EARTHQUAKE BREIFING

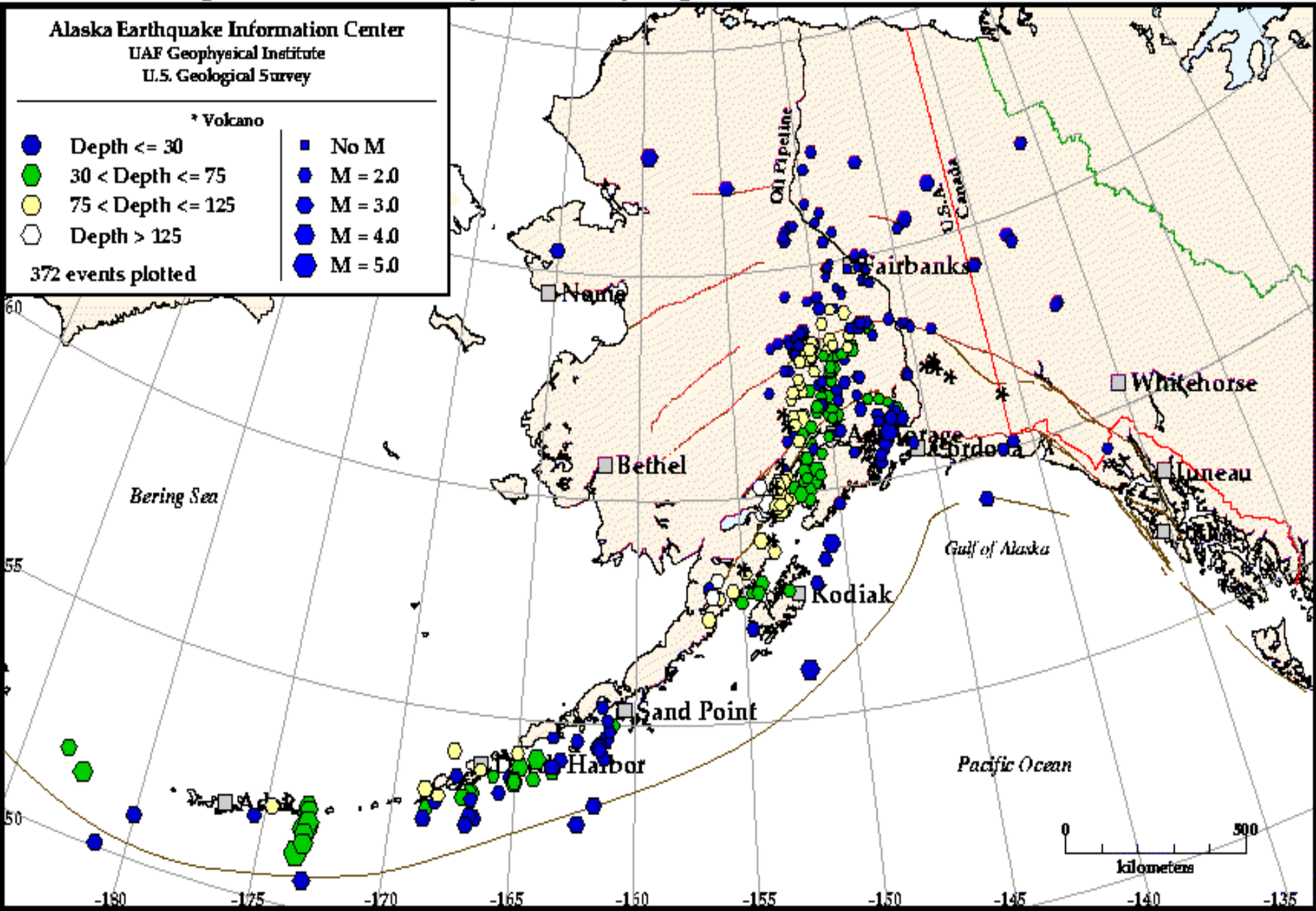
Dr. John L. Aho, Ph.D., Sc.D.
March 18, 2010

Presentation to: Alaska Partnership for Infrastructure Protection (APIP)

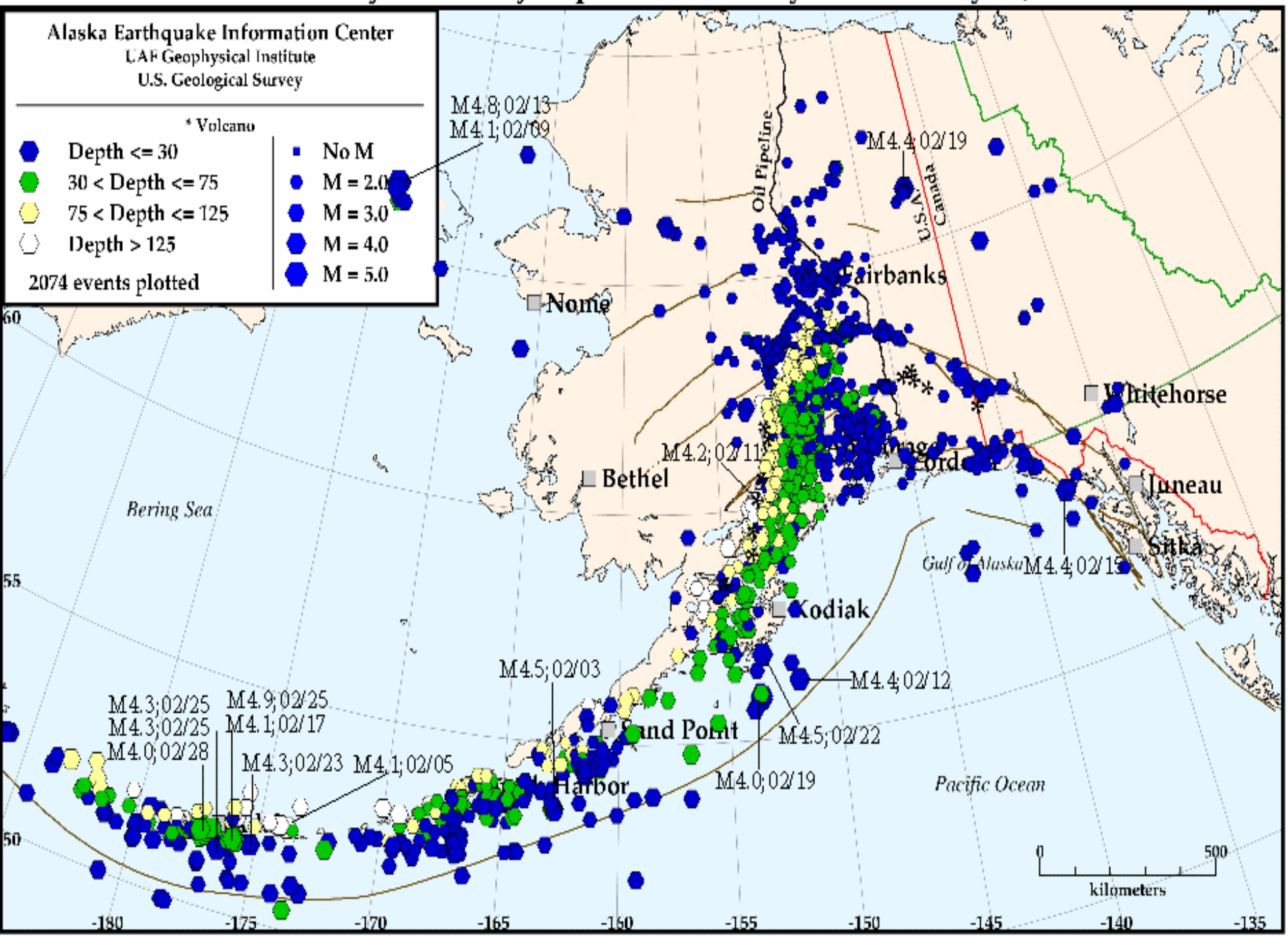
DISCUSSION TOPICS

- Why Worry?
- Terms and Facts
- Damage Causes
- Research Projects
- Alaska Seismic Hazards Safety Commission
- Questions (with possible answers)

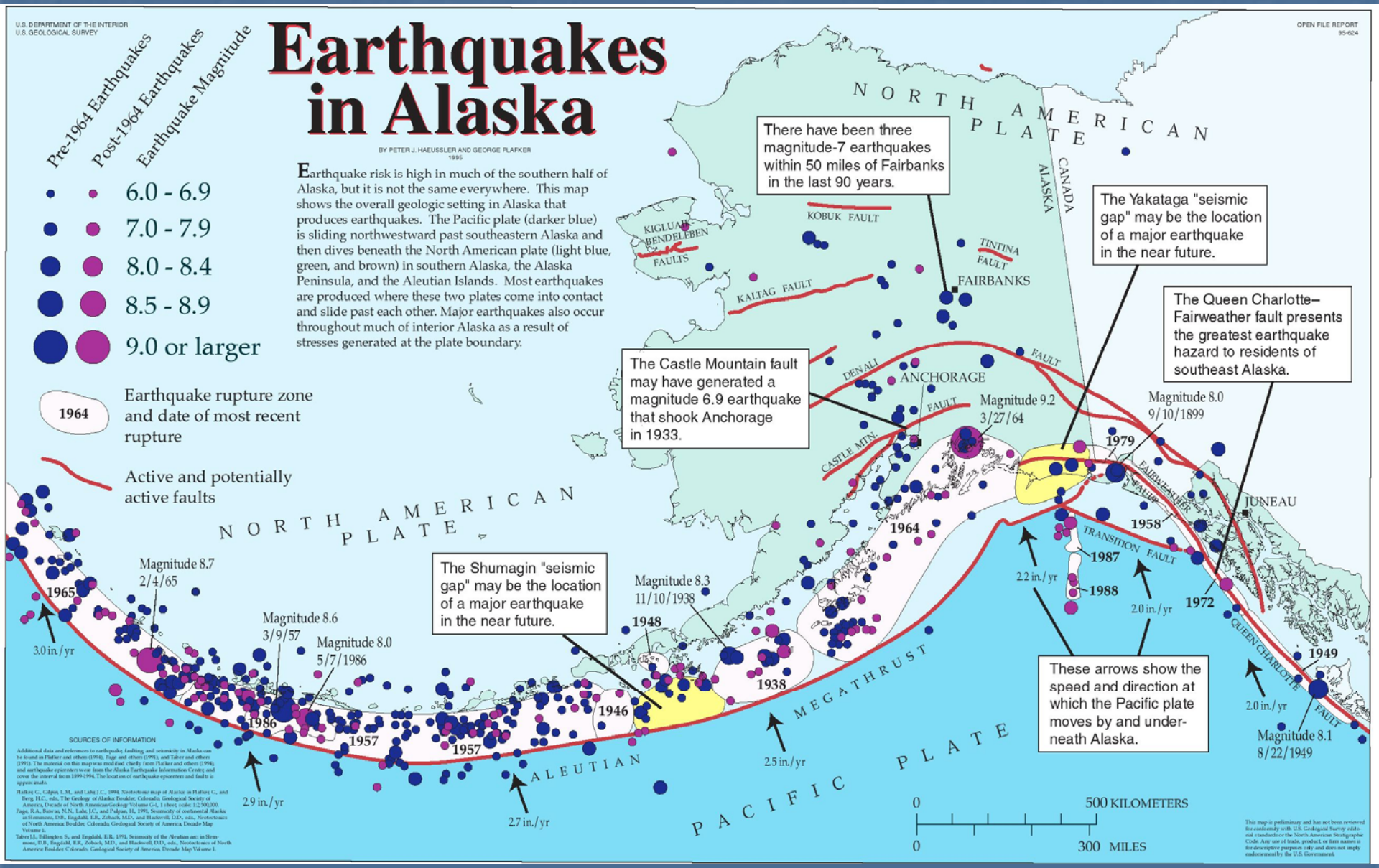
Figure 1: AEIC Weekly Seismicity Report for March 08 - March 14, 2010



