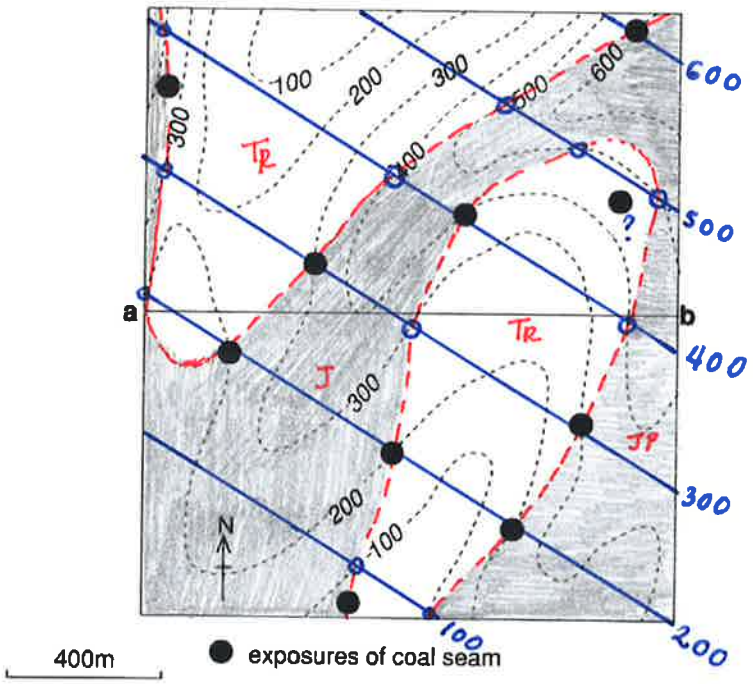
Student Name: Nestor Cardozo

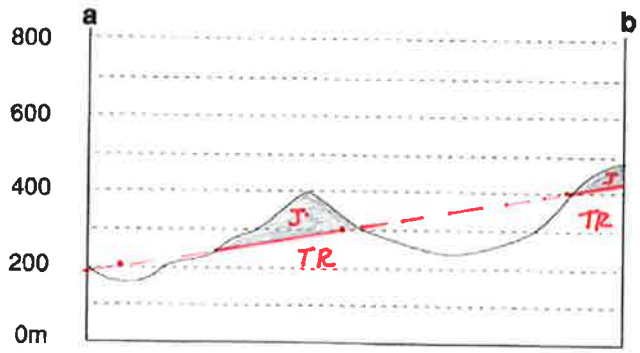
GEO210 Structural Geology
Midterm test
October 22, 2019

This test is closed book and closed notes. You have two hours to complete the test. Please be sure to show all your work. The total value of the test is 100 points. The point value of each question is shown.

Question 1 (20 points): The Triassic-Jurassic contact is exposed at the points shown on the map by black circles.

o: other contact.
---: contact.





a. Construct structure contours of the contact every 100m (i.e. 100, 200, 300, 400, 500, and 600 m structure contours).

See blue 100-600 m lines.

o: are other locations where the contact outcrops

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b. Determine the strike and dip of the contact

121 / 18 (RHR)

Strike: 121

Dip: $\text{atan}\left(\frac{100}{300}\right) = 18°$

c. Draw the complete outcrop trace of the contact on the map, paying attention to the effects of topography. Remember that wherever structure and topographic contours of the same value cross, the contact will be at ground level.

See dashed red line on map

d. Draw a cross-section using the profile provided and shade in, on the map and cross section, the rocks lying above the contact. Label the Triassic (TR) and Jurassic (J) on the map and cross section.

