

Instructions (shown before students start the test)



Geologic Mapping C

UT Regional

Exam Author:

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- You will have **50 minutes** to complete **57 questions**.
- Per Texas Science Olympiad rules, you must have printed notes for this event. If you are communicating with your partner through a voice or video call, please start it before you begin the test itself.
- Significant time spent outside of the browser window is grounds for a penalty or disqualification per TSO policies.
- This exam is fully digitized. Protractors, rulers, colored pencils, etc. are **NOT** required for this exam. However, a non-graphing scientific calculator is encouraged.

Introduction (shown after students start the test)

1. (1.00 pts) Which scale of USGS map is most commonly used for topographic mapping?

- ☐ A) 1:600
- ☐ B) 1:24,000
- ☐ C) 1:100,000
- ☐ D) 1:500,000

2. (1.00 pts) Rocks are

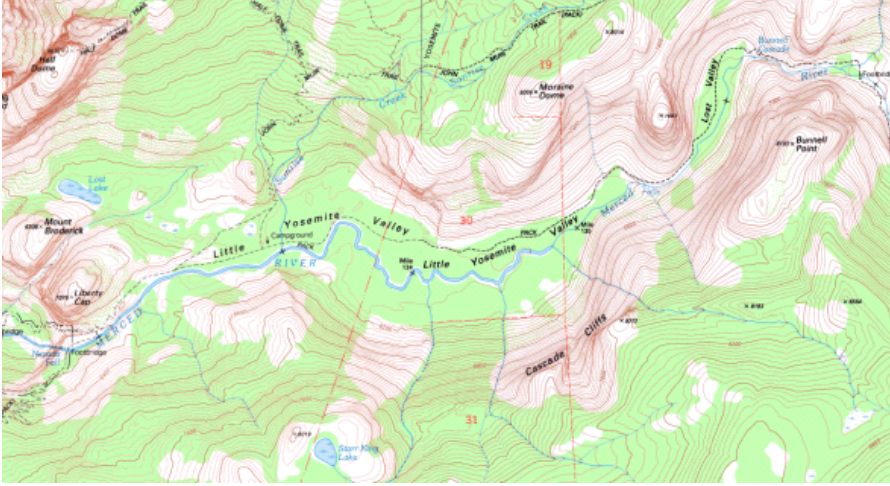
- ☐ A) Crystalline structures with a definite chemical formula
- ☐ B) Amorphous structures without a definite chemical formula
- ☐ C) Aggregates of minerals
- ☐ D) Aggregates of silicates

3. (2.00 pts) On topographic maps, magnetic declination is the angular difference between \_\_\_\_\_ and \_\_\_\_\_.

(Mark **ALL** correct answers)

- ☐ A) True north
- ☐ B) Grid north
- ☐ C) Magnetic north
- ☐ D) Local magnetic anomaly north

4. (1.00 pts)



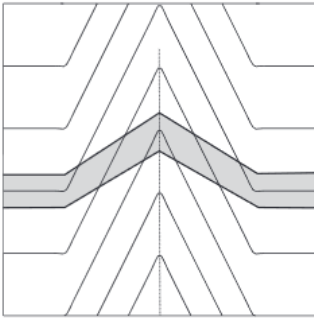
What type of weathering is responsible for the topography depicted above?

- ☐ A) Fluvial
- ☐ B) Aeolian
- ☐ C) Marine
- ☐ D) Glacial

5. (1.00 pts) Which of the following plate boundaries is conservative?

- ☐ A) Mid Atlantic Ridge
- ☐ B) East Pacific Rise
- ☐ C) San Andreas Fault
- ☐ D) Peru-Chile Subduction Zone

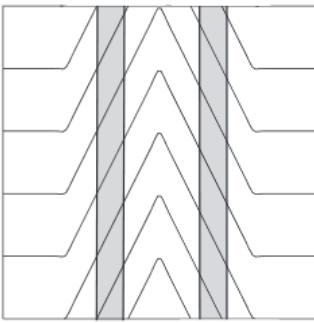
6. (1.00 pts)



If the outcrop pattern shown above is observed, what is the dip of the bed relative to the surface slope?

