Scioly Summer Study Session 2018-2019

Geologic Mapping

Answer Key

Written by Unome

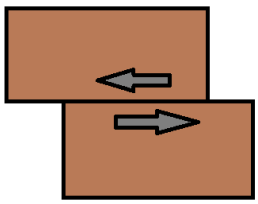
Instructions

Because this test is written for SSSS, the answer key includes explanations for most questions. It is also not formatted for ease of grading, as I usually tend to do. Note that explanations for calculation questions assume a good working knowledge of trigonometry. 1 point for a question where not specified. The original images are only shown when they include a part of the answer key (e.g. stream drawings).

Tiebreakers: 3, 9, 10, 11, 15, 19, 20, 24, 26, 27, 34, 41, 45, 50, 51, 52, 56, 58, 60

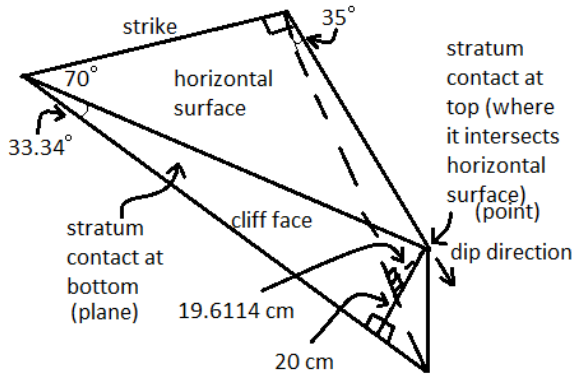
My philosophy on tiebreakers is to choose questions that require a good understanding of the material – these are usually, but not always, the harder questions.

1. Strike-slip fault
2. Dextral
3. A sinistral fault is shown below. Relative to an observer on one of the blocks, the other one appears to move toward the observer's left.

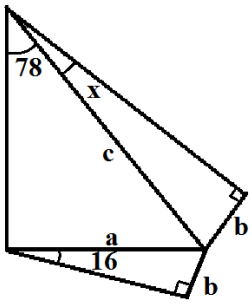


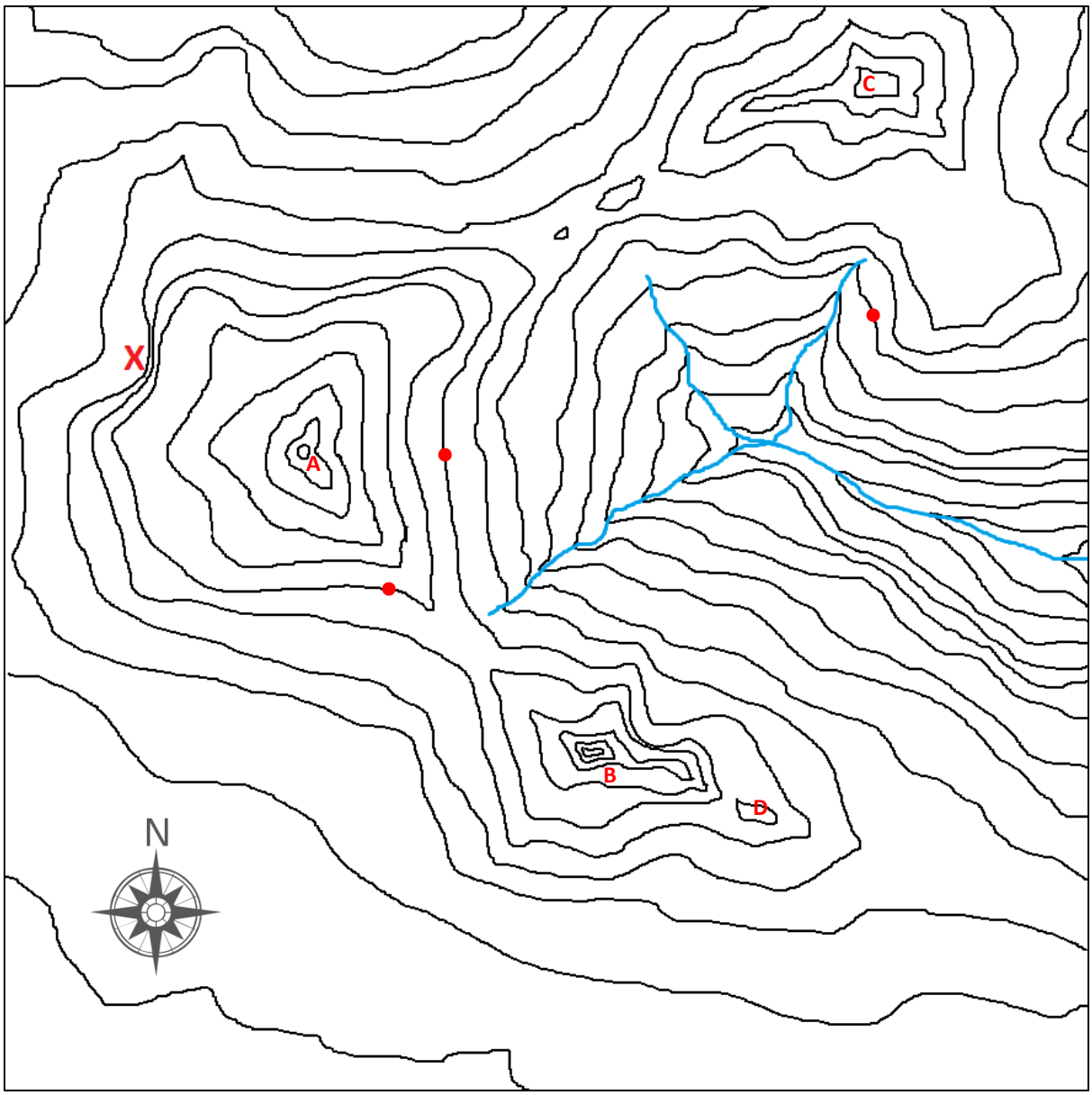
4. Looking at the image, the road is displaced by about 2.2-2.8 road widths, so around 22-28 meters. Dividing these two yields an answer between 157 and 200 years – any answer within that range earns the full 2 points.
5. Normal fault
6. 180 degrees – the dip direction is the direction of steepest descent along the fault plane.
7. Trigonometry – sin (dip) = 18 / 23.5, therefore dip = arcsin (18 / 23.5). The dip is 50 degrees, variance of less than 0.01 degrees is acceptable. (2 points)

