

1. Define "rock".

- a. A naturally occurring (1pt) solid (1)
aggregate/mass/accumulation of minerals or debris (1).

2. Define "mineral."

- a. A naturally occurring (1) solid (1) material with a definite
chemical composition/formula (1) and crystal structure (1).

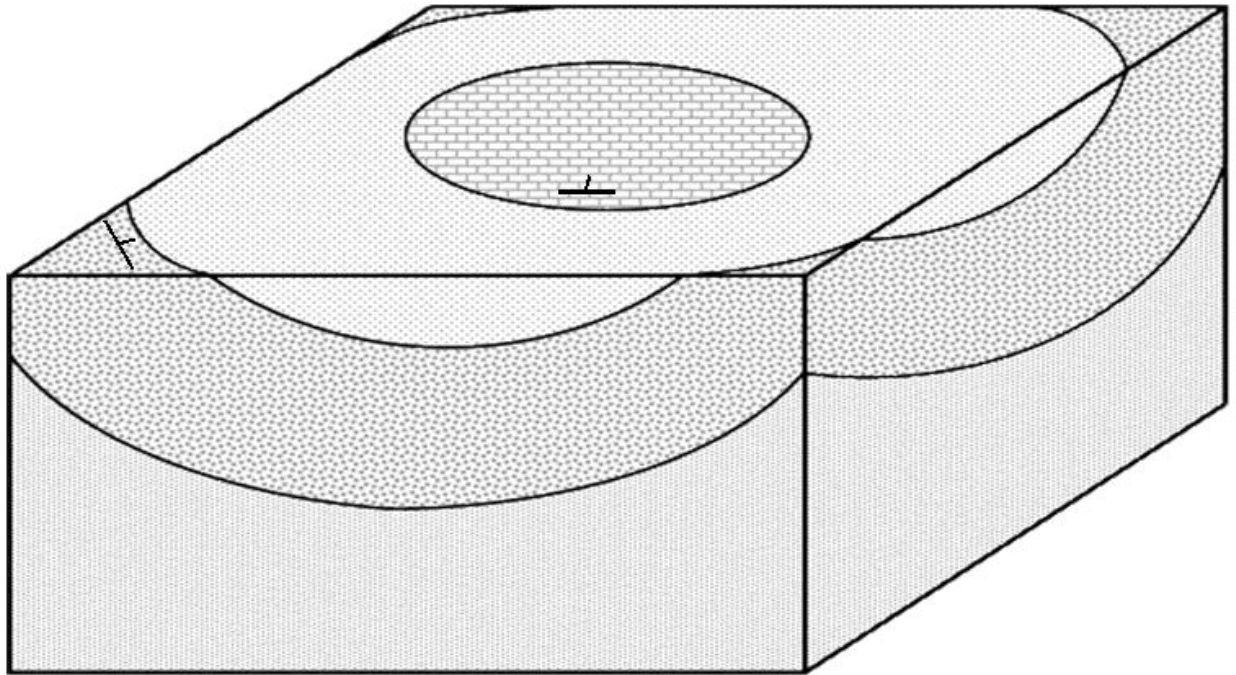
3. Define "lithosphere."

- a. The rigid (1) uppermost layer (1) of Earth containing the
crust and rigid mantle (1).

4. Define "weathering."

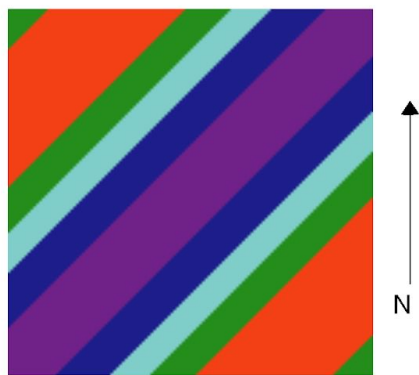
- a. The physical (1) and chemical (1) processes by which
rock/material is broken down (1).

5. What structure is this? Is the central stratum the oldest or youngest?



a. Basin (2); youngest (1);

6. Assuming the unit in the center is the oldest layer, what structure is this? What is the approximate strike (nearest multiple of 15)?



a. Anticline (2); 045 NE (1)

