PROCEDURE

PART A

Correlation of Siliciclastic Rocks

The first part of the exercise utilizes the Devonian rocks in New York and Pennsylvania. These rocks formed the basis for the acceptance of the facies concept in North America. Fifteen somewhat generalized stratigraphic sections, which were measured through the Devonian rocks at localities approximately 32 km apart, are plotted as logs in figure 7.5. Section 1 is toward the west and section 15 is toward the east in a traverse that lies generally along the New York–Pennsylvania border. Symbols of the lithology are those used in previous exercises.

Total thickness of the preserved sections are shown to scale. Various time lines, which have been identified and correlated by the use of fossils, are shown by a series of dots through each column and are marked by small letters. The various time horizons or levels of contemporaneous deposition are shown by the same letters. For example, all the rocks immediately below the dotted line marked "a" in each of the 15 sections were deposited contemporaneously.

1. Construct a restored section for these Devonian rocks (figure 7.5) similar to the example of Cambrian rocks in figure 7.4. Detach both pages of figure 7.5 (left and right). Placing them side by side the long way, tape the two pages together and proceed. With lines and symbols, interconnect various lithologic units and show the facies relationships of the relatively coarse-grained rocks in the east to the fine-grained rocks in the west.

2. Does Walther's law apply to these rocks? Are there exceptions?

3. Are all of the conglomerates the same age?

4. What trend is visible in the sandstone beds as they are traced from east to west?

5. Why do shale beds thin as traced from west to east?

6. What happens to the sandstone that occurs near the base of sections 12, 13, 14, and 15?

7. What is suggested by the small lens of conglomerate near the top of section 3 in the time interval between "f" and "g"?

8. What is the overall textural (sediment size) and thickness pattern displayed by these sedimentary rocks?

9. From which direction were the sediments transported?

10. By what media (e.g., wind, glaciers, streams, marine currents) were the sediments deposited?

11. This "wedge" of sediment is known as the "Catskill Delta," although it is not a delta in the strict sense. Which Paleozoic mountain chain was the source of sediment comprising the Catskill Delta?

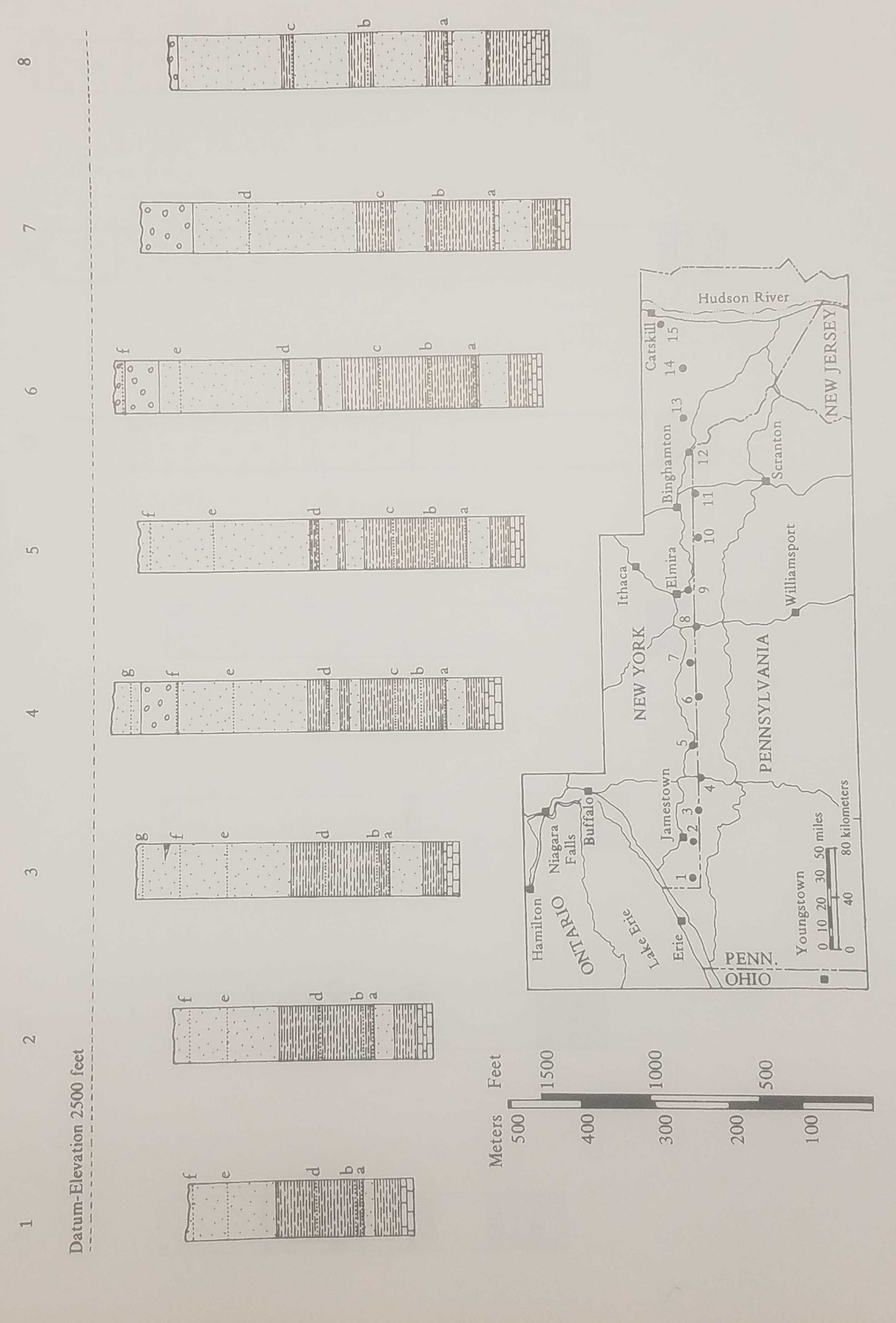


FIGURE 7.5 LEFT A series of 15 stratigraphic columns of the Devonian rocks in southern New York and northern Pennsylvania. This sequence is a classic example of integrating facies.