8. Essentially the problem is a true dip/apparent dip problem at an offset angle of 70 degrees (90 minus the strike of 20). So, sin (70) * tan (35) = tan (apparent dip) therefore apparent dip = 33.344 degrees. Any answer between 33.0 and 33.7 degrees is acceptable. (2 points)
9. This problem is quite difficult. Refer to the diagram below (next page) for some idea of what to do. The end result is: True thickness = 20 cm * (sin(35) / sin(33.344)) * sin(70) = 19.6114 cm. Any answer between 19.607 and 19.616 cm earns full credit. (3 points)



10. You could draw another diagram, but that's a waste of time. Simply consider the triangle formed by the 75-dip cliff, a horizontal plane, and an imaginary vertical cliff. Using trigonometry, the projection of the stratum on the vertical cliff has a thickness of 20*sin(75) = 19.3185 cm. Take this value and plug it into the equation from the previous question as the apparent thickness to get 18.943 cm. Full credit for answers between 18.938 and 18.948 cm. (2 points)
11. Rake is the angle of the striation from the strike direction to the dip direction along the surface of the plane, so this is really just an apparent dip calculation with different measurements (namely, instead of the problem giving an offset angle on a horizontal plane, the offset angle is on the stratum plane). Using orthogonal projection (see the diagram below) you can determine that plunge = arctan (sin (78) * sin (16)), which is 15.08 degrees. Any answer between 15 degrees and 15.2 degrees is acceptable. The actual values of a, b, and c are irrelevant – they are just placeholders to do trigonometry with. (2 points)

