

## Elephantower's Geomaps test II

**Time: 50 minutes**

*Make sure to print the test, as some problems require measurement and to have spare paper on hand to write longer answers, and to draw profiles and cross-sections.*

**Unless otherwise stated, all distances and contour intervals are in feet, north is up on all maps, and answers should be reported to the nearest whole number.** Points are assigned to questions as follows:

**Easy: 1 point (28 questions)**

**Medium: 2 points (21 questions)**

**Hard: 3 points (21 questions)**

**Challenge: 6 points (1 question)**

11 more time-consuming construction and application problems (underlined) are worth one extra point each.

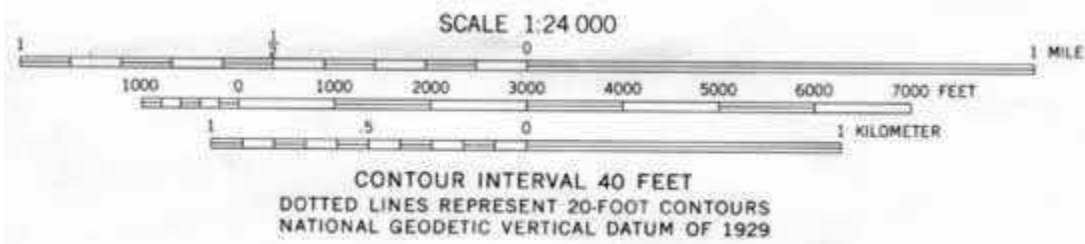
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150 points total

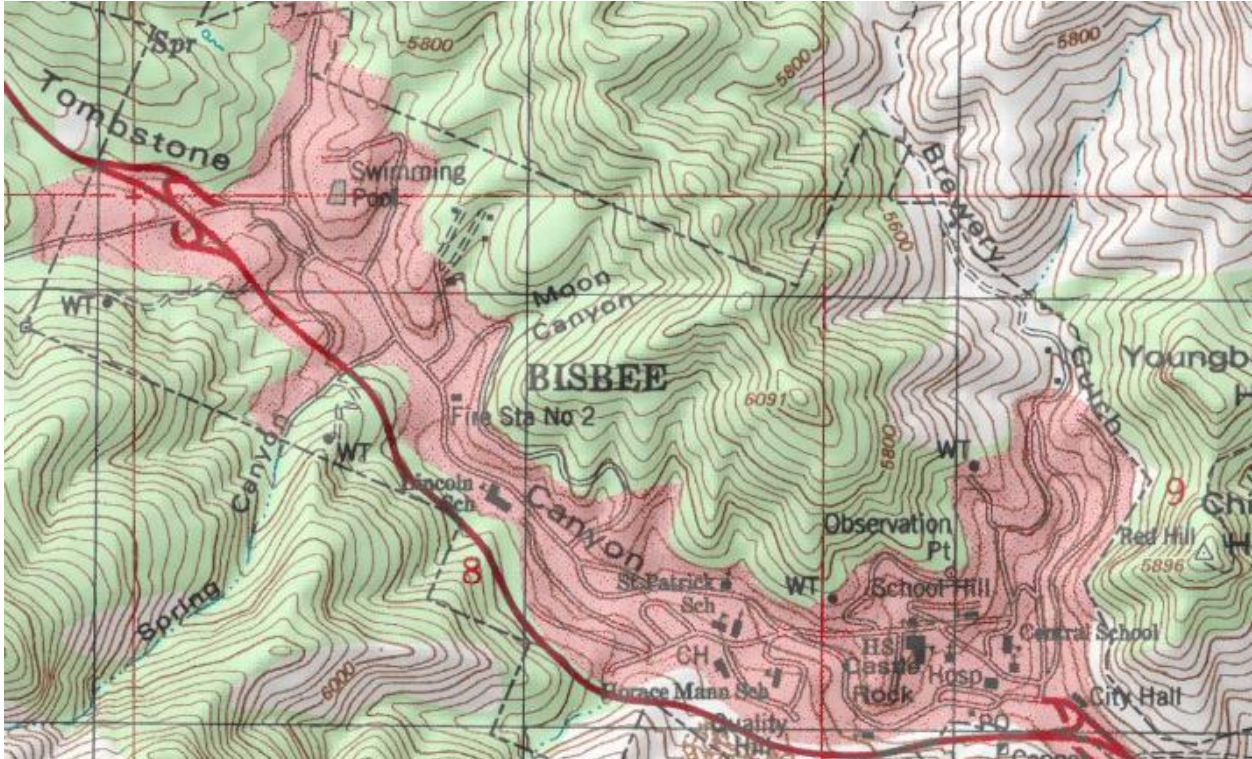
Good luck!