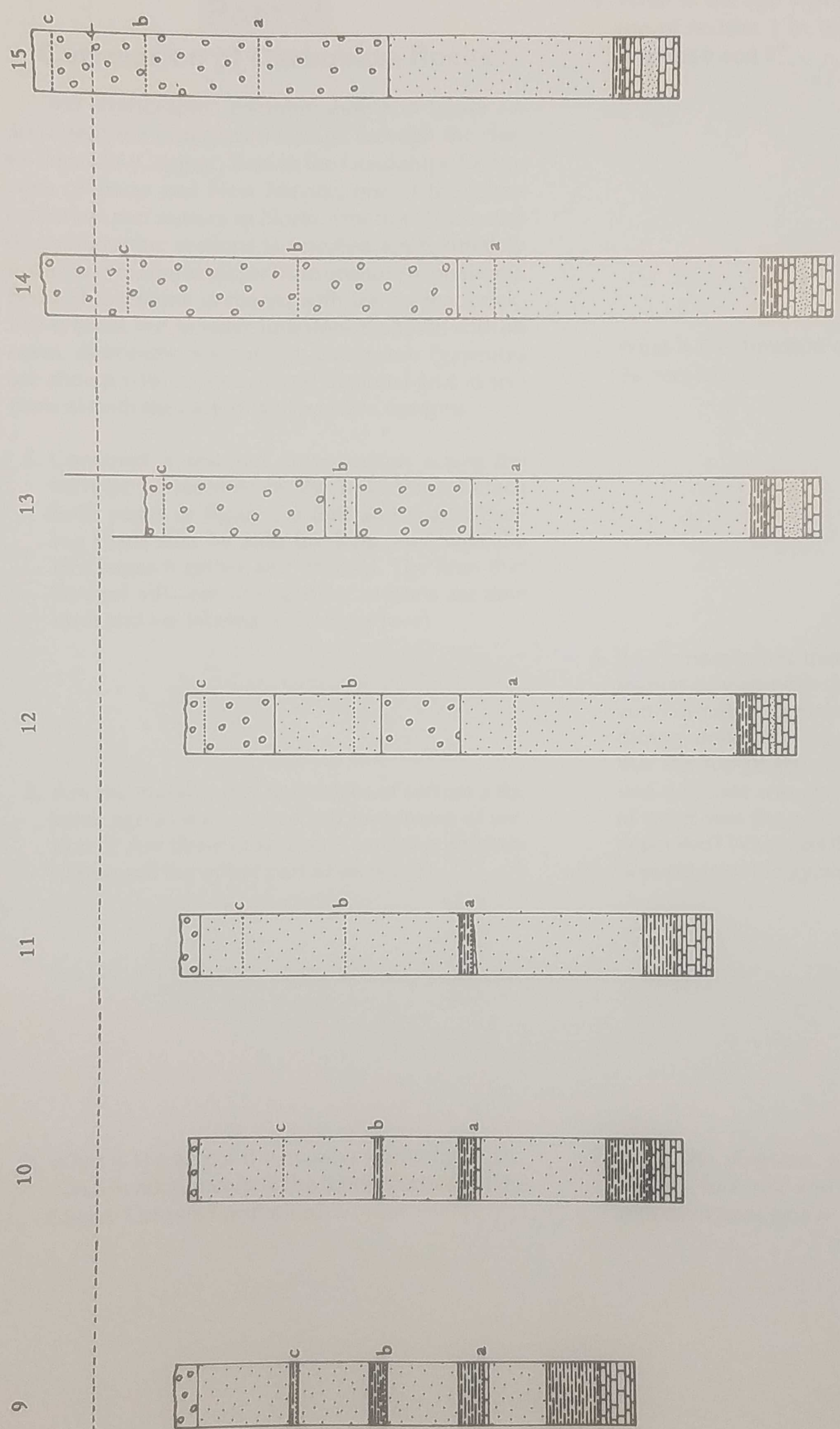


FIGURE 7.5 RIGHT A series of 15 stratigraphic columns of the Devonian rocks in southern New York and northern Pennsylvania. This sequence is a classic example of integrating facies.

PART B

Correlation of Carbonate Rocks

Ten stratigraphic columns shown in figure 7.6 document the facies relationships through the classic Permian (Capitan) Reef in the Guadalupe Mountains of Texas and New Mexico, one of the major carbonate reef masses in North America. This series of stratigraphic sections is oriented approximately northwest to southeast (or from onshore to offshore). Bedded limestone is shown with the normal brick-like symbol, but massive limestone is shown with an open, discontinuous pattern. Evaporites (gypsum) are shown with a close-spaced diagonal grid in sections at both the eastern and western margins.

1. Construct a restored cross section across the traverse represented by the 10 sections. Detach both pages of figure 7.6 (left and right). Placing them side by side the long way, tape the two pages together and proceed. The lines that connect adjacent stratigraphic sections are time lines and are labeled with letters (a–e).

2. Are the massive reef limestones of section 3 the same age as the massive reef limestones of section 7? Are those of section 3 contemporaneous to those of the upper part of section 6?

3. What is the age of the massive dolomite in section 2 in relationship to the limestone beds of the Cherry Canyon Formation?

