

National Exams May 2018

04-Geol-A4, Structural Geology

3 hours duration

NOTES:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.
2. This is a CLOSED BOOK EXAM.
One of two calculators is permitted - any Casio or Sharp approved model.
3. All questions constitute the complete exam paper. (100 marks)
4. Some questions require an answer in short answer or short essay format with figures as appropriate. Clarity and organization of the answer are important.

QUESTION A. (20 Marks)

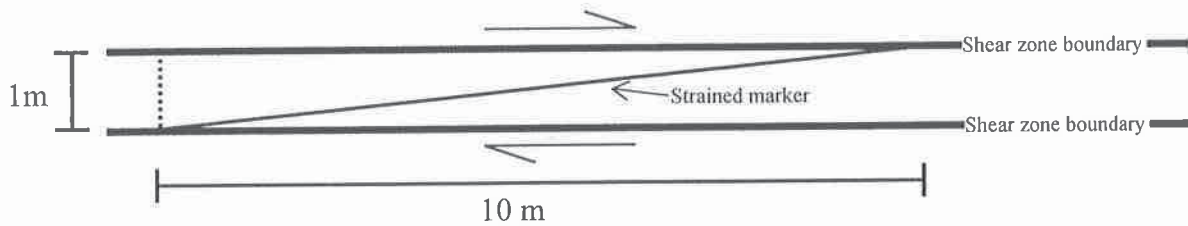
[1 mark per correct answer ; -0.5 marks for an incorrect answer; blanks = 0]

Answer all of the following T (True) or F (False) next to the number.

1. Rocks that have undergone purely dip slip faulting can show evidence of strike separation.
 2. Axial planar cleavage of a fold forms during the homogeneous strain stage of fold development.
 3. The fold axis connects points of maximum curvature for non-cylindrical folds.
 4. In theory, buckling involving flexural slip folding produces only Class 1B folds.
 5. Stress traction refers to stress at a point.
 6. Mode 1 fractures only form perpendicular to σ_1 .
 7. Mode 2 fractures have displacement perpendicular to the fracture front.
 8. A Mode I fracture may form from either positive or negative normal stresses.
 9. For ideally plastic material strain is linearly related to stress.
 10. An intersection lineation between bedding and cleavage provides the orientation of the axial surface.
 11. Solid state diffusion involving Nabarro-Herring creep occurs along grain boundaries.
 12. The same bedding contact can intersect the axial planar cleavage of a fold only once.
 13. An intersection lineation between bedding and cleavage provides the orientation of the axial surface.
 14. Lines that represent the principal strain axes were perpendicular before the strain.
 15. Finite strain represents the total accumulation strain for a given period of time.
 16. The stress tensor can be fully defined by 6 different components of stress.
 17. A screw dislocation is oriented parallel to the Burgers vector.
 18. The yield point in a rock deformation experiment is the onset of inelastic deformation.
 19. Principal strain axes for simple shear have some component of net angular shear.
 20. Plane strain is a product of non-coaxial strain.
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QUESTION C. (30 marks)

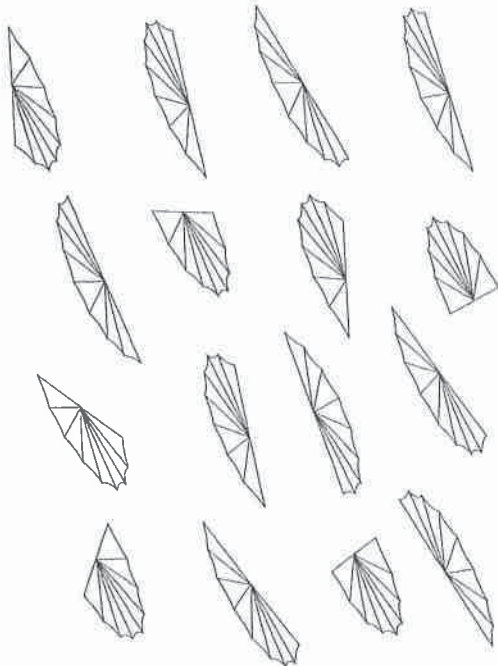
(1) The shear zone below is 1m wide and has had approximately 10m of dextral slip.



