

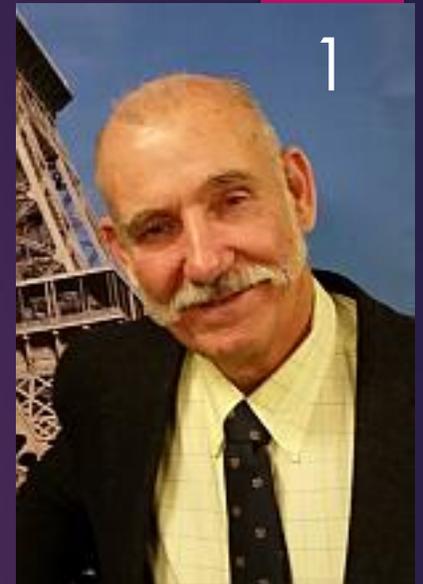
Physical Geology

Lab 12: Oceans and Shorelines

DR. GREGG WILKERSON

MICHAEL OLDERSHAW

SOLUTIONS ARE IN RED



Downloads and Links

- ▶ **Download and view these files prior to the Lab session:**
- ▶ **12 Lab Lecture for Streams**
- ▶ **12 Introduction to Waves and Shoreline Features Exercises**
- ▶ **12 Lab Streams Solutions**

Downloads and Links

- ▶ **Download these maps:**
- ▶ **A-Drake's Bay, California**
- ▶ **B-Morro Bay South, California**
- ▶ **C-Anacapa Island, California**
- ▶ **D-Essex Inlet Aerial photograph**
- ▶ **Open up Photoshop or some other image manipulation program**
- ▶ **Pan around**
- ▶ **Zoom in and out**

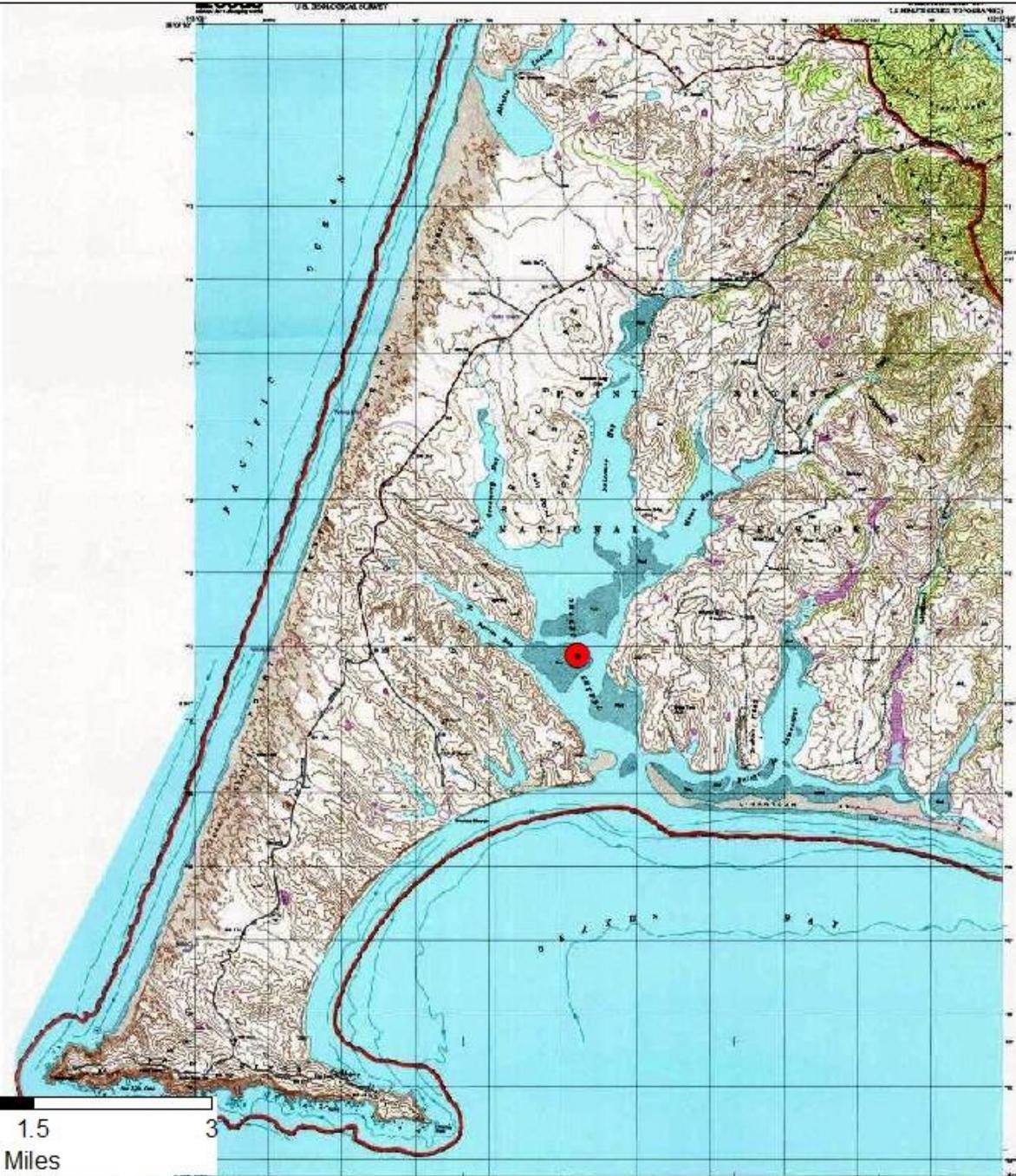


EXERCISE A. Drakes Bay, California

- ▶ 1-What type of feature is Drakes Estero (Drakes Estero photo)?
- ▶ 2-How did it form?
- ▶ 3-Is this an emergent or submergent coastline?
- ▶ 4-What is your evidence (i.e. specifically what is Drakes Estero)?
- ▶ 5-What is Limantour Spit made of (Drakes Estero photo and Drakes Bay Legend photo)?
- ▶ 6-How did Limantour Spit Form?

EXERCISE A-1. Drakes Bay, California

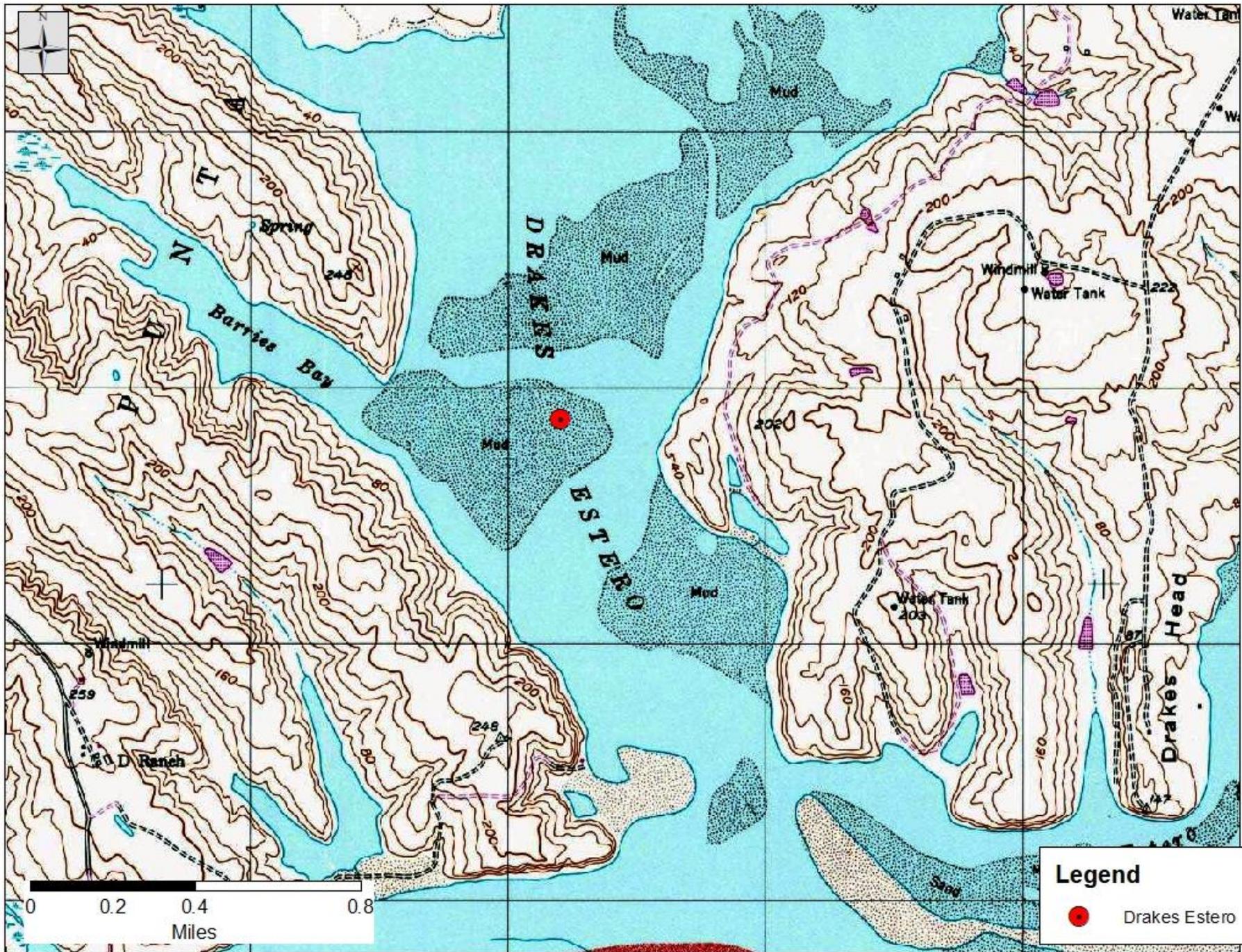
- ▶ 1-What type of feature is Drakes Estero (Drakes Estero photo)?



Legend

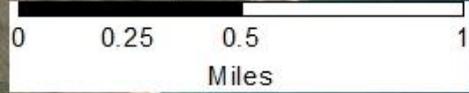
 Drakes Estero





Legend

- Drakes Estero



Legend

- Drakes Estero

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus
DIP, and the GIS User Community



WHAT IS AN ESTUARY?



EXERCISE A-1. Drakes Bay, California

SOLUTION

- ▶ 1-What type of feature is Drakes Estero (Drakes Estero photo)?
- ▶ **A1. Estuary**



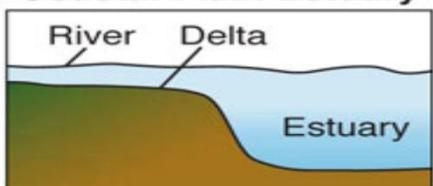
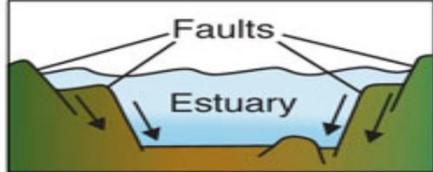
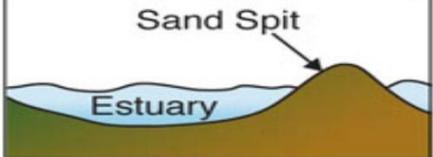
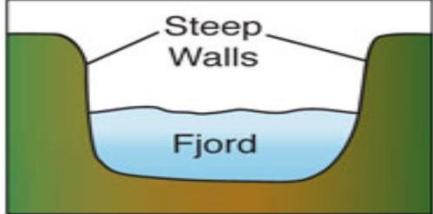
What is an estuary?

An **estuary** is a partly enclosed coastal body of water with one or more rivers or streams flowing into it, and with a free connection to the open sea.



EXERCISE A-2. Drakes Bay, California

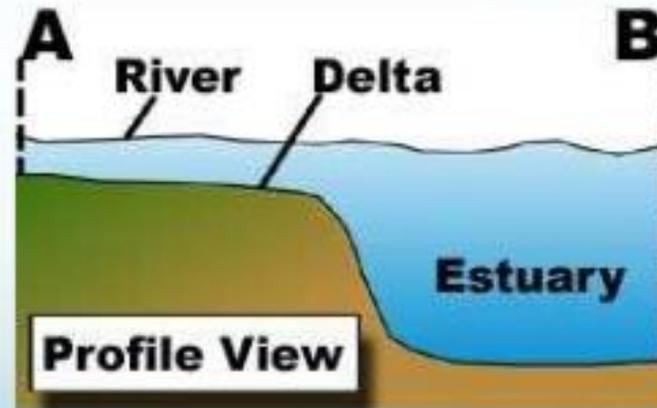
► 2-How did it (Drake's Estero) form?

KIND of Estuaries	IMAGE
<p>A coastal plain estuary is one that formed thousands of years ago at the end of the last ice age. During this time, sea levels were lower than they are today so more coastal land was exposed. As the large ice sheets on land began to melt around 10,000 to 18,000 years ago sea levels began to rise and fill in low-lying river valleys to create coastal plain estuaries.</p>	<p>Coastal Plain Estuary</p> 
<p>Tectonic (fault) estuaries form over time in areas with fault lines. During an earthquake, depressions can occur when land sinks along the fault lines. If the land sinks below sea level and it is near the ocean, the seawater pours into the depression. Over time other faults and depressions allow rivers to do the same and eventually the freshwater and seawater meet to form an estuary.</p>	<p>Tectonic Estuary</p> 
<p>Bar built estuaries, also called restricted mouth estuaries, are created when sandbars and barrier islands are formed after ocean currents push sediment toward the shore in areas fed by rivers and streams.</p>	<p>Bar-Built Estuary</p> 
<p>Fjords are the final type of geologic estuary and they are created by glaciers. As these glaciers move toward the ocean they carve long, deep valleys in the coastlines. After the glaciers later retreat, seawater fills in the valleys to meet freshwater coming in from the land to form estuaries.</p>	<p>Fjord</p> 
<p>Deltas are a type of geologic estuary that form at the mouth of a large river where sediment and silt carried by the river are deposited where the river meets the ocean. In these areas the sediment accumulates and overtime wetlands and marshes form as part of an estuary system.</p>	

Types

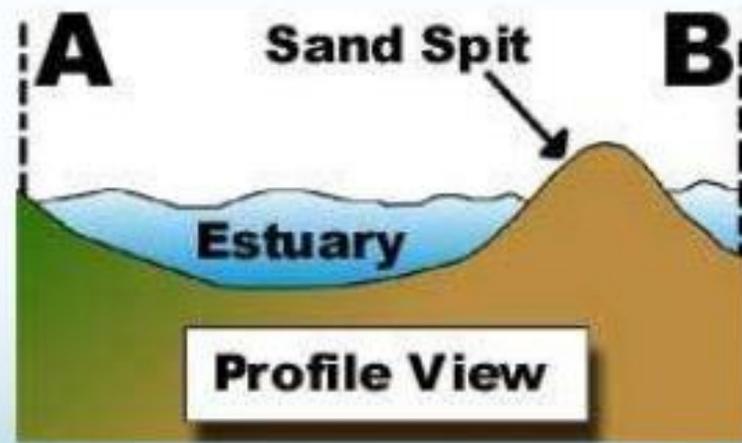
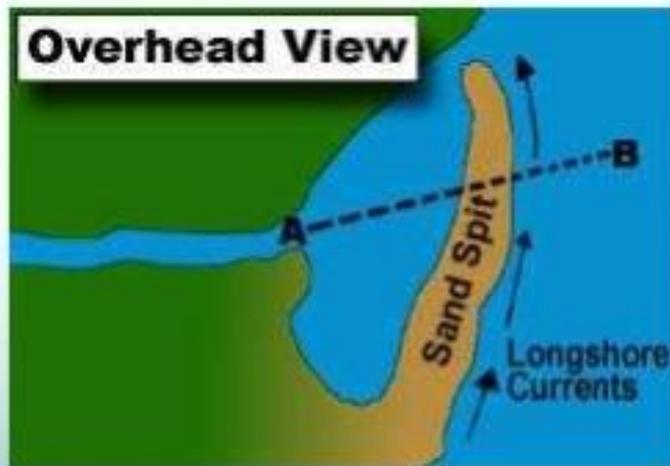
- Estuaries are divided into four types, depending on how they are formed:

1. Coastal Plain Estuaries are formed by the sea level rising and filling an existing river valley.



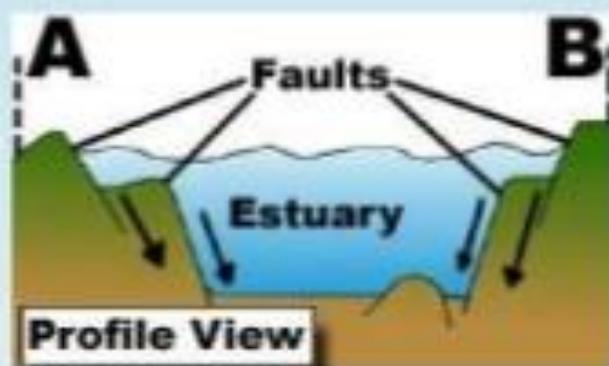
Types

3. **Bar-built Estuaries** form when a shallow lagoon or bay is protected from the ocean by a sand bar or barrier island.



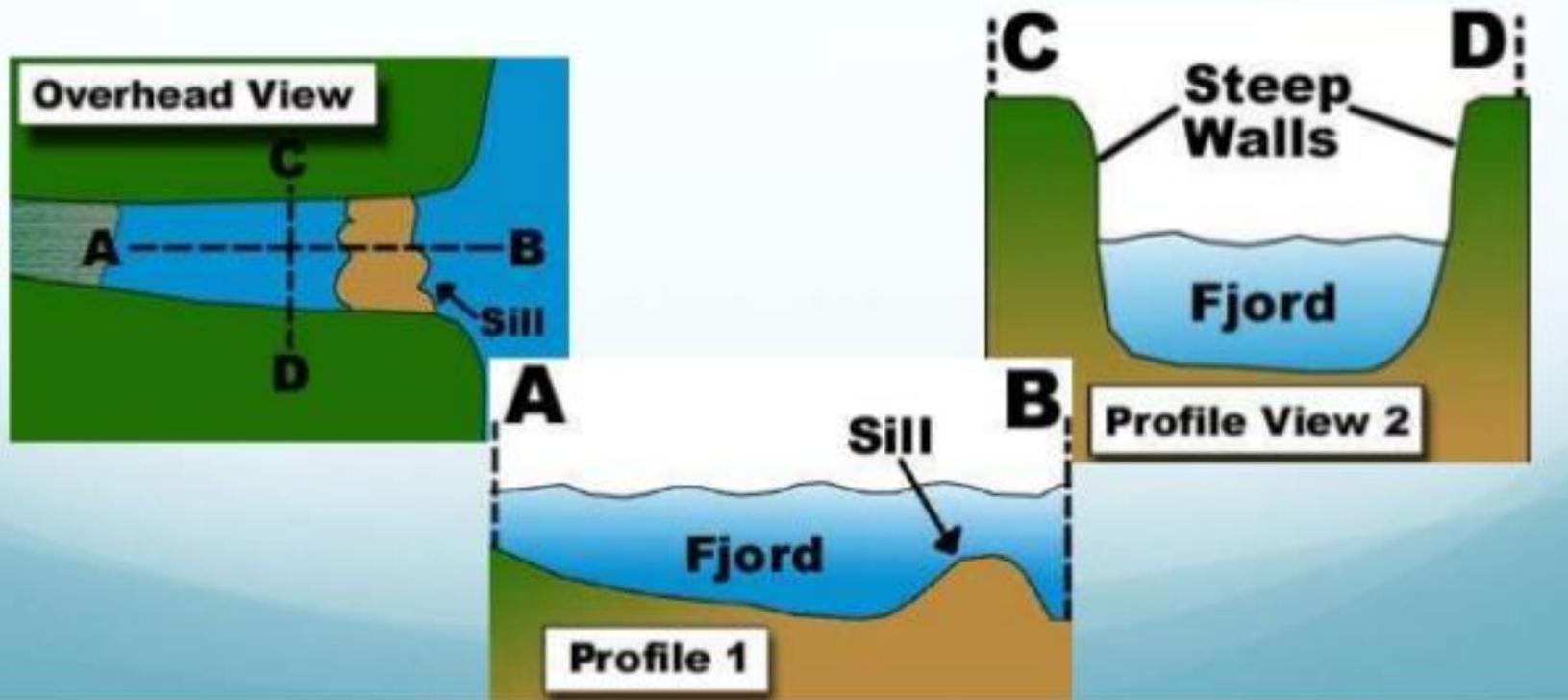
Tectonic Estuaries

- Tectonic Estuaries are formed by the movement of the Earth's crust. It can cause a section to sink or subside. This creates a depression or basin. Most of these estuaries form along the fault lines when earthquakes occur. The seawater and freshwater that pours into these estuaries after it's creation is the estuary. A good example would be the San Francisco Bay. It's right on a fault line and the area is known for it's earthquakes.



Types

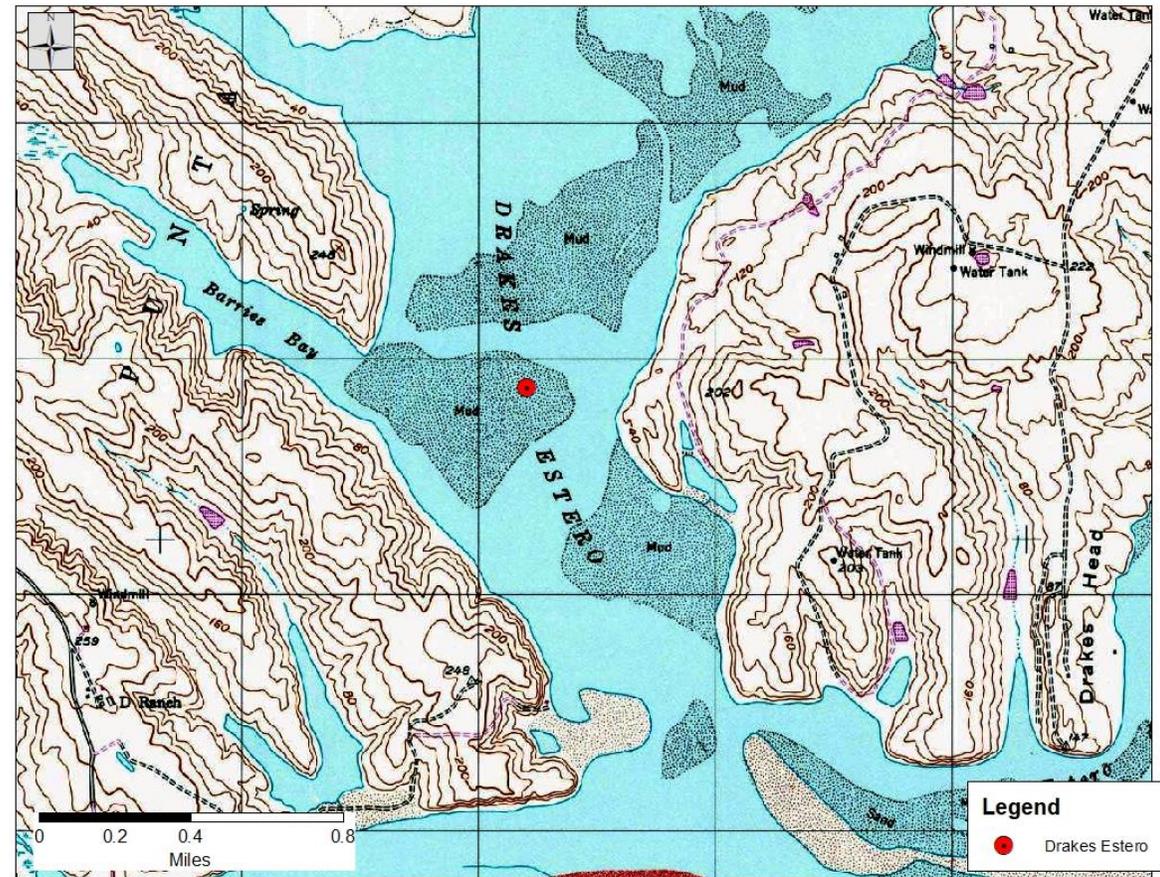
4. **Fjords are U-shaped** valleys formed by glacial action. Fjords are found in areas with long histories of glacier activity, like northern Europe, Alaska and Canada.