4. What is the age of the thin gypsum bed at the top of section 1 in relationship to the rocks in sections 8 and 9?

5. What is the direction of growth through time of the reef mass?

6. It is generally felt that the Cherry Canyon Formation contact with the top of the Brushy Canyon Formation remained essentially horizontal during deposition of these Permian reefs and that the top of the reef or the top of the massive dolomite was near sea level. In what depth of water was the gypsum in the top of section 1 deposited? What was the water depth during the deposition of the gypsum in sections 9 and 10?

7. From the diagram, which lithology would be termed *back reef* and which lithologies would represent *basin* or *fore-reef facies*?

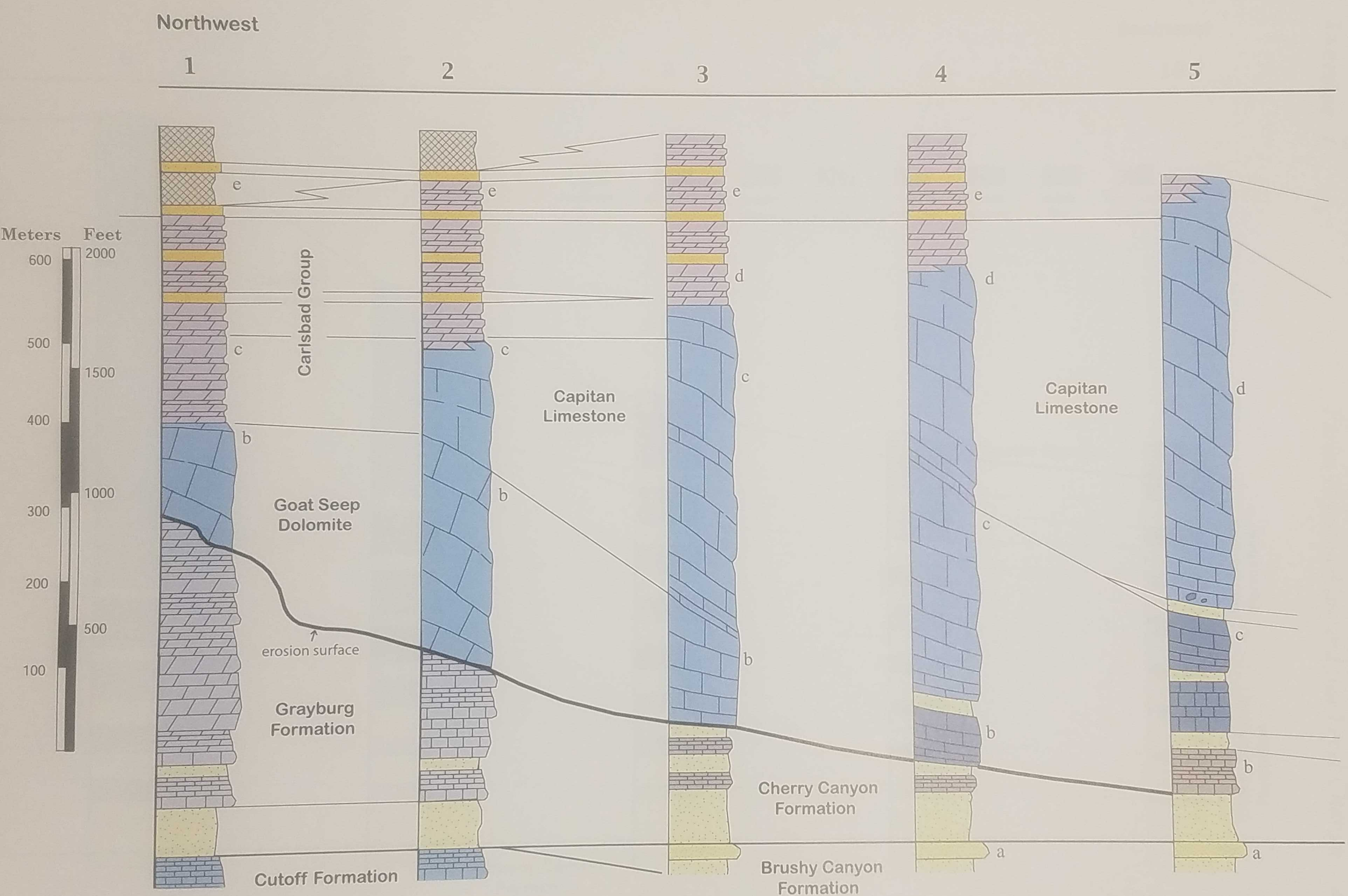


FIGURE 7.6 LEFT A series of 10 stratigraphic columns through the famed Permian Reef complex of the Guadalupe Mountains of western Texas and southern New Mexico. Horizontal distance from section 1 to 10 is approximately 8 km.

