Structural Geology Exercises

JEO256E and JEO252E

Aral Okay

Practical 1 – Strain and simple shear – changes in legths and angles during deformation

1. Deform a square ABCD with a side length of 40 mm by simple shear using an angular shear strains of ψ= -20°, -45° and -65°.

   a) Calculate the longitudinal strains (e) along the diagonals AC and BD.

   b) Draw a diagram showing shear strain (γ) on the x-axis against longitudinal strain (e) on the y-axis.

   c) Calculate the incremental longitudinal strain between the deformation stages of ψ= -20°,and ψ= -45° for the diagonal BD.

   d) Measure the angular shear strain along the diagonal AC.

   e) Draw a diagram showing the applied shear strain (γ) on the x-axis against shear strain along AC (γ_{AC}) on the y-axis.

Practical 2 – Strain and simple shear – changes in legths and angles during deformation

1. The average human finger nail grows 3 mm per month; calculate the strain rate of the finger nail.

2. The four wheels of a car have been deformed during an accident.

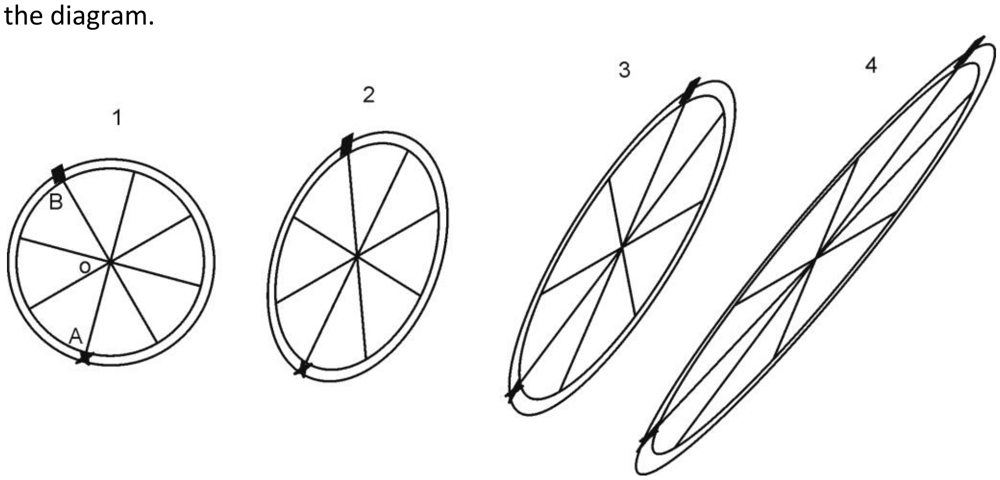
   a) Find out the ellipticity R for each wheel.

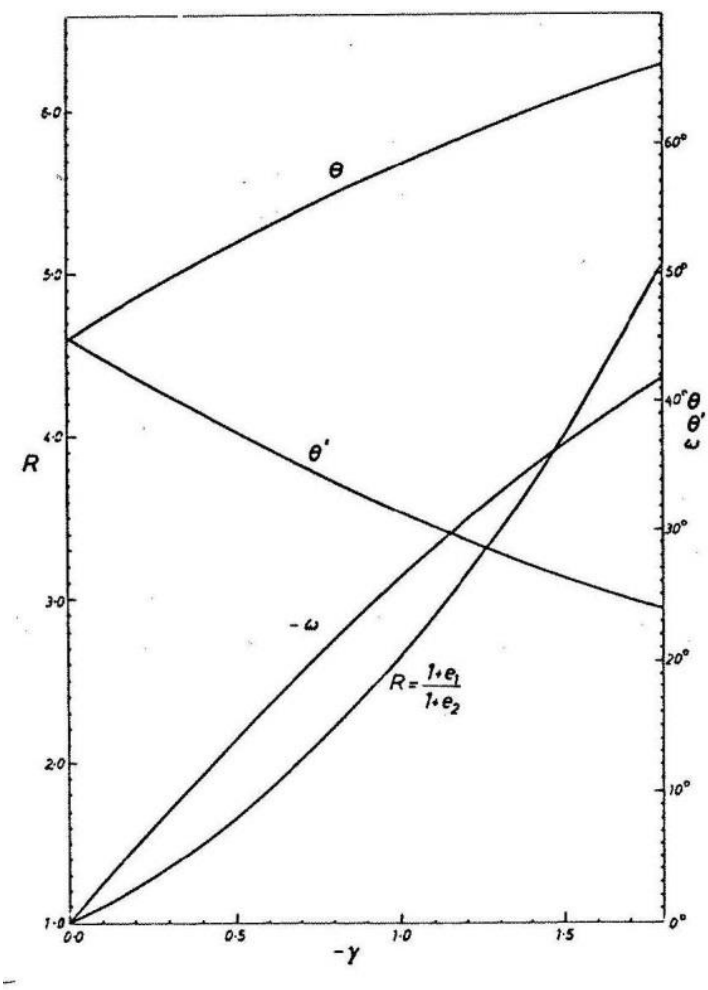
   b) Calculate the longitudinal and angular changes along the rod OA.