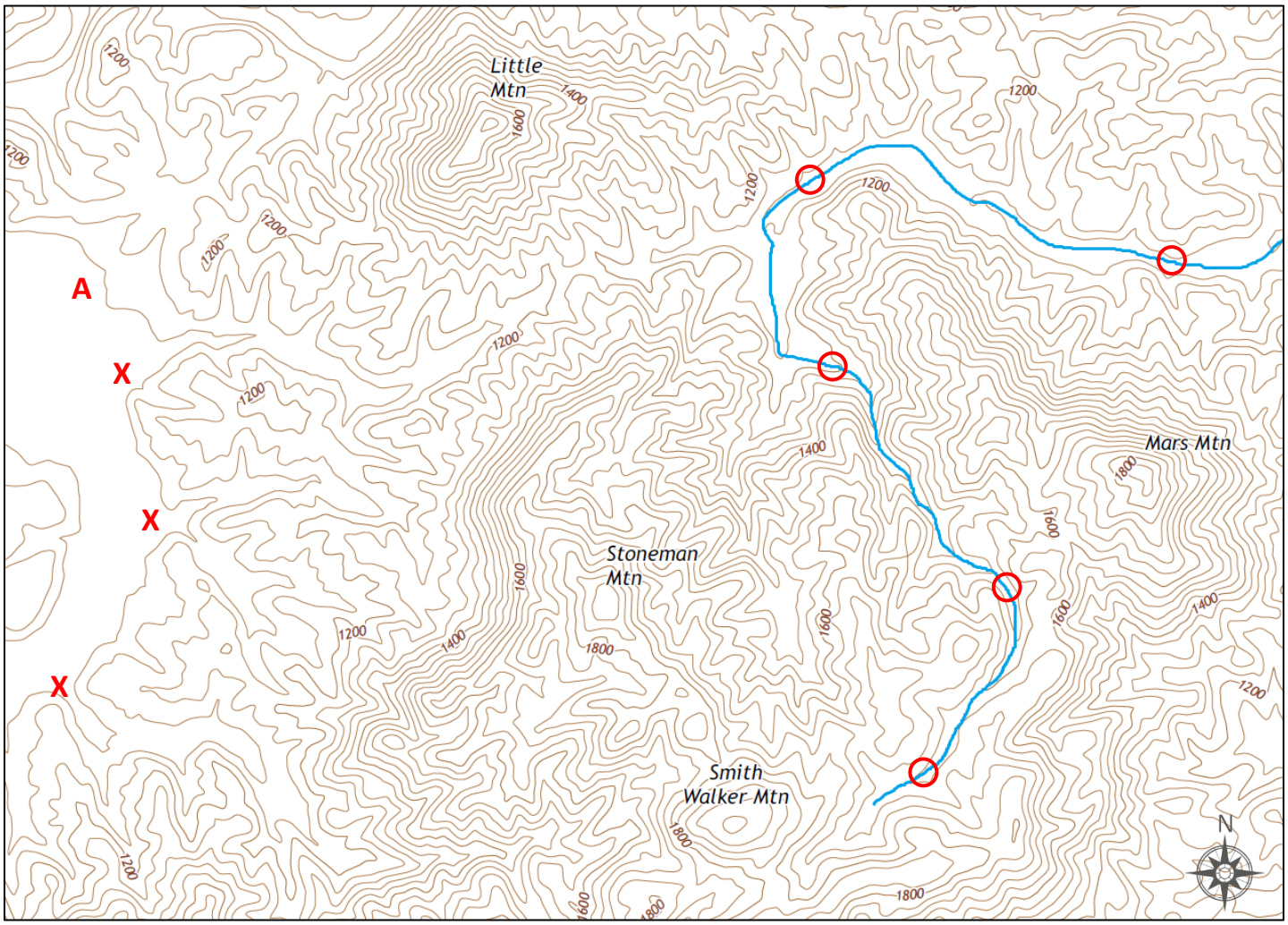




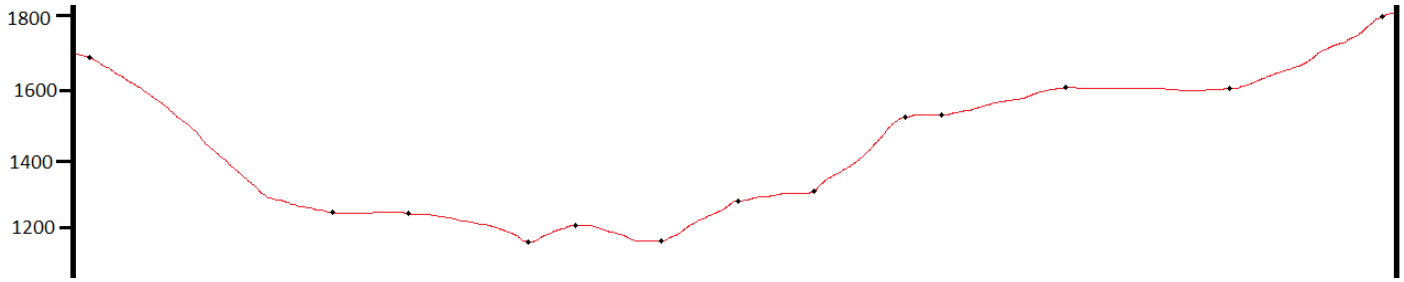
12. Mountain A is the tallest. Choose any point and measure every mountain's height relative to that point.
13. Mountain A is 4 contours higher than Mountain C, so the only contour interval that works with the height difference of approximately 40 meters would be a contour interval of 10 meters.
14. Any answer between 3550 and 3560 meters, since Mountain B is 1 contour lower than Mountain A.
15. Contour D could be either 3510 meters or 3490 meters (either descending or ascending from surrounding terrain). 3510 is more likely because a local subpeak is much more common than a local depression (or something to that effect- you would not normally find a random basin on a mountain like that, with such a sharp drop). This may be counteracted by other evidence (e.g. that might be a lake) hence the qualification in the question. (½ point for each elevation, 1 point for the more likely one, and 1 point for why).
16. See the map (marked in blue). (1 point per tributary, 1 point for the post-convergence stream)
17. Any answer between 3410 and 3420 meters.
18. See the map (red X). There's another cliff on the northeastern face of Mountain B, but it's not as tall.
19. Classic three-point problem, there are plenty of explanations on the internet. Strike is 140-160 degrees and dip is 2.6-3.0 degrees. 2 points for strike, 2 points for dip)

