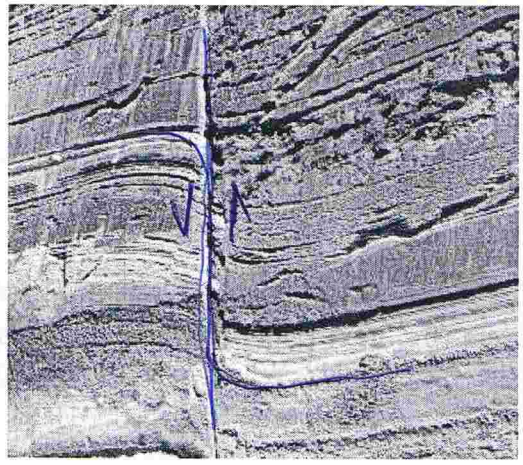
Examination in Structural Geology
(MSc, summer term 2011, 29/06/11, 2 h, 60 pts)

Name, First Name.. .....

Immatriculation number: .....

Problem 1 (3 pts)



What kind of fault is it? Name and describe the structures you observe and argument your answer.

Problem 2 (10 pts)

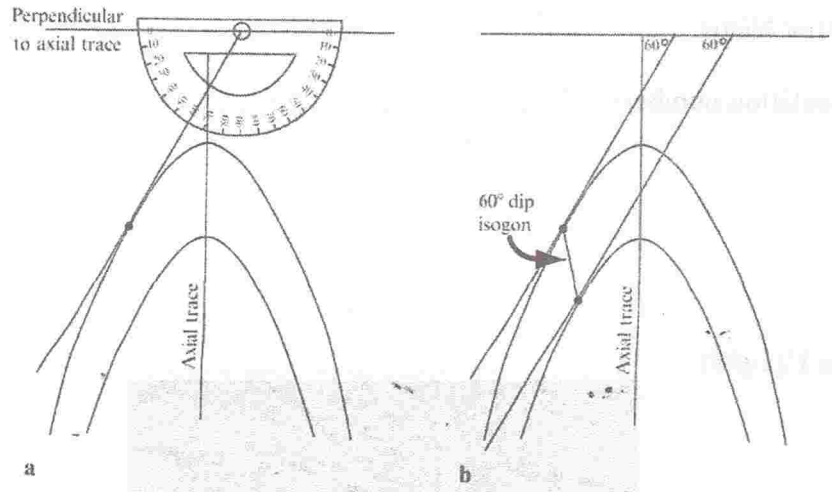
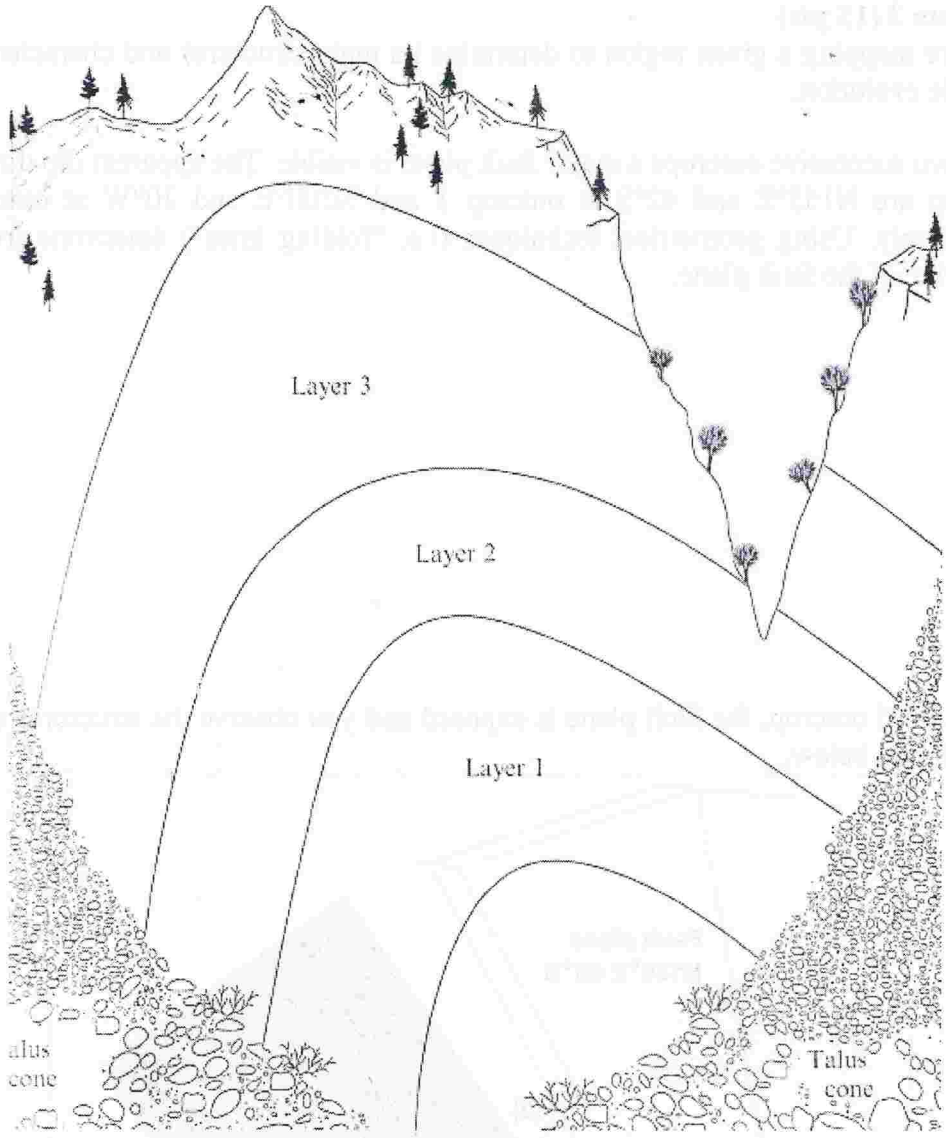


