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Figure 1

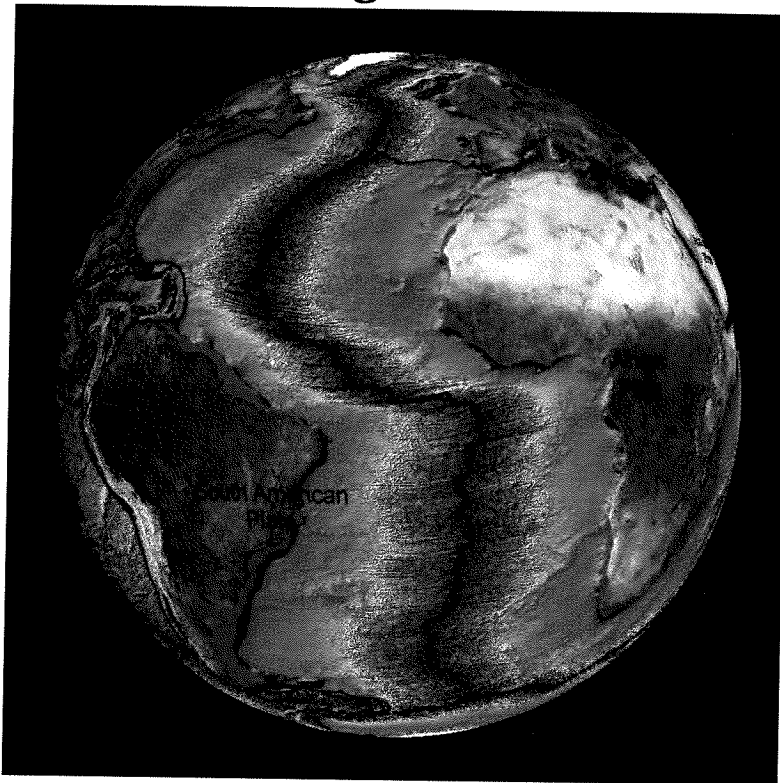
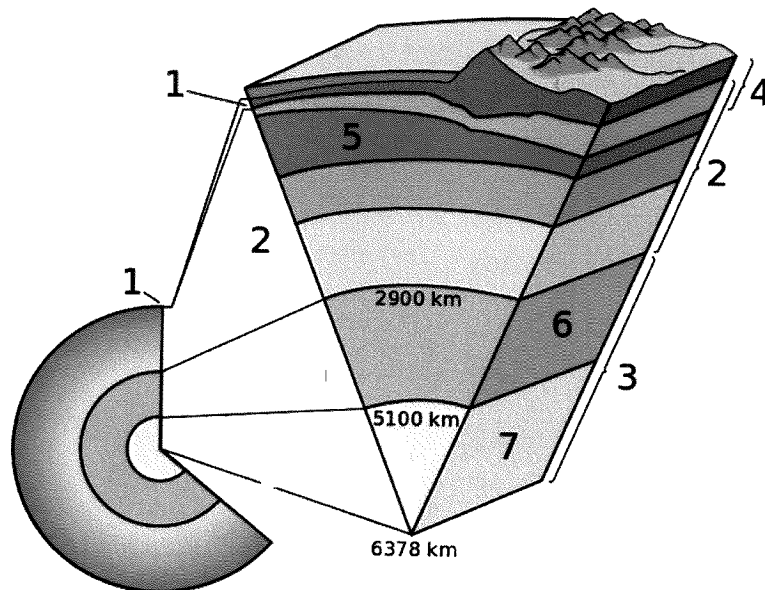


Figure 2



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Figure 3

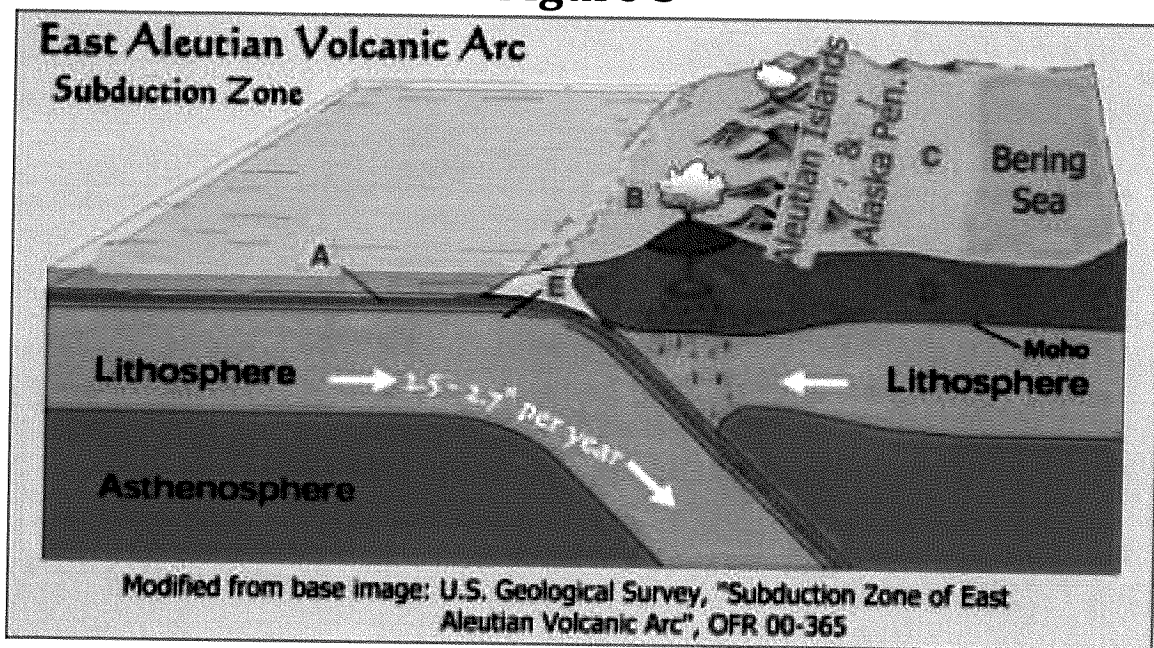
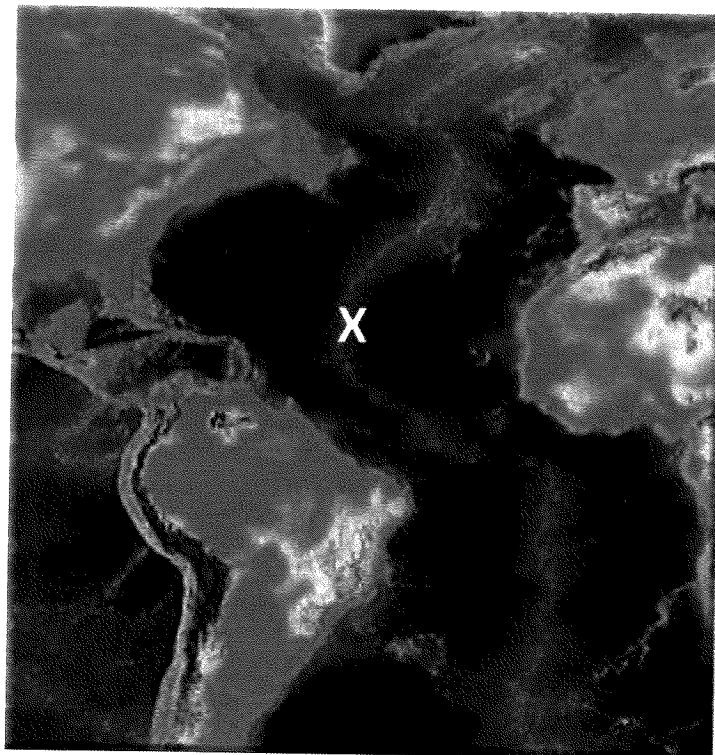
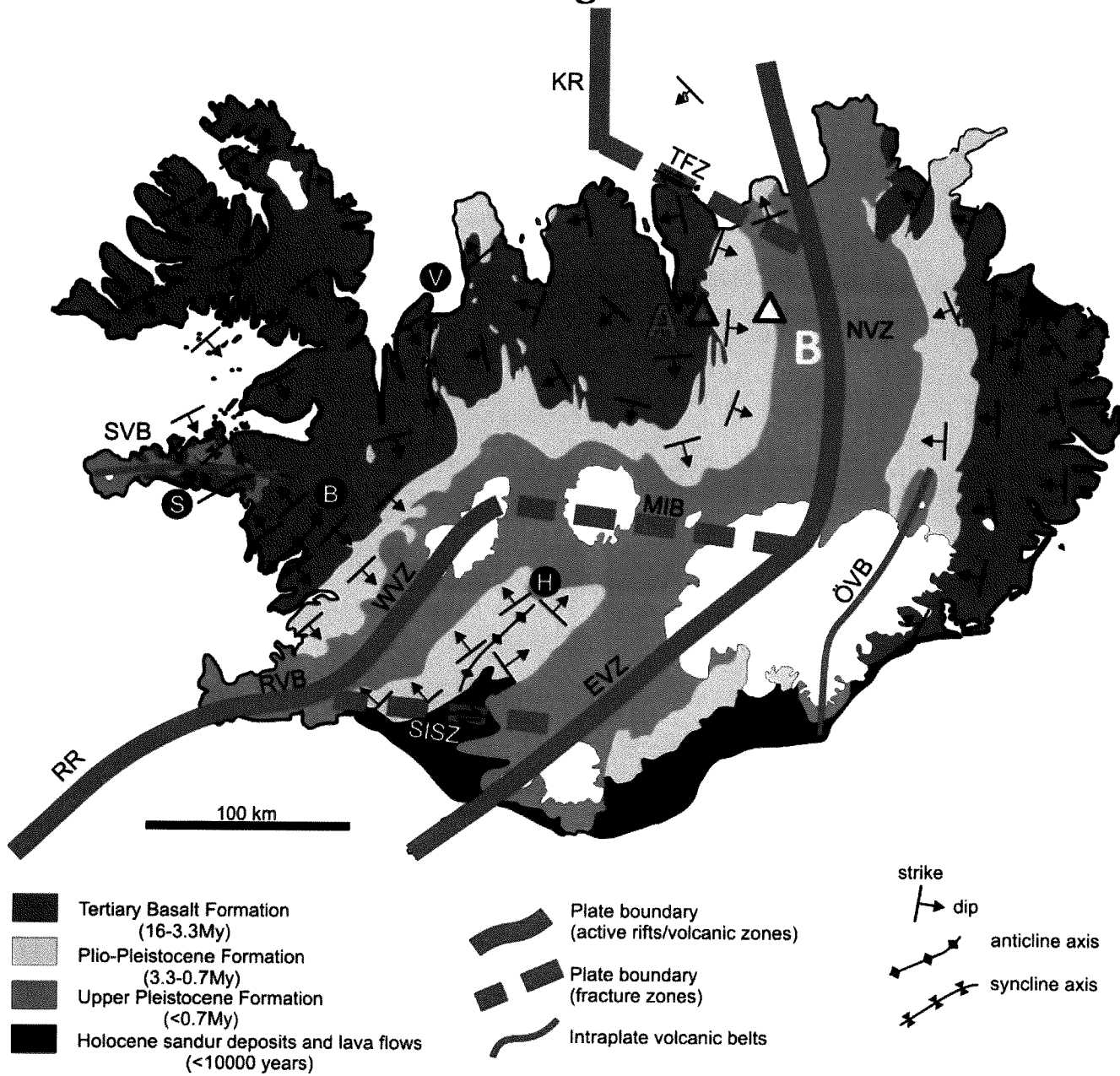