AEIC Monthly Seismicity Report for February 01 - February 28, 2010



Alaska Seismicity



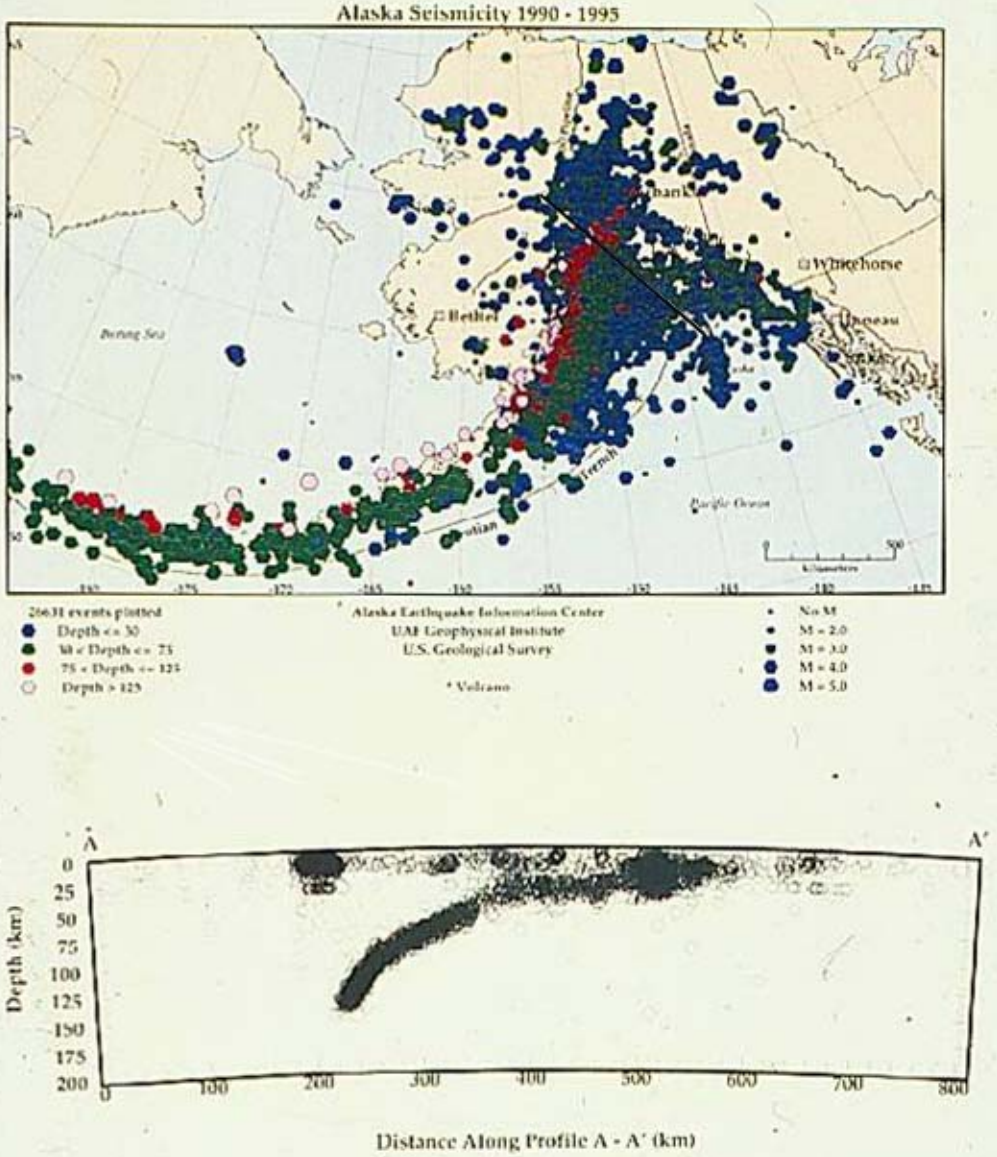
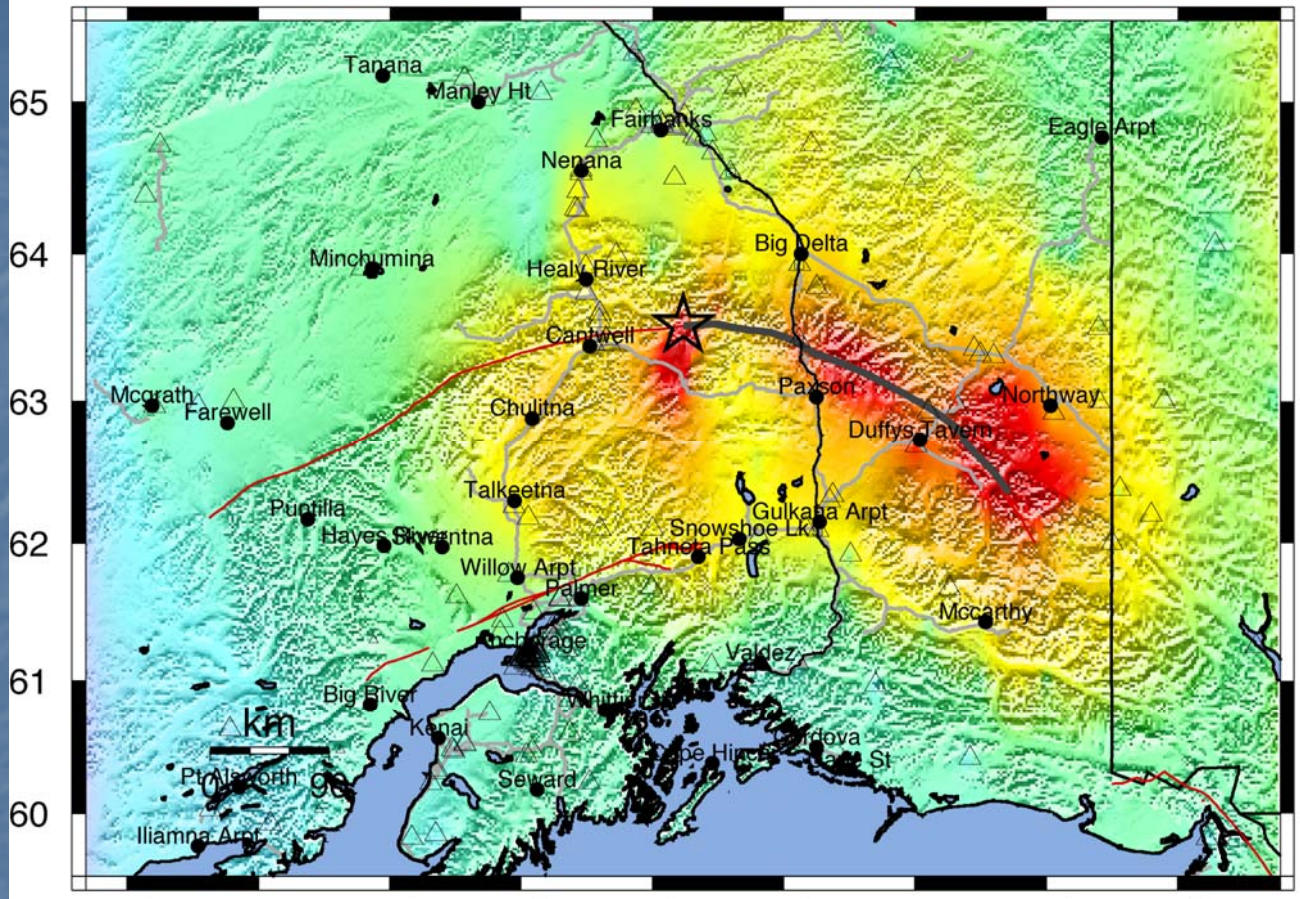


Figure 2. Map showing Alaska seismicity between the years of 1990 to 1995 (top). Cross section of seismicity along line AA' (bottom).

USGS Rapid Instrumental Intensity Map for event: 22614036

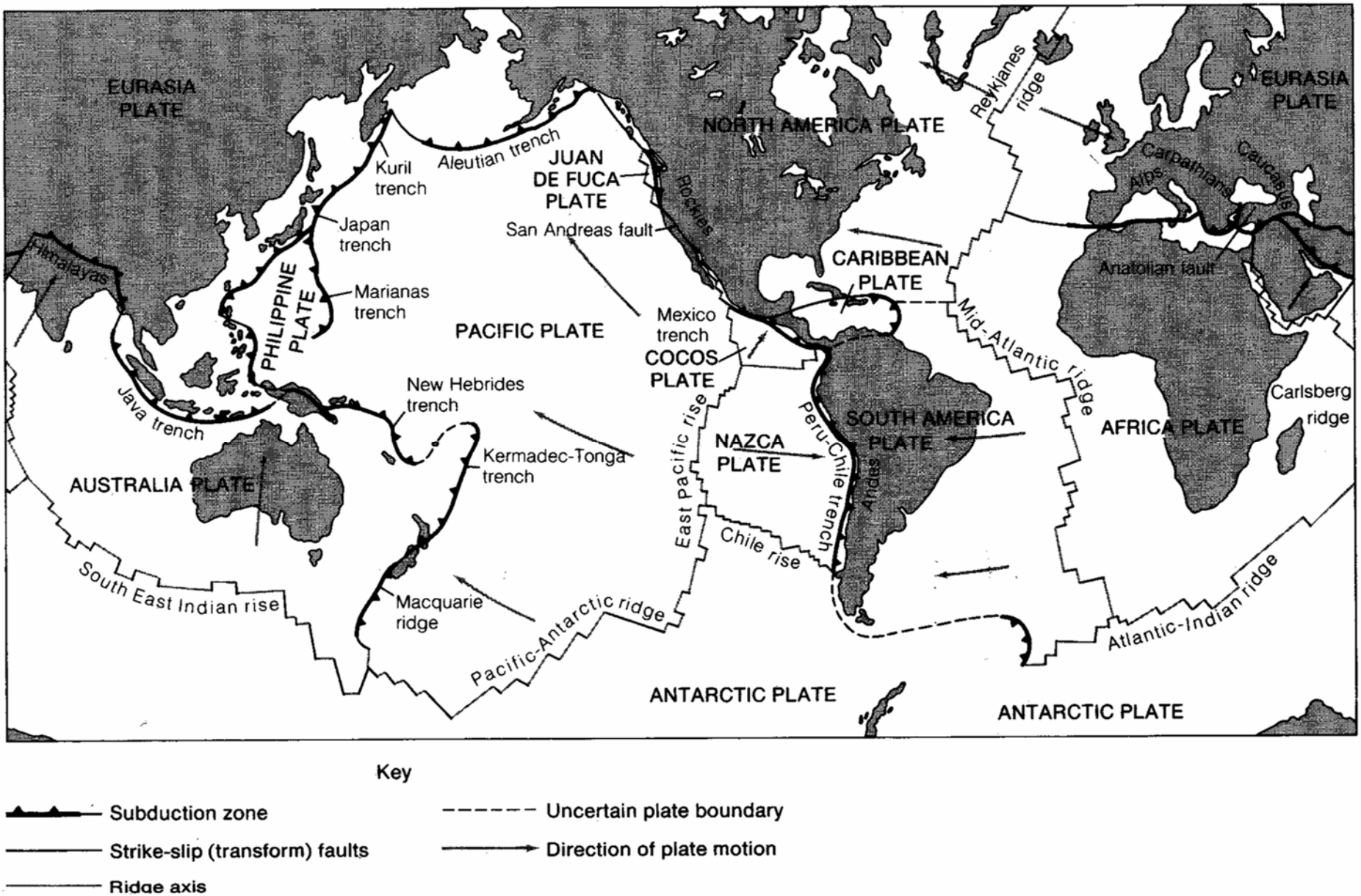
Sun Nov 3, 2002 10:12:41 PM GST M 7.9 N63.52 W147.53 Depth: 5.0km ID:22614036

