# Approaching the 5th anniversary of the 2002 M7.9 Denali Fault Earthquake

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Seismic Hazards Safety Commission
September 18, 2007

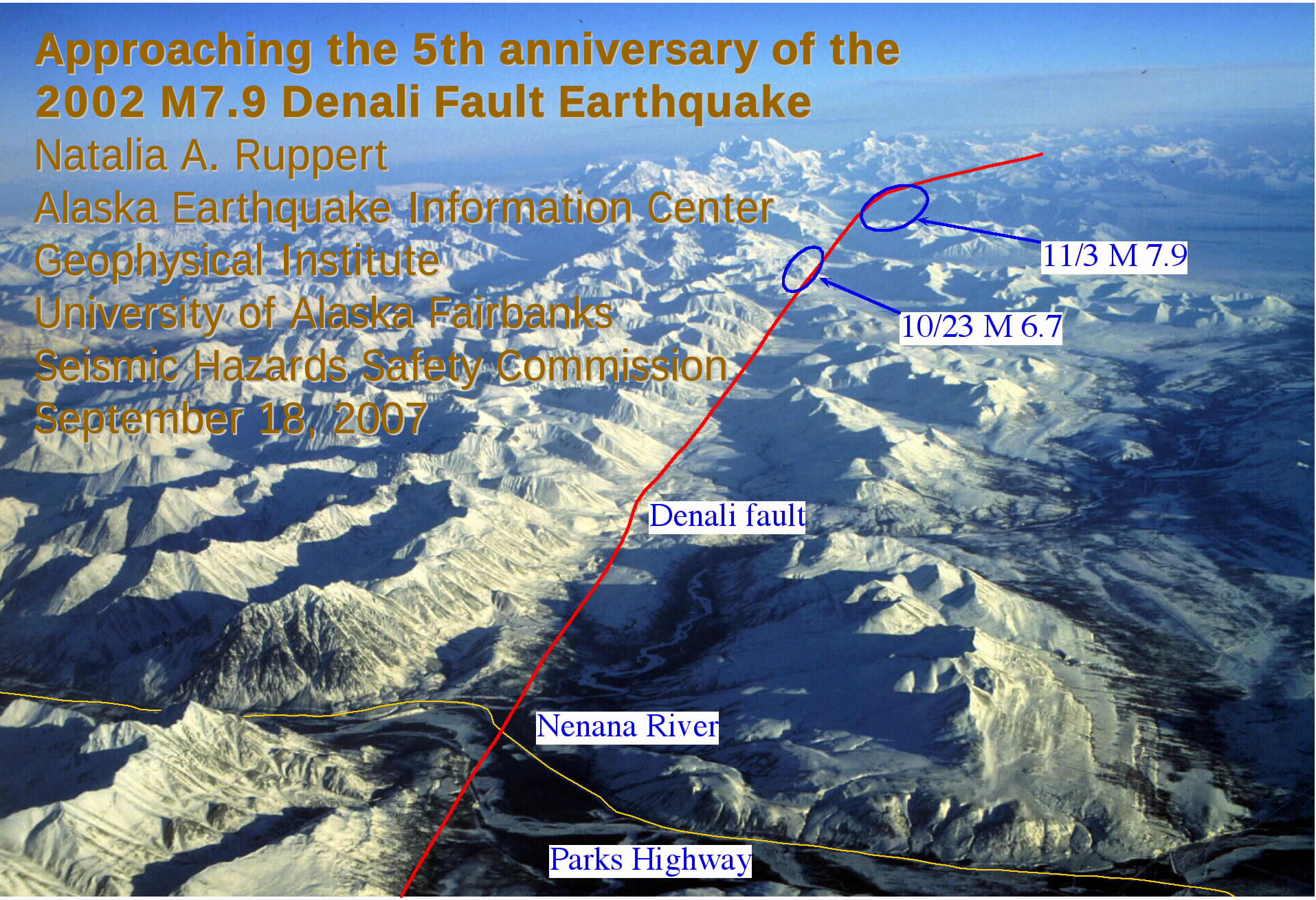



Photo by W.Wallace

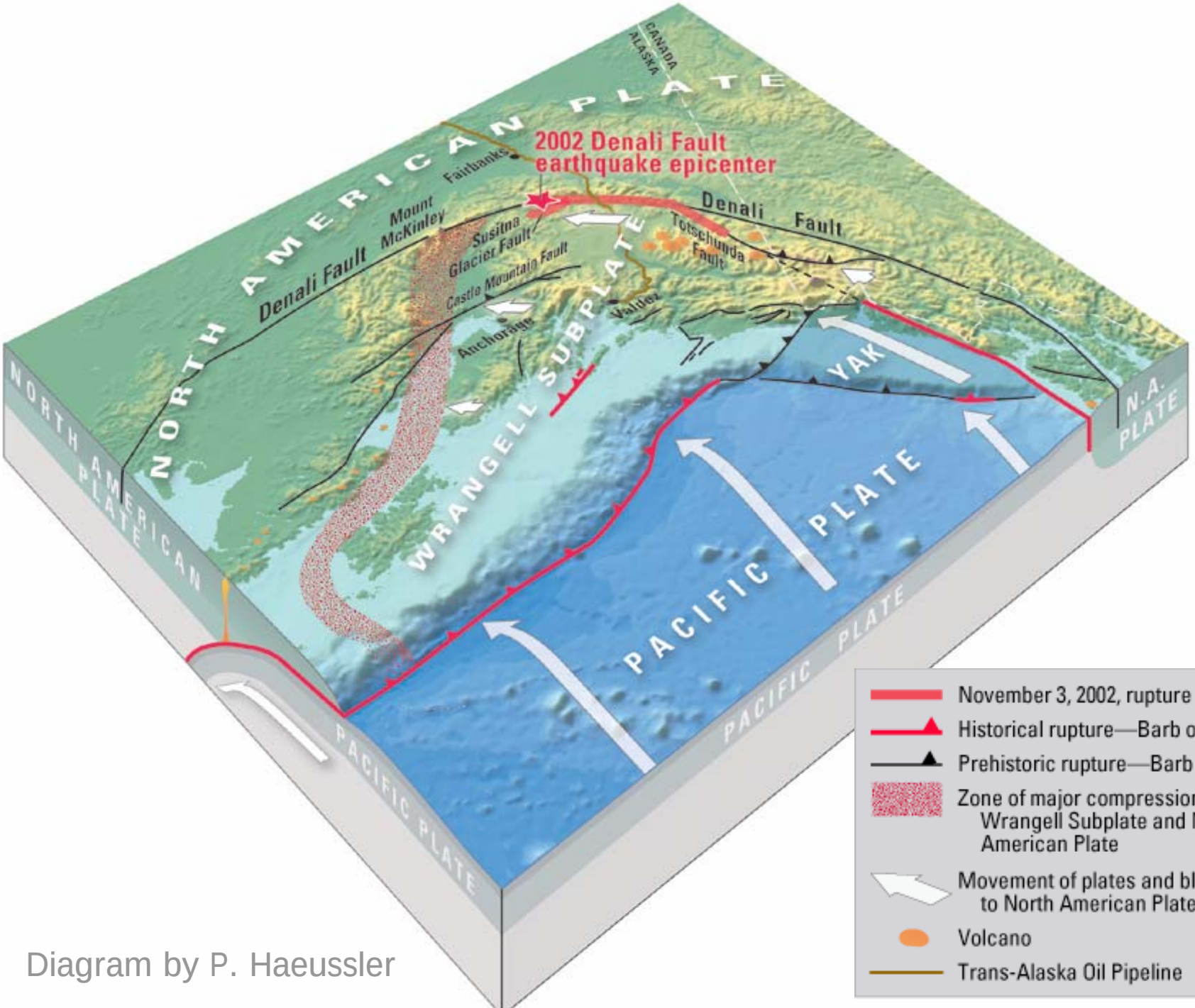
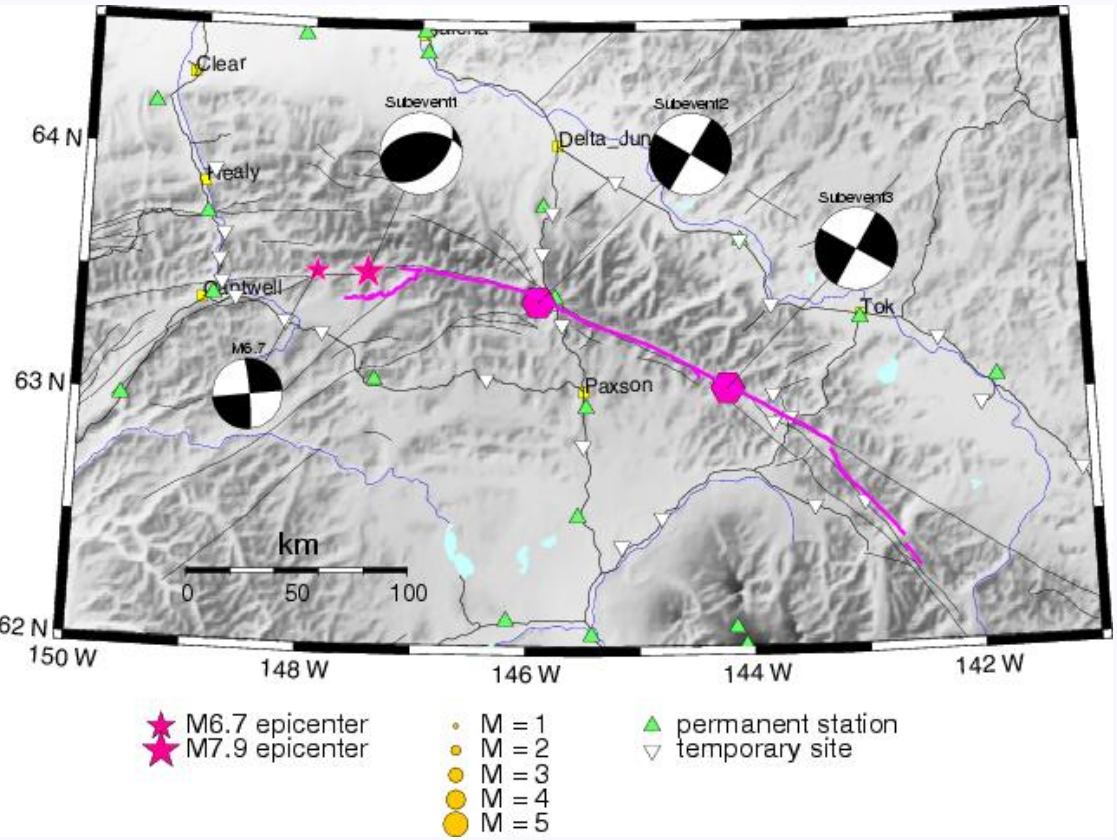