   c) Using the R-γ diagram below, find out the shear strain for the wheels 2 and 3.

   d) Make a plot of shear strain versus longitudinal and angular changes along OA.

   e) Using the diagram below find out the shear direction for the wheels 2 and 3 and show them on the diagram.





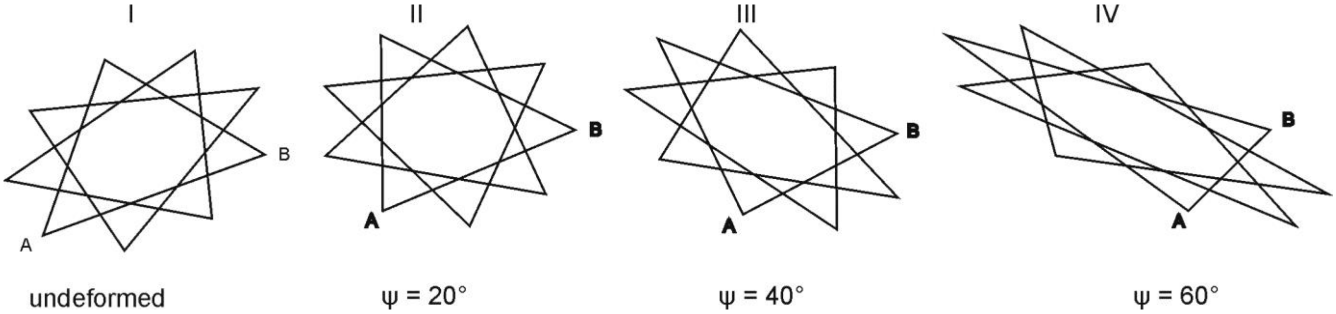
Practical 3 – Strain and simple shear – changes in legths and angles during deformation

In the diagram below there are one undeformed and three stars, deformation is by simple shear. The amount of angular shear strain is shown underneath the deformed stars.

a) Find out the the finite longitudinal extension along AB for each of the deformed stars. What is the incremental longitudinal extension between the stars II and III. Make a plot of shear strain versus finite extension.

b) Find out the angular shear strain along AB for each of the deformed stars. Make a plot of applied shear strain versus shear strain along AB.

c) Assuming that deformation between the stages III and IV takes place in five minutes, calculate the strain rate along AB.



Practical 4 – Calculation of pressure at depth

Calculate the pressure and temperature at a depth of 30 km using the following values and equations:

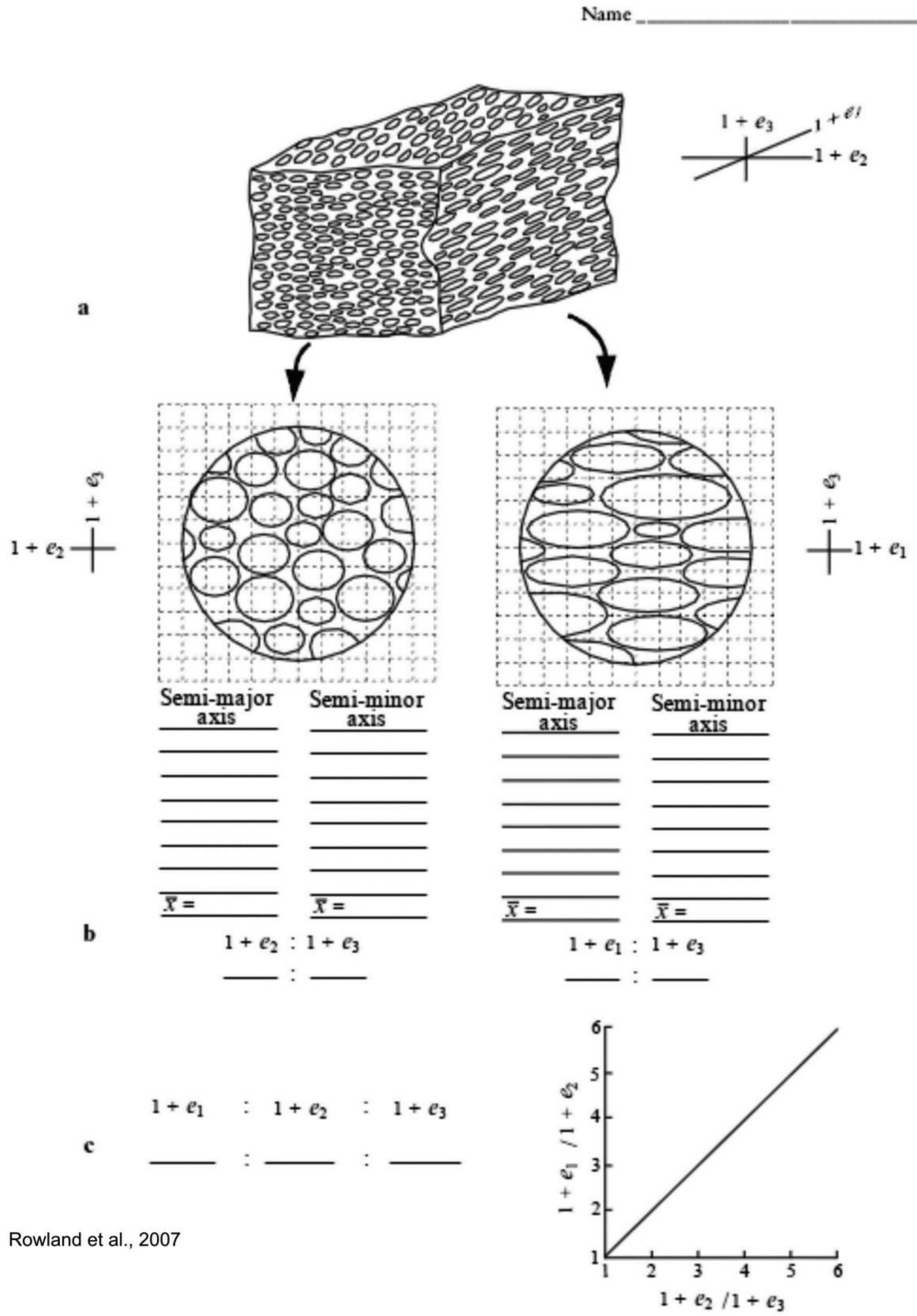
Density of the crust = 2700 kg/m^3
Geotherm = 25° C/km
Gravitation acceleration g = 9,8 m/s^2

Pressure (P) = r*h*g

Where r is the density, h is the height and g is the gravitational acceleration.

Express the pressure both as Pa (pascal = N/m2) and kbar (1kbar = 10^8Pa)
N = kgm/s^2

Practical 5 – Finite strain ellipsoid and the Flinn diagram



Rowland et al., 2007

The Figure above is a sketch of a hand specimen of oolite. The orientations of the principal strain axes have been determined in the field on the basis of lineations, cleavages, and the shapes of the ooids. Two thin sections have been cut perpendicular to two of the principal strain axes, and Fig. G-42b contains sketches of photomicrographs of each of the two thin-sections.

