Structural Geology and Tectonics GEO3-1307

Date: Friday April 18th 2008
Time: 09.00-12.00 hr.
Place: C.010 and C.008

Please read the complete exam before starting. Ask any language related questions. Then, answer all 4 questions (they are worth 2.5 points each). Always explain how you came to your answer. Be creative and good luck!

Question 1: Quantification of strain

Fig. 1 shows exposed conglomerates within a series of volcanic rocks. The pebbles in the conglomerates appear deformed, suggesting that the conglomerates form a shear zone. Shape and orientation of the pebbles have been measured using the R_f-ϕ' method. Pressure solution phenomena suggest a 10% volume decrease during deformation. There is no evidence for any strain in the direction perpendicular to the exposure.

a) The R_f-ϕ' measurements form a data cloud. What does this tell you?

b) Determine both the initial ratio and the strain ratio of the pebbles in all three conglomerates.

c) Quantify the strain of the central conglomerate by giving values for all three principal strains.

d) What is the shear sense of the shear zone? Anything more that can be said about the shear zone on the basis of the strain analysis?

e) An attempt has been made to describe the deformation of the central conglomerate by means of a forward position gradient tensor. The base of the conglomerate bed has been used as the reference line! Analyze the tensor and show whether or not it fits the results of b) to d).

$$F_{ij} = \begin{pmatrix} 1.1 & 0.7 \\ 0 & 0.8 \end{pmatrix}$$

Question 2: Structural styles

Fig. 2 shows an interpreted cross-section through a part of the Cordillera Oriental of the NW Argentinean Andes (after Carrera *et a.l*, 2006). Your task is to analyze the section:

a) Make a clear list of *observations*.

b) Give an *interpretation* of the geological history of the structure, consistent with your observations (part a). Present this interpretation in a framework of 'structural styles'.

c) Assume that you have measurements of fault orientations, lengths and throws. What could you do to test if the interpretations of b) make sense?

Question 3: Deformation processes in the elastic/brittle and ductile fields

a) Define very precisely what is meant with a 'compaction band'. Make a fully (!) labeled diagram that illustrates a realistic brittle failure envelope for a well-cemented sandstone with a porosity of ~25% and make sure that you indicate which part of the envelope is characterized by compaction bands.

b) Explain how you would distinguish between i) dislocation creep and ii) pressure solution creep (under closed system conditions) when studying thin sections of deformed rocks. Use diagrams for illustration.

Fig 3. gives polarized light microphotographs of a quartzite mylonite from the island of Naxos, Greece (from Krabbendam *et al.*, 2003). The white and grey coloured grains are quartz, the black particles are from some second phase (probably graphite). Assume that the stress during deformation was the same for material represented in the photographs.

c) Make a list of observations and give an interpretation. In particular, discuss what the observations tell you with respect to the use of a recrystallized grain size – paleostress ("piezometric") relationship.

Question 4: Anatomy of deformed terrains

a) What is the reason that Earth scientists make analogue scale models (sand box, brittle-ductile models etc.)?

b) Fig. 4 is a map of a part of the San Andreas Fault. Analyse the map and present your interpretation (but don't forget to include the observations that were essential for your interpretation).

c) Design a diagram in which the relative timing of porphyroblast growth and deformation is depicted for the various deformation events controlling the evolution of a metamorphic core complex. Give explanatory text in which the basic characteristics of a core complex are included.