20. Essentially extrapolating the strike and dip from the previous question to determine the outcrop height at another point on the map. Accept any value between 3505 and 3515 meters. (2 points)

For those interested, the map below is excerpted from the Boomer, NC 7.5-minute quadrangle.



21. 40 feet
22. Floodplain, specifically one bordering a small river/large stream.
23. See the map (1 point per stream mouth marked approximately correct)
24. See the map for an approximate trace of the stream. (1 point for each of the red circles that their stream passes through)
25. The dip angle and some chosen horizontal distance along the slope can be used to calculate a scale for the map. Any value between 800 and 1100 feet earns full credit. (3 points)
26. ½ point for each aspect marked with an asterisk. Be somewhat lenient with exact horizontal and vertical positions – Just above 1700 ft at leftmost edge*, descending to 1250 ft at position of 3/16 from leftmost edge*, flat-ish then descending to 1120 ft at 5/16*, rise to 1200 ft at 3/8*, descend to 1120 ft at 7/16*, rise to 1280 ft at 1/2*, rise slowly until 9/16*, rise to 1500 ft at 11/16* first quickly then nearly flat*, rise to 1600 ft at 6/8*, flat until 7/8*, rise to 1800 ft just before right edge*. (Max 6 points). See profile below.

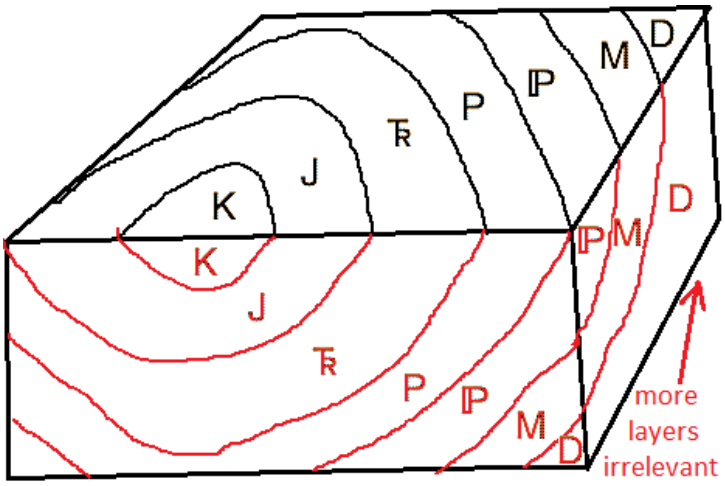


27. A - C - I - K - E - L - D - J - B - H - G - F (½ point for each correct *pairing* – e.g. C is directly after A, I is directly after C, etc., for up to 5 ½ points. The last ½ point awarded as bonus if they earn the other 5 ½)
28. Neither (because synthetic and antithetic faults don't directly meet the parent fault)
29. J is a thrust fault (1 point; ½ point only for "reverse fault"), hence the "assume significant vertical exaggeration." G is a normal fault (1 point).
30. Disconformity
31. Dike
32. Compression
33. Fold and thrust belt
34. Convergent (doesn't matter whether or not they give a specific type)
35. C

Questions 36-40 – 2 points per question. ½ pt per correct answer that is marked down, ½ pt per incorrect answer that is *not* marked down.