See map

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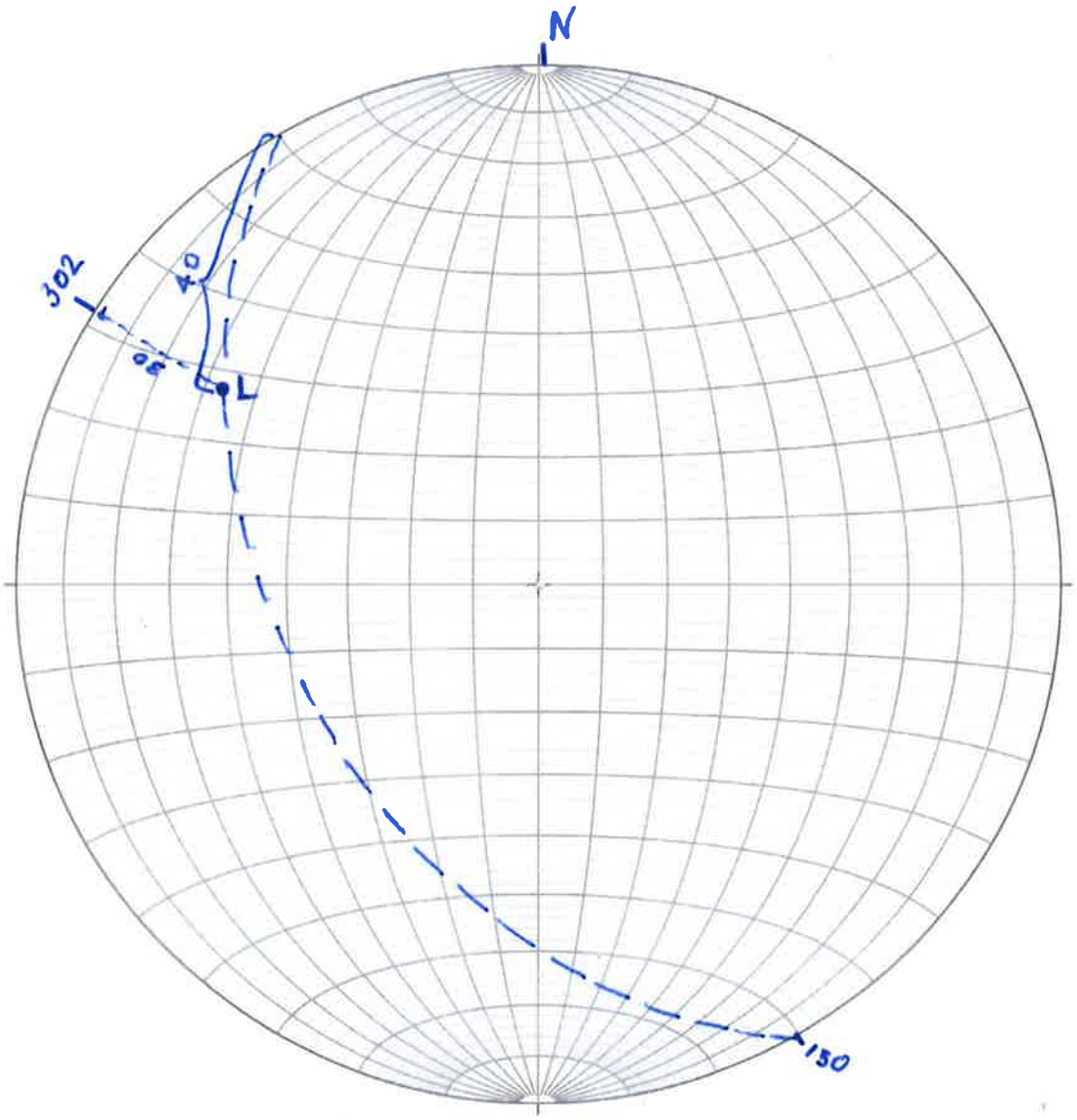
Question 2 (20 points): A fault plane with strike and dip 150/50 (RHR) has slickenside lineations (or striations) on it which pitch (rake) 40N. What is the trend and plunge of the lineations?



Equal area net

answer:
302 / 30

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Question 3 (20 points): Explain how to solve the following problems using linear algebra:

(a) Pitch (rake) of line on plane

- Direction cosines of line
- Direction cosines of strike line
- Dot product of line & strike line
- Pitch is acos of dot product between the lines

(b) Three point problem

- ENU coordinates of the three points P_1, P_2, P_3
- Make vectors $U = P_1 - P_2$ and $V = P_3 - P_2$
- Normal to plane is $P = U \times V$ (cross product)
- Normalize p (make it a unit vector) and put it in NED
- Compute trend and plunge of p
- Compute strike and dip of plane from trend and plunge of p.

(c) Thickness of sedimentary unit of strike S and dip D. East-North-Up coordinates of points on the top and base of the unit are known.

