STRUCTURAL GEOLOGY
Final Exam Questions
31st May 2010

1. a) Using a streogram find the plunge and trend of the intersection lineation between bedding at 127/42SW and foliaiton 38/46NW.

   b) Using a stereogram pass a plane through the lines 12/76NE and 146/12SE. Determine the strike and dip of the plane.

2. Explain the following terms with the help of diagrams:
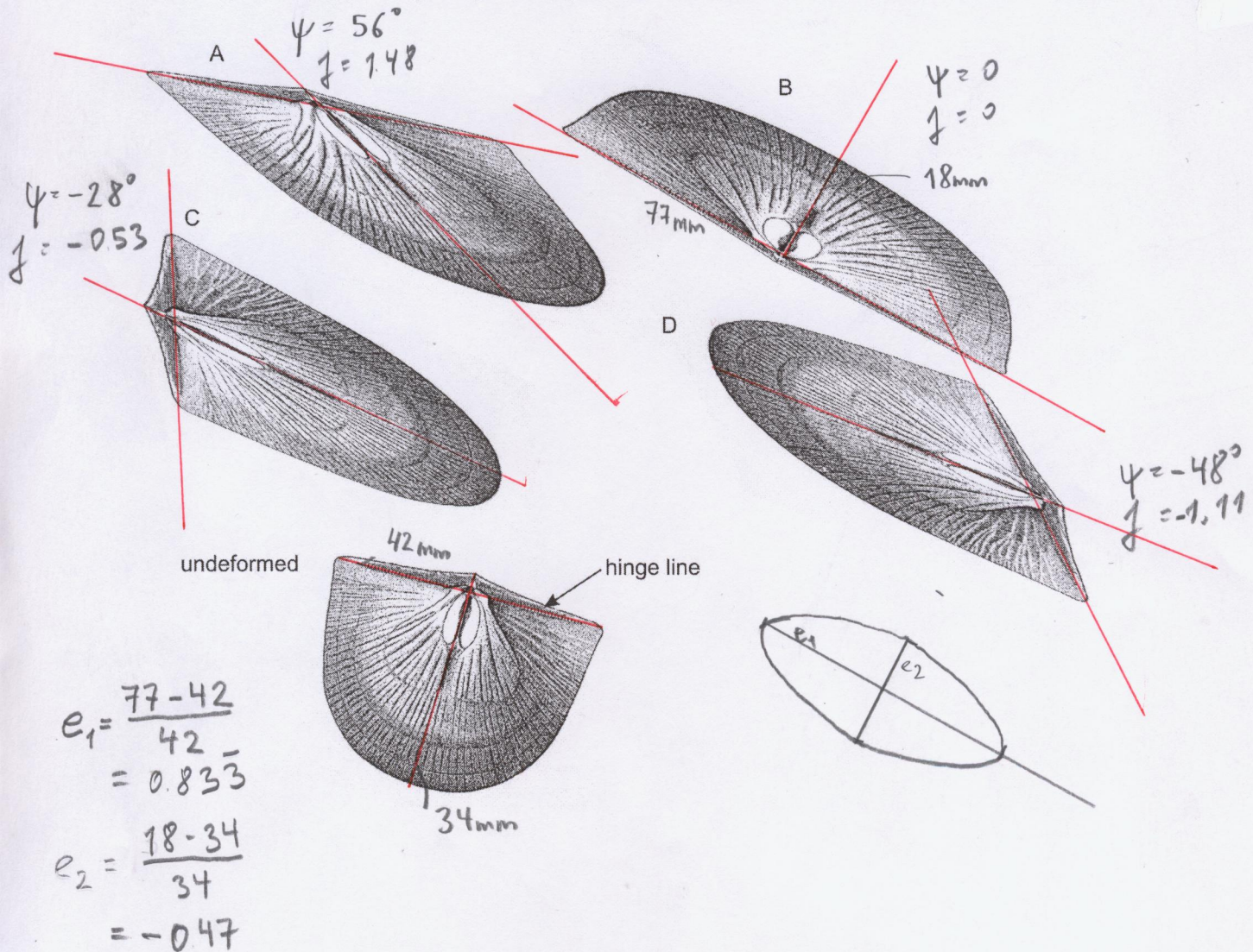transpression, parallel fold, listric fault, shear strain, shear zone, pull-apart basin, cataclasite

3. What is strain rate, how is it described? Western Anatolia is extending in a N-S direction at a rate of 2 cm/year. Assuming that the extension occurs over a width of 400 km, calculate the current strain rate in western Anatolia.