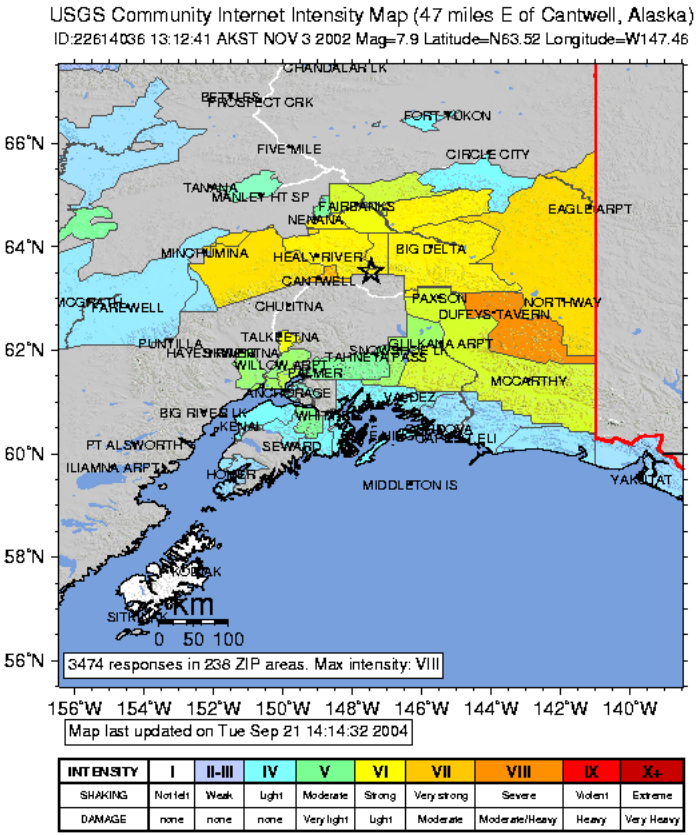

Diagram by P. Haeussler

# Earthquake Sequence



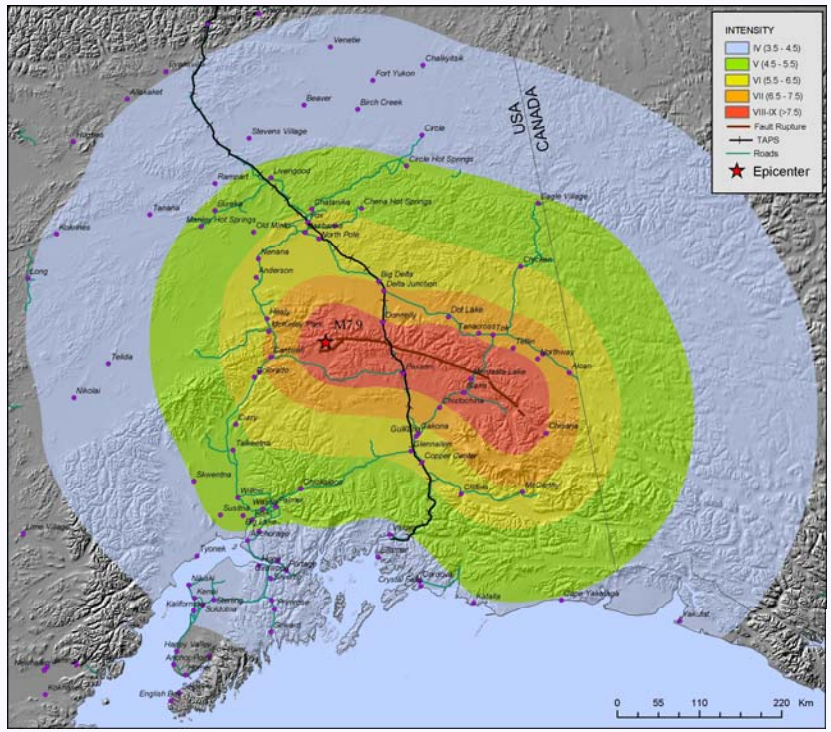

- Started with the M6.7 Nenana Mountain earthquake on October 23, 2002
- The main Denali event on November 3, 2002 started with the M7.2 thrust sub-event on previously unknown splay fault
- Continued as right-lateral strike slip event along main Denali fault
- Rupture transferred onto Totschunda branch