Fig. 6.11 Construction of dip isogons. (a) Drawing tangents at a predetermined angle. (b) A dip isogon connects points where parallel tangent lines intersect points on adjacent folded surfaces.

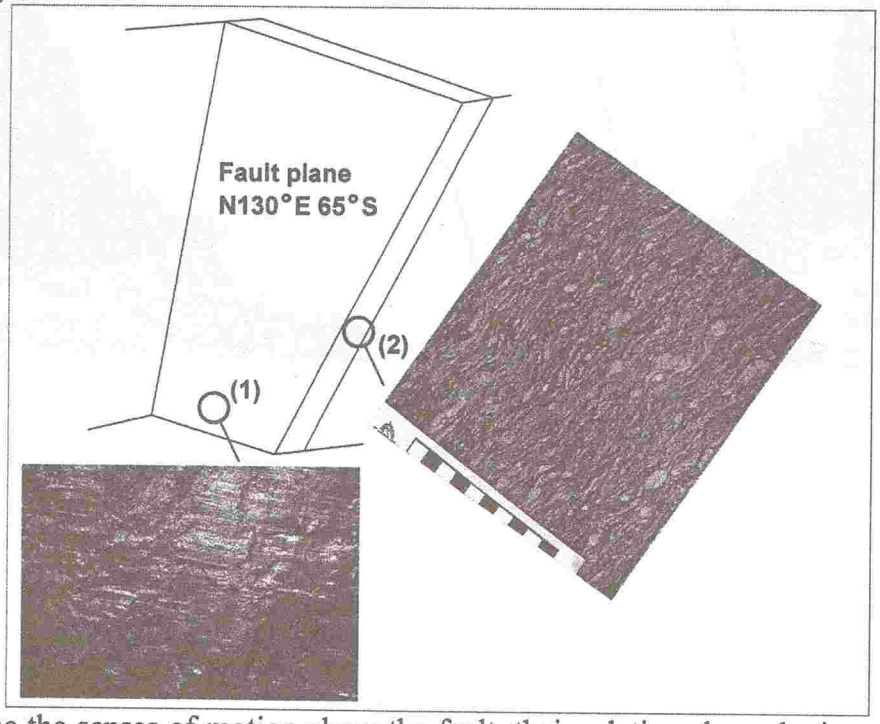
Using the method shown above, construct dip isogons from 10° to 40° at 10° intervals for the three folded layers (fig. **next page**) and give their respective classes. Which one of the layers is the most rigid? Which one of the layers is the less rigid? Argument your answers.