Figure 4



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Figure 5



Map of Iceland (in the northern Atlantic Ocean)

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Figure 6

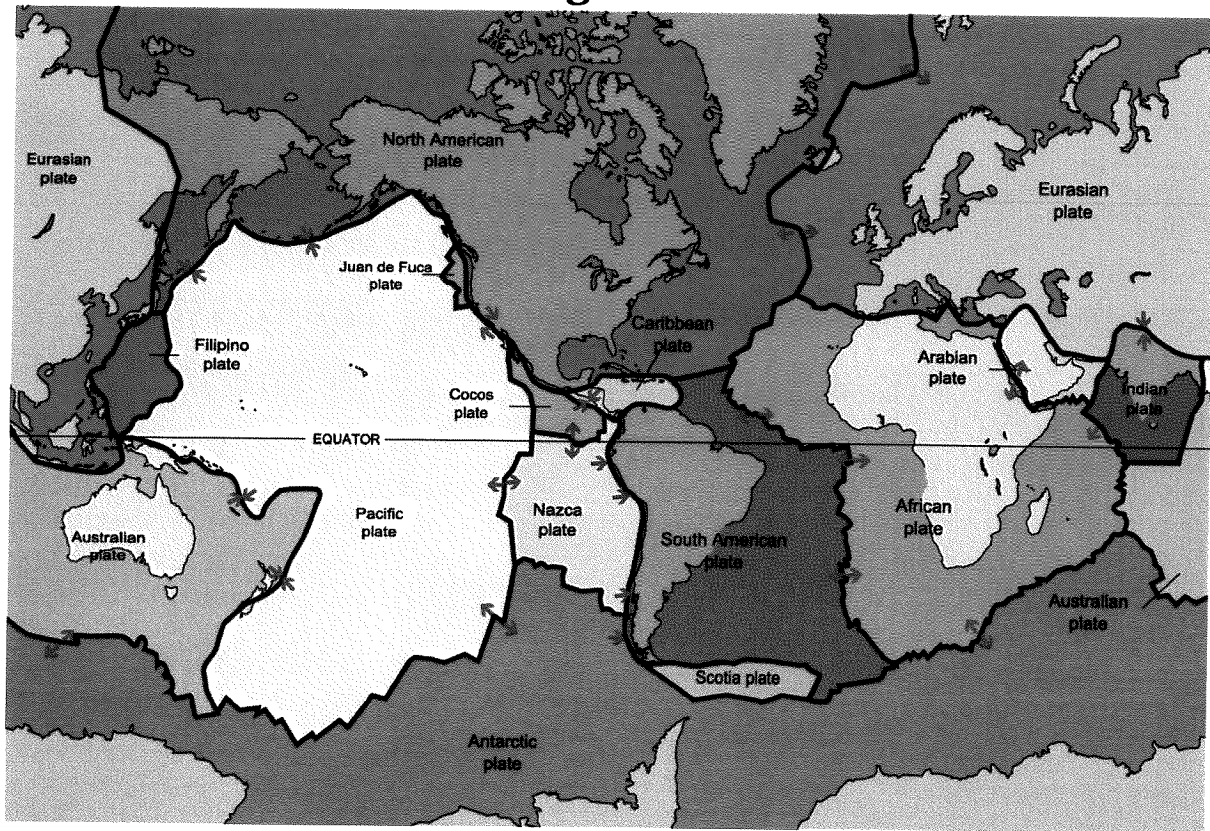
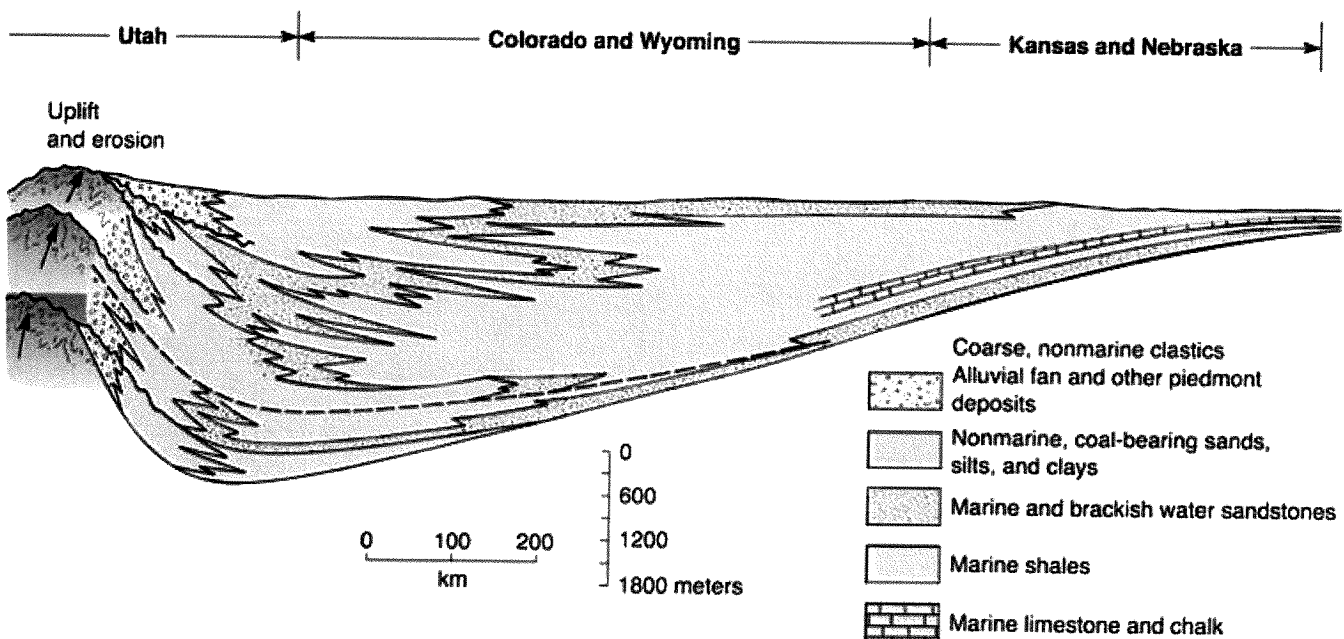