7. What type of fold is this? What general type of structure underlies it? (3)

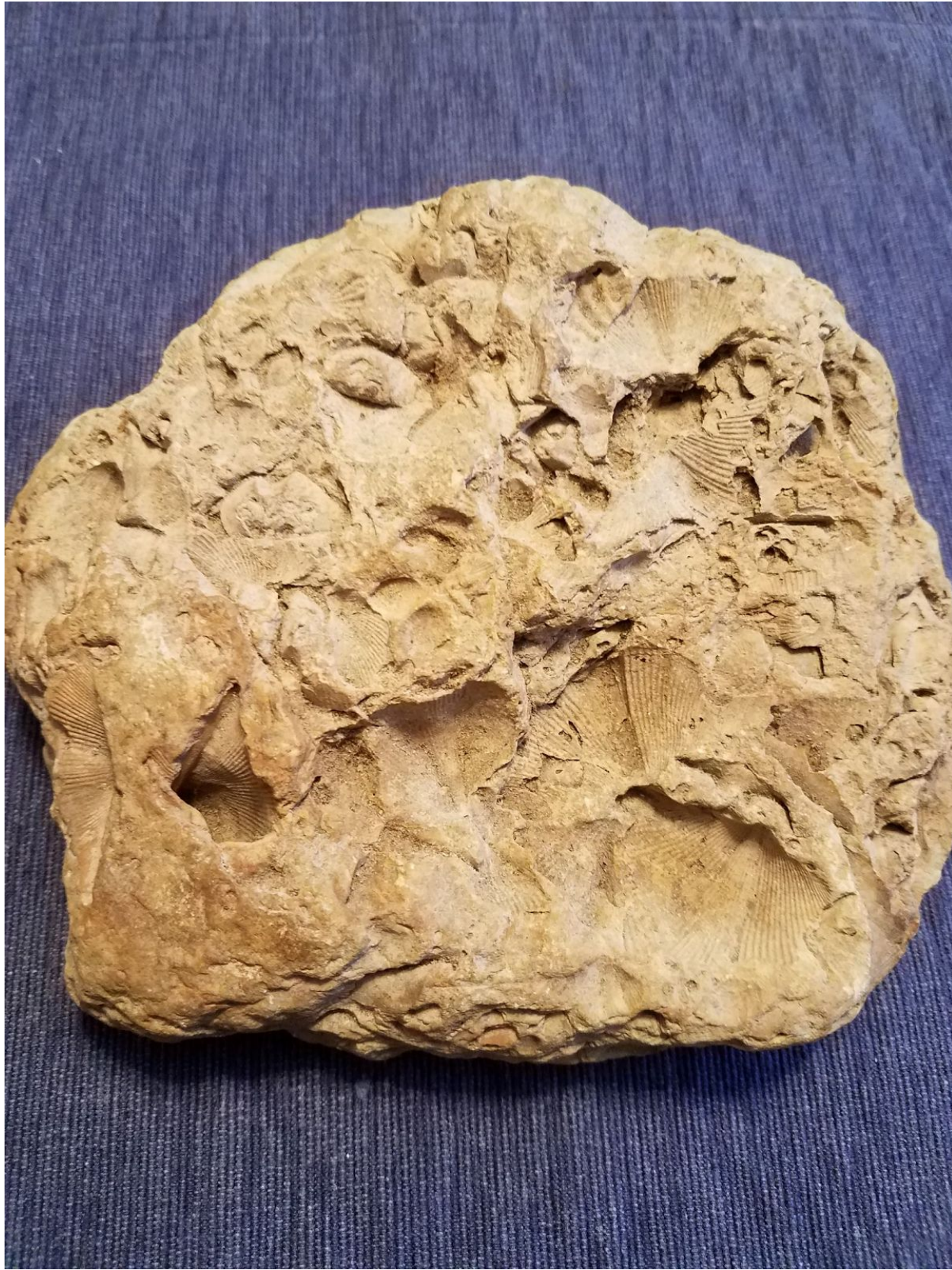


- a. Monocline (2); fault (1)
8. What are two of the main forces driving plate tectonics? Explain how these forces occur. (6)
- a. Ridge push (2) and slab pull (2); Ridge push occurs from mid-ocean ridges being pushed down by gravity thus sliding along the entire plate (1); slab pull occurs as the cooler slab becomes denser and sinks into the asthenosphere at subduction, pulling the rest of the plate with it (1).

9. Why does volcanism occur at subduction zones? Explain the process from subduction to the formation of the volcanoes. Why does the lava at these zones tend to be andesitic? (5)
- a. As oceanic crust subducts, the temperature increases (1) causing the water trapped in the surface/hydrous minerals to be released (1) and subsequently lowering the melting temperature of surrounding rock (1), creating a magma of a lower density (1) which rises to the surface. The andesitic composition is a result of basaltic magma melting through granitic continental crust mixing together (1).
10. An oblique fault with a strike of 067 NE and dip of 87° displaces one sign from another after an earthquake by 8m to the NE. This sign is located on the hanging wall block. This indicates that the fault has a _____ strike-slip component. (2)
- a. Left-lateral (correct)
 - b. Dextral
 - c. Right Lateral
 - d. Reverse
 - e. Normal
11. Which of these is NOT a hazard posed by earthquakes? (2)
- a. Surface waves
 - b. Tsunamis
 - c. Liquefaction