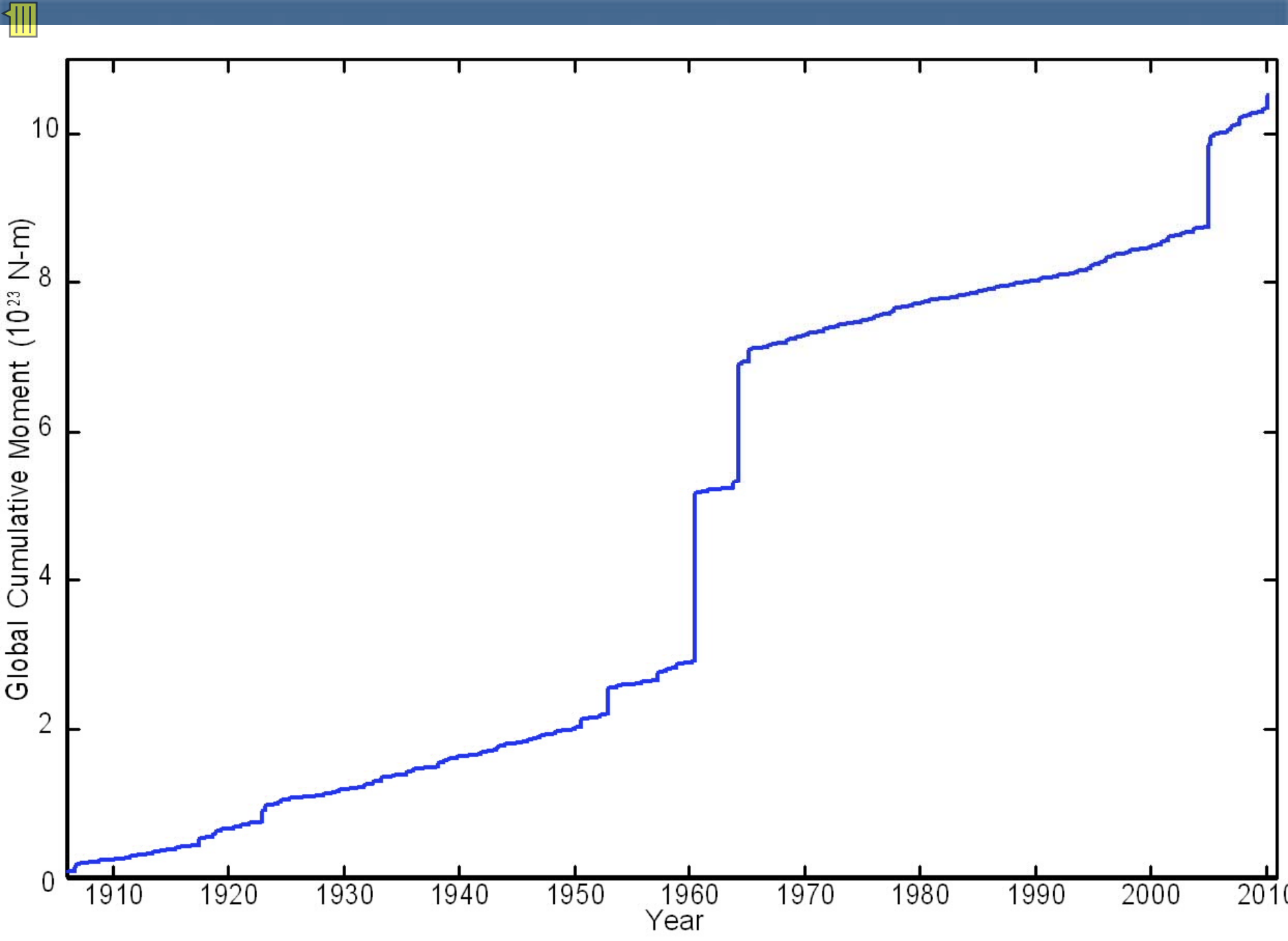


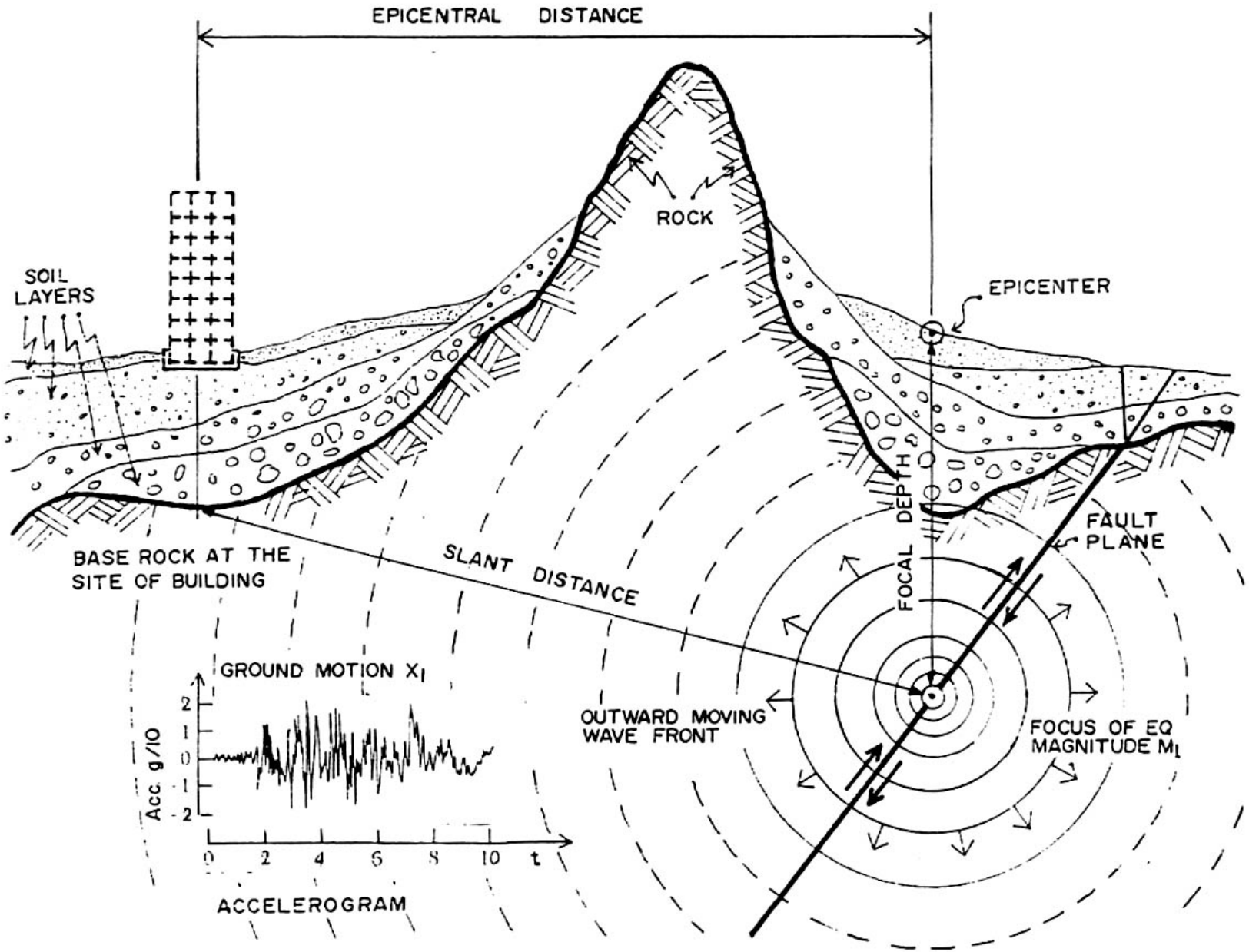
PROCESSED: Fri Jan 31, 2003 08:30:04 PM GST,

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+

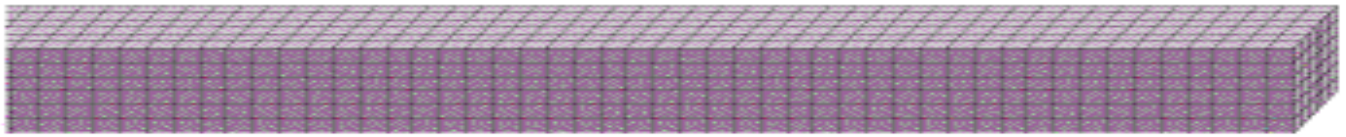
Earthquake Terms and Facts


EURASIA PLATE
NORTH AMERICA PLATE
Reykjanes ridge
EURASIA PLATE
Carpathians
Alps
Caucasus
Kuril trench
Aleutian trench
JUAN DE FUCA PLATE
Rockies
Japan trench
San Andreas fault
Himalayas
PHILIPPINE PLATE
Marianas trench
CARIBBEAN PLATE
Anatolian fault
PACIFIC PLATE
Mexico trench
COCOS PLATE
Mid-Atlantic ridge
New Hebrides trench
Java trench
East Pacific rise
NAZCA PLATE
Peru-Chile trench
SOUTH AMERICA PLATE
AFRICA PLATE
Carlsberg ridge
Kermadec-Tonga trench
AUSTRALIA PLATE
Andes
Chile rise
South East Indian rise
Macquarie ridge
Pacific-Antarctic ridge
Atlantic-Indian ridge
ANTARCTIC PLATE
ANTARCTIC PLATE
Key
Subduction zone
Uncertain plate boundary
Strike-slip (transform) faults
Direction of plate motion
Ridge axis

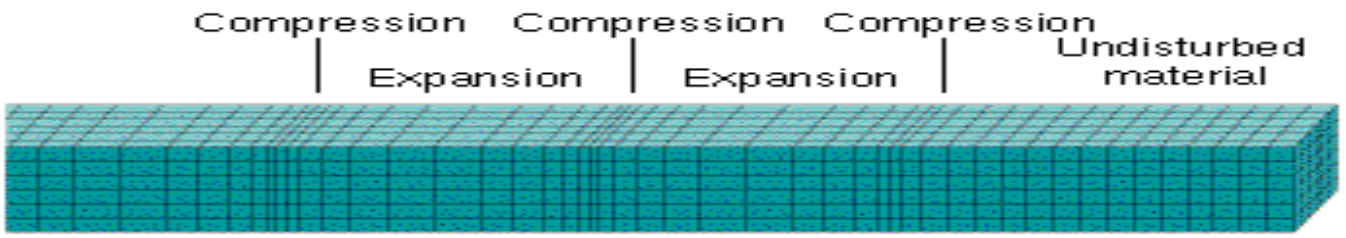

Global Cumulative Moment (10^{23} N-m)
0
2
4
6
8
10
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
Year


EPICENTRAL DISTANCE
ROCK
SOIL LAYERS
EPICENTER
FAULT PLANE
FOCAL DEPTH
BASE ROCK AT THE SITE OF BUILDING
SLANT DISTANCE
GROUND MOTION X_t
Acc. g/10
2
1
0
-1
-2
0
2
4
6
8
10
t
ACCELEROGRAM
OUTWARD MOVING WAVE FRONT
FOCUS OF EQ MAGNITUDE M_L