Figure 7



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Figure 8

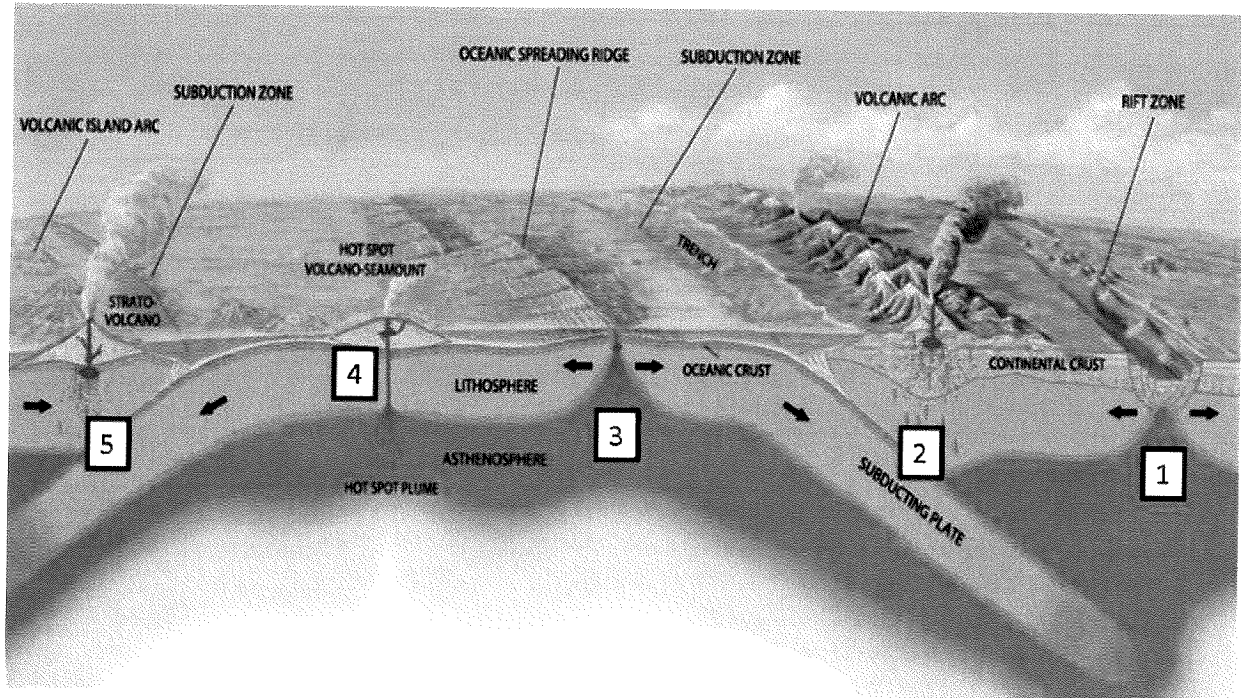
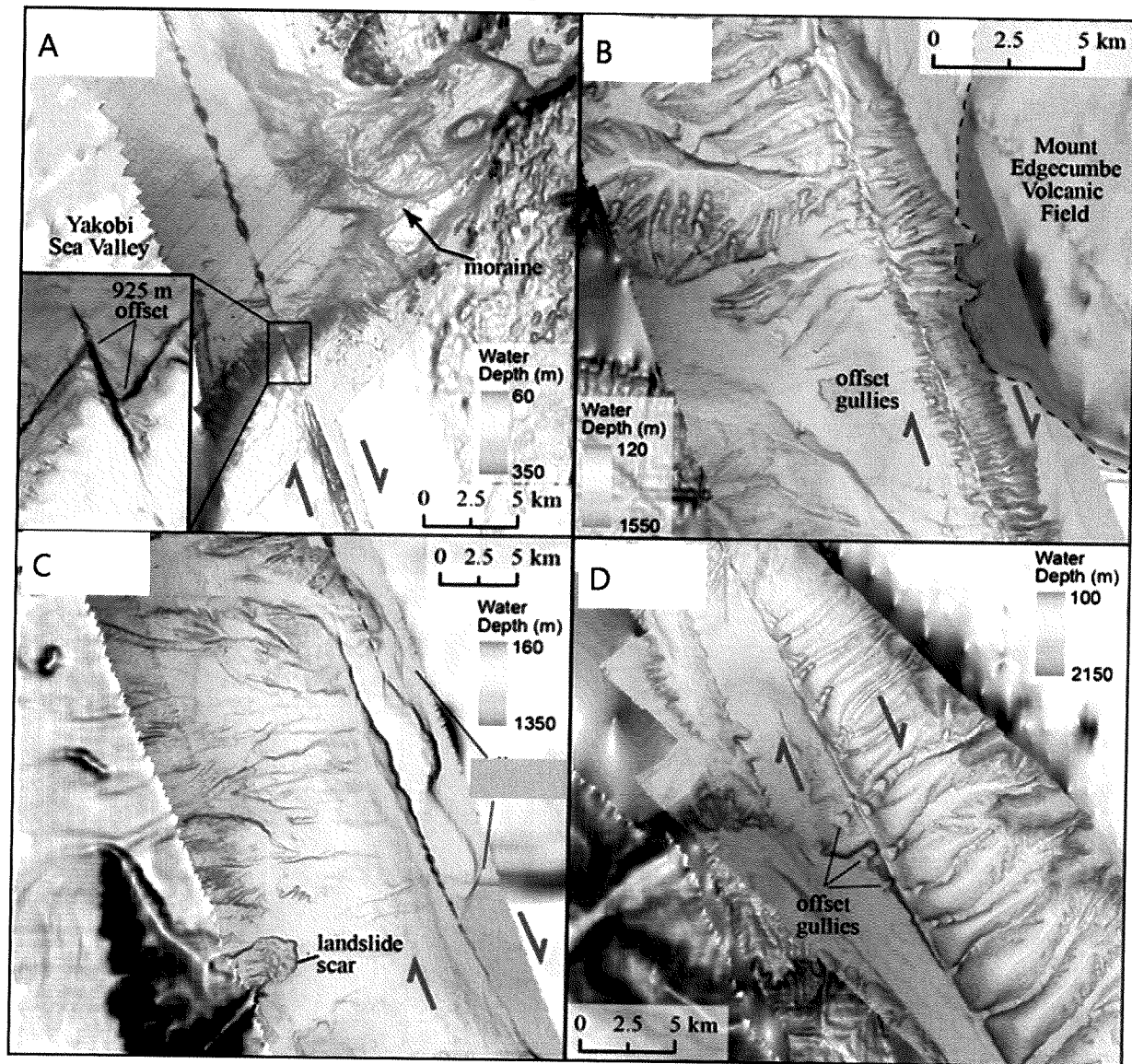


Figure 9



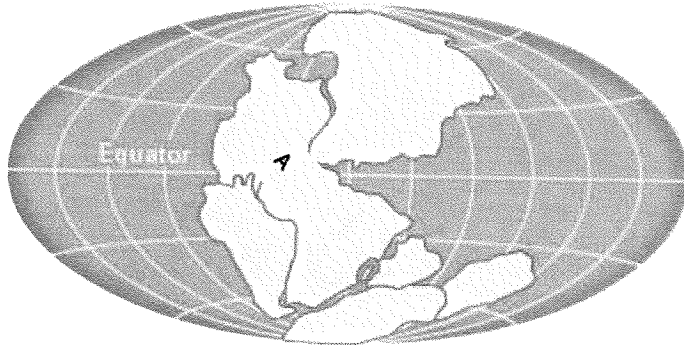
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Figure 10

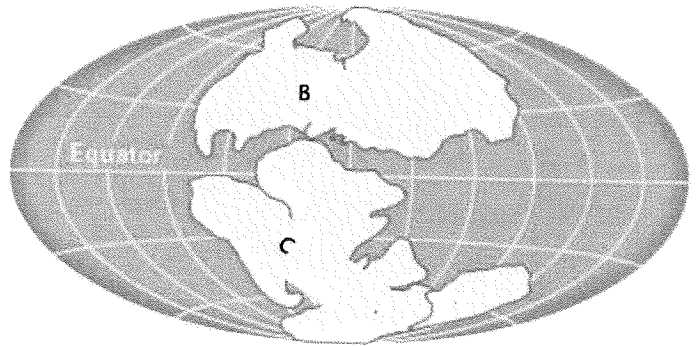


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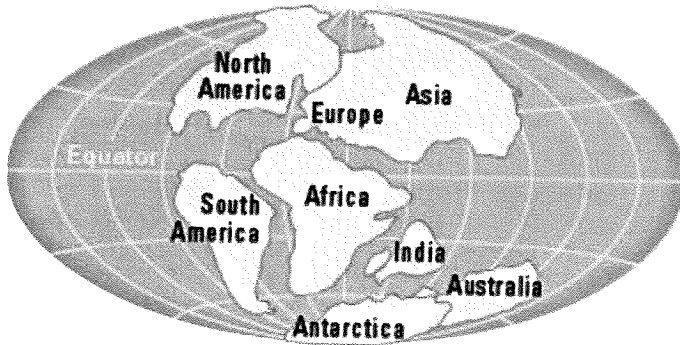
Figure 11



