Investigation 4B

Coastal Margins in Action

Objectives

Continental margins mark the boundary between continental and oceanic crust and can be classified as either passive or active. Passive margins are typically broad and geologically quiet, while active margins are associated with tectonic activity, including earthquakes, volcanoes, and deep-sea trenches. Cross-sectional profiles of the seafloor enable us to identify and compare these two types of margins based on their distinct features, from land to the abyssal plain.

In this investigation, we will:

- Describe the features along the transition zone from a continent to the abyssal plain
- Explore the profiles of tectonically passive and active continental margins

Seafloor Profiles

Long, sinuous ridges, deep valleys, and volcanoes punctuate the seafloor. Figure 4B-1 presents a cross-sectional view of the seafloor with the vertical scale greatly exaggerated. The left side displays a passive continental margin, and the right side an active continental margin. Passive margins include a wide continental shelf, continental slope, and continental rise, while active margins have narrower continental shelves and steeper continental slopes before descending into an oceanic trench.

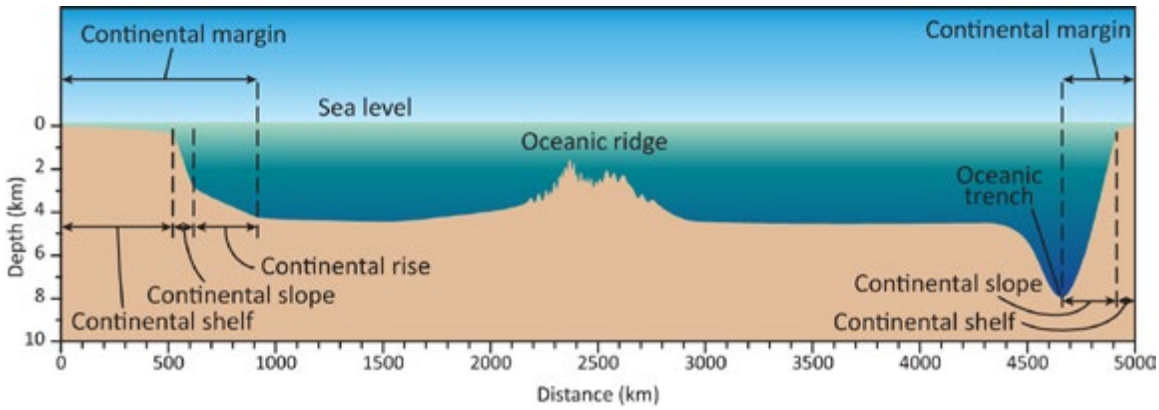

Figure 4B-1. A cross-sectional profile of the seafloor with the vertical scale greatly exaggerated. The left side is typical of a passive continental margin, while the right is typical of an active continental margin (subduction zone).

The *continental margin* consists of a continental shelf, slope, and in some cases a rise. At its outer edge, the continental margin either merges with the abyssal plain or gives way to an oceanic trench. Along active plate boundaries, the continental margin is much narrower, as shown on the right side of Figure 4B-1.

For both margins, the *continental shelf* is closest to the shore. The shelf descends along a gentle slope extending away from the coastline to a depth of about 200 m (650 ft.). Near this depth, the shelf drops off into the *continental slope*, which ends at about 3000 m (9800 ft.). At the base of the continental slope, the slope gentles again due to sediment deposition, producing the continental rise, which connects to the abyssal plain. The *abyssal plain* is the relatively flat, deep seafloor between the base of a continental rise and an oceanic ridge. It is typically at depths between 3 and 6 km (1.9 and 3.7 mi.).

1. In Figure 4B-1, the vertical and horizontal scales are given in kilometers with the vertical scale exaggerated for readability. 1 tick mark on the vertical scale represents 1 km, while a tick mark on the horizontal scale represents 100 km. This means that vertical features appear _____ times taller than their actual scale relative to the horizontal.

    a. 10
    b. 20
    c. 50
    d. 100

2. The oceanic trench in Figure 4B-1 has a maximum depth near _____ km below sea level and a width of about 400 km, a slope of _____ for the active margin. (Slope is the vertical divided by the horizontal or “rise over run.”)