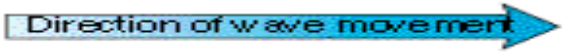
Seismic Waves

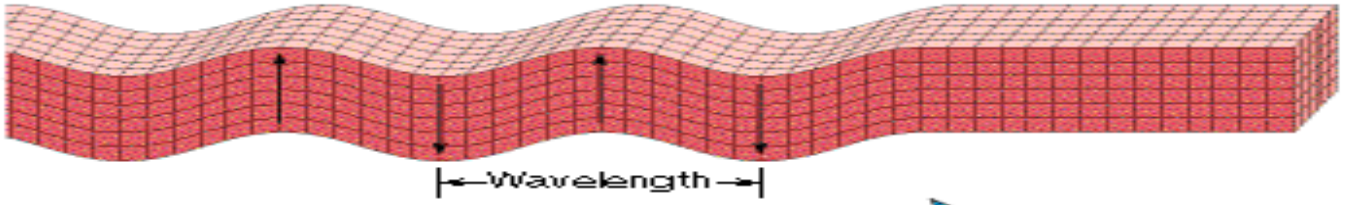


(a) Undisturbed material

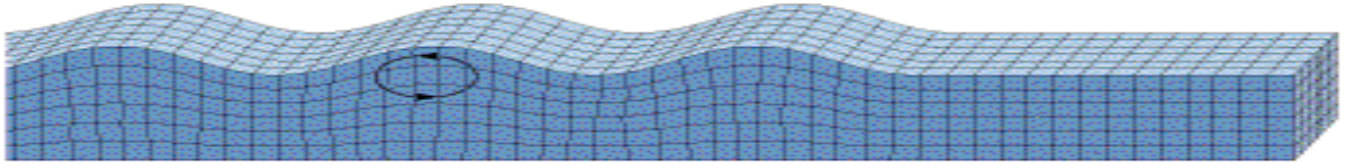


(b) Primary wave

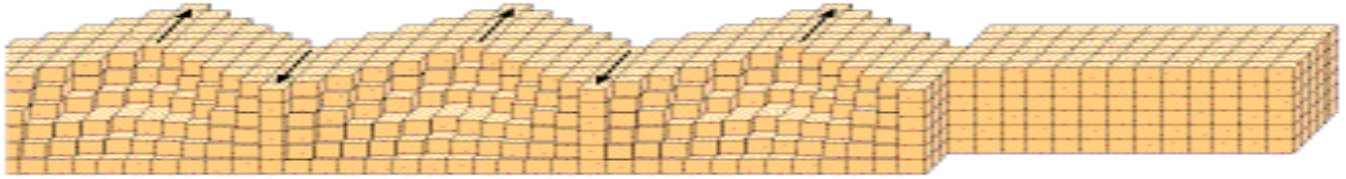




(c) Secondary wave



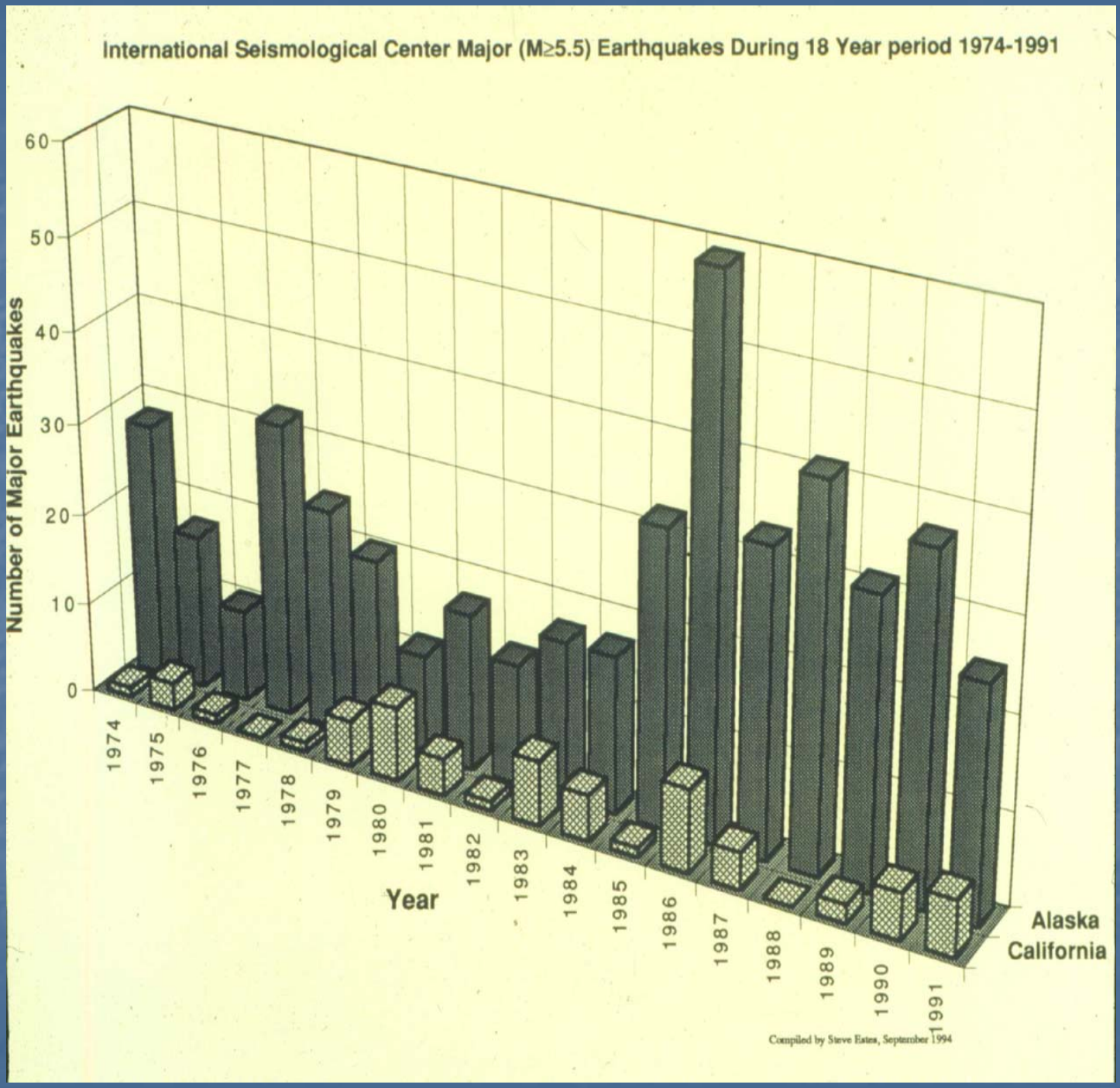
(d) Rayleigh wave

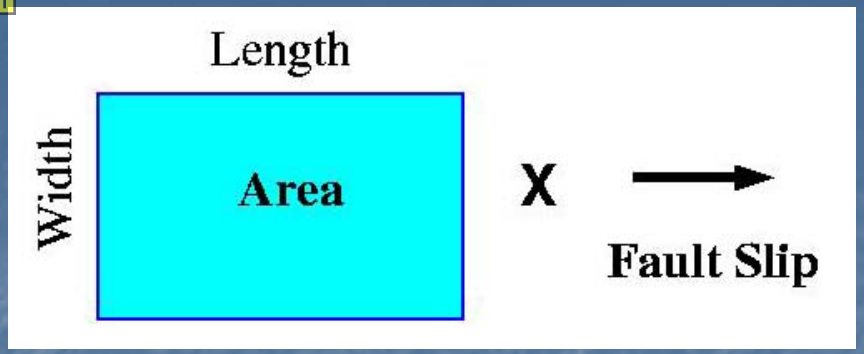


(e) Love wave

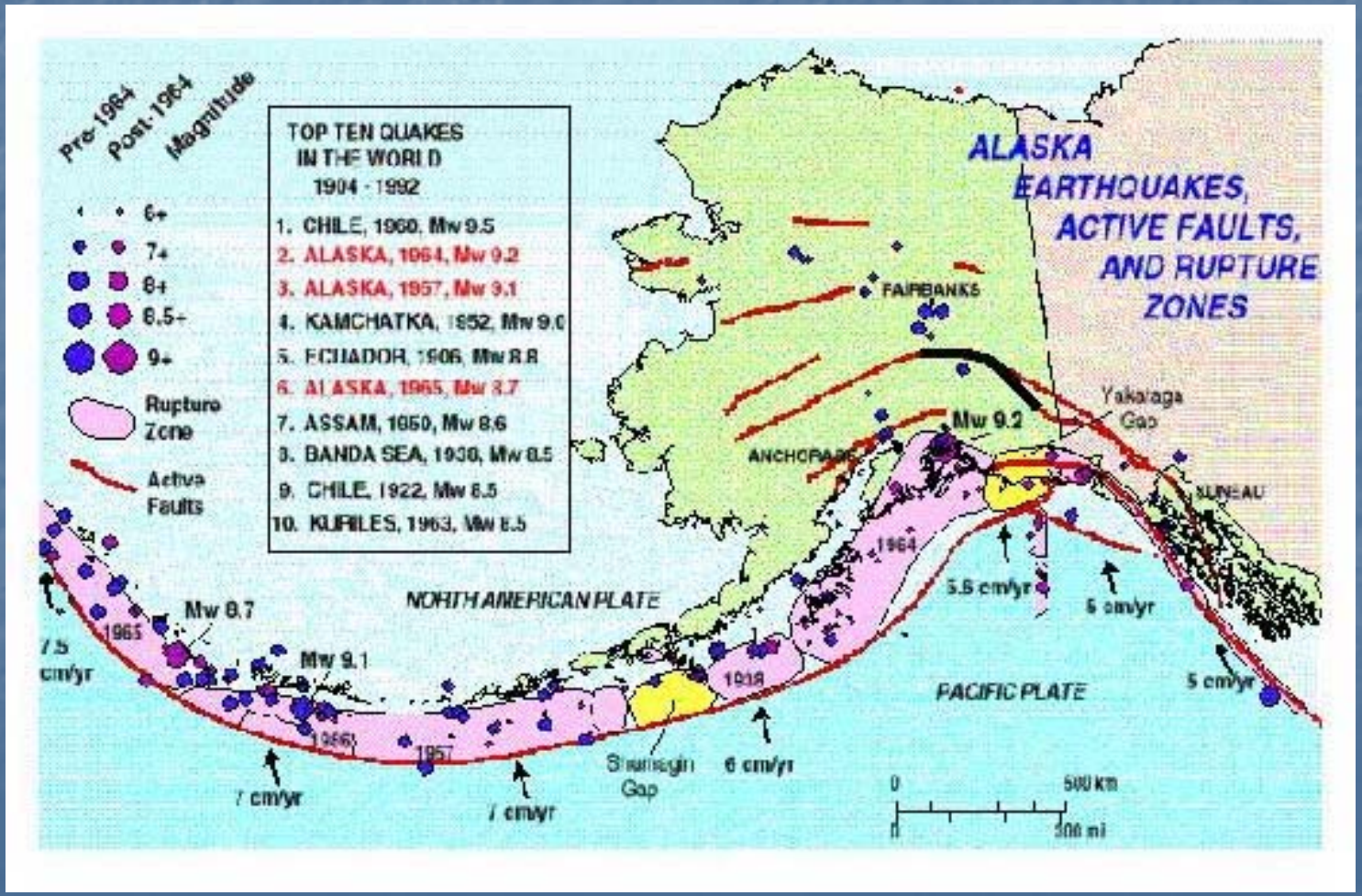
Hazard vs Risk

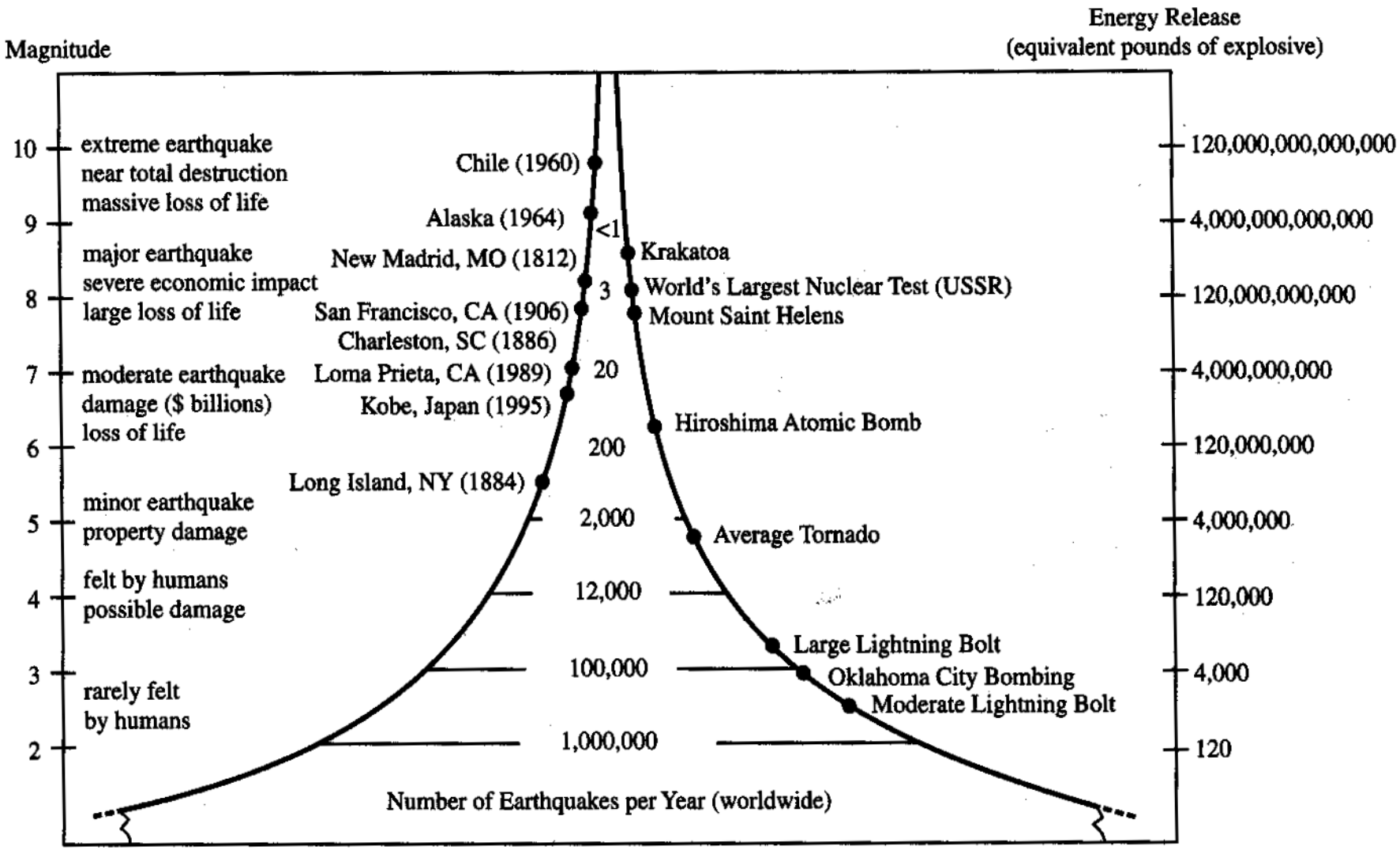
- Seismic Hazard
  - The expected occurrence of a future seismic event
- Seismic Risk
  - The expected consequences of a future seismic event


International Seismological Center Major (M≥5.5) Earthquakes During 18 Year period 1974-1991
Number of Major Earthquakes
60
50
40
30
20
10
0
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
Year
Alaska
California
Compiled by Steve Estes, September 1994