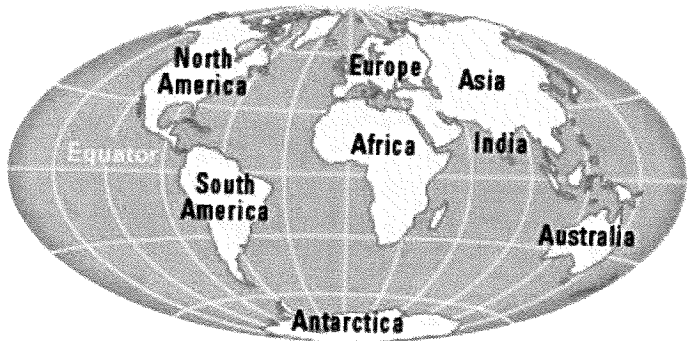
225 million years ago



150 million years ago



100 million years ago



Earth today

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Figure 12

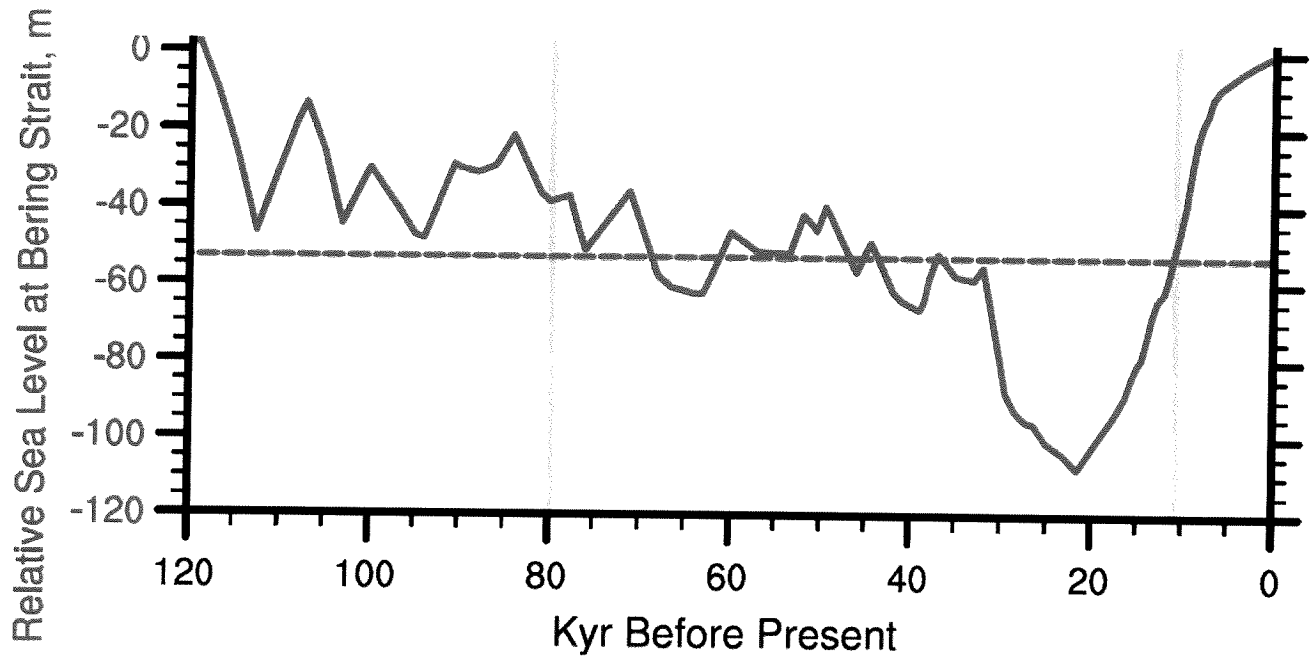


Figure 13

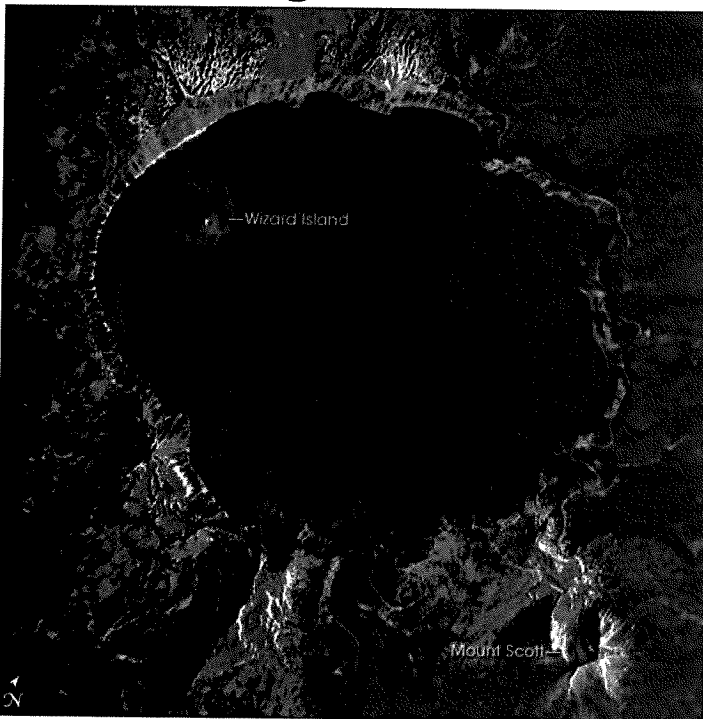
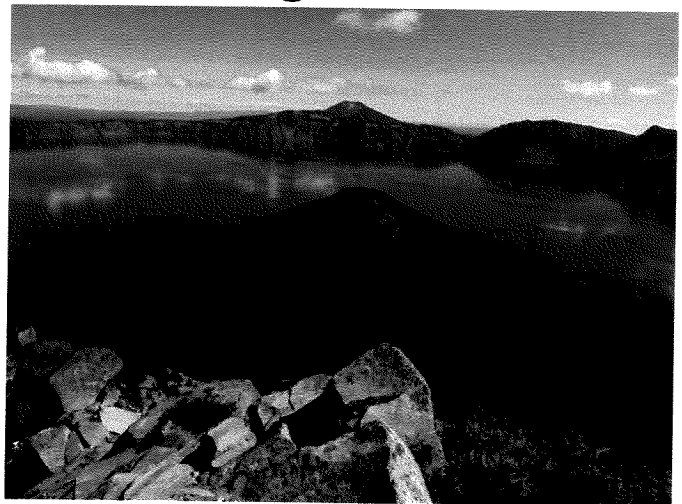


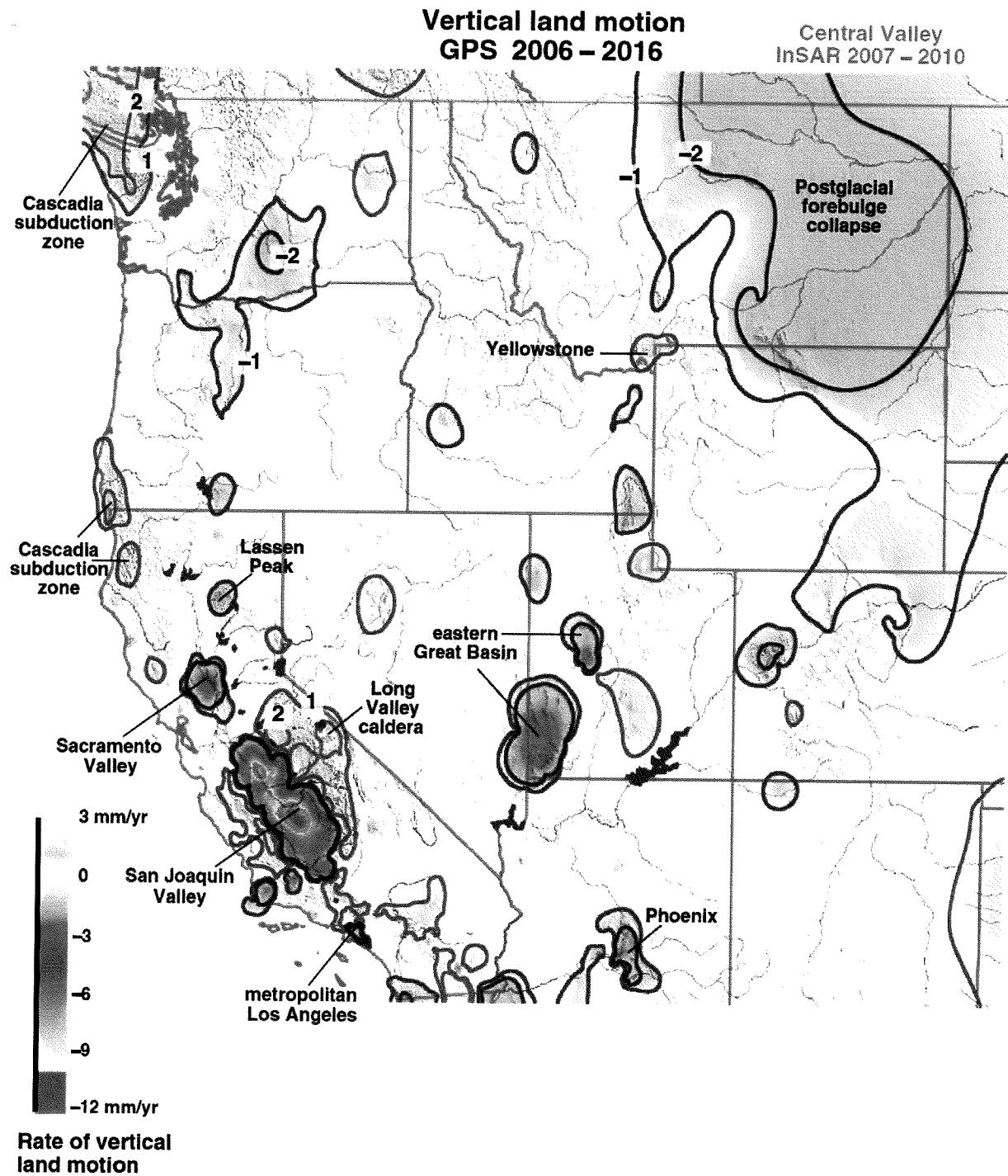
Figure 14



Close-up photo of Wizard Island

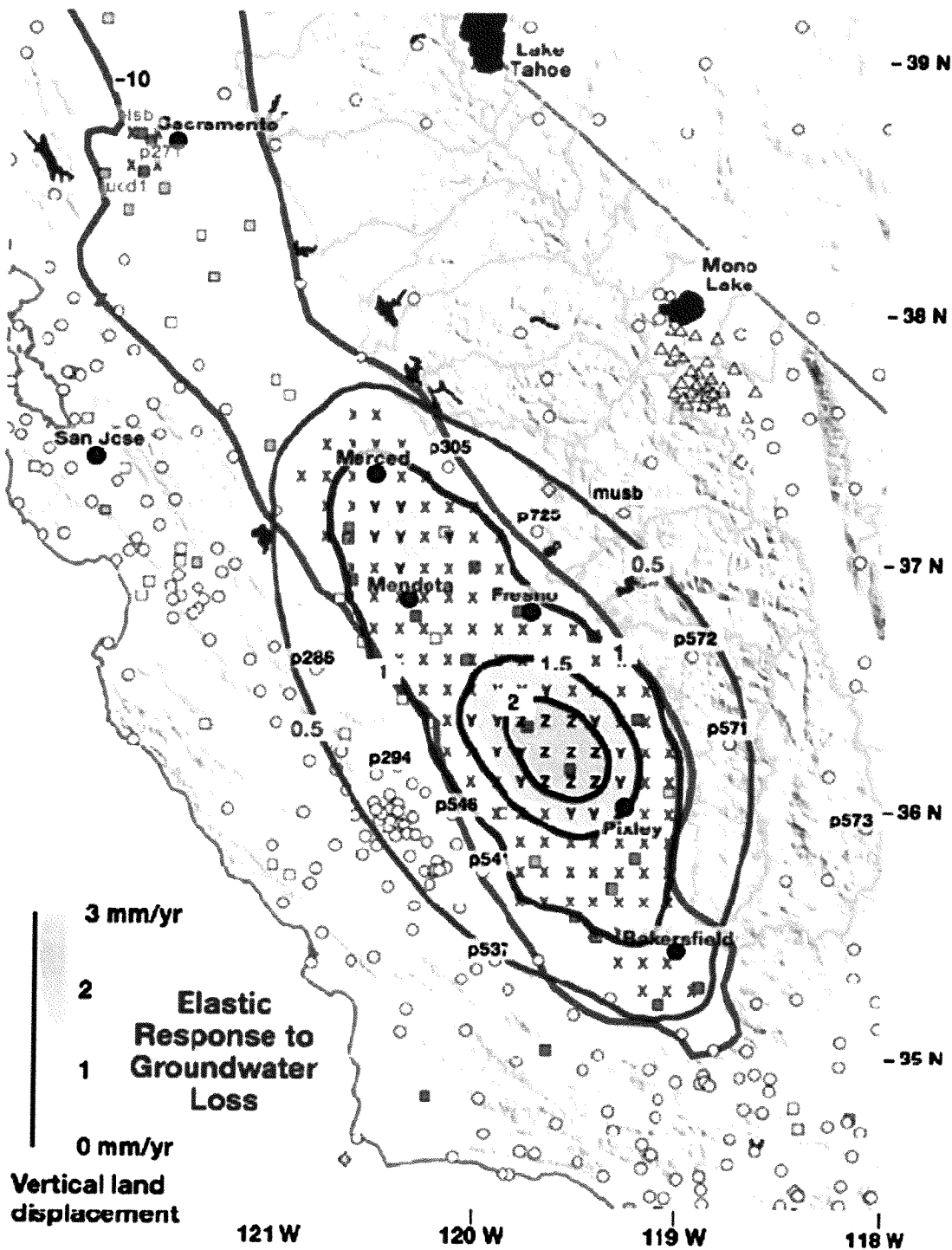
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Figure 15



