National Exams 2015

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 an OPEN BOOK EXAM.
   Any non-communicating calculator is permitted.

3. FIVE questions constitute a complete exam paper.
   There are choices in some questions (read instruction line)

4. Answer A,B,C in answer booklet; D,E on this exam paper

5. Some questions require an answer in short answer or short essay format with figures as appropriate. Clarity and organization of the answer are important.

NAME:_____

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) in the answer booklet next to the number.

Answer ALL of these 20 questions

1. In overturned folds the younging direction is always up.
2. Bedding thickness must be preserved in a balanced (palinspastic) section
3. Continental crust is normally thicker than oceanic crust
4. A Mohr circle represents the state of stress on an infinite number of planar orientations.
5. Fold thrust belts are associated with very high grade metamorphism
6. The apparent thickness of layered strata can be less than the true (normal) thickness.
7. Flexural slip lineations are normally parallel to the fold axis
8. Volcanic arcs are associated with subduction.
9. Elongation strain requires the presence of tensile stress.
10. In active folding regions gold prospecting focusses on the fold limbs for ore potential.
11. A higher fracture frequency results in an increased RQD
12. Blocky veins indicate gradual and trans-tensional strain
13. In a single outcrop, continuous joints are older than offset, discontinuous joints.
14. A viscous material continues to deform over time without an increase in stress..
15. The dip of the axial surface is normally less than the plunge of a fold axis.
16. Coaxial strain does not involve shear
17. Normal and reverse faults dip approximately parallel to the syntectonic σ_2
18. At great depth, the apparent friction angle decreases with increasing pressure.
19. Dislocation creep is a viscous mechanism of volume reduction.
20. Softer rock units within a sequence will have fewer joints than stiff rock units

QUESTION B (2.0 marks each + 0.5 for style and clarity = 25 marks)

For **ANY and ONLY 10** of the following, in two or three sentences (in addition to text you may use clear sketches or stereonets where appropriate) describe the relationship and distinguish clearly between: Answer in the answer booklet

Anticline and Monocline
Brittle and Ductile
Cleavage and Stretch Lineation
Cohesion and Friction
Equal Angle and Equal Area Projection
Fault Breccia and Cataclasite
Fault Trap and Pinchout Trap for Oil
Fold Plane and Hinge Line
Horst and Graben
Normal Fault and Reverse Fault
Parallel Folding and Similar Folding
RQD and RMR
Simple Shear and Pure Shear
True Dip and Apparent Dip

QUESTION C (4 marks each + 1 for style and clarity 25 marks)

Answer **ANY and ONLY 5** of the following questions in reasonable detail (1/3 to 2/3 of a page in the answer booklet)

In addition, use Sketches where appropriate.

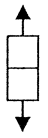
1. Describe four different primary structures which can be used for determining the younging direction. Explain with a figure how this is determined in each case.
2. Describe four types of structural traps key to the formation of hydrocarbon reserves.
3. Describe four typical components of a rockmass classification scheme for engineering geology. How does each element impact on excavation support requirements.
4. Describe four failure modes in slopes or tunnels associated with joint sets or intersecting joints. How would you mitigate each mode?
5. Describe and illustrate with a diagram at least 4 types of brittle structures associated with simple active folding of competent strata
6. Describe how confining pressure (depth), temperature, strain rate, and the presence of fluids affects the strength and ductility of geomaterials.
7. Describe two large scaled structural features and one small scale or microscopic feature of extensional, compressional, and strike slip shear terrain.
8. Explain with text and figures the formation of undulose extinction, subgrain boundaries and mechanical twinning.
9. Using a Mohr diagram and a complete Mohr-Coulomb strength envelope, illustrate the mechanics of cyclical fault pumping due to fluid pressure. Describe the nature of the resultant vein infilling.

QUESTION D (18 marks) **Place Answers HERE**

The following plot shows a complete Mohr-Coulomb Yield Criteria for Intact Rock (Dry).

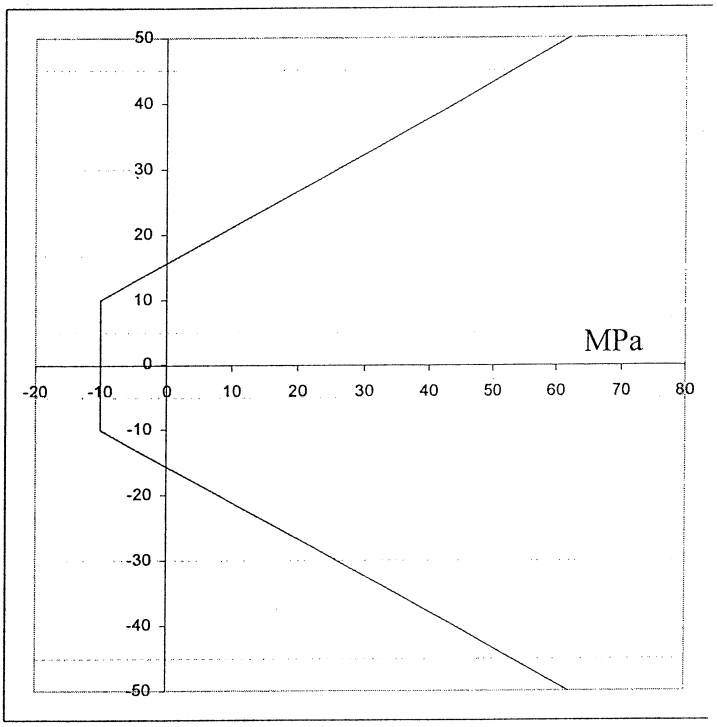
a) **Estimate or Calculate (give numbers), Illustrate** on the figure and **Label** on the plot, the 3 KEY STRENGTH PARAMETERS (material strength constants).