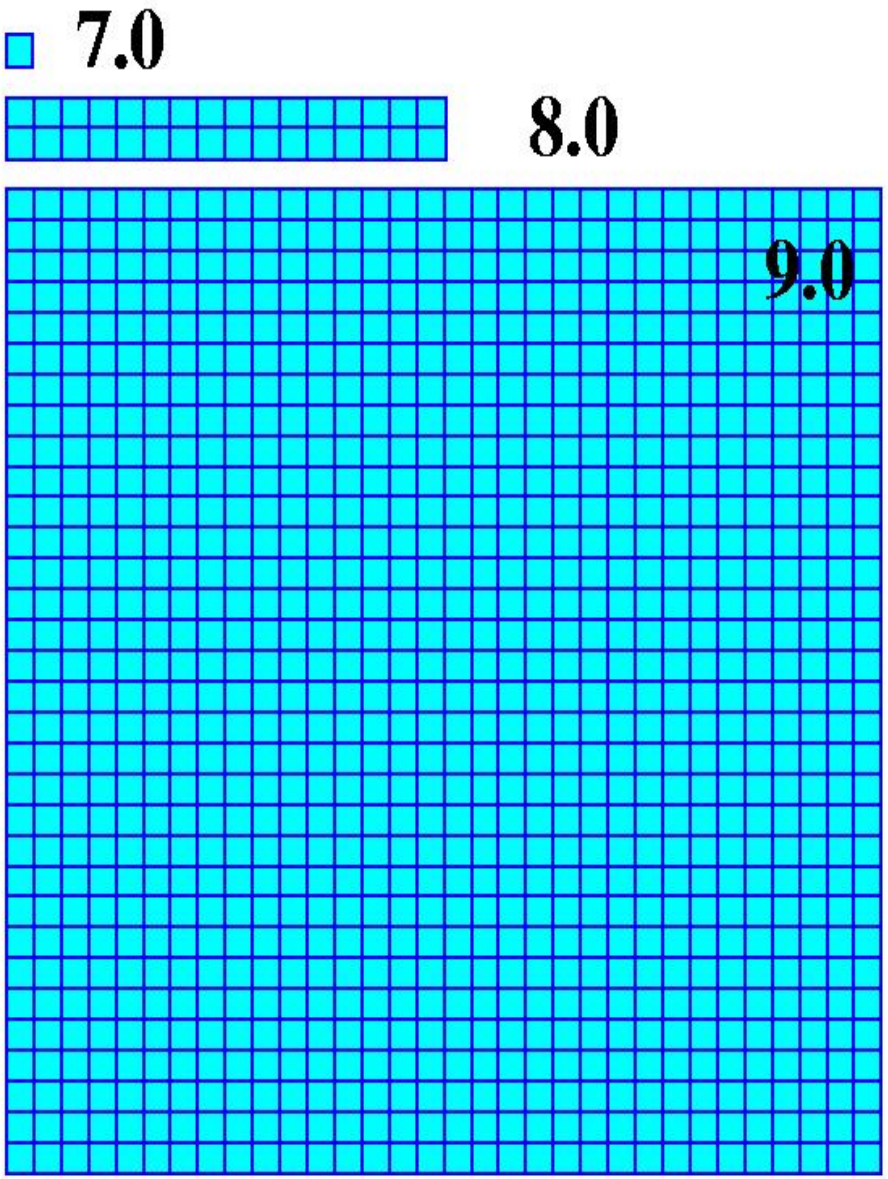


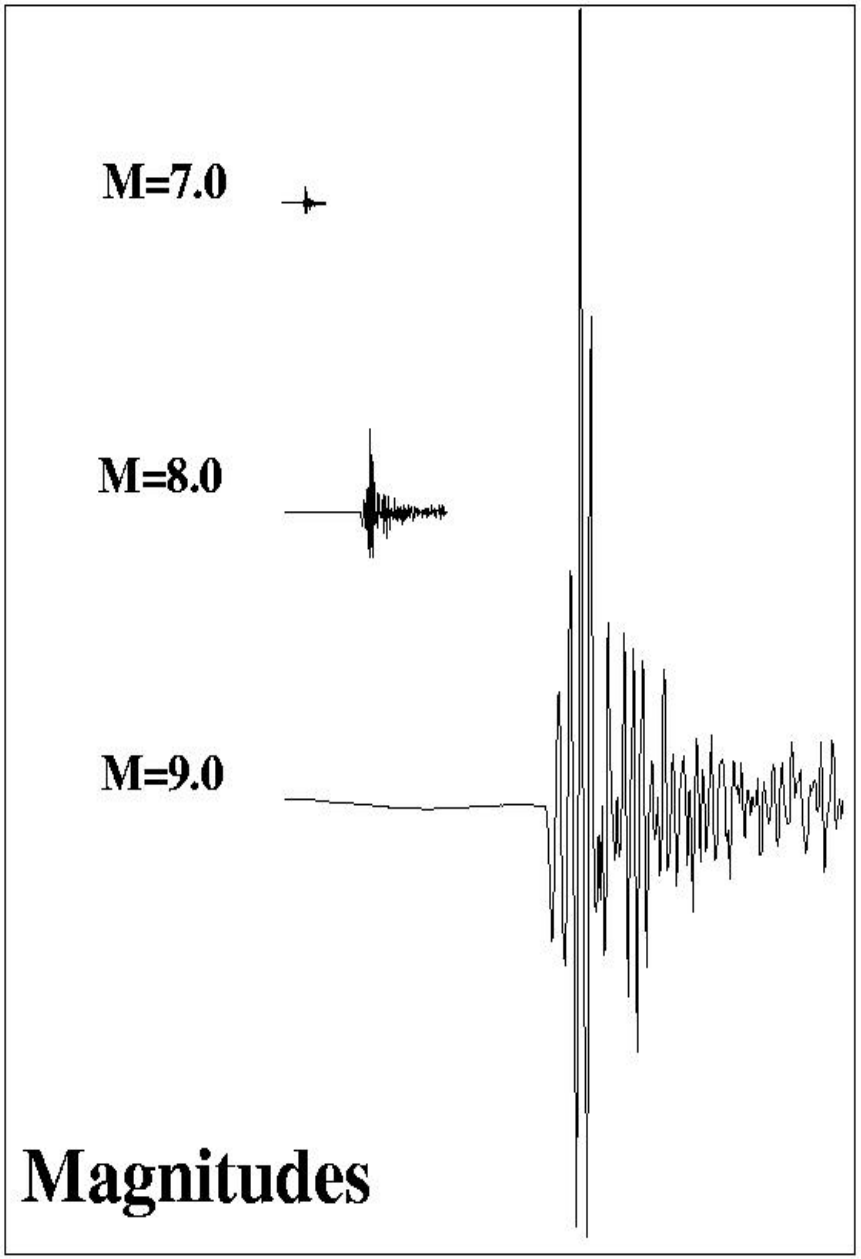
Denali Fault Earthquake M=7.9

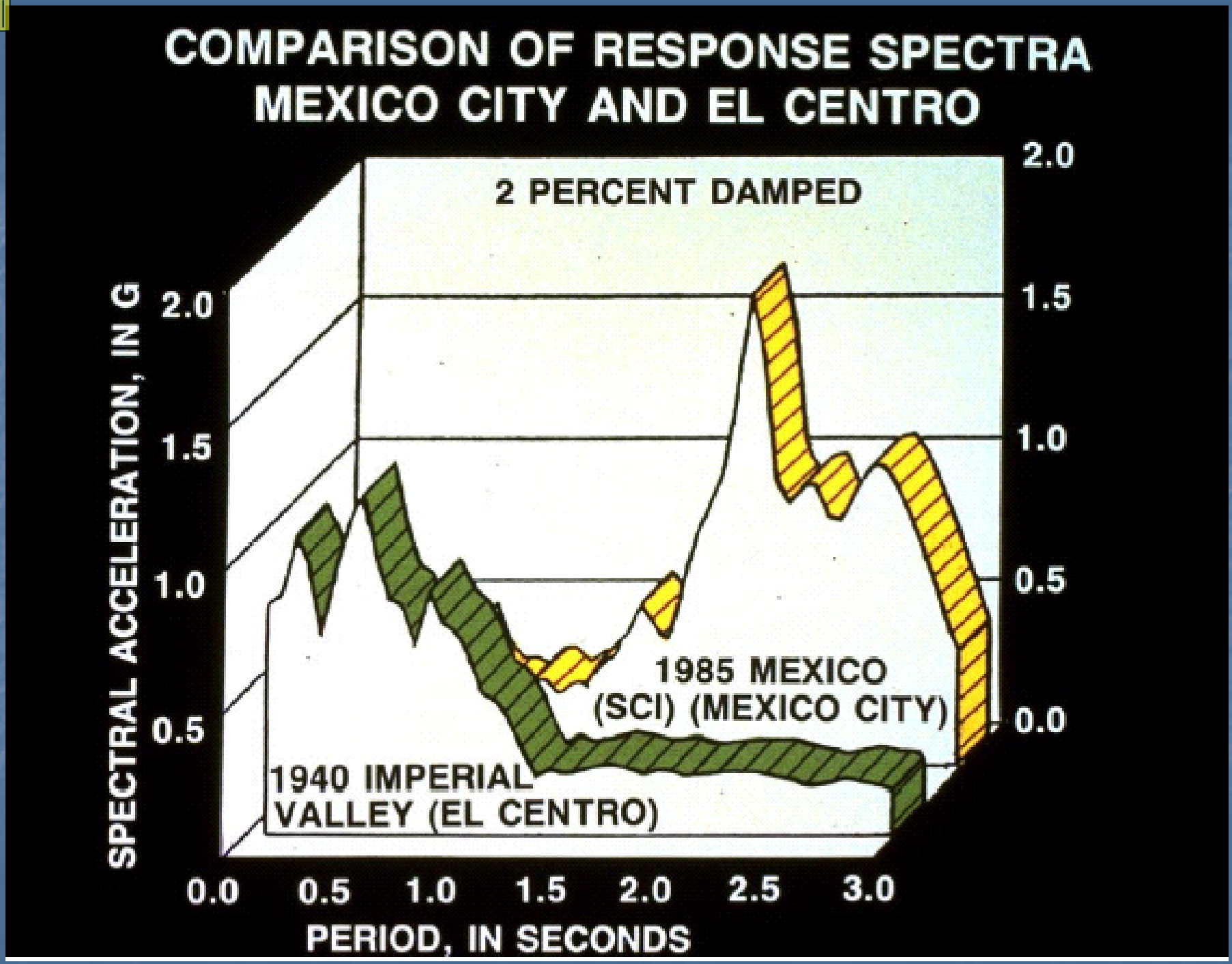



Magnitude
Energy Release
(equivalent pounds of explosive)
10
extreme earthquake
near total destruction
massive loss of life
9
major earthquake
severe economic impact
large loss of life
8
7
moderate earthquake
damage ($ billions)
loss of life
6
minor earthquake
property damage
5
felt by humans
possible damage
4
rarely felt
by humans
3
2
Chile (1960)
Alaska (1964)
New Madrid, MO (1812)
San Francisco, CA (1906)
Charleston, SC (1886)
Loma Prieta, CA (1989)
Kobe, Japan (1995)
Long Island, NY (1884)
<1
3
20
200
2,000
12,000
100,000
1,000,000
Krakatoa
World's Largest Nuclear Test (USSR)
Mount Saint Helens
Hiroshima Atomic Bomb
Average Tornado
Large Lightning Bolt
Oklahoma City Bombing
Moderate Lightning Bolt
120,000,000,000,000
4,000,000,000,000
120,000,000,000
4,000,000,000
120,000,000
4,000,000
120,000
4,000
120
Number of Earthquakes per Year (worldwide)

SEISMIC ENERGY




M=7.0
M=8.0
M=9.0
Magnitudes


COMPARISON OF RESPONSE SPECTRA
MEXICO CITY AND EL CENTRO
2 PERCENT DAMPED
SPECTRAL ACCELERATION, IN G
2.0
1.5
1.0
0.5
0.0
1985 MEXICO
(SCI) (MEXICO CITY)
1940 IMPERIAL
VALLEY (EL CENTRO)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
PERIOD, IN SECONDS