- ☐ A) The bed dips in the opposite direction of the surface slope.
- ☐ B) The bed dips at an angle shallower than the surface slope in the same direction
- ☐ C) The bed dips at an angle equal to the surface slope in the same direction
- ☐ D) The bed dips at an angle steeper than the surface slope in the same direction
- ☐ E) The bed is horizontal
- ☐ F) The bed is vertical

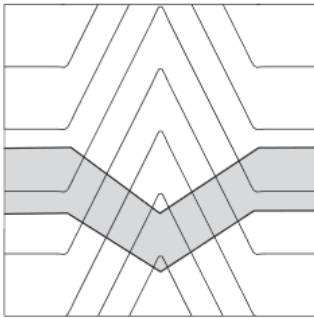
7. (1.00 pts)



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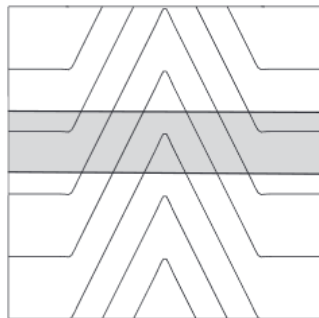
8. (1.00 pts)



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- ☐ F) The bed is vertical

**10. (1.00 pts)** Which of the following silicate minerals does not originate from igneous or metamorphic sources?

- ☐ A) Quartz  
☐ B) Orthoclase Feldspar  
☐ C) Glauconite  
☐ D) Mica

**11. (2.00 pts)** Banded iron formations provide supporting evidence for

(Mark **ALL** correct answers)

- ☐ A) the Great Oxygenation Event  
☐ B) the first emergence of microbial life  
☐ C) Snowball Earth  
☐ D) the Cambrian Explosion

**12. (1.00 pts)** Which of the following is not a sedimentary rock?

- ☐ A) Hornfels  
☐ B) Greywacke  
☐ C) Marl  
☐ D) Lignite

**13. (2.00 pts)** What paleoenvironment(s) could be suggested by the presence of cross-stratification?

(Mark **ALL** correct answers)

- ☐ A) Riverbeds  
☐ B) Abyssal plains  
☐ C) Swamp bottoms  
☐ D) Tidal flats  
☐ E) Aeolian

**14. (1.00 pts)** If a stratigraphic section was found to contain a thick layer of chalk, in which era is it most likely that it formed?

- ☐ A) Paleozoic  
☐ B) Mesozoic  
☐ C) Cenozoic  
☐ D) Neoproterozoic

**15. (1.00 pts)** Which of the following mass wasting events would result in surface features such as trees tilting in the same direction as land movement?

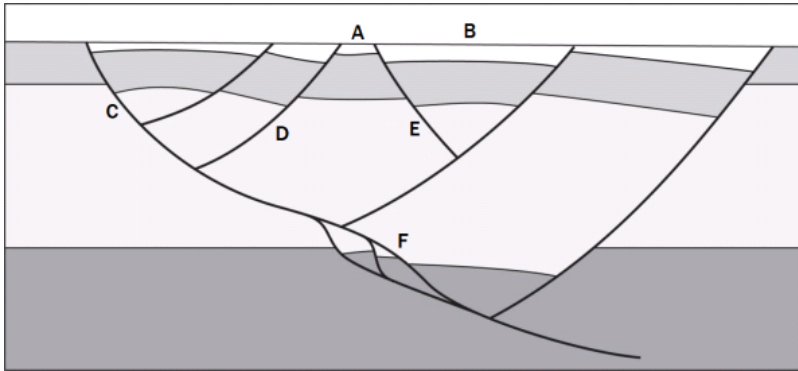
- ☐ A) Creep  
☐ B) Rotational landslide  
☐ C) Translational landslide  
☐ D) Earthflow

**16. (1.00 pts)** Where are extrusive rocks produced in greatest quantities?

- ☐ A) Divergent boundaries

- ☐ B) Convergent boundaries
- ☐ C) Volcanic hotspots
- ☐ D) Intracontinental extensions

17. (1.00 pts) Refer to the diagram below for questions 17-20.



On the diagram, which of the following letters corresponds to a horst?

- ☐ A) A
- ☐ B) B
- ☐ C) C
- ☐ D) D
- ☐ E) E
- ☐ F) F

18. (1.00 pts) On the diagram, which of the following letters corresponds to a graben?

- ☐ A) A
- ☐ B) B
- ☐ C) C
- ☐ D) D
- ☐ E) E
- ☐ F) F

19. (1.00 pts) On the diagram, which of the following letters corresponds to a synthetic fault?

