Faults and Faulting

Many diagrams are from Earth Structure, van der Pluijm and Marshak, 2004

2016

Topics
Ch. 8
- Faults on outcrop, maps, and cross sections
- Fault zones and fault rocks
- Types of faults and terminology
- Slip vs. separation
- Faults in wells
- Fault propagation

Terminology

Faults, fault zones, shear zones

Fault zone geometry depends on mechanical stratigraphy

Vertical Fault Discontinuity
Role of Mechanical Stratigraphy

Richard et al., 2013
Fault damage zone definitions

Fault zone, Brooks Range, AK

Fault rocks with depth

Fault Rocks
- Gauge: non-cohesive, fine grain
- Breccia: coarse angular fragments
- Cataclasite: cohesive fragments
- Mylonite: ductile-brittle shear zone
- Fault Melt (pseudotachylite): due to friction
Fault scarp after an earthquake - Nevada

Fault zone breccia in Quartzite Brooks Range, AK

Hydrothermal Fault Breccia

Fault Melt

Mylonites = metamorphic shear zone rocks

Undeformed granite

Shear zone granite

Types of fault

- Dip-slip faults
  - (a) Normal
  - (b) Reverse

- Strike-slip faults
  - (c) Right-lateral (or oblique)
  - (d) Left-lateral (or oblique)
Oblique slip

Small Normal Faults

Low angle fault- Whipple Mts, CA

Small Thrust Fault – Moss Beach, Ca

Plate Boundary-San Andreas Fault

Photo: EL Miller

Photo: EL Miller

Photo: EL Miller
Fault Striations - Slikenlines

Faults Account for Regional Strain

Orientation of Faults to the Stress Field

Types of Fault and the Principal Stresses

Faults are shear fractures in an elastic solid

Fault Propagation
Trishear: Strain in front of the fault tip. Fault Propagation and associated folding

Which came first: the fault or the fold?

The longer a fault, the more displacement it has

Young Mountains-Active Fault – Basin and Range Province

Stress concentration at the tips

Evolution of an Active Mountain Front

Slot Canyon, Faulted Alluvial Fan - Death Valley

Young Mountains-Active Fault – Basin and Range Province

Slot Canyon, Faulted Alluvial Fan - Death Valley
Faults Symbols in Map View
Decorations are on the hanging wall

Normal Faults

Thrust Faults

What kind of fault is shown on this map?

Map View of Faults
Slip vs. Separation

Block Diagram

Separation : 2D
If layers are tilted, the map may be deceiving
What kind of fault is this?

Some faults are almost flat

Interpreted Seismic Data

Map view of normal fault

Faults in Seismic Reflection Data - Hope Basin, AK

How is this possible?

(Shape, 2010)
Thrust Fault in a Well

DEPI 85639 (047-055-00226) Gamma Ray log

Cross-section A - A'

Take Home Points

- Relationship of type of fault to principal stresses
- Types of fault rocks vs. depth
- Fault slip vs. separation
- Recognizing faults in outcrop and in wells
  - Normal faults omit section
  - Thrust faults repeat section
- Faults don’t go on for ever they are elastic dislocations