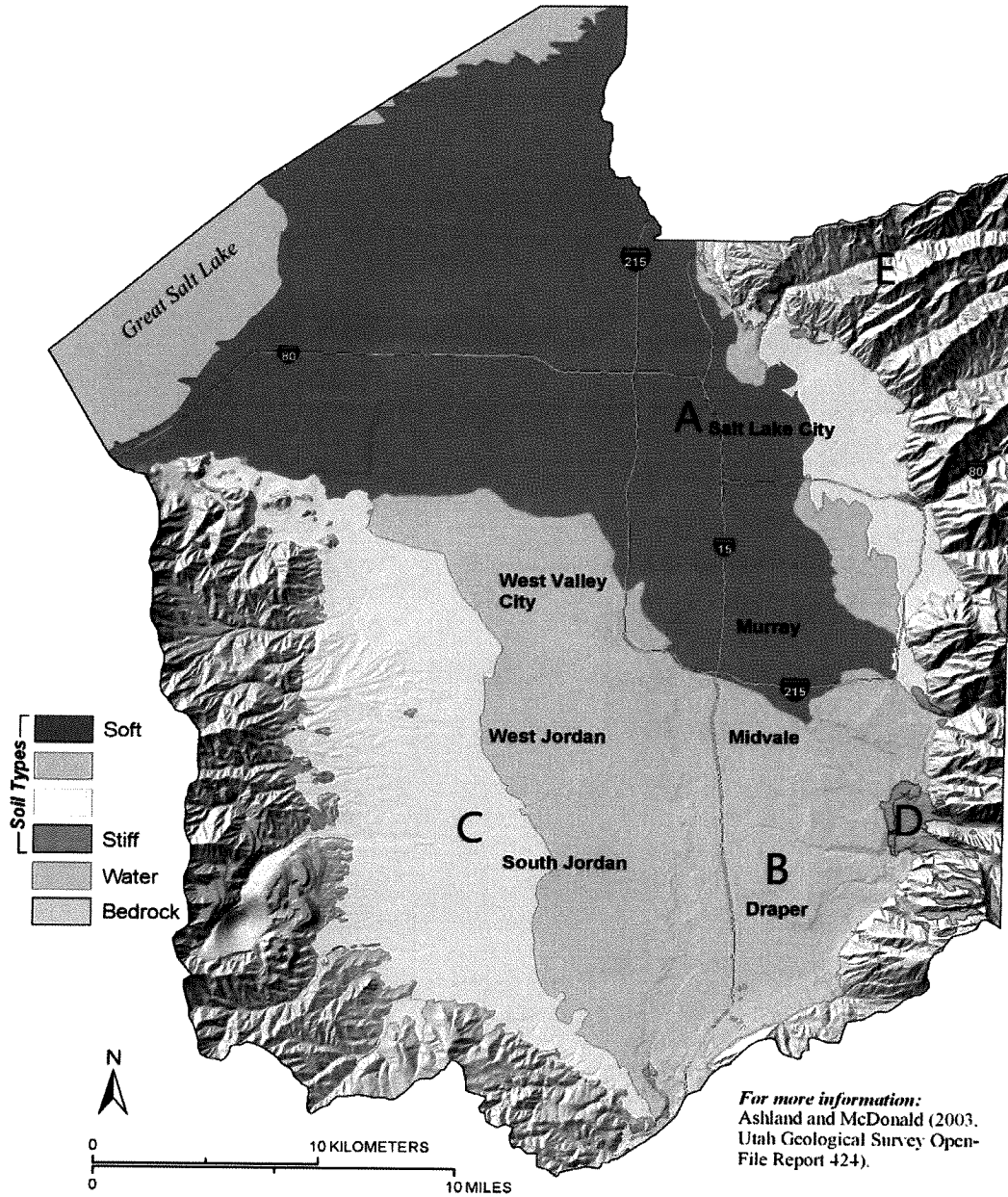
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Figure 16



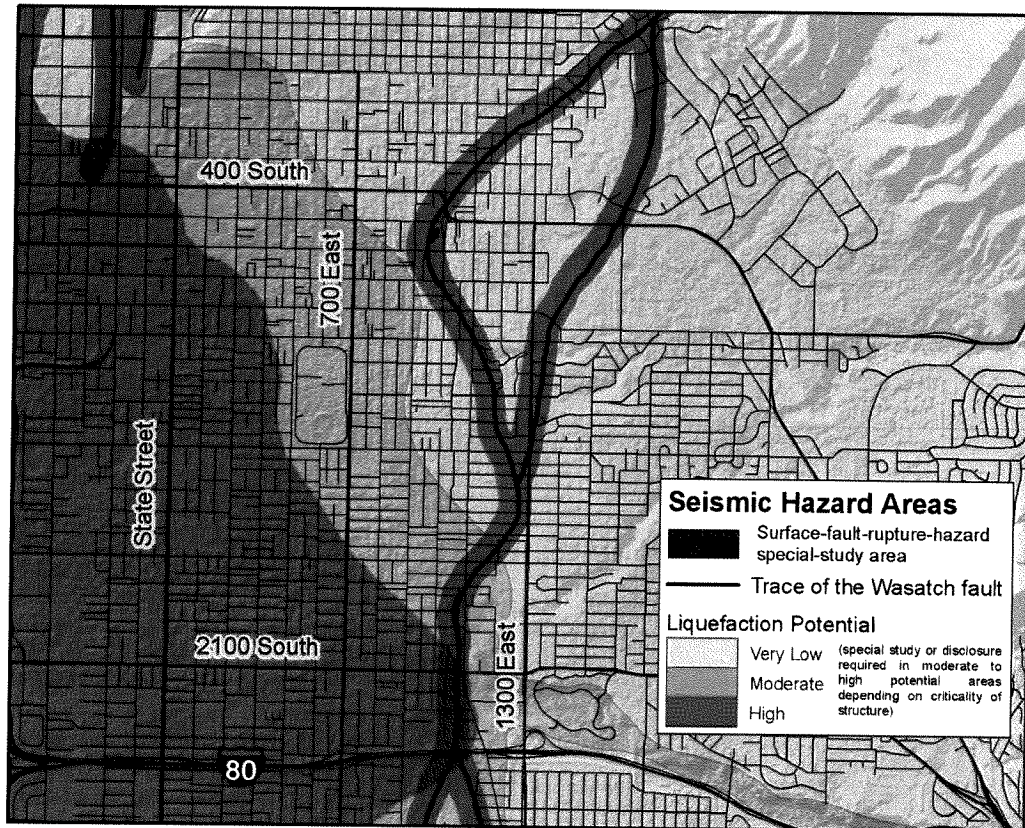
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Figure 17



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Figure 18



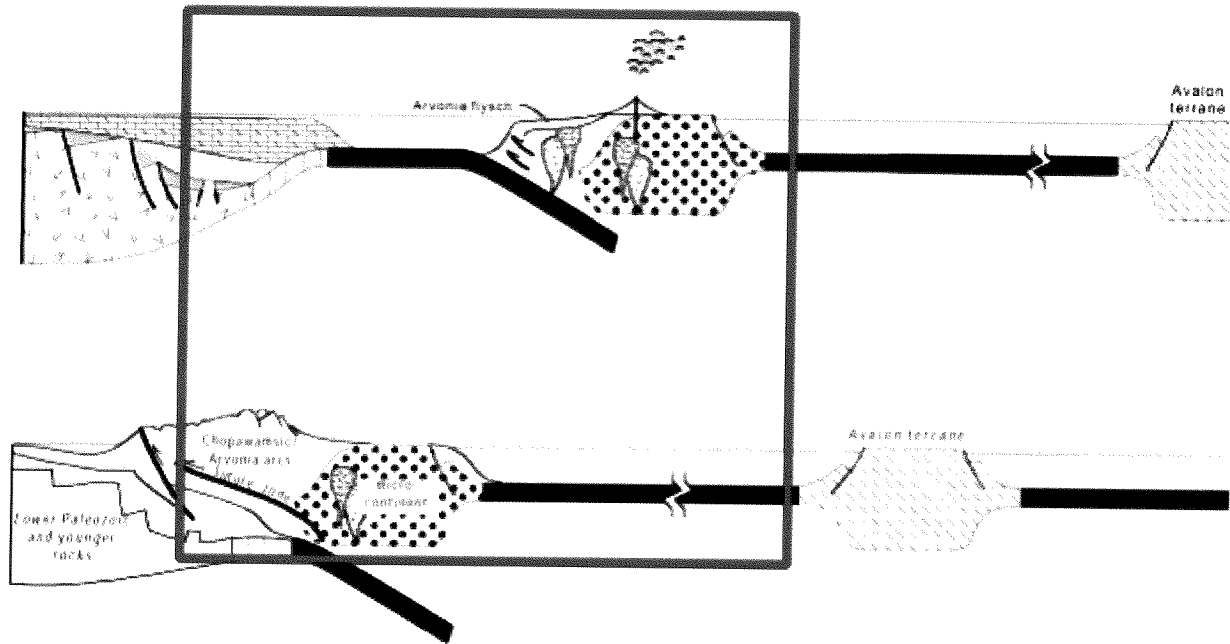
Map Showing Potential Seismic Hazard Areas

Source: Salt Lake County Planning and Development Services

This map of northeastern Salt Lake Valley shows areas where a surface-faulting or liquefaction hazard may exist and where site-specific studies addressing the hazards are recommended prior to development. Such special-study-area maps are available at most Wasatch Front county planning departments, and many cities have adopted them in their subdivision-approval process.