Cause of Damage

Tsunami

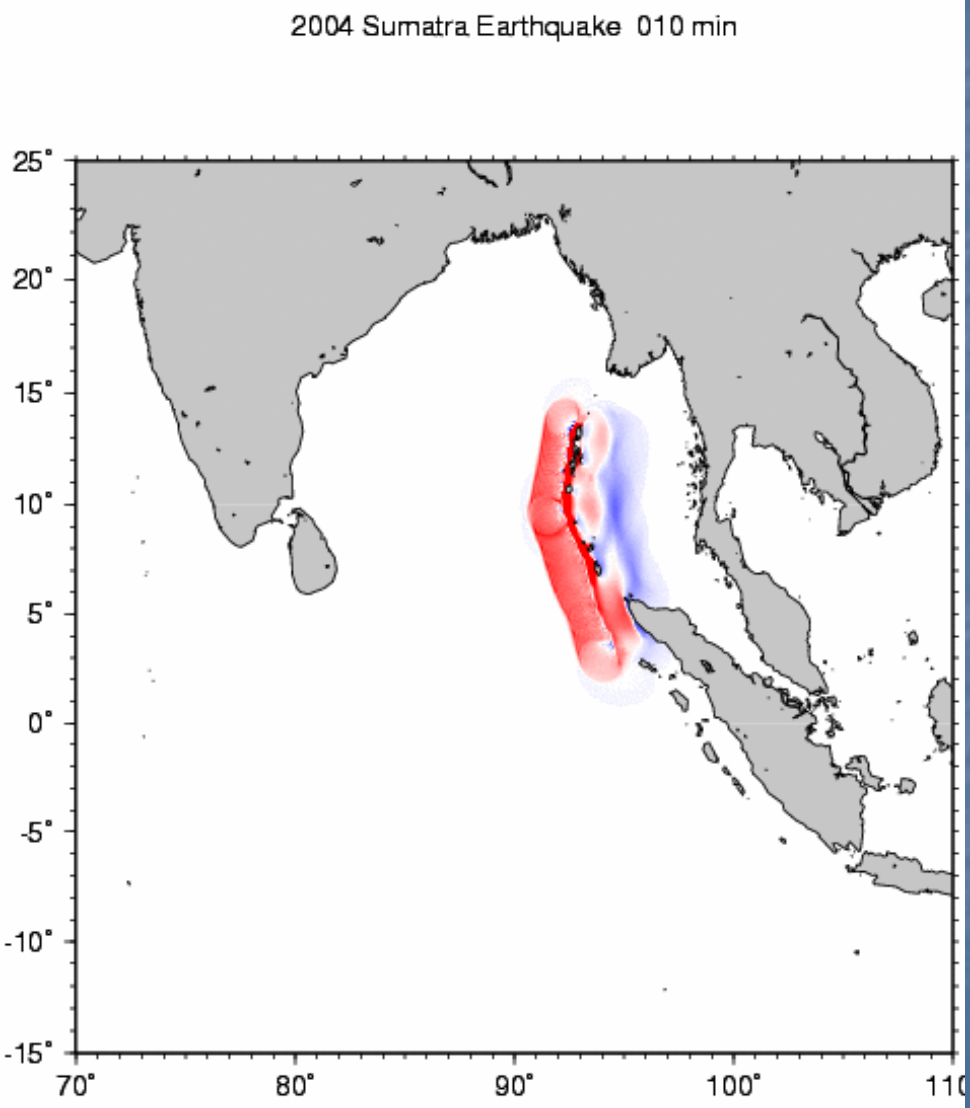
Ground Failure

Ground Rupture

Ground Shaking

Tsunami

Tsunami Propagation

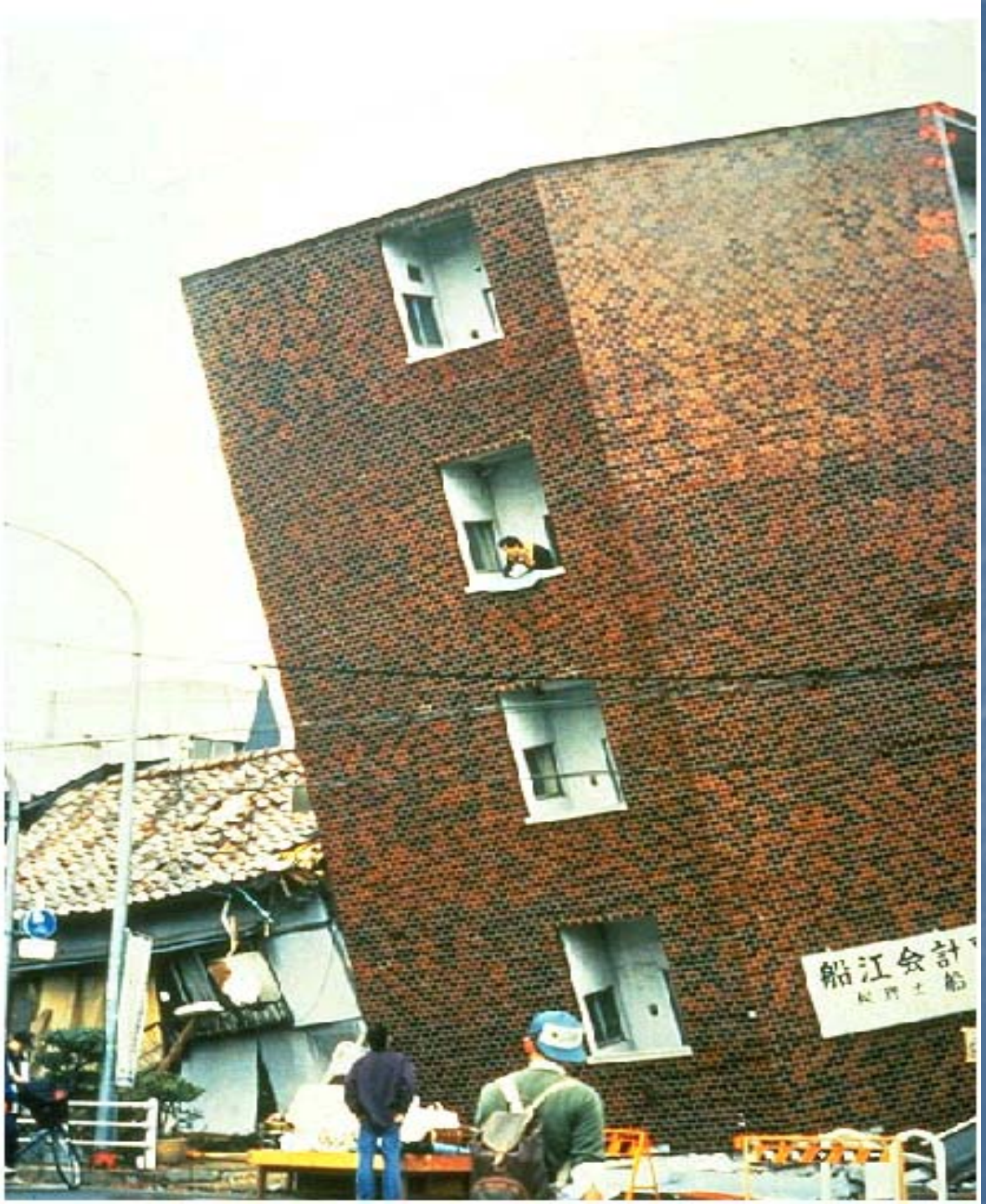


National Institute of Advanced Industrial Science and Technology, Japan

Ground Failure

Ground Failure-Turnagain Slide

Liquefaction


船江会計

Ground Shaking


Hôtel de Carlo

Current Research

ALASKA DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS
IN COOPERATION WITH THE MUNICIPALITY OF ANCHORAGE

MISCELLANEOUS PUBLICATION 32
WEEMS AND COMBELLICK

SEISMICALLY INDUCED GROUND-FAILURE SUSCEPTIBILITY ANCHORAGE, ALASKA

Harding-Lawson Associates (1979)

Digitally recompiled with 1993-1994 revised topography
by
S.M. Weems and R.A. Combellick
1997

KNIK ARM

TURNAGAIN ARM

EXPLANATION

- Very high ground-failure susceptibility
- High ground-failure susceptibility
- Moderate ground-failure susceptibility
- Moderately low ground-failure susceptibility
- Lowest ground-failure susceptibility

SCALE 1:25,000

TOPOGRAPHIC CONTOUR INTERVAL 5 METERS (WEST) AND 20 METERS (EAST)

APPROXIMATE MEAN DECLINATION, 1994

SOURCES:

Harding-Lawson Associates, 1979, Geotechnical hazards assessment study, Municipality of Anchorage: Harding-Lawson Associates job no. 5502,009.08

Base modified from U.S. Geological Survey Anchorage A-8NE, A-8NW, A-8SE, A-8SW, and Tyonek A-1NE Quadrangles, 1993 and 1994. Universal Transverse Mercator projection, Zone 6, NAD 27.

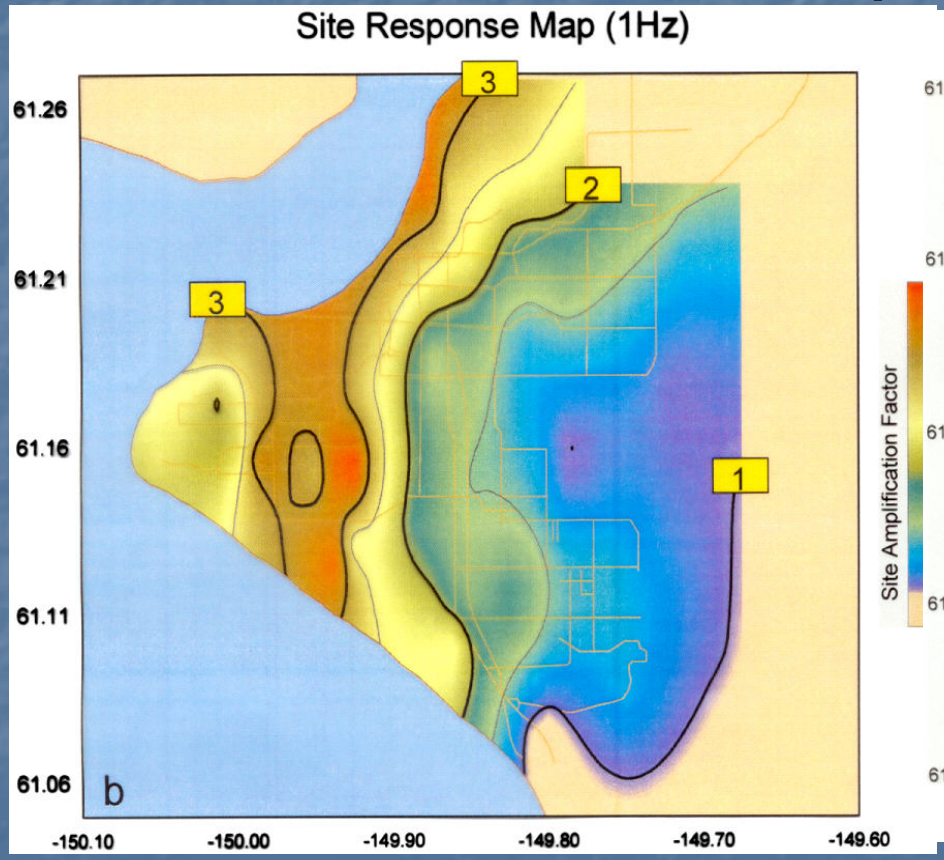
Alaska Department of Natural Resources
Division of Geological & Geophysical Surveys