- d. Landslides
 - e. Calving (correct)
12. River valleys have a (2):
- a. U-shaped cross section
 - b. Rectangular cross section
 - c. V-shaped cross section (correct)
 - d. Stairstep cross section
 - e. Wide U cross section
13. A fold which eventually has its limbs almost parallel to the surface is (2):
- a. Symmetric
 - b. Asymmetric
 - c. Isoclinal
 - d. Recumbent (correct)
 - e. Overturned
14. A scenario in which a measure of rake would be useful is (2):
- a. Determining the orientation of a ridge
 - b. Indicating the steepness of a fault
 - c. Illustrating bedrock striations on a face (correct)
 - d. Calculating the thickness of a folded stratum
 - e. Finding the intersection of two rock units
 - f. Optimizing a plan to minimize house chores
15. True or False: The west coast of Africa is an example of a passive margin. (2) (T)

16. True or False: The Andes Mountains are considered fault-block mountains. (2) (F)
17. True or False: Ocean-ocean subduction zones produce little or no volcanism. (2) (F)
18. True or False: The Sea of Japan is an example of a back arc basin (2) (T)
19. True or False: New Zealand is classified as a Large Igneous Province (LIP) (2) (F)
20. What type of faults are associated with convergent boundaries? What is the force that produces these faults called? (3)
- a. Reverse/Thrust (2); compression (1)



21.

What rock is this? What is it primarily composed of? What environment is it characteristic of? (5)

- a. Limestone (2); CaCO_3 /Calcium carbonate (1); Reef/shallow marine (2)



22.

What rock is this? Are samples with these types of clasts mature or immature? What are potential events that can form these samples? (5)

- a. Breccia (2); immature (1); faults (1), volcanic eruptions (1)

23. What type of silicate mineral are clays primarily made of? What is the size range of clay particles (4)?


- a. Phyllosilicates/clay minerals (2); $<.0039$ mm / 3.9 microns (2)

24. Why do cross beds change from angular to curved deposition as velocity increases (3)?

- a. As grains travel faster along the curve, they will deposit farther from the top of the curve (3)
25. How does Bowen's Reaction Series tie into the composition of sand? Can this explain why sand is primarily made of quartz? If so, why? (5)
- a. The series indicates minerals that are more or less stable (1) at surface conditions (1), thus the minerals closest to surface level conditions are primarily in sand (1); yes (1), since quartz is the series member closest to the surface and most resistant to weathering (1)
26. Can radiometric dating be used to determine the age of sediments or sedimentary rock? Why or why not? How else are accurate numeric dates obtained for these units? (4)
- a. No (1); Radiometric dating only measures the age of the provenance/parent rock/source material rather than when the sediment was lithified (2); fossil record (1)
27. Explain the differences among alluvium, eluvium, and colluvium. (6)
- a. Colluvium = sediment deposited (1pt) at the base of a slope or hill (1pt) Alluvium = sediment deposited (1pt) by flowing water such as rivers and streams (1pt) Eluvium = Sediment formed by weathering (1pt) of material in its original position (1pt)

28. What are the differences between mature versus immature sediments? Knowing this, what might we be able to know about the surrounding area from an immature fluviially deposited sediment? (5)

- a. Mature grains are more rounded (1), more stable mineral composition(1), smaller size (1); the provenance is nearby (1), high elevation area nearby (1)



	GRAIN SIZE	BOUMA (1962) DIVISIONS	INTERPRETATION
	Mud	E Laminated to homogeneous mud	Deposition from low-density tail of turbidity current ± settling of pelagic or hemipelagic particles
	Silt	D Upper mud/silt laminae	Shear sorting of grains & flocs
	Sand	C Ripples, climbing ripples, wavy or convolute laminae	Lower part of lower flow regime of Simons <i>et al.</i> (1965)
		B Plane laminae	Upper flow regime plane bed
	Coarse Sand	A Structureless or graded sand to granule	Rapid deposition with no traction transport, possible quick (liquefied) bed

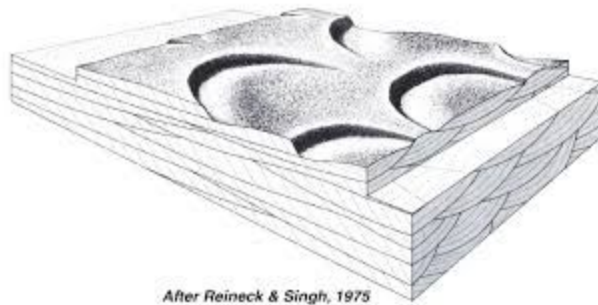
29.