EXERCISE A-2. Drakes Bay, California

SOLUTION

- ▶ 2-How did it (Drake's Estero) form?
- ▶ **A2. The estuary is a flooded (submergent) river coastal floodplain due to sea level rise.**



EXERCISE A-3. Drakes Bay, California

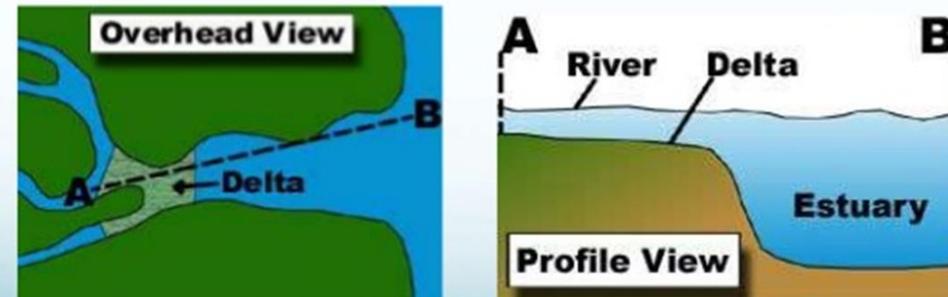
SOLUTION

- ▶ 3-Is this (Drake's Bay) an emergent or submergent coastline?
- ▶ **3A. The estuary is submergent in relation to the older floodplain**

Types

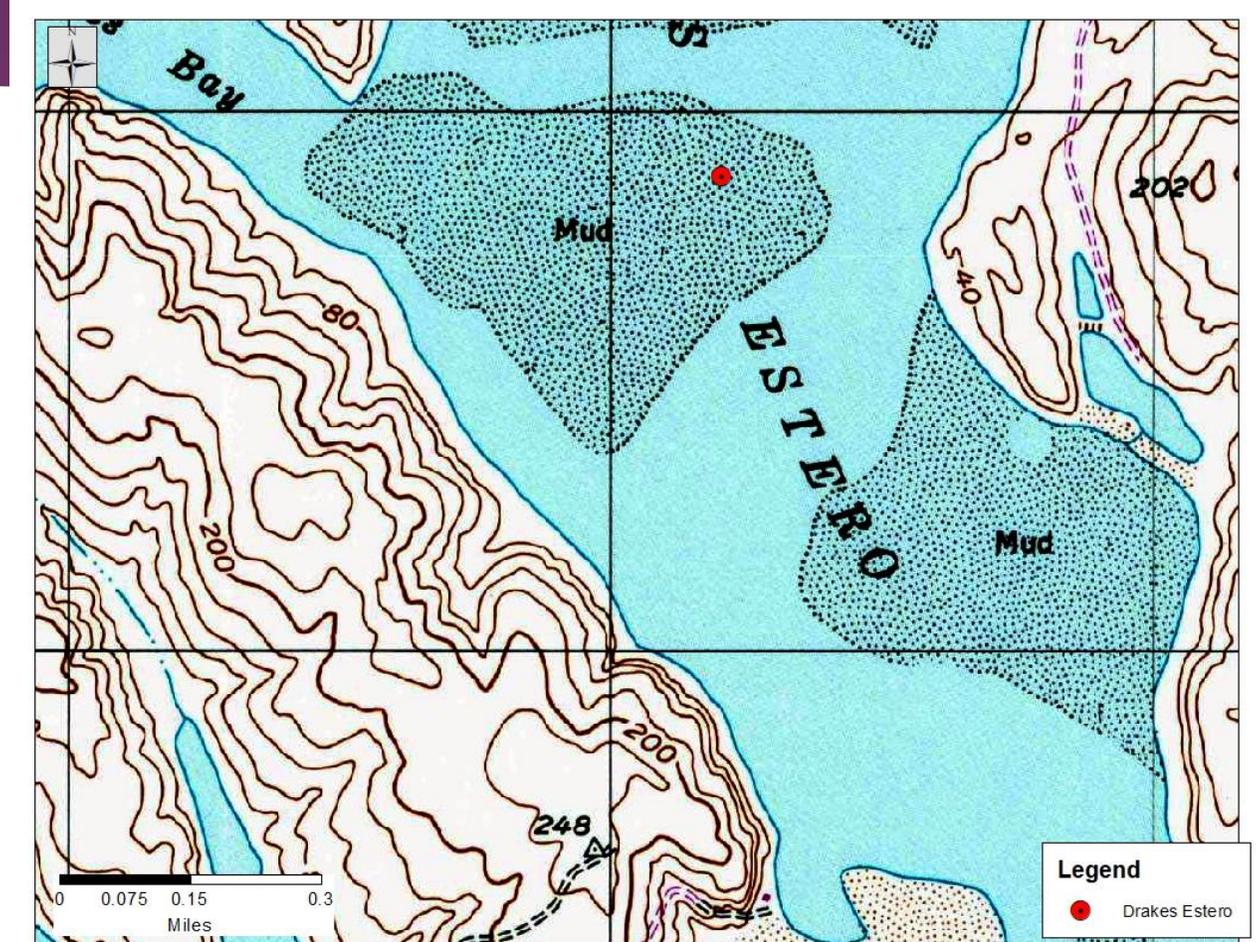
- Estuaries are divided into four types, depending on how they are formed:

- 1. Coastal Plain Estuaries** are formed by the sea level rising and filling an existing river valley.



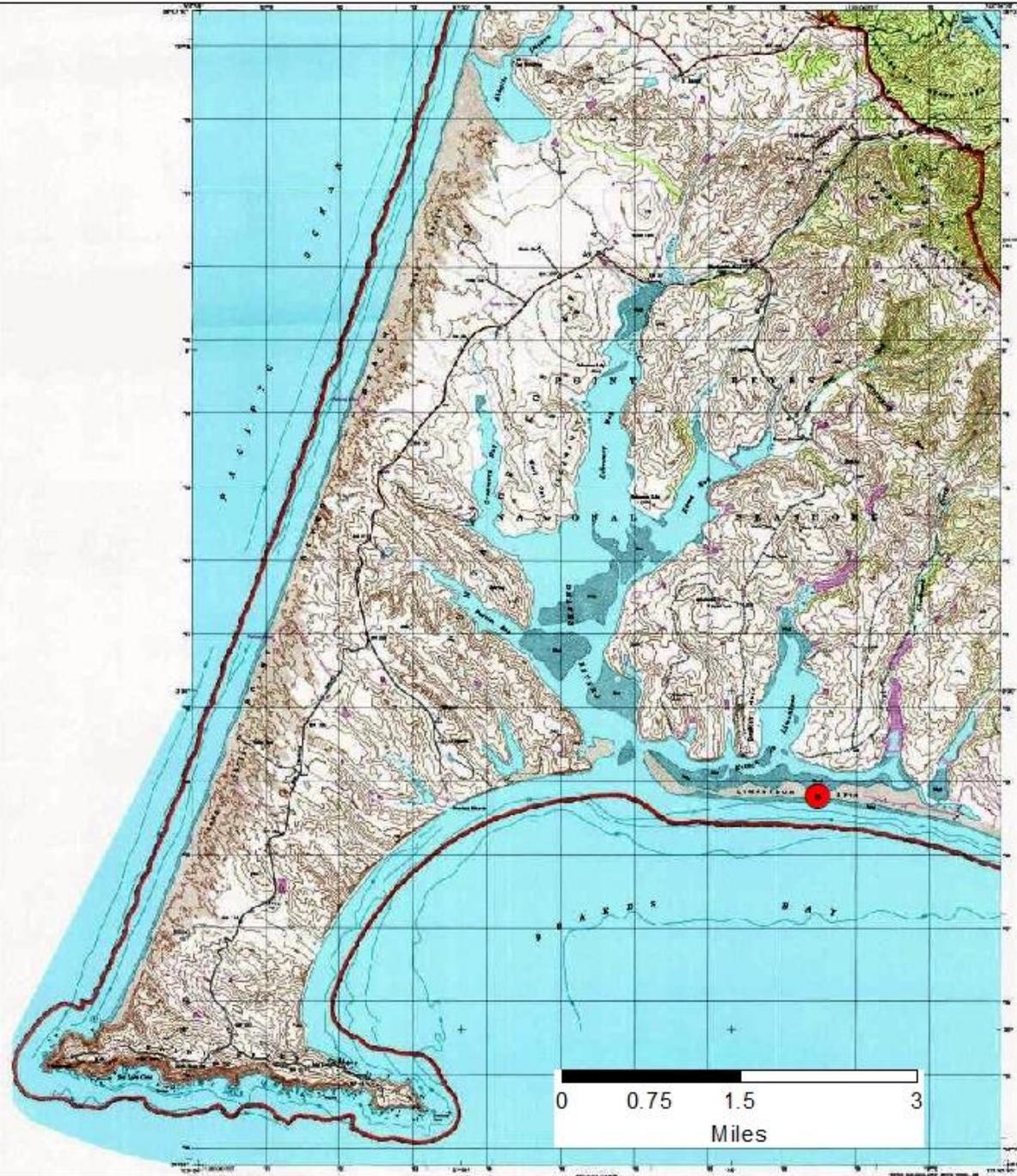
EXERCISE A-4. Drakes Bay, California

- ▶ 4-What is your evidence (i.e. specifically what is Drakes Estero)?
- ▶ **A4. Topographic lines are close together as they approach the water. So these are steep cliffs that at one time extended down to the bottom of a fluvial system. Now that steep river valley has been filled in with mud as indicated on the topographic map for the area of Drake's Estero. It is a drowned and now sediment-filled river valley.**



EXERCISE A-5. Drakes Bay, California

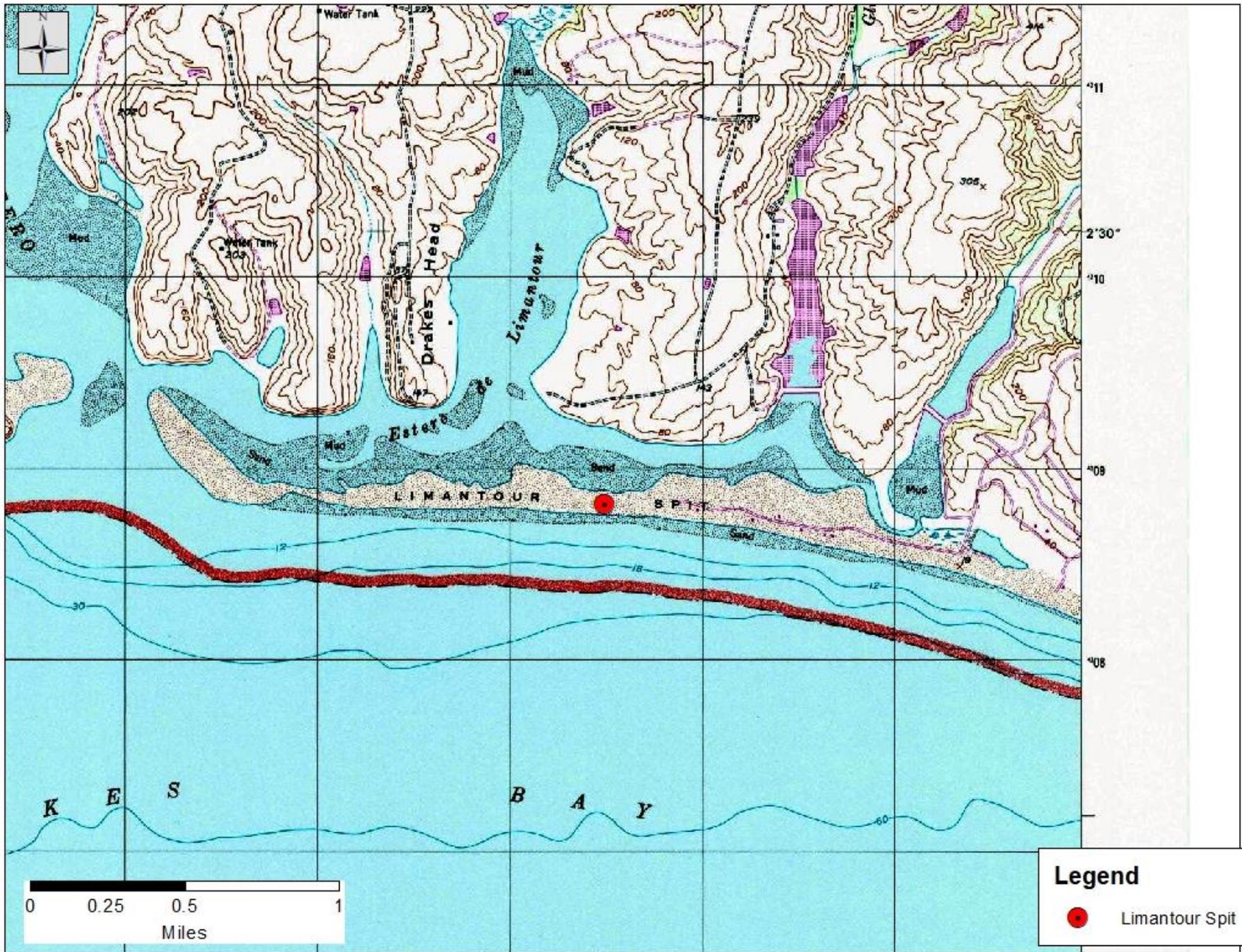
- ▶ **5-What is Limantour Spit made of (Drakes Estero photo and Drakes Bay Legend photo)?**

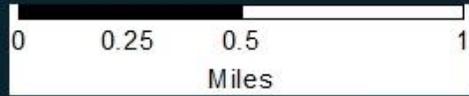
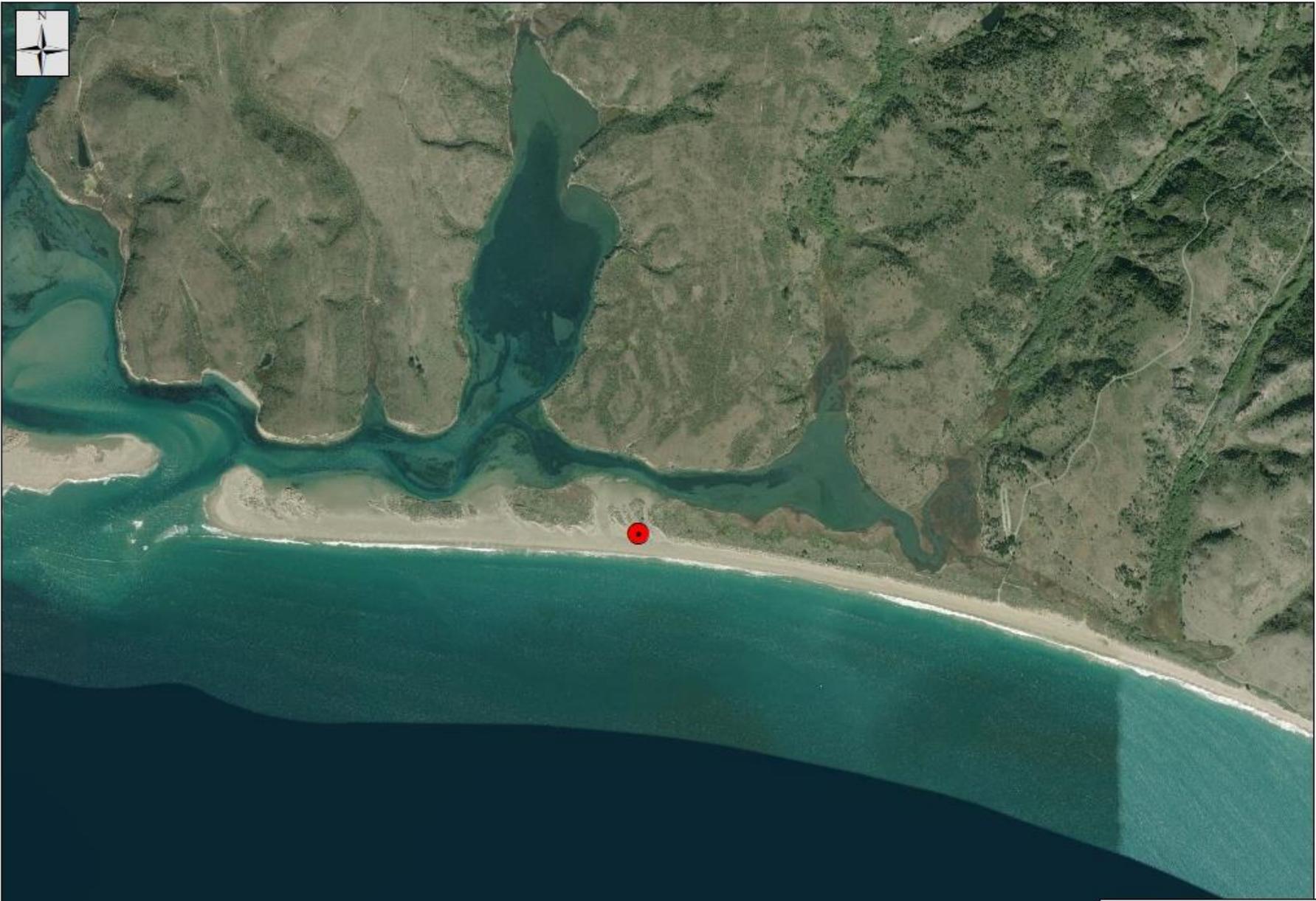


Legend

- Limantour Spit







Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus
IPN, and the GIS User Community

Legend

● Limantour Spit



EXERCISE A-5. Drakes Bay, California

SOLUTION

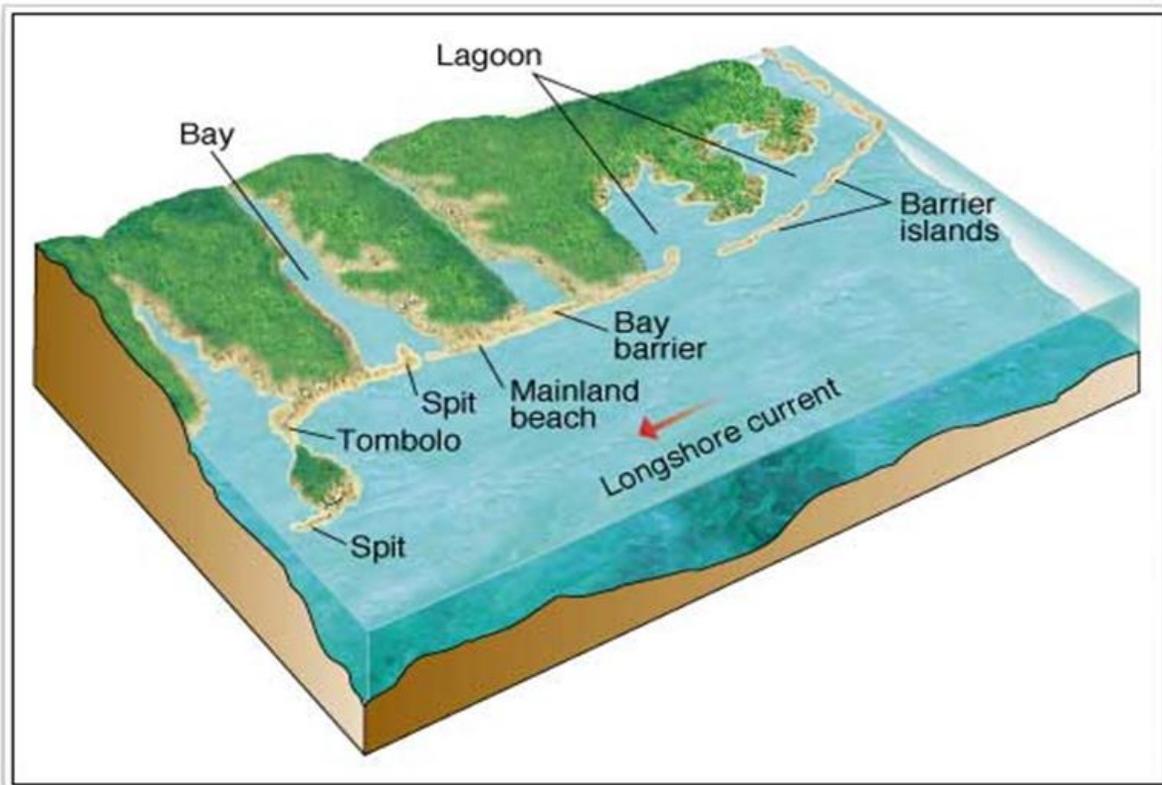
- ▶ 5-What is Limantour Spit made of (Drakes Estero photo and Drakes Bay Legend photo)?
- ▶ **A5. Sand Dunes**