    a. 8 ... 0.02
    b. 80 ... 0.2
    c. 800 ... 2
    d. 8000 ... 20

3. In Figure 4B-1, the passive continental margin between land and the abyssal plain ends at a depth of 4 km and spans about _____ km. That is a slope of _____ for the passive margin. A larger slope is steeper than a smaller slope.

    a. 200 ... 0.02
    b. 500 ... 0.008
    c. 900 ... 0.004
    d. 2500 ... 0.0016

4. Tectonically active regions, typically associated with convergent plate boundaries, experience frequent earthquakes, volcanic activity, or both. Convergent plate boundaries are found along the edges of the _____ Ocean, including along the _____. Refer to the previously examined locations of plate boundaries in *Investigation 4A* for help.

    a. Atlantic ... eastern coast of North America
    b. Indian ... southwestern coast of India
    c. Pacific ... western coast of South America
    d. Southern ... southern coast of Australia

5. The eastern coasts of North and South America are examples of passive continental margins. Their broad, stable features are primarily the result of _____.

    a. frequent subduction and volcanic activity
    b. transform fault boundaries along the margin

c. calm geological conditions that allow sediments to accumulate
d. recent tectonic collisions with oceanic plates

6. The western coasts of North and South America are tectonically active margins. Much of the sediment delivered from land to these margins _____.

a. spreads evenly across the seafloor
b. is recycled along with the subducting plate
c. forms islands and channels
d. accumulates on wide continental shelves

Continental margins are shaped by the interaction of tectonic plates, which influence the width of the continental shelf, sediment accumulation, and the presence of features like trenches and volcanic arcs.

Passive Margin Profile

Next, we will take a closer look at a vertical profile of the continental margin off the east coast of North America. **Figure 4B-2** shows the location of this vertical cross section, at 33°N from the coast of North Carolina at 80°W eastward to 76°W as a purple line. This section covers a total length of about 520 km, with a maximum depth of about 4000 m.

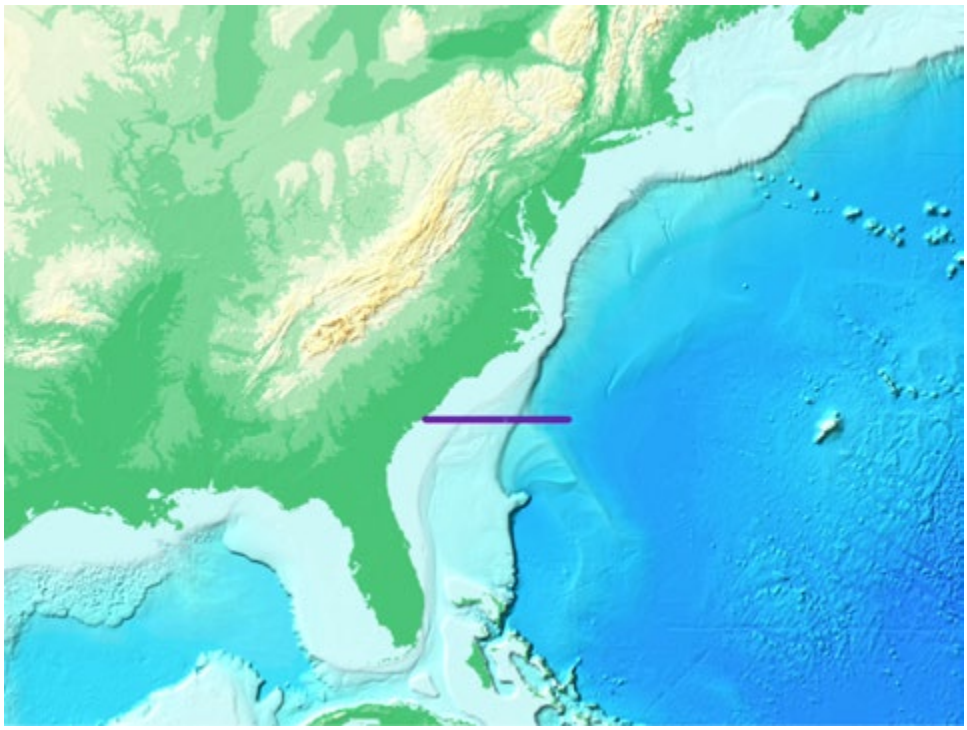

Figure 4B-2. Bathymetry and topography relief map of a portion of the southeastern U.S. with a purple line showing the cross-section location. [ESRI, 2025]

Figure 4B-3 is a vertical cross-section in the location marked by the purple line in Figure 4B-2.