Layer 3
Layer 2
Layer 1
alus
cone
Talus
cone

Problem 3 (15 pts)
You are mapping a given region to determine its main structures and characterise its tectonic evolution.

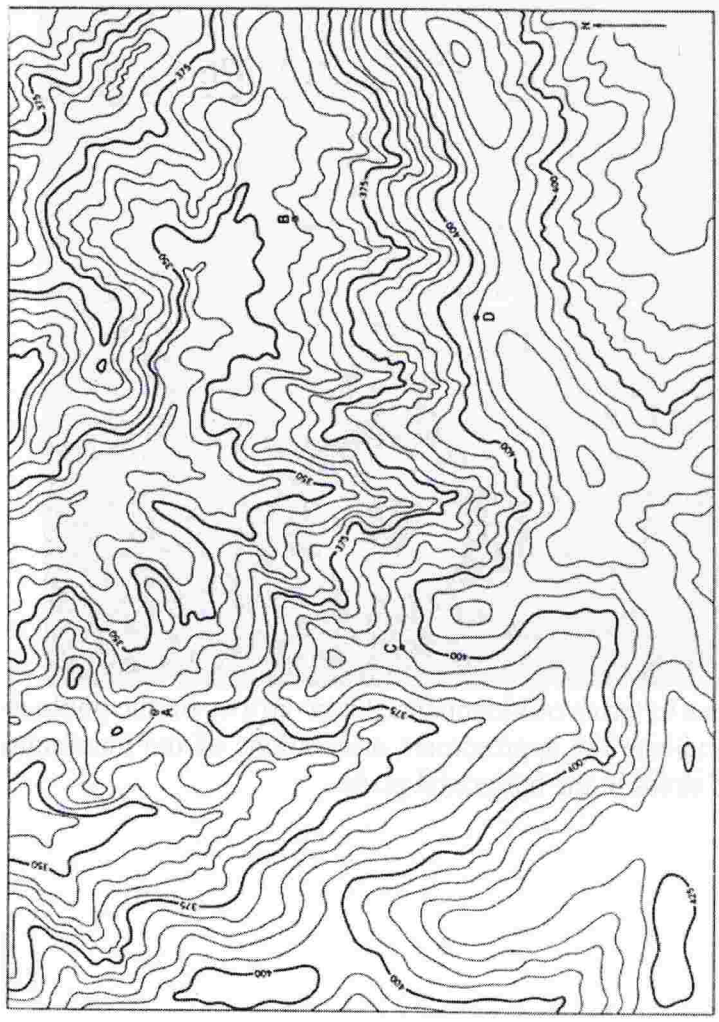
a) In two successive outcrops a major fault plane is visible. The apparent dip direction and dip are N155°E and 42°S at outcrop 1 and N300°E and 20°W at outcrop 2 respectively. Using geometrical techniques (i.e. "folding lines") determine true dip and strike of the fault plane.

b) In a third outcrop, the fault plane is exposed and you observe the structures shown in the figure below.