(a) What is the angular shear (ψ) and shear strain (γ) of the shear zone? {assume an initially perpendicular marker across the shear zone (i.e. dotted line) has had one end displaced 10m relative to the other} /4

(b) What is the elongation (e) of the offset marker? /2

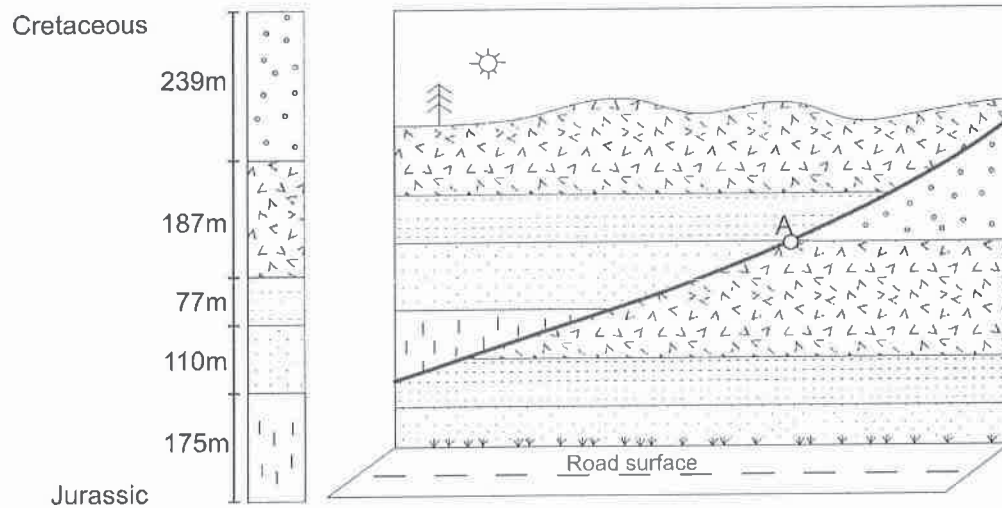
(2) The sketch below comes from a deformed bedding plane that is covered with brachiopods. Recall that the angle between the hinge and the bisector of living brachiopods is always 90° . A geologist noted that some of the brachiopods still have a 90° hinge angle but others have a distinctly different angle. Does this observation imply that the region has undergone heterogeneous or homogeneous strain? Explain. /4



(3) Referring to the sketch below:

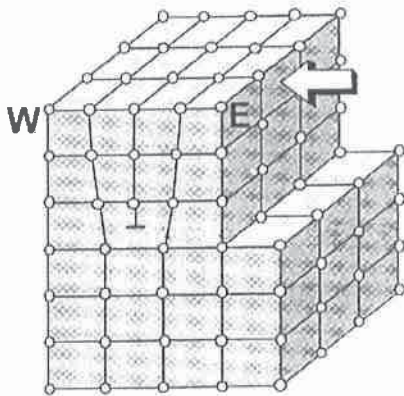
(a) Fully name the fault that cuts the vertical road cut shown below. /2

(b) What is the approximate stratigraphic throw in metres at point A? /2

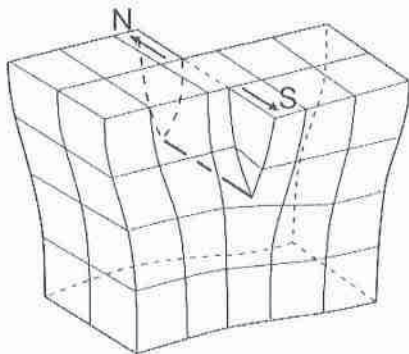


(4) Using the sketches provided:

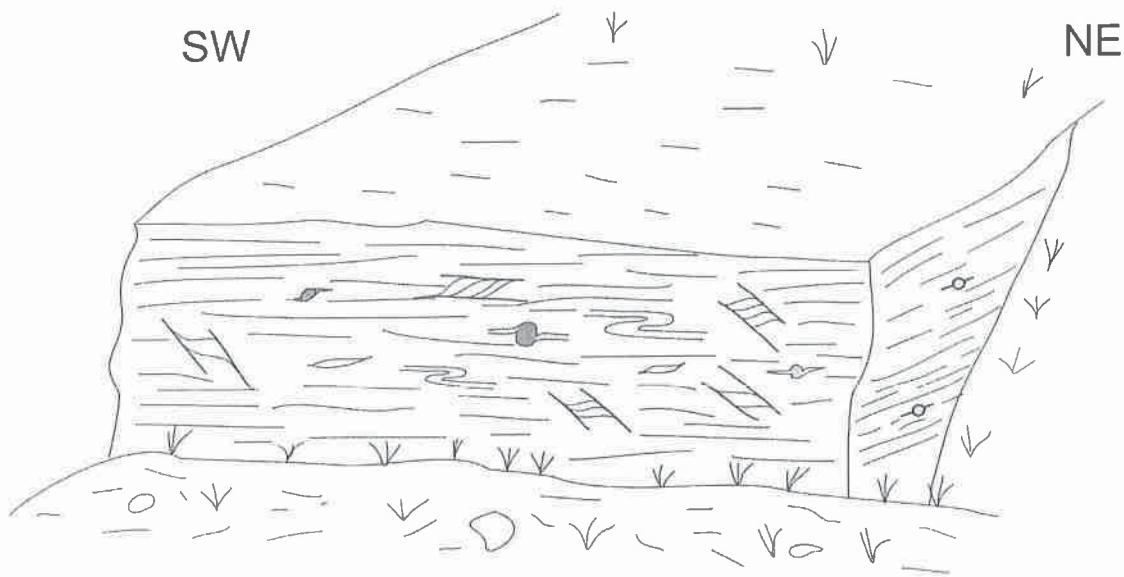
(a) Please name the type of dislocation, identify the glide plane, and determine the Burgers vector (make sure you include the direction of the Burgers vector). /4



(b) Please name the type of dislocation and determine the Burgers vector (make sure you include the direction of the Burgers vector). /2



- (5) For the line drawing below, identify the sense of shear. Circle and name three different types of shear sense indicators that support your interpretation. /4