36. A, B
37. B
38. C, D
39. C, D
40. A, B, D

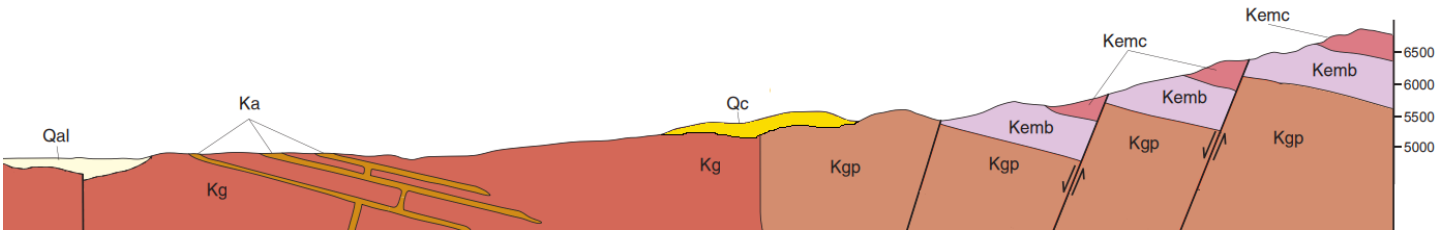
41. 1 point each of the two sides – ½ point for layer orientations (exact dip irrelevant), ½ point for labels.



42. Plunging fold. Only ½ point for fold. No points for syncline, since competitors should be able to tell that it is not an intended answer based on the wording of the next question.
43. Syncline

For those interested, the map for 44-52 is from http://mbmg.mtech.edu/pdf-publications/gm68_boulderEast.pdf

44. Quaternary (1 point); alluvium/alluvial (1 point)
45. River/stream
46. 40 feet
47. A fault line (1 point); it is dotted because it is covered by the Qal layer (1 point)
48. Lower bound between 6280 and 6320 ft (½ point); upper bound between 6680 and 6720 ft (½ point).
49. They dip west (1 point); they are normal faults (1 point)
50. A dike – notice the outcrop pattern relative to the topography, and also notice that it doesn't sit between layers.
51. Extensional/tension (1 point); The faults are normal, rather than reverse (1 point)
52. ½ point for each of the asterisks – Ascending left to right*, steeper toward right side*, accurate vertical labeling*, approximate horizontal accuracy*, Qal present as thin deposit layer*, Qc present as thin deposit layer*, Kemb present in three parts*, Kemc present in three parts*, Kemc layer over Kemb layer*, Kgp/Kemb and Kemb/Kemc contacts dip gently toward the east*, sub-Qal fault present and vertical (since direction isn't shown on the map excerpt)*, eastern faults present and dip steeply toward west*, eastern faults normal** (1 point for this rather than ½ point), Ka present*, Ka underground profile are as dikes* (attitude of dikes not relevant for points). Max 8 points. See example cross-section below.



In reality there are more subsurface layers, which can't be inferred without additional information of the area

53. A syncline/anticline refers to whether the bedding age is increasing/decreasing from the fold axis outward if eroded flat (½ point), whereas a synform/antiform refers to whether the fold hinge points upward or downward (½ point). A synformal anticline or antiformal syncline must mean that the layers were overturned (1 point).
54. Tilt the world 33 degrees downward and away from you – now the ground is flat and the stratum dips at 14 degrees. True thickness = 5.2 sin (14) = 1.257 meters (2 points for any answer between 1.25 and 1.26)

Use a stereonet for questions 55-60. Attach the piece of tracing paper you used to answer the questions. Plots within a reasonable distance of the exact attitude will be scored as correct.

55. Self-explanatory (½ point for outer circle, ½ point for 000 strike line).
56. Refer to image. Strike of 15 degrees, dip of 12 degrees, toward the east. All or no points.
57. Refer to image (for reference, trend = 49.4 degrees and plunge = 6.8 degrees). All or no points.
58. 6.8 (degrees is implied by the introductory instructions of the test).
59. Refer to image. Strike of 110 degrees, dip of 50 degrees, toward the south. All or no points.
60. Exact answers are trend of 119.924 and plunge of 11.606. Credit for 119.8 to 120.0 for trend (1 point) and 11.5 to 11.7 for plunge (1 point).

Stereonet answer key. The intersection line of the two planes (yellow-brown color) does not need to be plotted, only the attitude given as the answer for question 60. The stereonet itself comprises a total of 3 points (questions 56, 57, and 59). The competitor's tracing paper will not have the grid, cardinal markers (except the 000 one), or centerpoint marker – those are here for grading reference.