# Internet Community Intensity Map



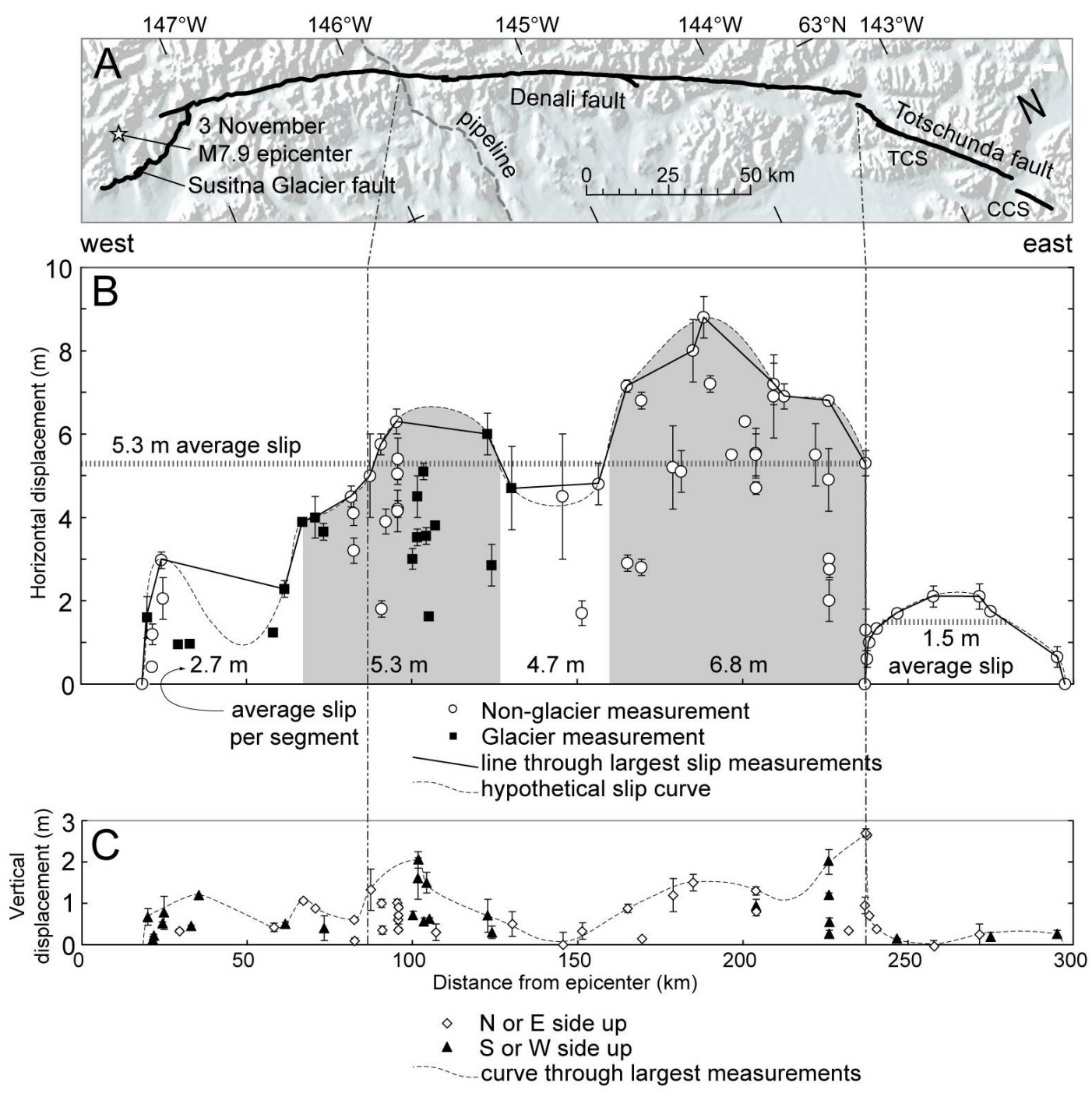

- Not detailed enough
- Maximum Intensity VIII

# Microseismic study




By A. Martirosyan, 2003

- Maximum reported Intensity - IX

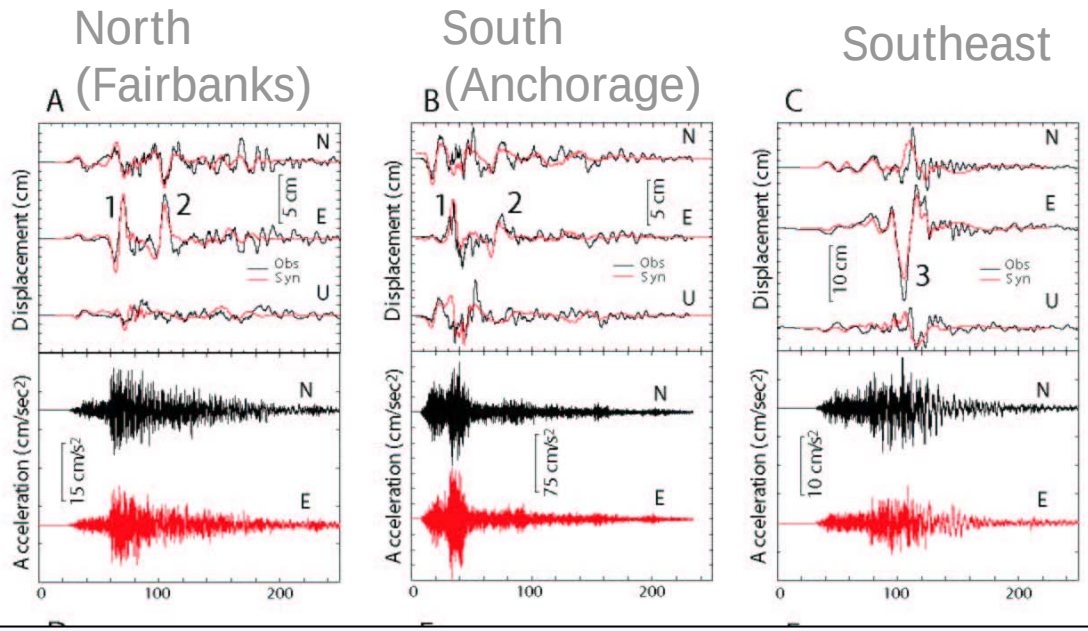



# Measured Surface Offsets

- Total of 342 km of surface faulting
- Maximum horizontal 8.8 m
- Maximum vertical ~2.8 m

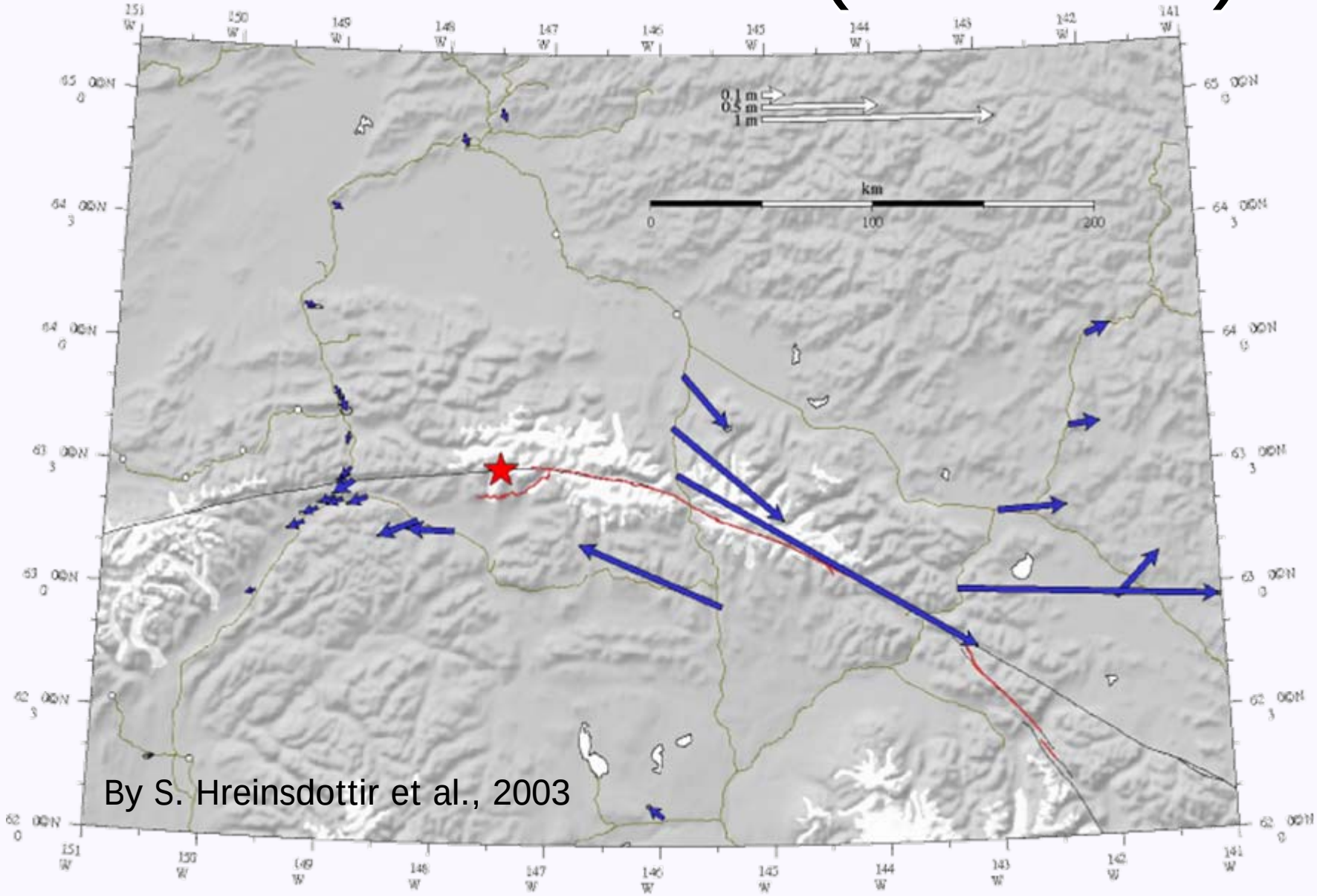
Haeussler et al., 2004

# Directivity Effects




Energy from the largest subevent (#3) propagated
Mainly to the southeast.
Plot by A.Frankel (USGS)