What is this structure called? In what environment do they form?

Why is the base of the structure irregular? (7)

- a. Turbidite (3); Deep marine (2); Scouring from high energy flow during formation (2)

30. What is this structure called? What activity does it indicate? (5)



a. Trough/Festoon/Sinuuous cross bedding (3); Dune/sand wave migration (2)

31. How do ooids form? Why do preserved samples tend to be calcite instead of aragonite? (5)

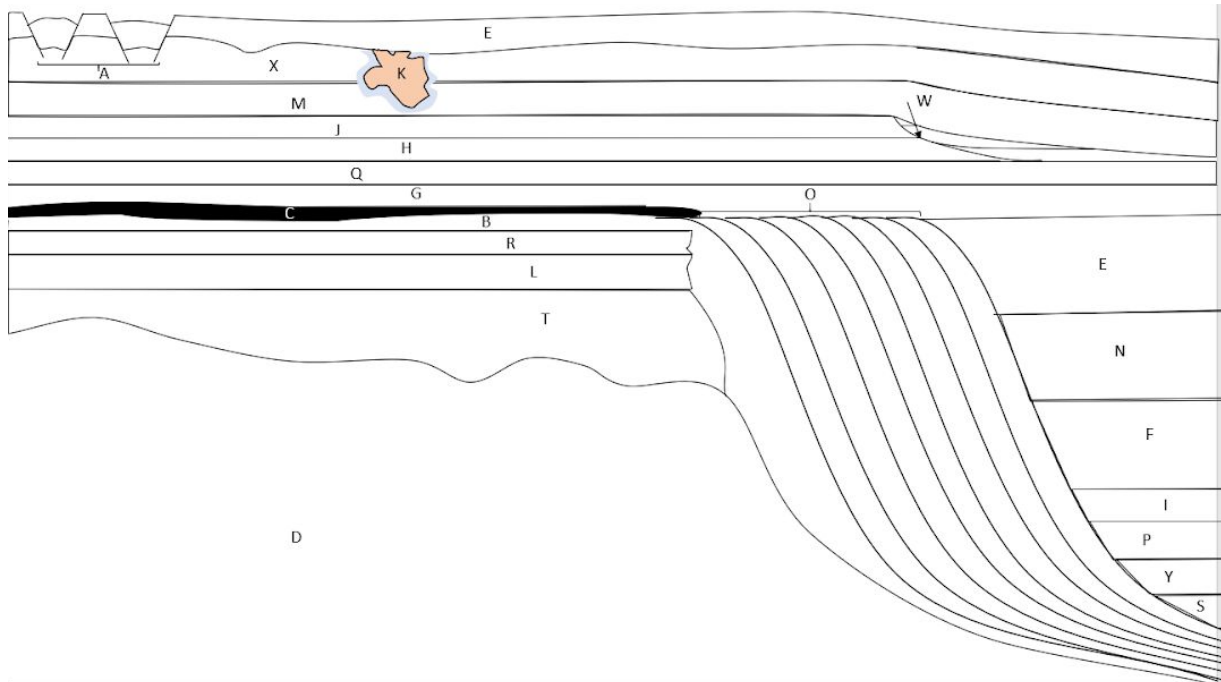
a. Grains rolling back and forth in high energy shore environment cause calcium carbonate to accumulate around nuclei as they precipitate (3); Calcite is more stable than aragonite (1) and will not dissolve as often (1)

32. Why are almost all carbonate deposits before the Jurassic located exclusively in shallow sea environments? Where did carbonate start forming after the Jurassic? What environmental factor predominantly controlled these deposits? How? (4)

a. Phytoplankton (1) had not yet evolved to precipitate carbonate in deep ocean environments (1); pH (1) would cause carbonate to dissolve at low levels and precipitate at high levels (1).

