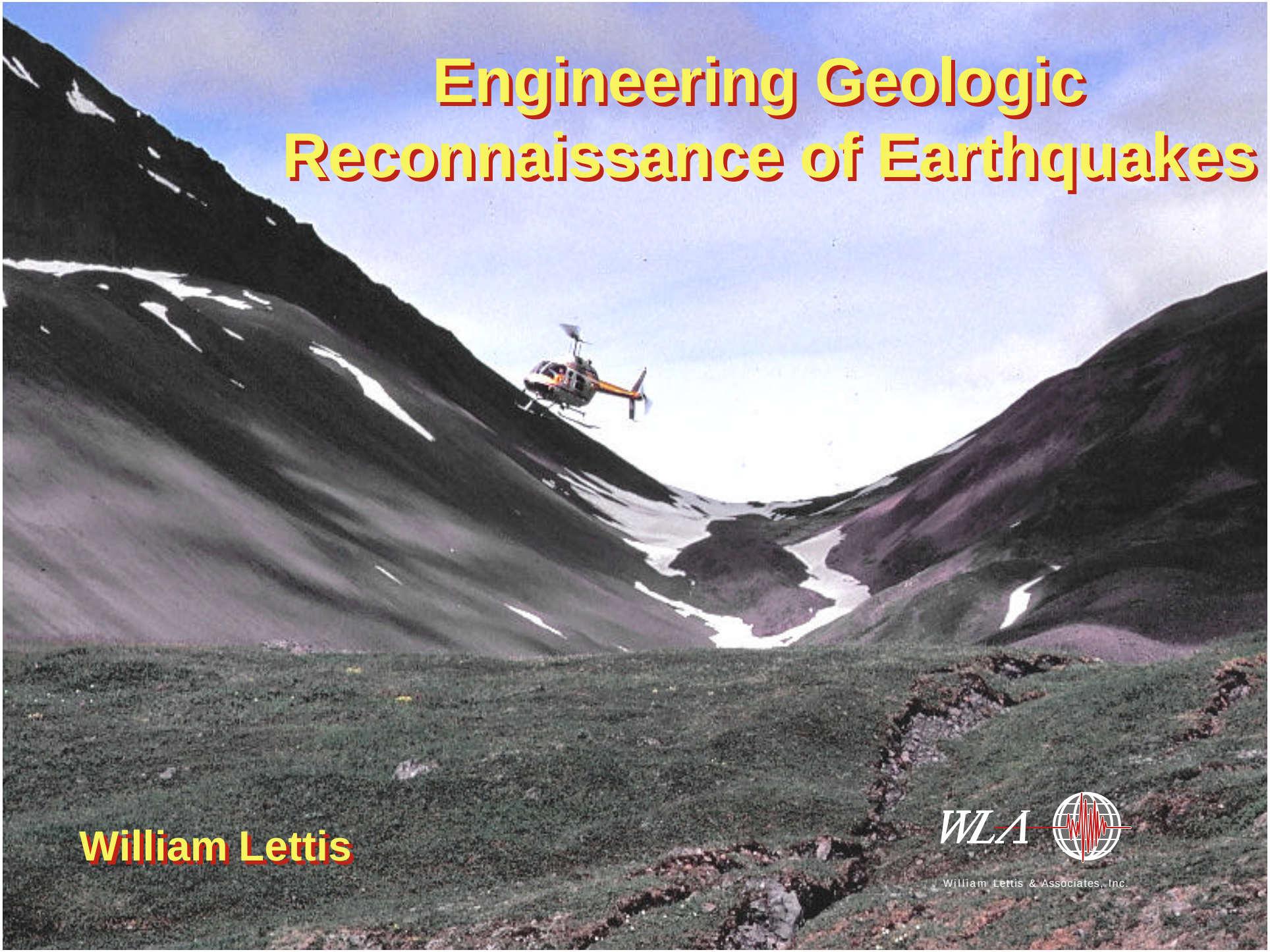
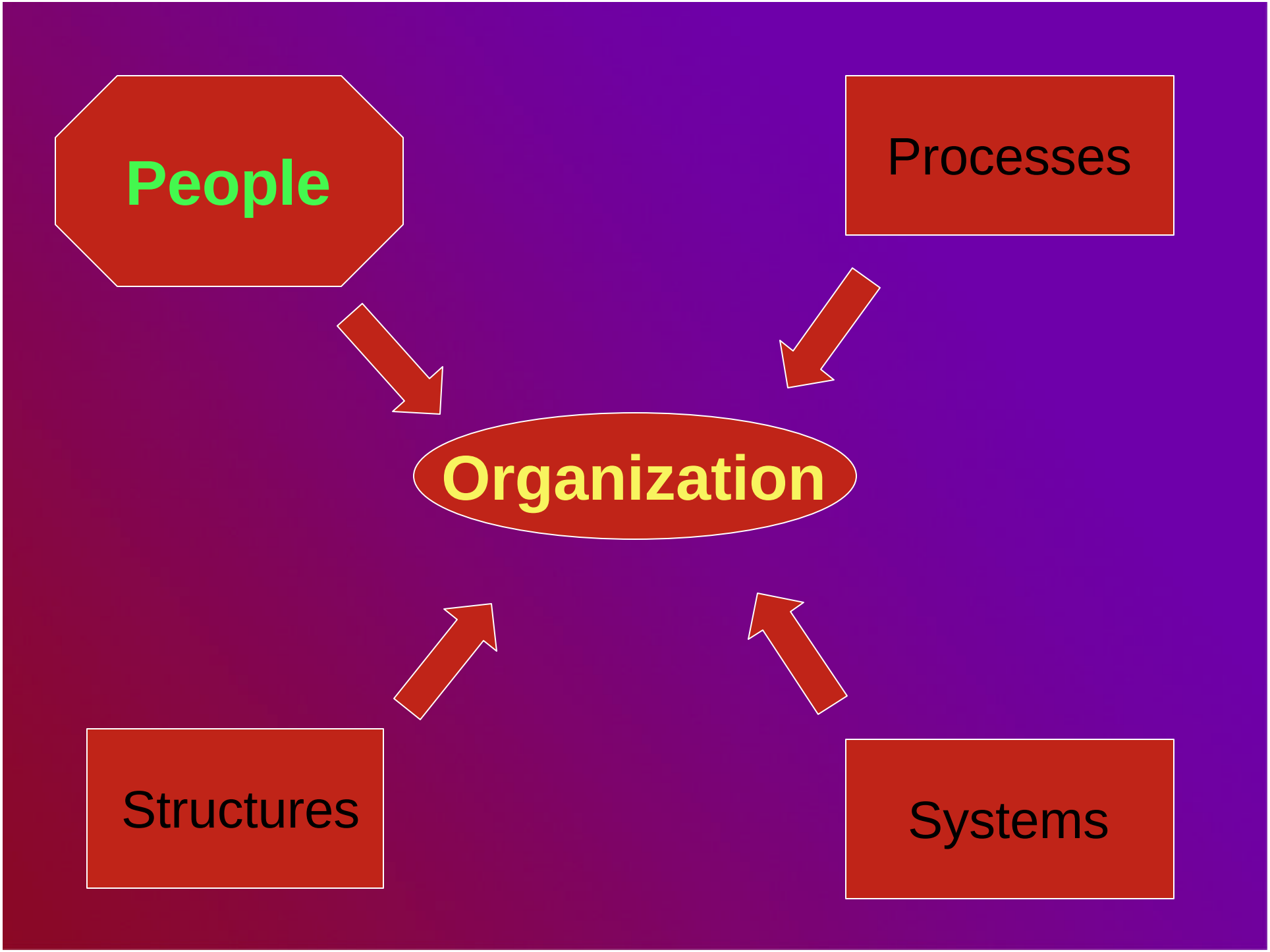
Engineering Geologic Reconnaissance of Earthquakes



