

EARTHQUAKE BRIEFING

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

Presentation to: Alaska Partnership for
Infrastructure Protection (APIP)












DISCUSSION TOPICS

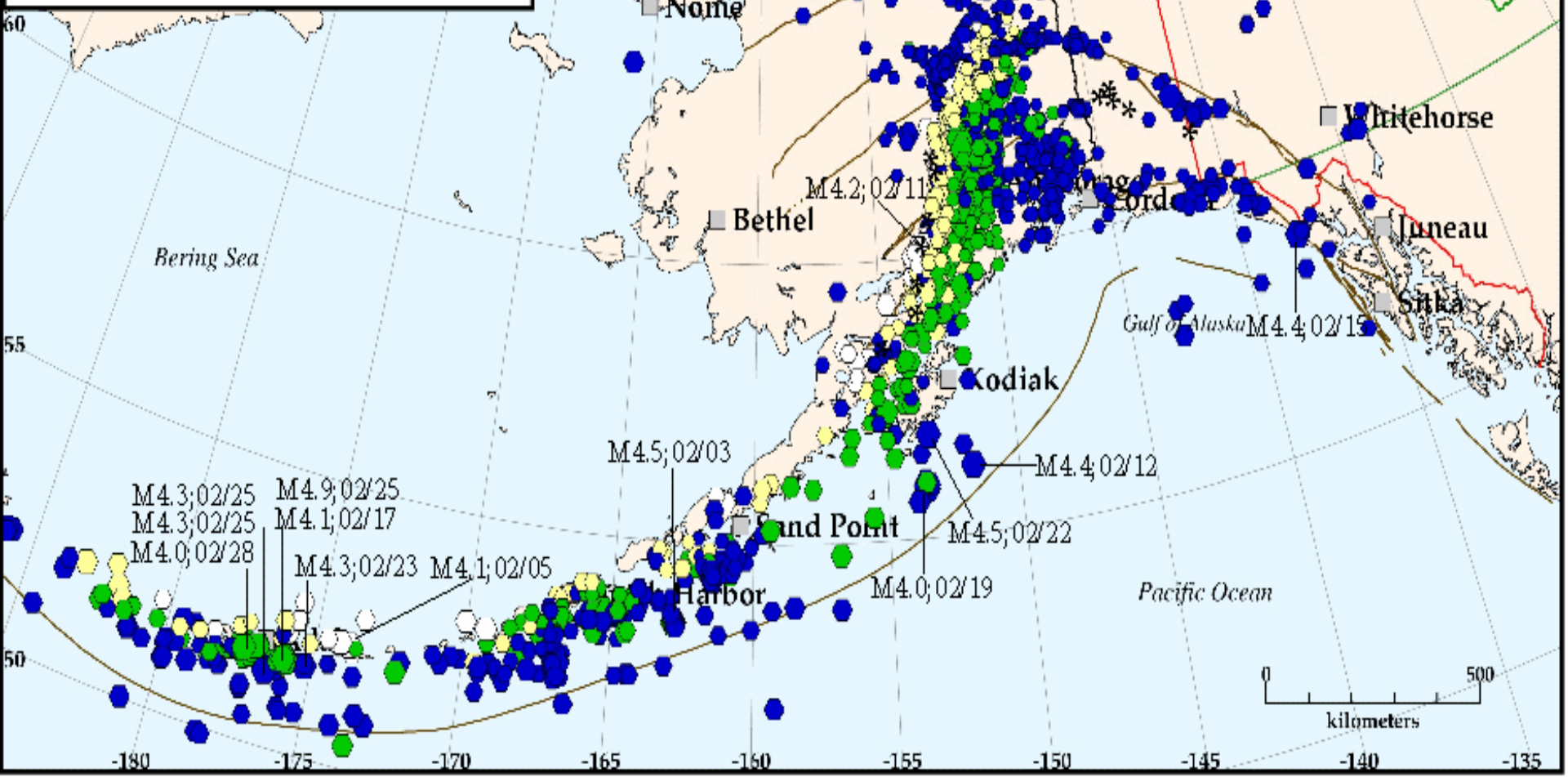
- Why Worry?
- Terms and Facts
- Damage Causes
- Research Projects
- Alaska Seismic Hazards Safety Commission
- Questions (with possible answers)

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

Alaska Earthquake Information Center
 UAF Geophysical Institute
 U.S. Geological Survey

* Volcano

- | | |
|---|---|
|  Depth <= 30 |  No M |
|  30 < Depth <= 75 |  M = 2.0 |
|  75 < Depth <= 125 |  M = 3.0 |
|  Depth > 125 |  M = 4.0 |
| 2074 events plotted |  M = 5.0 |



Alaska Seismicity

Earthquakes in Alaska

BY PETER J. HÄUSSLER AND GEORGE PLAFKER
1995

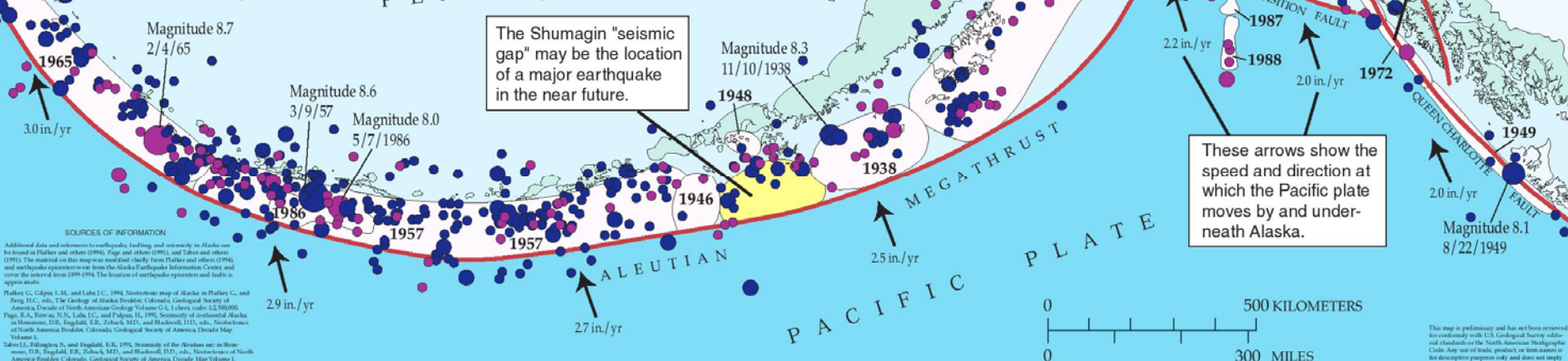
Earthquake risk is high in much of the southern half of Alaska, but it is not the same everywhere. This map shows the overall geologic setting in Alaska that produces earthquakes. The Pacific plate (darker blue) is sliding northwestward past southeastern Alaska and then dives beneath the North American plate (light blue, green, and brown) in southern Alaska, the Alaska Peninsula, and the Aleutian Islands. Most earthquakes are produced where these two plates come into contact and slide past each other. Major earthquakes also occur throughout much of interior Alaska as a result of stresses generated at the plate boundary.

- Pre-1964 Earthquakes
Post-1964 Earthquakes
Earthquake Magnitude
- 6.0 - 6.9
 - 7.0 - 7.9
 - 8.0 - 8.4
 - 8.5 - 8.9
 - 9.0 or larger

1964 Earthquake rupture zone and date of most recent rupture

Active and potentially active faults

NORTH AMERICAN PLATE



There have been three magnitude-7 earthquakes within 50 miles of Fairbanks in the last 90 years.

The Yakataga "seismic gap" may be the location of a major earthquake in the near future.

The Queen Charlotte-Fairweather fault presents the greatest earthquake hazard to residents of southeast Alaska.

The Castle Mountain fault may have generated a magnitude 6.9 earthquake that shook Anchorage in 1933.

The Shumagin "seismic gap" may be the location of a major earthquake in the near future.

These arrows show the speed and direction at which the Pacific plate moves by and underneath Alaska.

SOURCES OF INFORMATION
Additional data and references to earthquakes, faulting, and seismicity in Alaska can be found in Plafker and others (1986), Page and others (1991), and Taber and others (1991). The material on this map was modified (largely from Plafker and others (1986) and earthquake experience from the Alaska Earthquake Information Center and covers the interval from 1899-1994. The locations of earthquake epicenters and faults is approximate.
Plafker, G., Colpitts, L.M., and Lobe, J.C., 1984. Neotectonic map of Alaska in Plafker, G., and Berg, H.C., eds. The Geology of Alaska. Boulder, Colorado: Geological Society of America, Decade of North American Geology Volume 5, 1:600 scale, 1:2,500,000.
Page, R.A., Rose, G.N., Lobe, J.C., and Palacas, H., 1991. Seismicity of continental Alaska in Hameses, C.H., Engdahl, E.R., Zoback, M.D., and Blackwell, D.D., eds. Seismicity of North America. Boulder, Colorado: Geological Society of America, Decade Map Volume 5.
Taber, J.L., Billington, S., and Engdahl, E.R., 1991. Seismicity of the Aleutian arc in Hameses, C.H., Engdahl, E.R., Zoback, M.D., and Blackwell, D.D., eds. Seismicity of North America. Boulder, Colorado: Geological Society of America, Decade Map Volume 1.

This map is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards or the North American Stratigraphic Code. Any use of trade, product, or firm names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