**Topographic and Geologic Maps:**

**Q1.** What is the scale and contour interval of the map excerpted below?

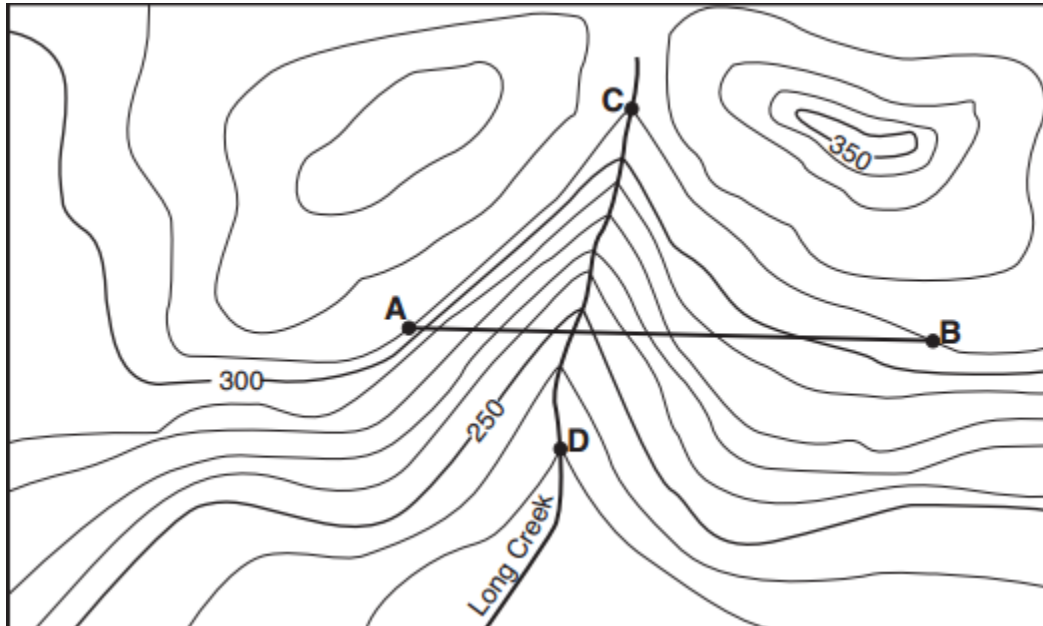


**Q2.** What is the elevation of Observation Point (to the nearest contour interval) in the map below?



**Q3:** If one walked in a straight line from the west end of Lincoln School to the end of the Brewery Gulch road, what is the highest point they would reach (to the nearest contour interval)?

**Q4:** In what ordinal direction of the spring in the NW corner of the map flowing (to the nearest 45°)?



**Q5:** Assuming a 1:2000 scale and linear dip between contour lines (in feet), what is the steepest dip angle between contour lines along the line BD in the map above?

**Q6:** Draw a topographic profile from A to B.

**Q7:** What does Qaf stand for on a geologic map? How is it formed?



**Q8:** What geologic structure is represented by this map symbol, and how is it formed?

**Q9:** Would a trilobite fossil be more likely found in a geologic map layer labeled as P<sub>2</sub>CA or M<sub>2</sub>IC? Why?

**Q10:** Which way will the water in a river flow if the riverbed descends at exactly the same angle as the geoid along the river does? How does this affect map datums?

**Tectonics, rock formation, Earth structure and history:**

**Q1:** True or False: Sedimentary rocks are formed out of sediment.

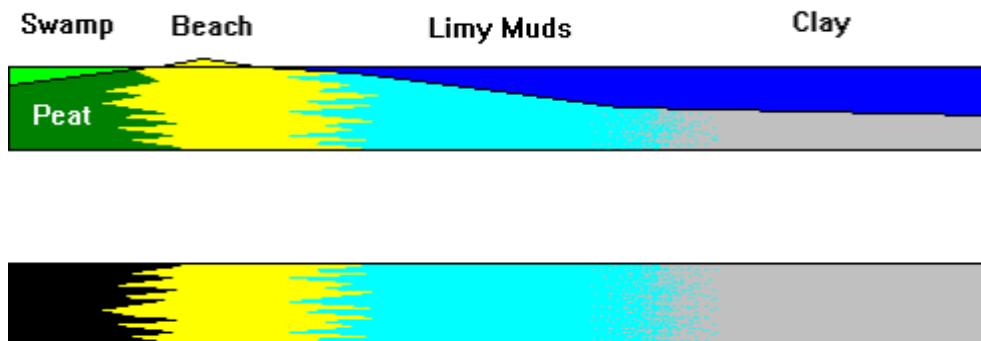
**Q2:** Which is hotter, the mantle or the core?

**Q3:** In what geologic era are we currently living?

**Q4:** What type of plate boundary forms deep-sea trenches?

**Q5:** What is the Mohorovicic discontinuity?

**Q6:** In the image below, sediment deposited in 4 different environments has turned into 4 different types of sedimentary rock (the second image). Give each type of rock, from left to right.



**Q7:** For what period is *Meganeura* an index fossil?

**Q8:** What are the three ways that magma is produced?

**Q9:** What is the Benioff-Wadati zone and what property does it have that makes it important for tectonic mapping?

**Q10:** What creates the Earth's magnetic field? Why does the magnetic field wobble?

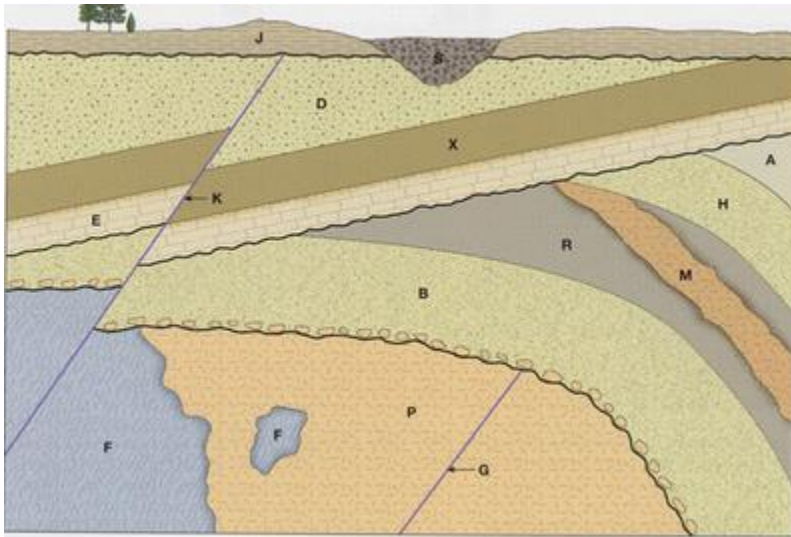
**Folds, faults, erosion, intrusion signatures, subsurface geometries, deformation sequences, and sub-surface depositional features**