EXERCISE A-6. Drakes Bay, California

SOLUTION

- ▶ 6-How did Limantour Spit Form?
- ▶ **A6. Longshore Current**

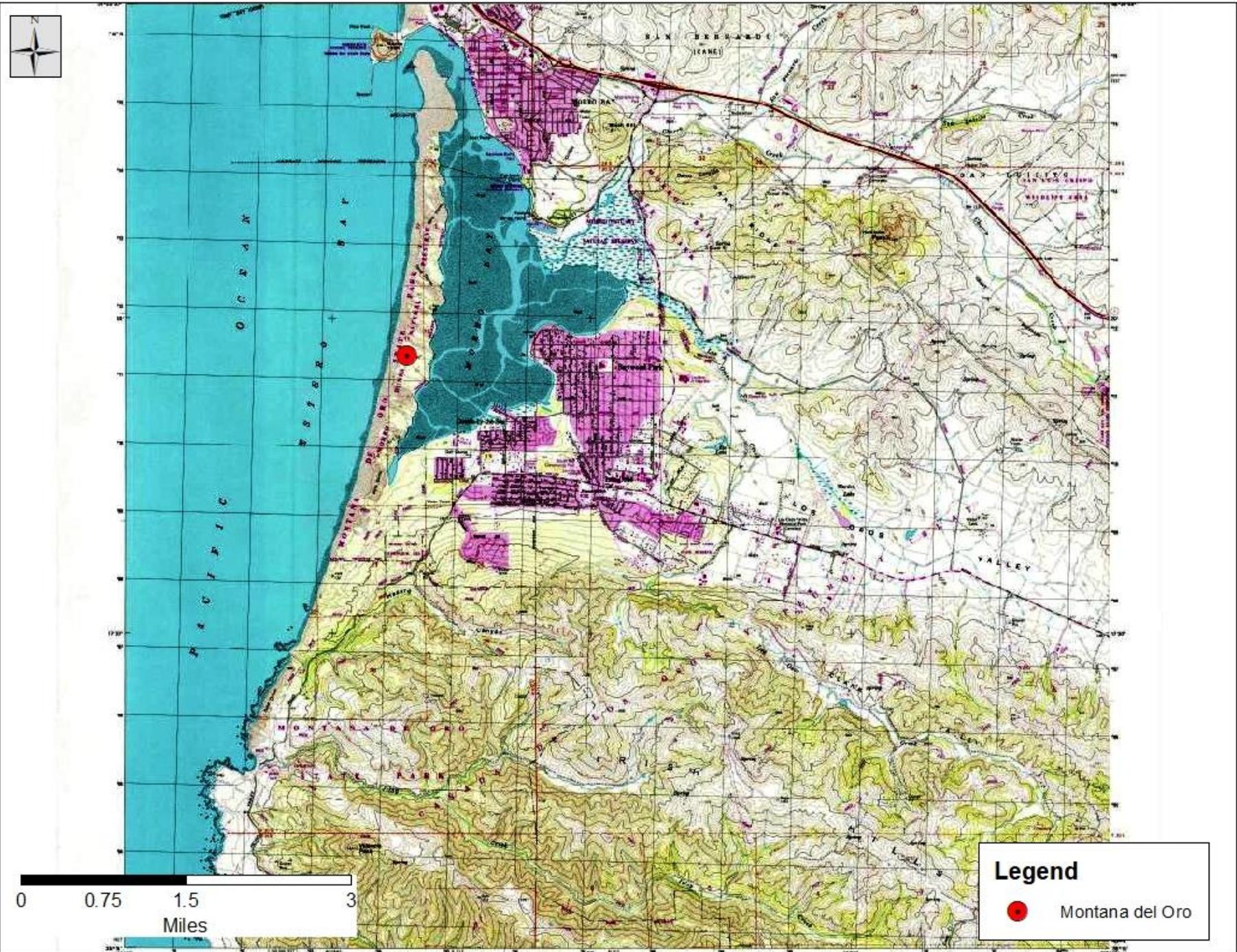


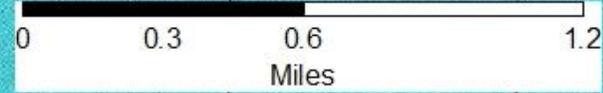
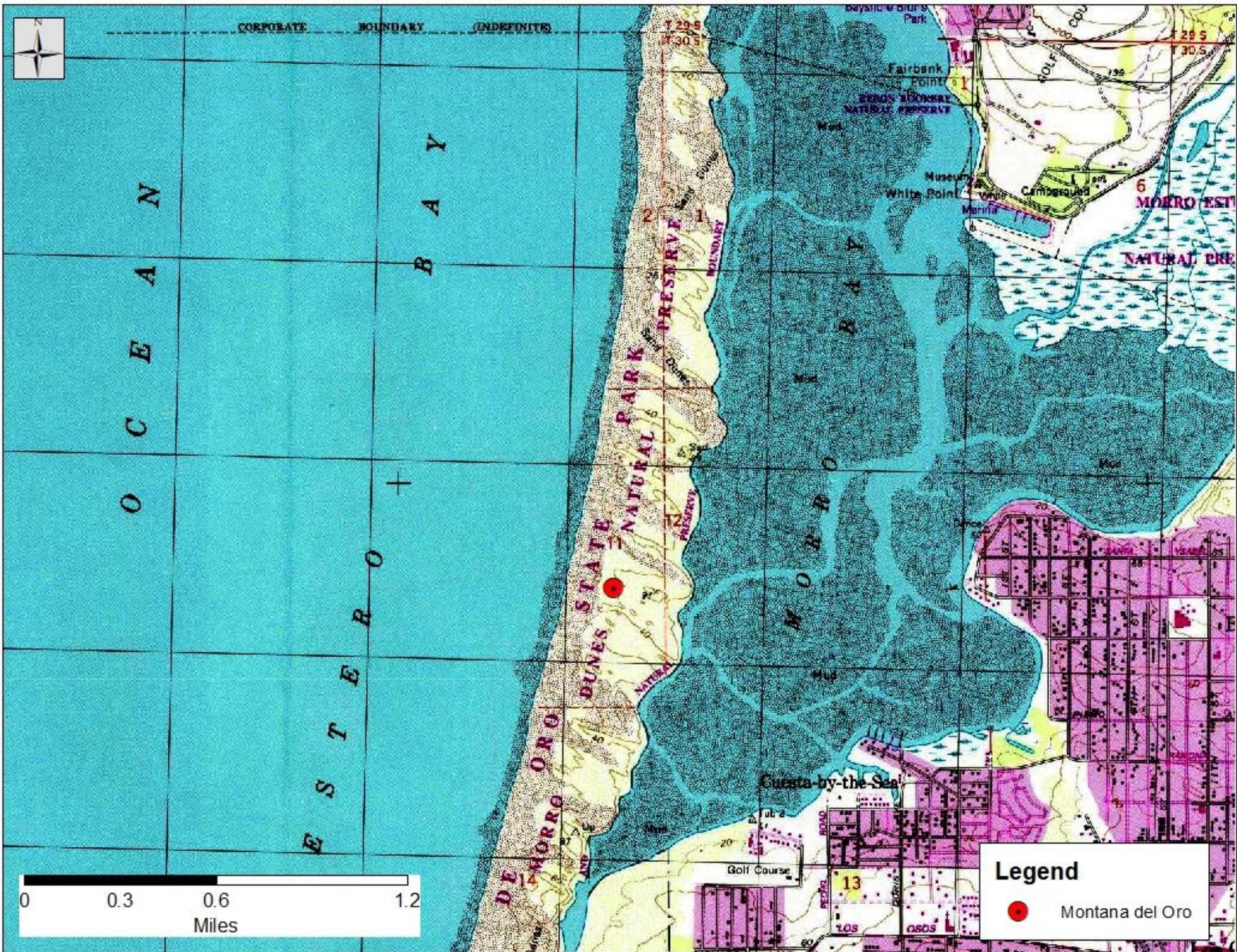
EXERCISE B. Morro Bay South, California

- ▶ 1-What is the feature labeled “Montana de Oro State Park” (Montana de Oro Park photo)?
- ▶ 2-What would it become if Morro Bay Harbor were not dredged?
- ▶ 3-What direction is the longshore current flowing in this area?
- ▶ 4-What feature connects Morro Rock to the mainland (Morro Rock photo)?
- ▶ 5-Look very carefully at the south end of the map and you will see areas where the contour lines are widely spaced indicating broad, flat platforms. What are these features (Montana de Oro photo)?
- ▶ 6-Is this area an emergent or submergent coastline?
- ▶ 7-What is your evidence (i.e. what are the platforms)?
- ▶ 8-Consider your answer to Question 6 above and your answer to Question 3 in the previous section (Drakes Bay). If they are different, what does that imply about sea level changes in Drakes Bay and Morro Bay which are less than 450 km apart (i.e. are the changes local or global)?
- ▶ 9-If the sea level changes are different, how is this possible?

EXERCISE B. Morro Bay South, California

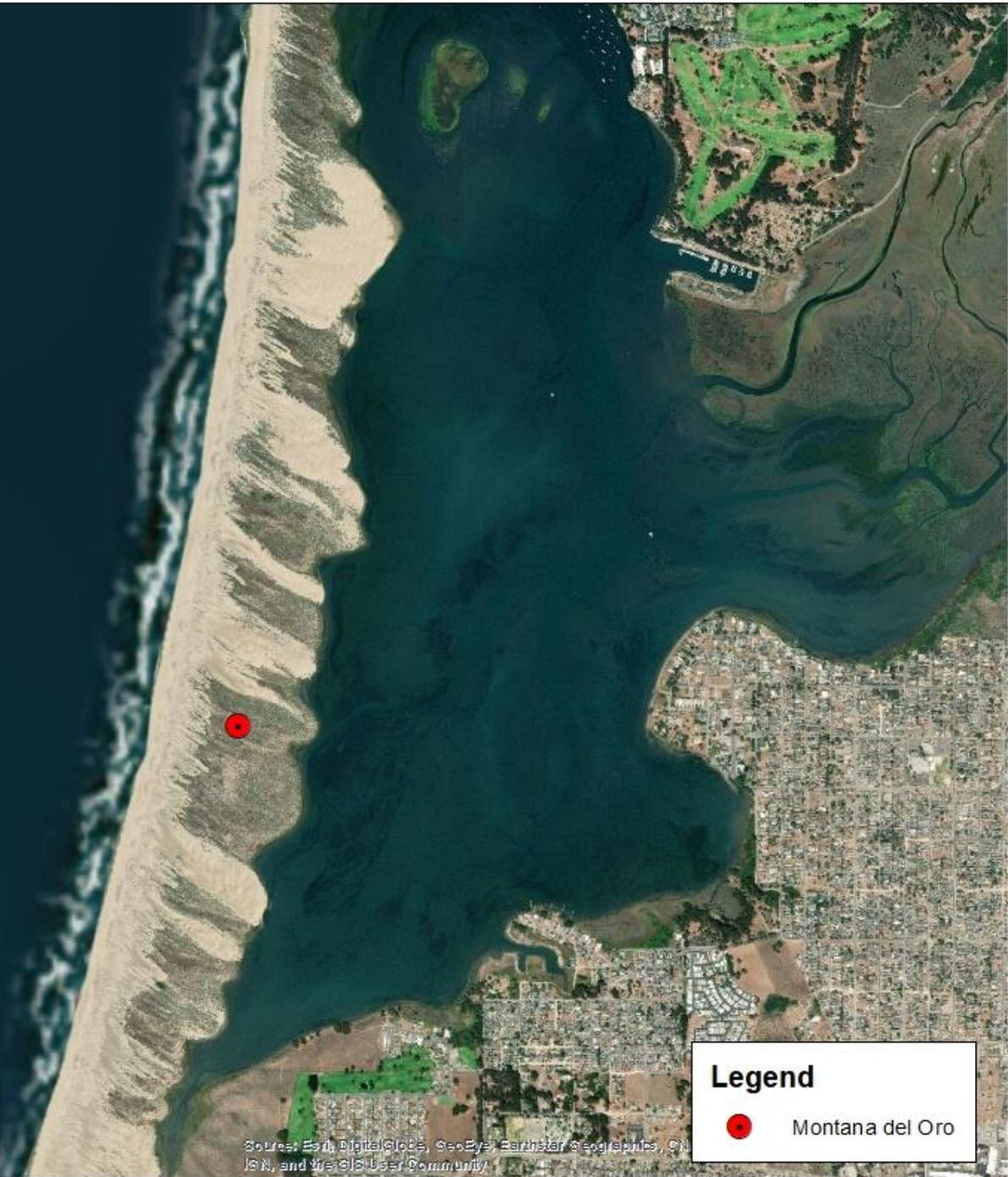
- ▶ 1-What is the feature labeled “Montana de Oro State Park” (Montana de Oro Park photo)?





Legend

- Montana del Oro

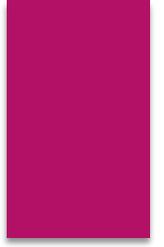


Legend

- Montana del Oro

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNR, IGN, and USDA User Community





EXERCISE B-1. Morro Bay South, California SOLUTION

- ▶ 1-What is the feature labeled “Montana de Oro State Park” (Montana de Oro Park (photo))?
- ▶ **A1. Sand Spit**



Sand Spit

EXERCISE B-2. Morro Bay South, California

- ▶ **2-What would it become if Morro Bay Harbor were not dredged?**



Legend

- Montana del Oro

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNR, IN, and the GIS User Community





EXERCISE B-2. Morro Bay South, California SOLUTION

- ▶ 2-What would it become if Morro Bay Harbor were not dredged?
- ▶ **A2. Baymouth Bar**

Baymouth bar

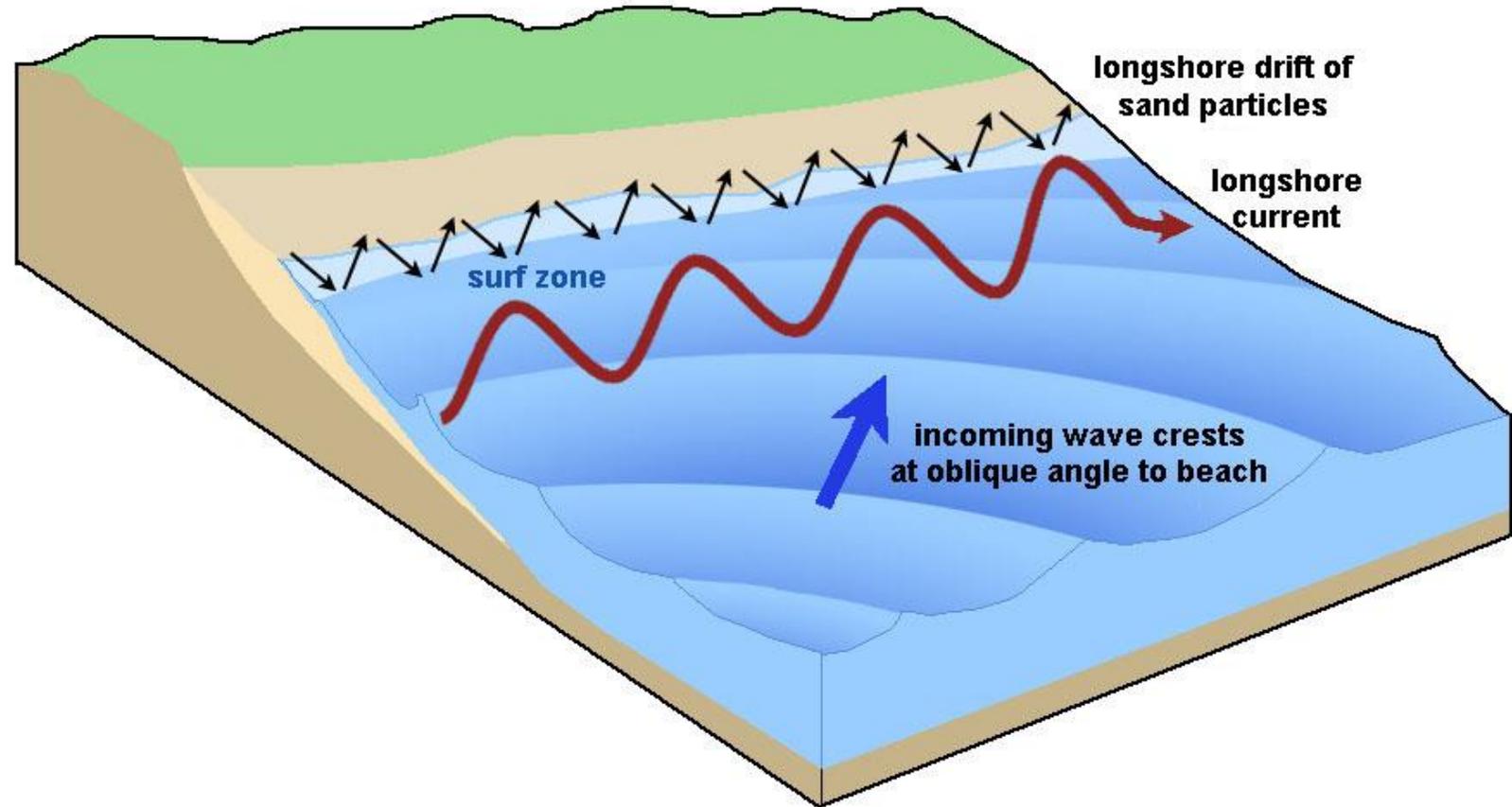
- A sand bar that completely crosses a bay, sealing it off from the open ocean.
- Such a feature tends to form across bays where currents are weak, allowing a spit to extend to the other side.



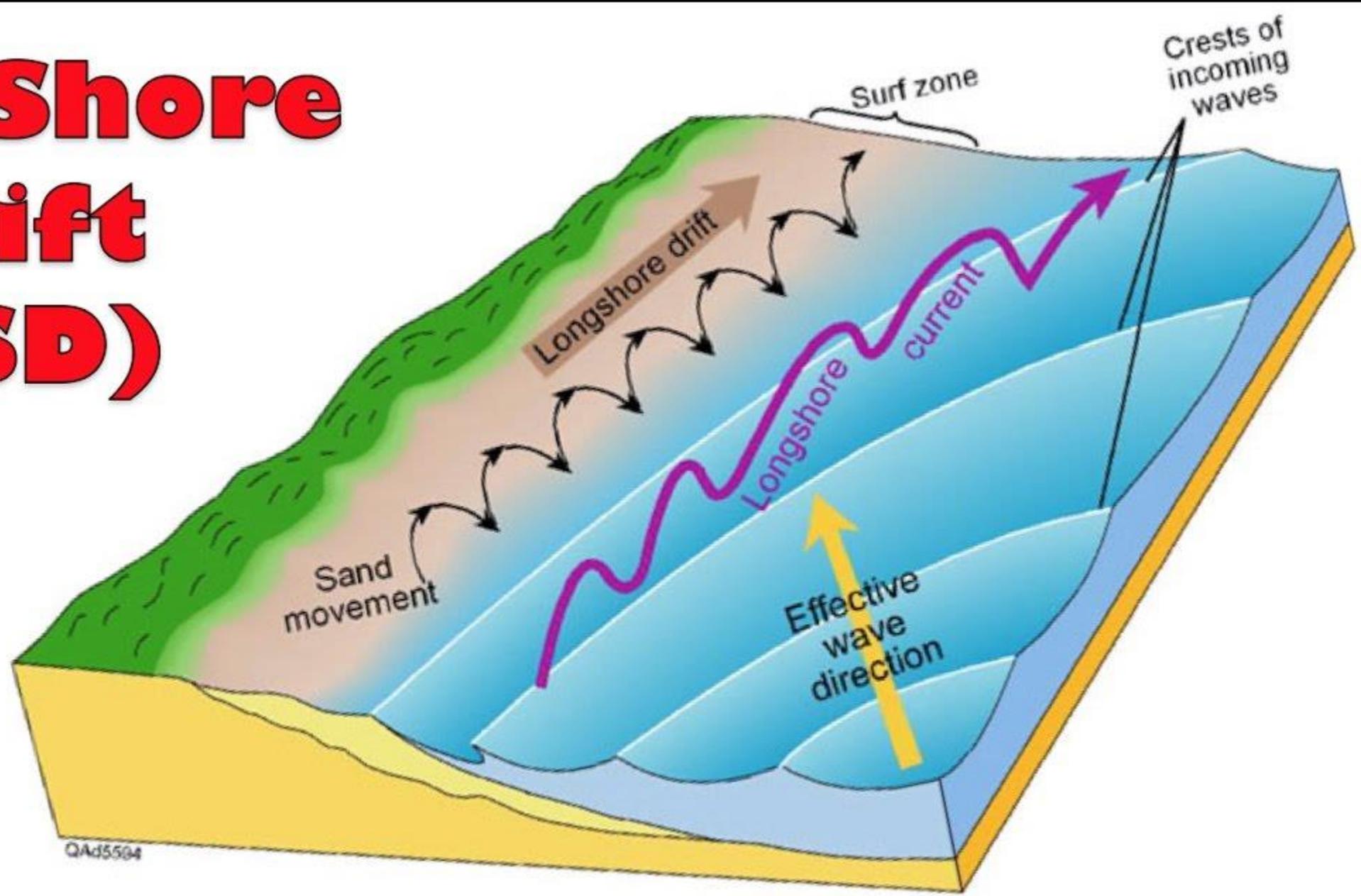
Baymouth barrier, Grand Beach, Lake Winnipeg, Manitoba

EXERCISE B-3. Morro Bay South, California

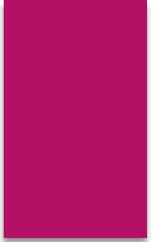
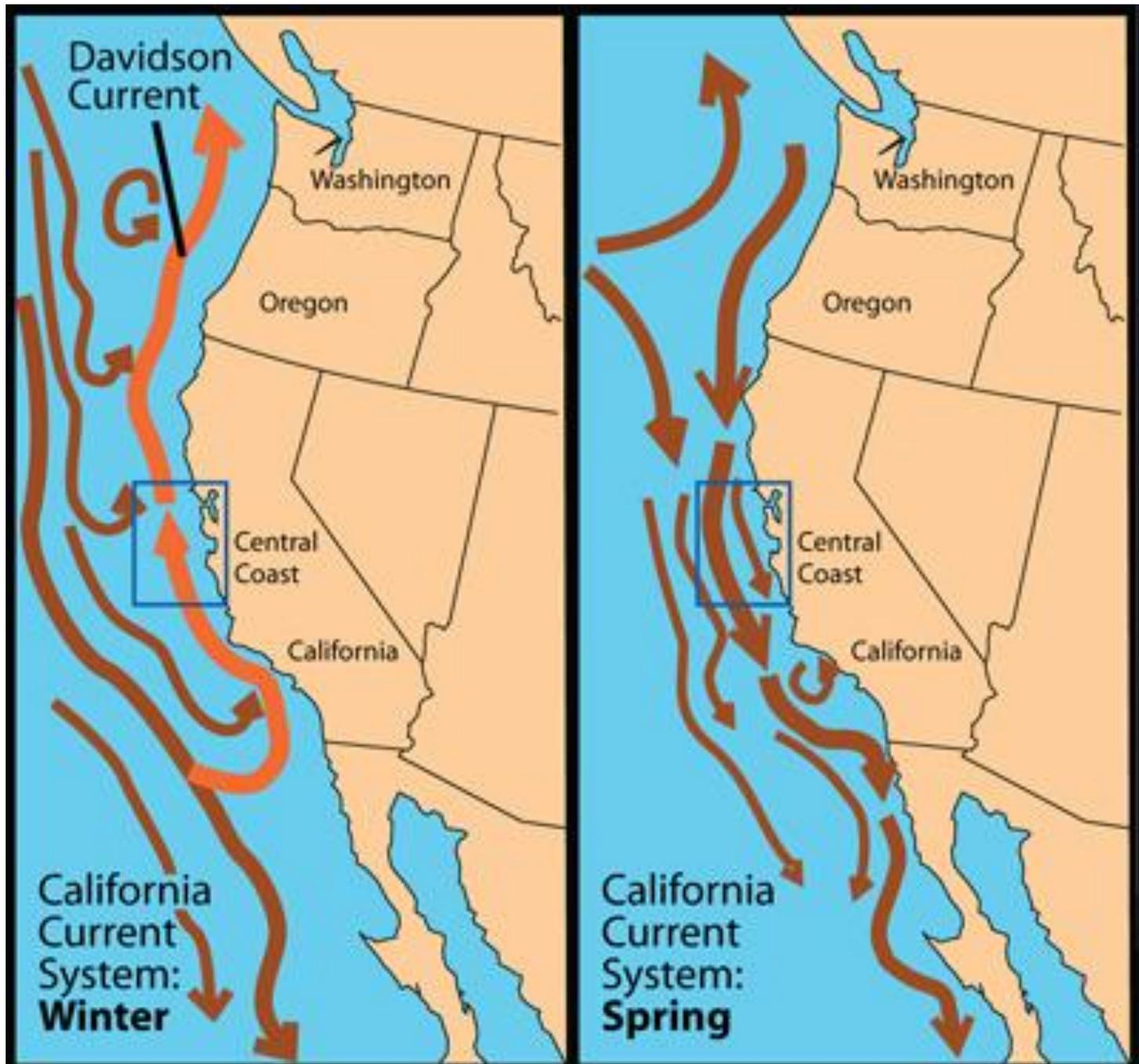
- ▶ 3-What direction is the longshore current flowing in this area?