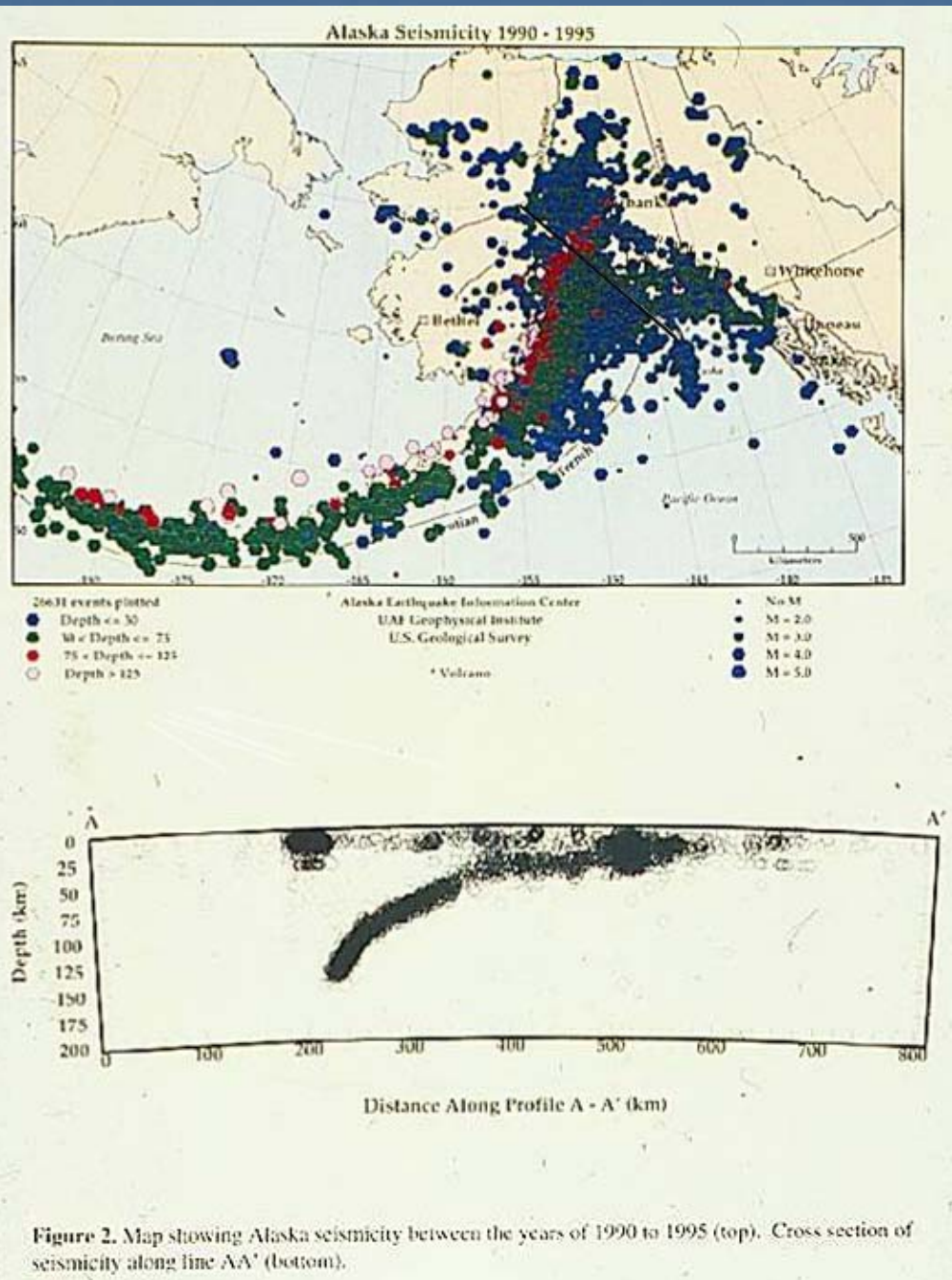
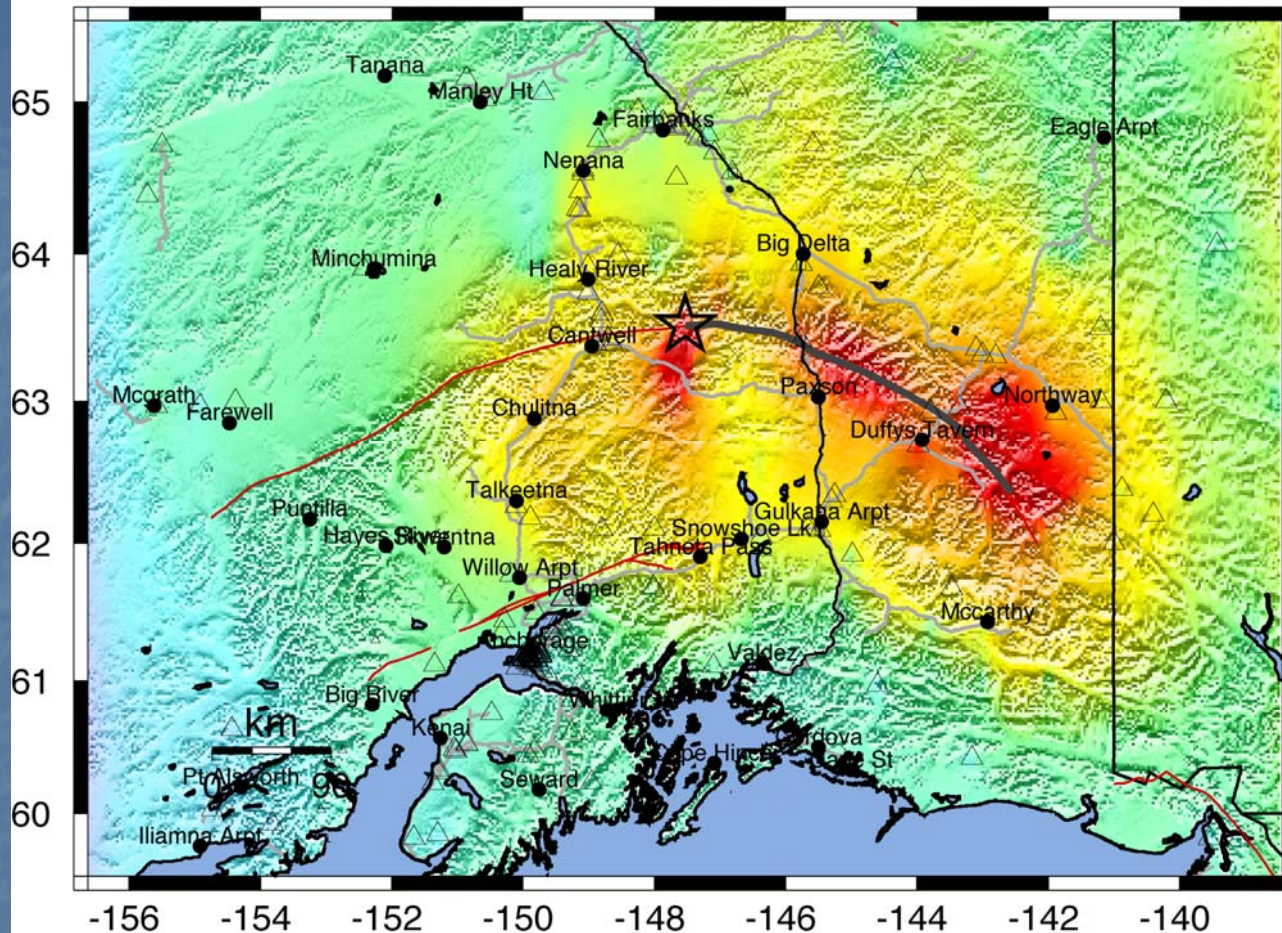


Figure 2. Map showing Alaska seismicity between the years of 1990 to 1995 (top). Cross section of seismicity along line AA' (bottom).

USGS Rapid Instrumental Intensity Map for event: 22614036

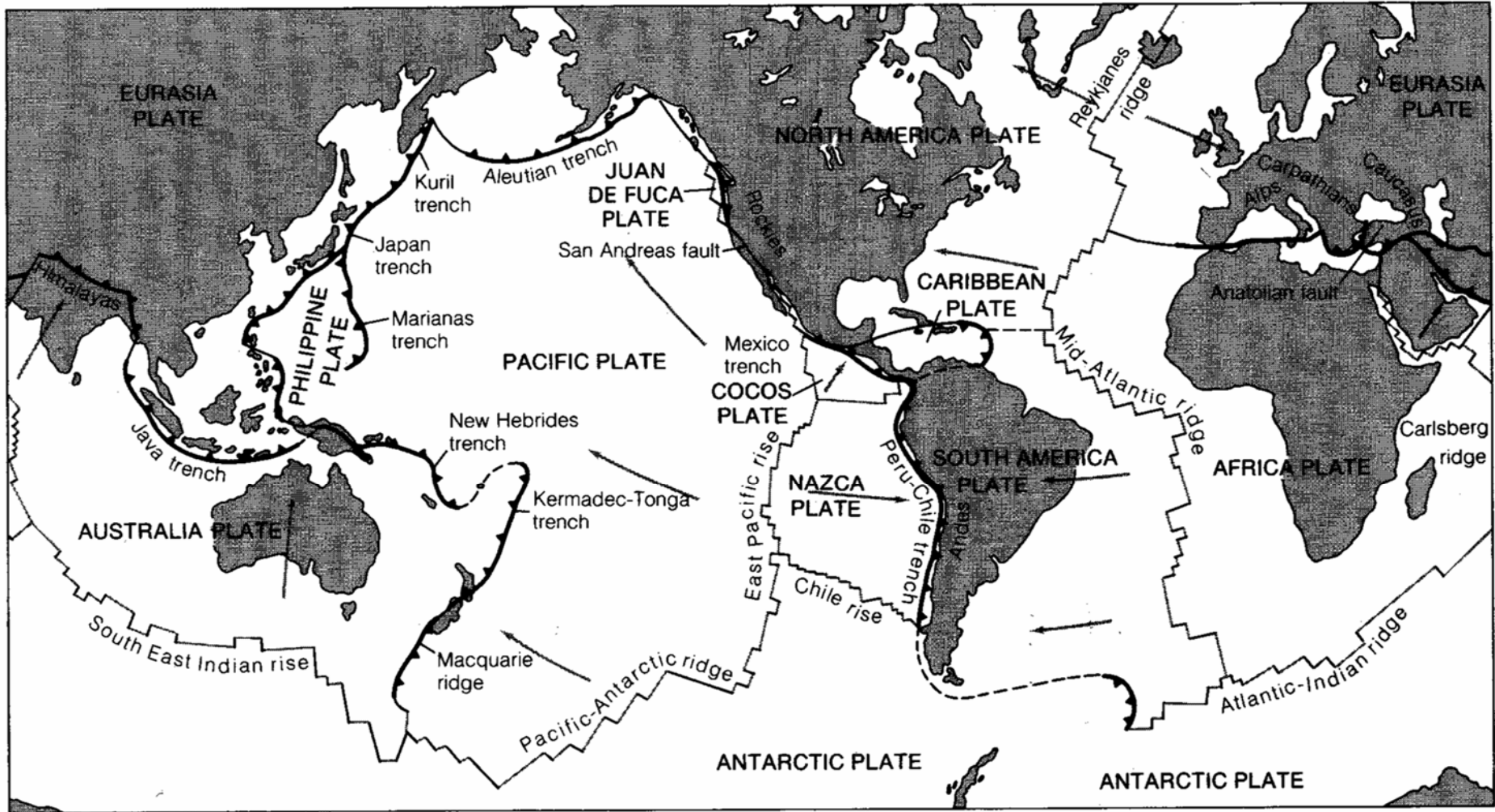
Sun Nov 3, 2002 10:12:41 PM GST M 7.9 N63.52 W147.53 Depth: 5.0km ID:22614036





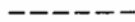
PROCESSED: Fri Jan 31, 2003 08:30:04 PM GST,

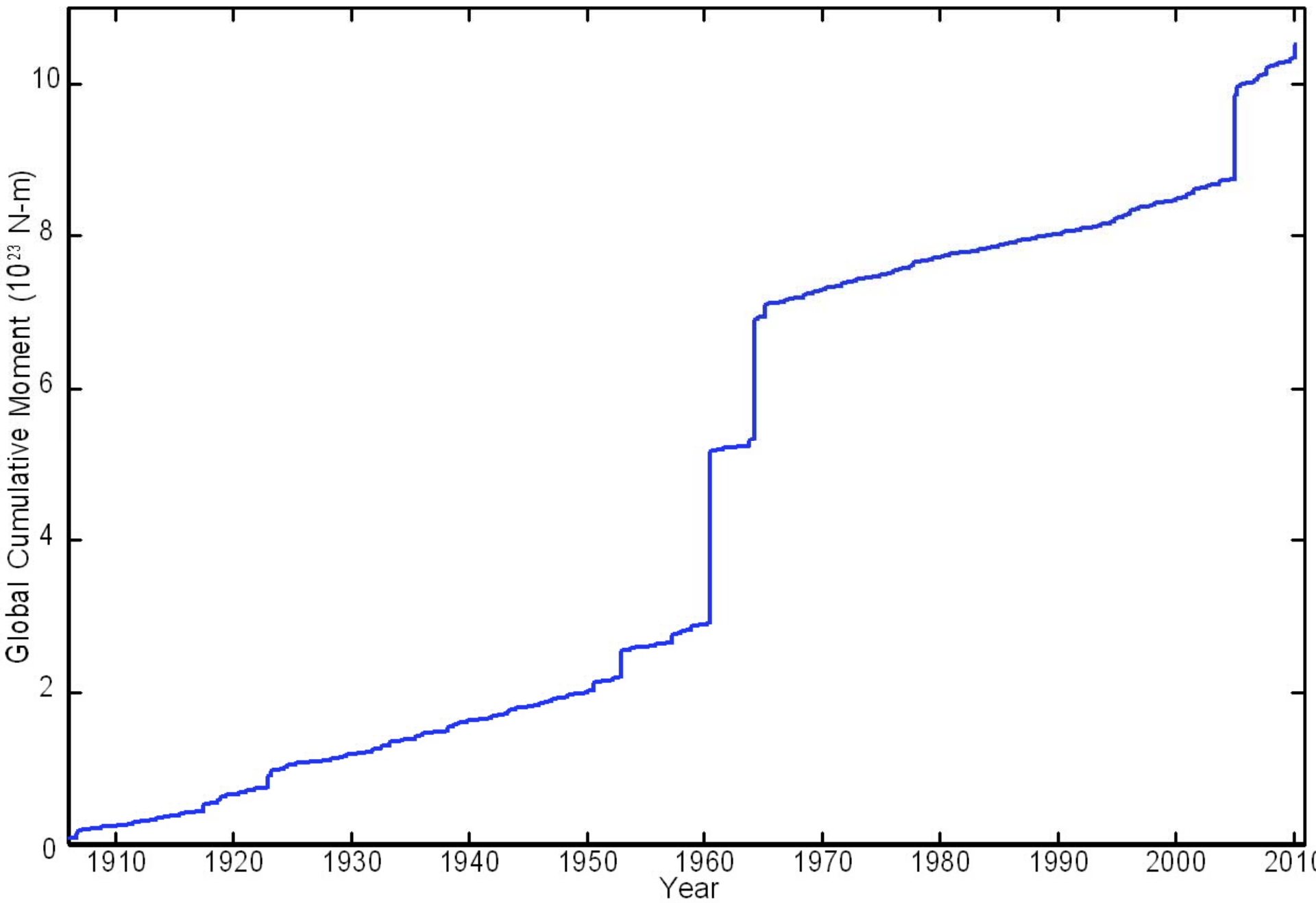
PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<.17	.17-14	1.4-39	3.9-92	9.2-18	18-34	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	16-31	31-60	60-116	>116
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