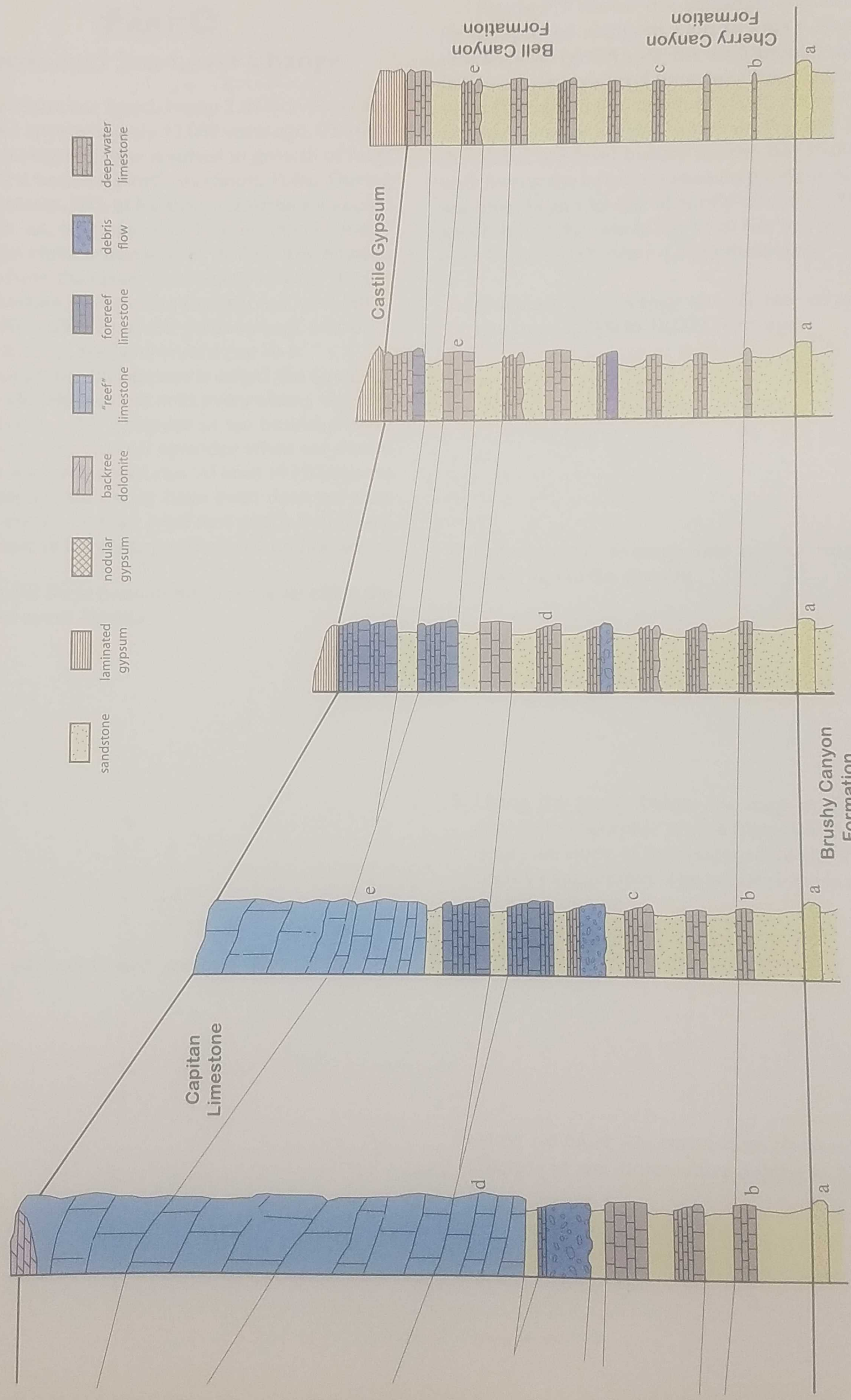


FIGURE 7.6 RIGHT A series of 10 stratigraphic columns through the famed Permian Reef complex of the Guadalupe Mountains of western Texas and southern New Mexico. Horizontal distance from section 1 to 10 is approximately 8 km.

PART C

Facies and Sea-Level Change

The Pleistocene Epoch began 2 million years ago and ended approximately 10,000 years ago. Climatic cooling during this time resulted in growth of huge ice sheets at both the North and South Poles. During glacial maxima, 30% of Earth's land surface was covered with ice, whereas only 10% is covered today during the current interglacial period. The shifting of water from the ocean reservoir to icecaps during glacial maxima resulted in a **eustatic** sea level fall of nearly 100 m (300 ft). If the polar icecaps and pack ice were to melt, sea level would rise 70 ft.

Although the Pleistocene is called the Great Ice Age, the climate was not cold everywhere, nor was it continually cold. Episodes of ice build-up were separated by interglacial episodes when ice would melt and sea level would rise. At least 18 Pleistocene glacial-interglacial cycles have been detected thus far. This means that sea level rose and fell dramatically at least 18 times during the last 2 million years.

1. How did these oscillations of sea level effect the face of south Florida?

2. How will continued melting affect Florida's future?

Figure 7.7 shows the subaerial and submarine topography of southern Florida today. Above current sea level (green area) the contour interval is 20 ft. Below current sea level (blue area) the contour interval is 10 ft down to a depth of 100 ft, after which the contours change to 100-ft intervals. Figure 7.8 shows the global sea-level history for the last 15,000 years with feet on the left and meters on the right. Note that sea level began to rise abruptly about 15,000 years ago, but that the rate of sea-level rise has tapered off over the last 6,000 years. Given these data:

3. Calculate the average annual rate of sea-level rise from 15,000 to 10,000 years ago.

4. Calculate the average rate of rise from 5,000 years ago to the present.

5. Using the graph below the map in figure 7.7, draw a topographic profile from A to A′. At this scale, the slope of the western Florida "ramp" is highly exaggerated. The actual slope is approximately 1 degree.

6. How far must you travel from the west coast of Florida to encounter water depths of 200 ft?

7. How far do you have to travel from the east coast of Florida to reach water depths of 200 ft?

8. Miami is currently situated at an elevation of 10 ft above sea level. What would Miami's approximate elevation have been 15,000 years ago?

9. Assume that seafloor sedimentation is controlled primarily by depth as follows:

- > 10 ft = soil genesis and small scale karstification of limestone bedrock
- 0 to 10 ft = coal swamp
- – 30 to 0 ft = quartz sand (quartz sandstone)
- – 60 to – 30 ft = fine clay and silt (shale)
- – 300 to – 60 ft = lime packstone with deep-water coral mounds

Using Maps A through D, draw the shoreline of Florida as it appeared 7,200 years ago (Map A), 5,000 years ago (Map B), and as it will appear at two points in the future when sea level is 20 ft (Map C) and 70 ft higher (Map D) than it is today. Map the facies boundaries using the depth-sediment relationships listed above. Neatly fill in the facies belts with the appropriate symbols (gray for coal, stippled pattern for sandstone, dashes for shale, brick pattern for limestone). On this and subsequent maps, fill in shorelines, facies belts, and symbols for only the area north of the line labeled A to A′.