**Q1:** When topsoil is eroded, (older/younger) rock layers are usually exposed.

**Q2:** Rock in the center of an anticline is (older/younger) than rock on the outside?

**Q3:** Normal faults typically (create/destroy) lithosphere.

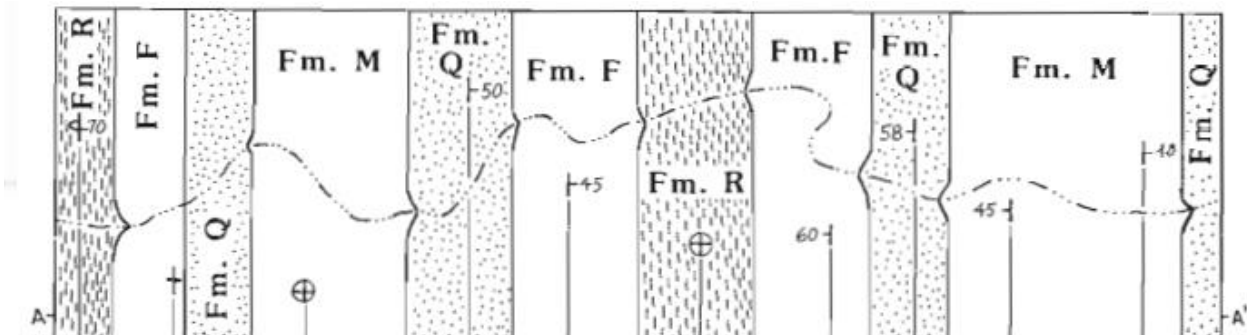
**Q4:** Order the layers in the image below from oldest to youngest.



**Q5:** What is an igneous intrusion?

**Q6:** What are three ways erosion can occur?

**Q7:** Draw a cross-section from A to A' from the map below.

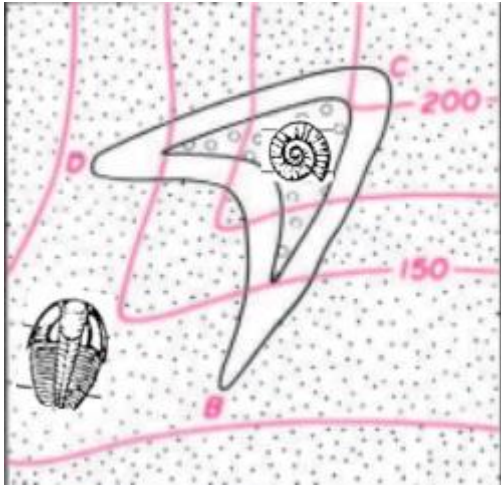


**Q8:** What is the difference between foliation and lineation?

**Q9:** What is the difference between an axial surface, axial plane, axial trace, hinge line, troughline and crestline?

**Q10:** A (dome/basin/antiform/synform/monocline/homocline) has a to scale, perpendicular to hinge-line cross-section most similar to a synclorium? Why?

**Q11:** The map below depicts an outcrop of quartzite. Is there a fold in the image? How do you know? If so, identify it (antiformal/synformal anticline/syncline), give the ordinal plunge direction, and describe the path of the axial trace and hingeline. Assume the ridge is symmetrical.



**Q12:** After millions of years, what type of rock (sedimentary, igneous, metamorphic) would a talus most likely form?

**Q13:** How does solution folding work? What Ramsay class folds can it produce?

**Q14:** In flexural folding of layers of differing competence, the more competent layer forms a class 1B fold. What class fold is the less competent layer most likely to be?

**Q15:** Normal antistructural faulting produces (antithetic/synthetic) (normal/reverse/strike-slip) secondary faulting. Explain why and draw a diagram.

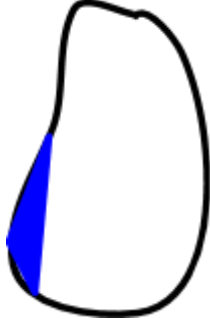
**Q16:** You are standing on a horizontal surface looking NW when you notice an eroded fold plunging N40E, with the distance between contacts broadening in width to your left. Is the fold an antiform or synform, and is the intrado or extrado exposed? How do you know?

**Q17:** Draw strain ellipses for a fold created by orthogonal flexure.

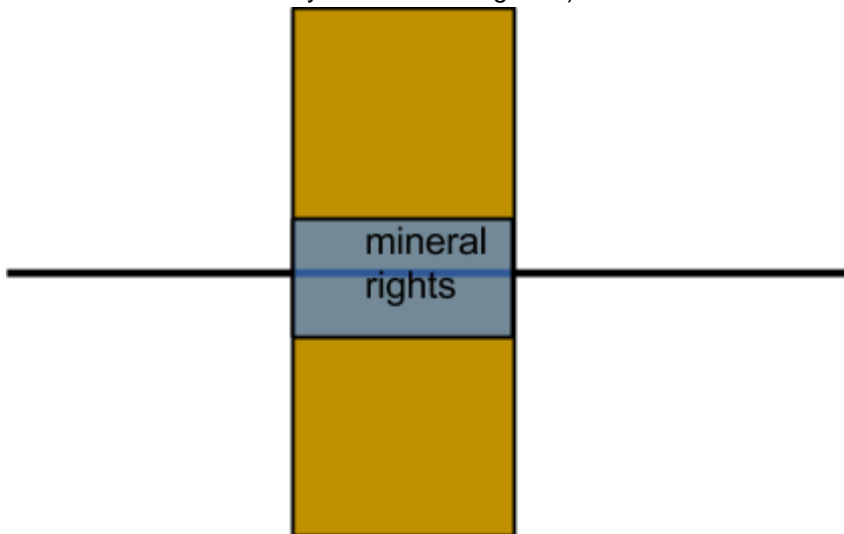
**Q18:** As I run my hand along a autochthonous fault plane, I notice that it feels rougher when I run my hand up the plane than when I move it down. What type of fault is this? How do you know?