- ENU coordinates of points
- Compute transformation matrix a from ENU to SDP
- Compute the P coordinates of the points

$$P_3 = a_{31} E + a_{32} N + a_{33} U$$

- The thickness of the unit is:

$$| P_{base} - P_{top} |$$

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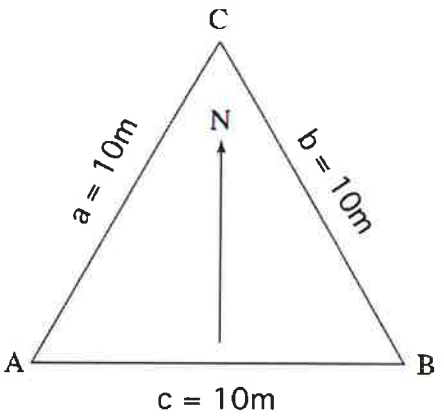
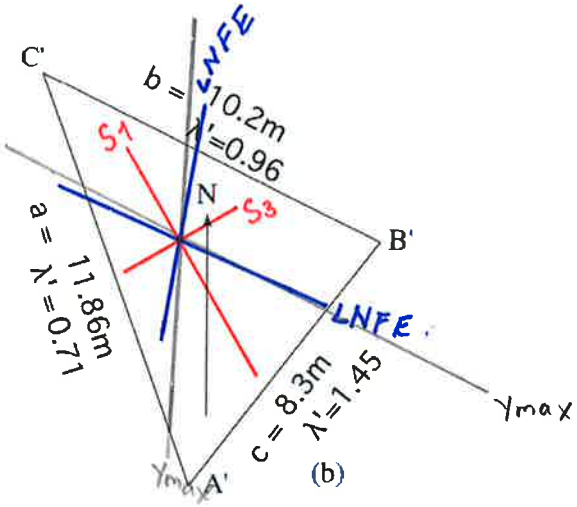
Question 4 (20 points): Three stakes were placed on the surface of a glacier to form an equilateral triangle of sides a = b = c = 10 m (left triangle). After one year the positions of the stakes were resurveyed (right triangle). The Mohr Circle for finite strain after one year is shown below. Points a, b, and c in the Mohr Circle represent the strain of sides a, b, and c, respectively. O_L is the pole of the Mohr Circle.

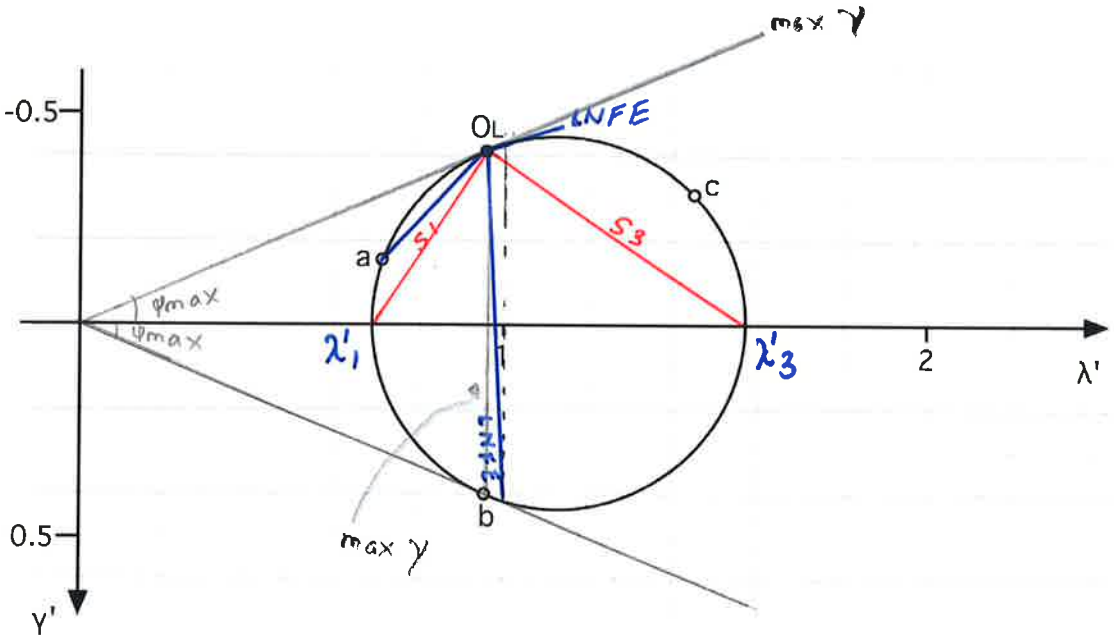
a. Draw the S_1 and S_3 directions in the Mohr Circle and the deformed triangle.

b. Draw the lines of maximum shear strain in the Mohr Circle and the deformed triangle.

c. Draw the lines of no finite elongation in the Mohr Circle and the deformed triangle. Use different colors for **a**, **b**, and **c**.







