Notes VII
Faults 1

Fall 2005

1 Reading assignment

Chapter 4 is essential reading. There's a lot of terminology: I suggest you make a glossary for yourself, adding little cartoons helps, too.

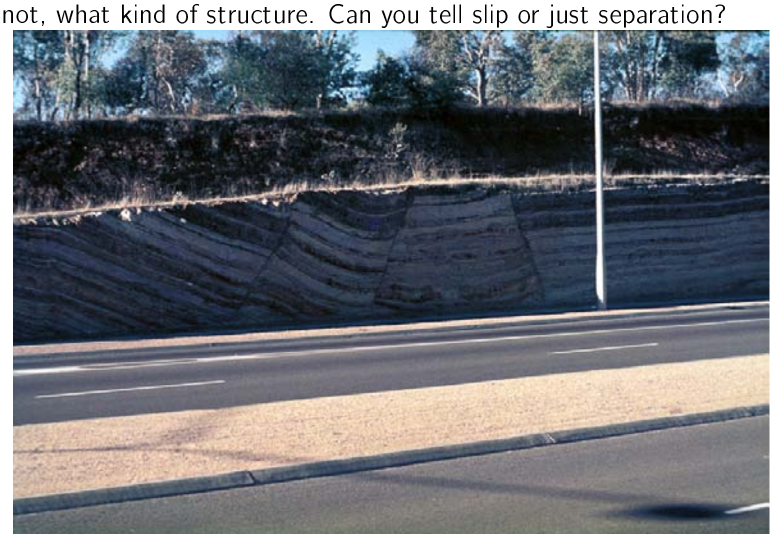
For the discussion of stress distributions, see section 10.9, pages 202 – 205.

2 Terminology

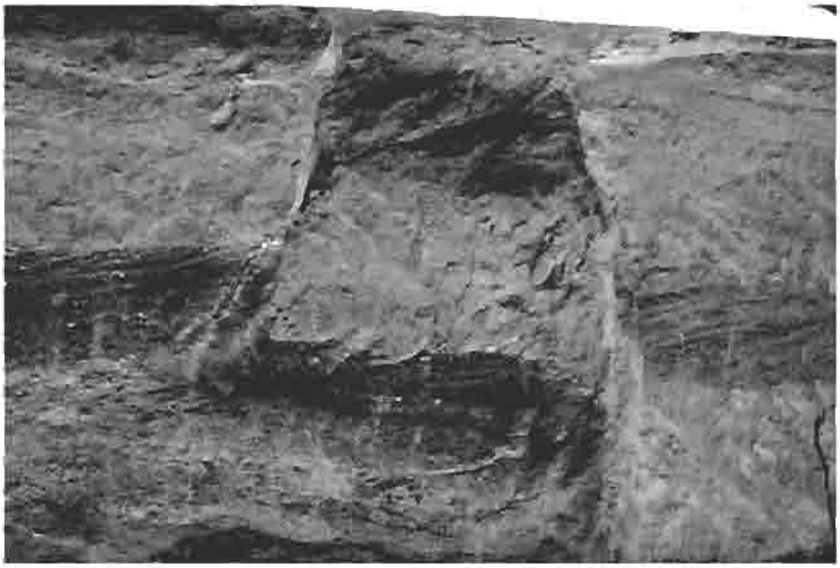
For the following terms, write yourself a definition, or, better, draw a cartoon or find a representative figure.
slip vs. **separation**
slickensides, **slickenlines**
fault scarps, **fault-line scarps**
breccia, **gouge**.
conjugate faults
Drag folds, **shift**.
Dip-slip faults: **reverse (thrust)**, **normal**. Strike-slip faults: **right-lateral**, **left-lateral**.

3 Slides

For each of the slides, take a pen and draw on the fault or faults, and interpret them: what kind of fault, active or not, what kind of structure. Can you tell slip or just separation?