1. Measure the dimensions of several ooids and determine the arithmetic mean ($\bar{x}$) of the semi-major and semi-minor axes in each field of view. Indicate the semi-major to semi-minor axes ratio for each field of view, and combine these ratios to find the $1 + e_1$: $1 + e_2$: $1 + e_3$ ratio for the strain ellipsoid.
2. Plot the strain ellipsoid on the Flinn diagram in the Figure.

The following maximum, indermediate and minimum axis of ooids have been measured in a deformed limestone:

max	interm	min
1.6 mm	0.4 mm	0.3 mm
3.0 mm	0.7 mm	0.5 mm
2.5 mm	0.5 mm	0.4 mm

a) Determine the principal axial ratios and show them on a Flinn diagram.
b) What are the k-values of the deformed oolites?
c) What has been the volume change during deformation ?.

Practical 6 – Stereographic projections

1. Plot the following planes as great circles on the Schmidt net.

130/24 NE, 12/48NW, 176/45NE, 90/25S, 78/86NW, 78/90, 67/2SE, 90/90

2. Plot the following lines on the Schmidt net.

130/24NW, 12/48NE, 165/2SE, 90/87W, düşey çizgi, 78/00

Practical 7 – Stereographic projections

1. Plot the following planes as great circles on the Schmidt net.
12/67NW, 23/45SE, 102/84SW, 78/55NW

2. Plot the following lines on the Schmidt net.
18/67NE, 25/47SW, 110/08NW, 165/34SE

3. Find out the trend and plunge of the line of intersection of the planes 49/15NW and 135/27SW.

4. Pass a plane through the lines 127/65SE and 76/81NE, and find out the strike and dip of this plane

5. The following strike and dips have been measured along the limbs of a fold: 152/70SW, 61/74SW, 164/70SW, 59/80SW. Find out the trend and plunge of the fold axis.

Practical 8 – Plotting the field structural data from the Ganos Mountain

Structure of the Ganos Mountain

Fig. 1 shows a geological map of the western end of the Ganos Mountain, which is located in southern Thrace southwest of Tekirdağ. The mountain exposes Eocene to Oligocene clastic rocks of the Thrace basin. There are four formations, which are from base upwards: Gaziköy (shale and siltstone), Keşan (sandstone, siltstone and shale), Mezardere (shale with minor sandstone) and Osmancık (coarse sandstone). The structure of the mountainous area in the south is characterized by steep to overturned dips, whereas in the north in the plains the beds dip at low angles.

a) Color the map using crayons, giving a color to each formation.

b) Plot the dip and strike of the bedding as π-poles on a stereographic projection. Use a different color for the overturned dips.

c) Contour the bedding using the Kalsbeek net provided. There are 239 dip and strike measurements shown on the map. Draw density contours at 1% intervals.

d) Find the average dip and strike for the normal and overturned beds.