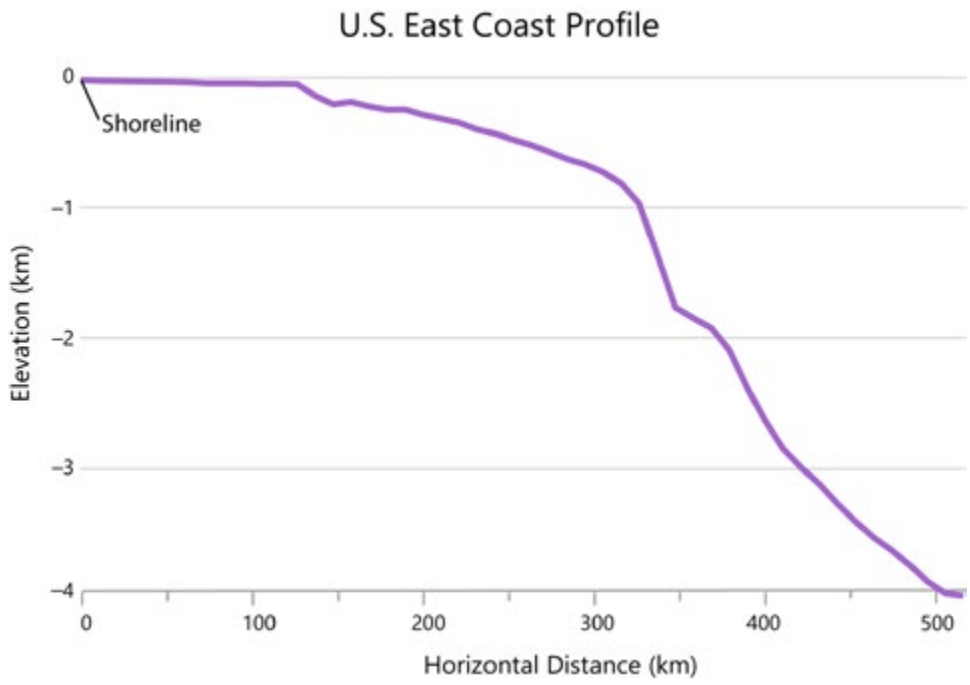

Figure 4B-3. Vertical profile of the passive continental margin on the eastern coast of the U.S. [Data from ESRI, 2025]

7. In the Figure 4B-3 profile, the vertical and horizontal scales are in kilometers. Sea level is at a depth of 0 km. The coastline is within a few kilometers of the western (left) end. From the coastline, water depth increases very gradually from the shore out to about 320 km, with a final depth of around 0.8 km. This segment resembles the _____ as labeled in Figure 4B-1.

   a. continental rise
   b. continental slope
   c. continental shelf

8. Beginning at a depth of 0.8 km, the seafloor profile “breaks” or has a drastic change in slope. This segment of the profile from 320 km to 340 km is the continental _____ portion of the continental margin as displayed in Figure 4B-1.

   a. rise
   b. slope
   c. shelf

9. The segment of the profile beyond 340 km is the continental _____, where much of the sediment from land is deposited.

   a. rise
   b. slope
   c. shelf

10. Beyond 500 km from land, the seafloor becomes a flat, featureless abyssal plain. In this part of the North Atlantic Ocean, water depth reaches about _____.

a. 0.8 km
b. 1 km
c. 3 km
d. 4 km

11. This section of the passive margin reaches this depth at about 500 km from the shoreline, giving this continental margin a slope of approximately _____.

a. 0.008
b. 0.08
c. 0.8
d. 8

Passive margins form where tectonic activity is minimal, typically along the trailing edge of a continental plate. Over time, seafloor spreading pushes the oceanic crust away from the margin, allowing sediment to accumulate and form broad continental shelves and gentle slopes.