- ☐ A) A
- ☐ B) B
- ☐ C) C
- ☐ D) D
- ☐ E) E
- ☐ F) F

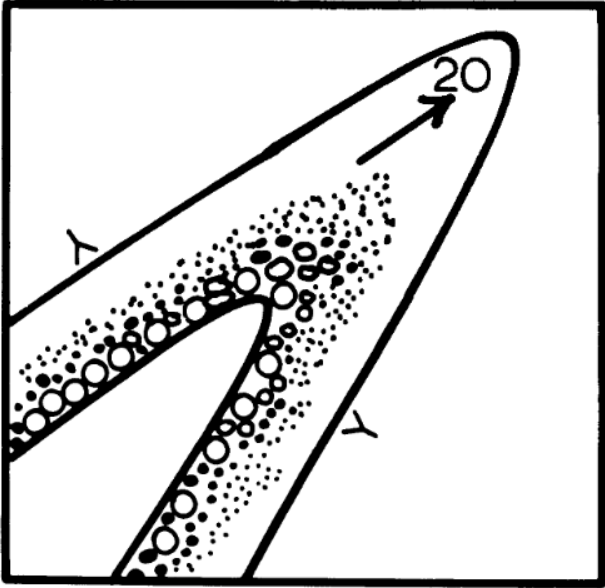
20. (1.00 pts) On the diagram, which of the following letters corresponds to an antithetic fault?

- ☐ A) A
- ☐ B) B
- ☐ C) C
- ☐ D) D
- ☐ E) E
- ☐ F) F

21. (1.00 pts) If an antiformal anticline is overturned, it becomes a(n)

- ☐ A) Antiformal anticline
- ☐ B) Antiformal syncline
- ☐ C) Synformal anticline
- ☐ D) Synformal syncline

22. (1.00 pts)



This is a top down view of a fold cross section. The upper side of the "Y" symbols in the diagram give the younging direction. The direction and angle of plunge are given by the arrow. This fold is therefore a:

- ☐ A) Antiformal anticline
- ☐ B) Antiformal syncline
- ☐ C) Synformal anticline
- ☐ D) Synformal syncline

23. (1.00 pts) Which of the following fold types has a negative interlimb angle?

- ☐ A) Fan folds
- ☐ B) Isoclinal folds
- ☐ C) Recumbent folds
- ☐ D) Chevron folds

24. (2.00 pts) Select all of the following that can be formed in a compressional environment but NOT in an extensional environment.

(Mark **ALL** correct answers)

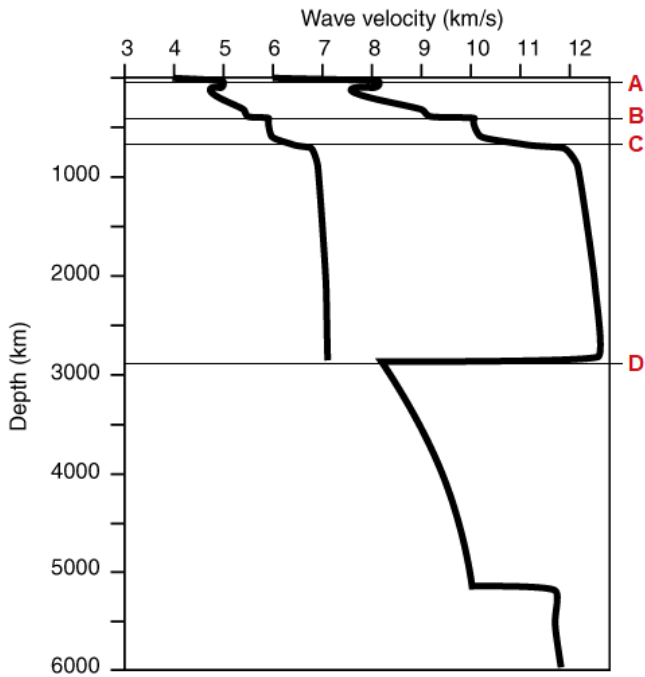
- ☐ A) Synclines
- ☐ B) Anticlines
- ☐ C) Synthetic faults
- ☐ D) Blind faults
- ☐ E) Listric faults

25. (1.00 pts) Which of the following pairs of properties are possible to simultaneously preserve on the same flat map projection?