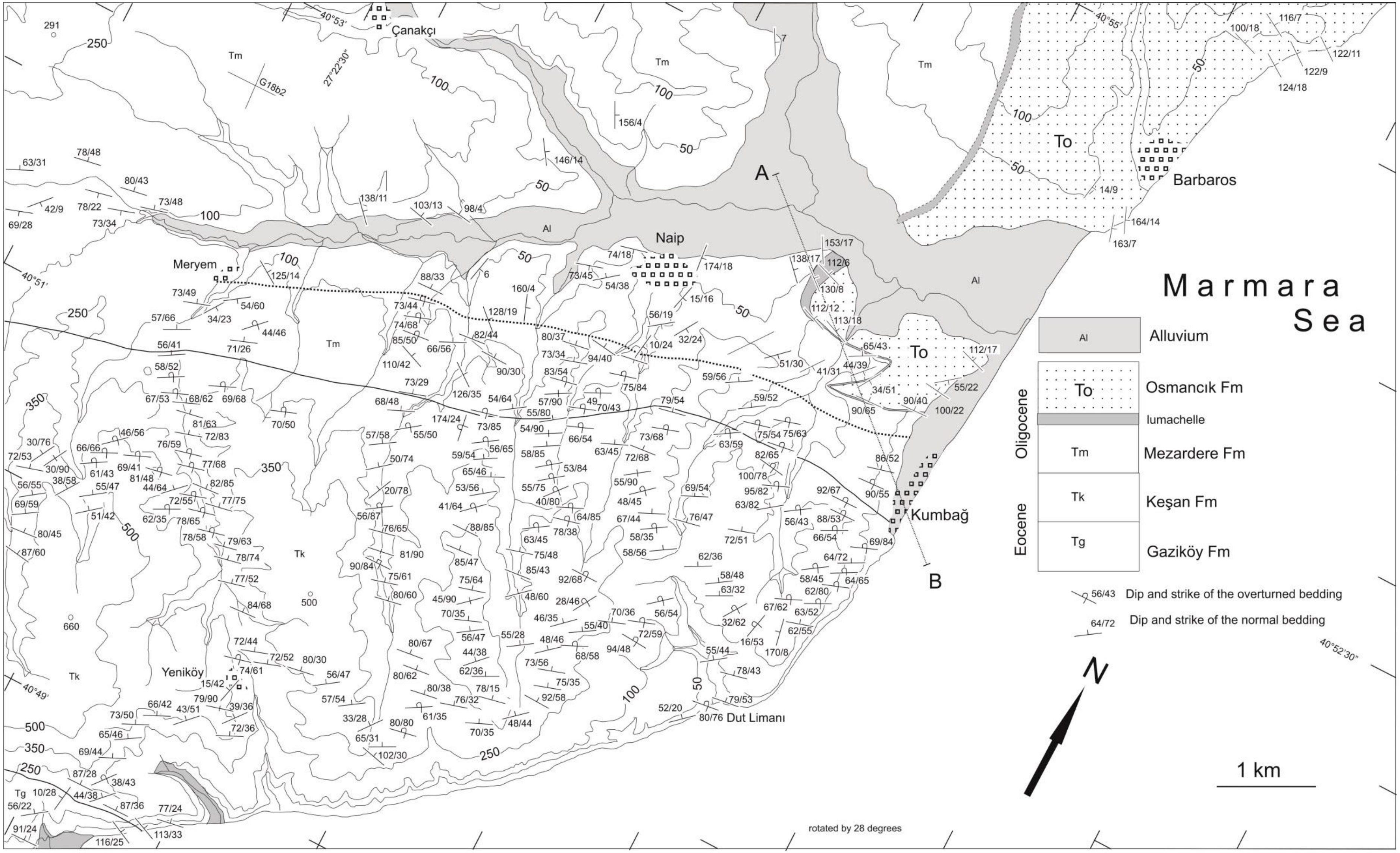
e) Find the trend and plunge of the average fold axis.

f) Why are there many bedding measurements in the south and few in the north?

g) Draw an unexagerated cross-section from north of Kumbağ from A to B.

h) In the field one can observe a fair number of folds. A typical fold is shown below. On the photograph draw the trace of the fold axial plane. How would you describe the attitude and orientation of the fold axis and fold axial plane. How can the folding explain the widespread occurrence of overturned beds?

Note. If interested you can read more on the structure of this interesting area in "Okay, A.I., Tüysüz, O. & Kaya, Ş., 2004, From transpression to transtension: Changes in morphology and structure around a bend on the North Anatolian Fault in the Marmara region. Tectonophysics, 391, 259-282. ", which can be downloaded from the web-site http://web.itu.edu.tr/~okay/AralOkayPapersChronologically.htm.



Çanakçı
Naip
Meryem
Barbaros
Kumbağ
Yeniköy
Dut Limanı
Marmara Sea
A
B
Al
Alluvium
To
Osmancık Fm
lumachelle
Tm
Mezardere Fm
Tk
Keşan Fm
Tg
Gaziköy Fm
Oligocene
Eocene
56/43 Dip and strike of the overturned bedding
64/72 Dip and strike of the normal bedding
N
1 km
rotated by 28 degrees

Fig. 1

Practical 10 – Faulting and stress

1) The orientation of two conjugate faults are: 85/67NW and 110/58SW (or 42/30NW and 20/50 SE)

a) Plot the faults on a stereographic projection as great circles (β-diagram).

b) Show the principal stress directions σ_1, σ_2 and σ_3 on the projection.

c) Find out the trend and plunge of σ_1, σ_2 and σ_3.