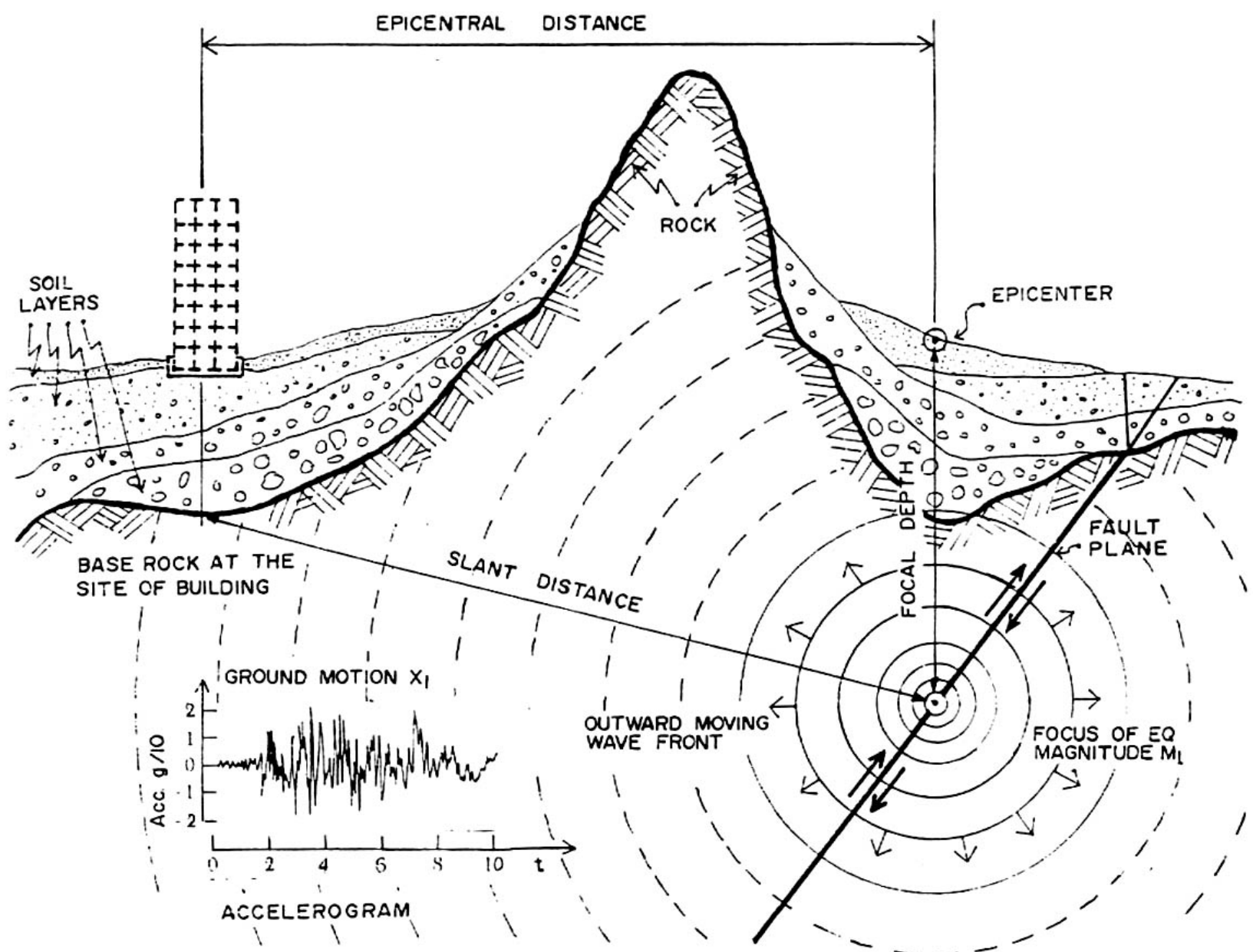
Earthquake Terms and Facts



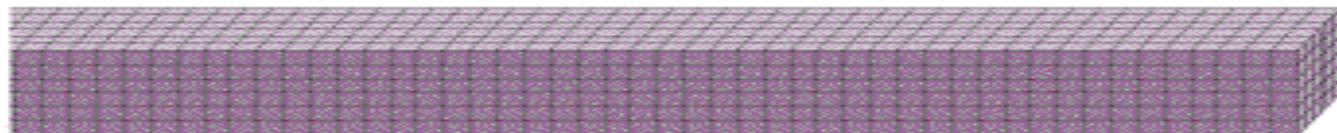
Key

-  Subduction zone
-  Strike-slip (transform) faults
-  Ridge axis
-  Uncertain plate boundary
-  Direction of plate motion