Long Shore Drift (LSD)

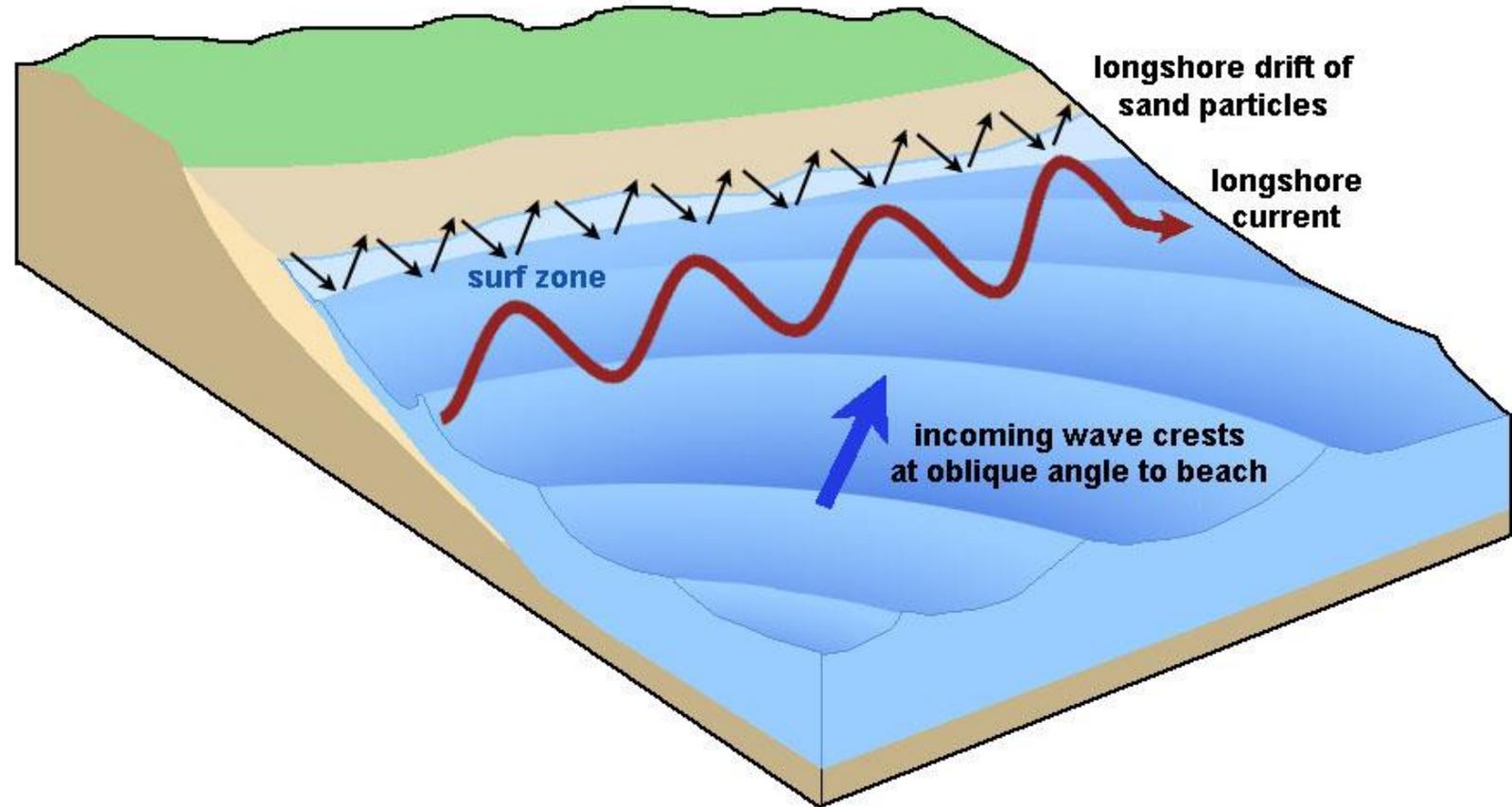


QA45504



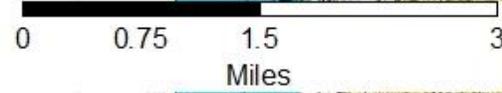
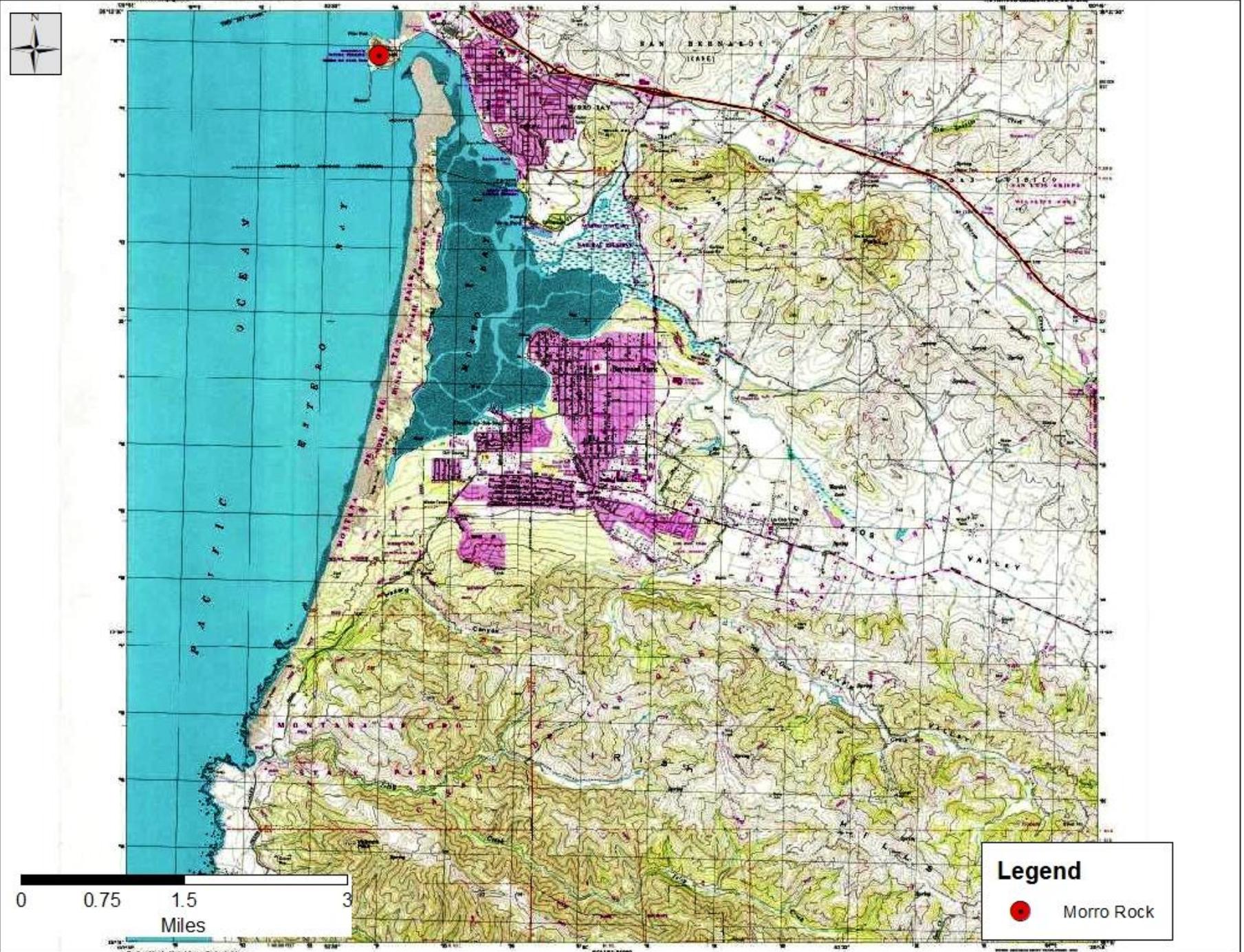
EXERCISE B-3. Morro Bay South, California SOLUTION

- ▶ 3-What direction is the longshore current flowing in this area?
- ▶ **3A. From south to north**



EXERCISE B-4. Morro Bay South, California

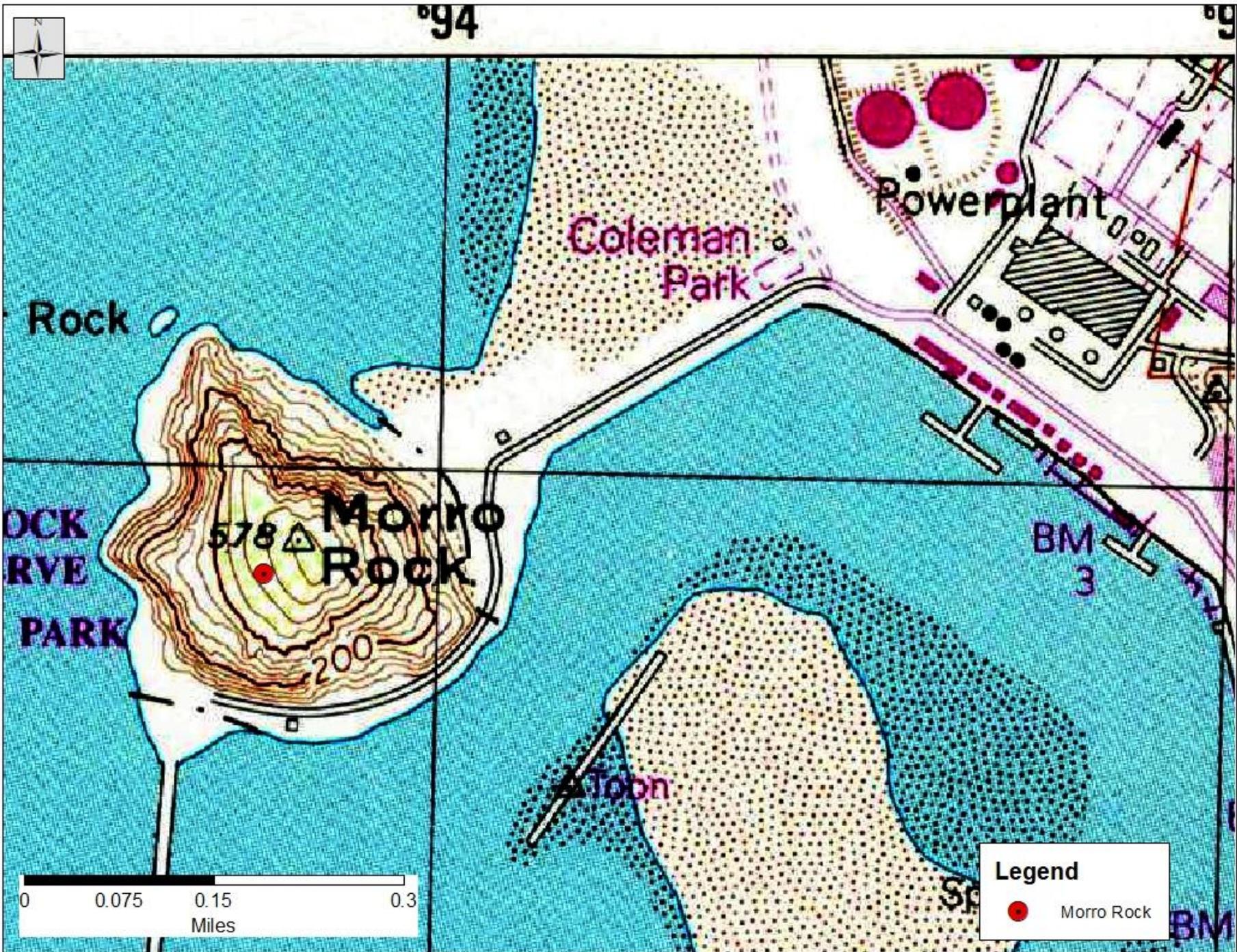
- ▶ **4-What feature connects Morro Rock to the mainland (Morro Rock photo)?**



Legend

- Morro Rock







TOMBOLO



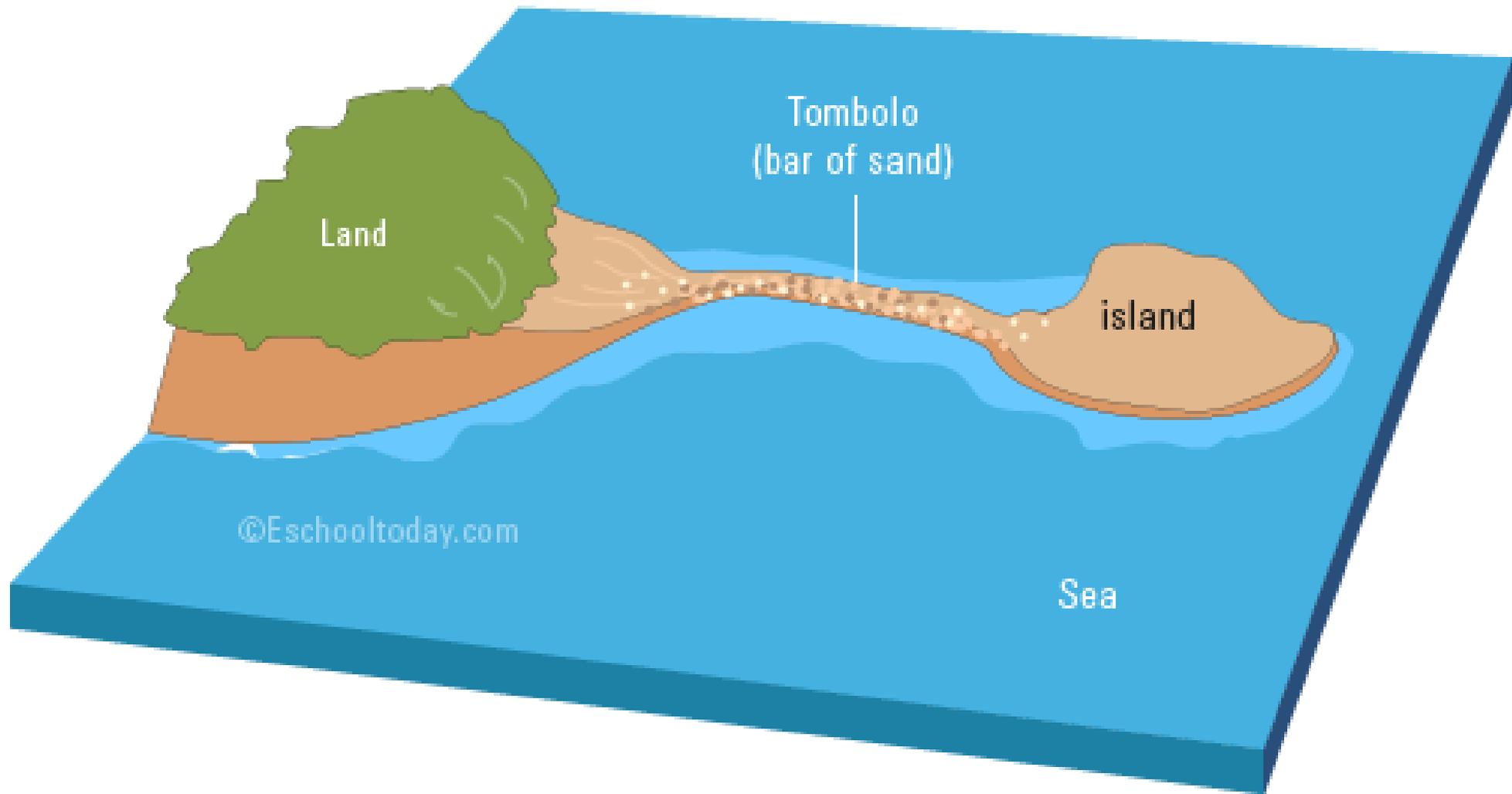
Legend

-  Morro Rock

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CN
IGN, and the GIS User Community

©2010





Land

Tombolo
(bar of sand)

island

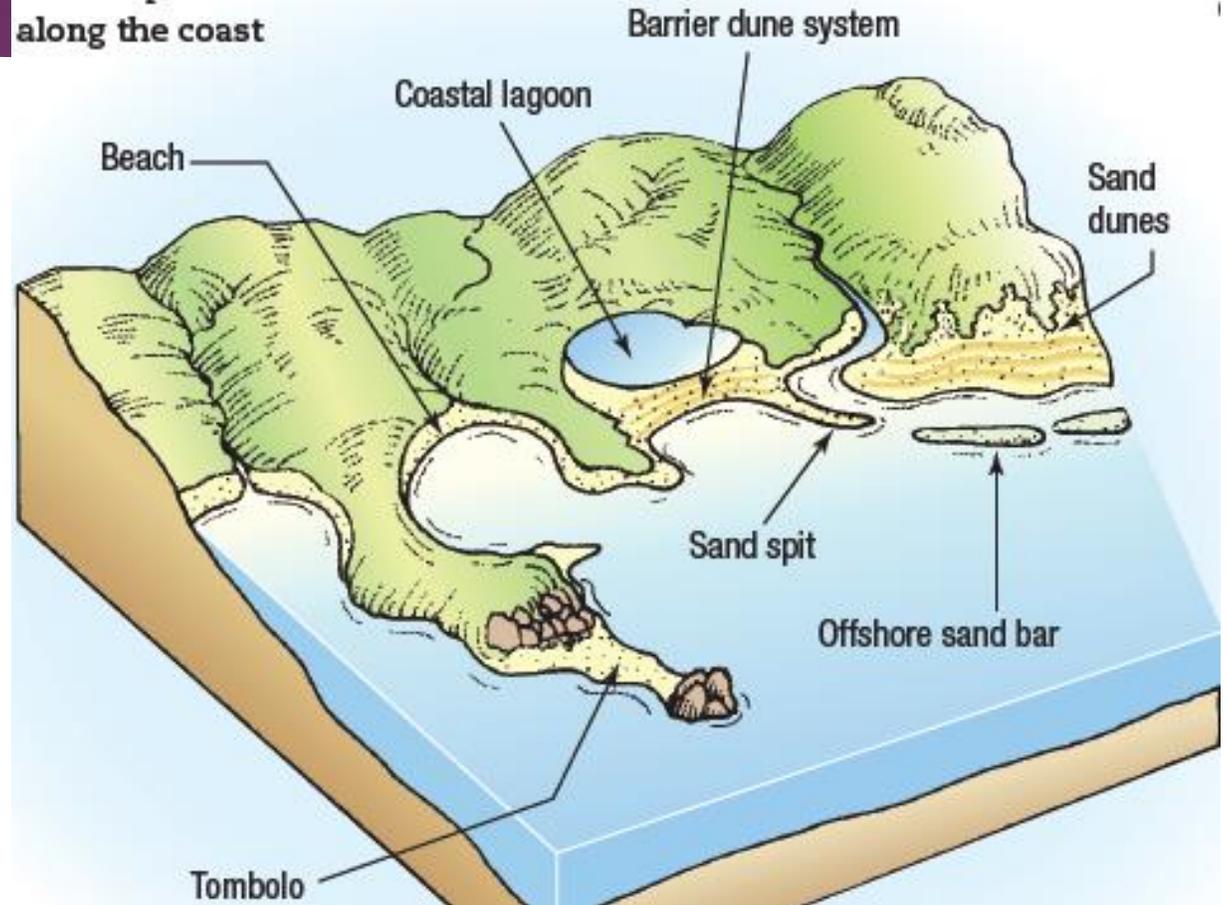
Sea

©Eschooltoday.com

EXERCISE B-4. Morro Bay South, California SOLUTION

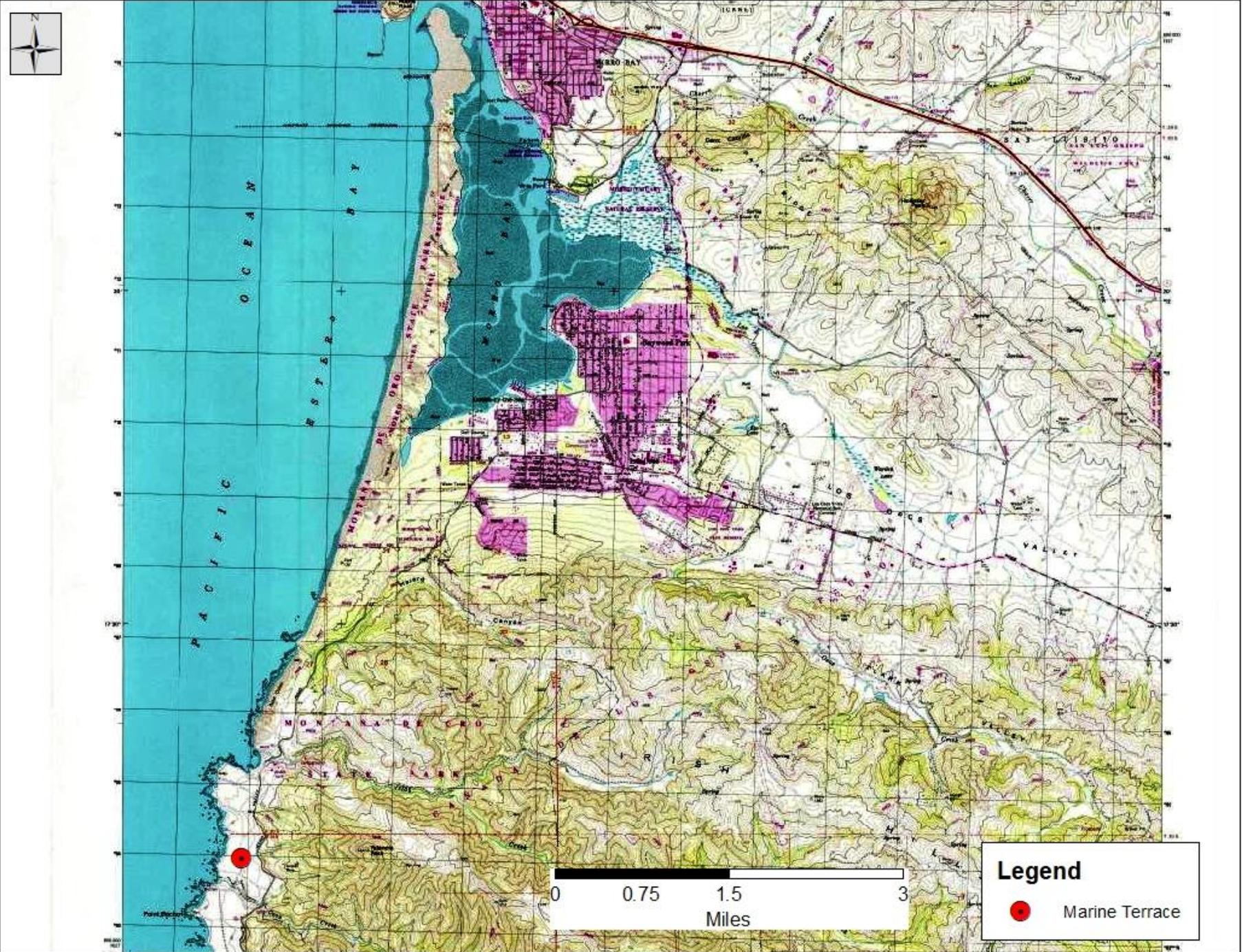
- ▶ 4-What feature connects Morro Rock to the mainland (Morro Rock photo)?
- ▶ **4A. Tombolo**