**Q19:** What is the typical direction is the vergence of a Z-fold, relative to the foliation of the rock ? Give the answer to the nearest compass quadrant, with the bearing of the foliation representing 0 degrees).

**Q20:** The drawing below shows a cross section of an amygdule with blue mineral deposits, found in a dike embedded in brittle, erosion-resistant rock (East/West is right/left). Geologists know that the area has undergone listric faulting (with the allochthon on the eastern side of the autochthon). Primary faulting is (normal/reverse/strike-slip), and secondary faulting is (antithetic/synthetic) and (normal/reverse/strike-slip). How do you know?



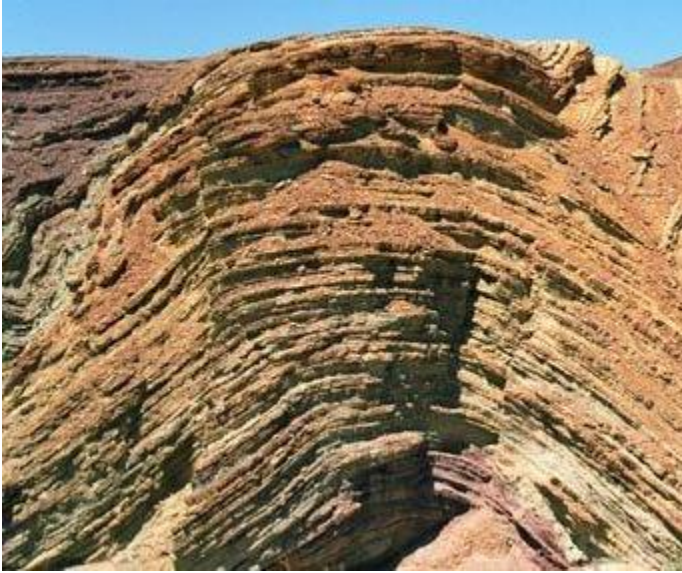
**Q21 (challenge, 6 pts):** A railway on level ground runs East-West over an eroded 6-layer upright concentric antiform with a plunge of  $0^\circ$ , a bluntness of 1, and an axial plane with an attitude of  $0^\circ$ . An 800 ft long exploratory borehole from the hingeline to inflection line passed through 5 equally thick layers. The railroad company has been granted rights over an 800 ft strip of land centered on the railway, which is lucky for them, because it turns out that the layer of the antiform visible on the surface contains a highly valuable ore. How many cubic feet of ore lie directly under the company's land? (area of a circular segment:  $.5r^2(a - \sin(a))$ , where  $r$  is the radius of the circle and  $a$  is the radian angle of the of the arc described by the circular segment)



**Structure ID:**

*Write the names of the following structures.*

**Q1:**



**Q2:**



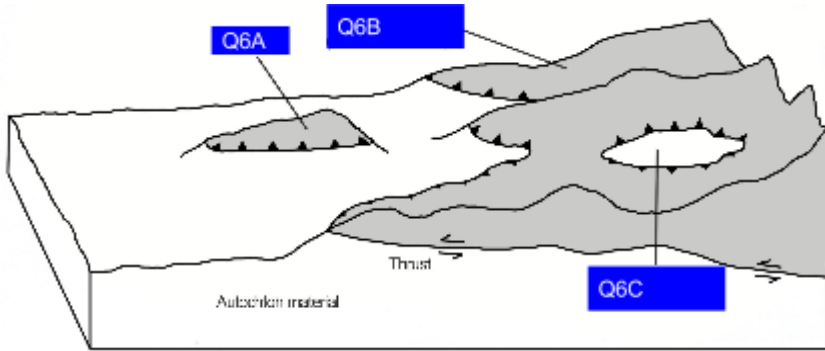
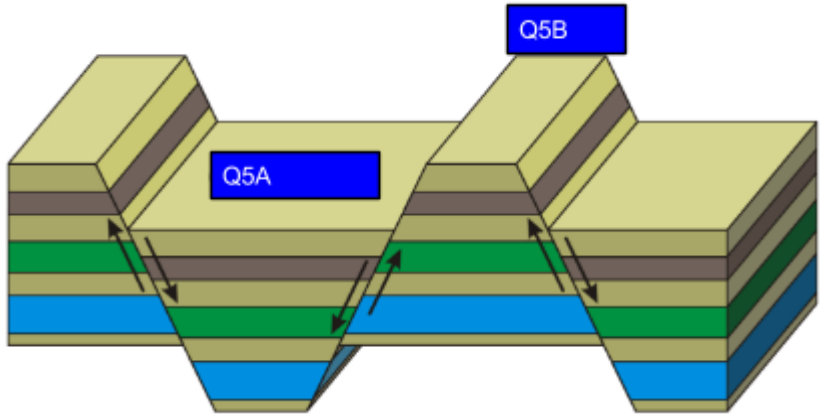
Q3:



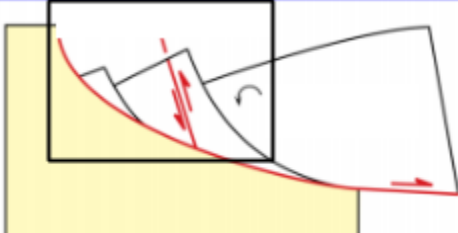
Q4:







Q7B: What is the name for this structure?