10. Using the rate that you calculated in question (3), calculate how long it would take to flood Florida to a depth of 70 ft above present sea level.

11. What percentage of modern-day Florida would remain emergent?

12. On figure 7.9 draw a stratigraphic column showing the vertical succession of Holocene strata that would develop as a function of the marine transgression that you just mapped. To obtain the necessary information, stack the four maps on top of one another with Map A on the bottom and Map D on top. Leaf through the stack and record the facies pattern developed at the position indicated by the red dot on figure 7.7 beginning with Map A. Transfer this information to the stratigraphic column using the thicknesses provided below. Use the same symbols on the stratigraphic column that you did on the facies maps.

- coal = 10 ft thick
- sandstone = 30 ft thick
- shale = 15 ft thick
- limestone = 30 ft thick

What vertical pattern is produced by this transgression of the sea across south Florida? How does this compare with the horizontal distribution of facies belts at any given time?

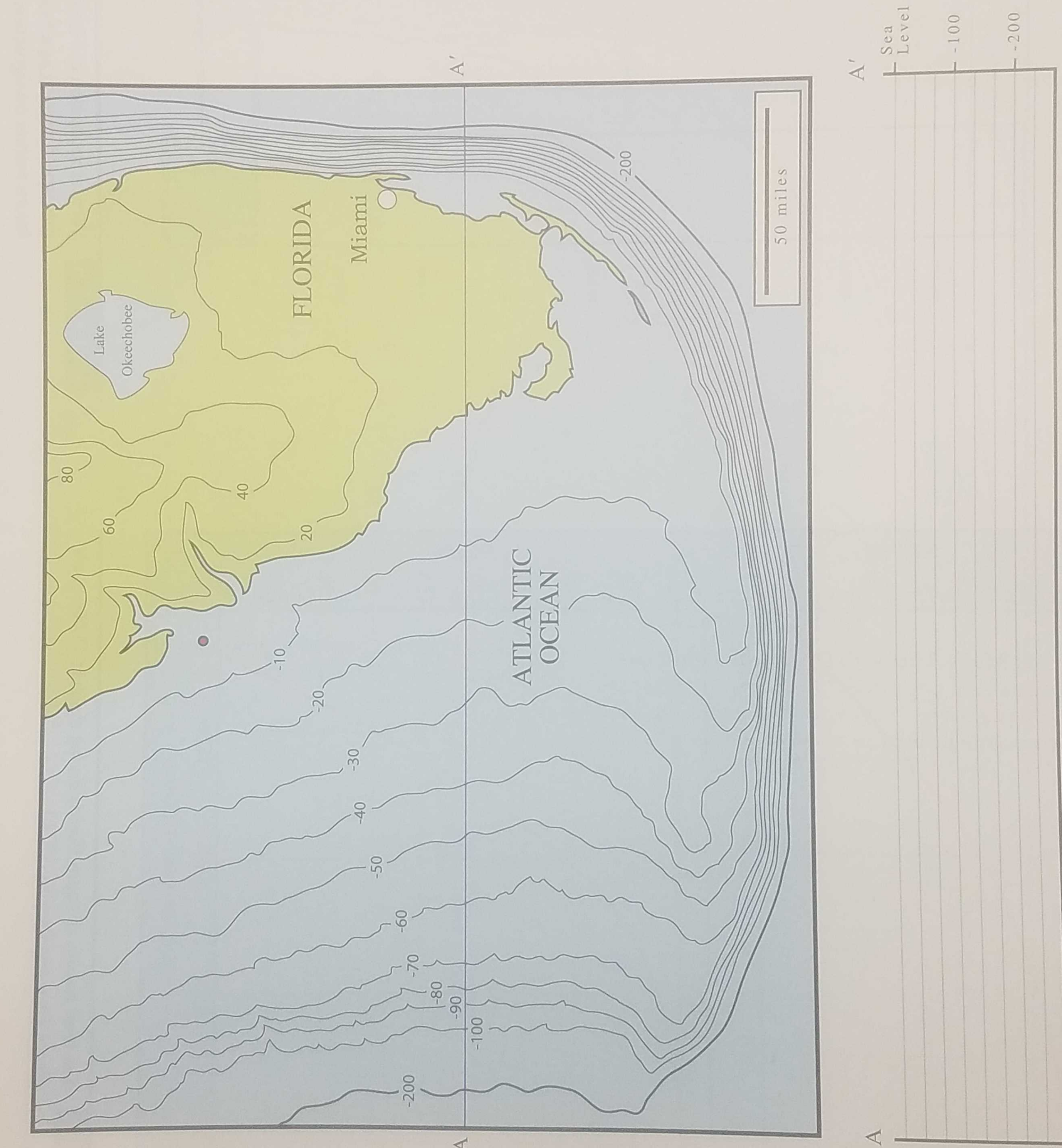


FIGURE 7.7 Contour map of south Florida region. Elevations/depths shown in feet above/below sea level.

FIGURE 7.8 Sea-level history of south Florida during the past 15,000 years. (From Enos and Perkins, 1977.)