7.13 Depositional landforms along the coast



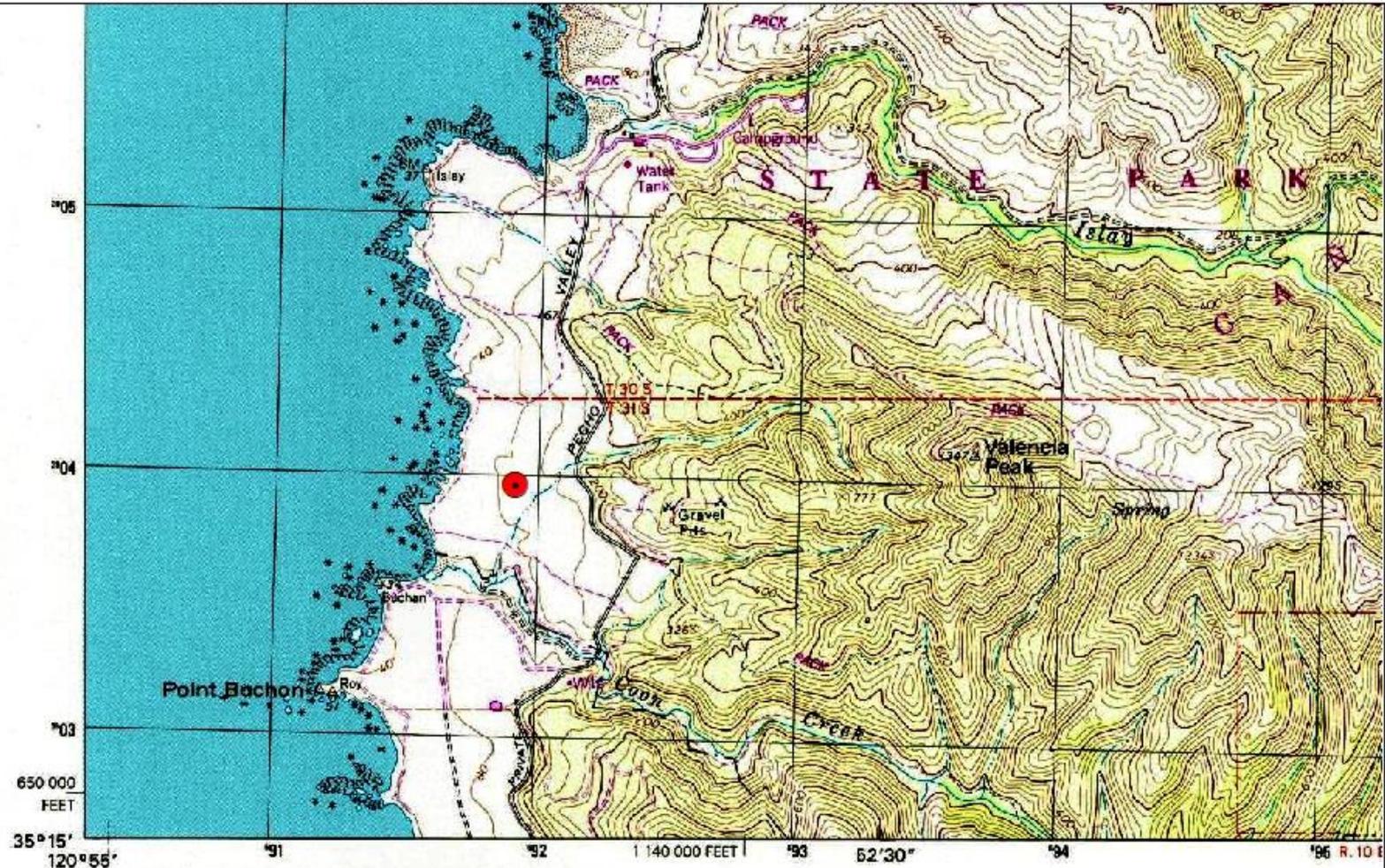
EXERCISE B-5. Morro Bay South, California

- ▶ **5-Look very carefully at the south end of the map and you will see areas where the contour lines are widely spaced indicating broad, flat platforms. What are these features (Montana de Oro photo)?**



Legend
● Marine Terrace





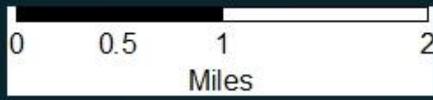
Produced by the United States Geological Survey
 Topography compiled 1963. Planimetry derived from imagery taken 1988 and other sources. Photoinspected using imagery taken 1998; no major culture or drainage changes observed. Public Land Survey System and survey control current as of 1990. Boundaries other than corporate, revised 2002.
 Information shown in purple may not meet USGS content standards and may conflict with previously mapped contours.
 North American Datum of 1927 (NAD 27). Projection and 1 000-meter grid: Universal Transverse Mercator, zone 10. 10 000-foot ticks: California Coordinate System of 1927 (zone 5).
 North American Datum of 1983 (NAD 83) is shown by dashed corner ticks. The values of the shift between NAD 27 and NAD 83 obtainable from National Geodetic



UTM GRID AND DECLINATION

Legend

- Marine Terrace

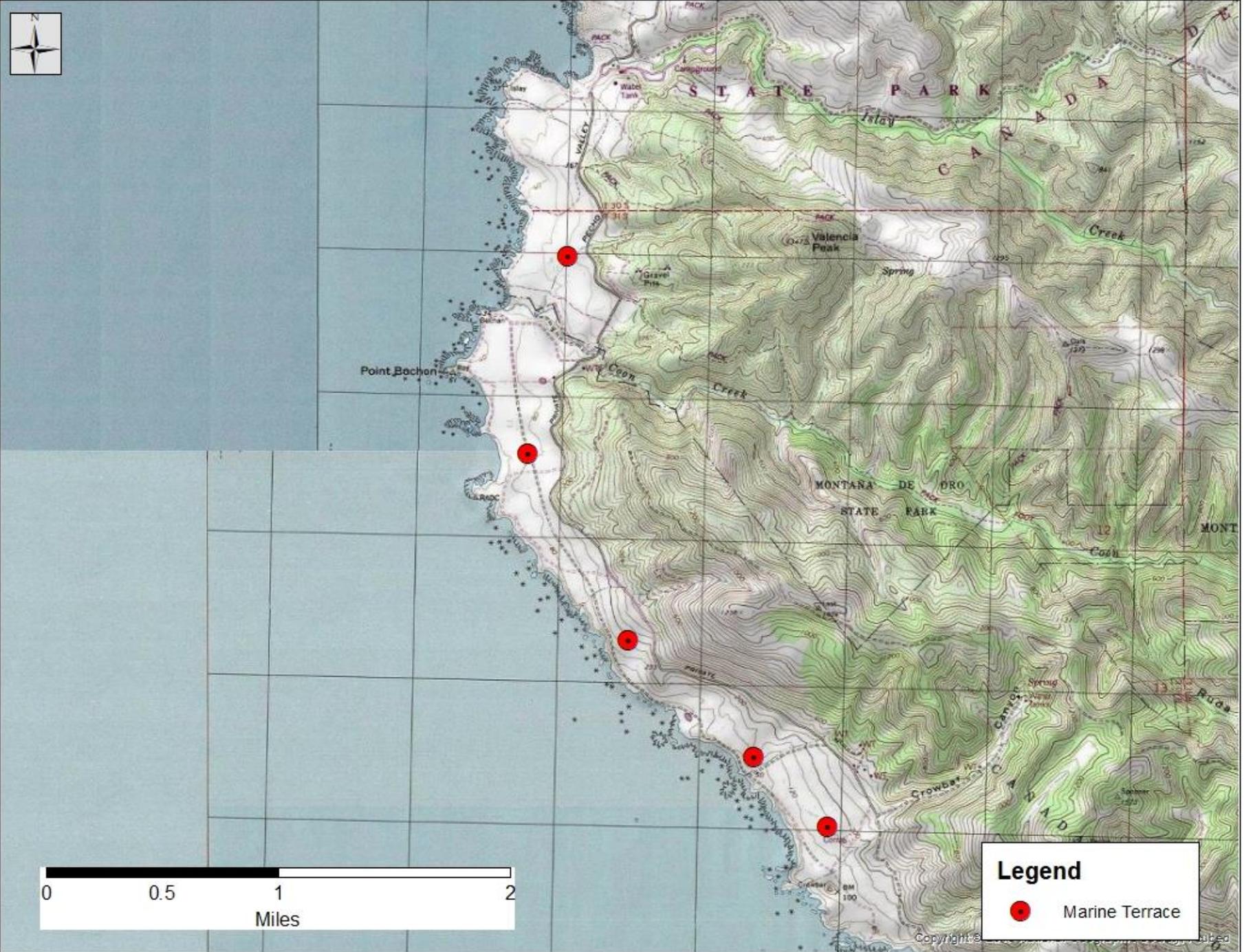


Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNR, and the GIS User Community

Legend

- Marine Terrace

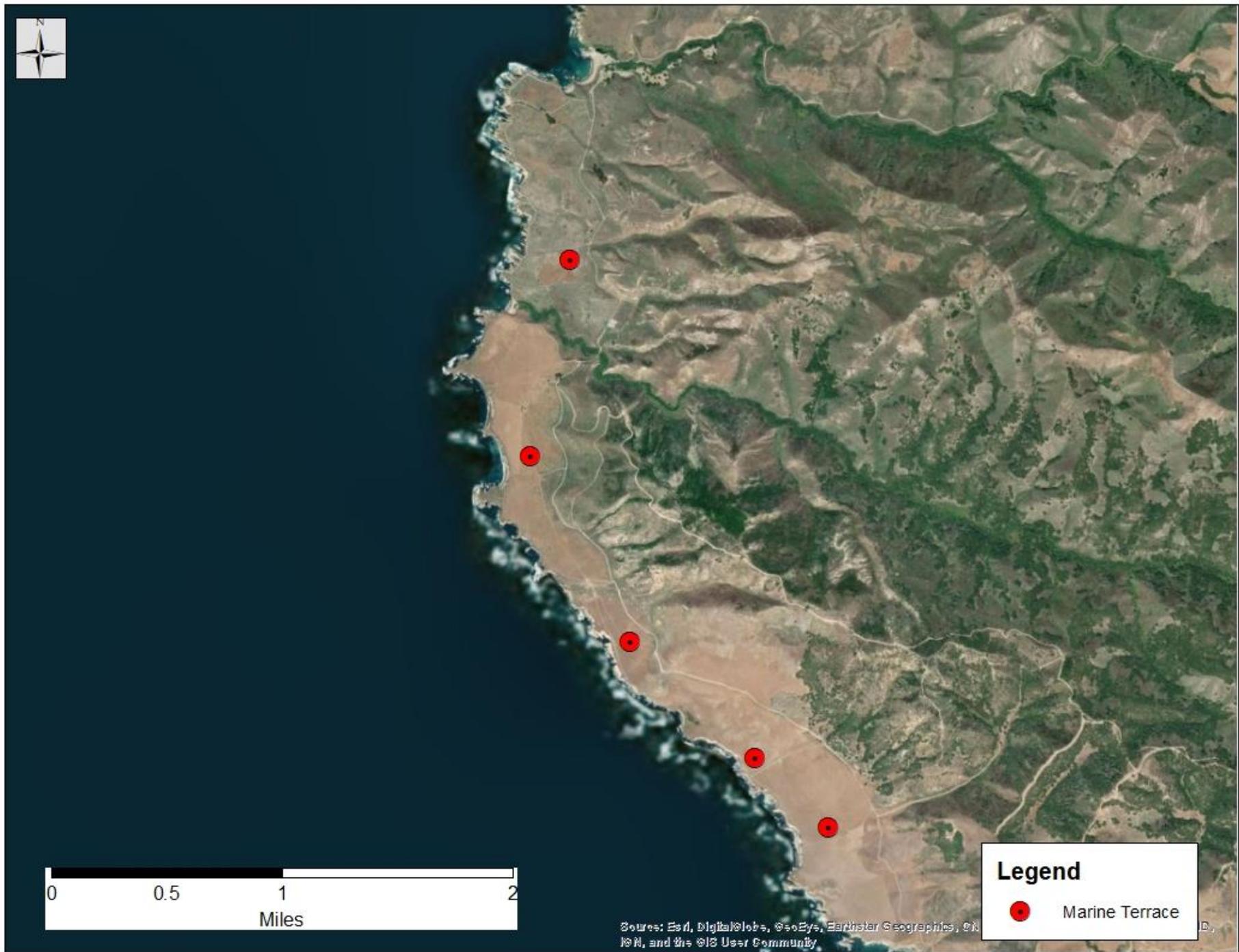




Legend

- Marine Terrace





Legend

- Marine Terrace

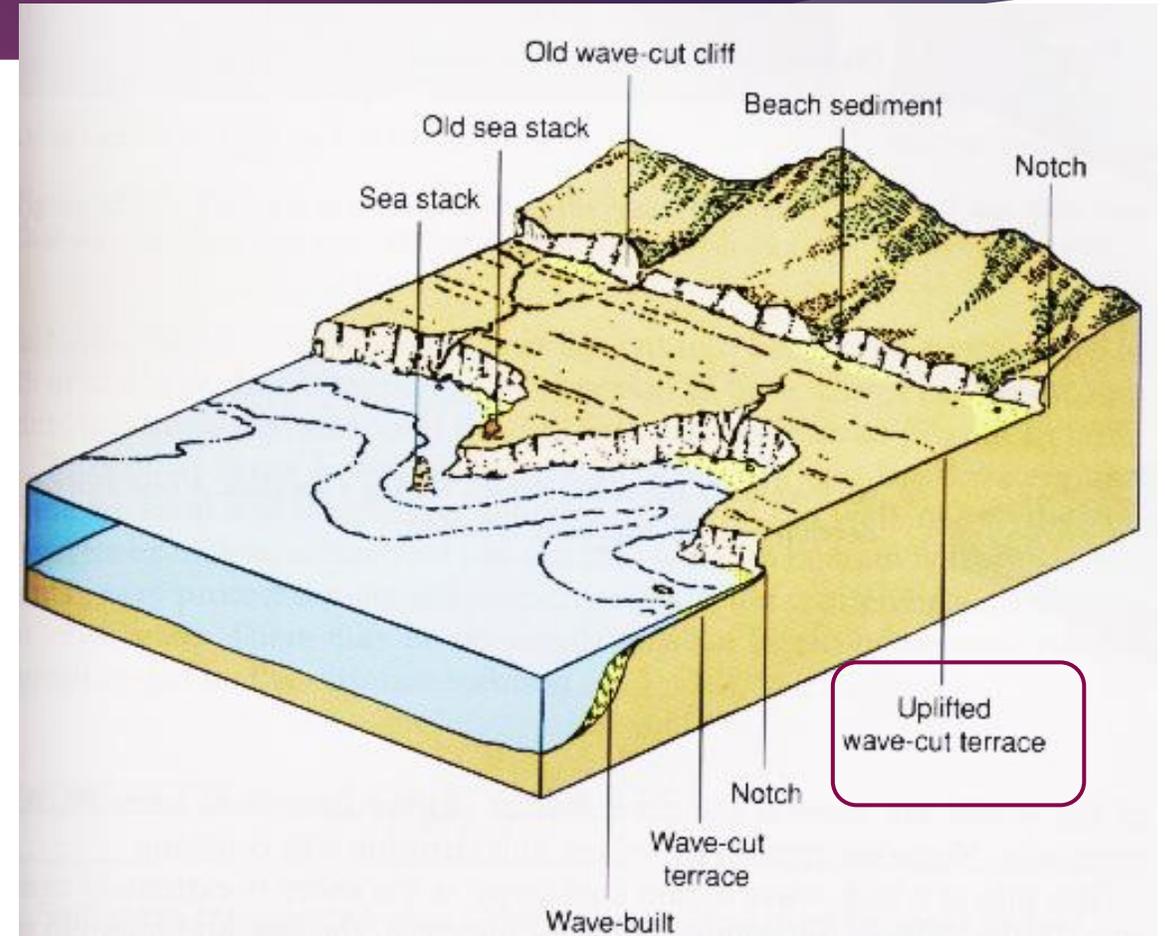
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNR, IGN, and the GIS User Community





EXERCISE B-5. Morro Bay South, California SOLUTION

- ▶ 5-Look very carefully at the south end of the map and you will see areas where the contour lines are widely spaced indicating broad, flat platforms. What are these features (Montana de Oro photo)?
- ▶ **A5. Elevated Marine Terrace**



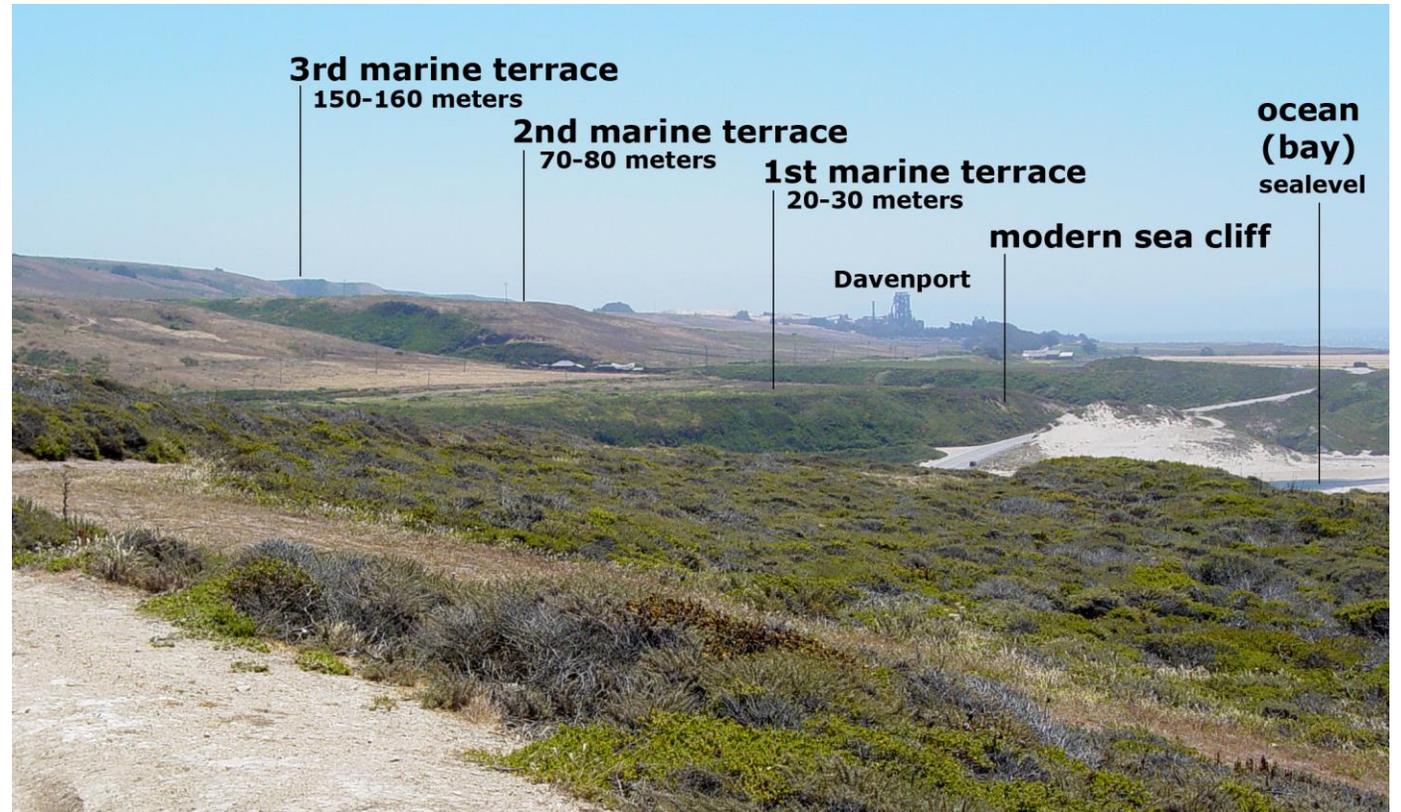
EXERCISE B-6. Morro Bay South, California SOLUTION

- ▶ 6-Is this area an emergent or submergent coastline?
- ▶ **A6. Emergent**



EXERCISE B-7. Morro Bay South, California SOLUTION

- ▶ 7-What is your evidence (i.e. what are the platforms)?
- ▶ **A7. There are a series of marine terraces indicating successive periods of terrace uplift.**



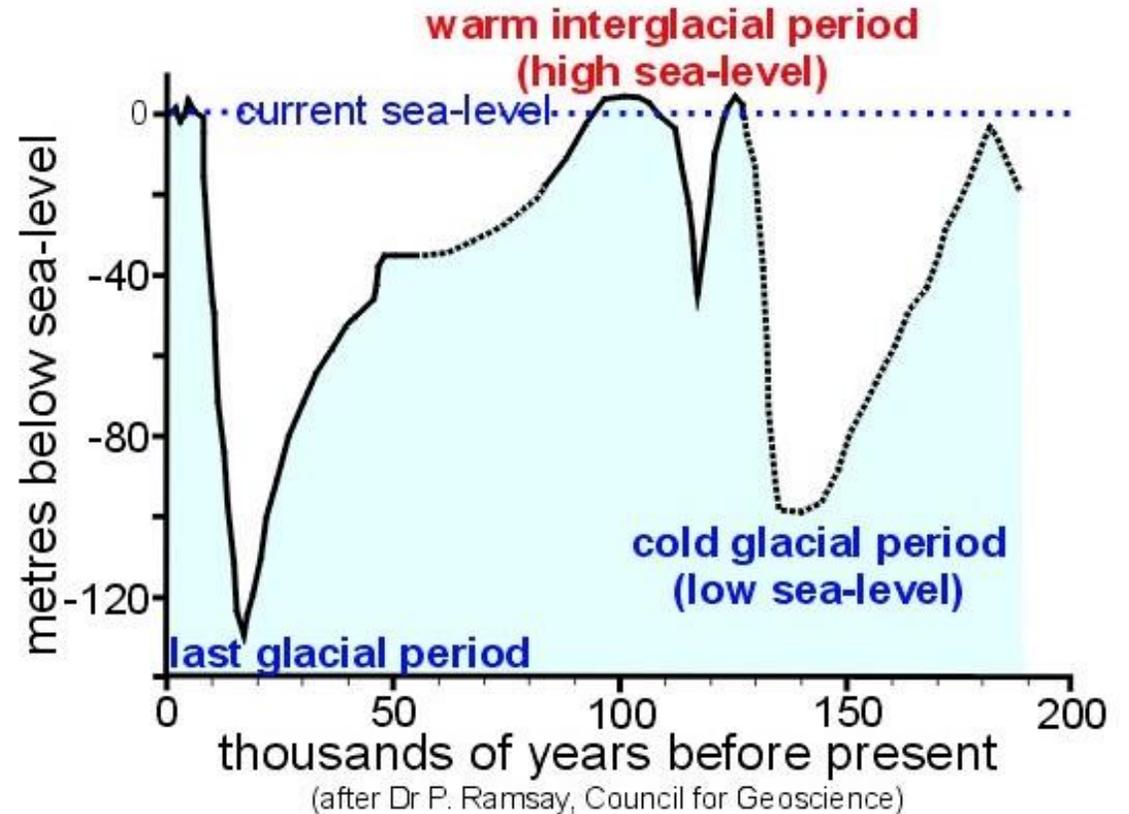
EXERCISE B-8. Morro Bay South, California SOLUTION