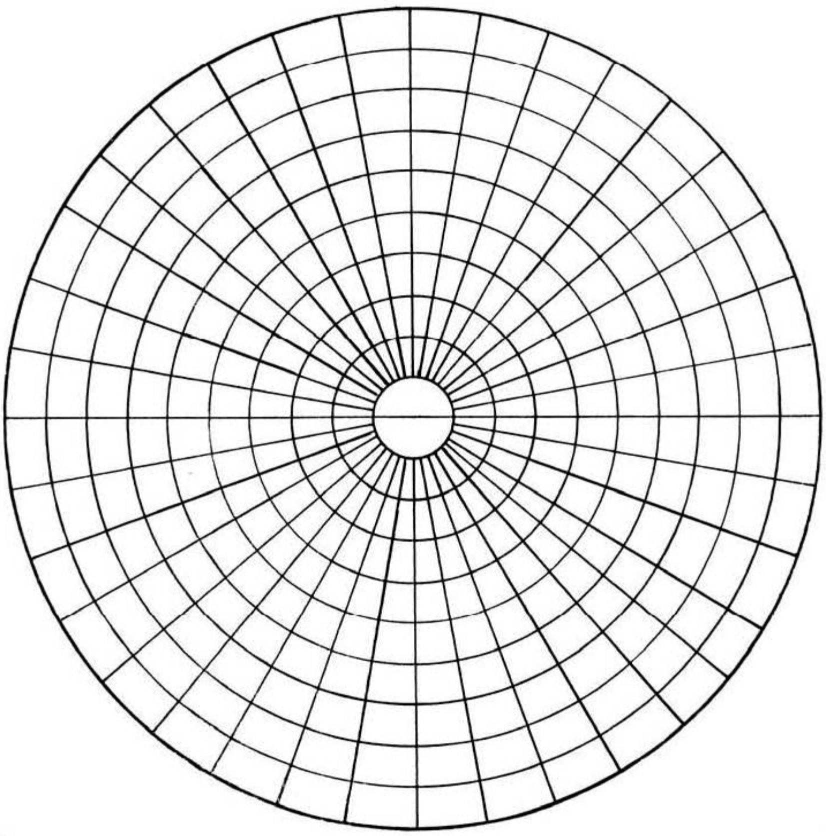
d) Find out the angle between the conjugate faults.

e) What is the type of faulting? Give reasons for your choice.