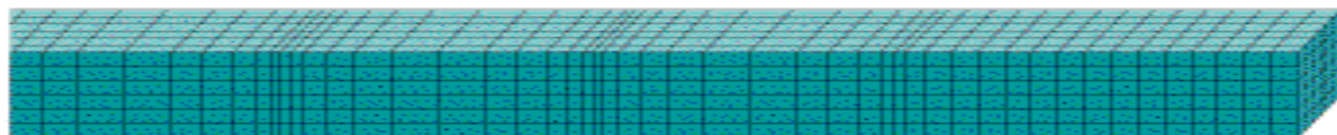


Seismic Waves



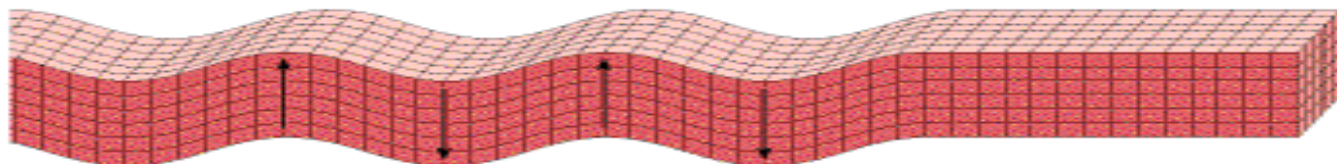
(a) Undisturbed material

Compression Expansion Compression Expansion Compression Undisturbed material



(b) Primary wave

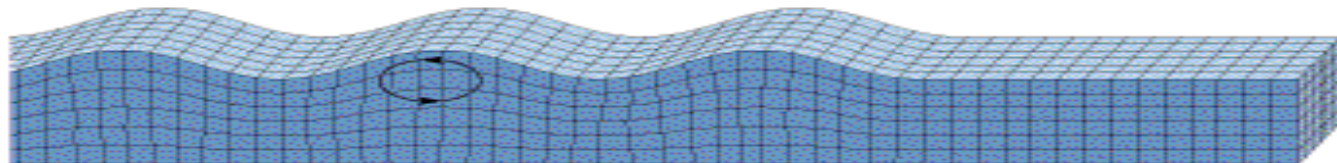
Direction of wave movement →



(c) Secondary wave

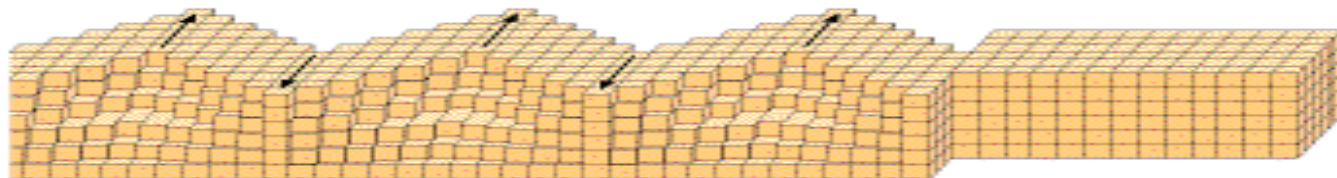
← Wavelength →

→



(d) Rayleigh wave

→



(e) Love wave

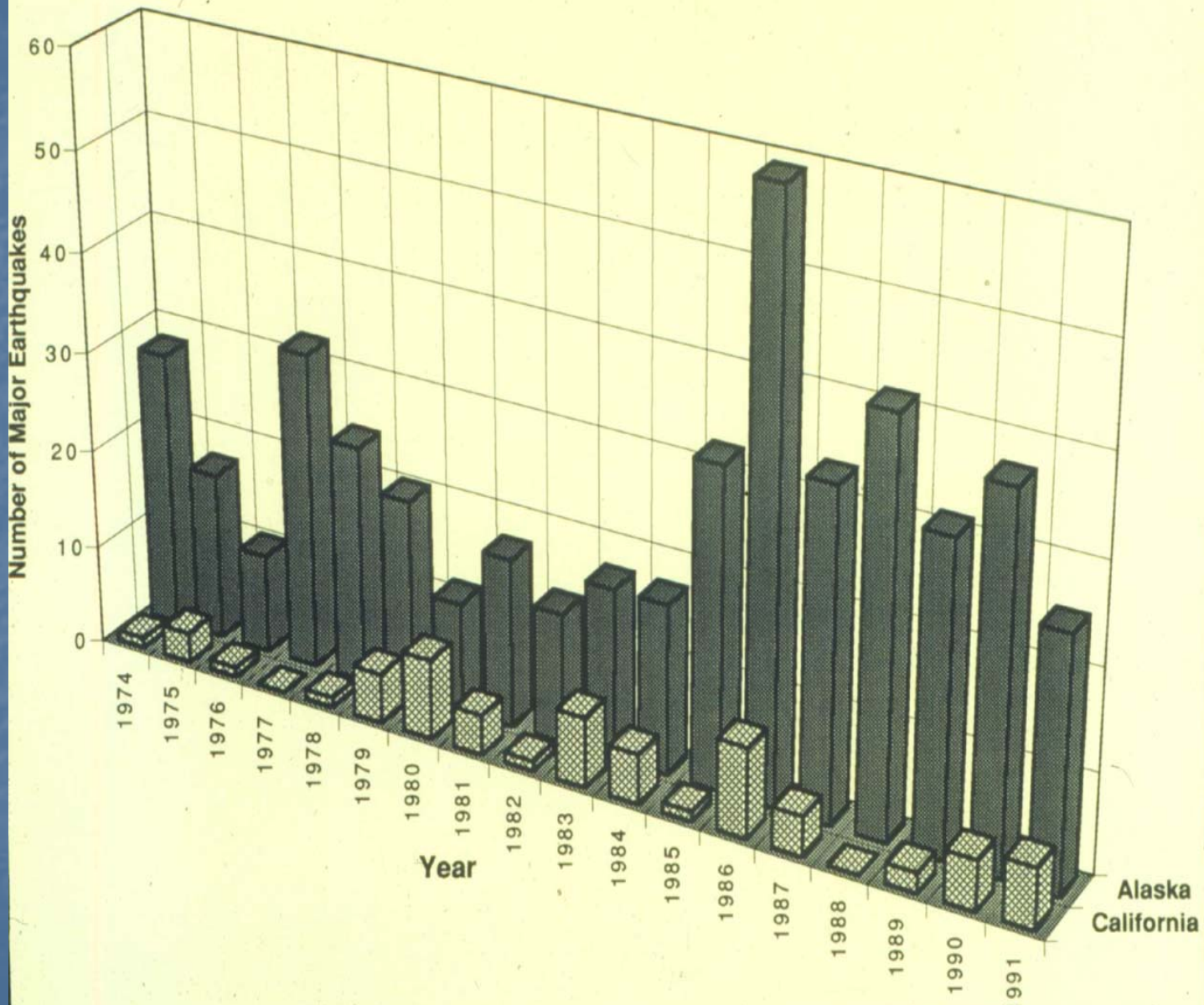
→

Hazard vs Risk

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

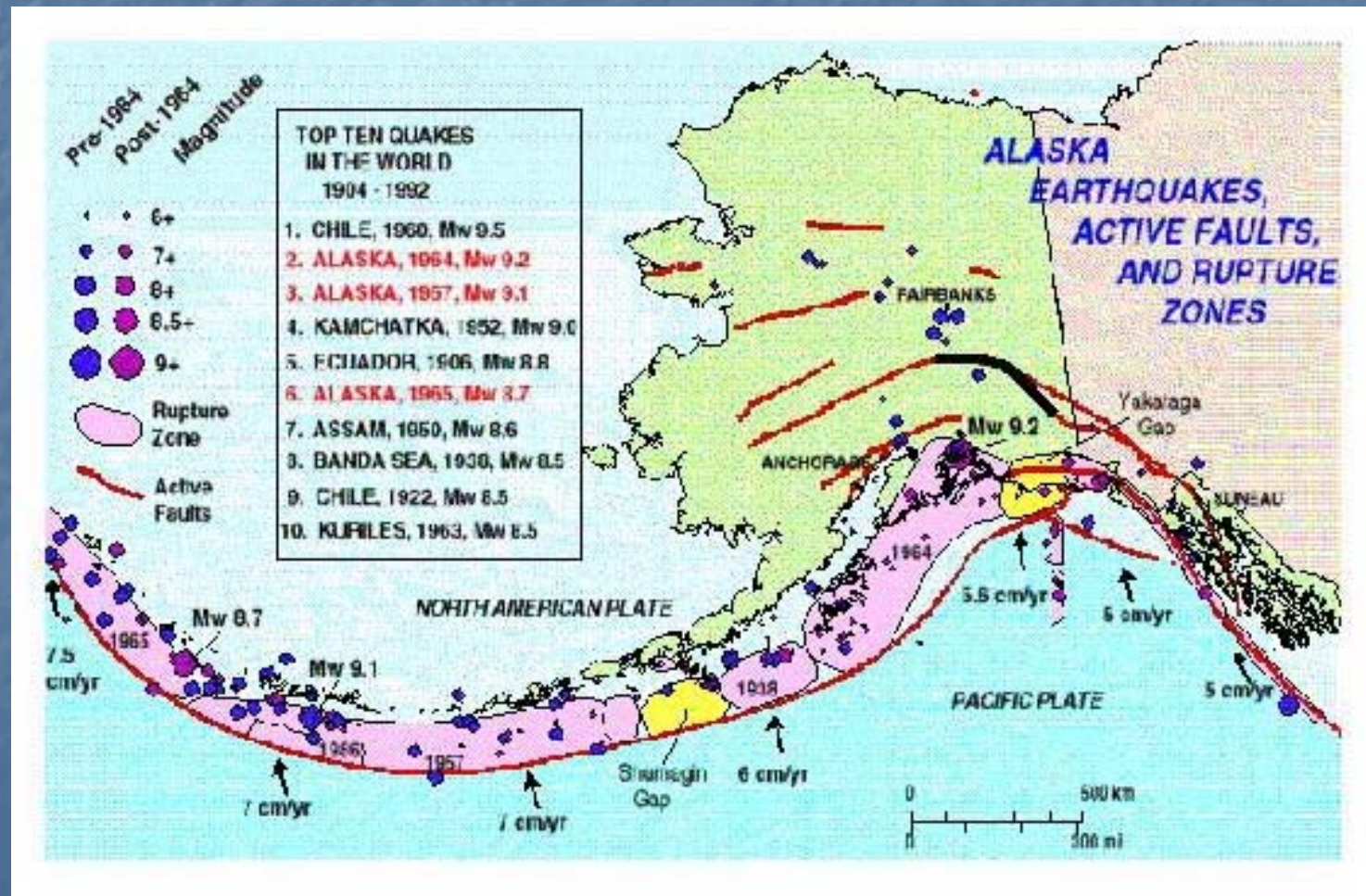
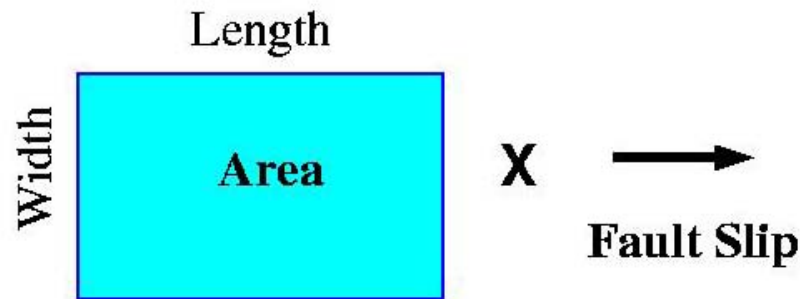


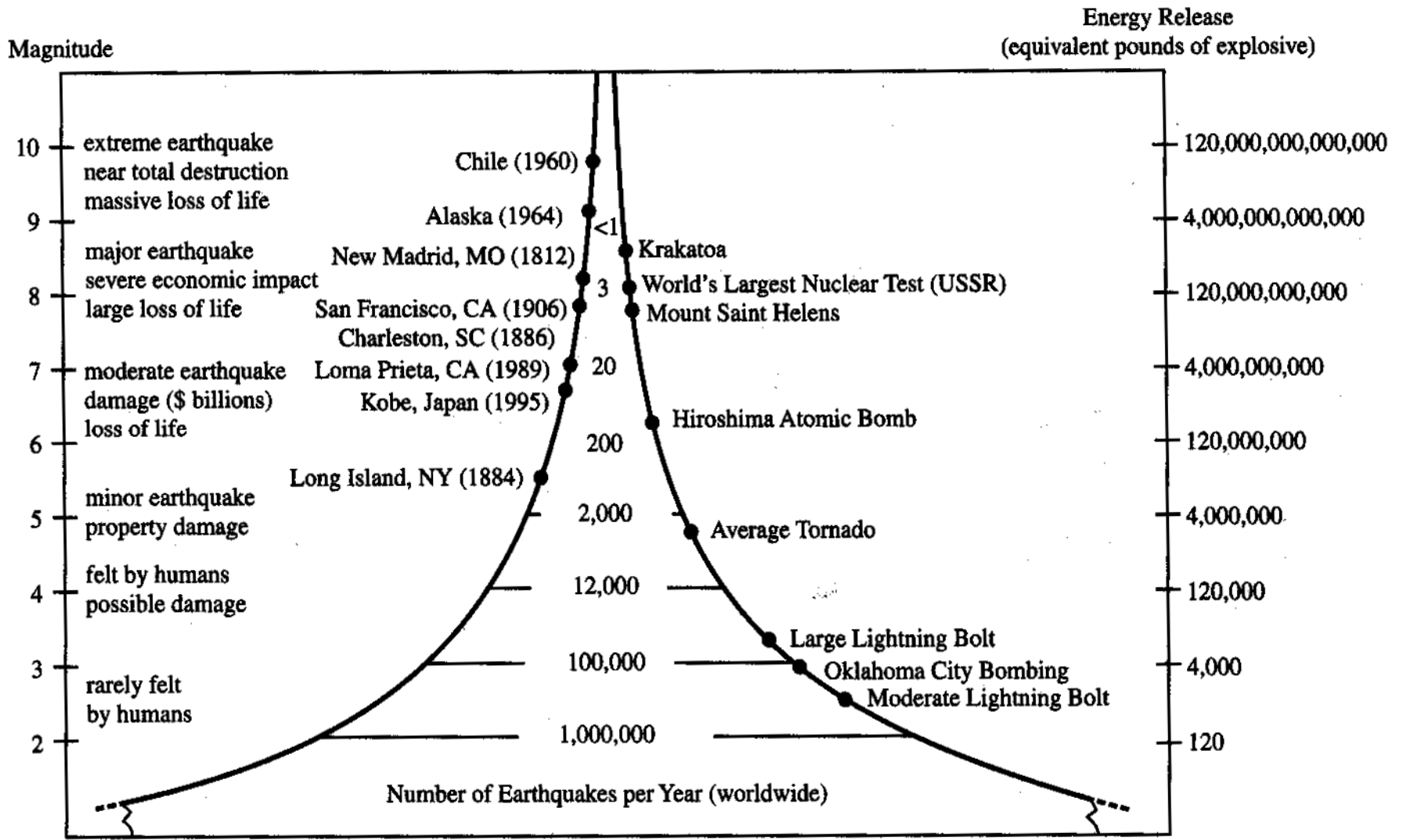
International Seismological Center Major ($M \geq 5.5$) Earthquakes During 18 Year period 1974-1991