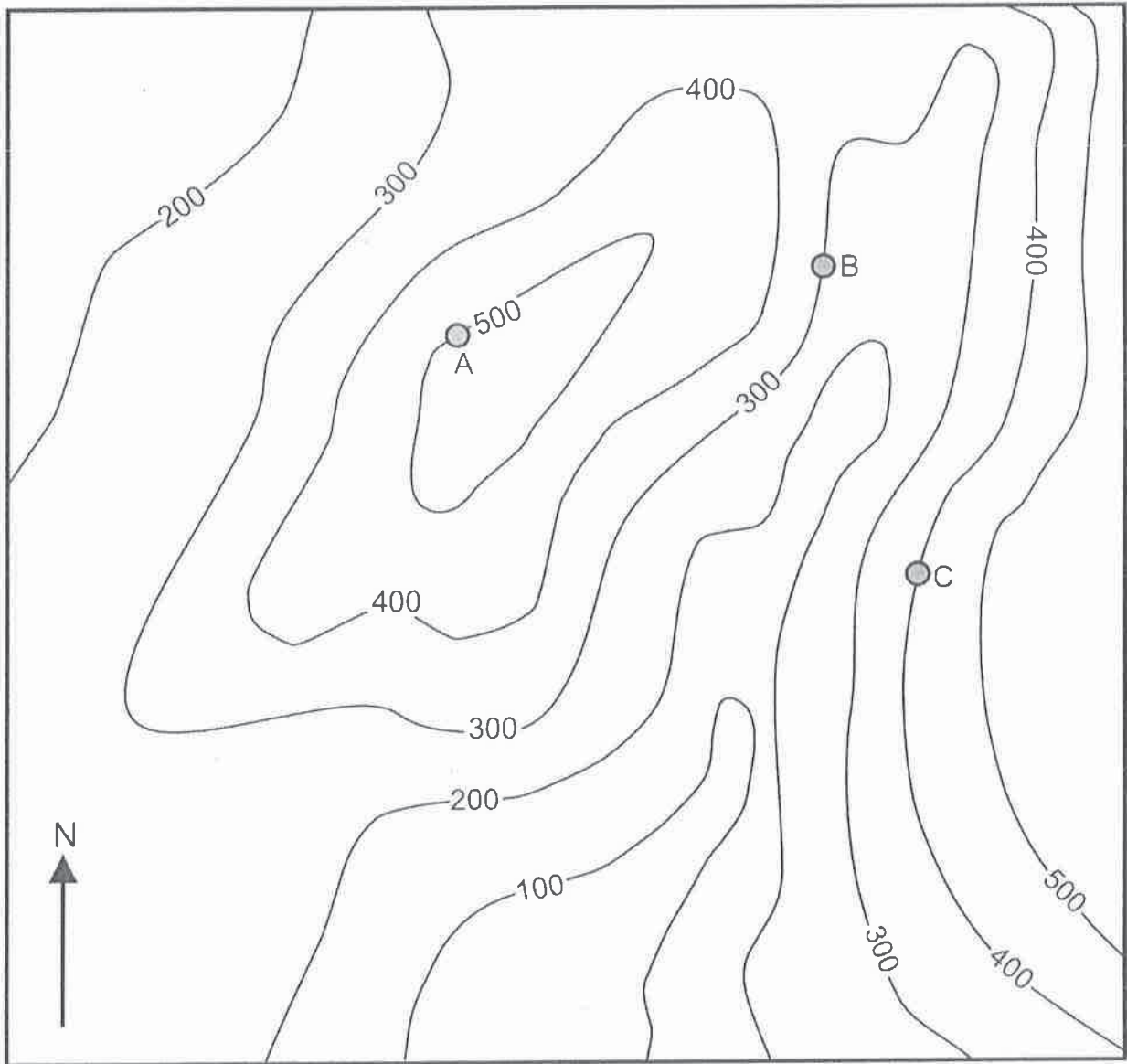


- (6) Ductile faulting is recognized to be very common in the middle and deep crust. Draw a ductile fault zone with an offset marker (e.g., a dike). /2
In the drawing, show a possible fabric trajectory across the zone with associated strain ellipses if the shearing is most intense in the centre and weakens outward from the centre of the shear zone. /4

QUESTION D. (10 marks)

(1) Using the map below – Points A, B and C are outcrops of a coal seam.

- (a) Assuming the coal seam is perfectly planar, determine the attitude of the coal seam (i.e. strike and dip). /5
- (b) Determine the outcrop pattern for the coal seam. /5



QUESTION E. (20 marks)

- (1) Intuitively, it seems reasonable that a preexisting plane of weakness should significantly compromise a rock's strength, i.e., reduce its resistance to failure. Using a fully labeled Mohr diagram of stress, explain the difference between the Coulomb Failure Criterion and Byerlee's Law. Be sure to include the equation specific to each failure criterion. /5

- (2) Using another Mohr diagram of stress, answer the following question: Is there ever a situation where it is more favorable for failure to occur along a new fracture rather than along a preexisting plane of weakness? /5