# Co-seismic Motions (from GPS)



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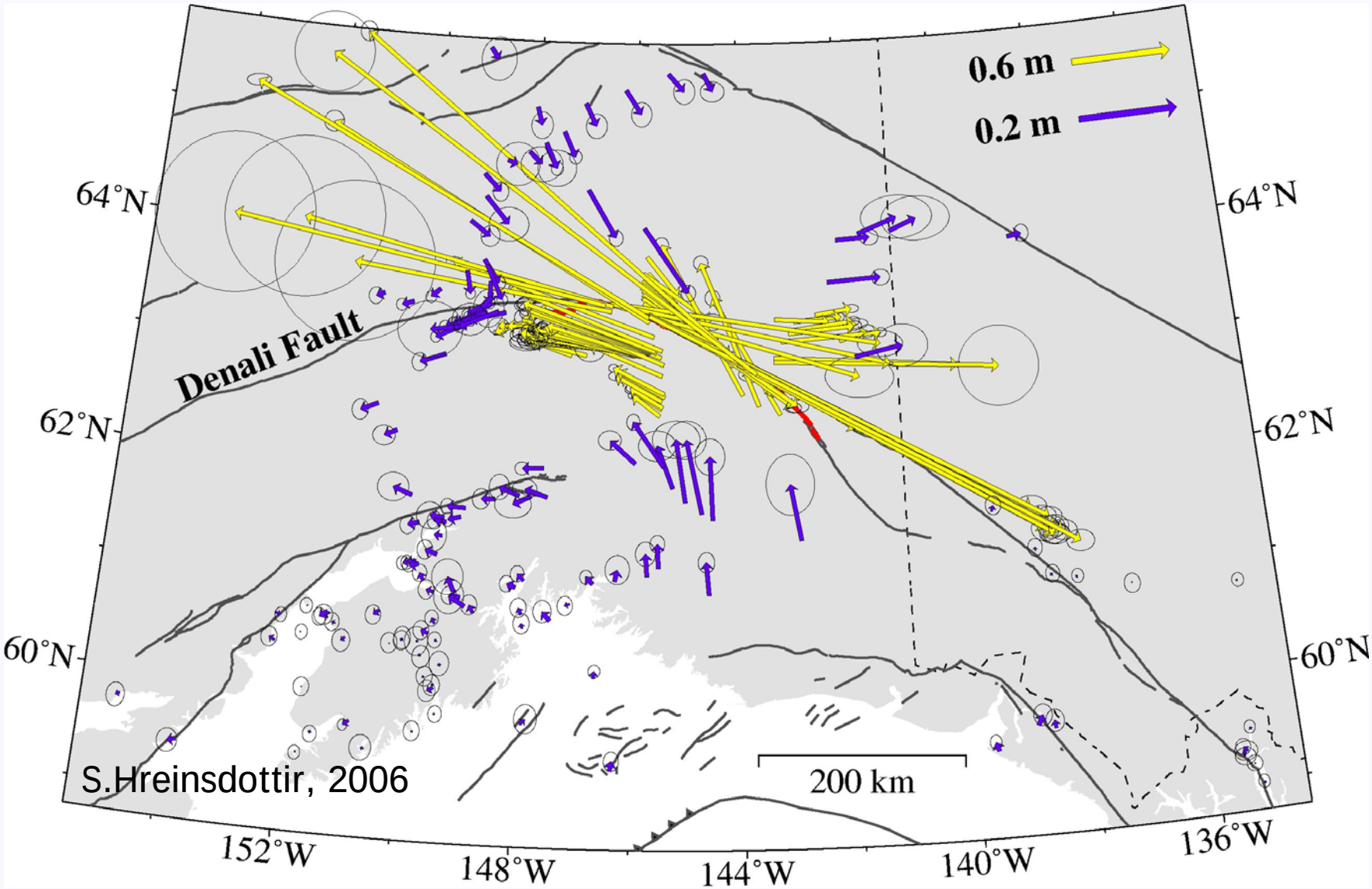
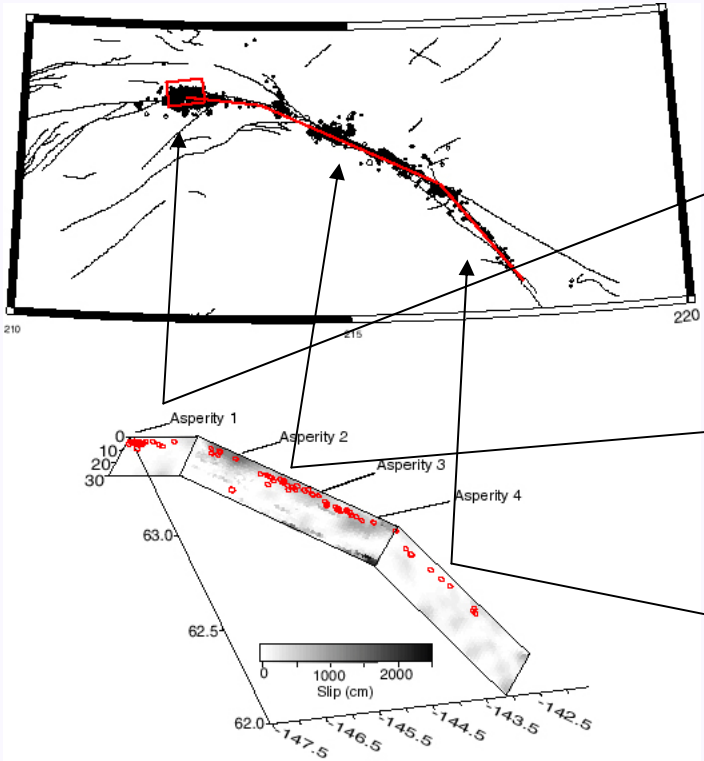
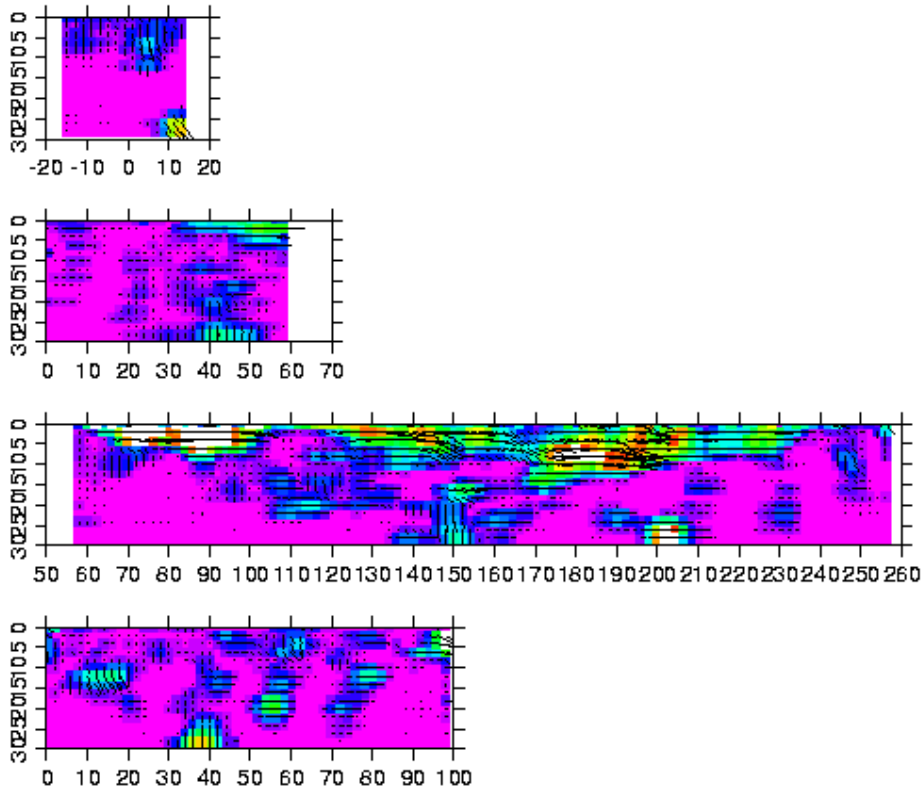


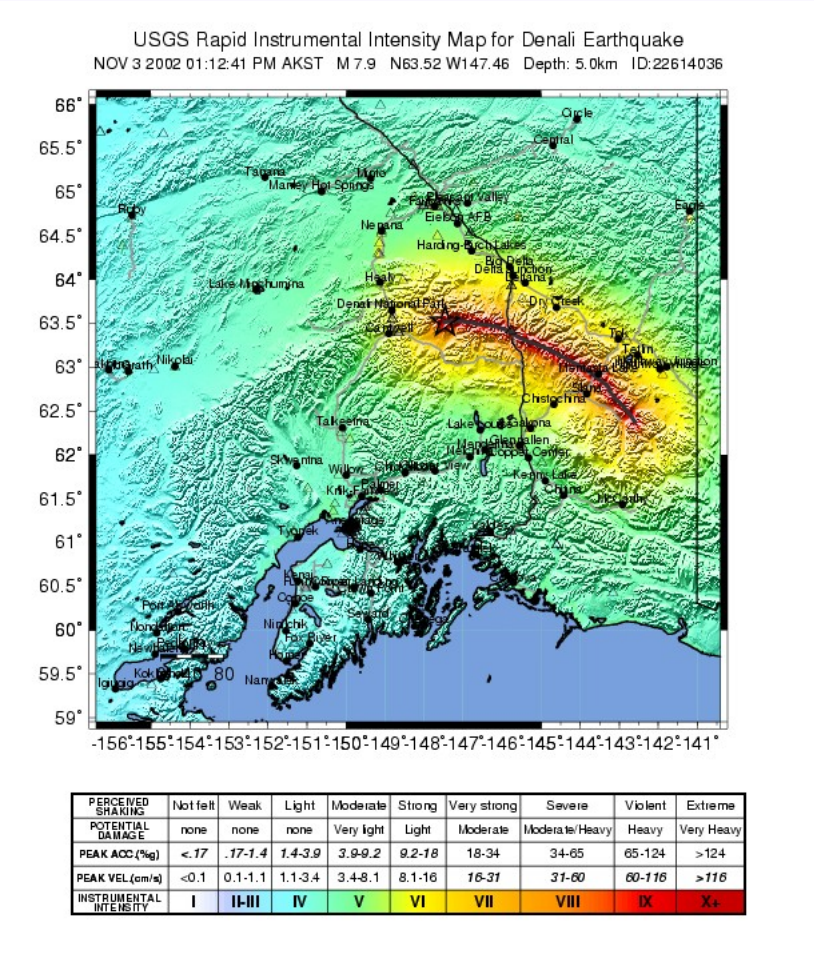
# Sub-surface Slip Distribution



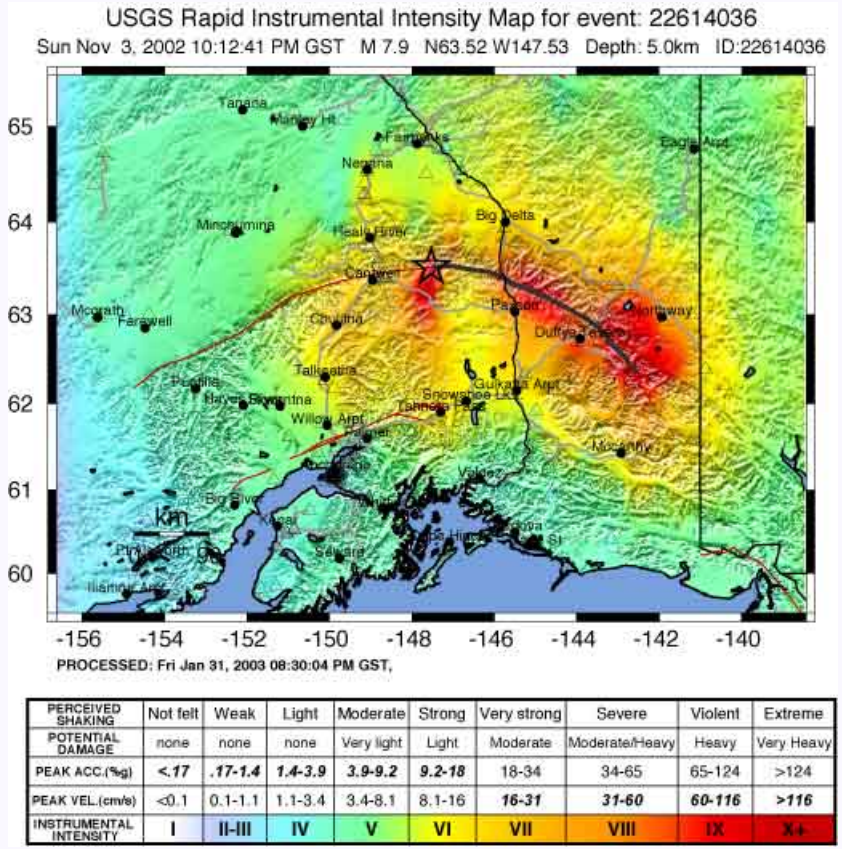




- Dreger et al., 2002-2003
- Based on regional seismic data and GPS displacements