William Lettis

WLA

William Lettis & Associates, Inc.


People
Processes
Organization
Structures
Systems

People

- Skill
  - Knowledge
  - Technology
  - Experience
- Personality
- Political/National Sensitivities
- License/Registration/Affiliation

- Knowledge
  - Quaternary Geology & Geomorphology
  - Earthquake processes
  - Tectonics
- Technology
  - Location
  - Documentation
  - Communication
- Experience
  - Earthquake processes
  - Earthquake hazards
  - Built environment

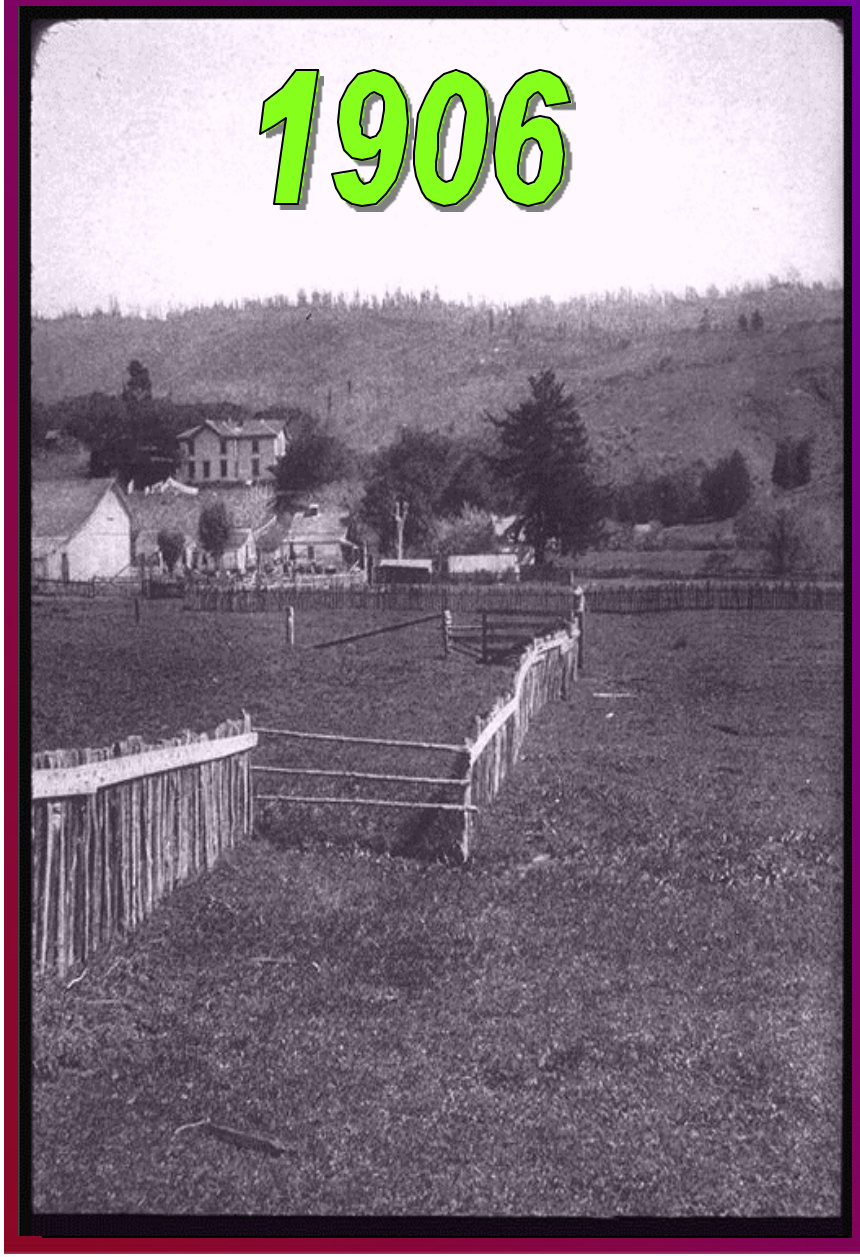
SKILL

Information Required

- Earthquake Process/Cycle
- Permanent Ground Deformation
  - Effects on Built Environment