Compiled by Steve Eaton, September 1994

Denali Fault Earthquake M=7.9





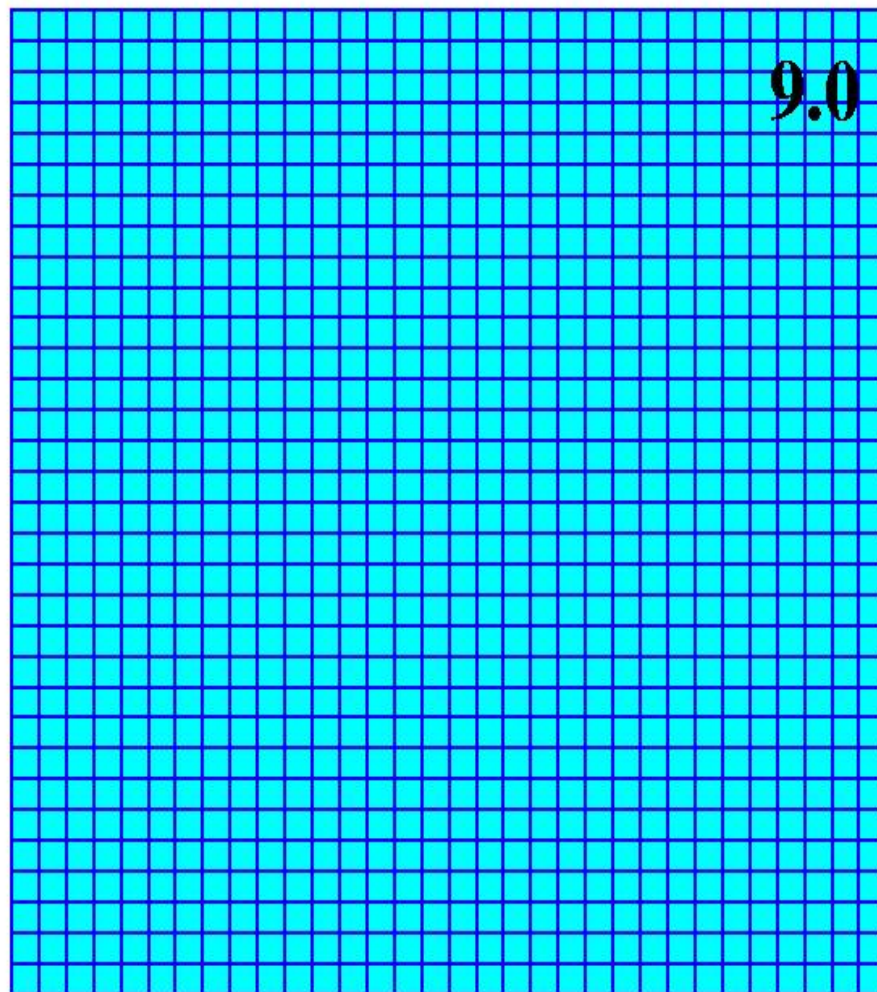


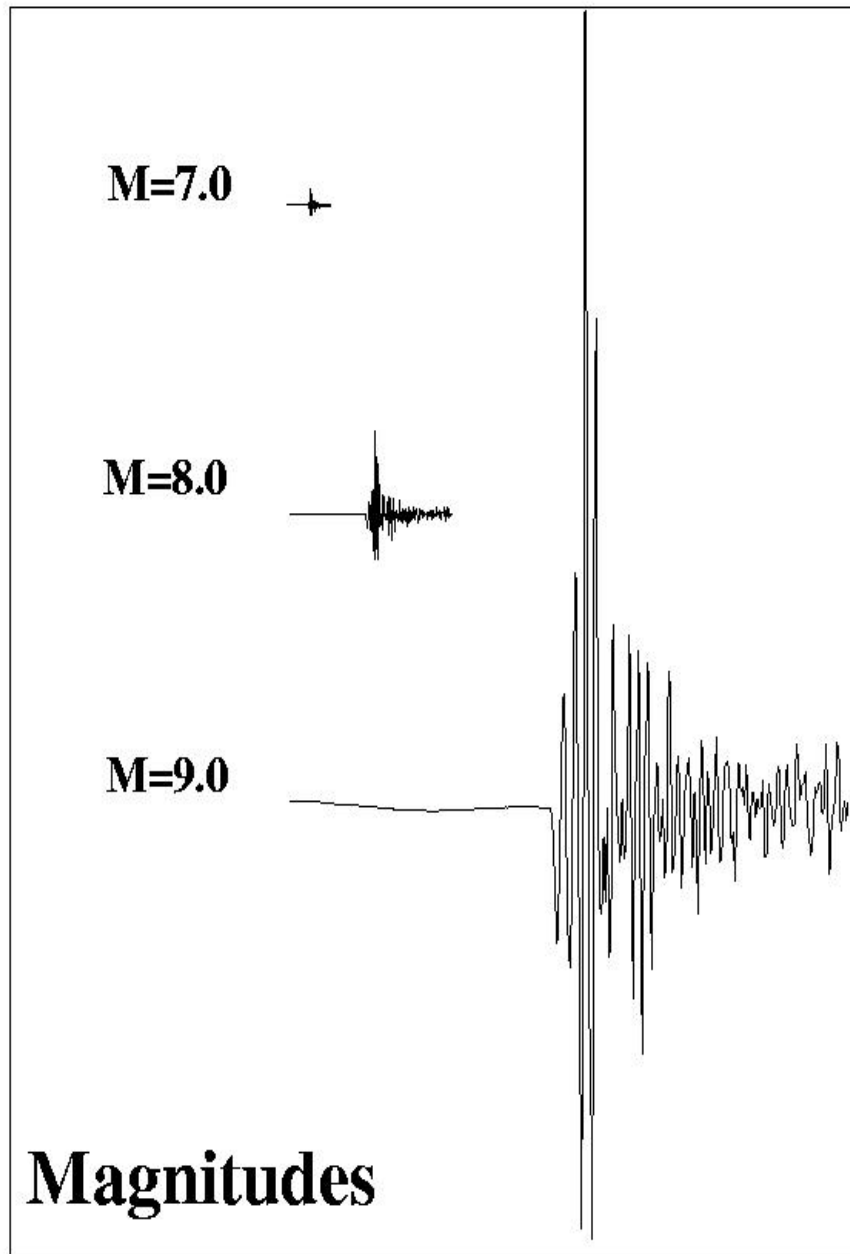
SEISMIC ENERGY

■ 7.0

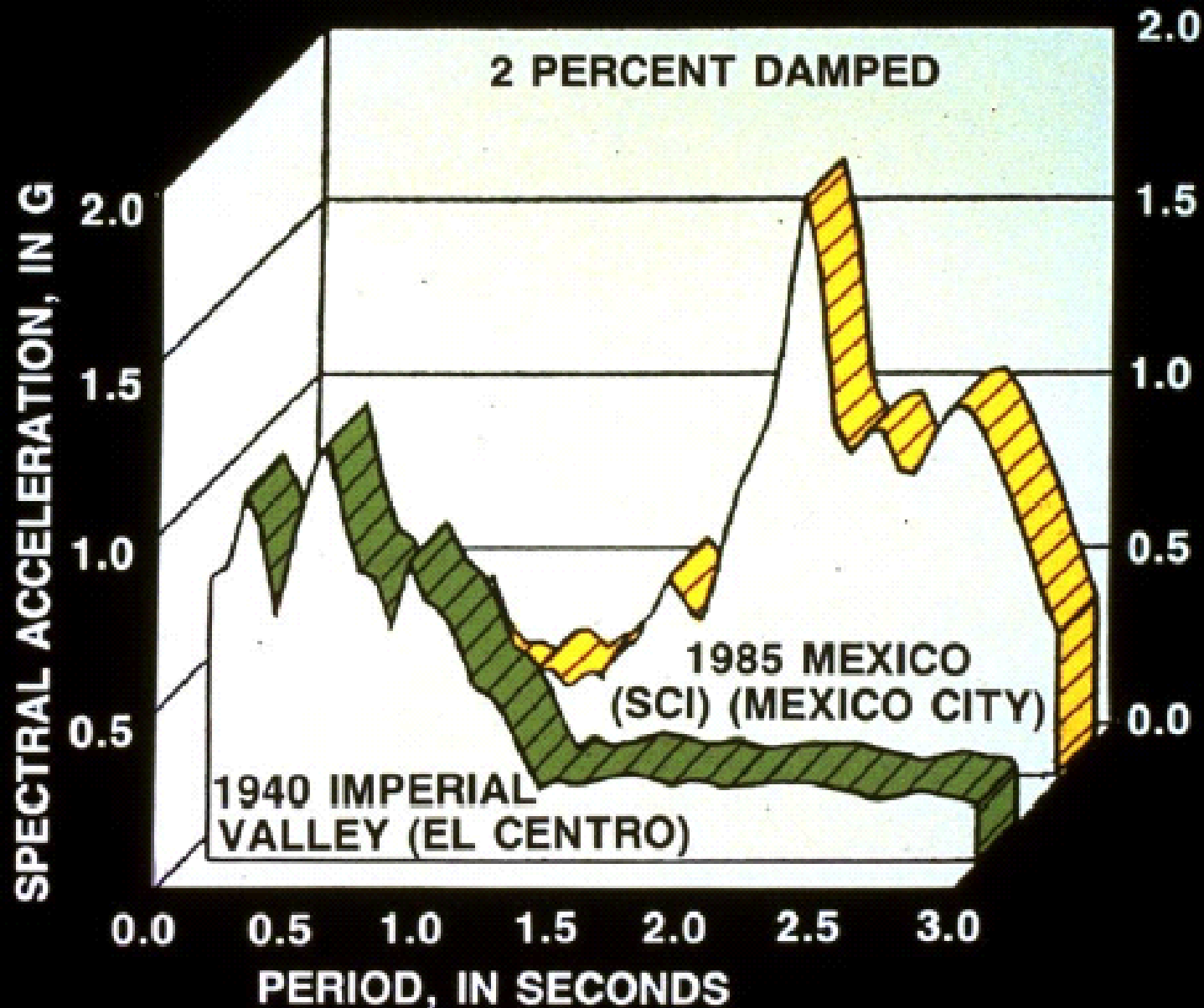


8.0





COMPARISON OF RESPONSE SPECTRA MEXICO CITY AND EL CENTRO





Cause of Damage

Tsunami

Ground Failure

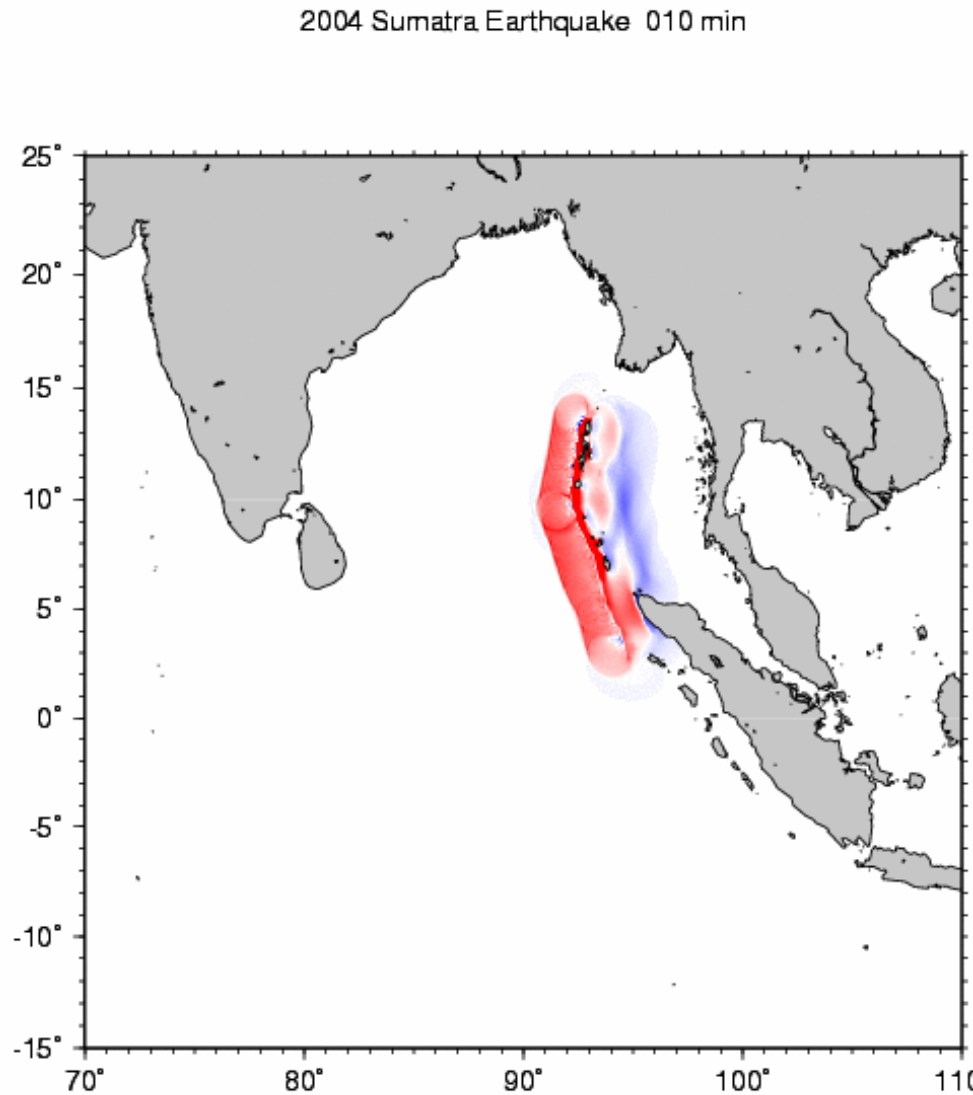
Ground Rupture

Ground Shaking

Tsunami



Tsunami Propagation



Ground Failure



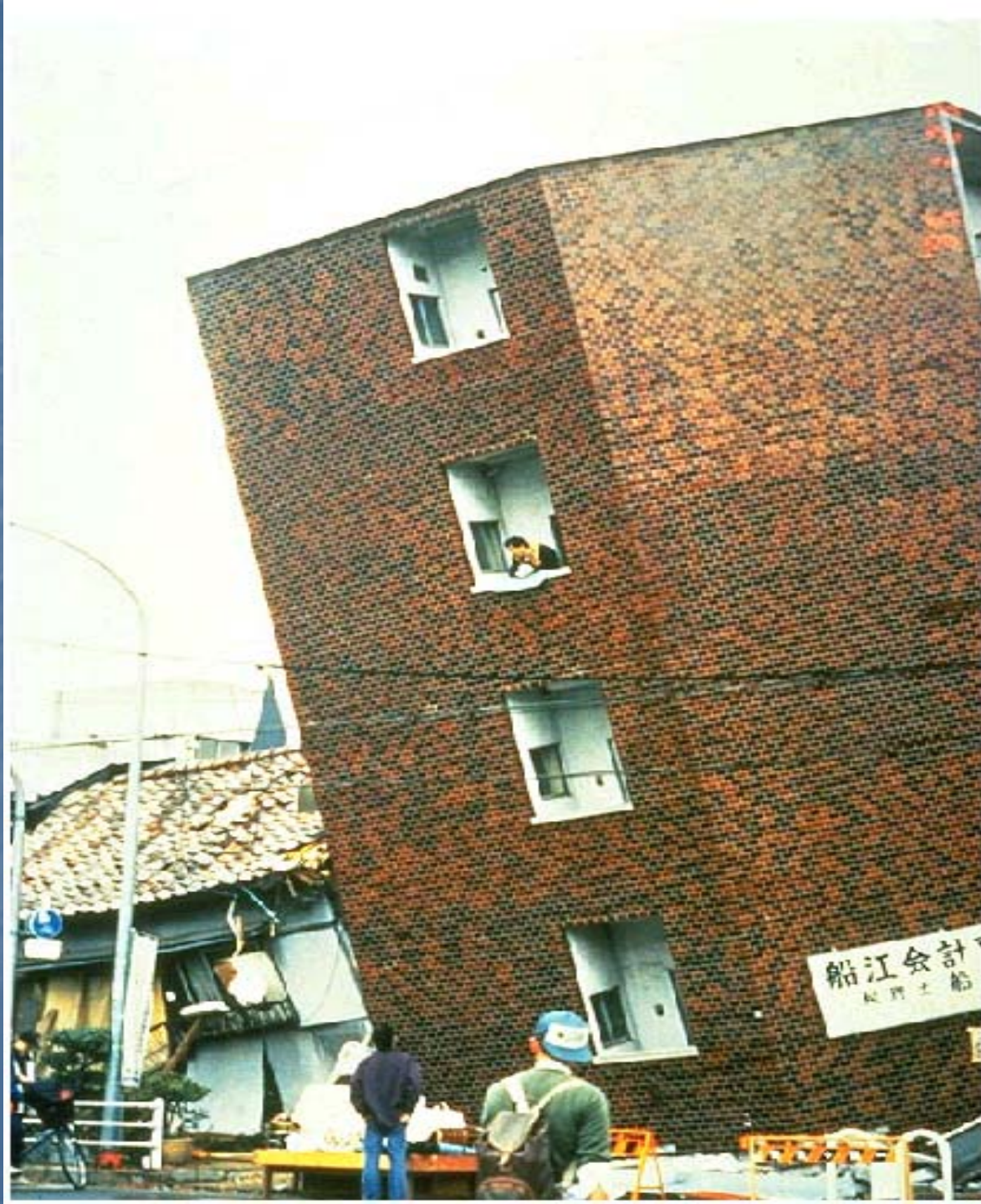
Ground Failure-Turnagain Slide







Liquefaction





Ground Shaking











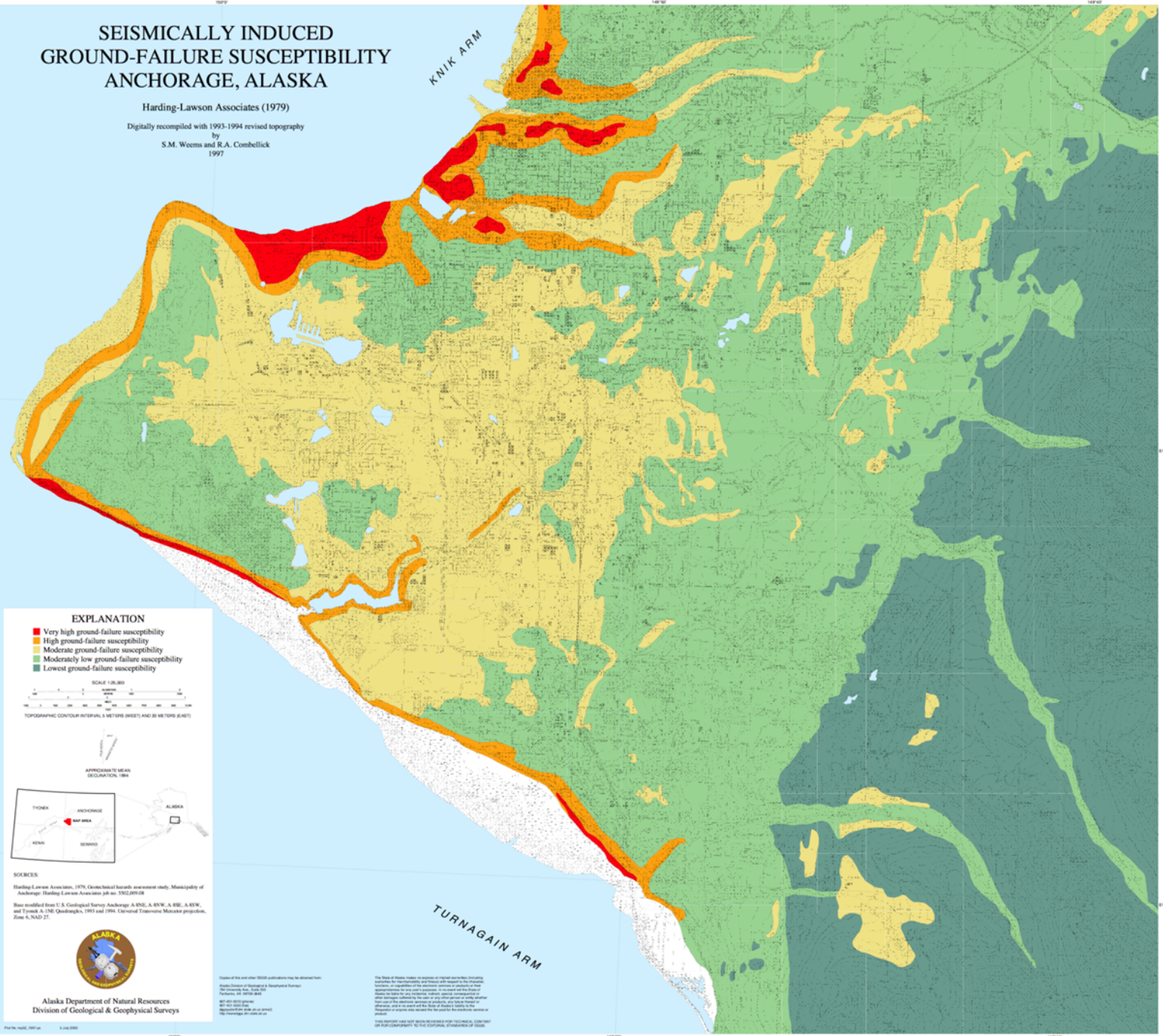


Current Research

SEISMICALLY INDUCED GROUND-FAILURE SUSCEPTIBILITY ANCHORAGE, ALASKA

Harding-Lawson Associates (1979)

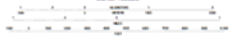
Digitally compiled with 1993-1994 revised topography
by
S.M. Weems and R.A. Combellick