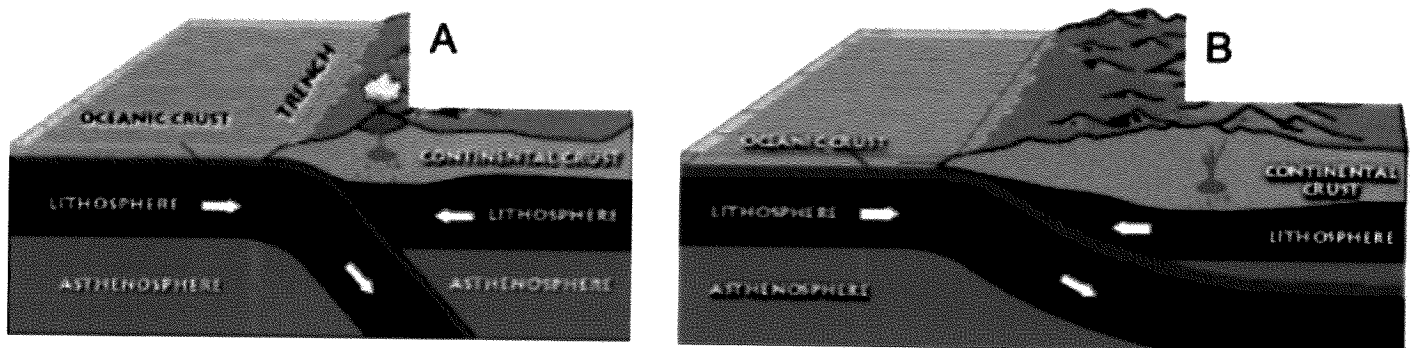
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Figure 19



(from S. Foster, 1993)

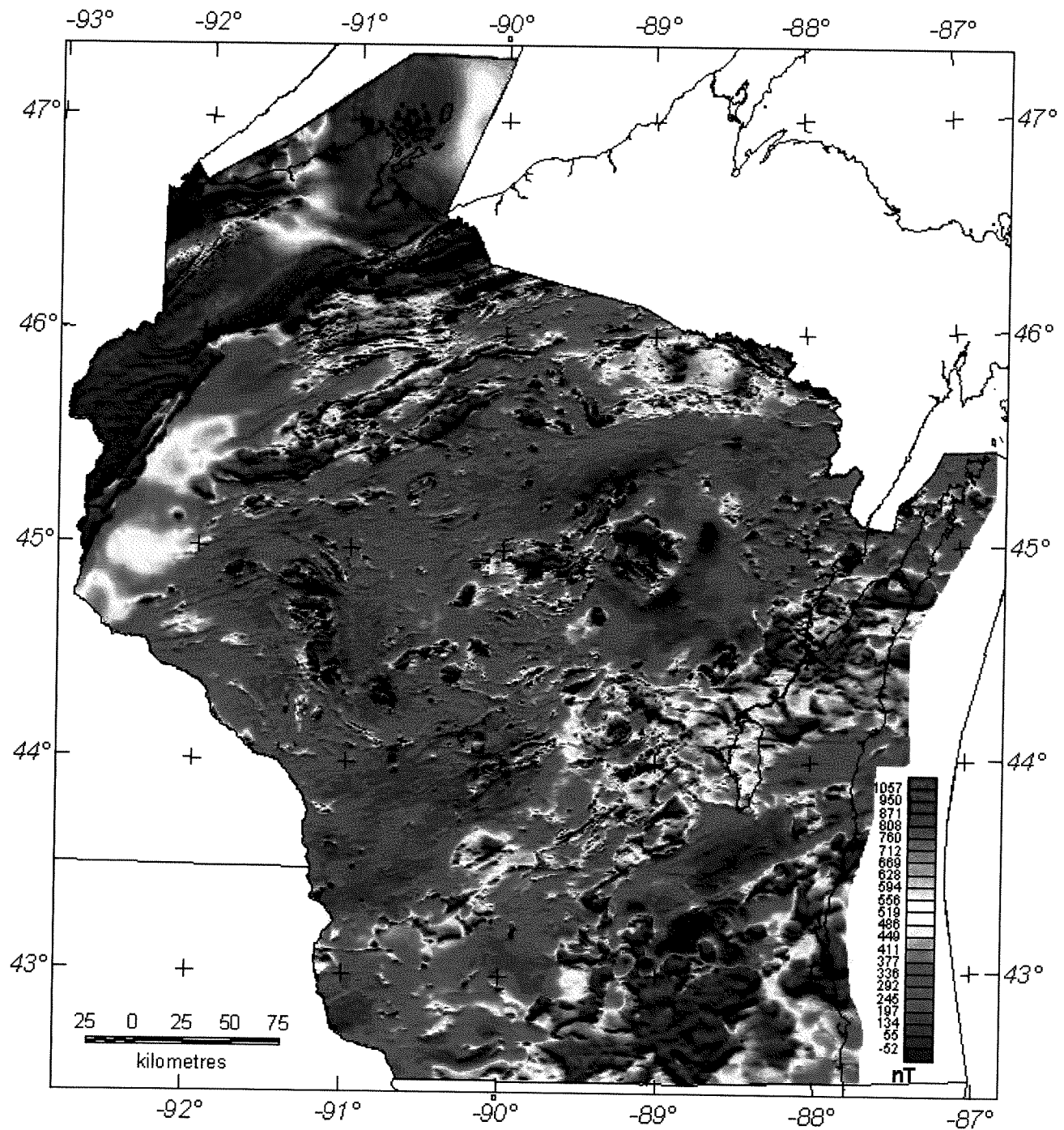
Figure 20



Please do not write on these figures.

Figure 21

Magnetic anomalies in and around the state of Wisconsin



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Figure 22

Australia

Topography and bathymetry

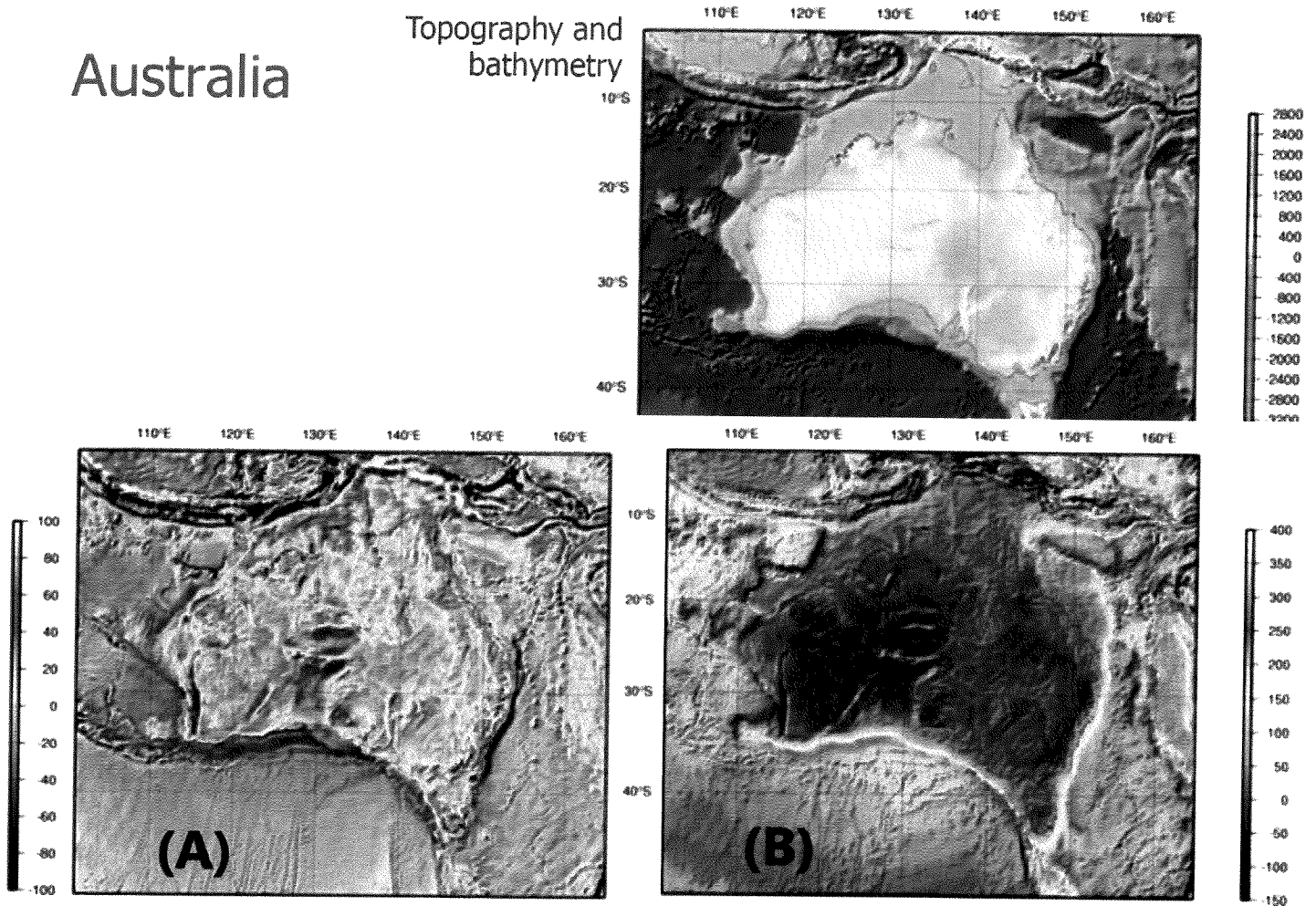
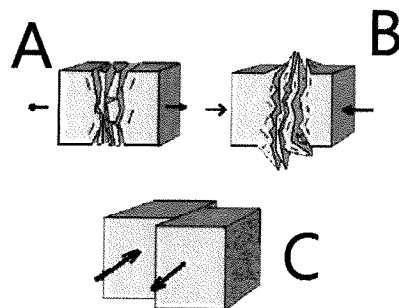


Figure 23



Please do not write on these figures.