San Francisco

1906



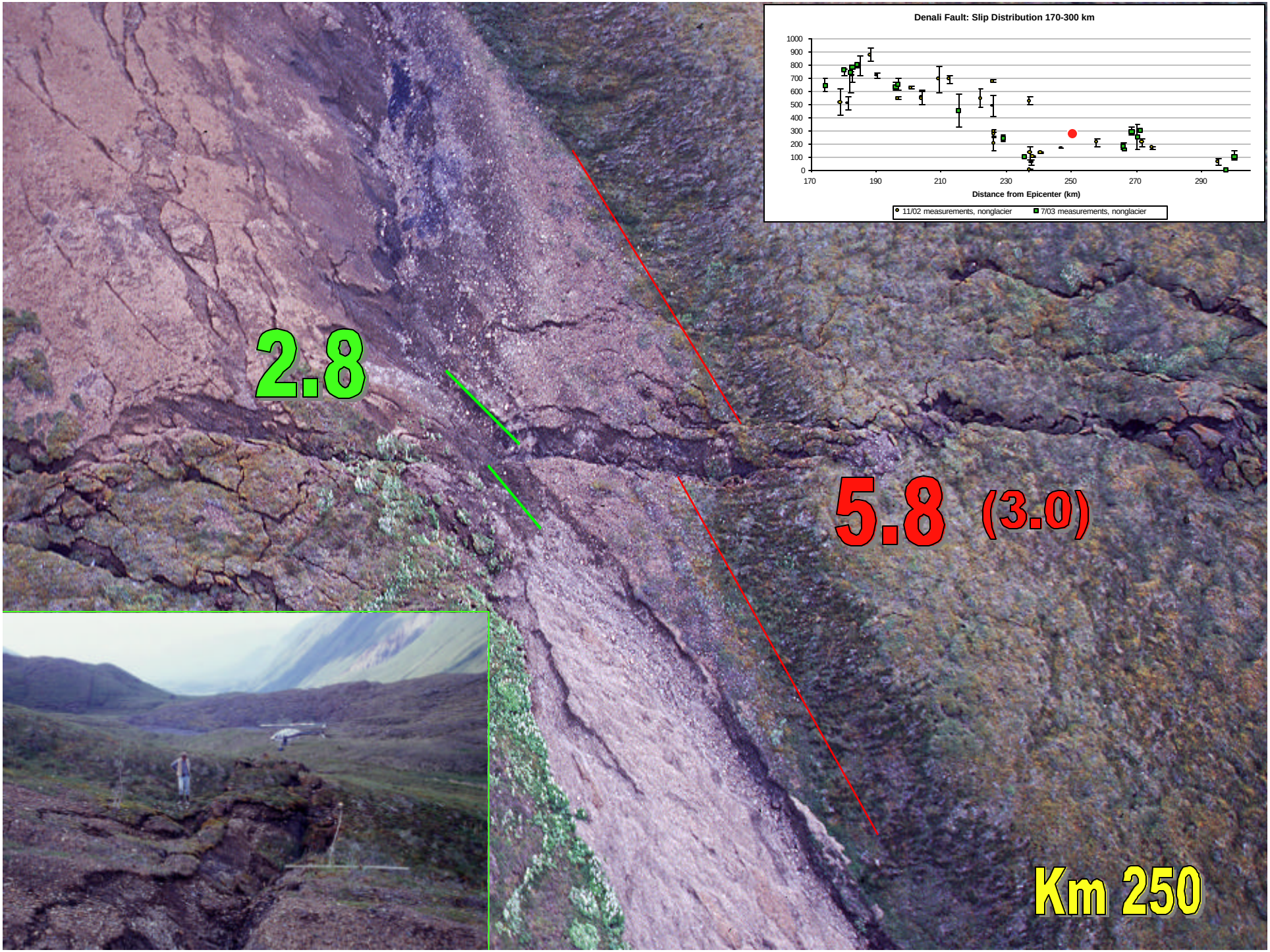
Earthquake Process/Cycle

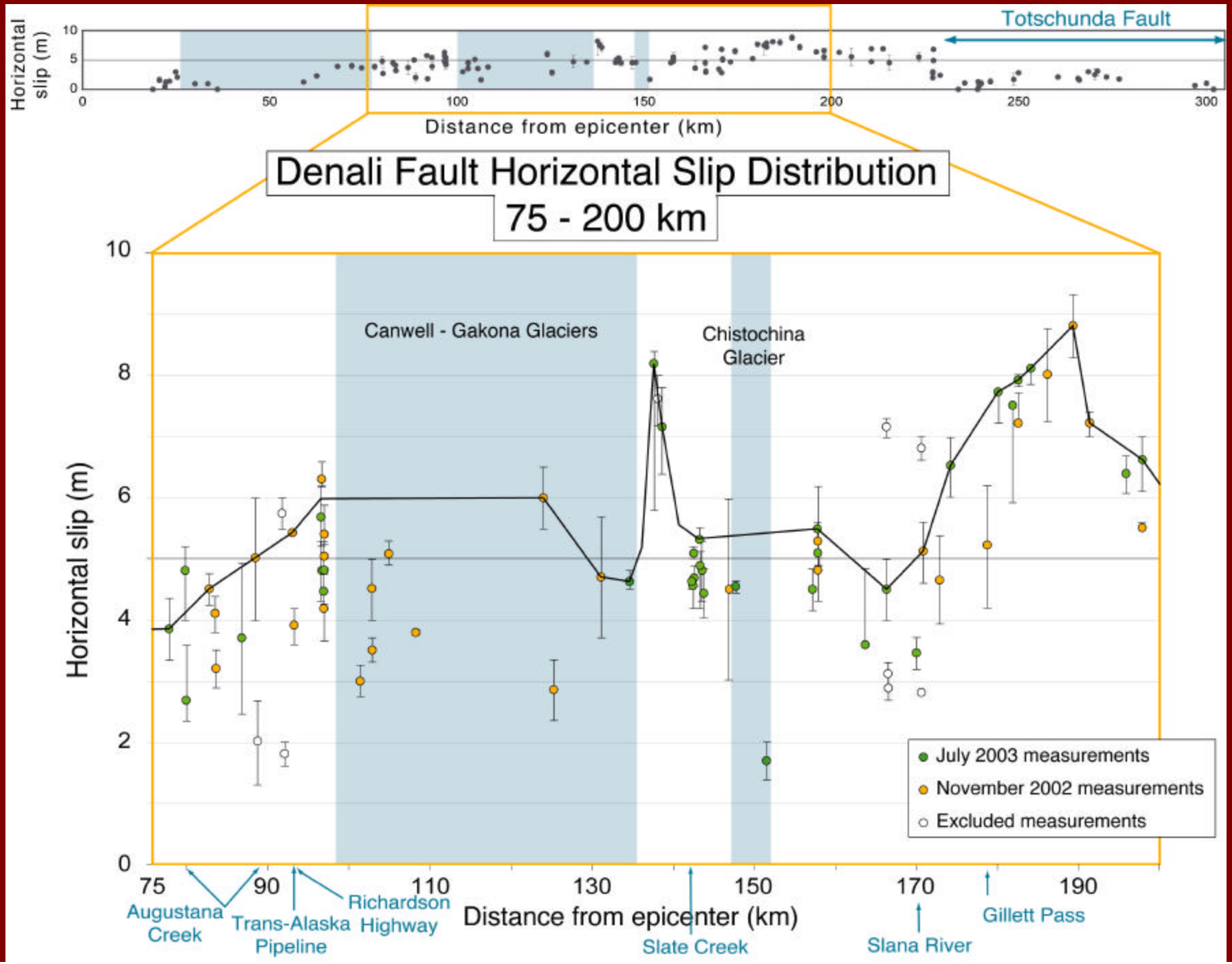
- Dimensions of fault rupture (also blind rupture)
- Distribution of slip (AND WHY)
- Fault interactions
- Geometry and Behavior
- Coseismic slip/After slip
- Rupture terminations
- Comparison to past ruptures