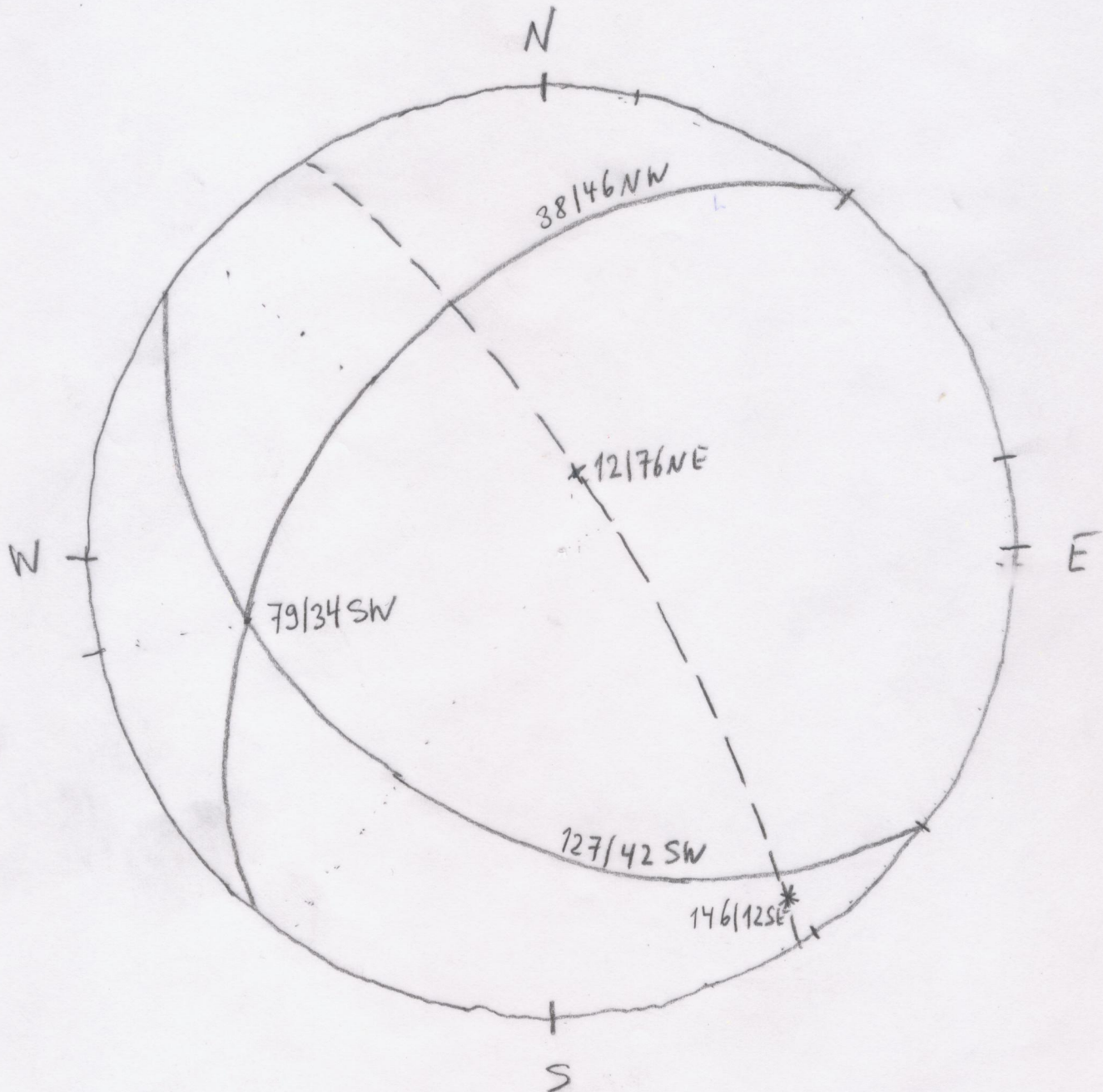4. In the photo below there are photographs of four deformed and one undeformed brachipods.
    a) Assuming that the deformation is by simple shear, find out the angular shear strain and shear strain along the long axis of the deformed brachipods A, B, C and D.
    b) Assuming that the deformed brachipods has the same initial size and shape as the undeformed brachiopod, calculate e_1 and e_2 values.
    c) Draw a strain ellipse representing the finite deformation associated with the deformed brachipod.