- ☐ A) Equal-area and conformality

- ☐ B) Straight-line geodesics and conformality
- ☐ C) Direction from a single point and conformality
- ☐ D) Straight-line geodesics and equal-area.

**26. (1.00 pts)** Refer to the diagram below to answers questions 26-30.



Match Discontinuity A to the correct reason for why it exists. Specifically, Discontinuity A is the sharp velocity change from 4 km/s to 5 km/s and 6 km/s to 8 km/s.

- ☐ A) A transition from solid silicate to fully melted silicate.
- ☐ B) A transition from brittle rock to ductile rock.
- ☐ C) A transition from ductile rock to brittle rock.
- ☐ D) An increase in the temperature of rock above the 1300° C isotherm.
- ☐ E) A compositional transition causing a sudden increase in rock density.
- ☐ F) A compositional transition causing a sudden decrease in rock density.

**27. (1.00 pts)** Match Discontinuity B to the correct reason for why it exists.

- ☐ A) A transition from solid silicate to fully melted silicate.
- ☐ B) A transition from brittle rock to ductile rock.
- ☐ C) A transition from ductile rock to brittle rock.
- ☐ D) A sharp change in the overall elemental makeup.
- ☐ E) A phase transition in the mineral olivine.
- ☐ F) A phase transition in the mineral pyroxene.

**28. (1.00 pts)** Match Discontinuity C to the correct reason for why it exists.

- ☐ A) A transition from solid silicate to fully melted silicate.
- ☐ B) A transition from brittle rock to ductile rock.
- ☐ C) A transition from ductile rock to brittle rock.
- ☐ D) A sharp change in the overall elemental makeup.
- ☐ E) A phase transition in the mineral olivine.
- ☐ F) A phase transition in the mineral pyroxene.

**29. (1.00 pts)** Match Discontinuity D to the correct reason for why it exists.

- ☐ A) A transition from solid silicate to fully melted silicate.
- ☐ B) A transition from brittle rock to ductile rock.
- ☐ C) A transition from ductile rock to brittle rock.
- ☐ D) A sharp change in the overall elemental makeup.
- ☐ E) A phase transition in the mineral olivine.
- ☐ F) A phase transition in the mineral pyroxene.

**30. (1.00 pts)** Which discontinuity is thought to be associated with the origin of hot spot volcanism?

- ☐ A) Discontinuity A
- ☐ B) Discontinuity B
- ☐ C) Discontinuity C
- ☐ D) Discontinuity D

**31. (1.00 pts)** Order the following events in Earth's history from oldest to youngest.

I: The Permian-Triassic Extinction Event

II: The Cretaceous-Paleogene Extinction Event

III: The Last Glacial Maximum

IV: The Formation of Pangaea

- ☐ A) IV -> I -> II -> III
- ☐ B) II -> III -> I -> IV
- ☐ C) I -> II -> IV -> III
- ☐ D) IV -> III -> I -> II
- ☐ E) I -> IV -> III -> II

**32. (1.00 pts)** What is a seismic gap?

- ☐ A) A cratonic region where earthquakes are very unlikely to occur
- ☐ B) The area inside the S-wave shadow zone of an earthquake
- ☐ C) A zone along a tectonically active area where no earthquakes have appeared recently
- ☐ D) A section missing from a stratigraphic sequence due to tectonic disturbances

**33. (1.00 pts)** Which of the following is least resistant to chemical weathering?

- ☐ A) Quartz
- ☐ B) Olivine
- ☐ C) Biotite
- ☐ D) Pyroxene

**34. (1.00 pts)** What property is conserved for a map projection when Tissot's indicatrices are circles everywhere?

- ☐ A) Distances between points
- ☐ B) Relative sizes
- ☐ C) Local angles
- ☐ D) Straightness of longitudinal lines
- ☐ E) None of the above

**35. (1.00 pts)** What property is conserved for a map projection when Tissot's indicatrices are ellipses of equal area everywhere?