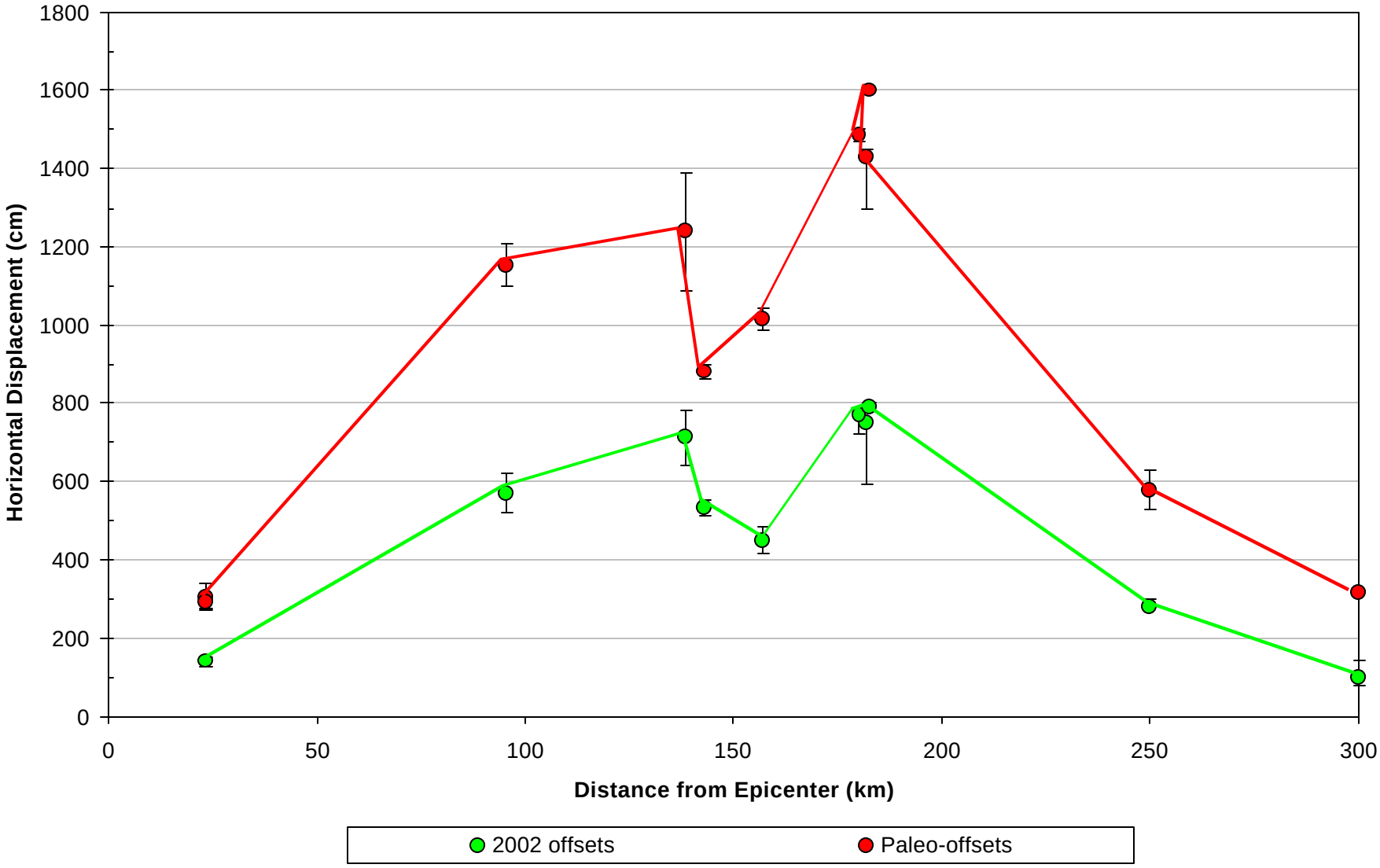

Km 184


Denali fault. Photo: Lloyd Cluff, 1973


Km 143
3,5
5,3

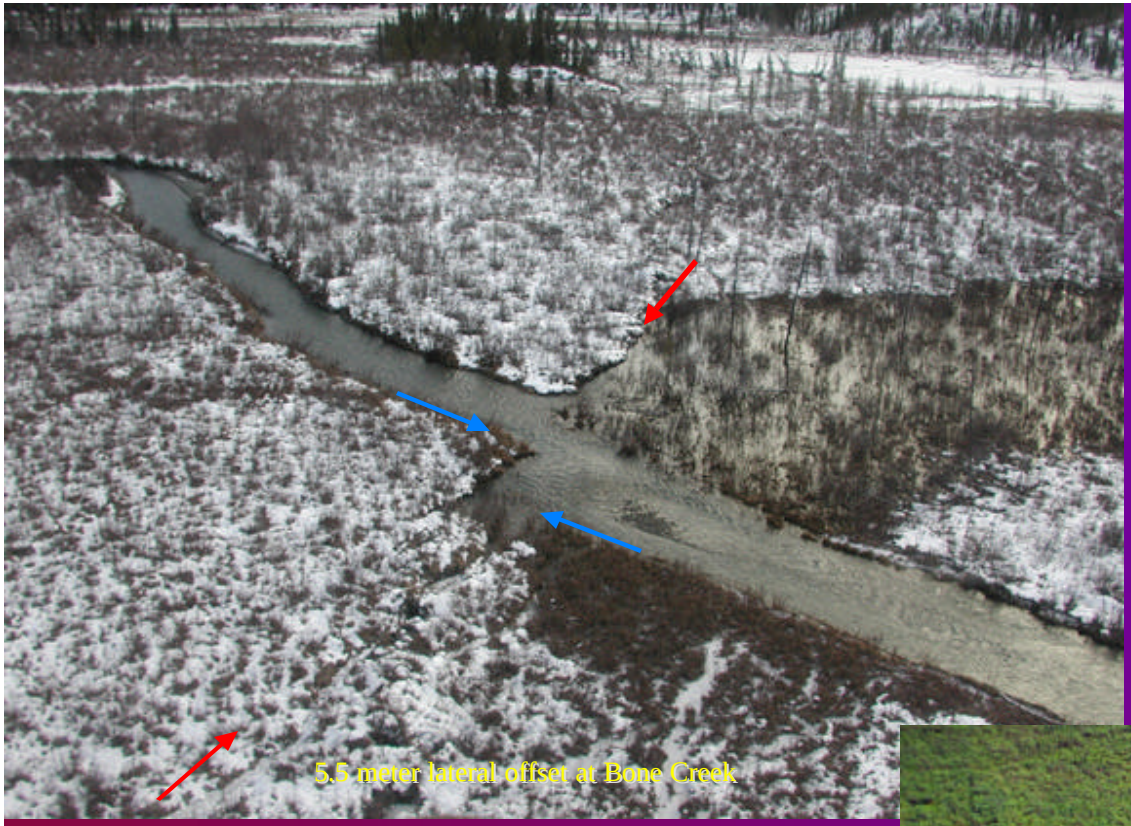

Denali Fault: Slip Distribution 170-300 km
1000
900
800
700
600
500
400
300
200
100
0
170
190
210
230
250
270
290
Distance from Epicenter (km)
11/02 measurements, nonglacier
7/03 measurements, nonglacier
2.8
5.8 (3.0)
Km 250


Horizontal slip (m)
10
5
0
0
50
100
150
200
250
300
Totschunda Fault
Distance from epicenter (km)
Denali Fault Horizontal Slip Distribution
75 - 200 km
Canwell - Gakona Glaciers
Chistochina Glacier
Horizontal slip (m)
10
8
6
4
2
0
July 2003 measurements
November 2002 measurements
Excluded measurements
75
90
110
130
150
170
190
Distance from epicenter (km)
Augustana Creek
Trans-Alaska Pipeline
Richardson Highway
Slate Creek
Slana River
Gillett Pass


Denali-Totschunda Paleo-offsets
Horizontal Displacement (cm)
1800
1600
1400
1200
1000
800
600
400
200
0
0
50
100
150
200
250
300
Distance from Epicenter (km)
2002 offsets
Paleo-offsets

Permanent Ground Deformation

- Fault Rupture
  - Primary, secondary, tertiary
  - Distribution of slip
    - Along strike and across strike
  - Width of rupture
  - Constraints on variability
  - Quantified with profiles and photos



Km 197

Permanent Ground Deformation

- Tilting and warping
  - Especially reverse & normal faults
- Ridge crest deformation (Sachung & Shattering)
- Liquefaction – settlement, lateral spreading
  - Relationship to geology
- Slope failure
  - Type, type, type

Permanent Ground Deformation

- Effects on Structures
  - Especially foundations & lifelines
  - Requires experience
- Critical Interaction with Geotechnical and Structural Engineers