# ShakeMap




| PERCEIVED SHAKING | Not felt | Weak | Light | Moderate | Strong | Very strong | Severe | Violent | Extreme |
|---|---|---|---|---|---|---|---|---|---|
| POTENTIAL DAMAGE | none | none | none | Very light | Light | Moderate | Moderate/Heavy | Heavy | Very Heavy |
| PEAK ACC.(%g) | *<.17* | *.17-1.4* | *1.4-3.9* | *3.9-9.2* | *9.2-18* | 18-34 | 34-65 | 65-124 | >124 |
| PEAK VEL.(cm/s) | <0.1 | 0.1-1.1 | 1.1-3.4 | 3.4-8.1 | 8.1-16 | *16-31* | *31-60* | *60-116* | *>116* |
| INSTRUMENTAL INTENSITY | I | II-III | IV | V | VI | VII | VIII | IX | X+ |

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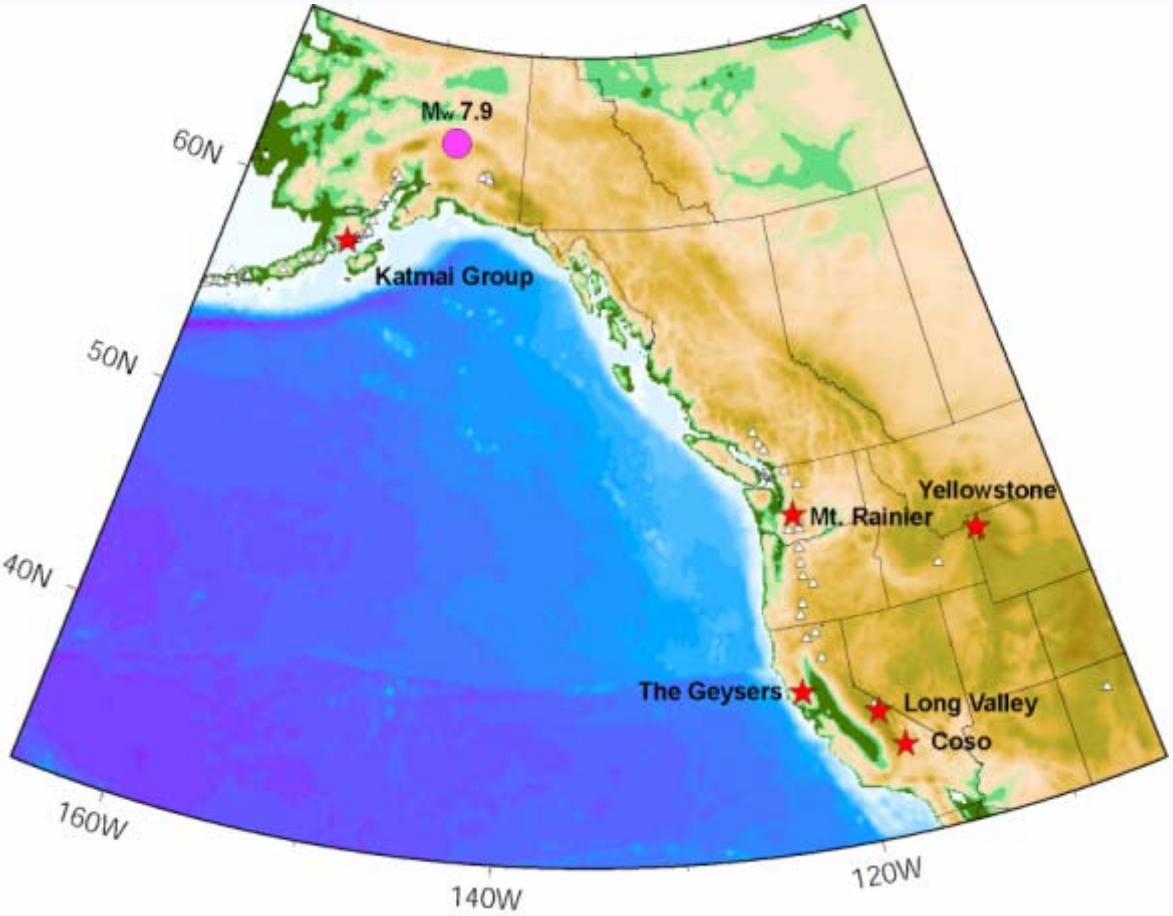
- Produced within days of the quake
- Based on ~50 measurements in the state (2/3 from Anchorage)

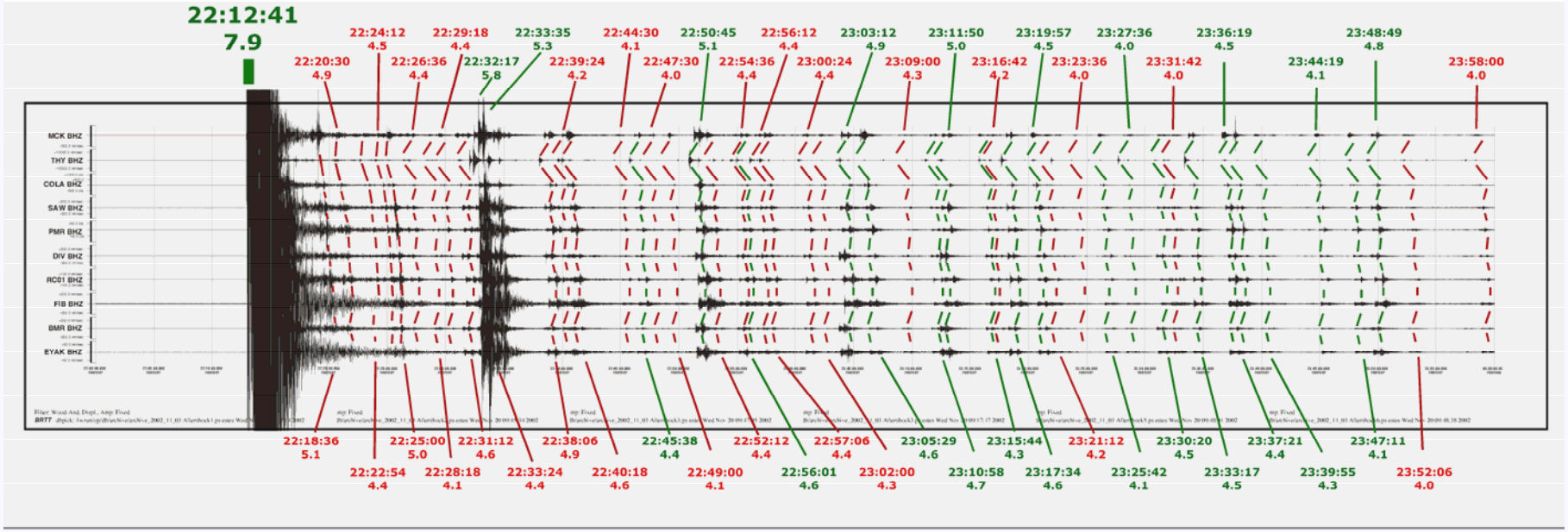
- By D.Wald (USGS), 2003-2004
- Composite dataset: ground motion measurements, microseismic survey, slip distribution

# Distal effects




- Felt as far as Washington State (~1,000 km away)
- Triggered seismicity at volcanic and geothermal centers (up to 3,000 km away)
- Seiches in distant lakes and pools (up to 3,000 km away)