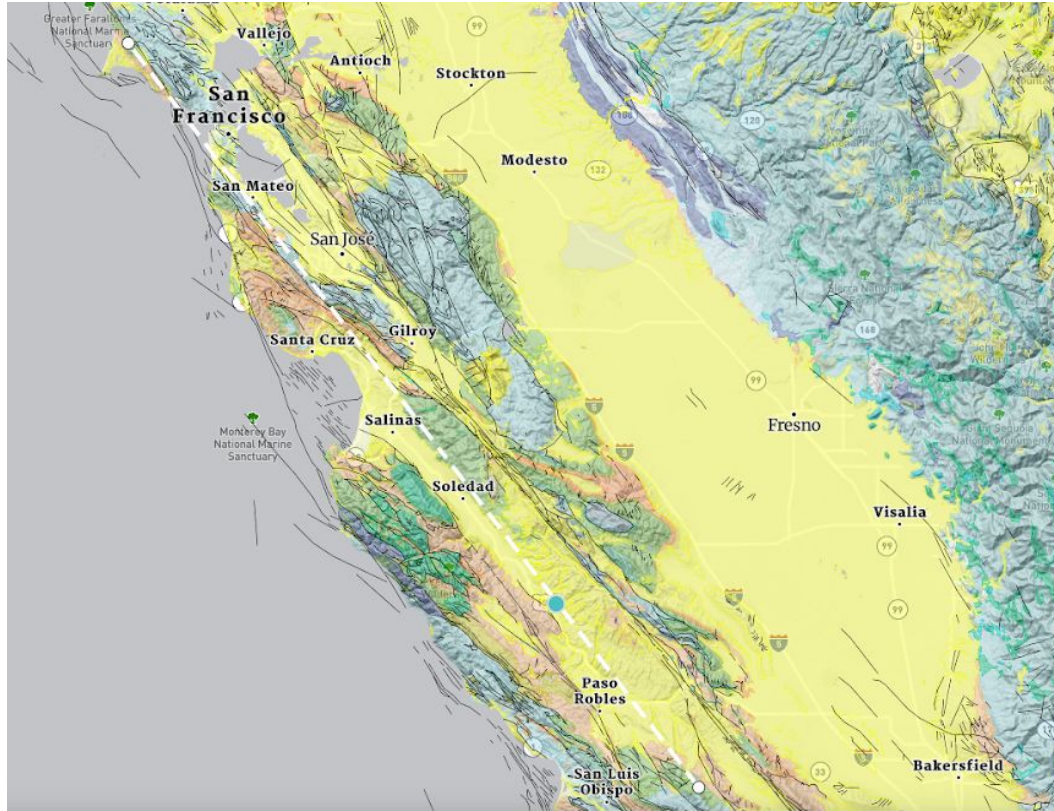
33. What sedimentary structures do we use to measure a historical glacier's size? Why can we only know the maximum extent of its existence using these structures? (4)
- a. Moraines (2); Old moraines are destroyed by the glacier every time it advances over the same ground (2)
34. Massive (30ft +) sandstone cross-bedding structures are characteristic of what environment (2):
- a. Deep marine
 - b. Beach
 - c. Braided stream
 - d. Desert (correct) (2)
 - e. Carbonate Platform Interior
 - f. Delta
35. Name 3 ways an alluvial fan can be discerned from a marine fan. (3)
- a. Sieve deposits, Coarser grains in alluvial fans, terrestrial fossils, Width, Surrounding area (3 for any 3)
36. Taking a cross section from point A to B on a map over a stream, the following sample sequence is generated: Vegetation, sand, gravel, sand, gravel, sand, vegetation. Does this stream have a higher or lower gradient? What type of stream is this? Is coal likely to form here over time? (4)
- a. Higher (1); Braided (2); No (1)

37. Which of these is NOT characteristic of deep marine environments?
- a. Linear bedforms
 - b. Turbidite sequences
 - c. High carbon content (correct) (2)
 - d. Sparse coarse clasts
 - e. Siliceous Ooze
 - f. Predominant shales and siltstones
38. What is the major sequence of evaporite precipitation? (3)
- a. Carbonates (1), then gypsum (1), then halite (1)
39. Which of these features are indicative of a beach environment?
- a. Varves
 - b. Aeolian cross bedded sandstones (correct) (2)
 - c. Loess deposits
 - d. Oolites
 - e. Coal deposits
 - f. Pyritization



40. Order the units from oldest to youngest
 - a. D, T, L, R, B, O, S, Y, P, I, F, N, E, C, G, Q, H, J, W, M, X, K, E, A (12.5)
41. What type of fault is unit W? What fold overlies it? (2)
 - a. Reverse (1); Monocline (1)
42. TB: Unit B appears to have a mottled texture and is full of silts and clays. What is this caused by? (2)
 - a. Burrowing organisms
43. Unit C is a coal seam. Would this be likely to have a lignite, bituminous, or anthracite coal composition?
 - a. lignite (2)
44. Would unit O likely have a high carbonate content? Why or why not? (3)

- a. No (2); surface migrates and would not support reef systems (1)
45. What is the direction of youngest to oldest deposition for unit O? (2)
- a. Right to Left/Towards unit D/Landward (2)
46. There are two unconformities between B/C and G (a limestone unit) as well as X and E. What types are they? Make sure to say which goes to which. (2)
- a. B/C and G - Disconformity; X and E - Nonconformity
47. What specific process occurred around unit K (granite)? (2)
- a. Contact Metamorphism (2)
48. What types of faults are within area A? What is this geologic system called? (3)
- a. Normal (1); Graben-Horst (2)
49. What sedimentary environments can be seen in the diagram? (9)
- a. Delta (3); Ocean basin (3); Meandering stream (3)



50.