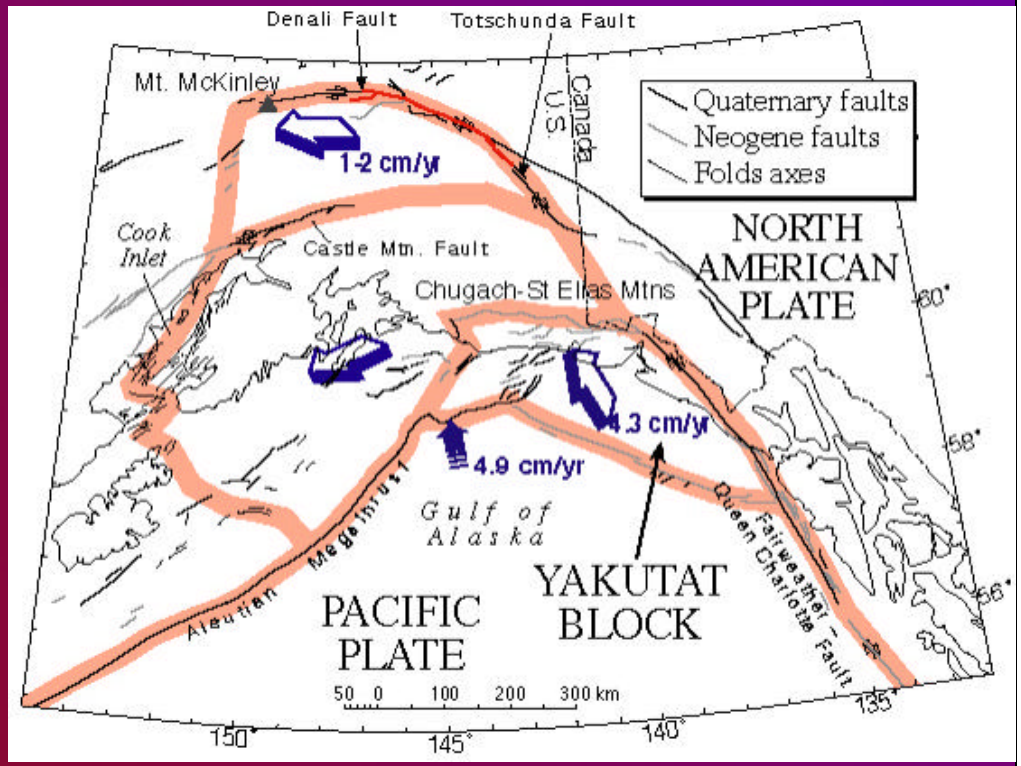
Techniques

- Observation, observation, observation
- Documentation, documentation, documentation
- Surveys – Quantify
  - Geometry (width, length, orientation)
  - Deformation (slip amount, orientation, distribution)
- Location
  - GPS, 1:24k scale maps (or better)

Techniques

- Photography
- Track lines (air and field)
  - Where did you go?
- Geologic context
  - “Sample” where appropriate
- Accurate sketch maps

Neotectonics of southern Alaska



- Megathrust (1964 EQ)
- Fairweather (1958 EQ)
- Yakutat terrane
  - Colliding for last 25-30 Ma
  - Causing earthquakes in interior Alaska
  - W to SW extrusion of southern Alaska
  - Cause of Oct-Nov M6.7 - 7.9 earthquakes