# Early Aftershocks

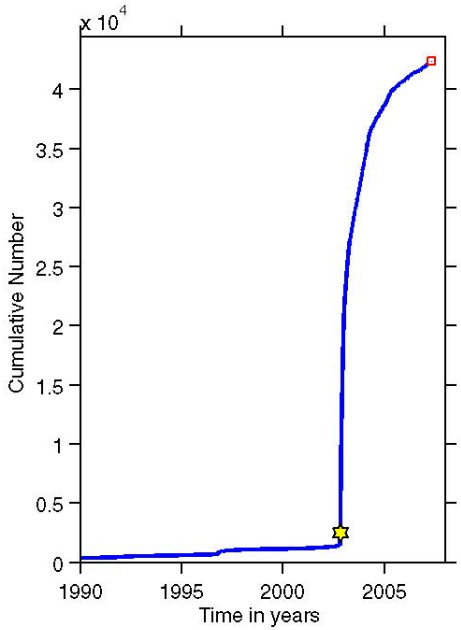



2 hours of data = 40+ M>=4 aftershocks

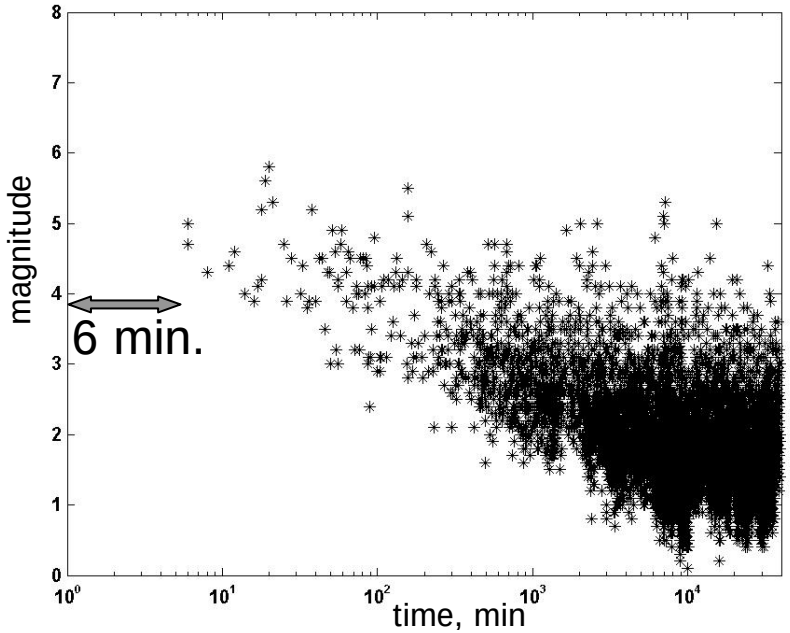
After S.Estes and S. McNutt

# Aftershock Statistics

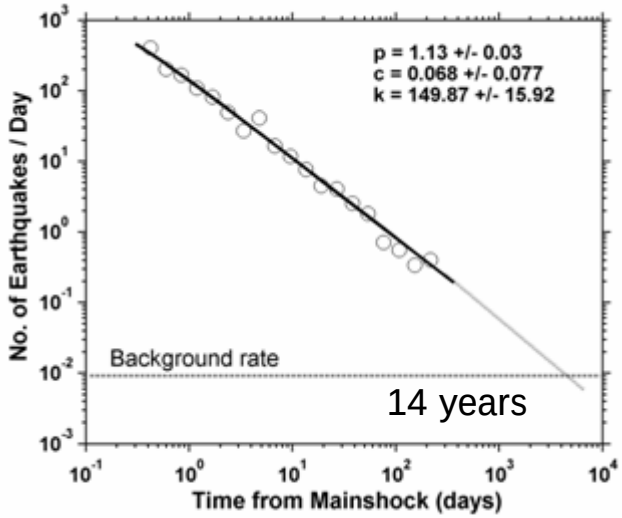
Cumulative Number: >40,000 Recorded aftershocks