- ☐ A) Distances between points
- ☐ B) Relative sizes
- ☐ C) Local angles
- ☐ D) Straightness of longitudinal lines
- ☐ E) None of the above

**36. (2.00 pts)** Select all of the following that are true about alluvial fans:

(Mark **ALL** correct answers)

- ☐ A) Alluvial fans are formed when sediments are deposited in a fan shape by mass wasting
- ☐ B) The slope of alluvial fans is determined by the angle of repose of its materials
- ☐ C) An alluvial fan is a stable structure to construct buildings on
- ☐ D) Alluvial fans have been identified on Mars

**37. (2.00 pts)** Select all of the following that are true about subduction zone metamorphism.

(Mark **ALL** correct answers)

- ☐ A) It is the most widespread type of metamorphism on Earth
- ☐ B) Subducted rocks typically reach a low pressure, high temperature peak
- ☐ C) Leads to flux melting beneath volcanic arcs through the release of water
- ☐ D) Metamorphic rocks formed beneath subduction zones are typically unfoliated

**38. (2.00 pts)** Select all of the following that are true about marine regressions:

(Mark **ALL** correct answers)

- ☐ A) Marine regressions are associated with interglacial periods
- ☐ B) They can cause land bridges to occur
- ☐ C) Marine regression can expose marine terraces
- ☐ D) Lateral movements of depositional environment are represented by a vertical sequence of sedimentary facies

**39. (1.00 pts)** Order the following rock types from most abundant to least abundant in the Earth as a whole: I. Granite, II. Basalt, III. Komatiite, IV. Peridotite

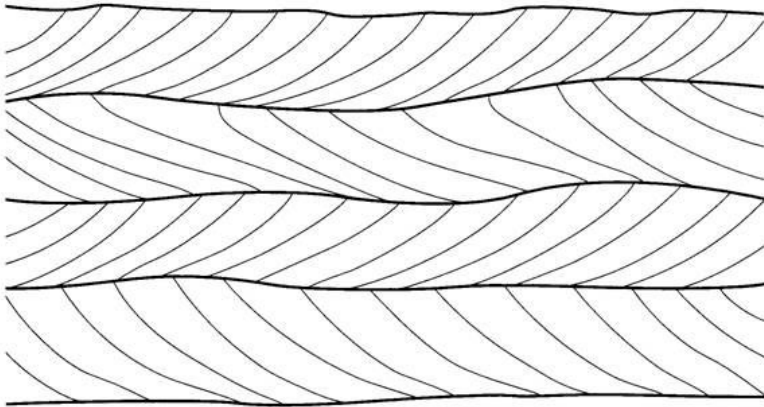
- ☐ A) II, I, IV, III
- ☐ B) I, II, III, IV
- ☐ C) I, II, IV, III
- ☐ D) II, IV, III, I
- ☐ E) IV, II, I, III

**40. (5.00 pts)**



Based on the photo above, is the dark-colored rock type more competent or less competent than the light-colored rock type? Geologically, what might have led the dark-colored rock to have a different competence than the light-colored rock? What force regime culminated in this structure?

41. (3.00 pts)



What information do the beds in the diagram shown above suggest about the paleoenvironment in which they were deposited?

42. (2.00 pts)



Suppose one day you are wandering along the coast when you discover this fascinating geologic formation! As seen in the picture, it consists of planar layers of rock tilted at an high angle with alternating gaps between these layers. If you were to drip HCl solution onto the existing rock layers, bubbling would occur. Refer to this image for the next 5 questions.

Explain why there are gaps between the planar layers.

43. (2.00 pts) In the background of this picture, there is another geologic feature. What is it? Was it formed before or after the tilting event occurred?

44. (4.00 pts) How were the planar layers originally laid down? What were the two rock materials?

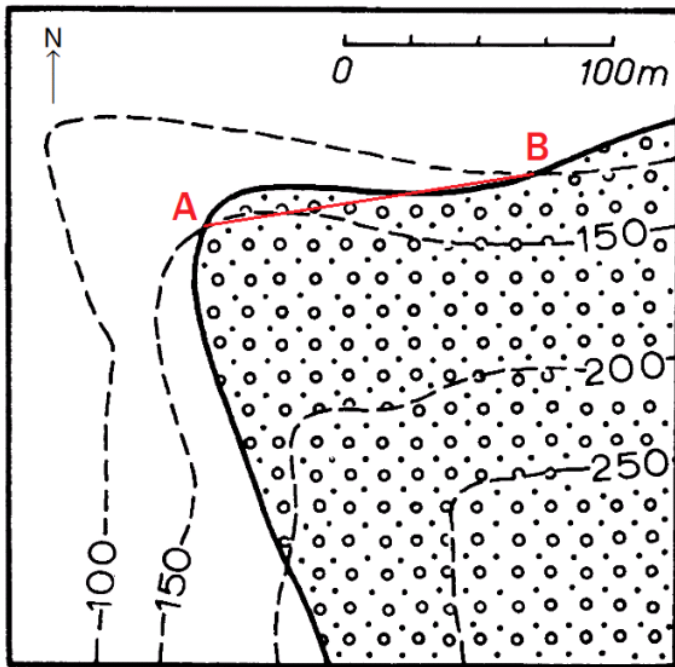
45. (2.00 pts) If these beds were subjected to compressive stress after being laid down, what formation would be characteristic to occur?