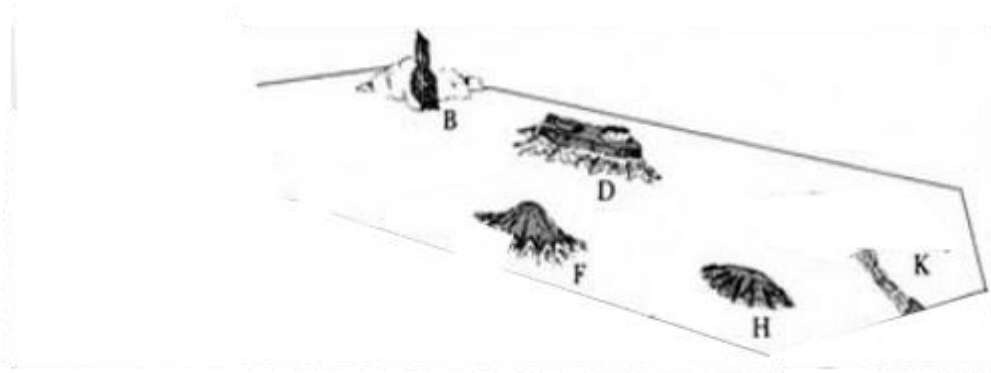


Q7A: What fault type is the primary fault?

Q8:



**Q9:** The image shows 4 eroded igneous intrusions. Identify each, in the order B, D, F, H, K



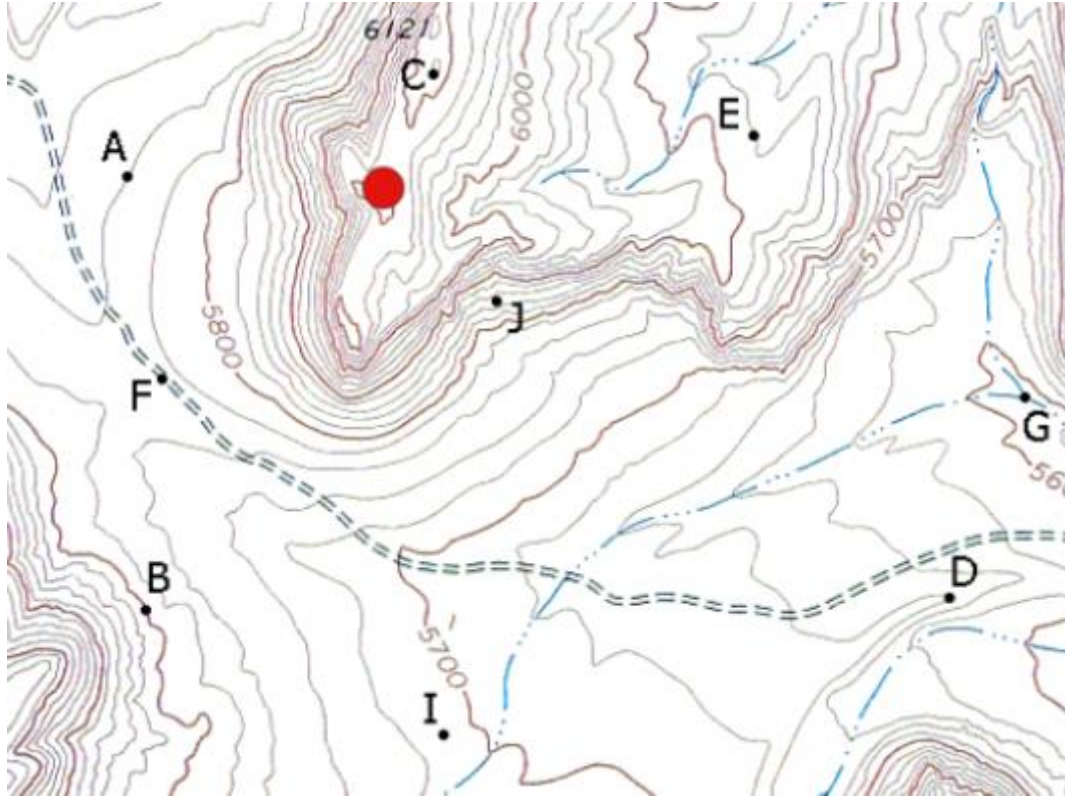
**Q10:**



## Applications

### Geohazards:

**Q1:** A group of fanatic would-be homeowners descended on Geohazards Desert (1:2000 map below), determined to build a house at each of the labeled points. The only people happier about the proposed locations than themselves are their children, who see the scheme as a great way to collect an early inheritance. However, not all locations are equally risky. Which pair of houses are the most and least likely to flood, and which pair are the most and least likely to be buried in a landslide?