1997



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 (16 FEET) AND 20 METERS (66 FEET)

APPROXIMATE MEAN
DEGLACIATION, 1984



SOURCES

Harding-Lawson Associates, 1979. Geotechnical hazard assessment study, Municipality of Anchorage. Harding-Lawson Associates job no. 790201010.
Base modified from U.S. Geological Survey Anchorage A-82N, A-82W, A-82X, A-82Y, and Frank A. The Quadriga's, 1993 and 1994. Universal Transverse Mercator projection, Zone 6, NAD 83.



Alaska Department of Natural Resources
Division of Geological & Geophysical Surveys

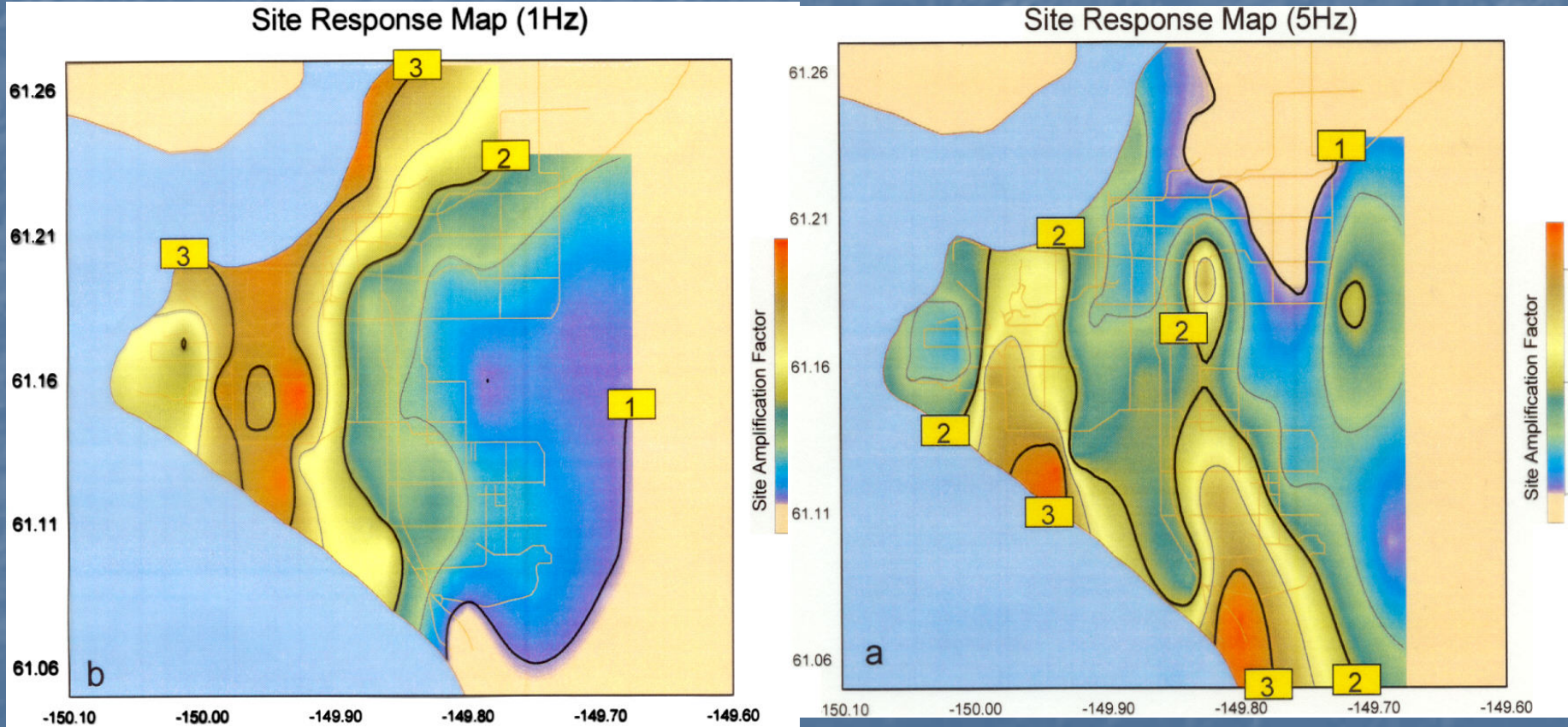
Some of the text and other 1997 publications may be obtained from:
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This map was prepared by the Alaska Department of Natural Resources, Division of Geological & Geophysical Surveys, in cooperation with the Municipality of Anchorage.