The light green portions of rock connected by the dashed line are both pieces of the same terrane. How did this occur? (3)

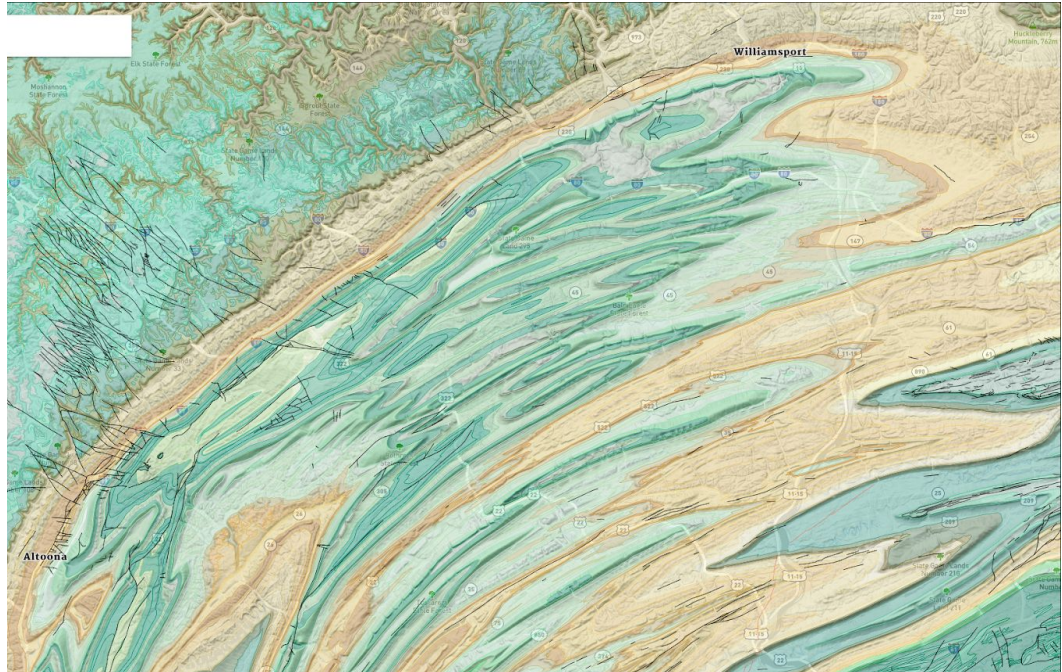
- a. Pressure from accretion/convergence/collision of terranes into the continent (1) formed transform/strike-slip faults (1) which ran parallel to the coast (1)

51. What city appears to be the only one in the image not situated on a mostly flat aeolian plain? (2)

- a. San Luis Obispo

52. What renown fault is captured in the image? What type of fault is it? (2)

- a. San Andreas fault (1); Transform/Strike-slip (1)



53.

TB: What folding sequence produces the arrangement of rock units in the image? (2)

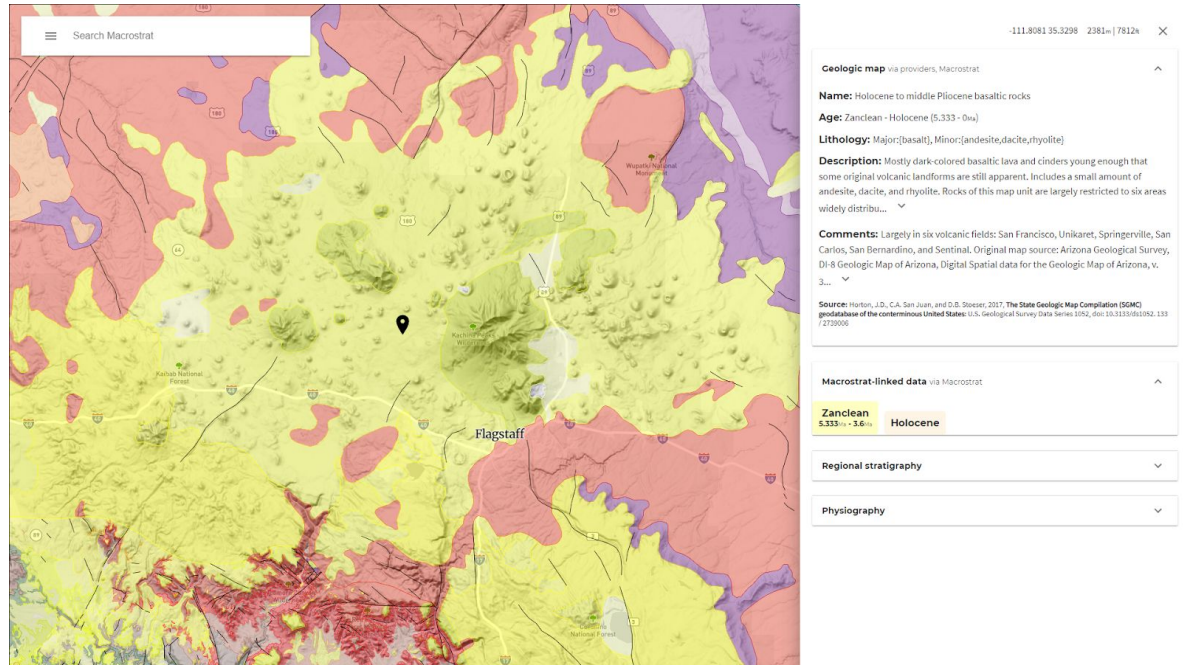
- a. One fold parallel to the surface and another fold that is perpendicular to the surface and the fold axis of the first fold.