— : a S1 and S3

— : b LNFE

— : c γmax

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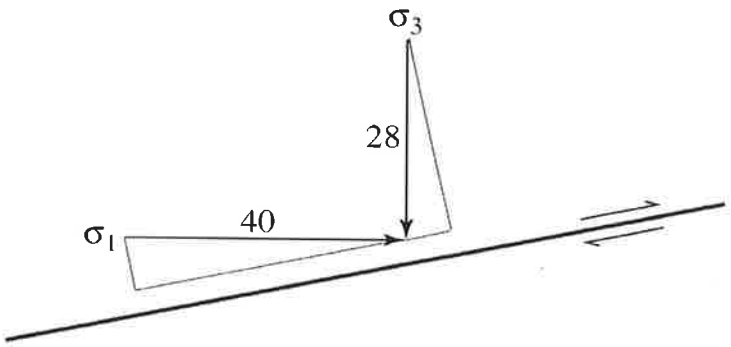
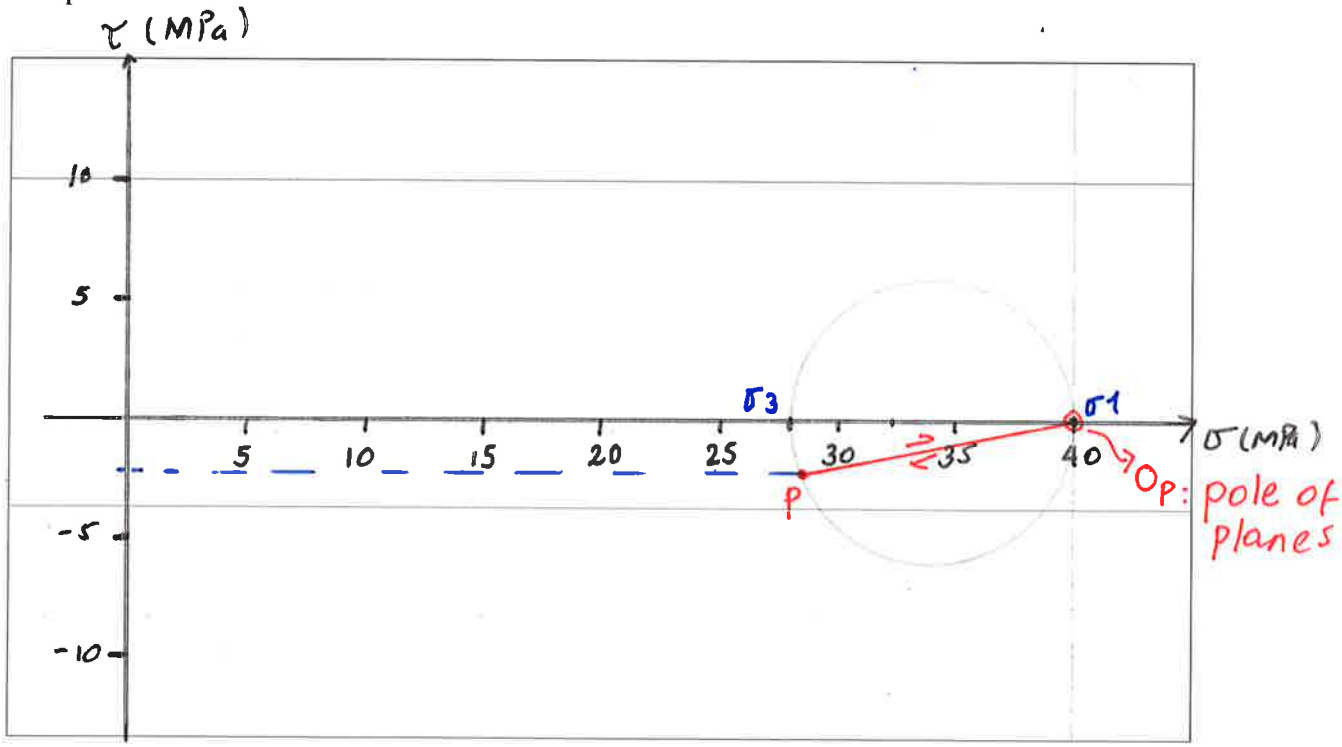
Question 5 (20 points): An example from a structural geology text is shown below. The principal stresses are treated as force vectors and the normal and shear components of each in the plane of the fault are found. The vector sum of the components parallel to the fault is 33.3 MPa, and the author supposes this is the shearing stress which drives the fault.



Using the graph paper below, show why this example is wrong. i.e. Construct the Mohr Circle diagram for this case, and estimate the actual normal and shear tractions acting on the fault plane.



σ : 28.5 MPa (≈)

τ : -2.5 MPa (≈)