Geology 3120 -
Introduction to Shear Zones
Outline

• What’s Going On With Shear Zones?
• Brittle Shear Zone
• Ductile Shear Zone
• Semi-Brittle Shear Zone
• Brittle-Ductile Shear Zone
Formation of Shear Zones

“All faults are shear zones but not all shear zones are faults”

- Brittle Deformation
- Ductile Deformation
- Zone of Deformation
- Discontinuous
- Continuous

- Brittle shear zones tend to form in the upper 5 - 10 km
- Ductile shear zones are located in the mid-lower crust and aesthenosphere
## Controlling Factors

<table>
<thead>
<tr>
<th></th>
<th>Brittle</th>
<th>Ductile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>Cooler</td>
<td>Hotter</td>
</tr>
<tr>
<td>Pressure</td>
<td>Lower</td>
<td>Higher</td>
</tr>
<tr>
<td>Strain Rate</td>
<td>Higher</td>
<td>Lower</td>
</tr>
<tr>
<td>Fluid Pressure</td>
<td>Lower</td>
<td>Higher</td>
</tr>
</tbody>
</table>

- Also mineralogy and grain size
Brittle Shear Zones

Parallel Faults
Brittle Shear Zones

A
Parallel Faults

B
Anastomosing Faults
Brittle Shear Zones

A. Parallel Faults

B. Anastomosing Faults

C. En Echelon Faults
Example - Volcanic Tablelands
Example - Volcanic Tablelands
Volcanic Tablelands (horsetail splay)
Ductile Shear Zones

Markers

Xenoliths/Plutons
Ductile Shear Zones

Markers

Xenoliths/Plutons
Ductile Shear Zones

Markers

Xenoliths/Plutons
Example - Sheared Xenoliths
Semibrittle Shear Zones

\( s_1 \) - axis of maximum instantaneous stretching

\( s_3 \) - axis of maximum instantaneous shortening
Semibrittle Shear Zones

\[ \hat{s}_1 \text{ - axis of maximum instantaneous stretching} \]

\[ \hat{s}_3 \text{ - axis of maximum instantaneous shortening} \]
Semibrittle Shear Zones

\[ \dot{s}_1 \] - axis of maximum instantaneous stretching

\[ \dot{s}_3 \] - axis of maximum instantaneous shortening
Semibrittle Shear Zones

\[ \dot{s}_1 \text{ - axis of maximum instantaneous stretching} \]
\[ \dot{s}_3 \text{ - axis of maximum instantaneous shortening} \]
En Echelon Vein Arrays

Where is sigma 1?
Brittle-Ductile Shear Zones

A
Fault
Foliation
Pseudotachylite
Fractures
Veins

B
Fractures
Boudins
Fault
Example - Brittle-Ductile Shear Zone

- Brittle deformation - feldspar crystals
- Ductile deformation - groundmass
References

Slide 1
http://earth.leeds.ac.uk/shearzones/gallery/kohi2.htm

Slides 3, 5 - 8, 12 - 14, 16 - 19, 21

Slide 9

Slide 15
http://earth.leeds.ac.uk/shearzones/gallery/laghetti.htm

Slide 20
http://earth.leeds.ac.uk/minor/tensiongash/index.htm

Slide 22
www.brunel.ac.uk/depts/geo/iainsub/ ShearKin/ShearKin.PPT