- ▶ 8-Consider your answer to Question 6 above and your answer to Question 3 in the previous section (Drakes Bay). If they are different, what does that imply about sea level changes in Drakes Bay and Morro Bay which are less than 450 km apart (i.e. are the changes local or global)?
- ▶ **A8. These are local tectonic changes. There is a syncline associated with Drake's Estero**



EXERCISE B-9. Morro Bay South, California SOLUTION

- ▶ 9-If the sea level changes in relation to the land are different, how is this possible?
- ▶ **A9. Sea level is global, but land elevations change locally due to tectonic activity**



EXERCISE C. Air Photo Essex Inlet, Massachusetts

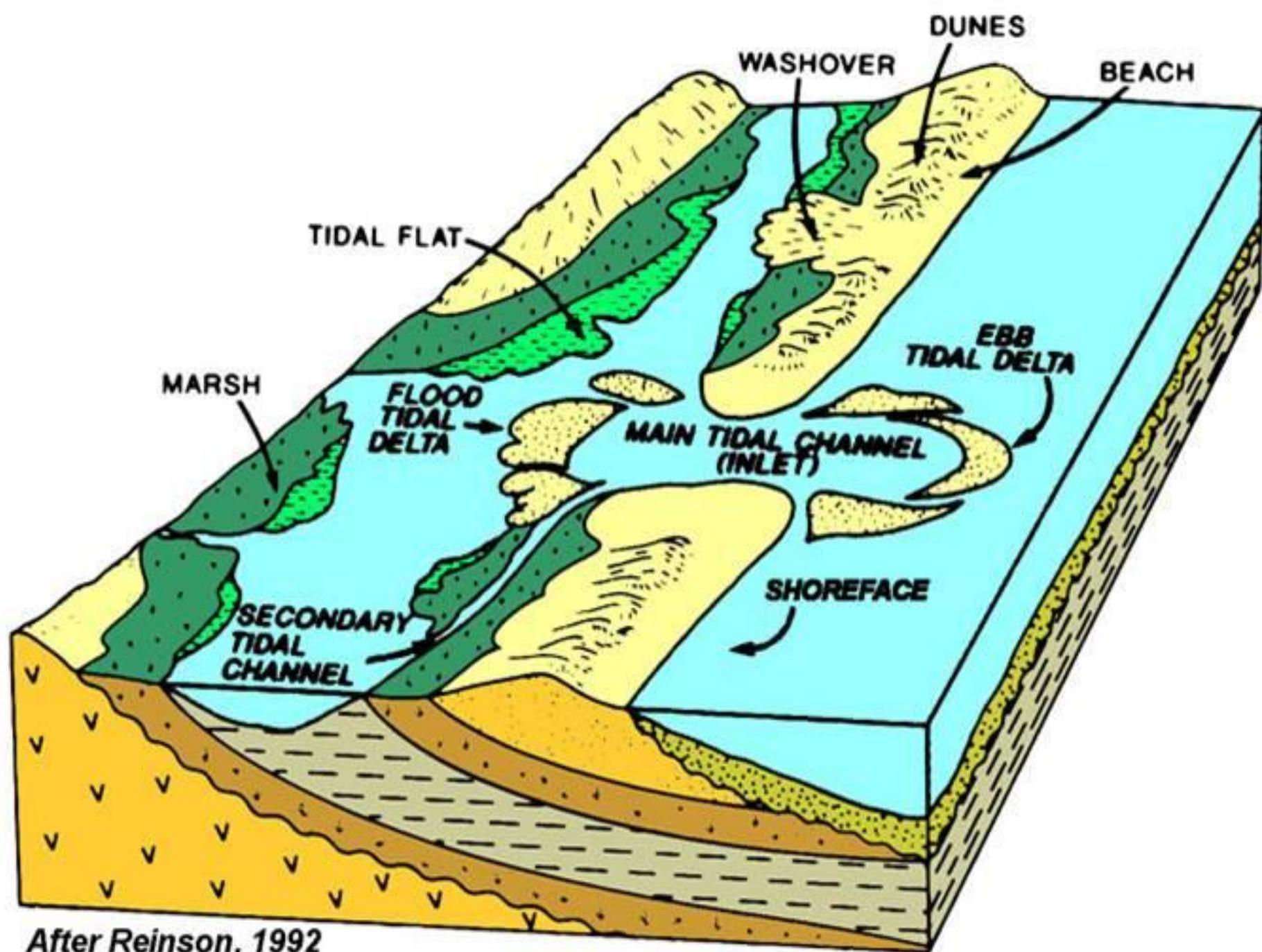
- ▶ 1-What feature do you see in the deeper water of the photo (Essex Inlet photo)?
- ▶ 2-What is the shallow body of water at the bottom of the photo?
- ▶ 3-What feature connects the two bodies of water?
- ▶ 4-What force formed this feature?

EXERCISE C-1. Air Photo Essex Inlet, Massachusetts

- ▶ 1-What feature do you see in the deeper water of the photo (Essex Inlet photo)?

???





After Reinson, 1992



Mainland

Marsh

Backbarrier

Tidal Creek

Barrier Island

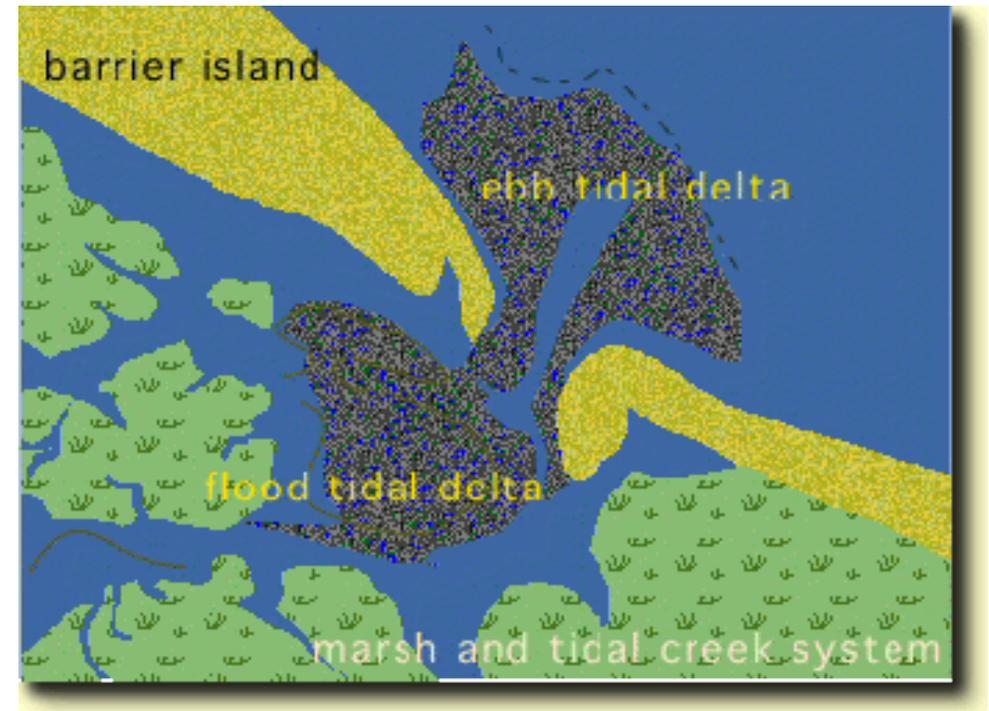
Tidal Inlet

Ebb-tidal Delta



EXERCISE C-1. Air Photo Essex Inlet, Massachusetts SOLUTION

- ▶ 1-What feature do you see in the deeper water of the photo (Essex Inlet photo)?
- ▶ **A1. Ebb Tidal Delta**
- ▶ **A tidal delta is not the same as a river delta. River deltas are created by soil deposits forming from the outflow of the water, such as on the Mississippi and Atchafalaya Rivers. A tidal delta is the sand bar or shoaling area left at the mouth of a river by the movement of bottom mud and sand by a diurnal tide and the currents that result from that tide**



EXERCISE C-2. Air Photo Essex Inlet

- ▶ **2-What is the shallow body of water at the bottom of the photo?**



???

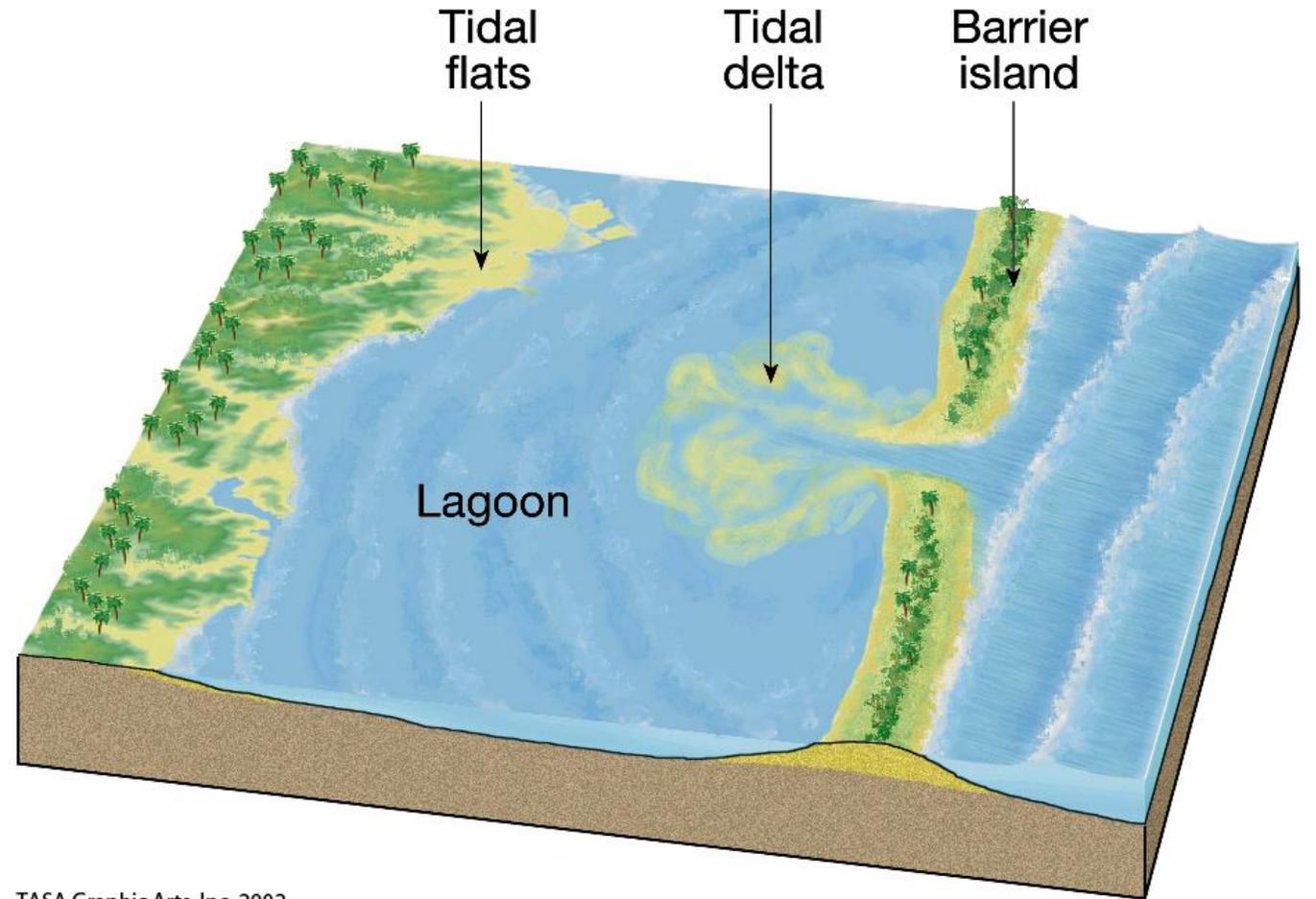


© 2004 Thomson - Brooks/Cole

EXERCISE C-2. Air Photo Essex Inlet

SOLUTION

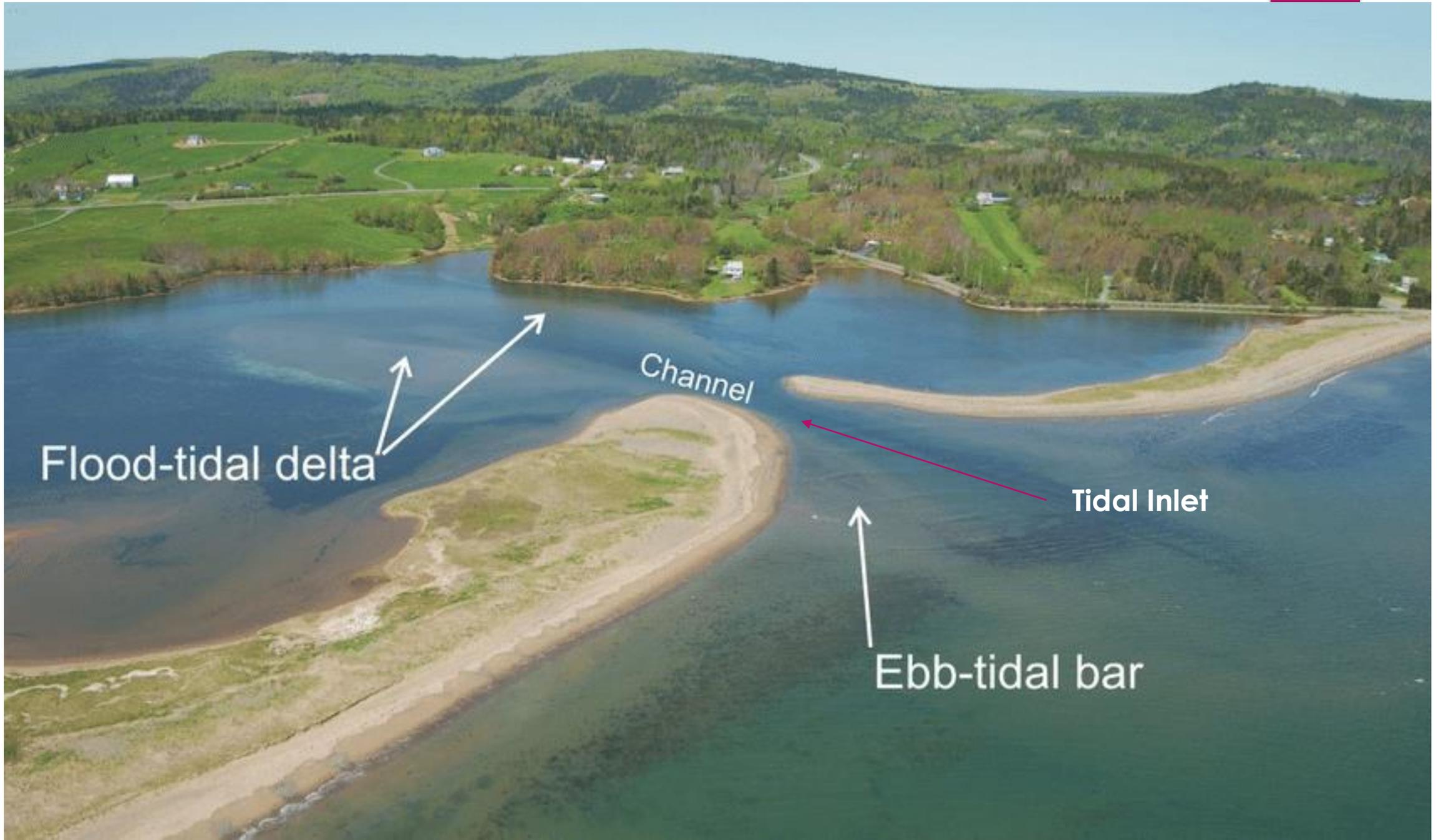
- ▶ 2-What is the shallow body of water at the bottom of the photo?
- ▶ **2A. Lagoon**



EXERCISE C-3. Air Photo Essex Inlet

- ▶ **3-What feature connects the two bodies of water?**





Flood-tidal delta

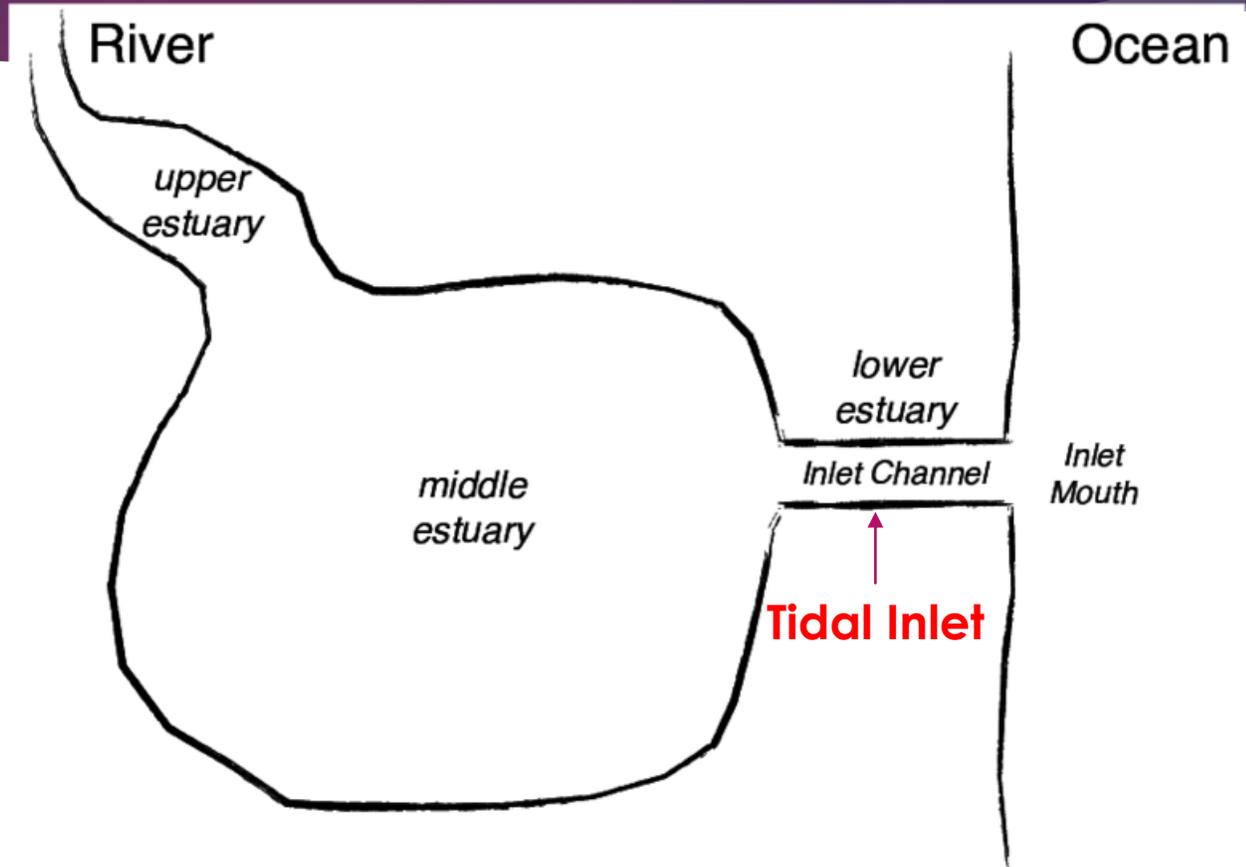
Channel

Tidal Inlet

Ebb-tidal bar

EXERCISE C-3. Air Photo Essex Inlet SOLUTION

- ▶ 3-What feature connects the two bodies of water?
- ▶ **A3. Tidal Inlet**



EXERCISE C-4. Air Photo Essex Inlet

- ▶ **4-What force formed this feature?**

Essex Inlet





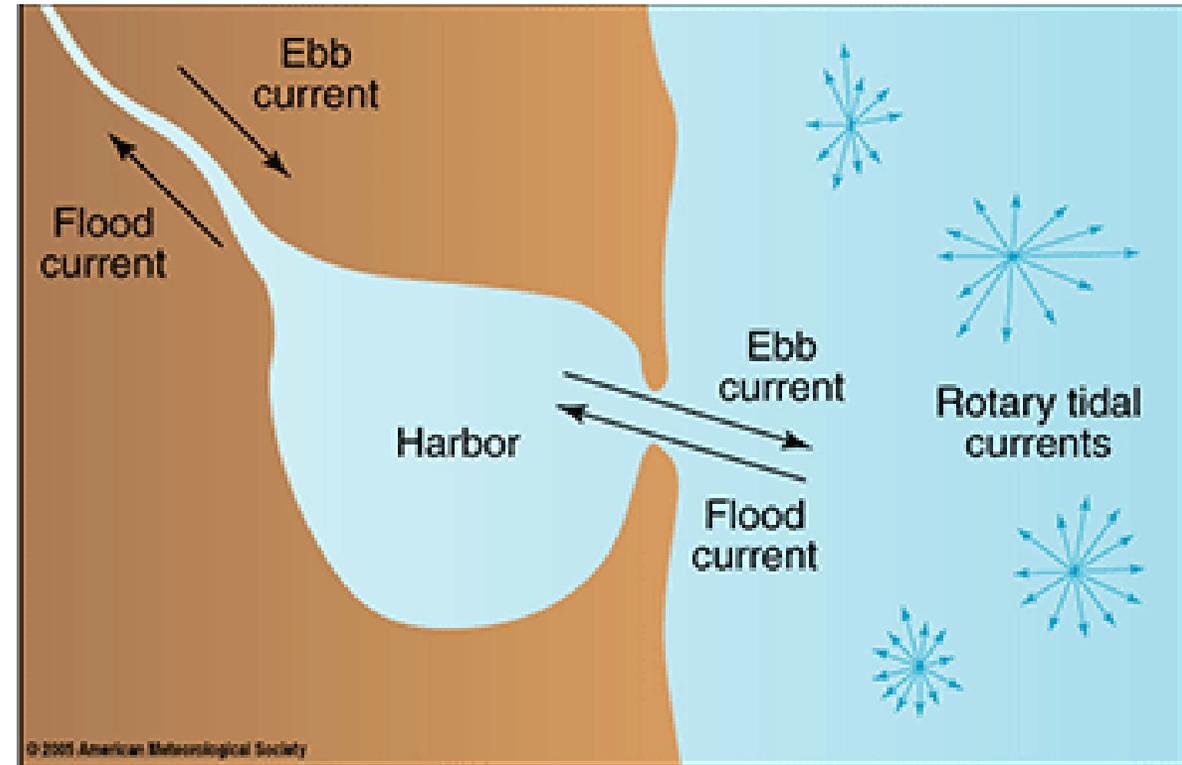
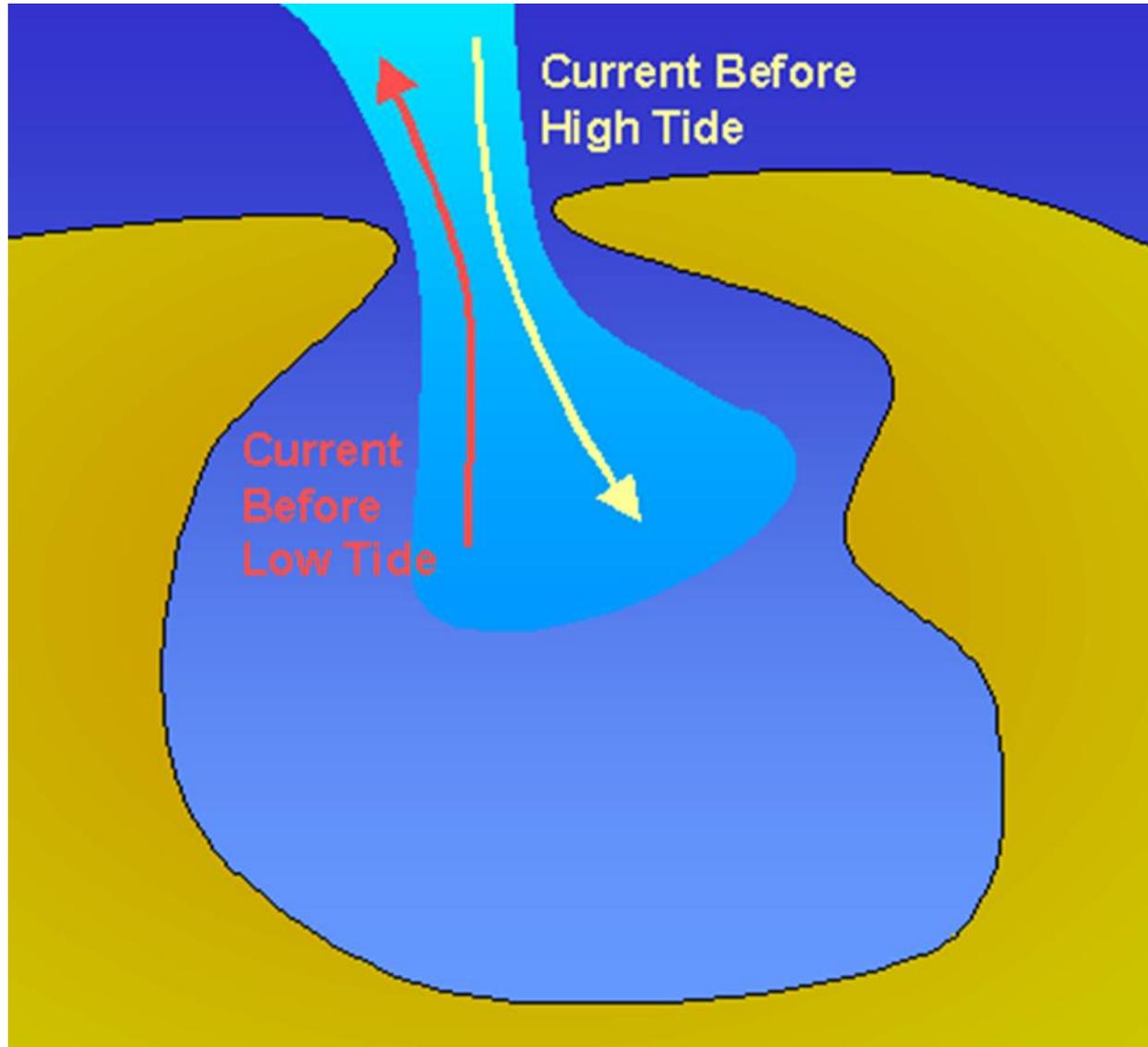