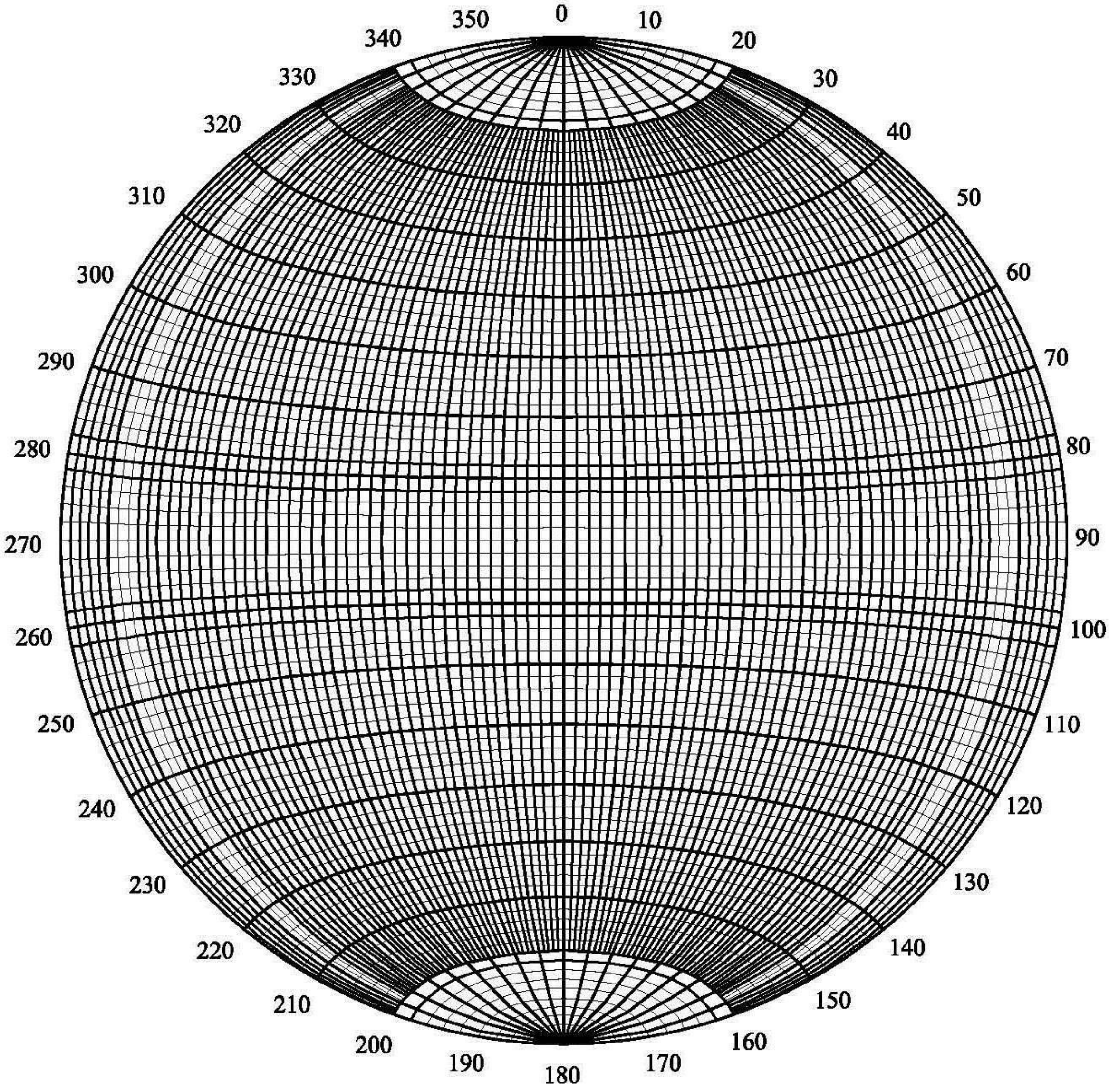
Practical 10 – Joints and rose diagram

The following fracture planes have been measured alon g a trench. Show the strikes of the fracture planes ina rose diagram. How many fracture strike trends can you identfy?