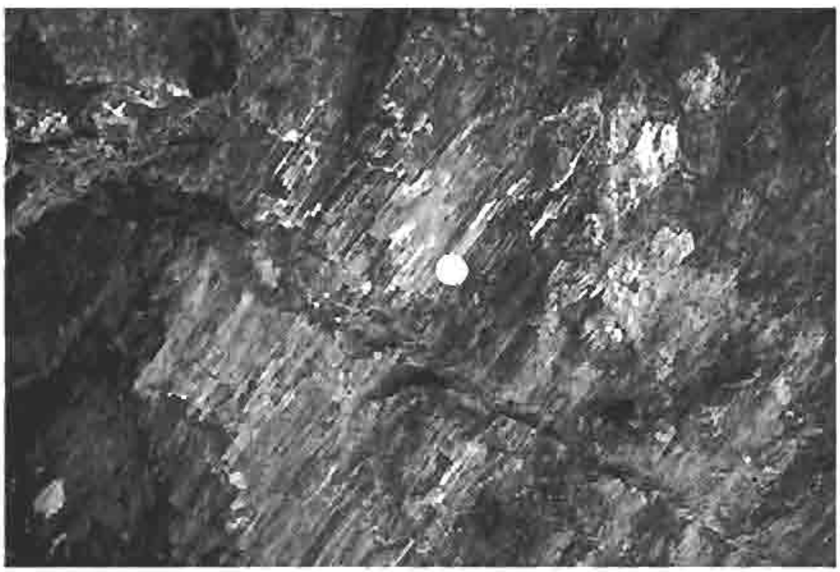


3.1 Neotectonics slides



3.2 Fault rocks

In the above figure, note that the fault surface is not quite planar. The cylindricity of a fault zone is an important indicator of the kinematics of motion.



The above photo is of mylonitic rocks. Fault gouge, fracture and fault breccia are all expressions of brittle failure. Mylonites are produced by ductile deformation mechanisms and are the deep, hot equivalent of brittle faults.

3.3 The Keystone fault

Red rocks are the Jurassic Aztec sandstone. Dark grey rocks are the Cambrian Bonanza King dolostone. What is the nature of the contact? What is the direction of transport?

4 Stress distributions, faulting and tectonic setting

Rock mechanics and Anderson's theory of faulting give us a first order picture of how the types and orientations of faults are related to the orientations of principal stresses. In particular, this was the subject of an exercise in the first lab on stress, and in the lab about faults. The idea follows from the results of rock deformation experiments, where it has been observed that shear fractures occur as conjugate sets such that the greatest principal stress bisects the conjugate shear fractures. Since the Earth's surface must be a principal plane of stress (no shear stresses are transmitted across the Earth's surface), Anderson fault theory predicts that normal faults occur where the greatest principal stress is vertical, thrust faults occur where the least principal stress is vertical and strike-slip faults occur where both greatest and least principal stresses are horizontal. Since the greatest principal stress is usually at an acute angle to the shear fractures, this also predicts that normal faults ought to be steep, and thrusts are shallow. However, there definitely are steep thrust faults (reverse faults) and very low angle normal faults. Part of this results

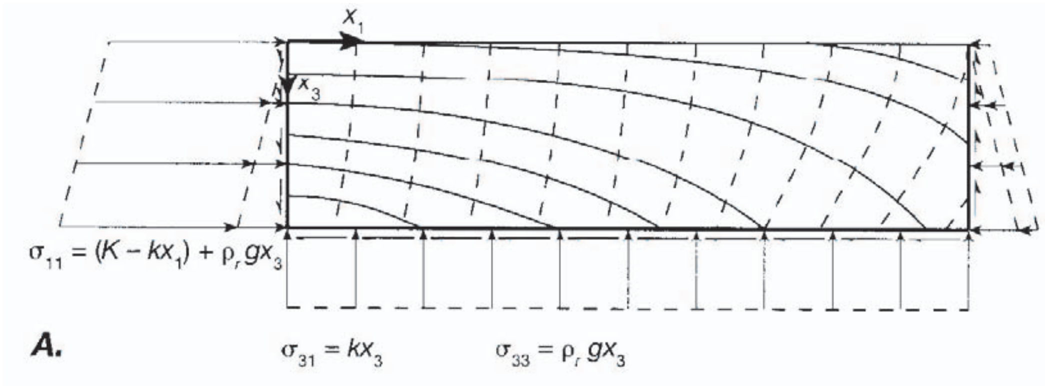


Figure 1: From Twiss and Moore, see textbook for discussion

from the inherent uncertainty and imprecision of the Mohr-Coulomb model of fault formation, but part of it has to do with the fact that stress orientations ought to change with depth.

Consider a "free body" diagram where a compressive tectonic stress is added to the standard state of stress (pressure due to rock thickness increases linearly with depth). If this stress is sufficiently high, you will get faulting, but stress trajectories are straight lines. More importantly, if you consider the addition of shear stresses at the base, much more interesting stress orientations result. Horizontal shear stresses have to be balanced by vertical shear stresses and all shear stresses must vanish at the surface. The result is that the free body diagram shows curved stress trajectories and a much wider variety of predicted fault orientations. As an exercise, take the diagrams of stress trajectories and draw on the expected orientations of faults.