FIGURE 1:
ONE HOUR

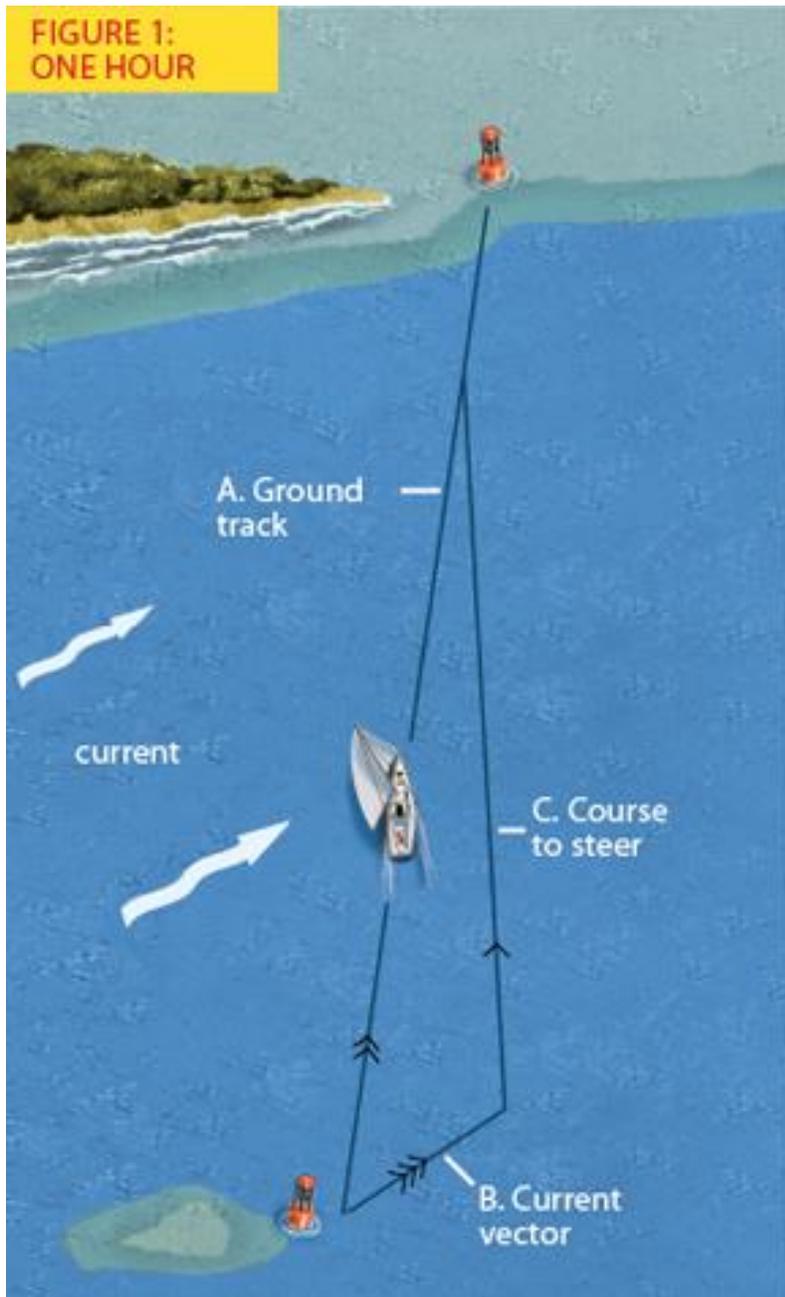
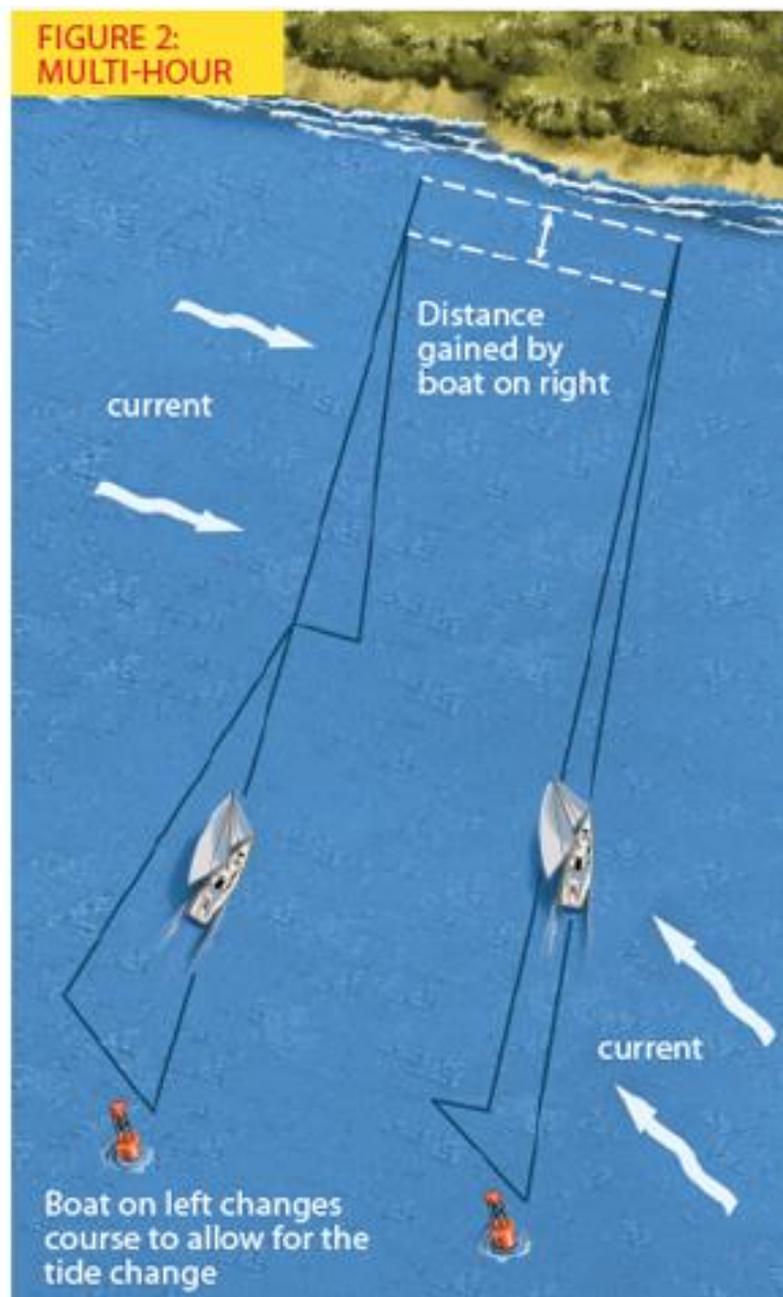


FIGURE 2:
MULTI-HOUR



EXERCISE C-4. Air Photo Essex Inlet

SOLUTION

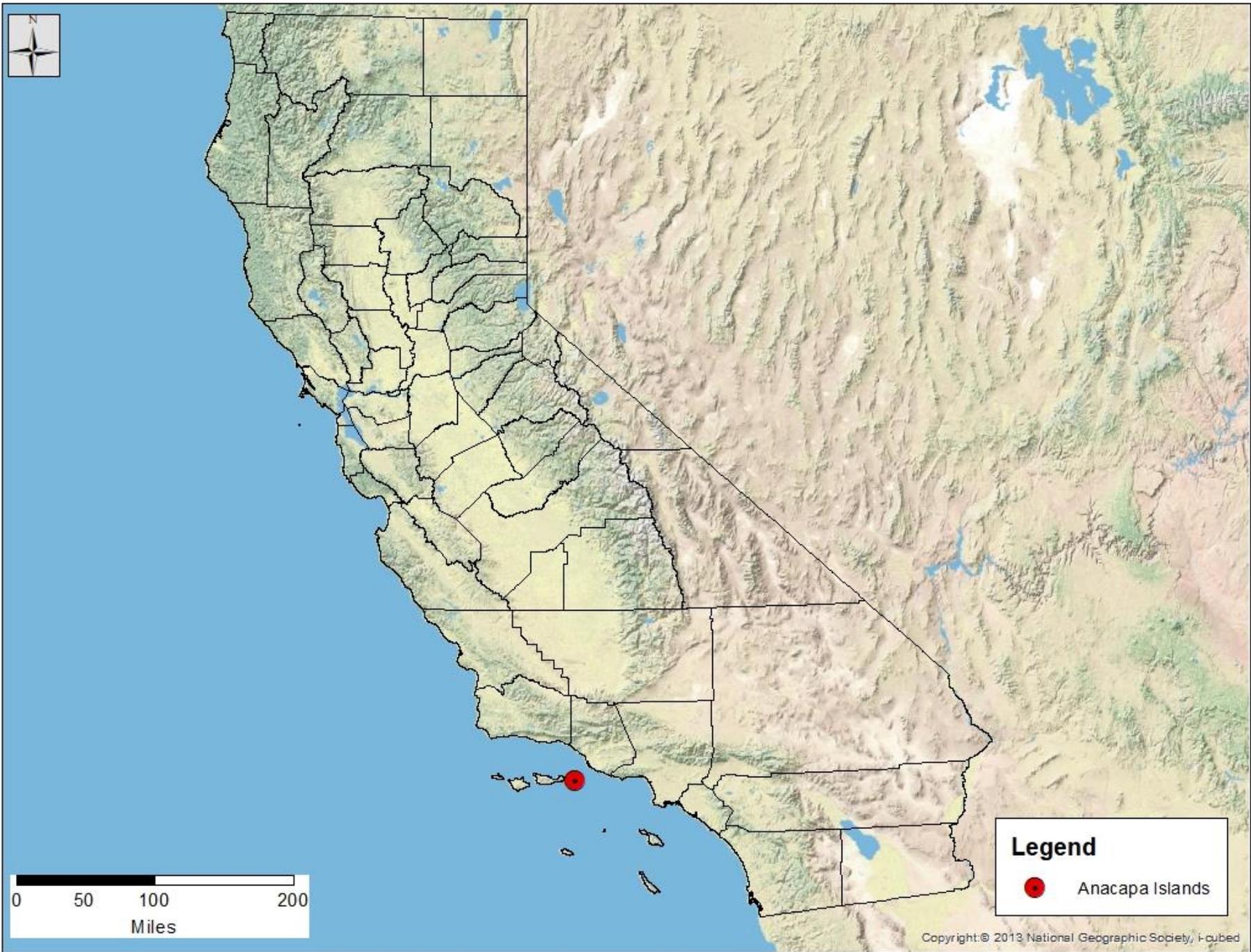
- ▶ 4-What force formed this feature?
- ▶ **A4. Tidal Currents**

EXERCISE D. Anacapa Island

- ▶ Take a look at the picture below. This is from Anacapa Island, one of the Channel Islands in California.
- ▶ 1-What is the prominent feature to the right of the photo?
- ▶ 2-How did it form?
- ▶ 3-What is the other feature in the picture (there are 2 on the left side)?
- ▶ 4-How did it (they) form?

EXERCISE D. Anacapa Island

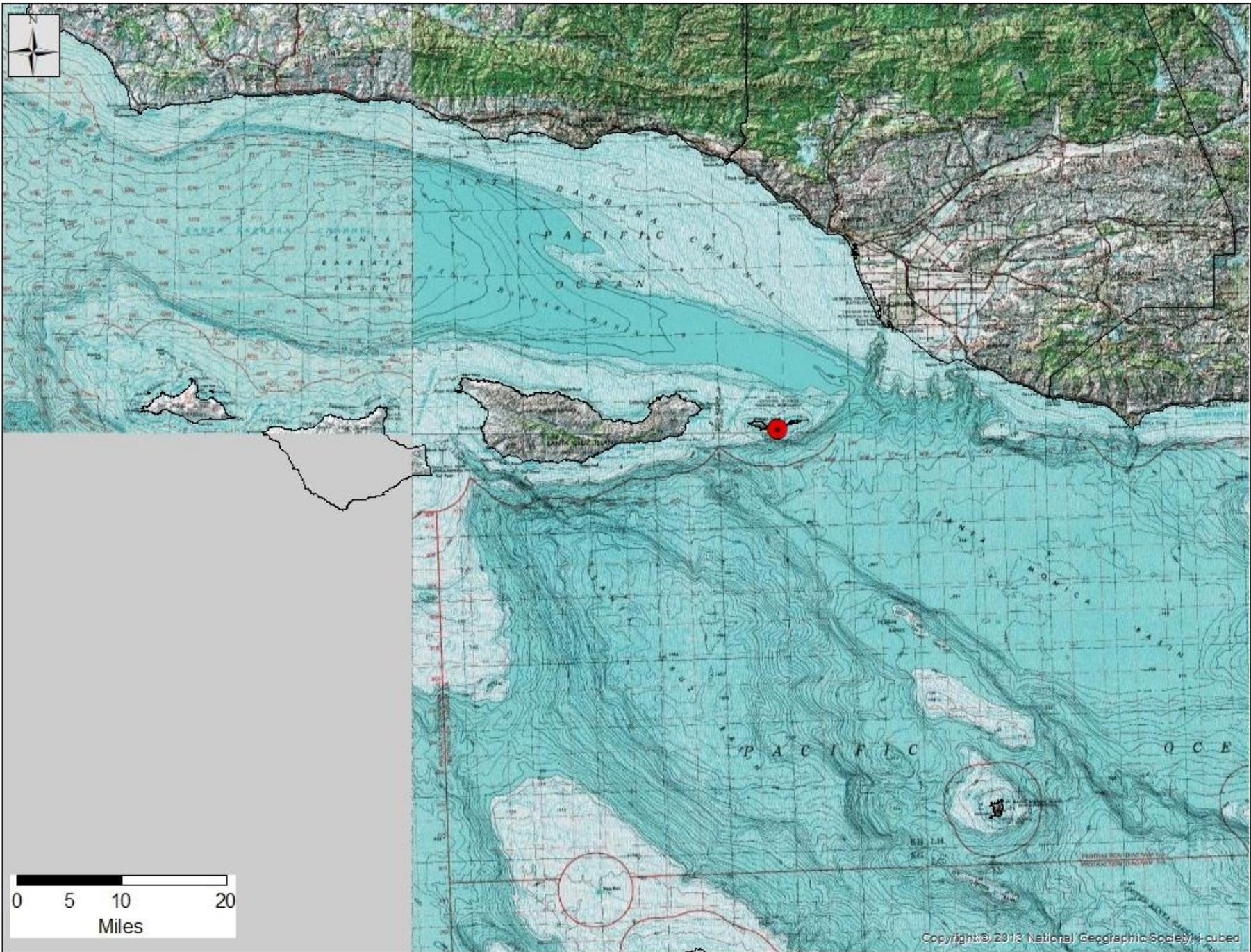


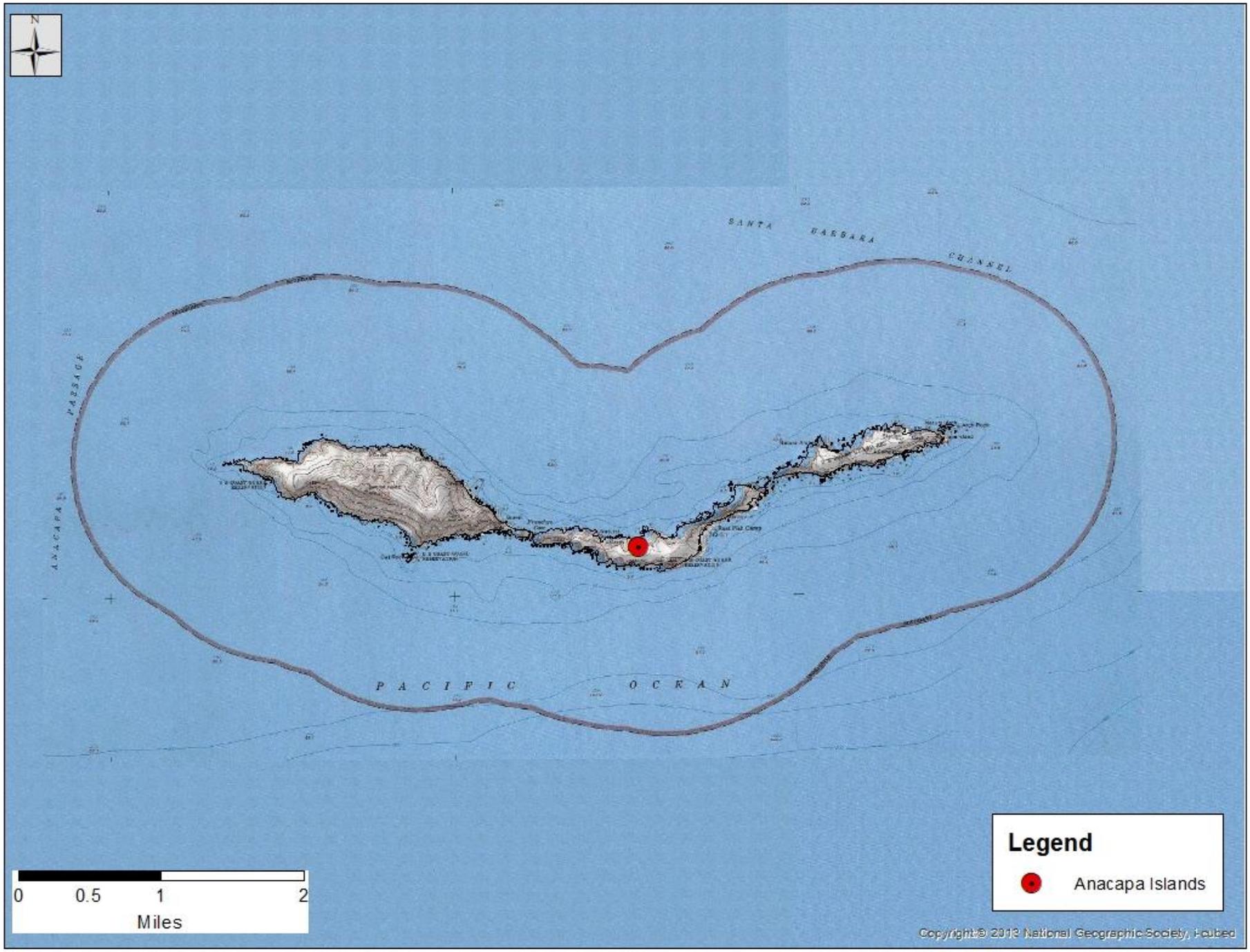


Legend

- Anacapa Islands







Legend

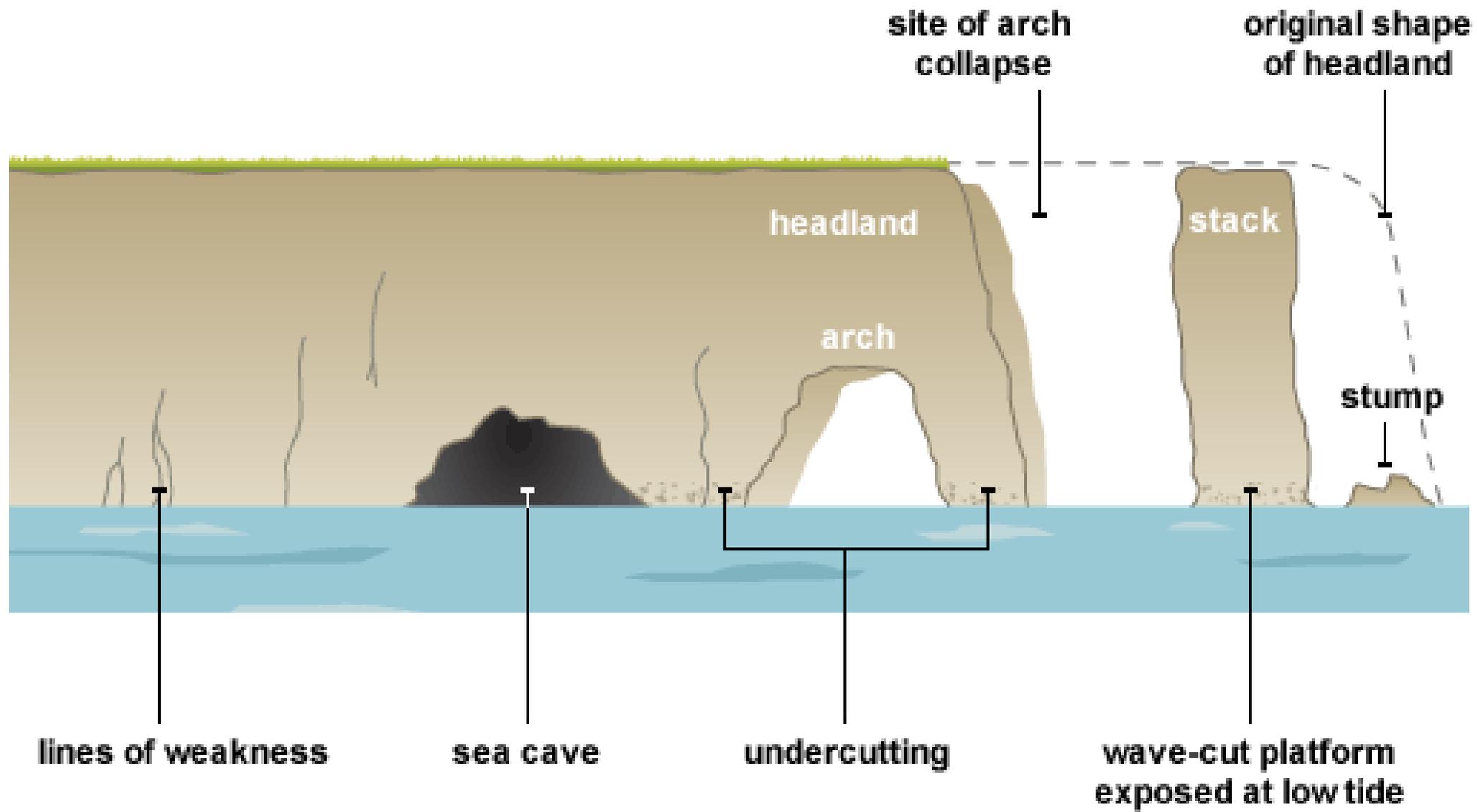
- Anacapa Islands

EXERCISE D-1. Anacapa Island

- ▶ Take a look at the picture below. This is from Anacapa Island, one of the Channel Islands in California.
- ▶ 1-What is the prominent feature to the right of the photo?