Figure 24



Figure 25

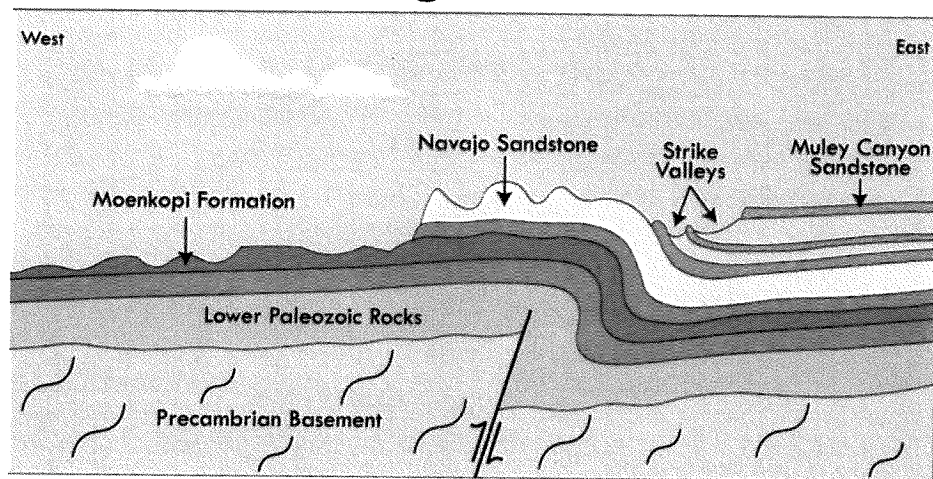
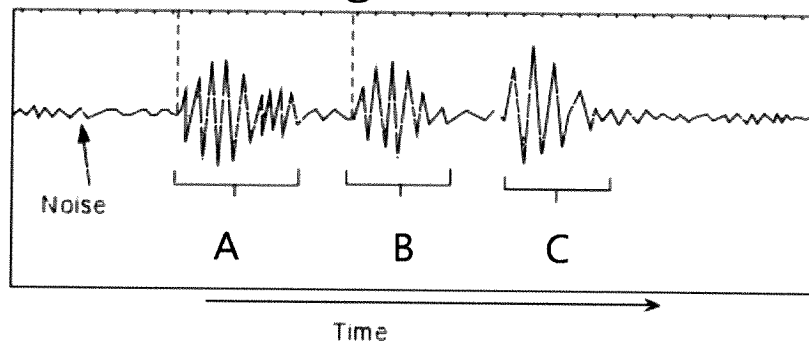


Figure 26



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QUESTIONS 1-2: No figures needed.

#1 (1 pt): Which scientist suspected that South America and Africa once made up one continent because of the shape of their shorelines?

#2 (4 pts): Besides similarity of shorelines between South America and Africa, what are two other pieces of evidence for movement of Earth's continental plates?

QUESTIONS 3-4: Use Figure 1.

#3 (1 pt): Figure 1 shows a plate boundary and age of the ocean floor. Which color indicates the youngest rocks?

- A. blue
- B. green
- C. yellow
- D. red

#4 (1 pt): Out of the choices below, what is a piece of evidence for movement of Earth's continental plates that Figure 1 shows?

- A. a mid-ocean ridge or rift system in the Atlantic Ocean
- B. older rocks indicated by red colors
- C. the Sahara Desert in northern Africa
- D. seismicity along the east coast of South America

QUESTIONS 5-10: No figures needed.

#5 (1 pt): The crust is _____ the mantle.

- A. thicker than
- B. thinner than
- C. the same thickness as

Match the terms with the descriptions. Choose from: mantle, inner core, outer core, and crust.

#6 (1 pt): Solid and made up of iron and nickel, with temperatures up to 5,500 °C

#7 (1 pt): Made up primarily of magma and has a thickness of about 2,900 km

#8 (1 pt): A thin layer between 0 – 60 km thick

#9 (1 pt): Liquid, and made up of iron and nickel

#10 (2 pts): These two layers, along with Earth's rotation, cause the Earth's magnetic field.

QUESTIONS 11-13: Use Figure 2.

#11 (1 pt): What is the name for layer 1 in Figure 2?

#12 (1 pt): What is the name for layer 4 in Figure 2?

#13 (1 pt): What is the name for layer 5 in Figure 2?

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QUESTIONS 14-16: No figures needed.

#14 (1 pt): The driving forces for plate movement, according to the Plate Tectonics theory, are thought to be the result of _____.

- A. isostasy
- B. earth's rotation
- C. thermal convection cells
- D. magnetism
- E. polar wandering

#15 (1 pt): Earth's crustal plates move:

- A. a few meters per year
- B. a few centimeters per year
- C. a few millimeters per 1000 years
- D. a few millimeters per day

#16 (1 pt): Continental plates move at a _____ rate.

- A. highly variable
- B. constant

QUESTIONS 17-20: Use Figure 3.

In Figure 3, several letters are matched with different features. For each of the vocabulary terms shown in Questions #17-19, write the letter (shown in Figure 3) that matches the term *on the separate answer sheet*.

#17 (1 pt): Accretion Wedge

#18 (1 pt): Backarc

#19 (1 pt): Oceanic Crust

#20 (1 pt): What type of volcanoes are most often seen along boundaries like the one shown in Figure 3?

- A. Cinder
- B. Shield
- C. Stratovolcano/Composite
- D. It depends on the type of crust

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QUESTIONS 21-22: Use Figure 4.

#21 (1 pt): What type of plate boundary is shown in Figure 4 at the X?

- A. divergent
- B. convergent
- C. transform

#22 (1 pt): At the plate boundary indicated by the X in Figure 4, what type(s) of plates are involved?

- A. a continental plate and a continental plate
- B. a continental plate and an oceanic plate
- C. an oceanic plate and an oceanic plate
- D. a continental plate and a rift valley

QUESTIONS 23-26: Use Figure 5.

#23 (1 pt): What is the most likely age of the rocks at point A?

- A. 16.3 My
- B. 3.3 My
- C. 0.7 My
- D. < 10,000 years old

#24 (1 pt): What is the most likely age of the rocks at point B?

- A. 16.3 My
- B. 3.3 My
- C. 0.7 My
- D. < 10,000 years old

#25 (6 pts): Compute the approximate distance in kilometers between points A and B (shown as triangles) on the map in Figure 5.

- Measure from the center of the triangles.
- Compute the distance in km. Round to the nearest whole km. Don't forget to include units of km on your final answer.
- Show your work on the separate answer sheet.
- *You must show your work on the separate answer sheet to get full credit. Don't just write your final answer on the separate answer sheet.*

#26 (7 pts): Using information from Questions #23, 24, and 25, calculate the approximate rate at which the west side of Iceland is moving away from the zone of active rifting. Assume the zone of active rifting is indicated by the thick red line labeled NVZ.

- Compute the rate in cm/year. Round to the nearest tenth of a cm/year. Don't forget to include units of cm/year on your final answer.
- Show your work on the separate answer sheet.
- *You must show your work on the separate answer sheet to get full credit. Don't just write your final answer on the separate answer sheet.*

**** Remember to write your answers on the separate answer sheet ****

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QUESTIONS 27-32: Use Figure 6.

#27 (1pt): What landform is located where the Indian and Eurasian plates meet?

- A. Mariana Trench
- B. Himalaya Mountains
- C. Rocky Mountains
- D. Eurasian craton

#28 (1 pt): The collision of the Indian and Eurasian plates would result in ocean levels that _____.

- A. rise
- B. fall
- C. stay the same

#29 (1 pt): The Indian and Eurasian plate boundary is an example of a(n):

- A. spreading center
- B. continental-oceanic plate collision
- C. continental-continental plate collision
- D. oceanic-oceanic plate collision

#30 (1 pt): The Nazca and South American plate boundary is an example of a(n):

- A. continental-oceanic plate collision
- B. continental-continental plate collision
- C. spreading center
- D. oceanic-oceanic plate collision

#31 (1 pt): The isolation of Antarctica and the establishment of the Antarctic Circumpolar Current occurred about 40 million years ago when a back-arc basin separated Antarctica from _____.

- A. Australia
- B. Africa
- C. South America
- D. New Zealand

#32 (1 pt): The boundary between the Arabian Plate and the African plate is an example of a(n) _____.

- A. continental-continental collision
- B. oceanic-continental collision
- C. volcanic arc
- D. spreading center

*** Remember to write your answers on the separate answer sheet ***

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QUESTIONS 33-36: Use Figure 7.

#33 (1 pt): Which state(s) has(have) *only* sediments that were deposited within an ancient sea?

- A. Utah
- B. Colorado and Wyoming
- C. Kansas and Nebraska

#34 (1 pt): Which type of basin is shown in Figure 7?

- A. foreland
- B. forearc
- C. backarc
- D. abyssal plain

#35 (1 pt): At what depth would you find “marine and brackish water sandstones”?

- A. 0 m/at the surface
- B. 600 m
- C. 1200 m
- D. at multiple depths

#36 (1 pt): Alluvial fan deposits in Utah were moved across the landscape by _____ that _____ them.

- A. oceans, submerged
- B. rifts, exposed
- C. rivers, eroded
- D. hot spots, formed

QUESTIONS 37-42: Use Figure 8.

#37 (1 pt): Which numbered areas would generate the largest earthquakes?

- A. 2 and 5
- B. 4 and 3
- C. 1 and 2
- D. 5 and 1

#38 (1 pt): Which number (1-5) represents an opening of a future new sea (that does not exist yet)? Choose only one.

#39 (1 pt): Which number (1-5) would represent the Cascade Range in the northwestern United States? Choose only one.

#40 (1 pt): Which number (1-5) would represent the islands of Japan? Choose only one.

#41 (1 pt): At which location (1-5) would the youngest oceanic crust be found? Choose only one.

#42 (2 pts): What will eventually happen to the island (#4)?

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QUESTION 43: Use Figure 9.

#43 (1 pt): The people in Figure 9 are looking at an offset stream bed. What type of fault caused the offset in the stream bed?

- A. Normal
- B. Reverse
- C. Strike-Slip

QUESTIONS 44-45: Use Figure 10.

#44 (1 pt): What type of fault is shown in Figures 10A-10D?