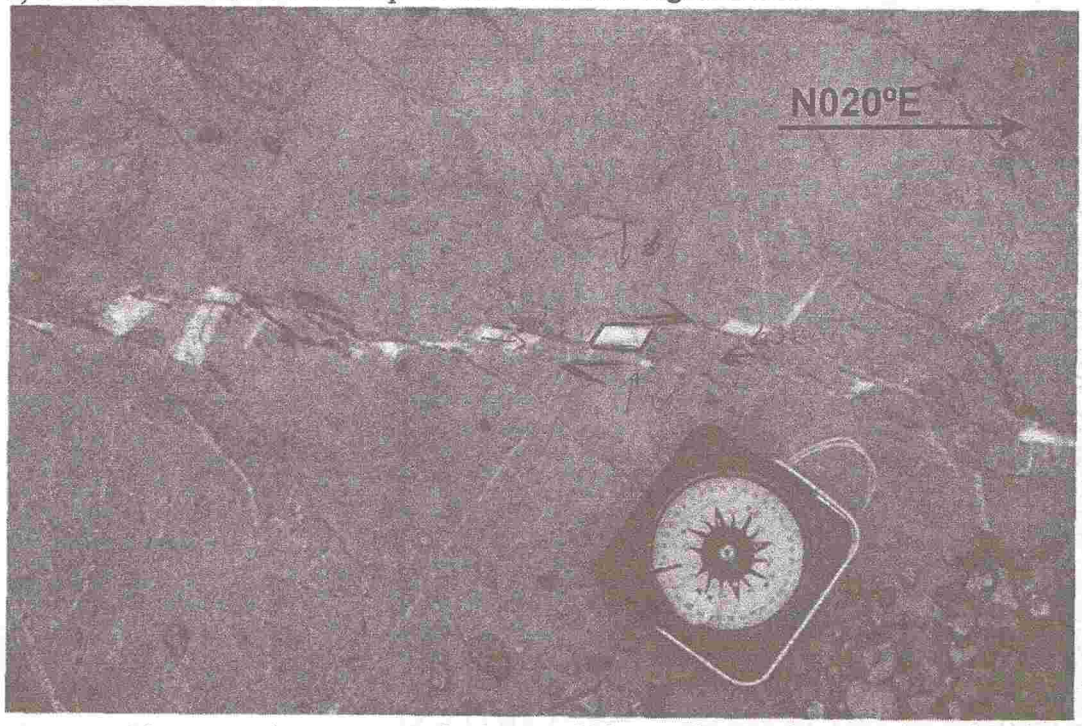


Determine the senses of motion along the fault, their relative chronologies and name the observed structures. Describe the tectonic evolution of the rock mass. What about faulting depths?

c) Using the topographic map below draw the outcrop pattern of the N130°E 65°S fault plane. The plane was observed at point A and scale is 1:5000.

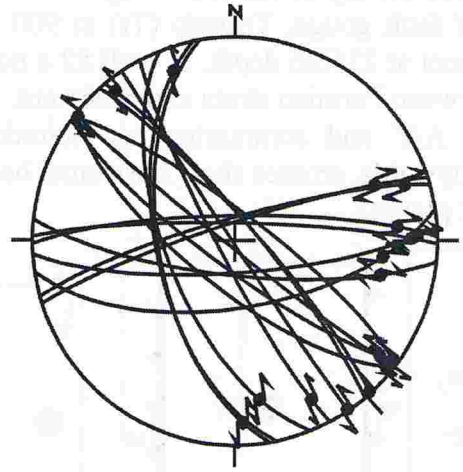


d) The floor of another outcrop reveals the following structures.



Name and interpret the structures in terms of kinematics. Draw arrows on the photo to illustrate your interpretation. Indicate the approximate orientations of the maximum and minimum principal axes of stress in the horizontal plane.

e) Along road cuts, you measure a collection of fault planes and their respective kinematic indicators (slickensides and fault striae). The results are shown on a lower hemisphere stereonet where double-paired arrows represent senses of slip.