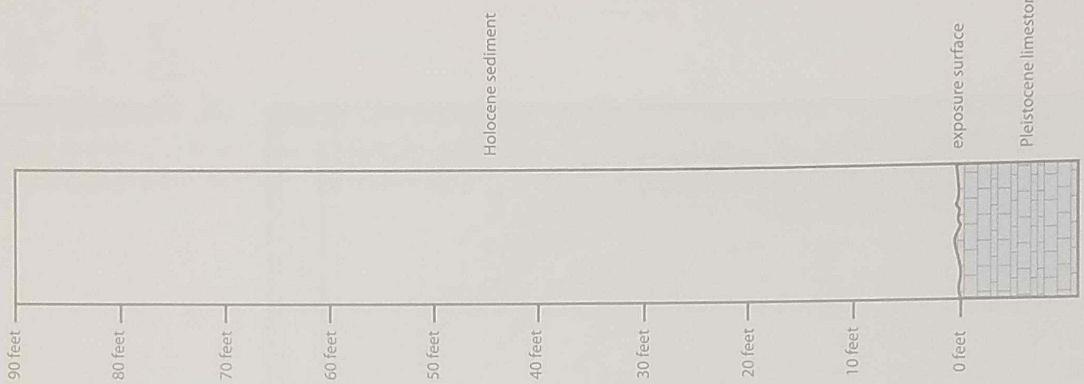
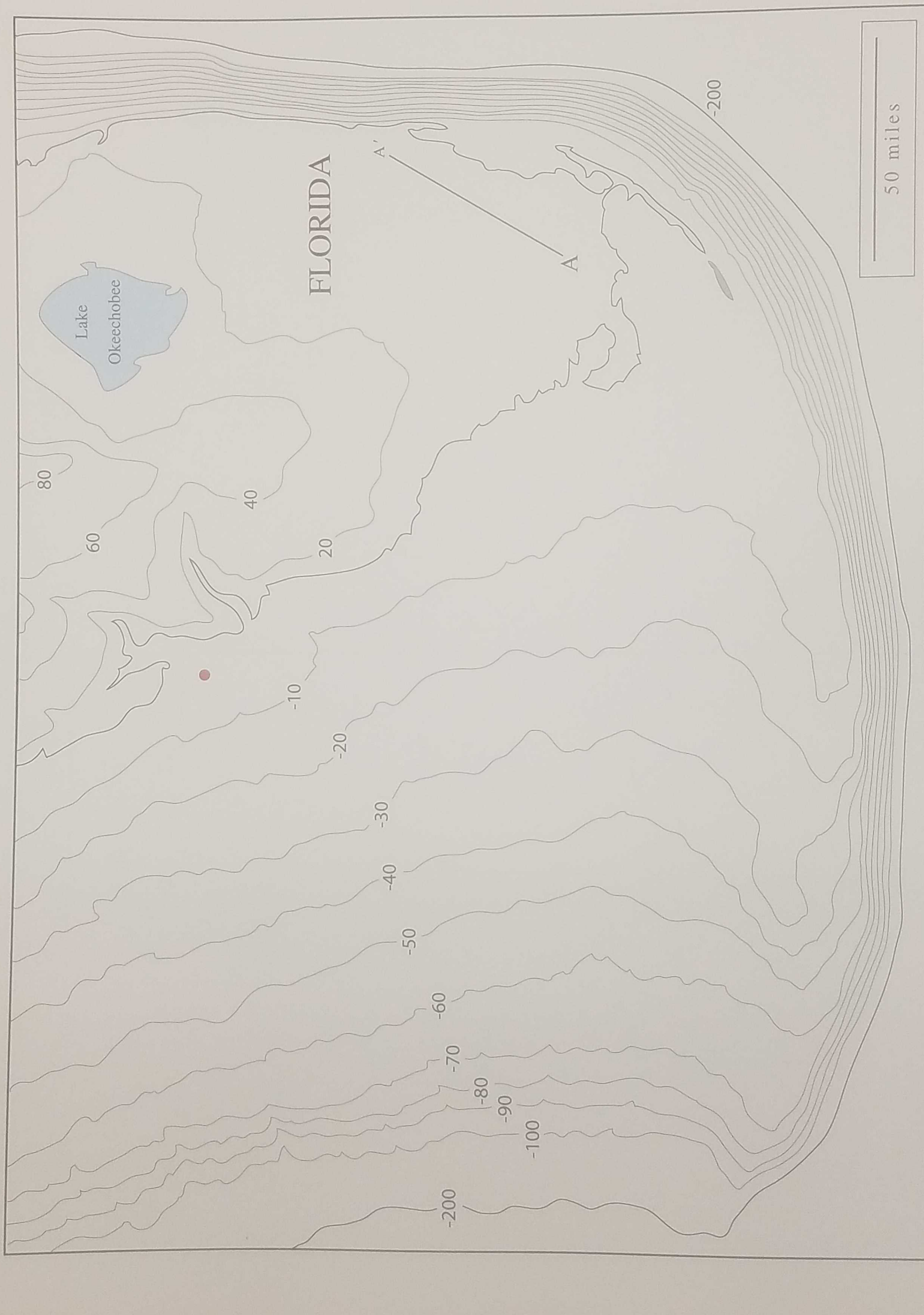
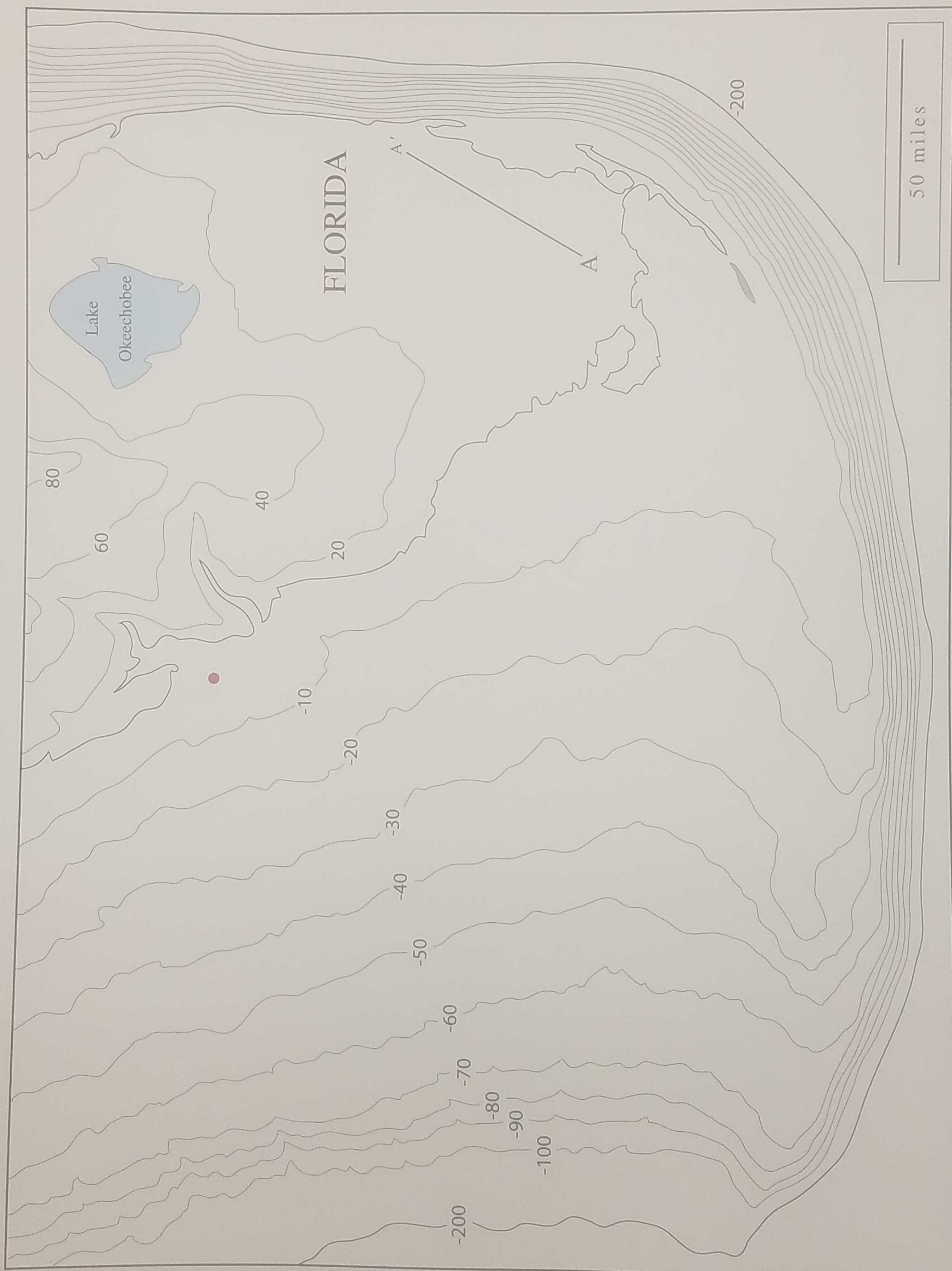


