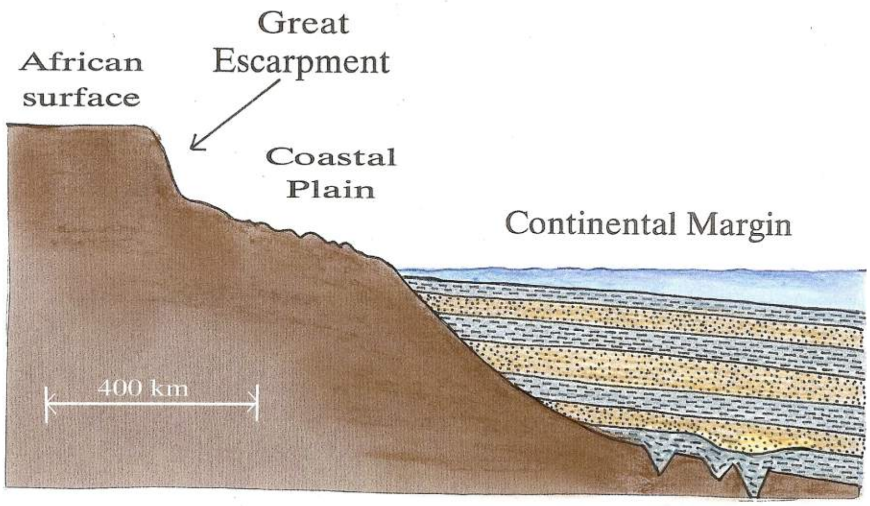

Figure 11.7. Series of schematics showing the formation of the continental margin and coastal Great Escarpment of southeast Africa as it uplifted out of the Floodwater while the ocean basins sank (great vertical exaggeration, drawn by Mrs. Melanie Richard).
a) Uplift and erosion of southeast Africa while the ocean basin sank during Flood runoff.
b) The sediments of the continental margin continue to pile up while the Great Escarpment is eroded to the left.
c) The continental margin sedimentary rocks and the Great Escarpment that now separates the high African Surface from a coastal plain.