Anchorage Strong Motion Program: Site Response





Delaney Park Downhole Array

Enclosure



Hyposensor



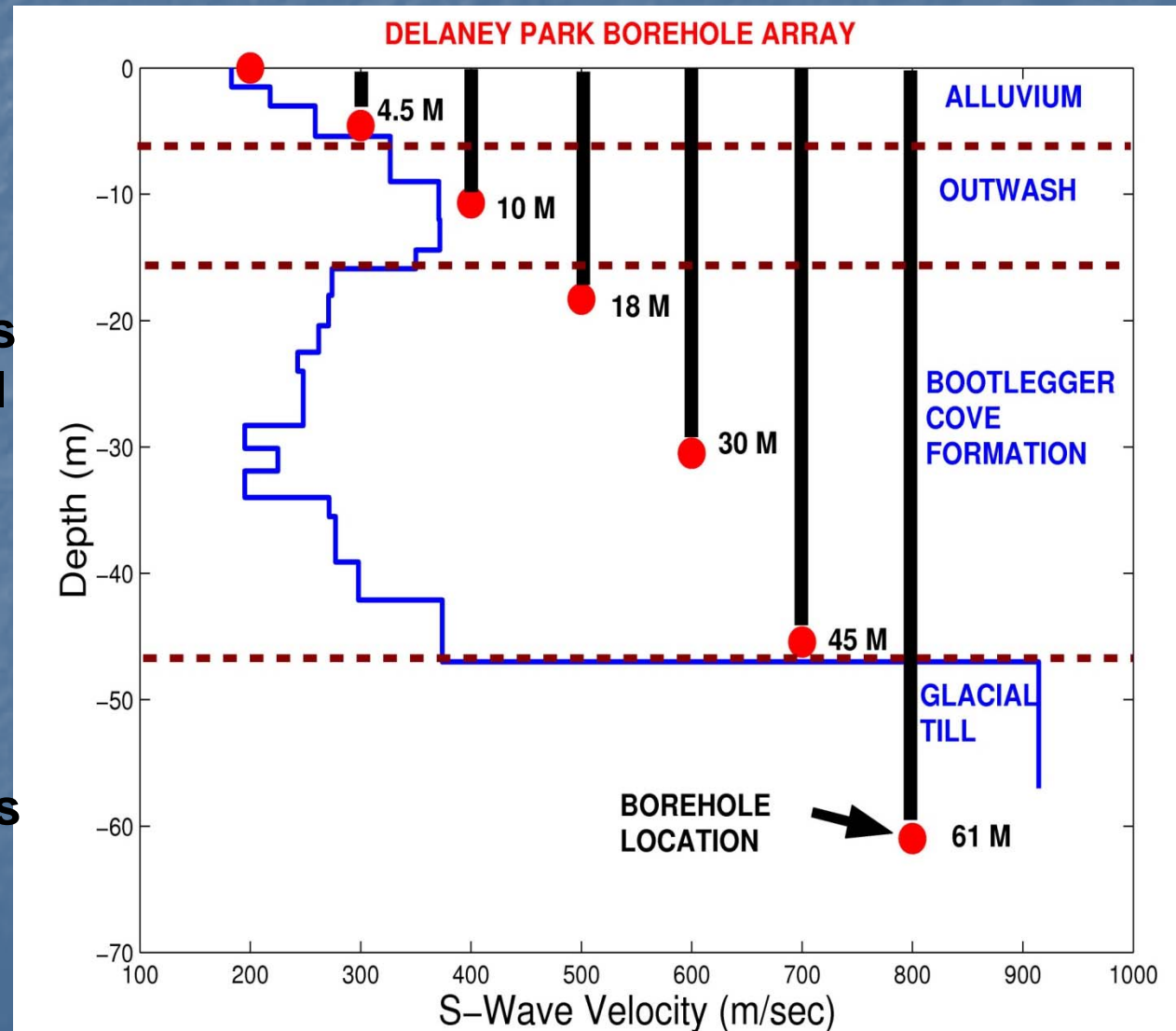
Atwood Building

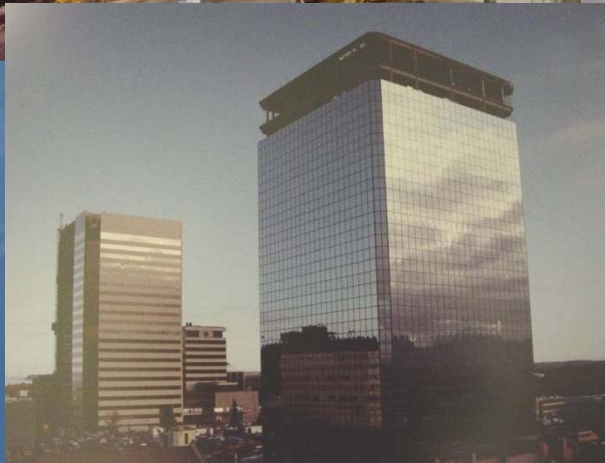
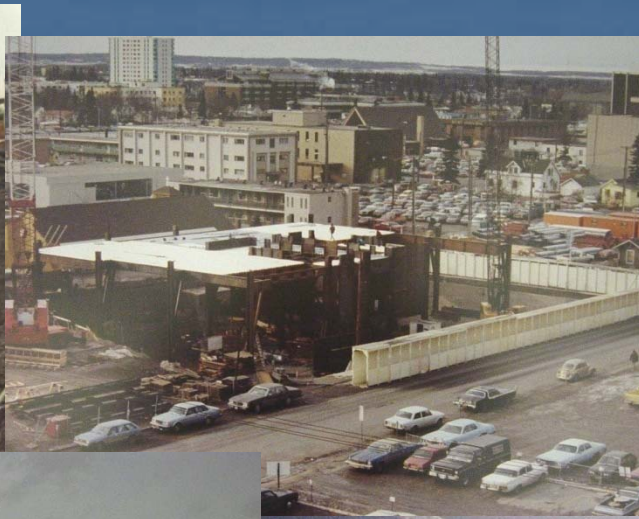
Downhole Array



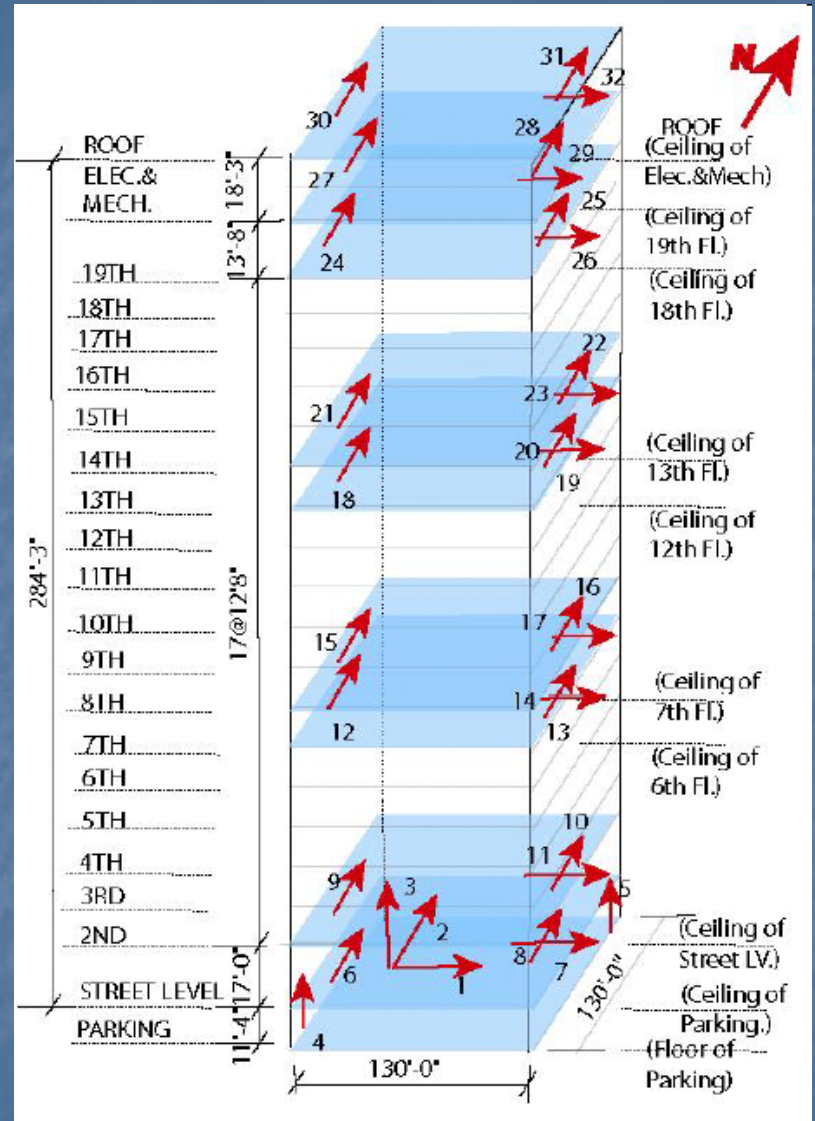
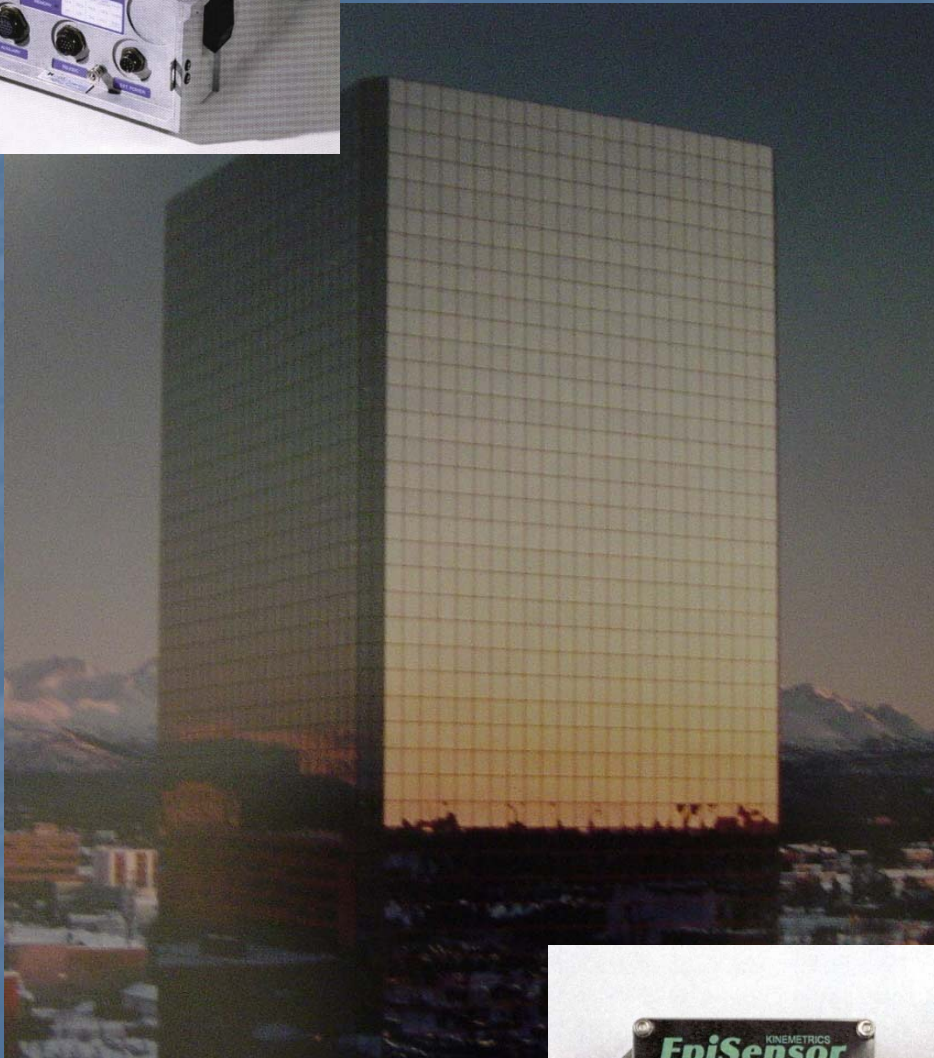
Delaney Park Downhole Array: Depth Profile