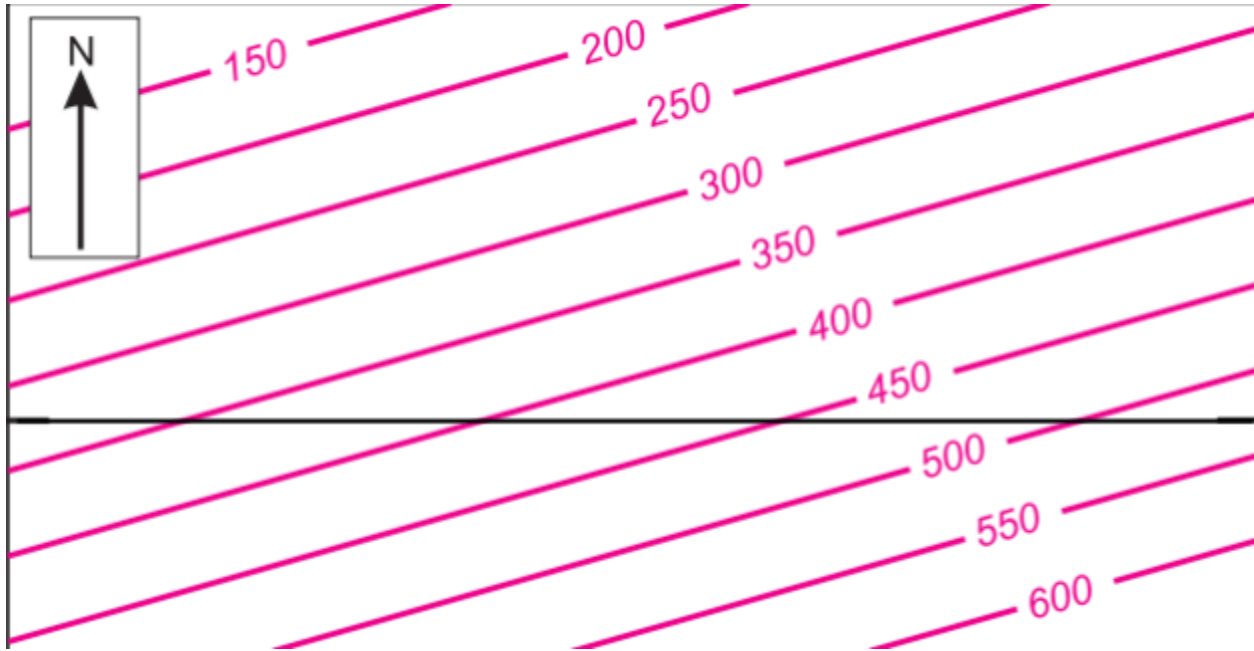
**Q2:** 20 years and several flooded homes later, the survivors decide to dam all the intermittent streams in the area (far upstream from their homes, of course), permanently drying up all existing streams. Unfortunately, this causes small, sporadic flows of water from a previously dry spring (marked by the red dot). Assuming that the only water danger is from the spring, which 2 houses are the most likely to flood?

**Q3:** What is thixotropic clay, and what geohazard does it cause?

*True and apparent dip:*

**Q4.** What is the true dip of a vertical bed?

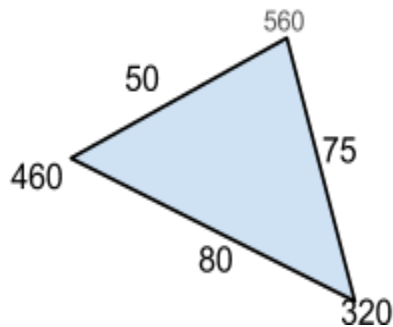
**Q5:** What is the dip and dip direction of this bed in the structure contour below (1:2000 scale)?



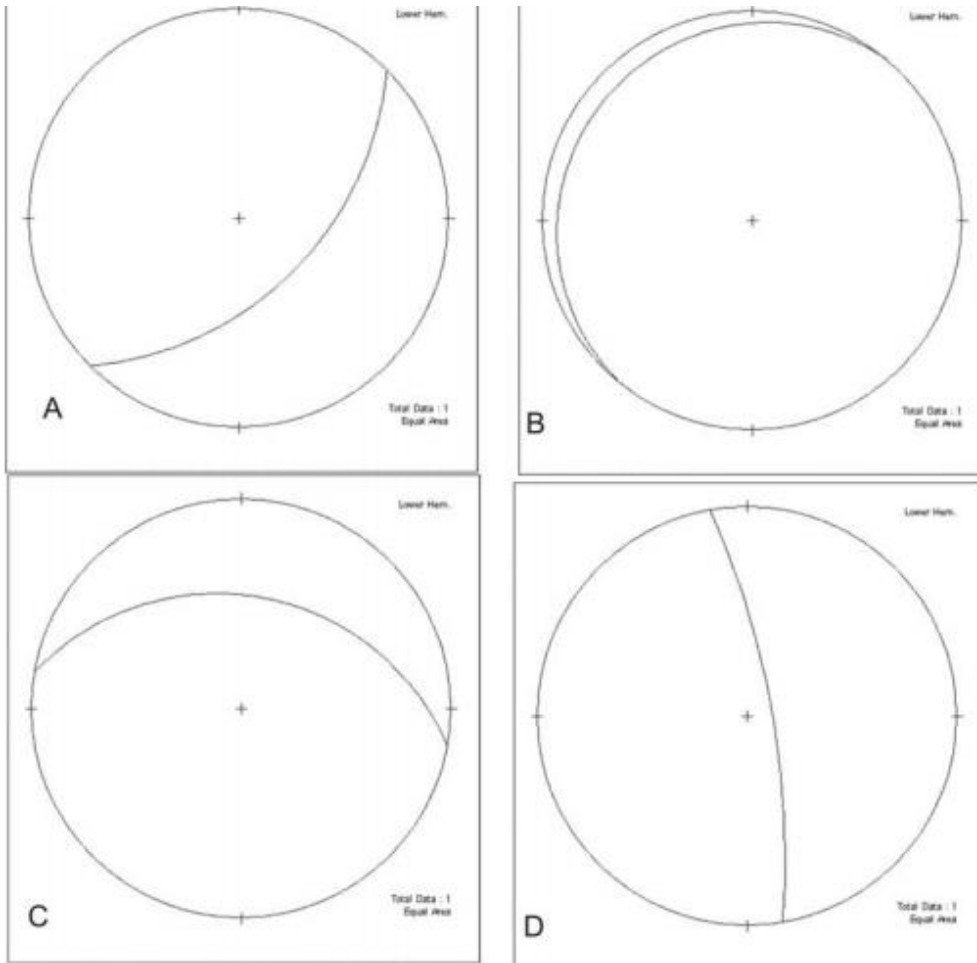
**Q6:** What is the angle of obliquity of the black line in the image above?