$\psi = 56°$
$\gamma = 1.48$

A

$\psi = 0$
$\gamma = 0$

B

18mm

77mm

$\psi = -28°$
$\gamma = -0.53$

C

D

$\psi = -48°$
$\gamma = -1.11$

undeformed

42mm

hinge line

34mm

$e_1 = \dfrac{77-42}{42}$
$= 0.833$

$e_2 = \dfrac{18-34}{34}$
$= -0.47$

e_1
e_2

Answer 1

N

38/46NW

×12/76NE

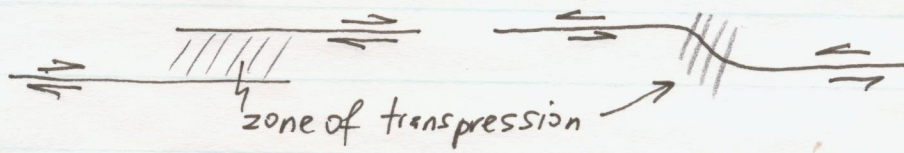W ─┼─ ... ─┼─ E

79/34 SW

127/42 SW
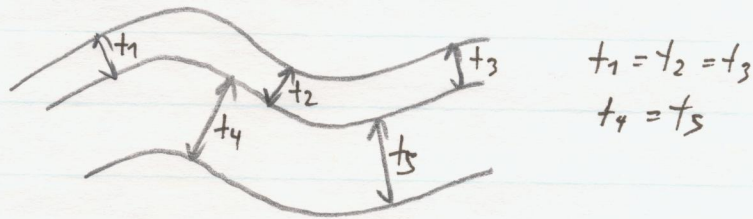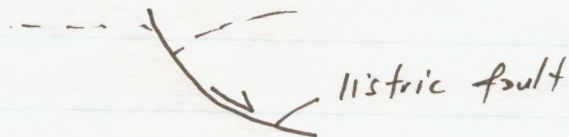
146/12SE

S

1a) 79/34 SW
  b) 148 /80 NE

Answer 2

transpression — is strike-slip plus contraction in strike-slip fault zones. It arises from bends and jumps in the strike-slip faults
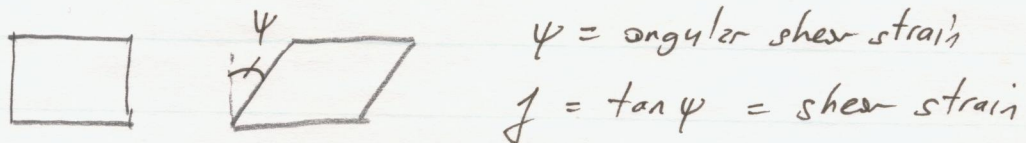
zone of transpression

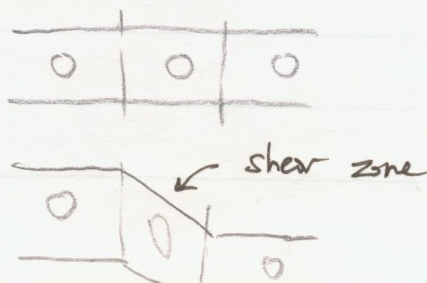parallel fold is a fold where bed thickness as measured perpendicular to the bedding surfaces is constant along the fault.

$t_1 = t_2 = t_3$

$t_4 = t_5$

listric fault is a fault with a concave-upward cross-section.

listric fault

shear strain is the tangent of angular shear strain

ψ = angular shear strain

$\gamma = \tan \psi$ = shear strain

shear zone is a zone with subparallel contacts where shear is concentrated

shear zone

pull-apart basin is an elongate basin produced in strike-slip fault zones. It arises from extensional jumps or bends of the strike-slip fault

pull-apart basin

cataclasite is a type of breccia produced through mechanical grinding of rocks in fault zones

Answer 4

a) The angular shear strain and shear strain in the deformed brachiopds are

$A: \psi = 56$ $\gamma = 1.48$, $B: \psi = 0$, $\gamma = 0$, $C: \psi = -28°$, $\gamma = -0.53$, $D: \psi = -48$, $\gamma = -1.11$

b) From the inspection of the shapes of the brachiopods, it is clear that the max. elongation direction of the finite strain ellipsoid (e_1 direction) is top left to bottom right. Furthermore in the brachiopod B the hinge line and the axial rib have preserved their original perpendicular relation. This can only occur when these lines correspond to the principal axis of the strain ellipsoid, therefore the hinge line in the brachiopod B represents the direction of max. elongation (e_1 direction) and the axial rib the direction of min. elongation:

$$e_1 = \frac{77-42}{42} = 0.8\bar{3} \qquad e_2 = \frac{18-34}{34} = -0.47$$

where 42 mm is the length of the hinge line in A, and 77 mm in B

Answer 3

strain rate $\dot{E} = \dfrac{\text{extension } e}{\text{time (in seconds)}}$

extension $e = \dfrac{l - l_0}{l_0}$

$l_0 = 400 \text{ km} = 400 \times 10^3 \times 10^2 \text{ cm}$

$l - l_0 = 2 \text{ cm}$

$e = \dfrac{2}{400 \times 10^3 \times 10^2} = 0.5 \times 10^{-7}$

$\dot{E} = \dfrac{0.5 \times 10^{-7}}{365 \times 24 \times 60 \times 60}$

$= 1.6 \times 10^{-15} \text{ s}^{-1}$

The strain rate in western Anatolia is $1.6 \times 10^{-15} \text{ s}^{-1}$