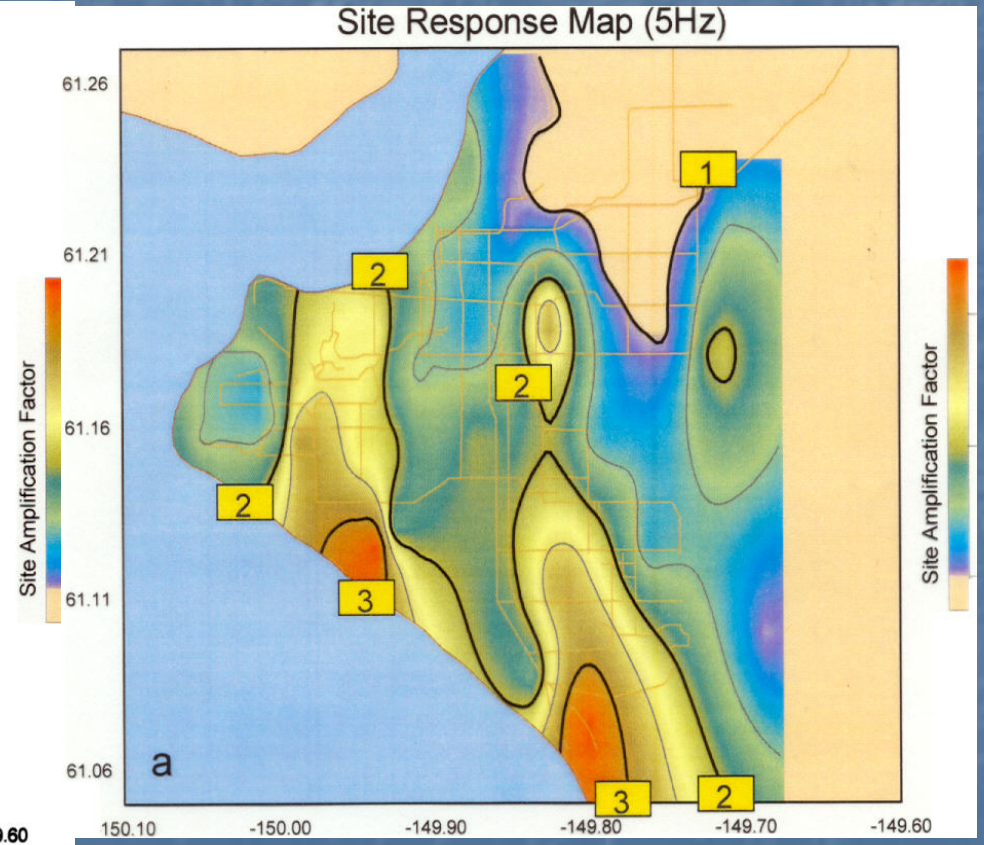
ANSS Anchorage Strong Motion Stations

Red - UAF GI sites

Black - USGS NSMP sites

Anchorage Strong Motion Program: Site Response





Delaney Park Downhole Array

Enclosure

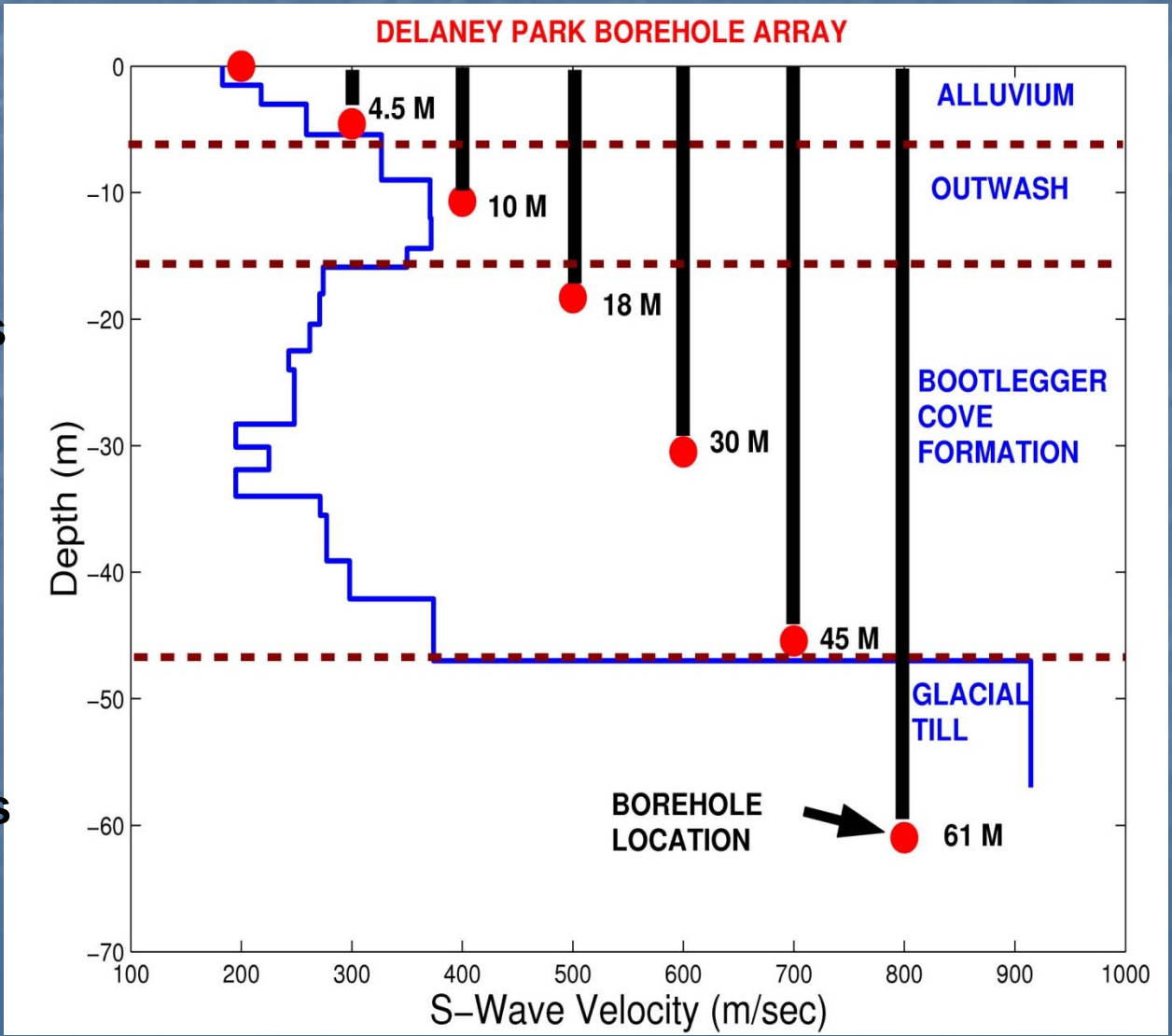
Hyposensor

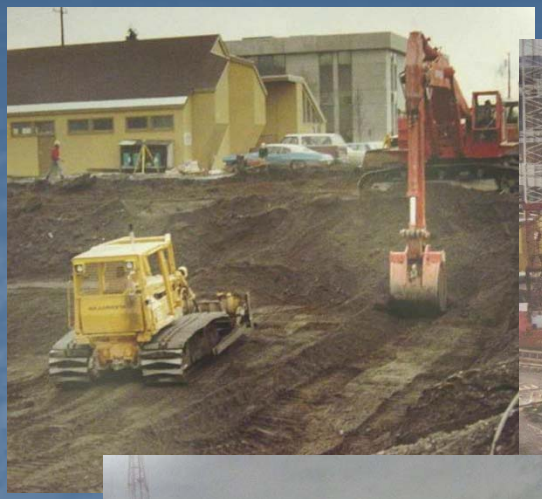
Atwood Building

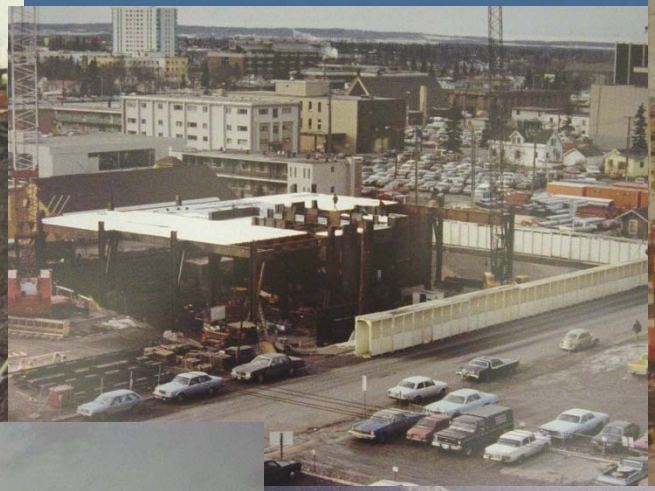
Downhole Array

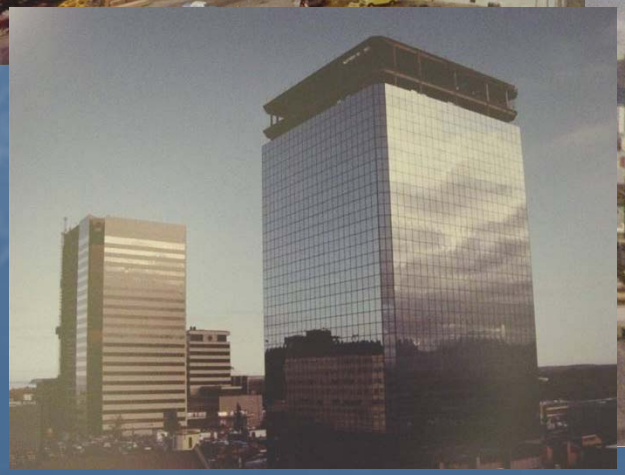
Delaney Park Downhole Array: Depth Profile

DPDA Consists of 6 boreholes and one surface accelerometers.
The deepest sensor is located in a glacial till formation with shear wave velocity > 900m /s, corresponding to engineering bedrock.
The sensors are arranged such a way so that characteristics of major formations can be studied.