46. (4.00 pts)  
The formation of this sedimentary sequence is often associated with an adjacent mountain building event. What is the link between the formation of this sequence and the nearby mountain building?

47. (3.00 pts)  
An underground passage linking two cave systems follows the line of intersection of the base of a limestone bed and a vertical rock fracture. The bedding in the limestone dips 060/60 and the strike of the fracture is 010°. What is the plunge of the underground passage? Round to the nearest whole number in degrees.

48. (3.00 pts)

The following diagram shows the contact of two uniformly dipping rock units. The red line labeled AB has a length of 125 meters. The contour interval is also in meters.



Determine the dip angle of the contact to the nearest whole number in degrees.

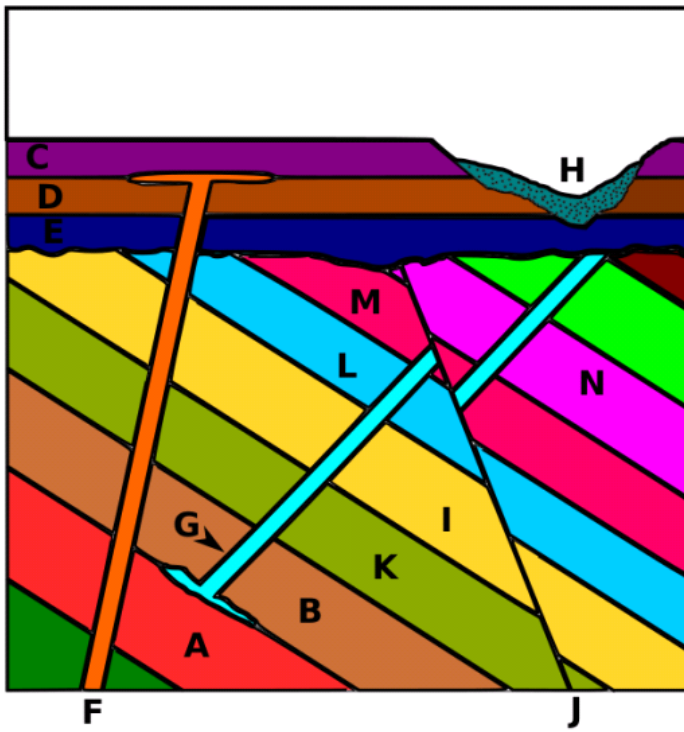
49. (3.00 pts)

A cross section of a bed has an apparent dip of 35 degrees and a strike of  $N70^{\circ}E$ . The true strike of the bed is  $N45^{\circ}E$ . Find the true dip of the bed to the nearest whole number in degrees.

50. (1.00 pts) Is this a thrust fault or a reverse fault?