54. The outermost light brown unit near Altoona is from the Upper Devonian while the dark green unit is from the Upper Ordovician. What structure is this called? (2)

- a. Plunging anticline (2)

55. This orogeny was formerly unified with (2):

- a. The Zagros Mountains
- b. The Atlas Mountains (correct)
- c. The Urals
- d. The Andes
- e. The Pyrennees



56.

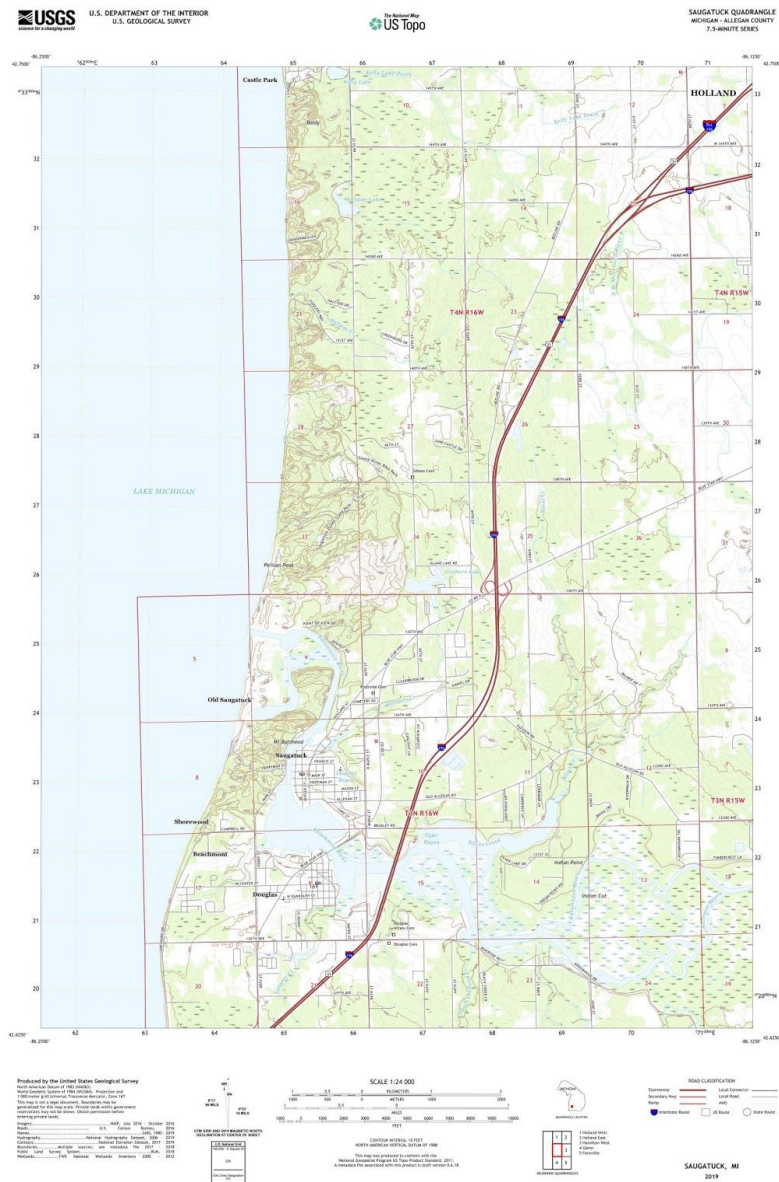
What are the structures in the above image in the yellow units called? What are 2 other structures that could potentially be underground? (4)

- a. Volcanic Necks/Plugs (2); Dikes, sills, laccoliths, lopoliths (2 for any 2)

57. If this area is eventually buried under shale and lithified, what type of unconformities will be found in this area? (2)

- a. Nonconformity, disconformity

58. True or False: This area appears to likely have had former hotspot activity (2) (F)



59.