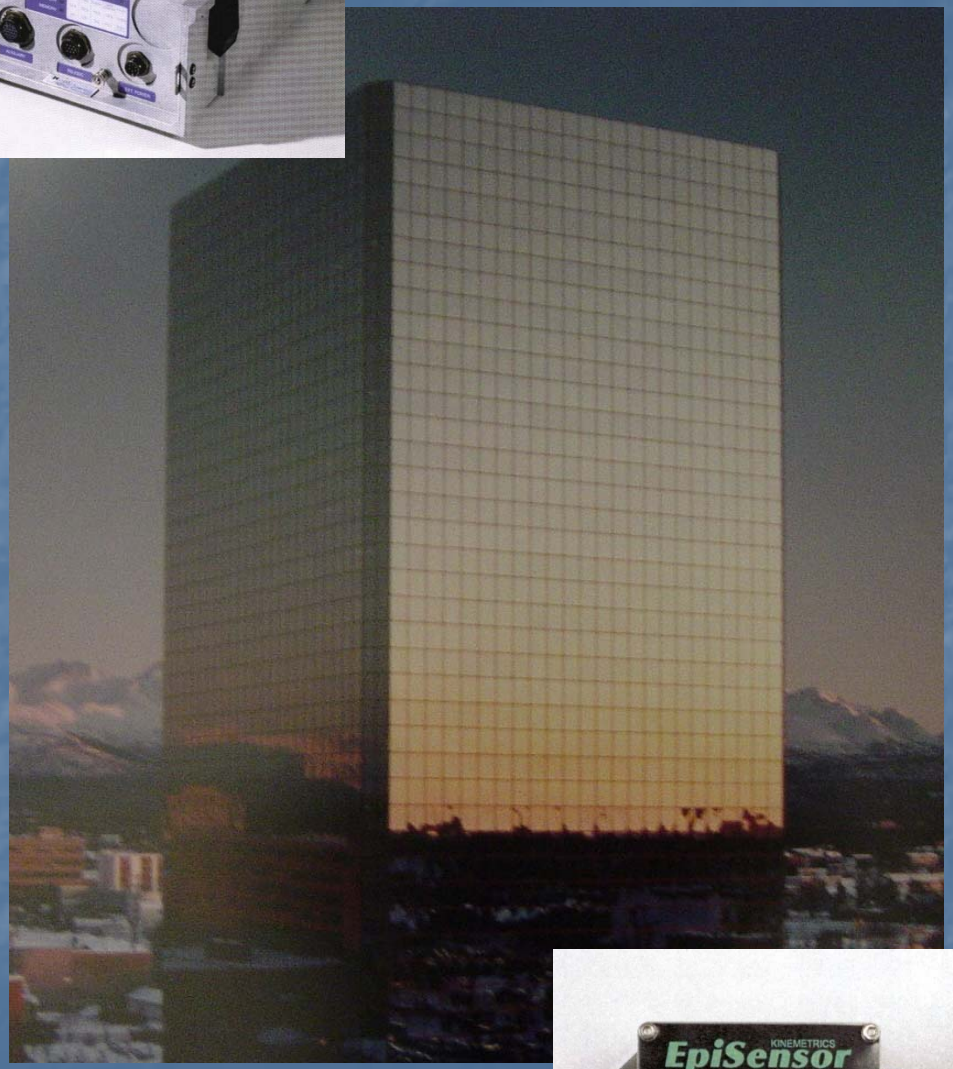


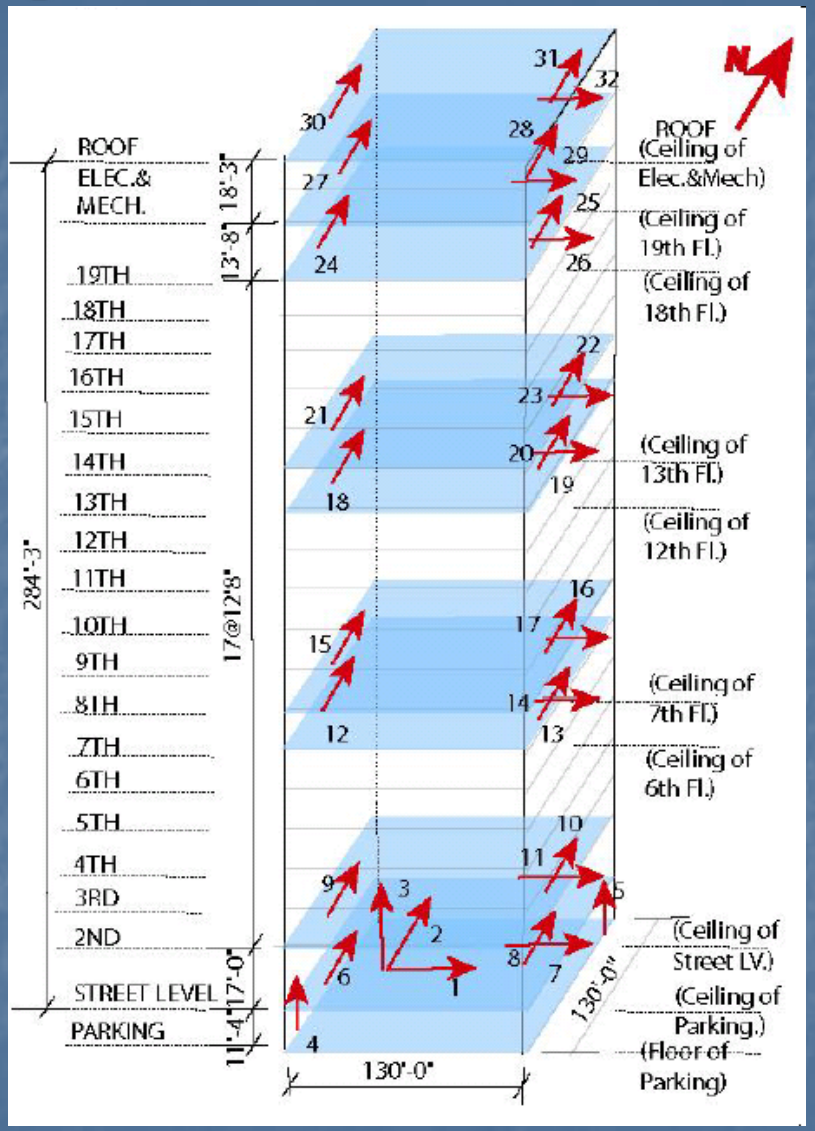


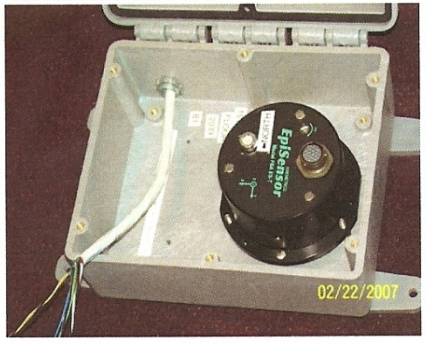


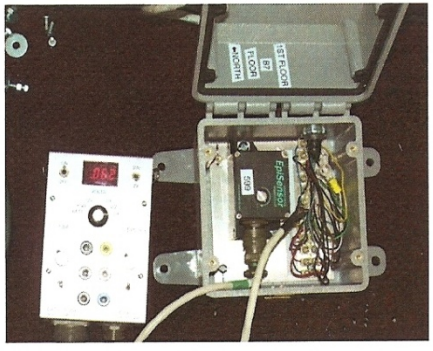


Atwood Building



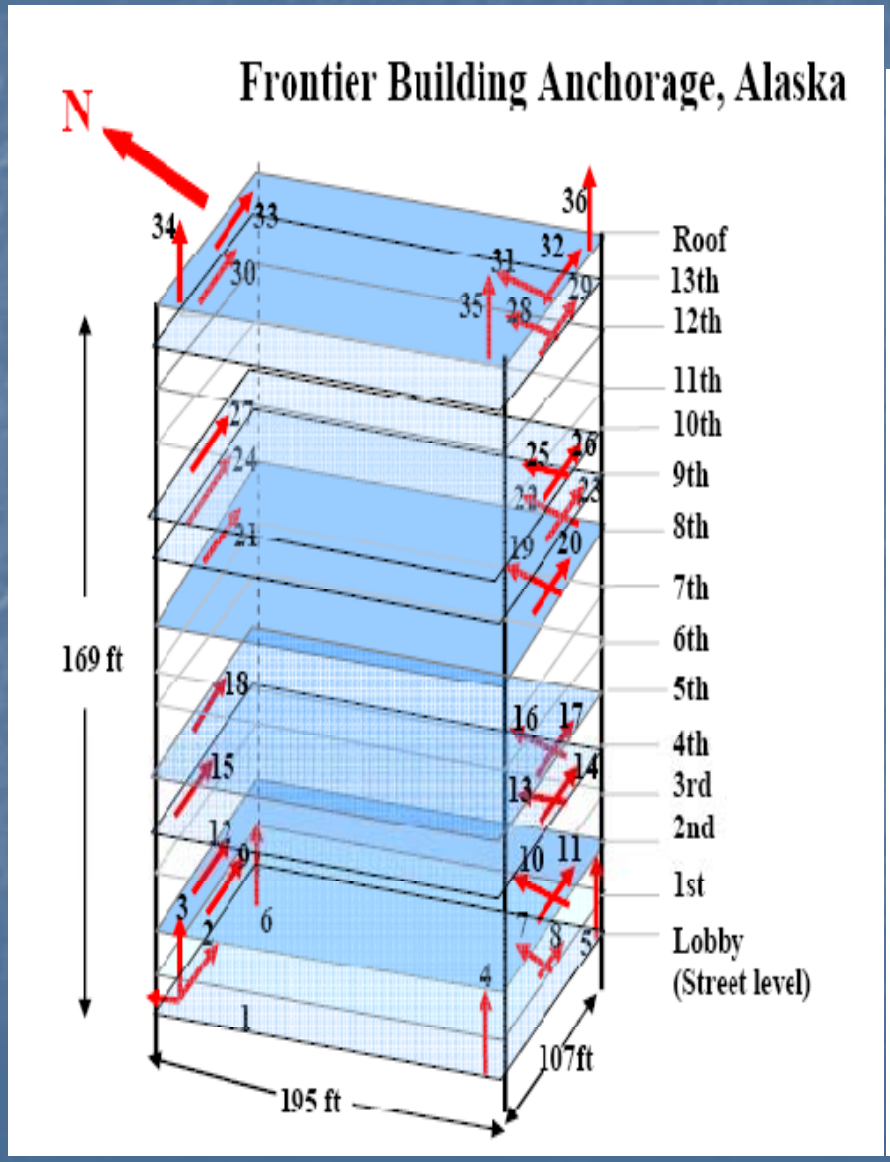



EpiSensor
02/22/2007

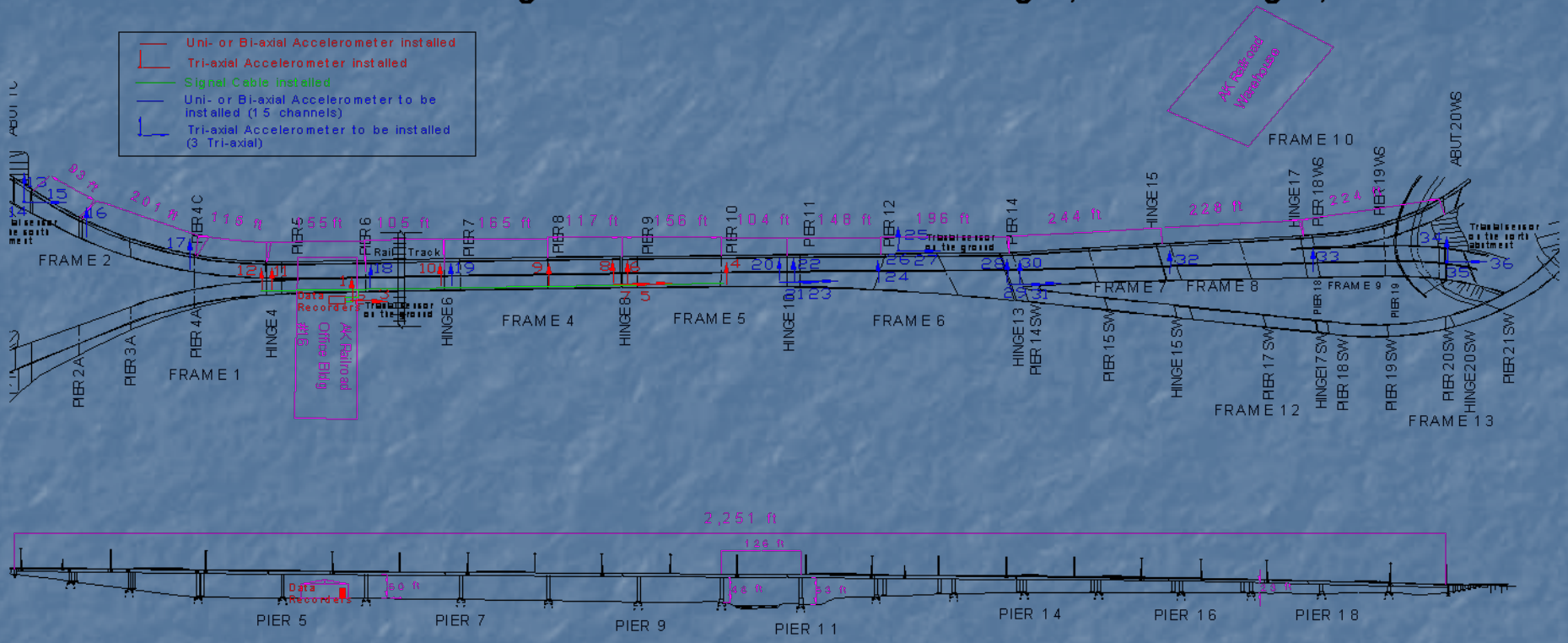

1ST FLOOR
67
11 FLOOR
HIGHER
EpiSensor


02/21/2007

Anchorage Strong Motion Program: Frontier Building



Anchorage Strong Motion Program: Port Access Bridge



Alaska Seismic Hazards Safety Commission

Membership

- Dr. John L. Aho, Chair
- Laura Kelly, P.E., Vice-chair
- David Cole, P.E.
- Dr. Roger Hansen,
- Dr. Gary Carver
- Rod Combellick
- Gayle White
- Gay Dunham
- Dave Miller
- Mark Roberts

ASHSC Alaska Seismic Hazards Safety Commission

Powers & Duties

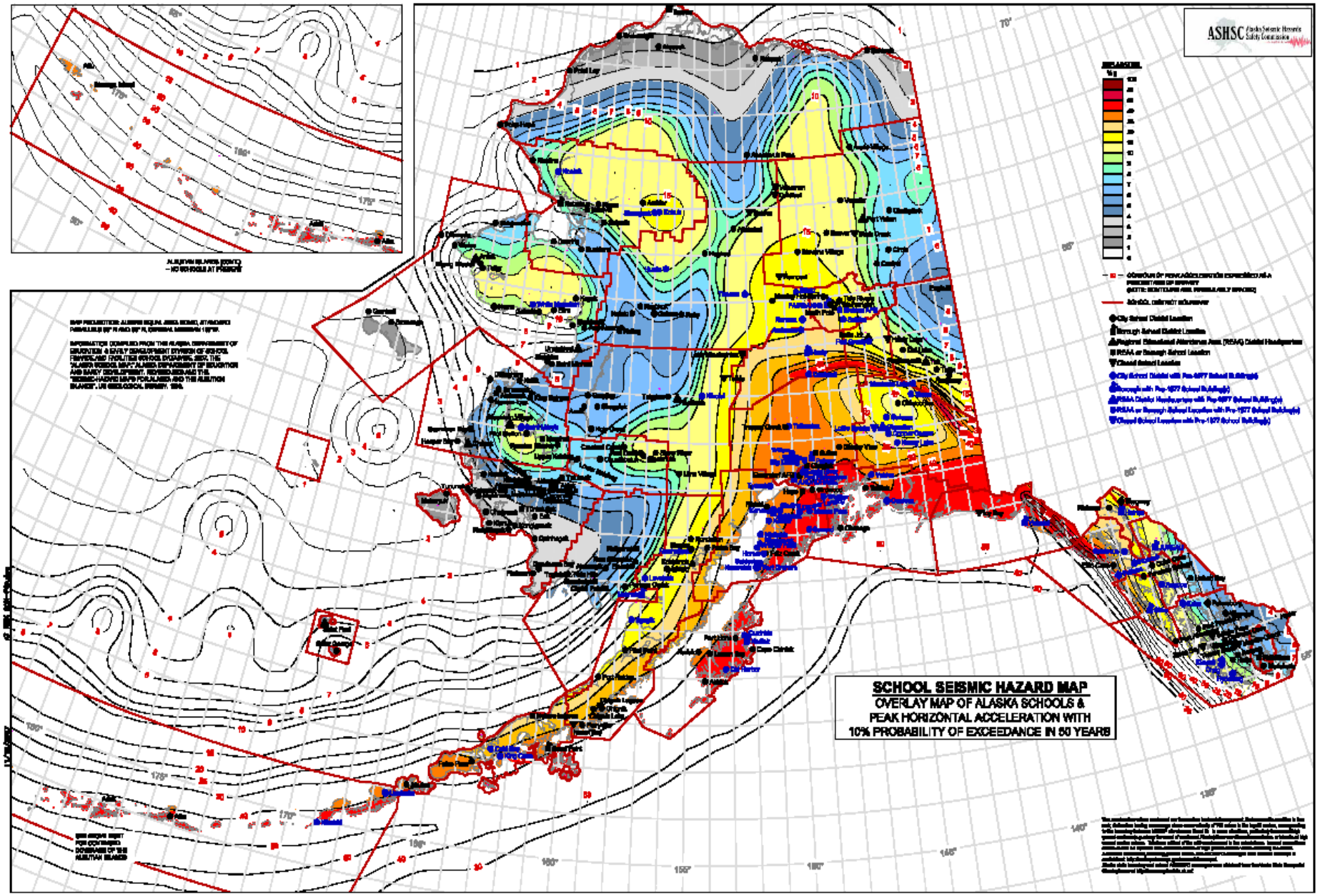
1. Recommend seismic risk mitigation goals & priorities
2. Recommend needed research, mapping, and monitoring programs
3. Offer advice on coordinating disaster preparedness
4. Review practices for recovery & reconstruction
5. Recommend improvements to mitigate losses from future events
6. Gather, analyze, & disseminate information
7. Establish working relationships with public and private agencies
8. Review warnings & suggest appropriate responses
9. Review proposed seismic notifications
10. Recommend issuance of notifications
11. Give appropriate response advice

ASHSC Alaska Seismic Hazards Safety Commission

Standing Committees

- Schools
- Earthquake Scenario
- Education and Outreach
- Insurance
- Hazards Identification
- Response & Recovery
- Partnership
- 2014 Conference Planning

ASHSC Alaska Seismic Hazards Safety Commission


ASHSC
SCHOOL SEISMIC HAZARD MAP
OVERLAY MAP OF ALASKA SCHOOLS &
PEAK HORIZONTAL ACCELERATION WITH
10% PROBABILITY OF EXCEEDANCE IN 50 YEARS

QUESTIONS?

Me and my airplane