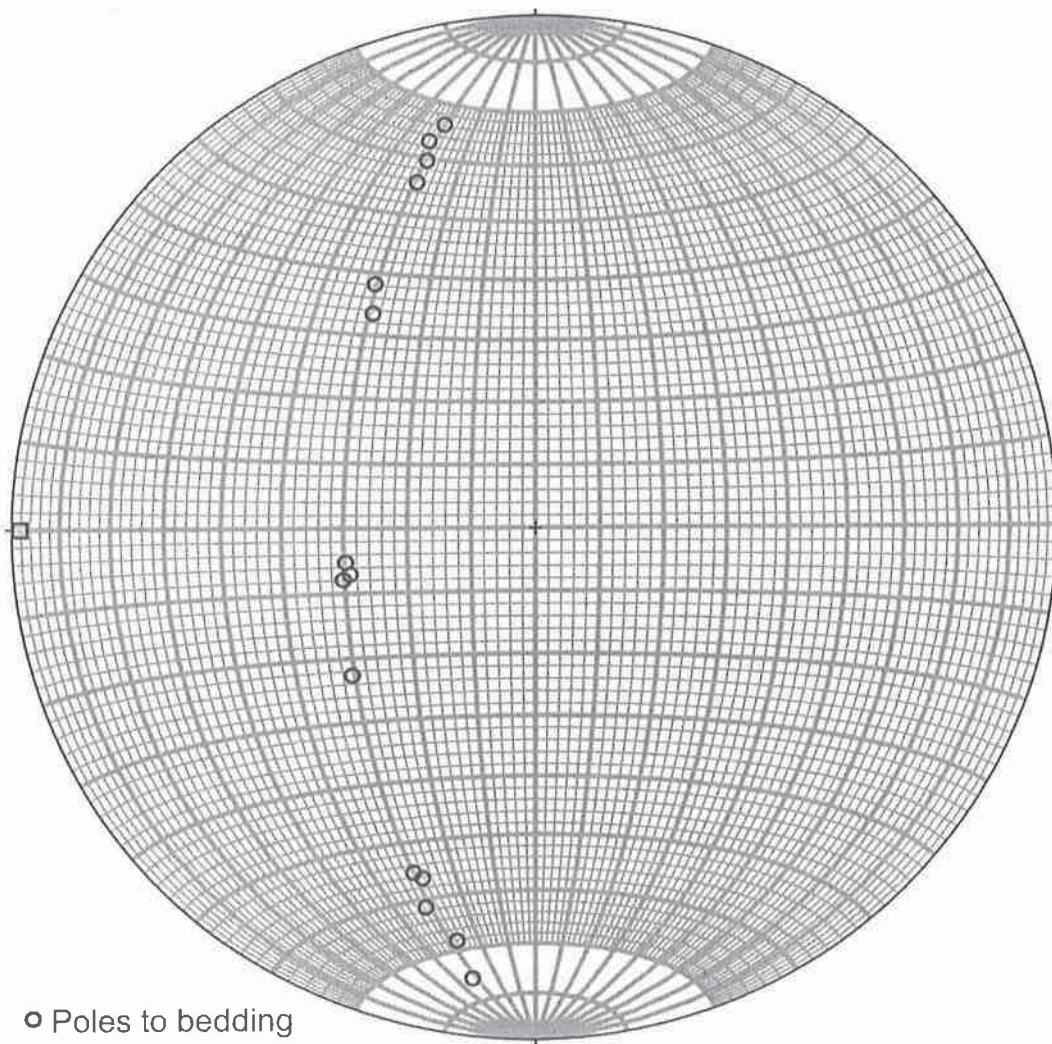
(3) Please answer the following questions using the data plotted from a cylindrical fold on a lower hemisphere equal-area net below.

(a) What is the orientation of the Pi circle? /2

(b) What is the orientation of the Pi axis? /2

(c) What is the orientation of the axial plane? /2

(d) Describe the fold completely using at least 3 standard terms. /3



○ Poles to bedding

▣ Axial trace measurement