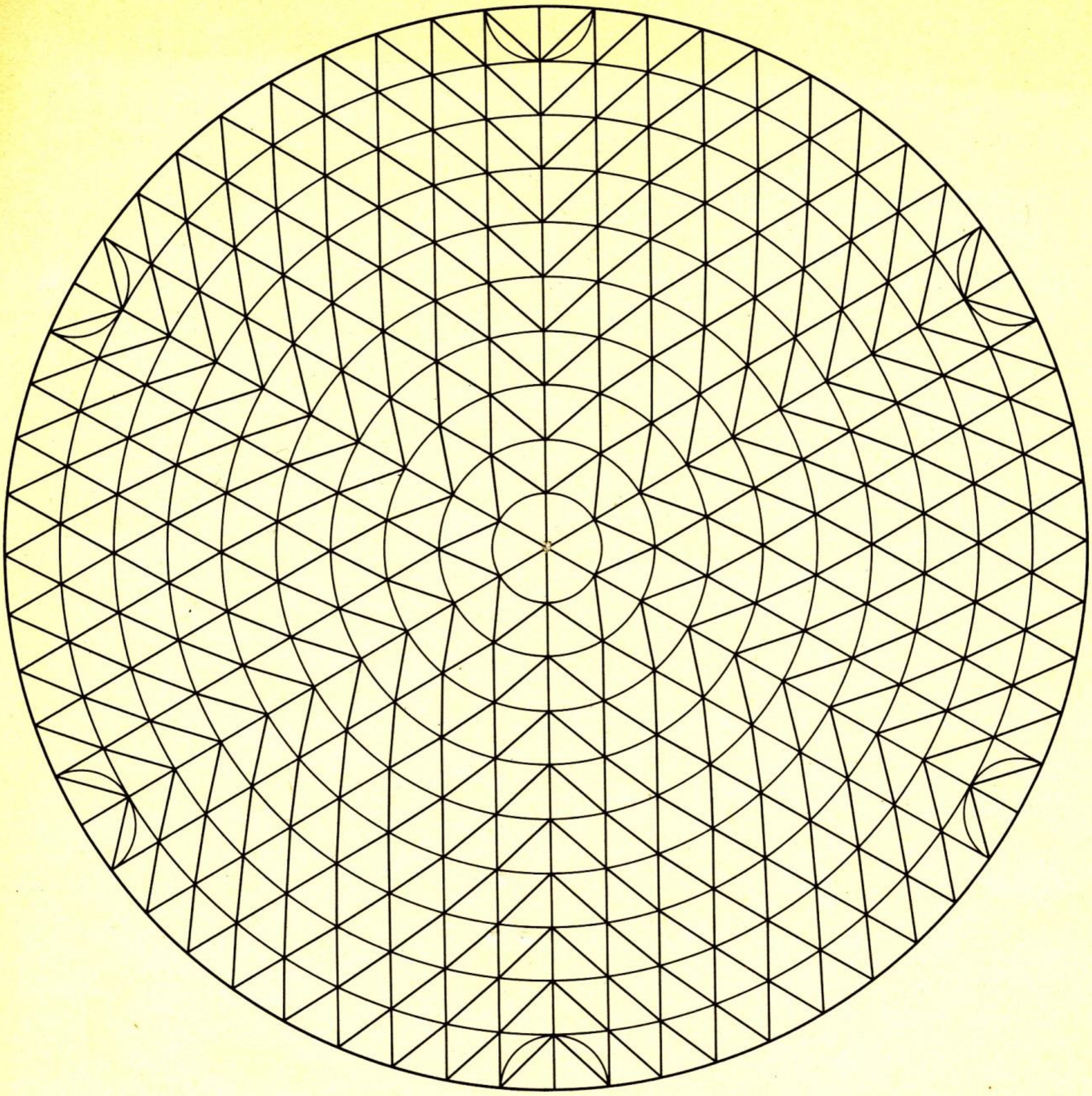
56/08KB, 67/10KB, 78/20GD, 59/10KB, 53/6KB, 61/12GD, 57/06KB, 120/80KD, 122/78KD, 129/67KD, 130/89KD, 132/78GB, 133/77GB, 126/56KD, 127/82KD, 137/67GB, 133/78KD, 69/26KB, 122/77KD, 135/73KD, 141/65KD, 147/66GB, 153/78GB, 157/66KD, 166/10KD, 178/6W, 12/23KB, 15/24KB, 17/12KB, 54/10KB, 125/76KD, 123/56KD, 15/56KB, 56/12KB, 123/68KD, 129/71KD, 135/59GB, 62/67KB, 68/12KB, 142/77GB, 145/69GB, 11/24KB, 77/56GD, 126/78GB, 129/78KD, 132/77GB, 138/79KD, 65/34KB, 66/12KB, 129/89KD, 135/67KD, 141/87KD, 121/78KD, 12/12KB, 33/23KB, 121/79KD, 125/77KD, 129/90, 123/90, 65/11KB, 67/12KB, 61/10GD, 72/12KB, 74/13KB, 12/12KB, 112/78KD, 114/77KD, 118/67GB, 119/78GB, 22/12KB, 23/13KB, 172/12B, 176/14B, 178/12B



Templates



Kutupları be büyük daireleri işaretlemede kullanılan eşit alanlı ekvatoral ağ



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