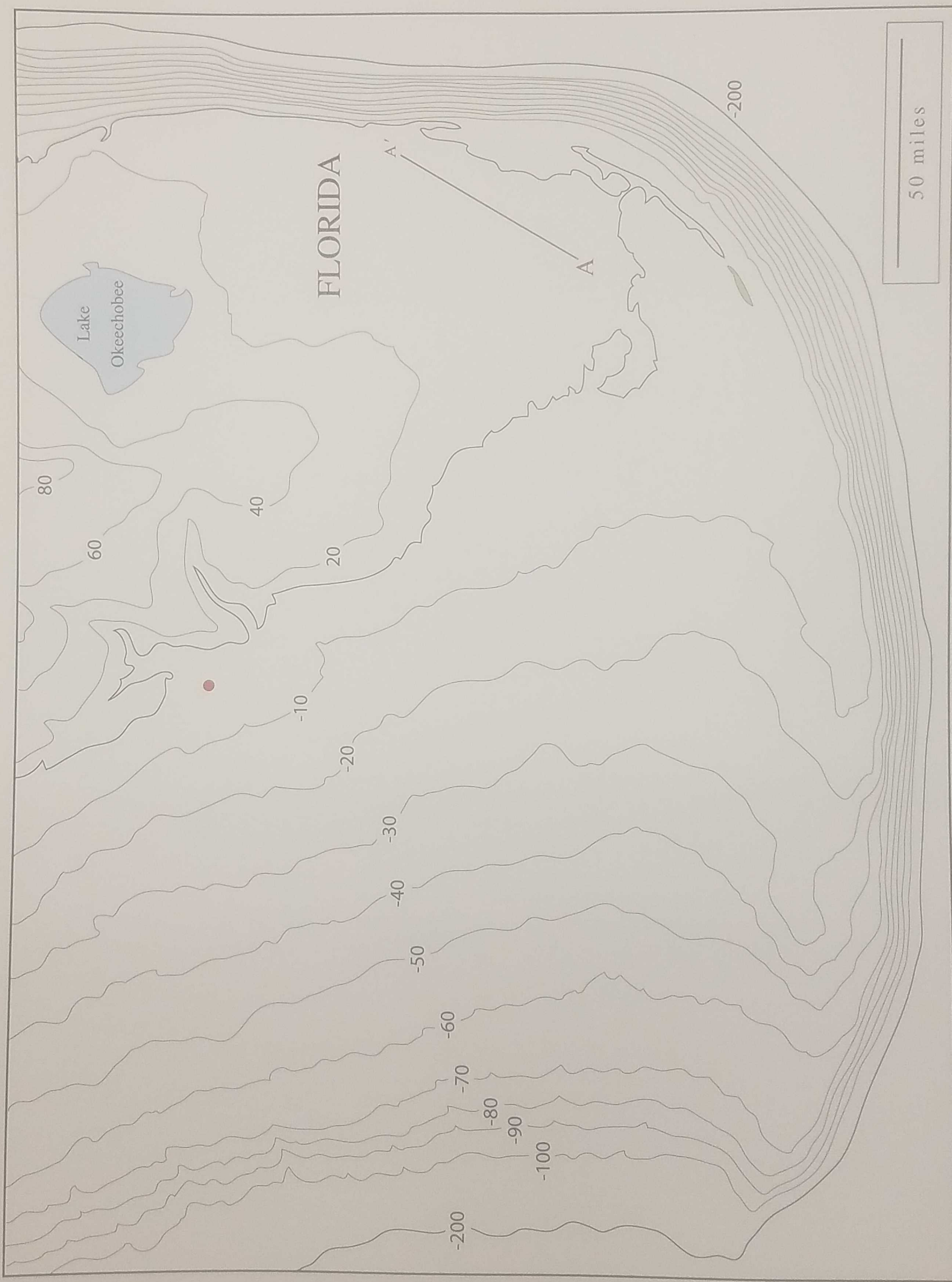
FIGURE 7.9 Vertical succession of Holocene strata that would develop as a function of a future marine transgression.