What direction is the leeward side of the dunes? (2)

a. East

60. Coal is most likely to form in the _____ area of land on this map

a. NE

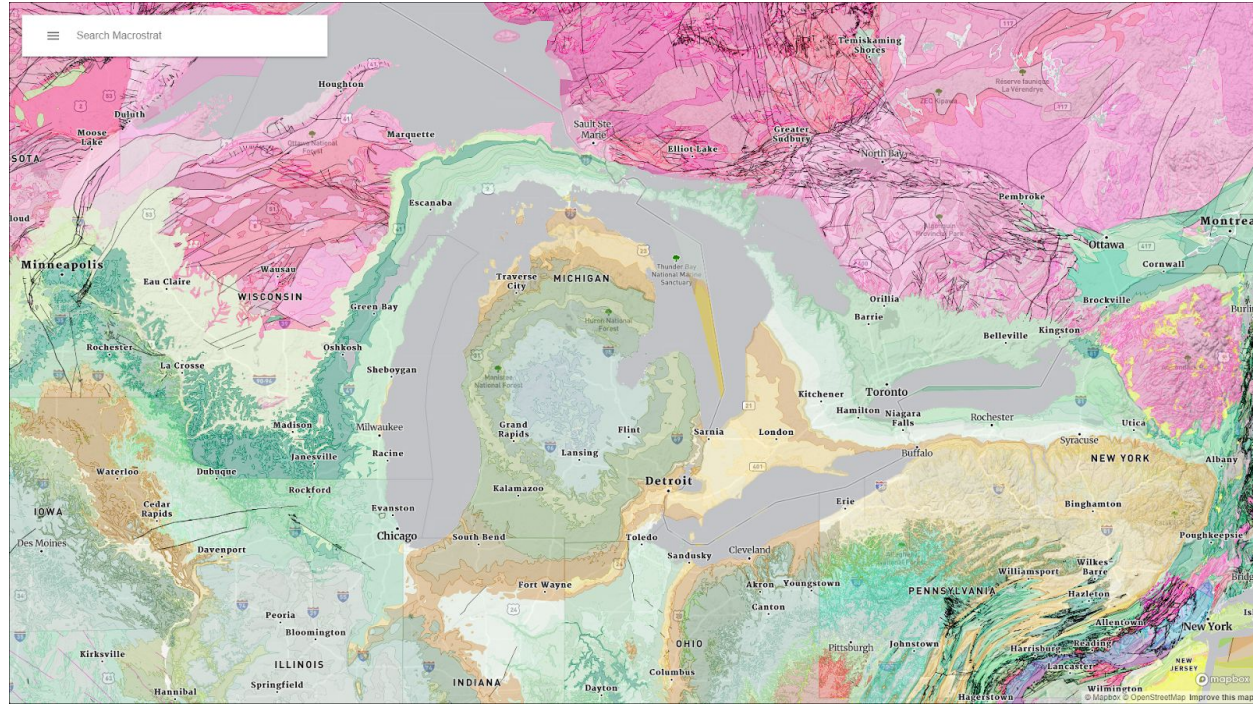
b. NW

c. SW

d. SE (correct)

e. Central

61.



The unit in central Michigan is from the Jurassic while the dark green unit on the eastern Upper Peninsula is from the Early Ordovician. What type of structure is this? (2)

a. Basin

62. The pink units around Duluth and Houghton striking at about 060 NE are deep layers of volcanic rock. What event caused this? Why did it stop? (4)

a. Mid-continental rifting (2); Terrane/continent collision/accretion to the SE (2)

- a. Section 6; High density/larger size causes gold/gems/materials/etc. to be deposited/drop from the flow when it spreads out and slows down.

65. BONUS ROUND: Of the locations listed, identify what resource(s)/gemstone(s) each is majorly associated with; several possible answers and can be multiple (0.5 each answer):

Ex: California: Gold

Arizona: Turquoise, Gold, Copper

Nevada: Gold, Silver, Uranium

Michigan: Copper, Iron, Halite, Agates

Montana: Copper, Sapphires

West Virginia: Coal/Anthracite

Indiana: Limestone

Alaska: Gold

Texas: Oil/Gas

North Dakota: Oil/Gas

Chile: Copper, Gold, Lithium

South Africa: Diamonds, Gold

Australia: Gold, Opal, Diamonds, Iron, Aluminum

Colombia: Emeralds

Myanmar/Burma: Jade, Ruby

Sri Lanka: Sapphires

Tanzania: Tanzanites

Saudi Arabia: Oil/Gas

Mexico: Silver