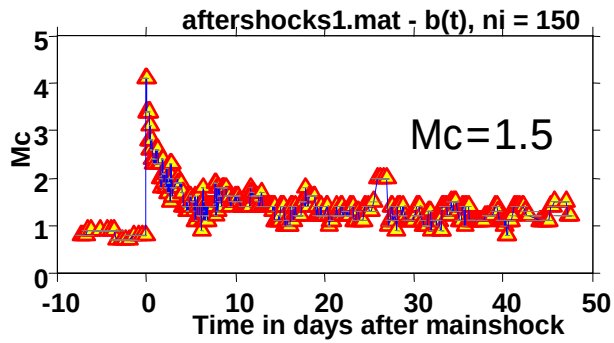

Magnitude vs log time, minutes



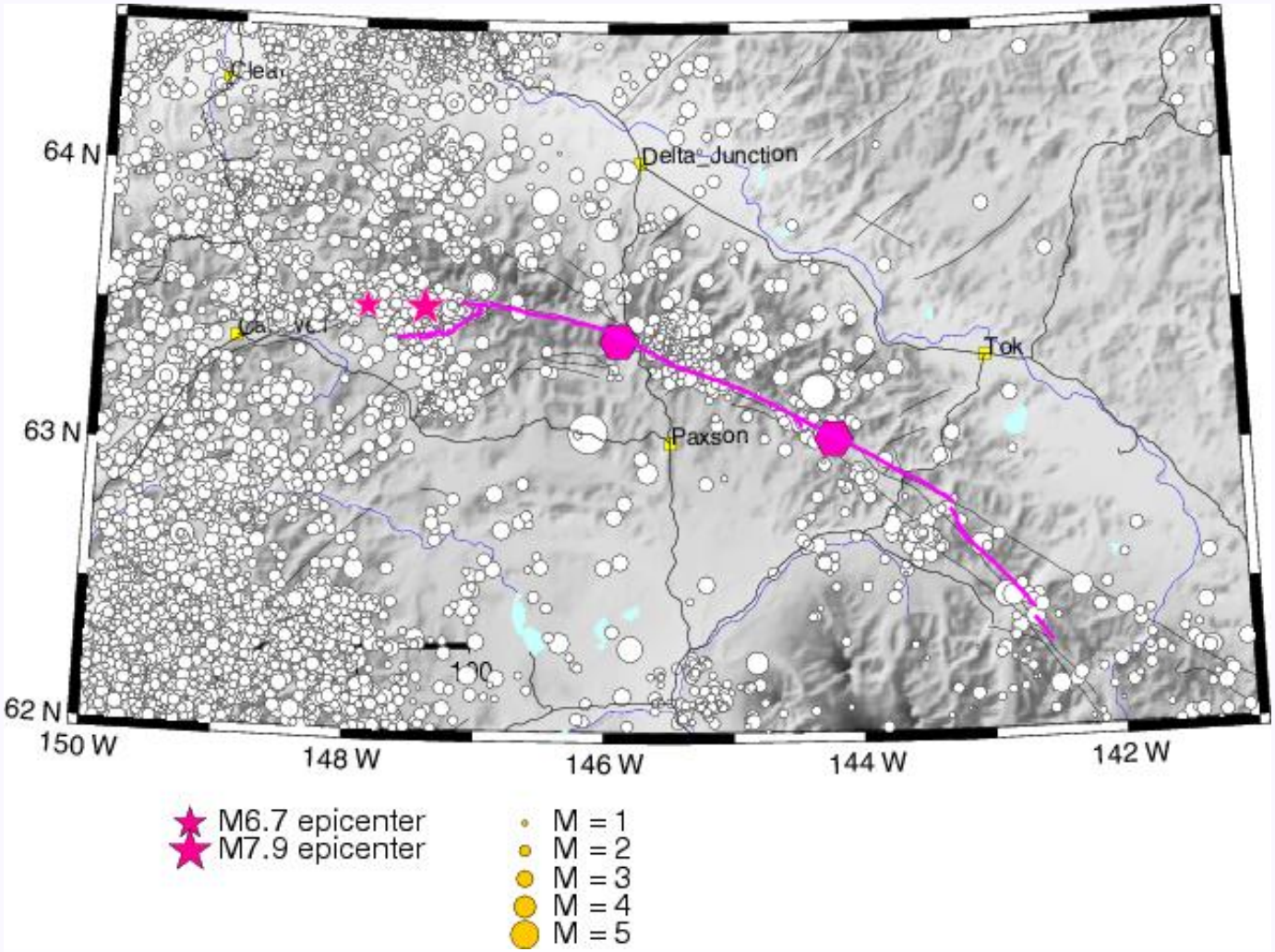

Decay rate




Magnitude of completeness

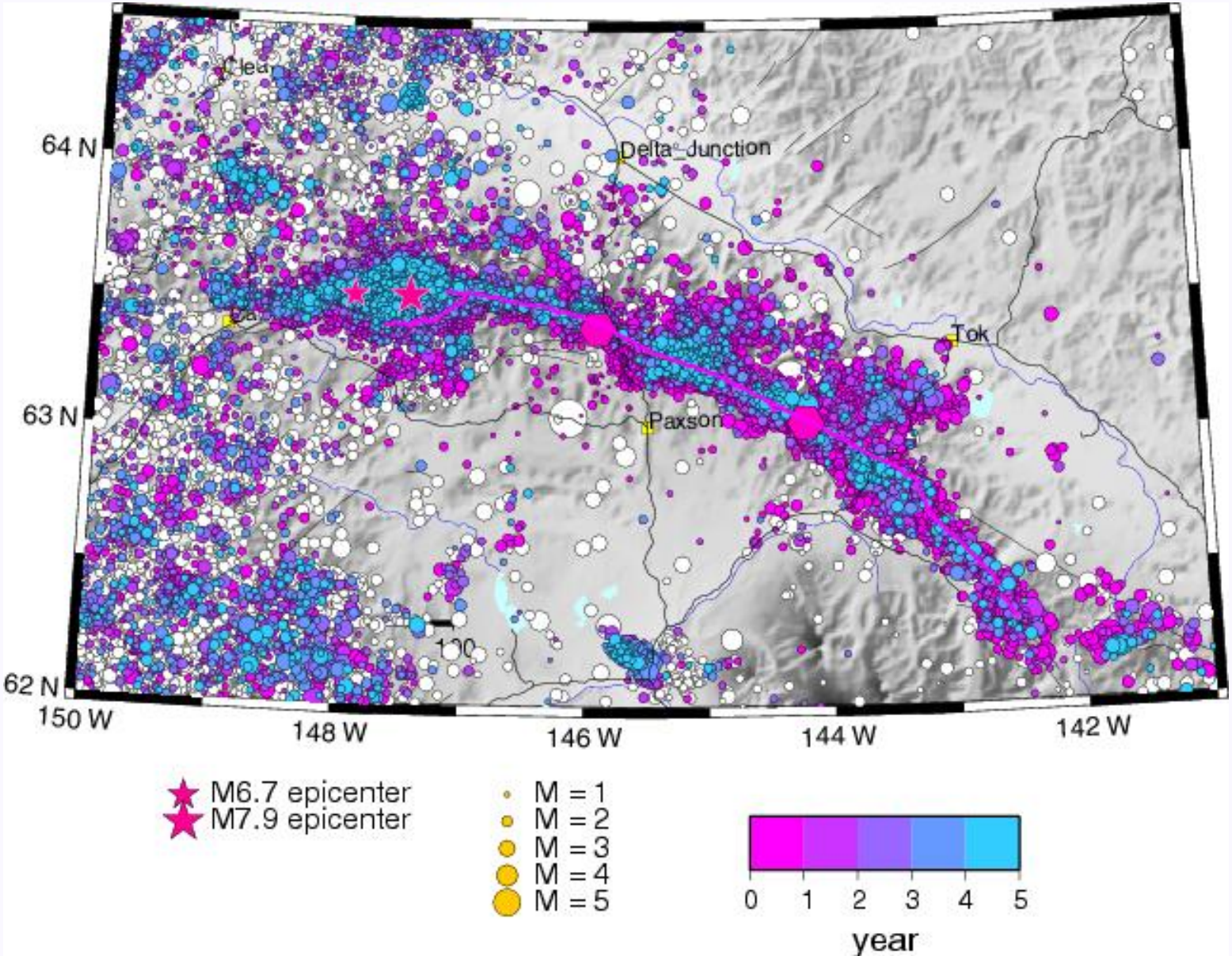


# Regional Seismicity




Before 2002

# Regional Seismicity and Recorded Aftershocks

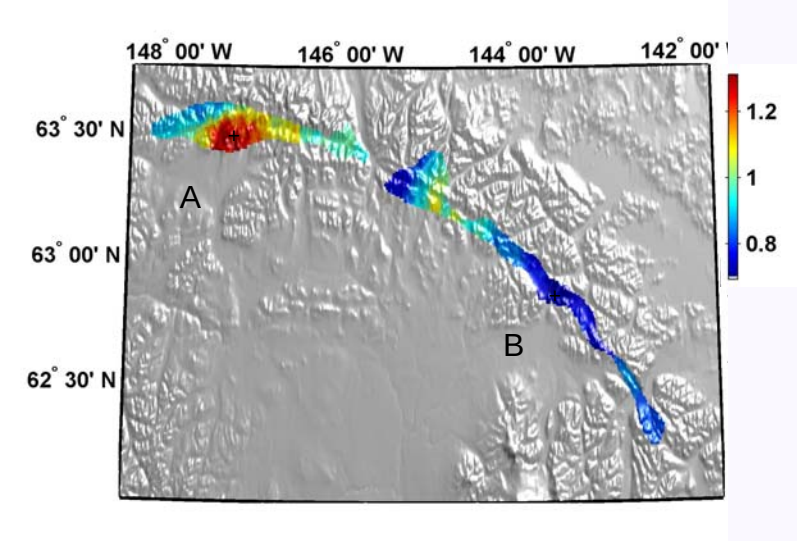


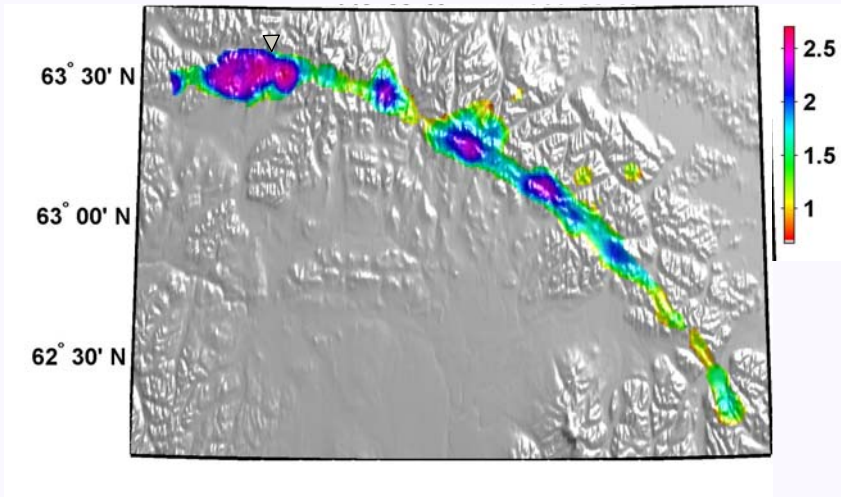
# *b*- and *a*-values for the aftershock sequence

*b*-value

logN=*a*-*b*M

*a*-value (activity rate)

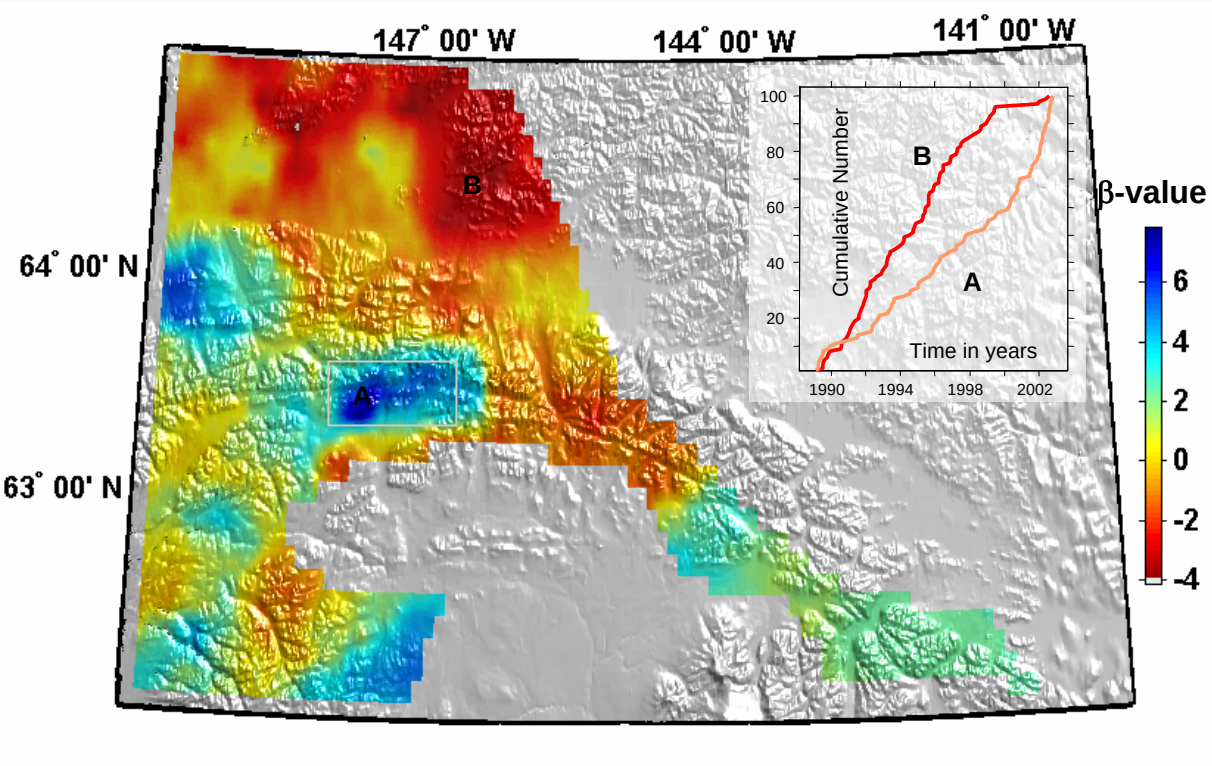


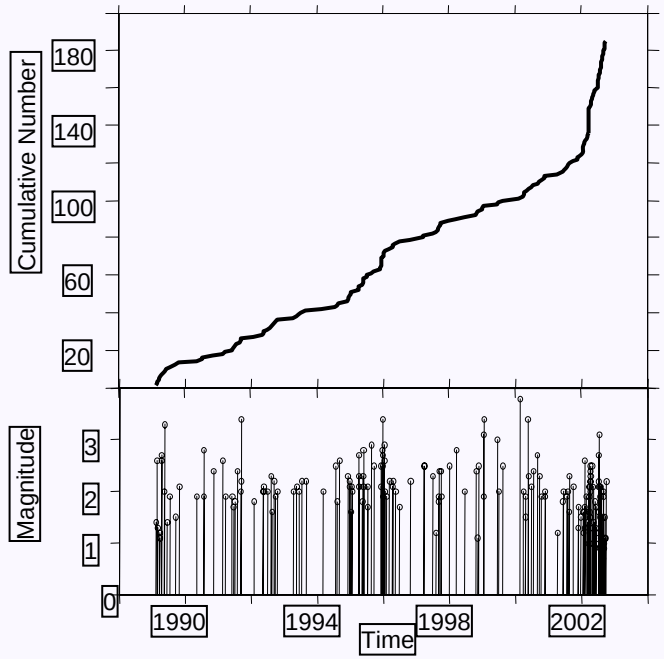

- *b*-value is mapped on 0.1x0.1º grid with the nearest 150 events per sample.
- The highest *b*-values (*b*=1.4) are found near the epicenter. The eastern part of the rupture is characterized by much lower *b*-values (*b*=0.7).