b) Sketch one Mohr circle for <u>rock failure</u> under Uniaxial Tension

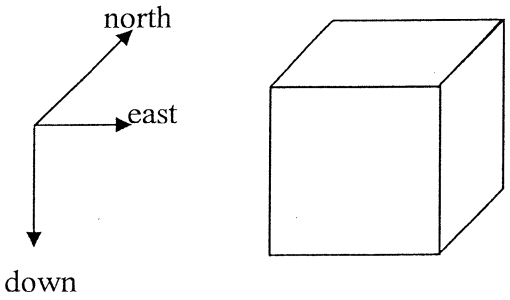


c) Sketch one Mohr circle for <u>rock failure</u> under Confined ("Triaxial") Compression

d) Draw the shear strength envelope for a continuous and fully formed planar joint surface with the same frictional strength as the intact rock.



e) For a limestone rockmass with a N-S horizontal principal stress $0.5x\sigma_{vertical}$ and a E-W principal stress equal to the average volumetric pressure at this point:. DRAW the and label Principal 3D stress tensor at a depth of 2000m.
Label the calculated stresses:



f) i) What is the maximum shear stress (MPa) on any planes through this point? _____?

ii) What is the common dip of these (maximum shear) planes? _____?

g) What is likely to form if the pore water pressure here is 45 MPa_____?
Give a likely orientation for these structures (sketch above)

NAME:_____

QUESTION E (12 marks)

ONE and ONLY ONE of the following (E-I or E-II) Place Answers here

E-I On the following stereoplot, DRAW, IDENTIFY and SOLVE for :

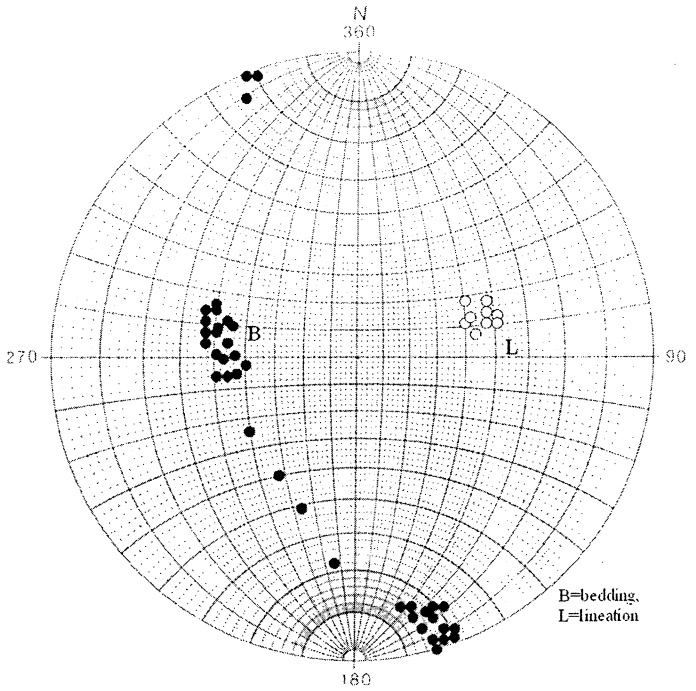
a) Fold Axis: label and give approximate trend

b) Profile plane: label and give approximate strike and dip (estimate)

c) Axial plane: label and give approximate strike

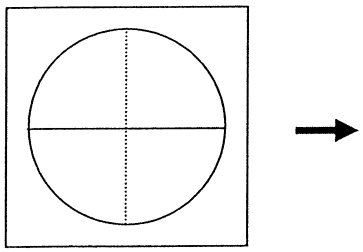
d) Apparent dip of the profile plane on a vertical cliff striking 180

e) Describe the fold completely (using three standard terms)

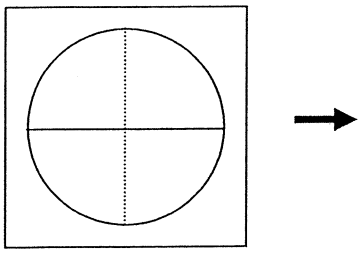


E-II Draw these two reference objects (including reference lines) after straining under:

a) pure shear (coaxial strain):



b) simple shear (non-coaxial strain):



Draw and label (c,d,e,f), on each "before and after" figure:

c) A line most likely to be boudinaged.
d) The most probable plane of cleavage formation.
e) In the pure shear example, show the most likely orientation(s) of shear joints
f) In the simple shear example, draw a line which is likely to be folded first and then boudinaged as strain increases.

NAME:_____