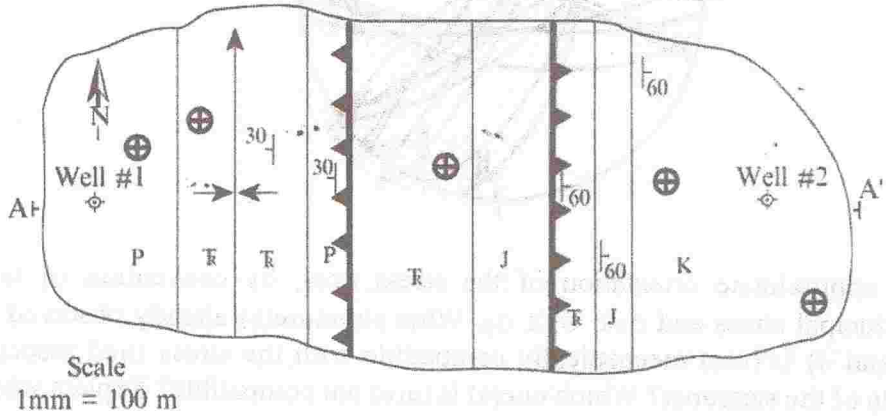


Indicate the approximate orientation of the stress axes, by convention σ_1 is the maximum principal stress and $\sigma_1 \geq \sigma_2 \geq \sigma_3$. What structure(s) already observed (see questions a and d) is (are) mechanically compatible with the stress field associated with the faults of the stereonet? Which one(s) is (are) not compatible? Explain why.

Problem 4 (10 pts)

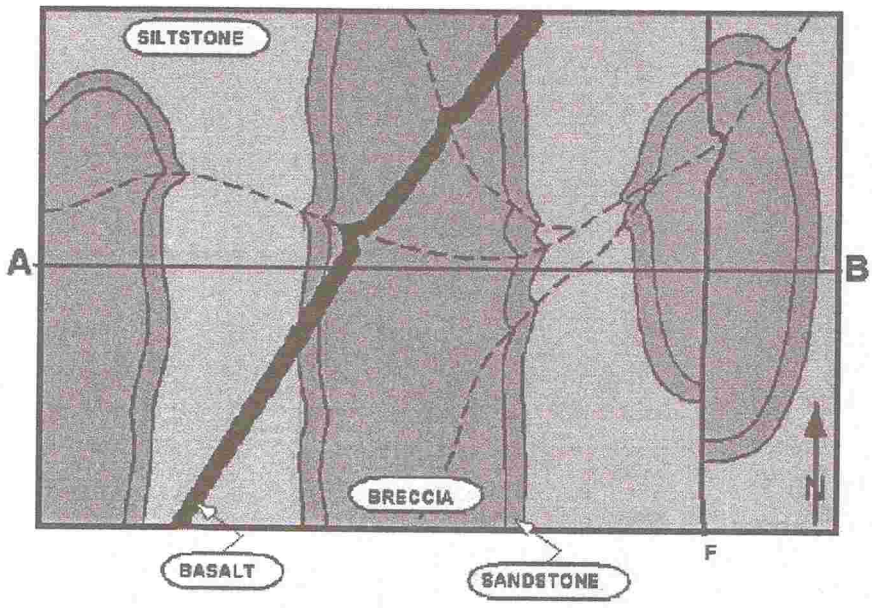
Well #1 encountered basement top at 470 m depth and a thrust decollement at 1500m depth. Well #2 encountered the top of the following units: Jurassic (J) at 350m depth and below an interval of fault gouge, Triassic (Tr) at 900 m depth, Permian (P) at 1680 m depth and basement at 2150m depth. In well #2 a normal fault dipping 45°W represents the contact between Permian strata and basement.

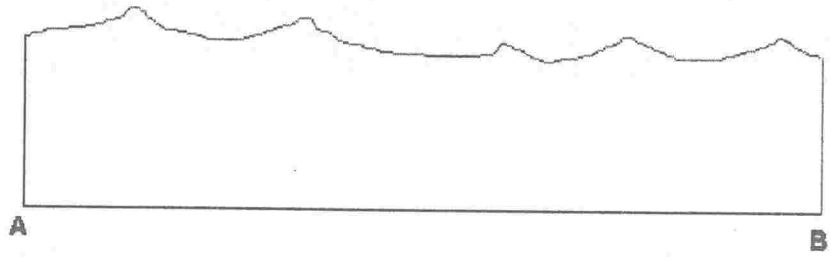
Construct cross section AA' and summarise the tectonic evolution of the area (K=Cretaceous, north is upwards, crosses show horizontal bedding, triangles show dip directions of major thrust planes).



Problem 5 (5 pts)
The area has been folded, faulted and intruded.