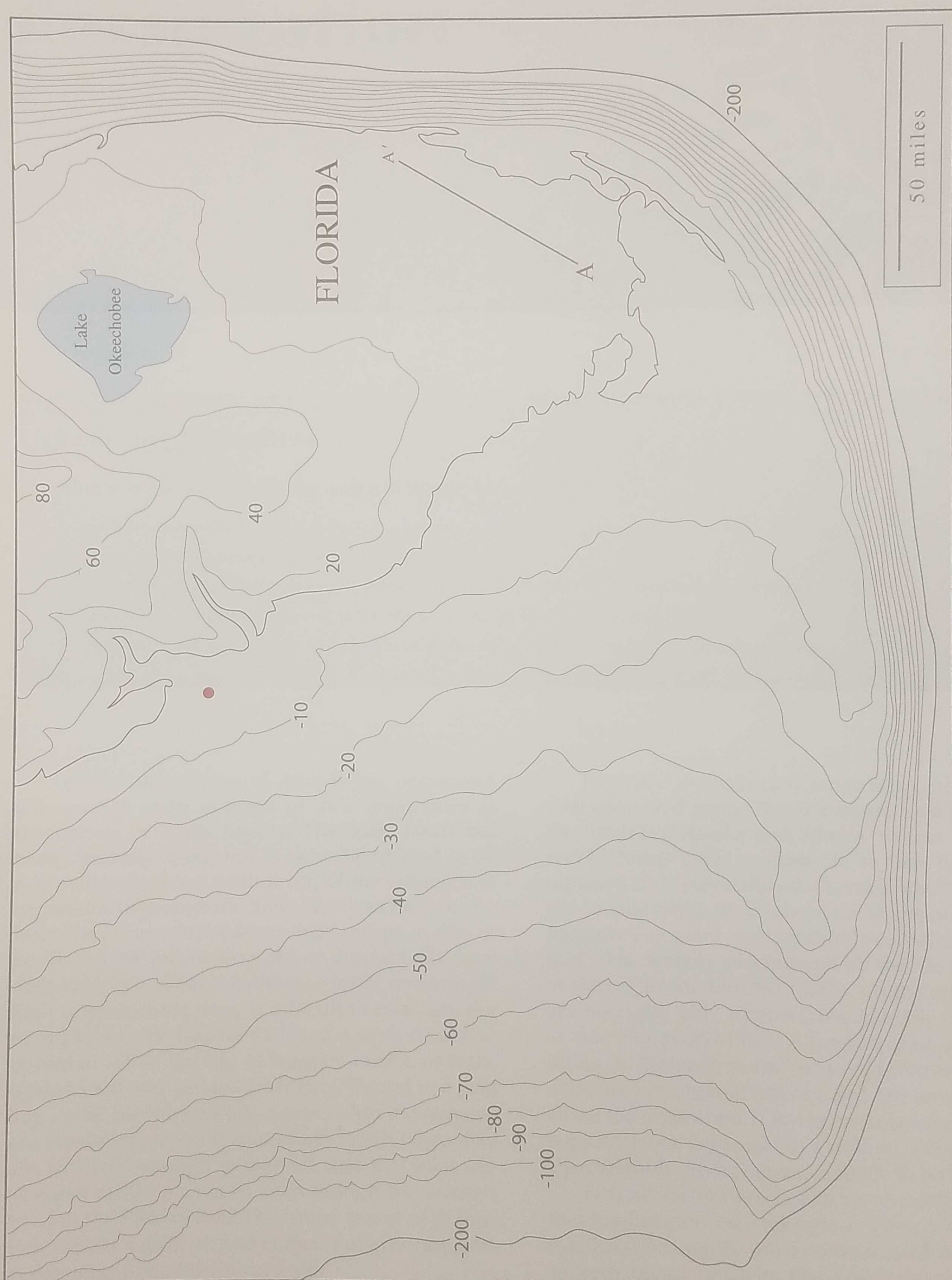
MAP A Florida 7,200 years ago.



Map B Florida 5,000 years ago.



MAP C Florida at modern sea level plus 20 feet.



MAP D Florida at modern sea level plus 70 feet.