TRANSFORMATIONS IN SHALLOW FAULT ZONES
EVIDENCE FROM FAULT ROCKS IN YOUNG STRIKE-SLIP SYSTEMS

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Fault rock transformations in the “brittle” regime

- Deformation (fracturing)
- Chemistry (mineralization)
- State (melting)

Focus on localization, conditions and role

Earth Structure, 2nd ed, 2004
Alpine Fault pseudotachylyte
(at Wanganui Rv)
Texture and Age of Alpine Fault pseudotachylyte

Warr et al., Geology 2007

PST is 0.57 Ma
Protolith is 332 Ma
Alpine Fault pseudotachylyte – Formation depth and conditions

PST age 570 ka
Uplift ~6-9 mm/yr (last 4 m.y.), so
• 3.5-5 km formation depth
• 100-150°C temperature
Clays and frictional properties of faults

Mineral transformations:
• Illite/Illite-smectite
• Chlorite/Chlorite-smectite

Saffer and Marone, EPSL 2003
Detrital (discrete) Illite
Dioctahedral Smectite

Approaches:
• Lowest-variance peak analysis
• Total spectrum analysis ("bowing of background")
• NewMod and Wildfire programs (Reynolds and Reynolds)

47% detrital Illite, 53% I/S; 80% I in I/S
TEM: localization of clay
Fabric quantification
X-ray Texture Goniometry
Phyllosilicate fabric intensities by geologic environment

Results from >300 samples

Haines et al., JGR, in press
“shallow” fault zone at 3066 m

“deep” fault zone at ~3302 m

“deep” zone at ~3300 m
>300 samples; Haines et al., JGR, in press

chlorite mrd 2.26

I-S mrd 2.13

SAFOD (~2.2)

Ho et al., 1999
SAFOD gouge (nano-)coatings

Gouge zone at ~3310 m

Schleicher et al., GRL 2006
Schleicher et al., CMP 2009
Young coatings - Ar ages

SAFOD coatings

3060m fault
Fault: 8.1 Ma +/- 1-2 Ma
Host: 48.7 Ma

~3300m "active" fault
Fault: 5.1 Ma +/- 1-2 Ma
Host: 72.2 Ma

Schleicher et al., this meeting (Monday)
Processes and localization in shallow fault rocks

Frictional strength

Earthquake (fracturing +/- melting)

Coating Production

Creep + Reactivation
Conclusions

- Mineralization and melting v. cataclasis in shallow fault zones
- Clay gouge transformations at low-T (< 4km)
  - Illite
  - Chlorite
  - Smectite (interlayers)
- Mechanical role
  - Coating: creep
  - Friction melting: earthquake
- Potential for radiometric dating
- Location is everything (talc vs. clay)