- A. normal
- B. reverse
- C. strike slip
- D. transform

#45 (1 pt): Out of the options below, what is a piece of evidence shown in Figure 10 that directly supports your answer to Question #44?

- A. offsets in features
- B. glacial moraine
- C. landslide scar
- D. sea valley

QUESTIONS 46-48: Use Figure 11.

#46 (1 pt): What is the name of the past supercontinent shown at A?

#47 (1 pt): What is the name of the past supercontinent shown at B?

#48 (1 pt): What is the name of the past supercontinent shown at C?

QUESTIONS 49-50: Use Figure 12.

#49 (1 pt): What two continents connected across the Bering Strait during the last Ice Age with a lowering of sea level?

- A. Australia and Asia
- B. Asia and North America
- C. North America and South America
- D. Africa and Asia

#50 (1 pt): According to Figure 12, when were the two continents you chose in Question #49 last connected?

- A. 120,000 years ago
- B. 80,000 years ago
- C. 20,000 years ago
- D. 10,000 years ago

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QUESTIONS 51-52: Use Figures 13-14.

#51 (1 pt): Crater Lake in Oregon (shown in Figure 13), the deepest lake in the United States, occupies a _____.

- A. rift basin
- B. caldera
- C. sinkhole
- D. deflation basin

#52 (1 pt): Wizard Island within Crater Lake (shown in Figure 14) is a _____.

- A. cinder cone
- B. stratovolcano
- C. composite volcano
- D. shield volcano

QUESTIONS 53-55: No figures needed..

#53 (1 pt): Which type of isostasy assumes that mountains have a crustal root that compensates for their relief?

#54 (1 pt): Which type of isostasy assumes that density of the crust varies laterally due to changes in temperature and/or composition?

#55 (1 pt): In isostasy, at the depth of compensation, the weight of the columns of crust are [equal or unequal].

QUESTIONS 56-59: Use Figures 15-16.

*In Figure 15, some areas are rebounding and some are subsiding. For each area, identify whether it is **rising** or **subsiding**. You can write "R" or "S" or the full words, whichever you like. Remember to write your answers on the separate answer sheet.*

#56 (1 pt): Cascadia

#57 (1 pt): Eastern Great Basin

#58 (1 pt): Yellowstone

#59 (1 pt): The land in the area shown in Figure 16 is responding elastically to a change in groundwater amount. This means:

- A. the land can go back and forth between subsiding and rebounding without fracturing
- B. if the land changes vertically, it will fracture and no longer be able to either rebound or subside
- C. Change in the amount of groundwater below the land surface has no effect on the land's vertical position.

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QUESTIONS 60-61: No figures needed.

#60 (1 pt): Which is a hazard that is a direct effect of plate tectonics?

- A. ground rupture
- B. fire
- C. tsunami
- D. landslide

#61 (4 pts): Name two causes of tsunamis that are related to plate tectonics.

QUESTIONS 62-63: Use Figure 17.

#62 (1 pt): Based on soils information alone, as shown in Figure 17, which area would be most likely to have low-frequency shaking if an earthquake occurred?

- A. Salt Lake City
- B. Draper
- C. west of South Jordan
- D. area to the east of Draper and Midvale, where the valley meets the mountains
- E. areas of bedrock to the northeast of Salt Lake City, in the mountains

#63 (1 pt): At which location would it be probably be safest to build a house?

- A. Salt Lake City
- B. Draper
- C. west of South Jordan
- D. area to the east of Draper and Midvale, where the valley meets the mountains
- E. areas of bedrock to the northeast of Salt Lake City, in the mountains

QUESTIONS 64-65: Use Figure 18.

Suppose heavy rainfall occurs for several days across the area shown in Figure 18.

#64 (1 pt): Which area is most at risk of liquefaction if an earthquake occurred?

- A. Intersection of 400 South and 700 East
- B. Intersection of 400 South and State Street
- C. Intersection of 2100 South and 1300 East
- D. Intersection of 2100 South and State Street

#65 (1 pt): Which of the statements below supports the correct answer for Question #64?

- A. Storm drains will carry rain and any water runoff away from the soils, leading to almost no impact on soils.
- B. Consolidated sediments will stick together in this area.
- C. Unconsolidated sediments will lose grain-to-grain contact with ground shaking.
- D. Unconsolidated sediments will stick together and grains will stay in contact and connected.

*** Remember to write your answers on the separate answer sheet ***

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QUESTIONS 66-69: No figures needed.

Rank the building types in order from least likely to be safe in an earthquake to more likely to be safe. *Remember to write your answers on the separate answer sheet.*

Building Type	Rank (1 = least likely to be safe, 4 = most likely to be safe)
short wooden building	#66 (1 pt):
tall wooden building	#67 (1 pt):
masonry brick construction, reinforced with steel	#68 (1 pt):
unreinforced masonry bricks	#69 (1 pt):

QUESTIONS 70-72: No figures needed.

#70 (1 pt): Which type of magma is generated by decompression melting as hot asthenosphere rises and partially melts?

#71 (1 pt): Which type of magma leads to more explosive eruptions, **basaltic** or **rhyolitic**? Choose one.

#72 (1 pt): The present-day topography of the North American craton is due to:

- A. Intense orogenies of 500 million years ago and glaciation
- B. Glaciation and billions of years of erosion
- C. Deposition of sediments from local rivers and streams after floods across the entire craton

QUESTION 73: Use Figure 19.

#73 (1 pt): Figure 19 shows two geologic events that are part of the sequence of geologic events that built the Appalachian Mountains. Which phase of the Wilson Cycle is occurring in the red box?

- A. Opening ocean basin
- B. Closing ocean basin
- C. Stable craton
- D. Rifting
- E. Full ocean basin

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QUESTIONS 74-77: Use the separate map and separate stratigraphic units table.

This map shows subcropping geology of a portion of the the Mid-Atlantic region of the eastern United States. Subcropping means that the rock at the surface is most likely bedrock. The map is centered on the state of North Carolina (NC). The Atlantic Ocean is the body of water on the east side of the map.

#74 (1 pt): As you go from the *east towards the west* across North Carolina, the rocks shown in the subcropping geology map generally get [**older** or **younger**].

#75 (1 pt): Which reason below supports the correct answer for Question #74?

- A. Basement rocks are exposed at the surface in eastern NC near the Atlantic Ocean.
- B. Rocks from the ancient version of the African continent are closer to the surface in eastern NC near the Atlantic Ocean.
- C. Erosion has deposited more sediments at the surface in western NC.
- D. Erosion of sediments by rivers in western NC has exposed what is likely to be bedrock.

#76 (1 pt): Which area is closest to the most intense deformation along a formerly active margin, millions of years ago during the formation of the Appalachian Mountains?

- A. Nash County, NC (in the smallest oval on the map, near 36 N, 78 W)
- B. where the Chowan River drains into Albemarle Sound in northeastern NC (largest black oval on the map, near 36 N, 76.5 W)

#77 (1 pt): Which area is closest to a passive continental margin in the present day?

- A. the area around the cities of Raleigh and Durham (in the medium-sized black oval on the map, near 36 N, 78-79 W)
- B. towards Pamlico and Albemarle Sounds in eastern North Carolina

QUESTION 78: Use Figure 20.

#78 (1 pt): Which of the diagrams in Figure 20 (A or B) is more likely associated with the building of the Rockies?

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QUESTIONS 79-82: Use Figure 21.

#79 (1 pt): Which type of rock would be most likely to have values near zero on a magnetic anomaly map?

- A. igneous
- B. metamorphic
- C. sedimentary

#80 (1 pt): What is the most likely value of the magnetic anomaly at the latitude/longitude of 43.0, -89.0?

- A. 0 nT
- B. 100 nT
- C. 500 nT
- D. 1000 nT

#81 (1 pt): What is the most likely value of the magnetic anomaly at the latitude/longitude of 44.0, -88.0?

- A. 100 nT
- B. 300 nT
- C. 500 nT
- D. 700 nT
- E. 900 nT

#82 (1 pt): At which latitude/longitude would you expect to find iron ore?

- A. 45.5, -92.5
- B. 45.5, -89.0
- C. 44.5, -89.0
- D. 43.5, -91.0

QUESTION 83: Use Figure 22.

#83 (1 pt): Figure 22 shows two gravity anomaly maps of the continent of Australia. In Figure 22, the *free-air anomaly* map is [A or B] and the *Bouguer anomaly* map is the other map.

The map of topography and bathymetry for Australia in Figure 22 may also be helpful.

QUESTIONS 84-86: Use Figure 23.

Name the types of stress shown in Figure 23. Choose from shear, compressional, or tensional.

#84 (1 pt): A =

#85 (1 pt): B =

#86 (1 pt): C =

*** Remember to write your answers on the separate answer sheet ***

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QUESTION 87: Use Figure 24.

#87 (1 pt): The Basin and Range Province of the United States,, a portion of which is shown in Figure 24, is a result of _____ stress on Earth's crust and is fractured by _____ faulting.

- A. tensional; normal
- B. compression; reverse
- C. tensional; transform
- D. compression; normal

QUESTION 88-92: Use Figure 25.

Examine Figure 25 and think about what events happened to form the layers as shown in the figure. Put the following events in order by numbering them from 1 (earliest) to 4 (latest). *Remember to record your answers on the separate answer sheet.*

Event Number	Event
#88 (1 pt):	faulting of the basement rocks
#89 (1 pt):	deposition of Muley Canyon Sandstone
#90 (1 pt):	deposition of the Moenkopi Formation
#91 (1 pt):	erosion that exposed Navajo Sandstone

#92 (1 pt): What type of fault is shown in the Precambrian Basement rocks as shown in Figure 25?

- A. normal
- B. reverse
- C. transform

QUESTIONS 93-95: Use Figure 26.

Seismology is the study of different types of waves and how those waves move through the earth. Figure 26 shows different types of waves, arriving at a location after an earthquake.

#93 (1 pt): Which set of waves (A, B, or C) is the S-waves?

#94 (1 pt): Which set of waves (A, B, or C) is the P-waves?

#95 (1 pt): Which set of waves (A, B, or C) is the surface waves?