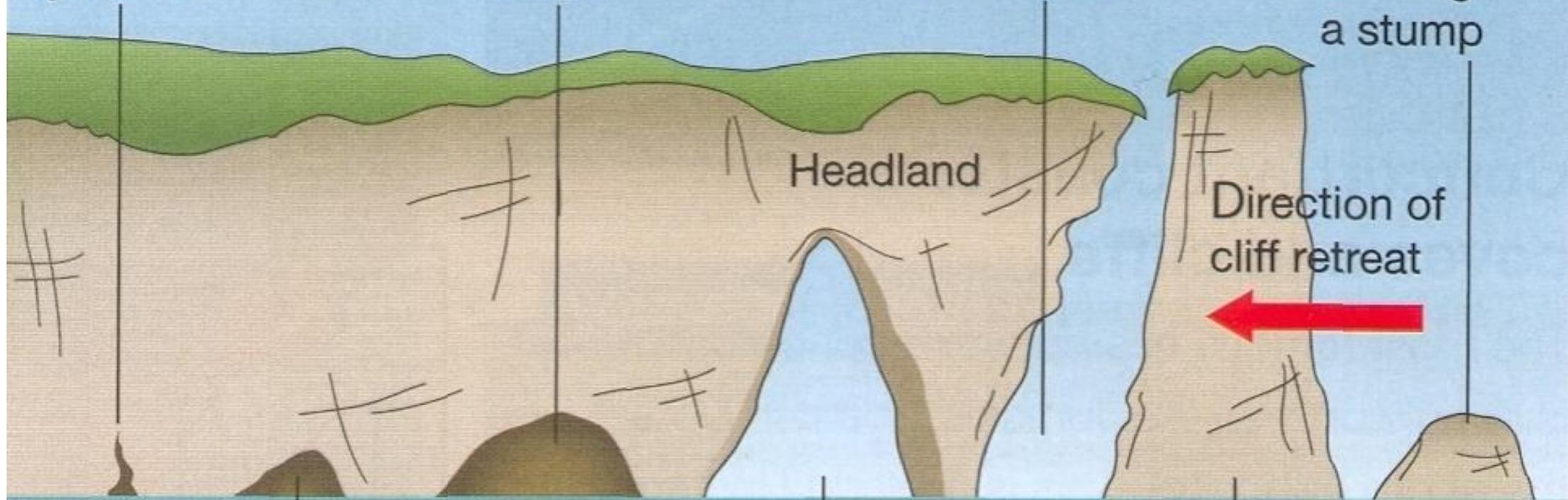


1. Large crack,
opened up by
hydraulic action

3. The cave
becomes
larger

5. The arch is
eroded and
collapses

7. The stack
is eroded
forming
a stump



Headland

Direction of
cliff retreat

2. The crack grows
into a cave by
hydraulic action
and abrasion

4. The cave breaks
through the headland
forming a natural arch

6. This leaves
a tall rock stack

EXERCISE D-1. Anacapa Island

SOLUTION

- ▶ Take a look at the picture below. This is from Anacapa Island, one of the Channel Islands in California.
- ▶ 1-What is the prominent feature to the right of the photo?
- ▶ **A1. Sea Arch**



EXERCISE D-2. Anacapa Island

- ▶ Take a look at the picture above. This is from Anacapa Island, one of the Channel Islands in California.
- ▶ 2-How did it (the sea arch) form?

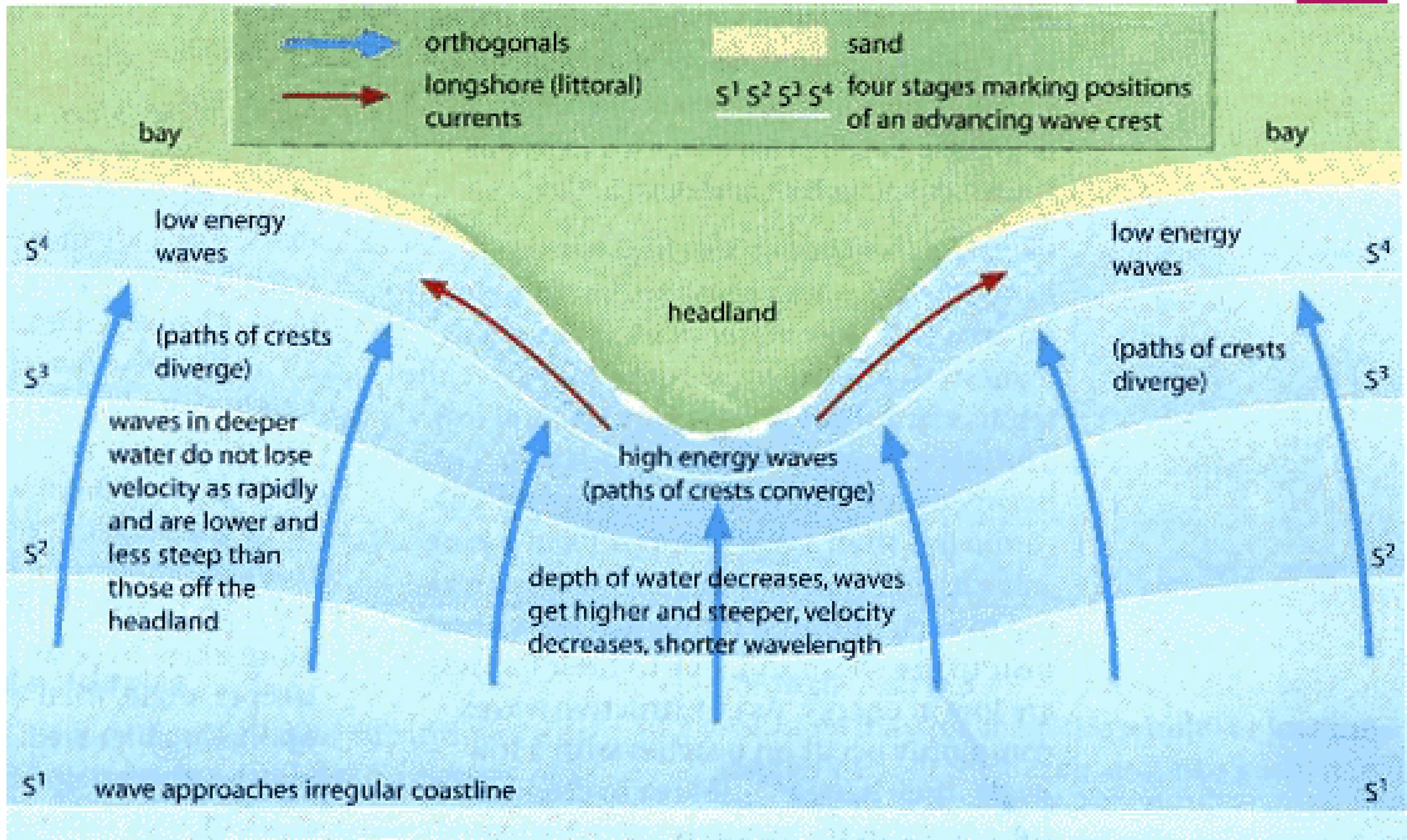


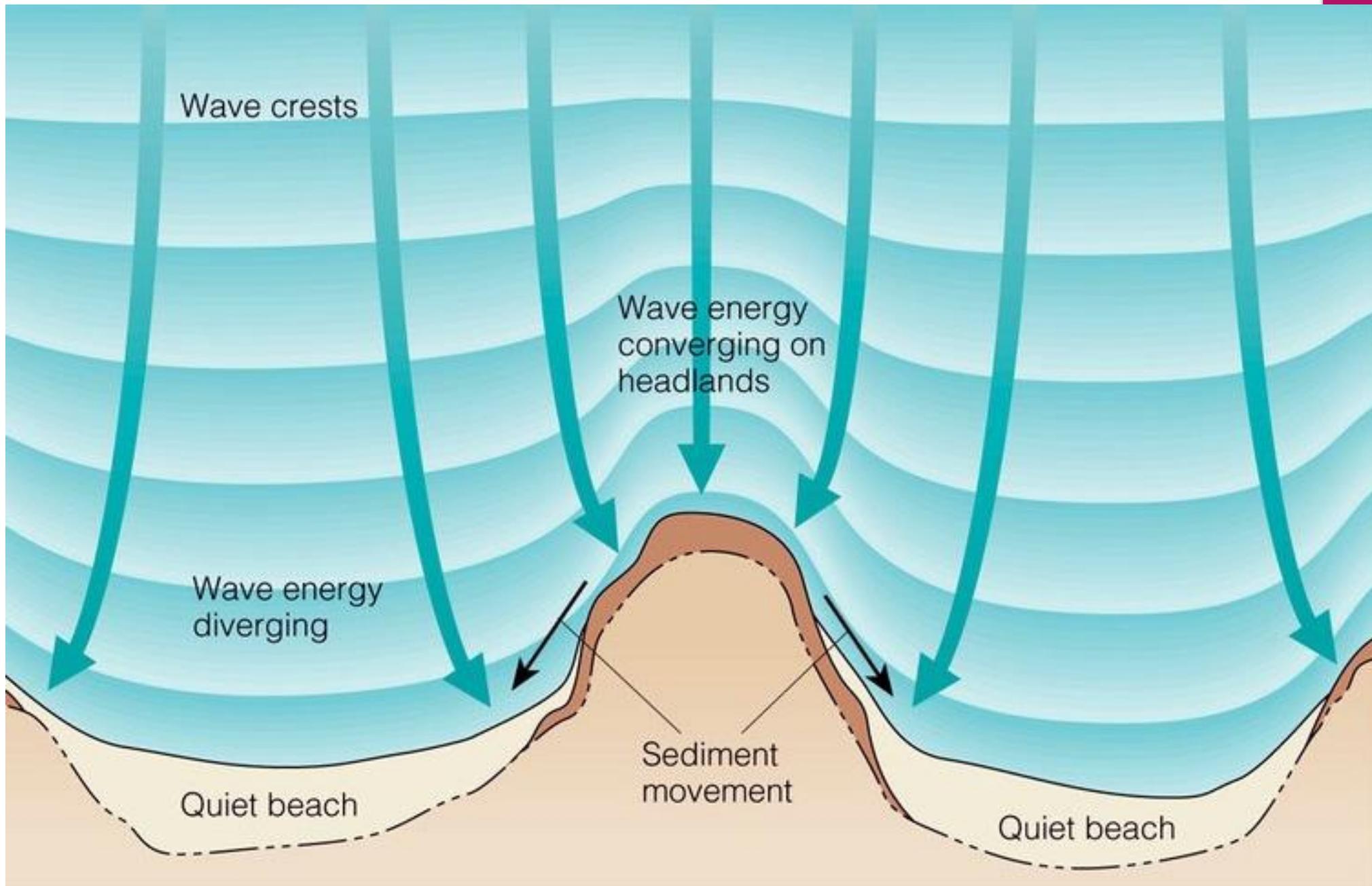
HEADLAND



HEADLAND



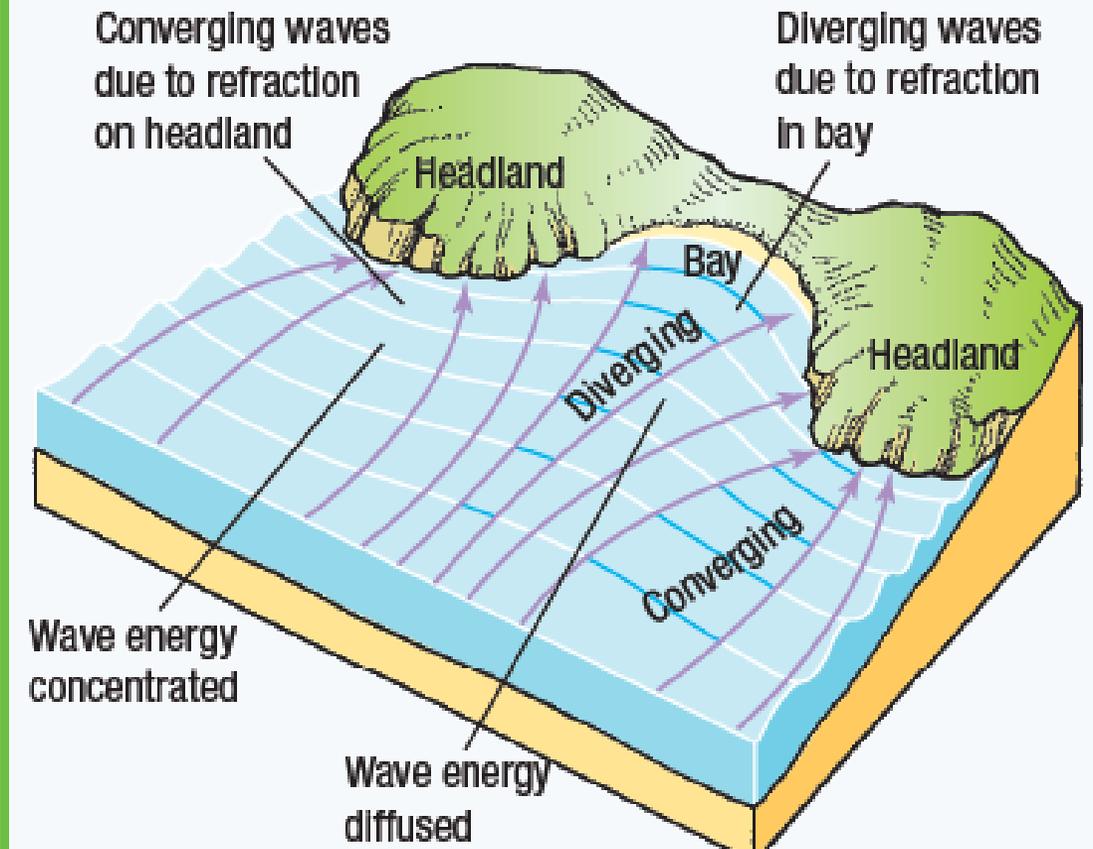




EXERCISE D-2. Anacapa Island SOLUTION

- ▶ Take a look at the picture above. This is from Anacapa Island, one of the Channel Islands in California.
- ▶ 2-How did it (the sea arch) form?
- ▶ **2A. From wave refraction causing erosion on both sides of the western Anacapa Island headland**

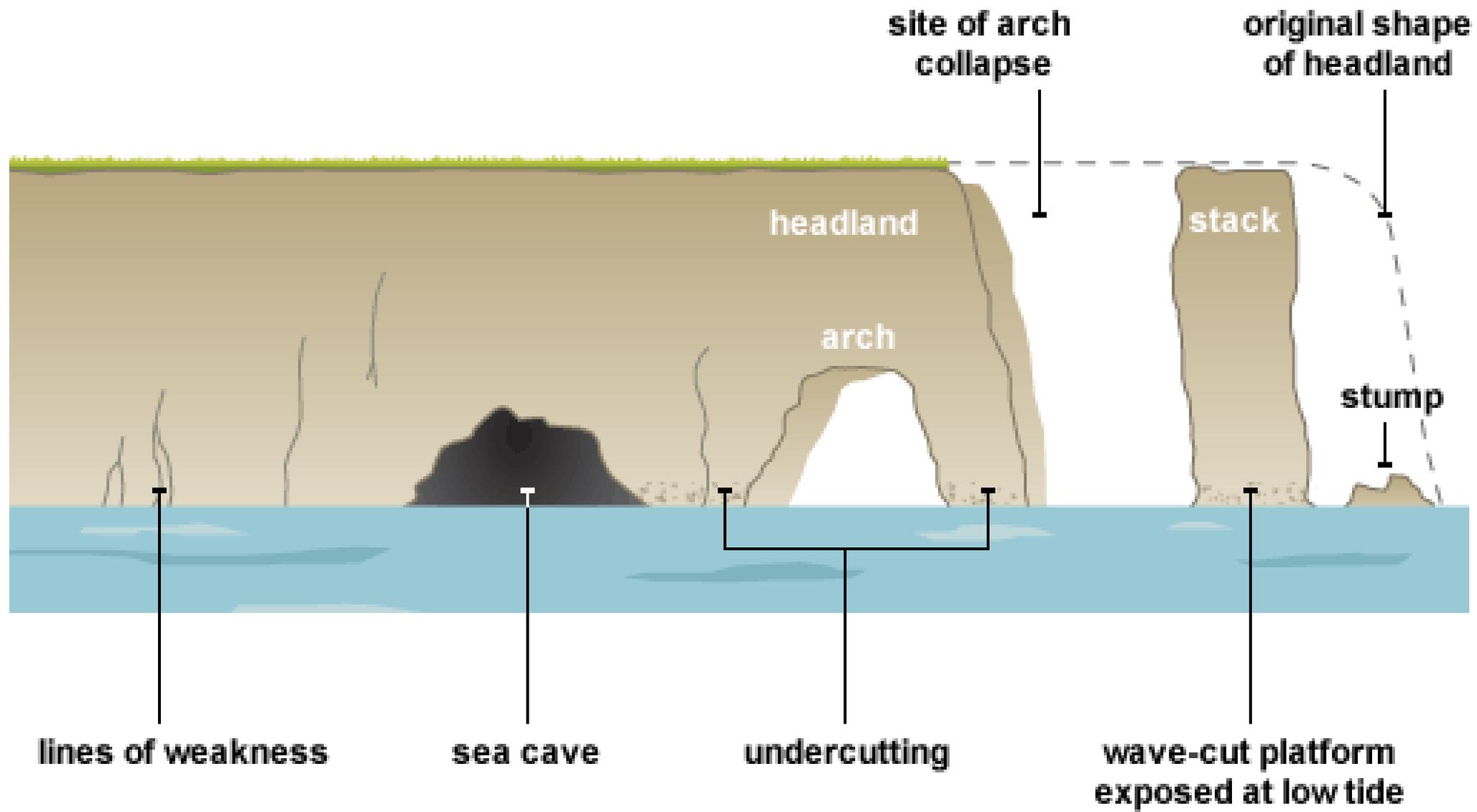
7.7 Waves are refracted and energy is concentrated around headlands and more dispersed along beaches located in bays.



EXERCISE D-3. Anacapa Island

- ▶ Take a look at the picture. This is from Anacapa Island, one of the Channel Islands in California.
- ▶ 3-What is the other feature in the picture (there are 2 on the left side)?



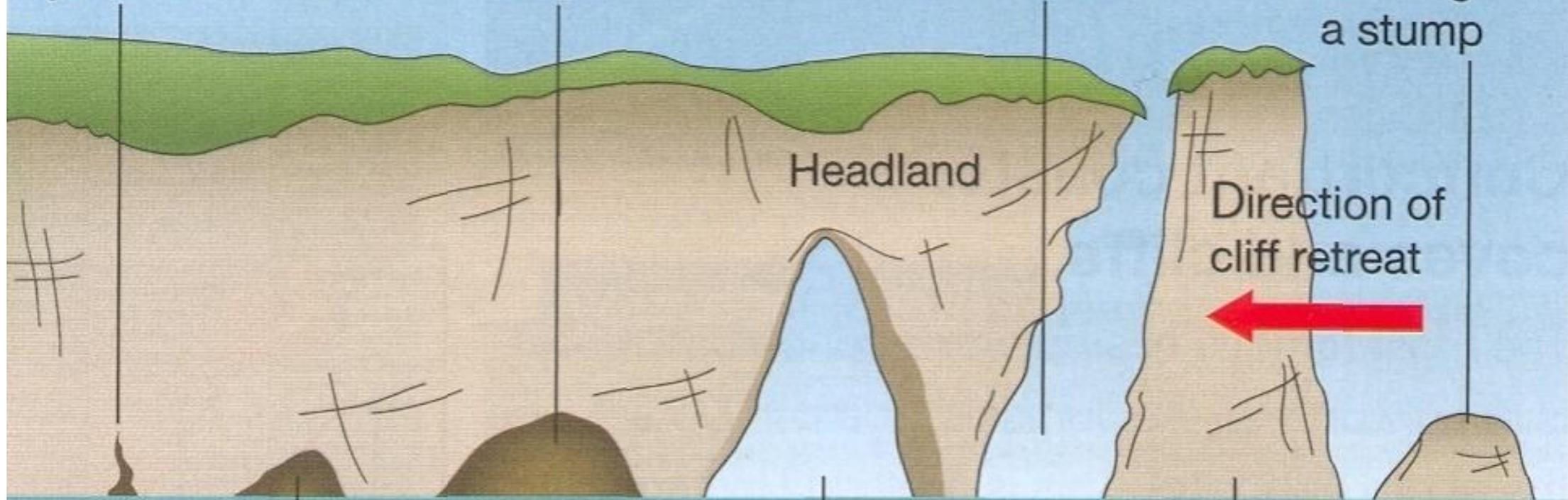


1. Large crack,
opened up by
hydraulic action

3. The cave
becomes
larger

5. The arch is
eroded and
collapses

7. The stack
is eroded
forming
a stump



Headland

Direction of
cliff retreat

2. The crack grows
into a cave by
hydraulic action
and abrasion

4. The cave breaks
through the headland
forming a natural arch

6. This leaves
a tall rock stack

EXERCISE D-3. Anacapa Island SOLUTION

- ▶ Take a look at the picture. This is from Anacapa Island, one of the Channel Islands in California.
- ▶ 3-What is the other feature in the picture (there are 2 on the left side)?
- ▶ **3A. Sea Stack**



EXERCISE D-4. Anacapa Island

- ▶ Take a look at the picture below. This is from Anacapa Island, one of the Channel Islands in California.
- ▶ 4-How did it (they) form?



EXERCISE D-4. Anacapa Island SOLUTION

- ▶ Take a look at the picture below. This is from Anacapa Island, one of the Channel Islands in California.
- ▶ 4-How did it (they) form?
- ▶ **A4. Collapse of Sea Arch**