*a*-value is computed for volumes of radii 5 km.
The highest activity is near the epicenter.
The eastern part of the rupture is characterized by lower aftershock productivity.

# Seismicity rate changes

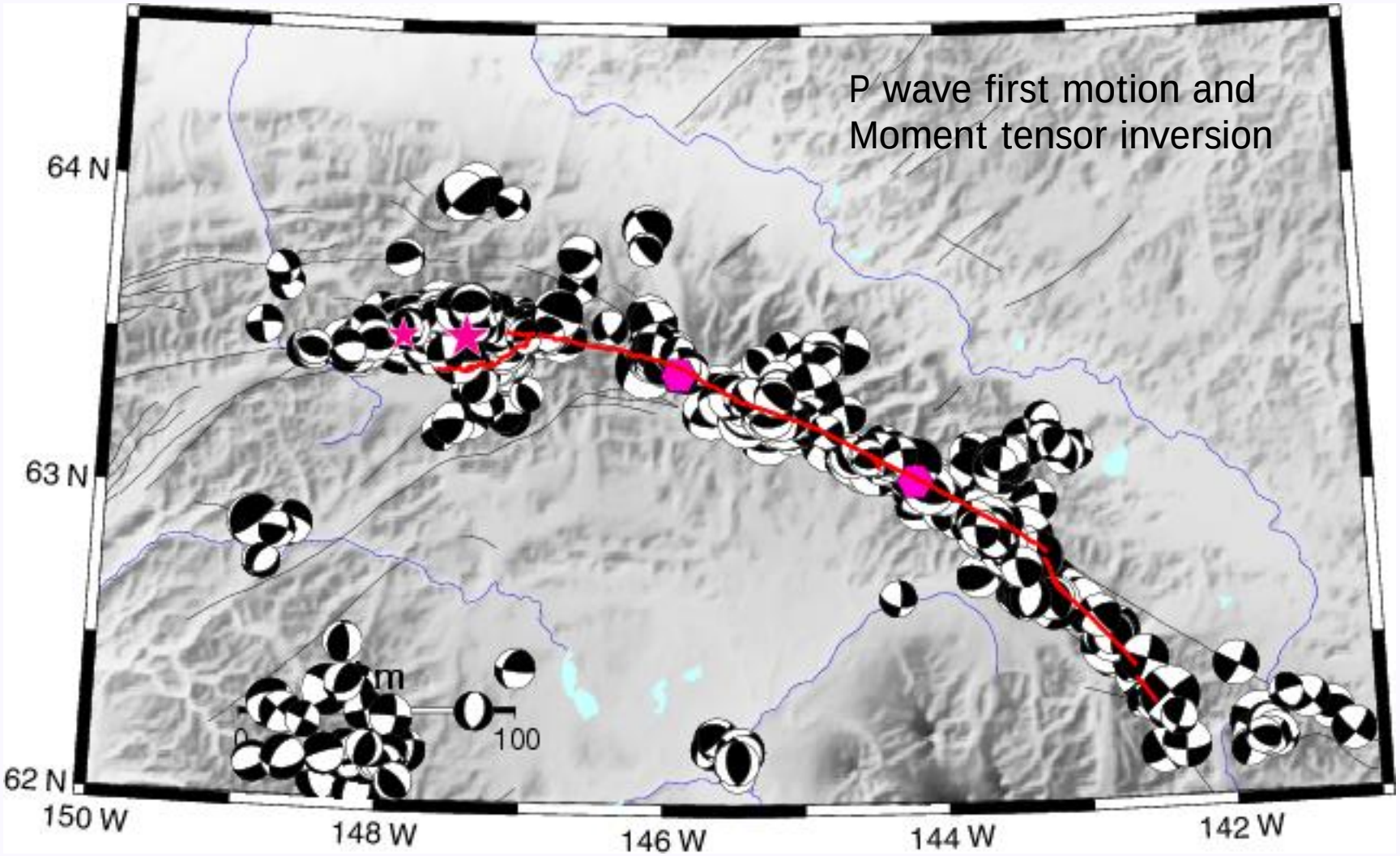



- We observe a significant increase in the seismicity rate within the epicentral region of the M7.9 event (node A).
- A less sharp decrease in the seismicity rate is observed ~100 km north of the M7.9 epicenter (node B).

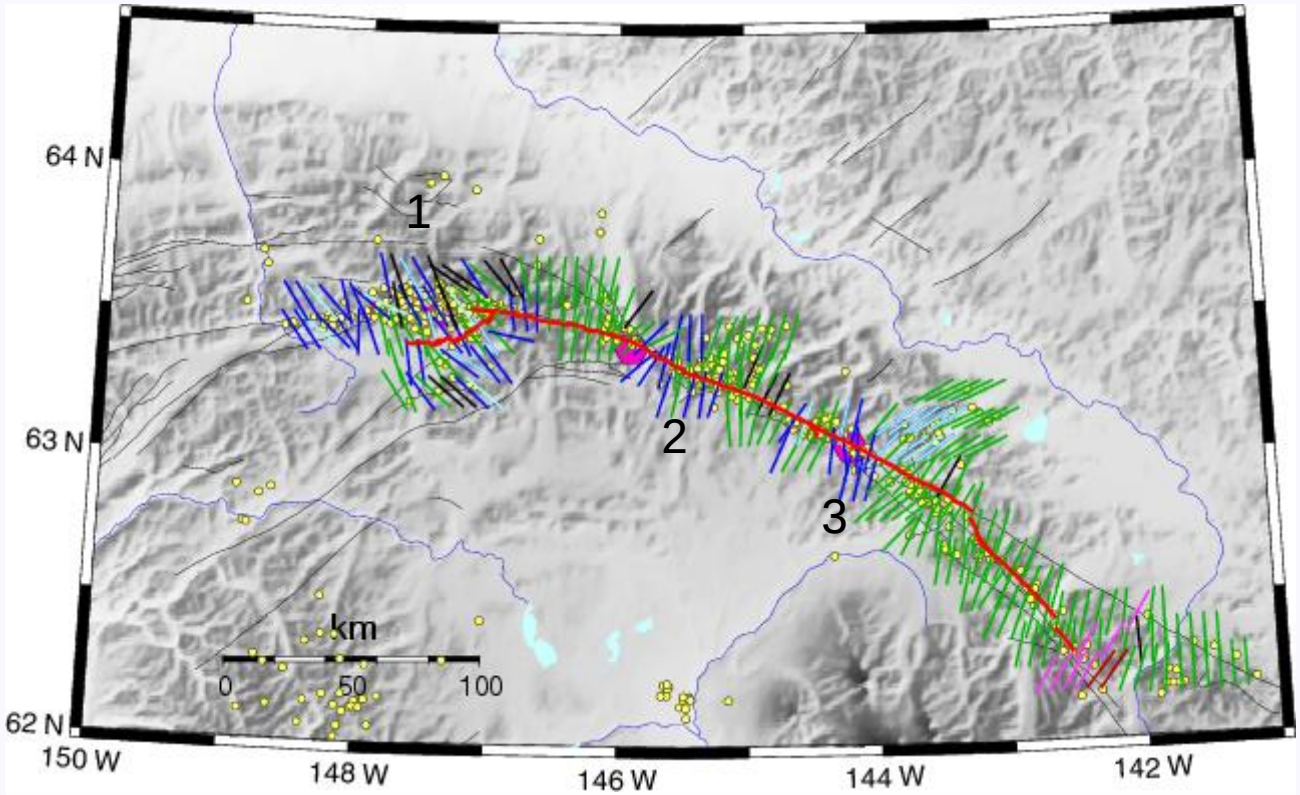



- Seismicity rate change (or β-value) is mapped on 0.1x0.1° grid with the nearest 100 events per sample using seismicity with M>=1.6.
- The time period 1989-2000 is compared with 2000-09/2002.

# Focal mechanism data



# Stress Field: Maximum Horizontal Compressive Directions




Faulting Style:

- Strike-slip
- Normal to strike-slip
- Normal
- Reverse
- Reverse to strike-slip
- Unknown

# Conclusions

- The M7.9 2002 Denali fault earthquake was a complex event.
- Rich aftershock dataset is still being assembled.
- It will take ~9 more years for seismicity to go back to the background level.

- The 2002 Denali earthquake is being used as a model event to forecast rupture effects in other areas, such as rupture of the San Andreas fault in California.