**Q7:** The Ghastly Gorge Group LLC wants to make their gorge slightly less ghastly, by providing wheelchair access to the bottom (the skeletons of dead tourists at the bottom are starting to hurt business) through a ramp from the newly renovated visitor center. However, they only bothered to buy enough wood to build a 350 ft ramp. The cliffs of the gorge are 230 ft high (measured vertically), and dip  $80^\circ$ . How steep will the ramp be (in degrees from horizontal)?

**Q8:** Find the true dip: image not to scale



Stereonet ([source](#)):



**Q9:** Give the strike and dip in each of the images below to within 20 degrees.

**Q10:** Plot a plane with a strike of 40 and dip of 60 and a lineation with a rake of 40 degrees from the NE. What is the trend and plunge of the line?

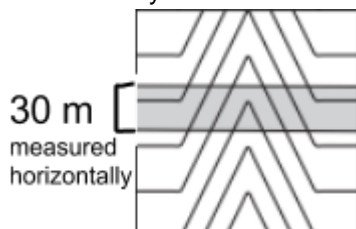
**Q11:** Plot a plane with a strike of 240 and dip of 40. In the plane, there is a line with a trend of 350. What is the plunge of the line? What is the rake of the line?

**Q12:** In your notes, you wrote down that a plane had a strike of 110 and lineations in it with a trend of 180 and plunge of 40. You forgot to take a dip measurement, but you can calculate it. What is the dip of the bed?

*Bed measurements:*

**Q13:** A well drilled completely through one horizontal bed is 100 ft deep. How thick is the bed?

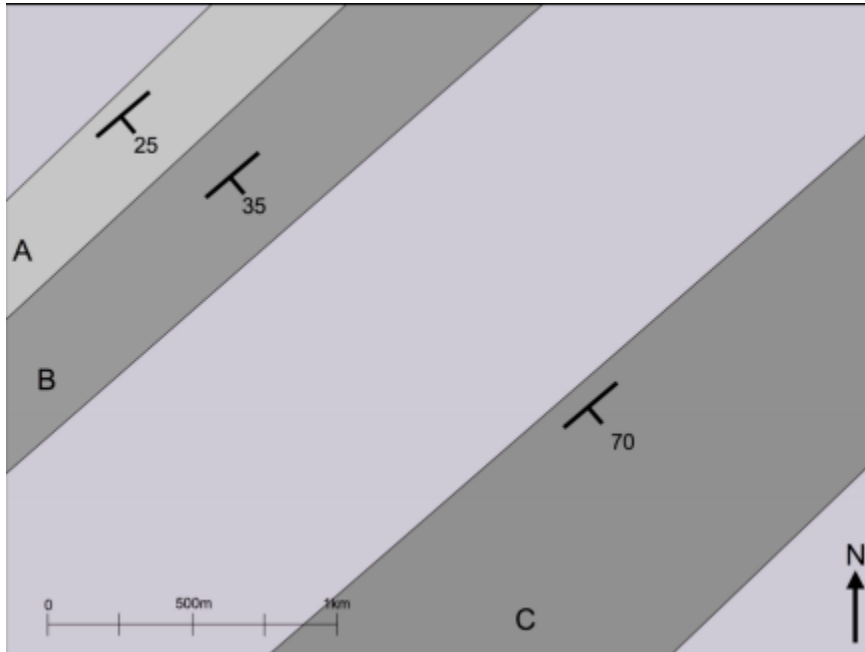
**Q14:** The image below shows a bed (in gray) outcropping in a valley. What is the true thickness of the bed? How do you know?



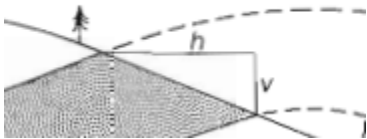
**Q15:** Give the dip azimuth for the gray bed shown outcropping below.