Active Margin Profile

Tectonically active coasts have a relatively narrow continental margin similar to the right profile of Figure 4B-1. **Figure 4B-4** displays a section of the South American west coast, with mountains shown in brown and white and a dark-blue oceanic trench that aligns with the Chilean coast. The red line marks the location of the vertical cross-section at 23.5°S from 74°W to 71°W, shown in **Figure 4B-5**.

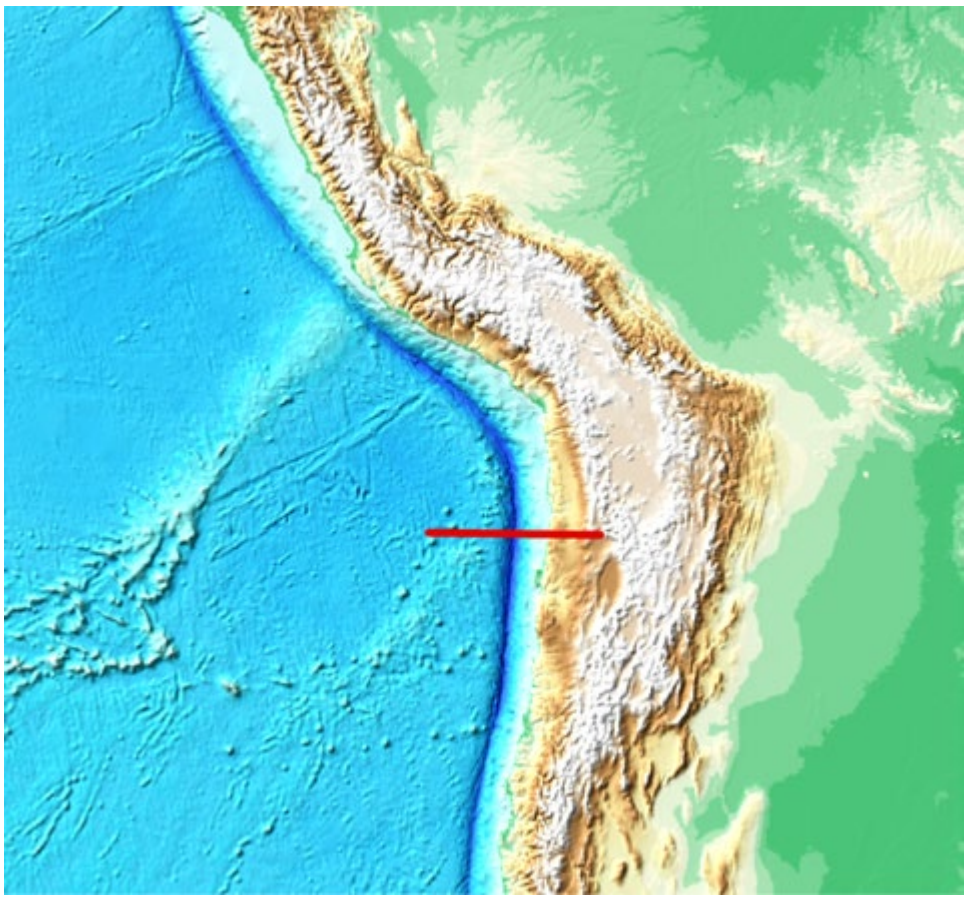

Figure 4B-4. Bathymetry and topography relief map centered on Chile, South America, with the

red line on 23.5°S, the Tropic of Capricorn, extending from 74°W to 71°W. [ESRI, 2025]