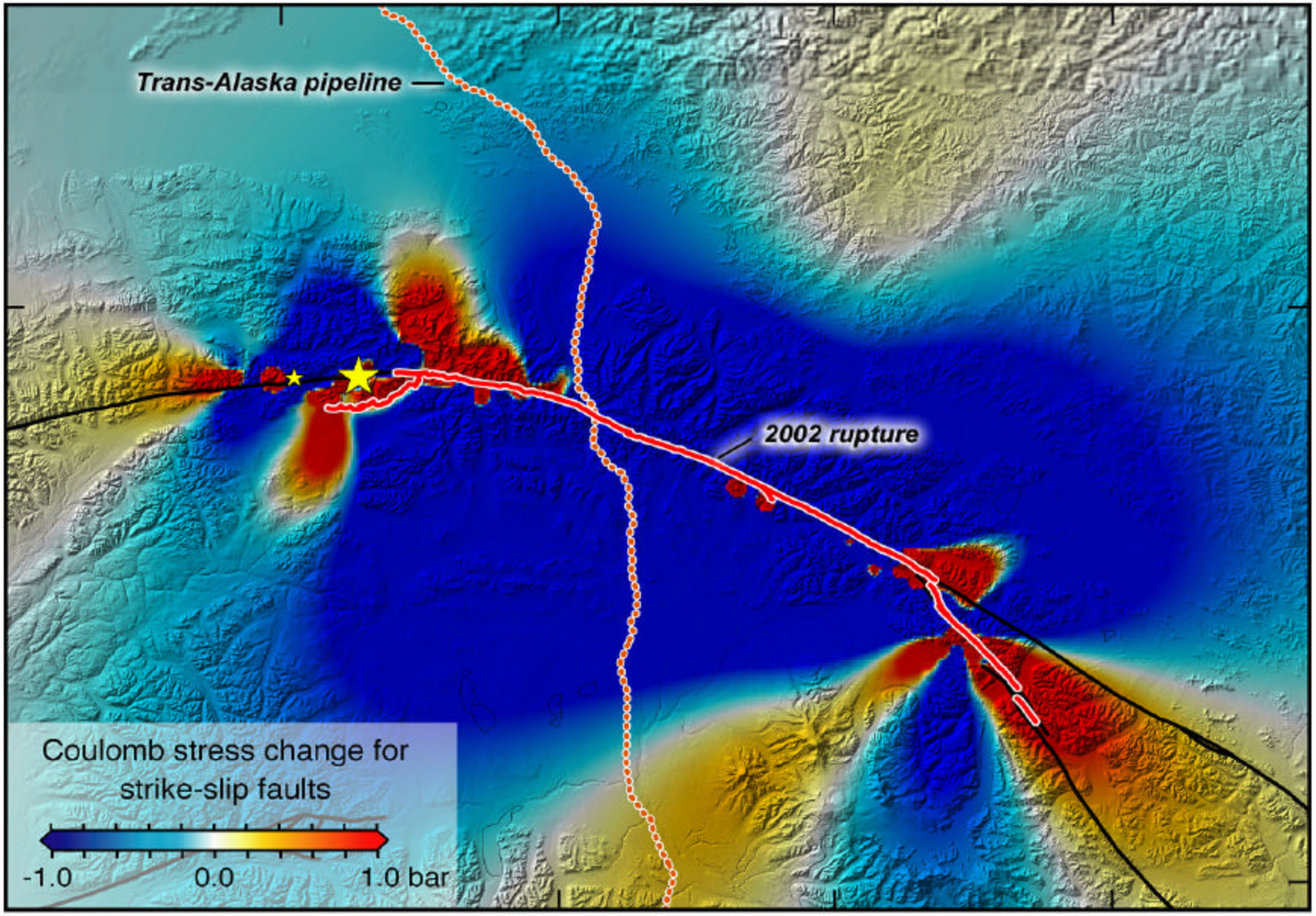
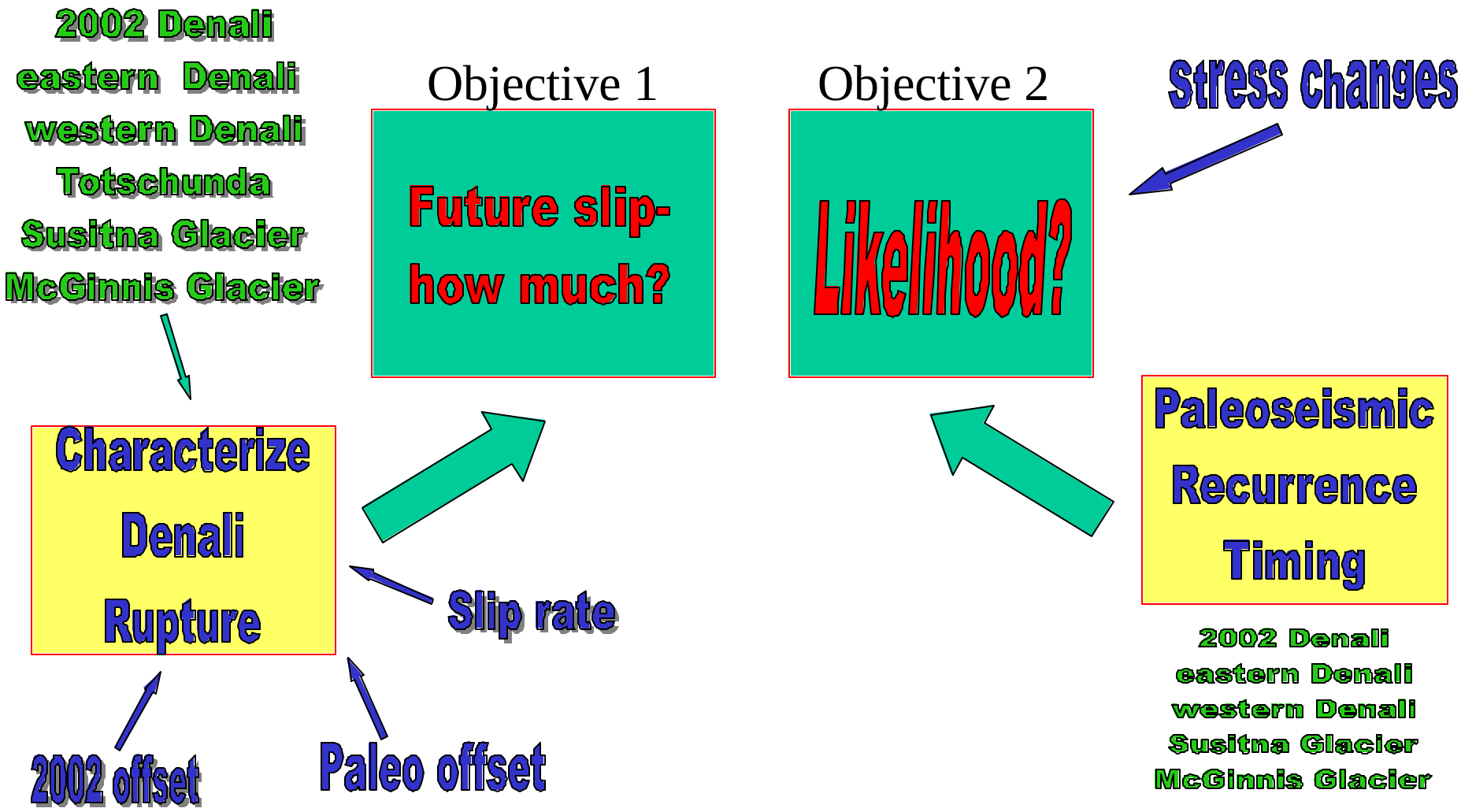


Figure 3. Stress changes caused by the Denali rupture

2003/2004 Field Tasks, Denali Fault System




Km 81


Km 139

Comparison with seismically-inferred moment release