- ☐ A) Thrust fault
- ☐ B) Reverse fault

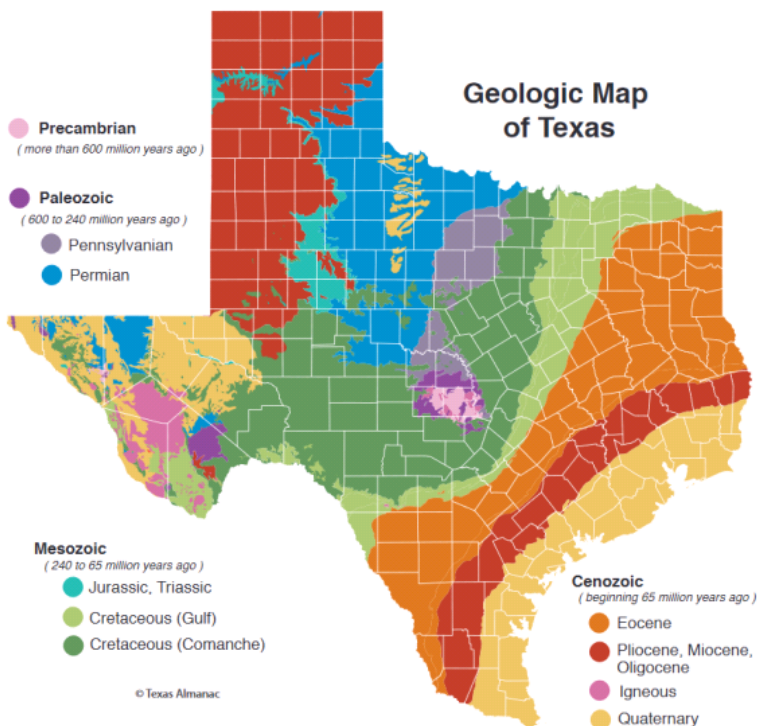
51. (4.00 pts) Order the lettered layers and events from oldest to youngest. All igneous intrusions were exposed to the surface at the time of their formation.



52. (4.00 pts)

A major stratigraphic event occurred at some point in this stratigraphic sequence which radically affects how we should designate the order of events. What happened? Which lettered feature gives evidence that this event occurred?

53. (2.00 pts)



Use this geologic map of Texas to answer the following questions.

Where are the oldest rock units in Texas located? What is this region called?

**54. (2.00 pts)** Describe where in Texas you should look if you were hunting for fossils of primitive amphibians. Justify your answer.

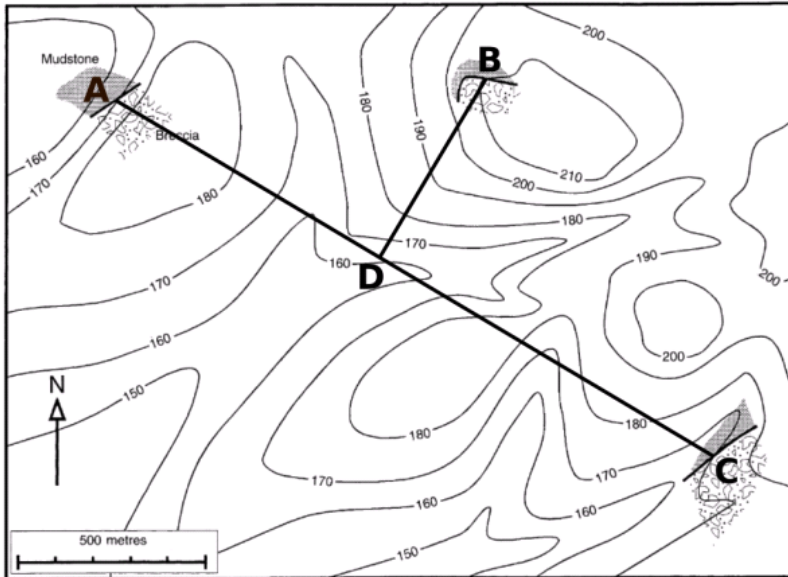
**55. (2.00 pts)**

Fossils of ammonites, an extinct order of cephalopod, can be found in some areas of Texas. What does this observation imply about what Texas must have been like at some point in the past?

**56. (2.00 pts)**

There are several geologic periods notably absent from the geologic map, such as the Devonian and the Mississippian. This makes it more challenging to learn what these periods were like in Texas. What is the main way of reaching rocks from these periods?

**57. (6.00 pts)**



A layer of breccia is found at three outcrops shown on the map. The contour interval is in meters. With a coordinate system where +X points to the east and +Y points to the south, let us designate the coordinates on the map in units of cm.

A = (0 cm, 0 cm)

B = (8.34 cm, -0.49 cm)

C = (13.48 cm, 8.01 cm)

D = (? cm, ? cm)

The scale bar is measured to be 4.23 cm long.

For the breccia layer, calculate the dip angle and dip direction (azimuthal) each to the nearest whole number in degrees.

Thank you for competing! Feel free to contact me at **[r.anselm@utexas.edu](mailto:r.anselm@utexas.edu)**.

Best of luck on the rest of your events!

If you have any feedback about any of the exams at this tournament, please let us know through this form: <https://tinyurl.com/utreg21feedback> (<https://tinyurl.com/utreg21feedback>)