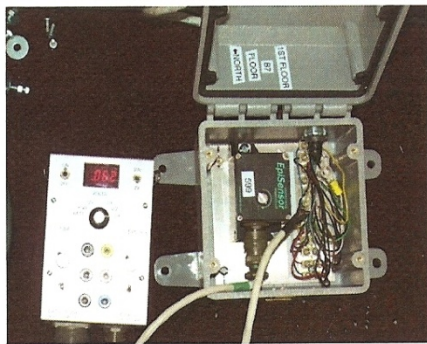
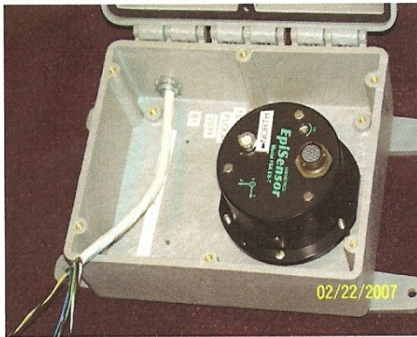
DPDA Consists of 6 boreholes and one surface accelerometers. The deepest sensor is located in a glacial till formation with shear wave velocity > 900 m/s, corresponding to engineering bedrock. The sensors are arranged such a way so that characteristics of major formations can be studied.





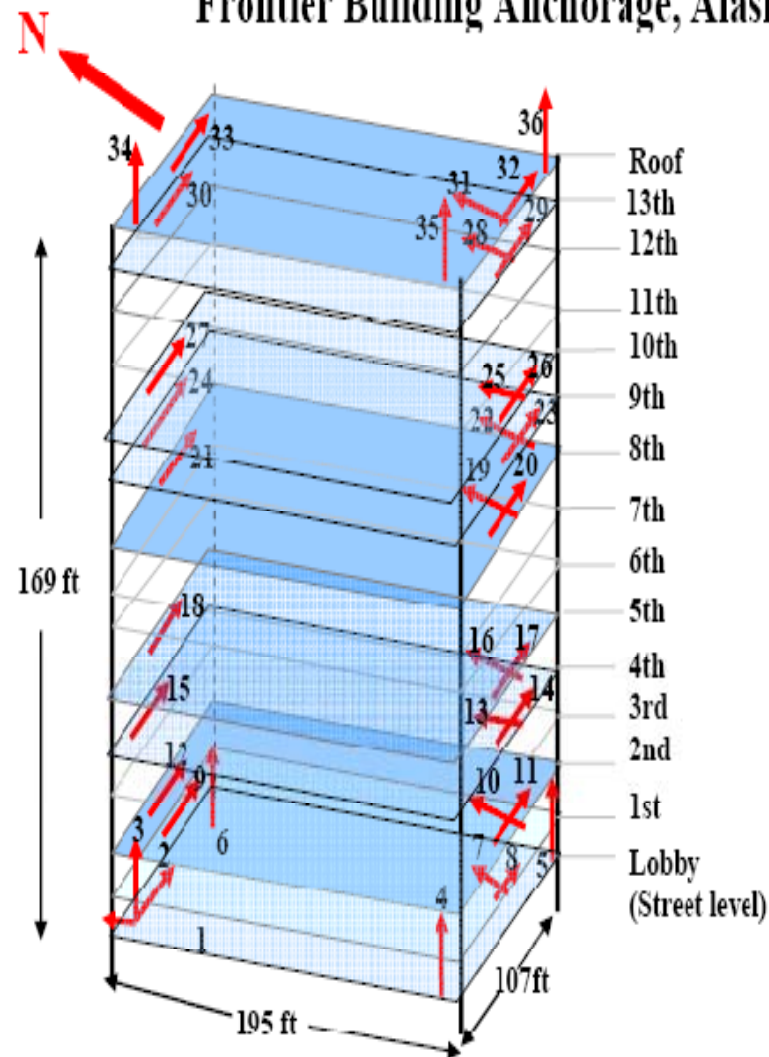
Atwood Building





Anchorage Strong Motion Program: Frontier Building

Frontier Building Anchorage, Alaska



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

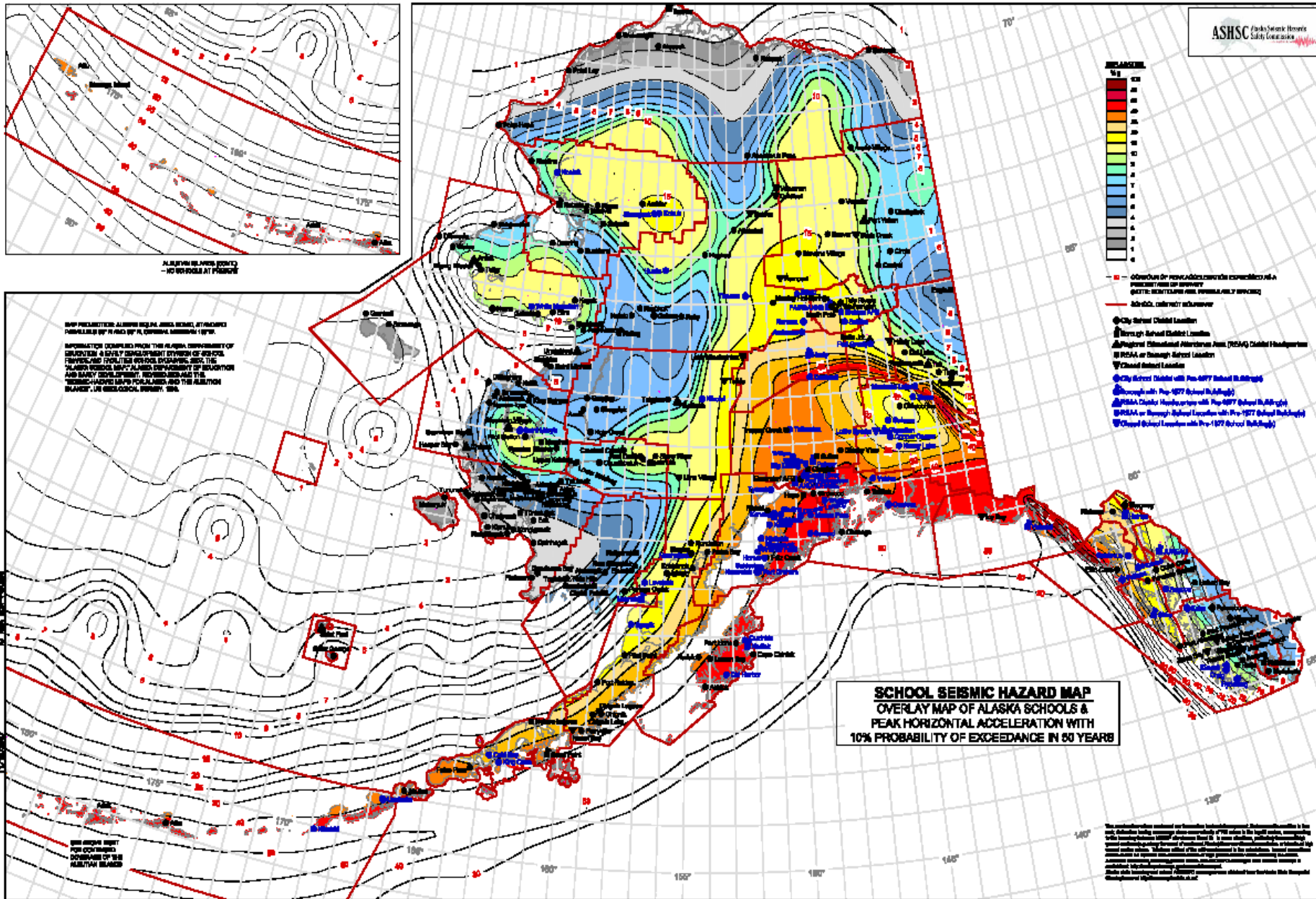
Powers & Duties

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

Standing Committees

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





- Contour of peak horizontal acceleration with a probability of exceedance in 50 years
- School district boundary
- City School District Location
- ▲ Borough School District Location
- ▲ Regional Educational Assessment Area (REAA) District Headquarters
- ▲ REAA or Borough School Location
- ▲ School District Location
- City School District with Pre-1977 School Building
- Borough with Pre-1977 School Building
- ▲ REAA District Headquarters with Pre-1977 School Building
- ▲ REAA or Borough School Location with Pre-1977 School Building
- ▲ School District Location with Pre-1977 School Building

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

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MAP PREPARATION: ALASKA SEISMIC HAZARD MAP, AT PEAK HORIZONTAL ACCELERATION WITH 10% PROBABILITY OF EXCEEDANCE IN 50 YEARS. INFORMATION OBTAINED FROM THE ALASKA DEPARTMENT OF GEOLOGY AND EARTH SCIENCE DIVISION OF SEISMICITY, TROPICAL CYCLONE DIVISION, AND THE ALASKA SCHOOL MAPS DIVISION. DIVISION OF GEOLOGY AND EARTH SCIENCE, UNIVERSITY OF ALASKA, FAIRBANKS. THE SEISMIC HAZARD MAPS FOR ALASKA AND THE ALUTSIAN ISLANDS, IN GEOLOGICAL SURVEY, 1978.

SEE OTHER MAPS FOR CONTINUED COVERAGE OF THE ALUTSIAN ISLANDS



QUESTIONS?

*one and my
airplane*