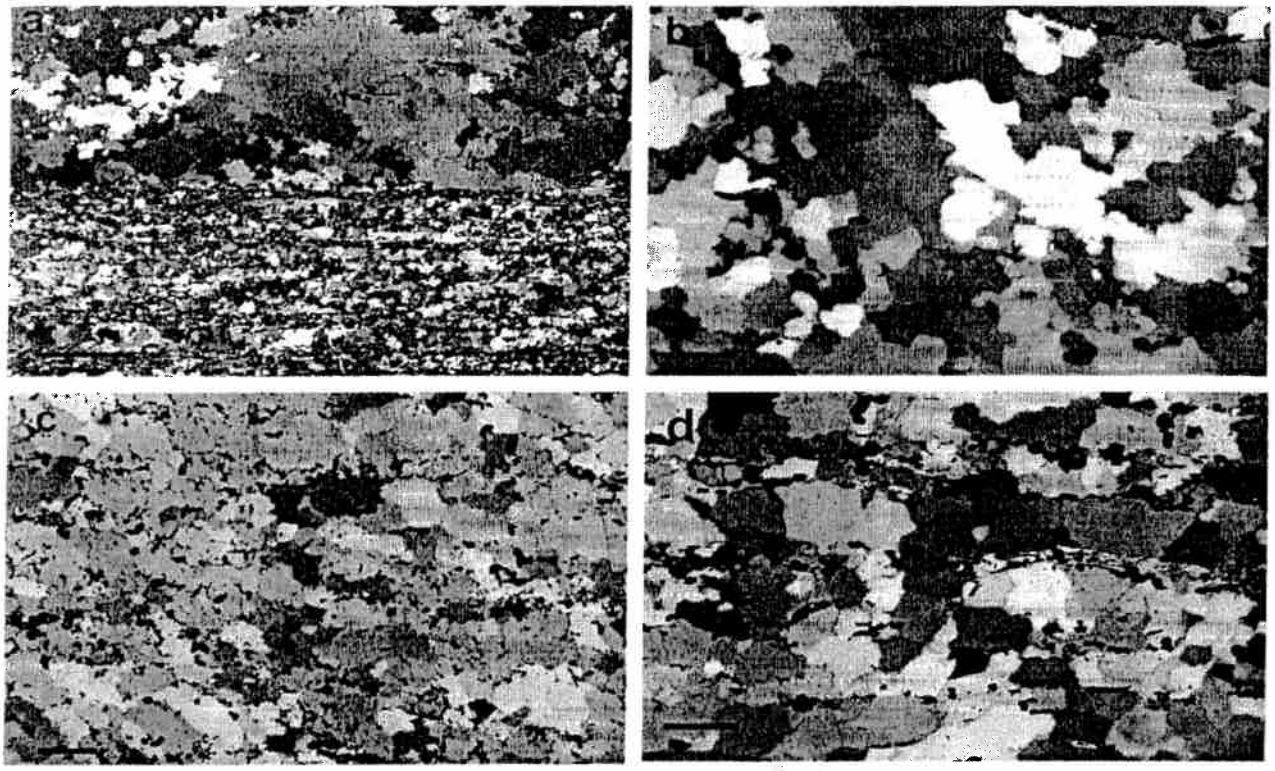

Fig.3 (with question 3)

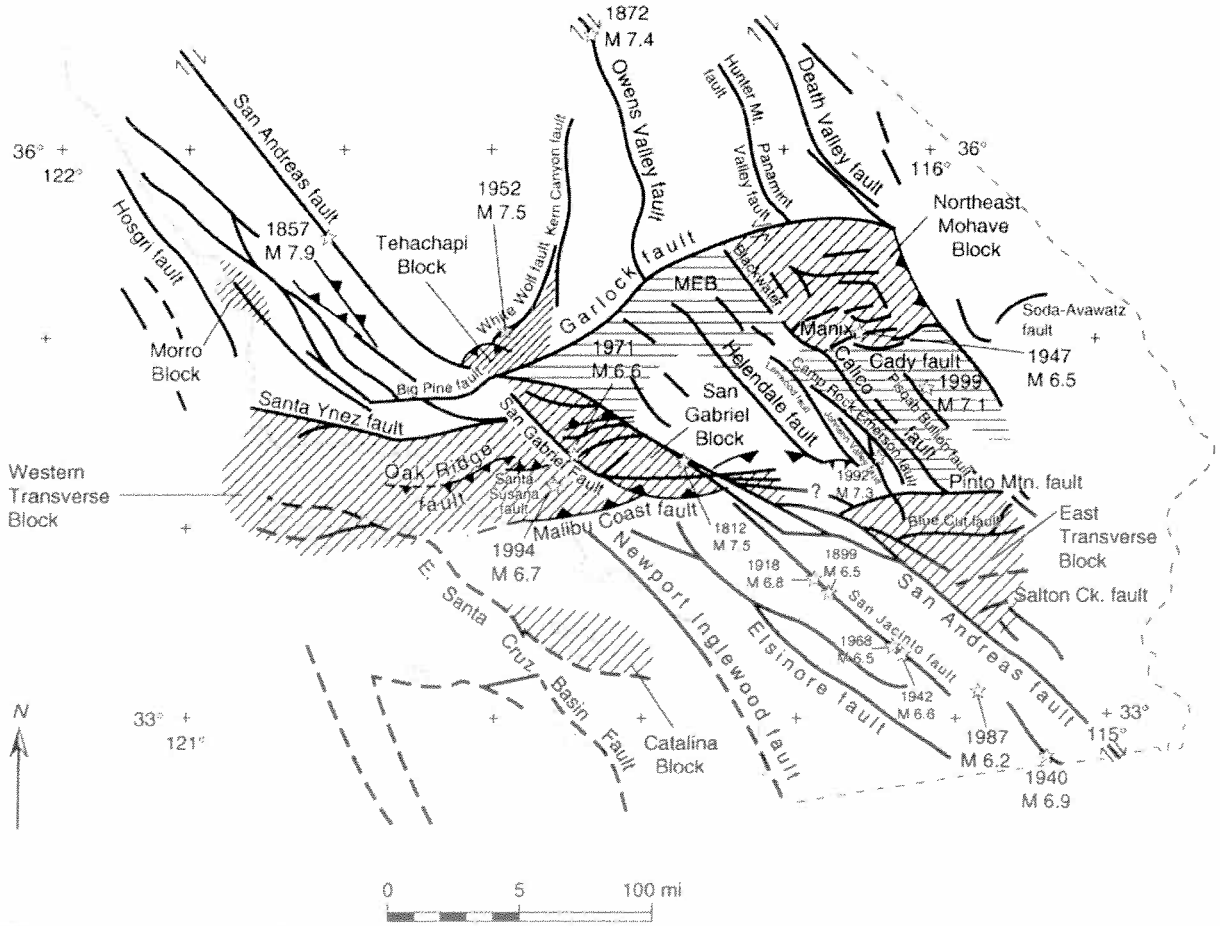

Fig.4 (with question 4)
Thrust faults have triangles in hanging wall block