**Q16:** What is the true thickness of unit C?

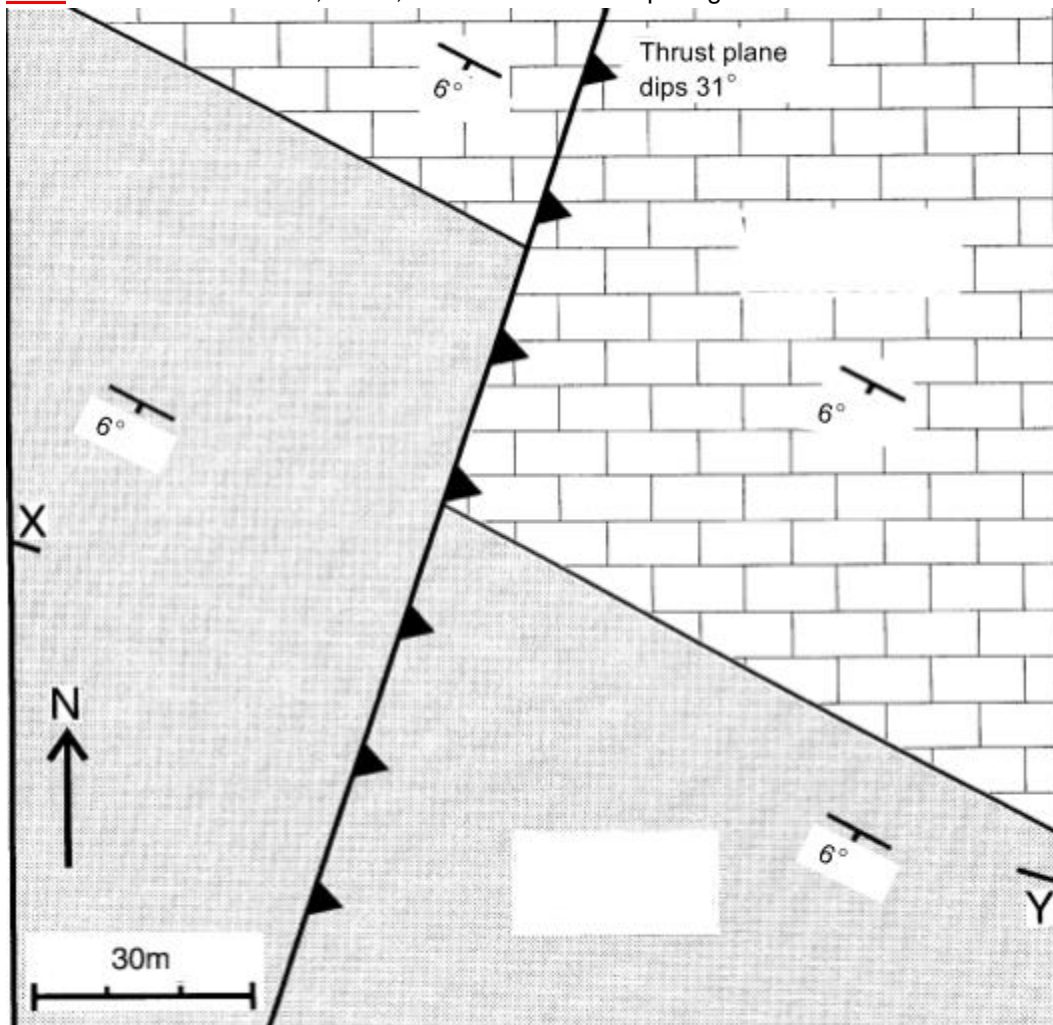


**Q17:** What is the true thickness of the outcropping bed below if  $h=5$ ,  $v=3$ , and the bed dips  $20^\circ$ ?



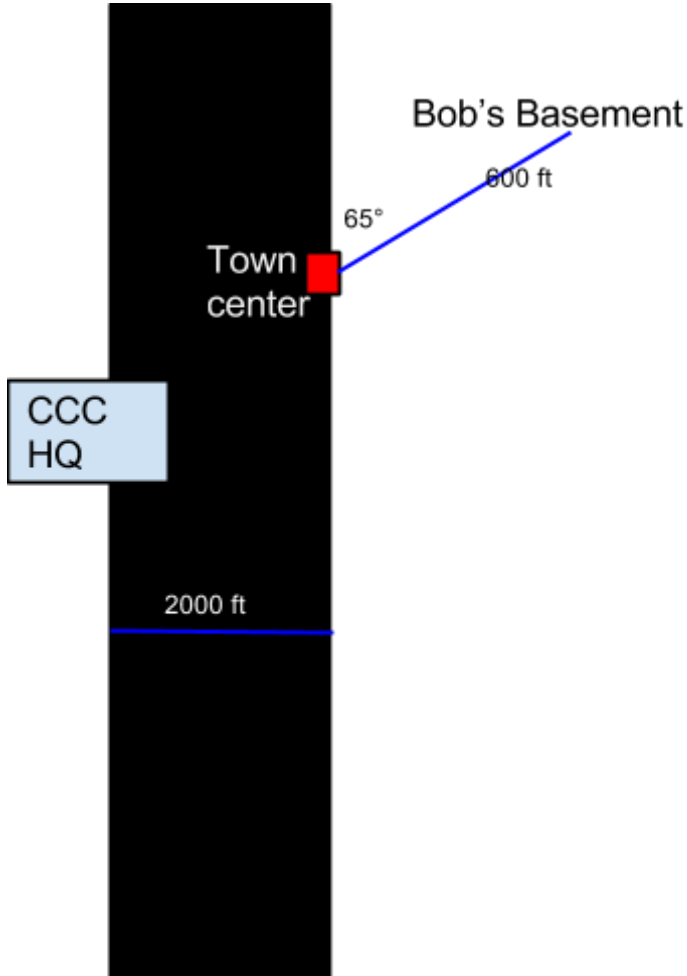
**Q18:** Between Appleville and Berrytown lies a large mountain formed from an eroded symmetrical upright antiform with a bluntness of 0 and an interlimb angle of  $30^\circ$ . A 800 ft borehole from the crestline to the troughline of the anticline passes through equal thicknesses of chalk, limestone, sandstone, and mudstone. As the citizens of Appleville are becoming thoroughly sick of apples, the decision is made to build a tunnel through the mountain, both to facilitate trade between the two towns and to secure more federal infrastructure funds. If the tunnel only goes through chalk (the softest of the rocks), what is the maximum possible tunnel distance?

**Q19:** Calculate the heave, throw, and minimum net slip magnitude of the thrust fault.



**Q20:**

The perfectly flat Coal County has a problem -- a 2000 ft wide strip of coal running down the middle of it, decreasing house values and interfering with people's lives. In fact, just last week, Basement Bob struck the coal seam 20 ft below the surface when he tried to build a basement 600 ft away from the town center (exactly on the east edge of the coal outcrop) along a bearing of N65W.



Luckily for the suffering inhabitants, the Caring Coal Corporation has bought them out, to mine the coal seam. The mining company wants to build passages **from their headquarters (on the west edge of the coal outcrop) through the coal bed with a slope of at least 3°** to ensure proper drainage, and the **passage floor needs to intersect the coal bed for at least 1800 feet** to be worth the cost of excavating them. Assuming the coal bed is a homocline, **what is the range of possible azimuths for the dip directions of the passages?**