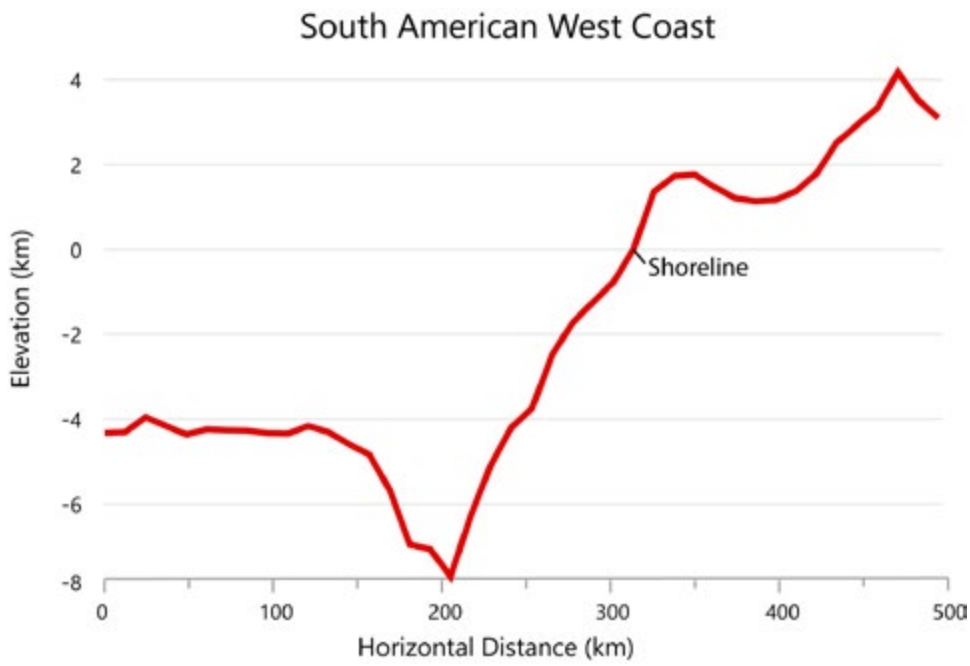

Figure 4B-5. Bathymetry profile from 23.5°S from 74°W to 71°W, left to right. [Data from ESRI, 2025]

12. Since this cross-section is on the western coast of South America, the ocean is on the west (left) side and the land is on the eastern (right) side. The east side shows _____ that reach 4000 m above sea level.

    a. plains
    b. mountains
    c. trenches

13. Unlike the active margin diagram in Figure 4B-1, this cross-section has little to no continental _____ because the depth of the seafloor drops quickly into an oceanic trench.

    a. shelf
    b. slope
    c. rise

14. The oceanic trench reaches a maximum depth of approximately 8 km, about _____ km from the shoreline, where the profile crosses sea level at 0 km height.

    a. 10
    b. 100
    c. 200
    d. 300

15. West of the oceanic trench, the seafloor rises and then levels off to a depth of approximately 4 km on the abyssal plain. The trench is about _____ km deeper than the surrounding abyssal plain.

a. 2
b. 3
c. 4
d. 5

16. The continental margin reaches the abyssal plain (4 km deep) about 160 km from shore. This continental margin has a slope of _____, which is _____ than the passive margin. *Hint: Higher slope values are steeper than lower slopes.*

    a. 0.025 ... steeper
    b. 0.25 ... steeper
    c. 2.5 ... less steep
    d. 25 ... less steep

Along passive continental margins, such as those surrounding the Atlantic basin, tectonic plate boundaries are absent. The sediment eroding from the continent spreads over the seafloor, forming a broad continental margin. Along active continental margins, a convergent plate boundary produces a characteristic trench along a subduction zone. The continental margin is very narrow because the slope descends into deep oceanic trenches.

Summary

Bathymetric maps and vertical cross-sections can be used to infer the geological processes shaping the seafloor from the coast to the abyssal plain. Both passive and active margins include features such as the continental shelf, slope, and rise. Still, these features are more clearly defined along passive margins, where sediment can accumulate undisturbed by subduction or frequent earthquakes.

References

Figure 4B-2 – ESRI, 2025: TopoBathy - Elevation tinted hillshade. Accessed 25 July 2025, maps.arcgis.com/home/item.html?id=ad7e1f1787814a2abd5557ad24a66b22.

Figure 4B-3 – ESRI, 2025: TopoBathy - Elevation tinted hillshade. Accessed 25 July 2025, maps.arcgis.com/home/item.html?id=ad7e1f1787814a2abd5557ad24a66b22.

Figure 4B-4 – ESRI, 2025: TopoBathy - Elevation tinted hillshade. Accessed 25 July 2025, maps.arcgis.com/home/item.html?id=ad7e1f1787814a2abd5557ad24a66b22.

Figure 4B-5 – ESRI, 2025: TopoBathy - Elevation tinted hillshade. Accessed 25 July 2025, maps.arcgis.com/home/item.html?id=ad7e1f1787814a2abd5557ad24a66b22.