- Establish schematically the bedding attitude at various locations and properly indicate these on the map
- Draw the traces of axial planes and plunge directions.
- Establish the attitude of the fault (F) and the displacement on the fault.
- Construct cross-section A-B on the topographic profile below.
- Summarise the geological evolution of the area.

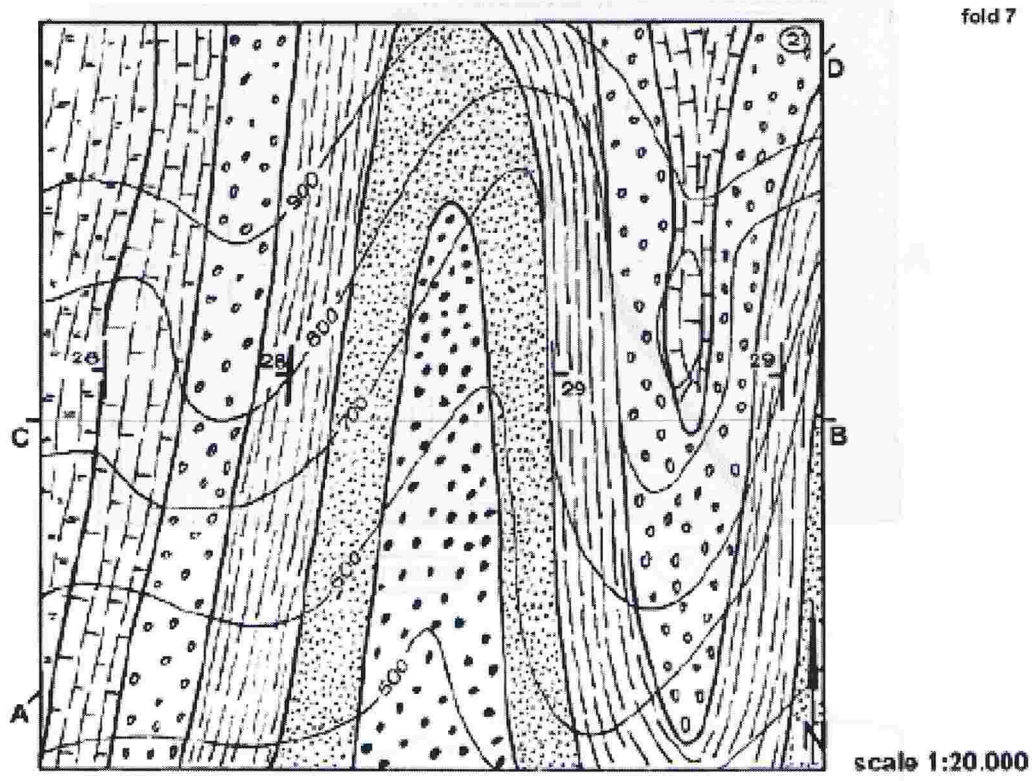


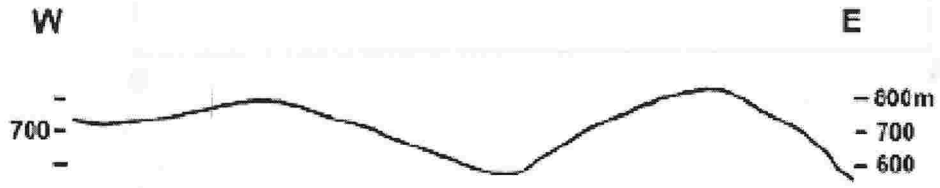


Problem 6 (7 pts)

The map shows plunging folds in a simple succession.

- Determine fold types.
- Indicate on the map the trace of the axial planes and axial plunges.
- Construct the cross section CB on the topographic profile.





Problem 7 (10 pts)

The area has been intruded (dikes are vertical) and faulted.

- Indicate the outcrop patterns of the base and the top of the sandstone layer.
- Estimate dip and dip direction for the sandstone layer (errors up to 10° are expected from the map).
- Determine the type (i.e. dextral or sinistral) and estimate the amount of strike slip along the fault.
- Examine carefully the map and indicate the block that moved upwards with respect to the other block.
- Estimate the amount of vertical displacement.