A brief overview of the Seismicity and earthquake hazard of Europe and the Middle East

Péter Tildy

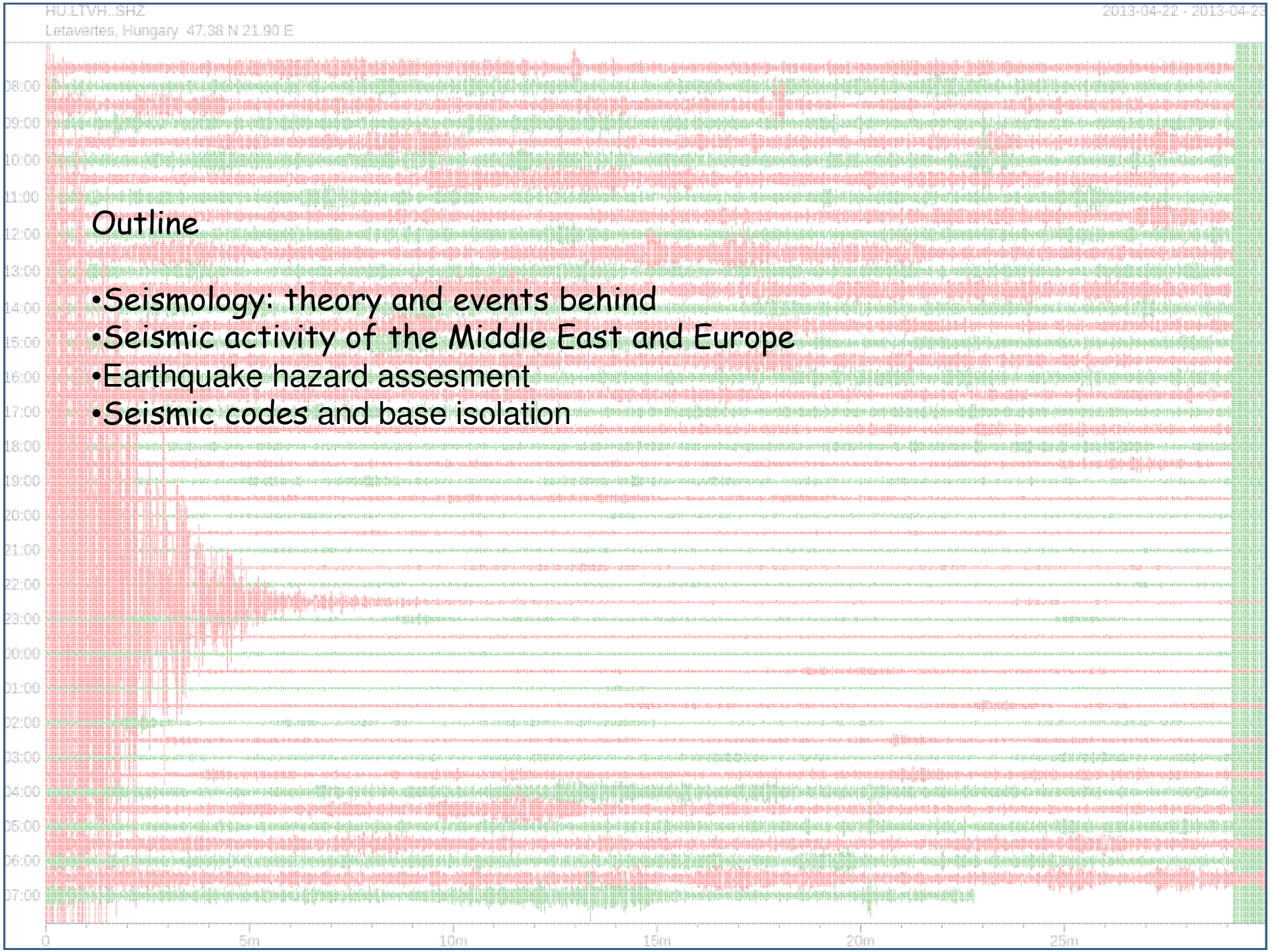
senior research geophysicist,

Geological and Geophysical Institute of Hungary

A brief overview of the Seismicity, Earthquake Hazard and Building Codes of Europe and the Middle East

Péter Tildy, Dr. Endre Törös, Dr. Mária Vidó

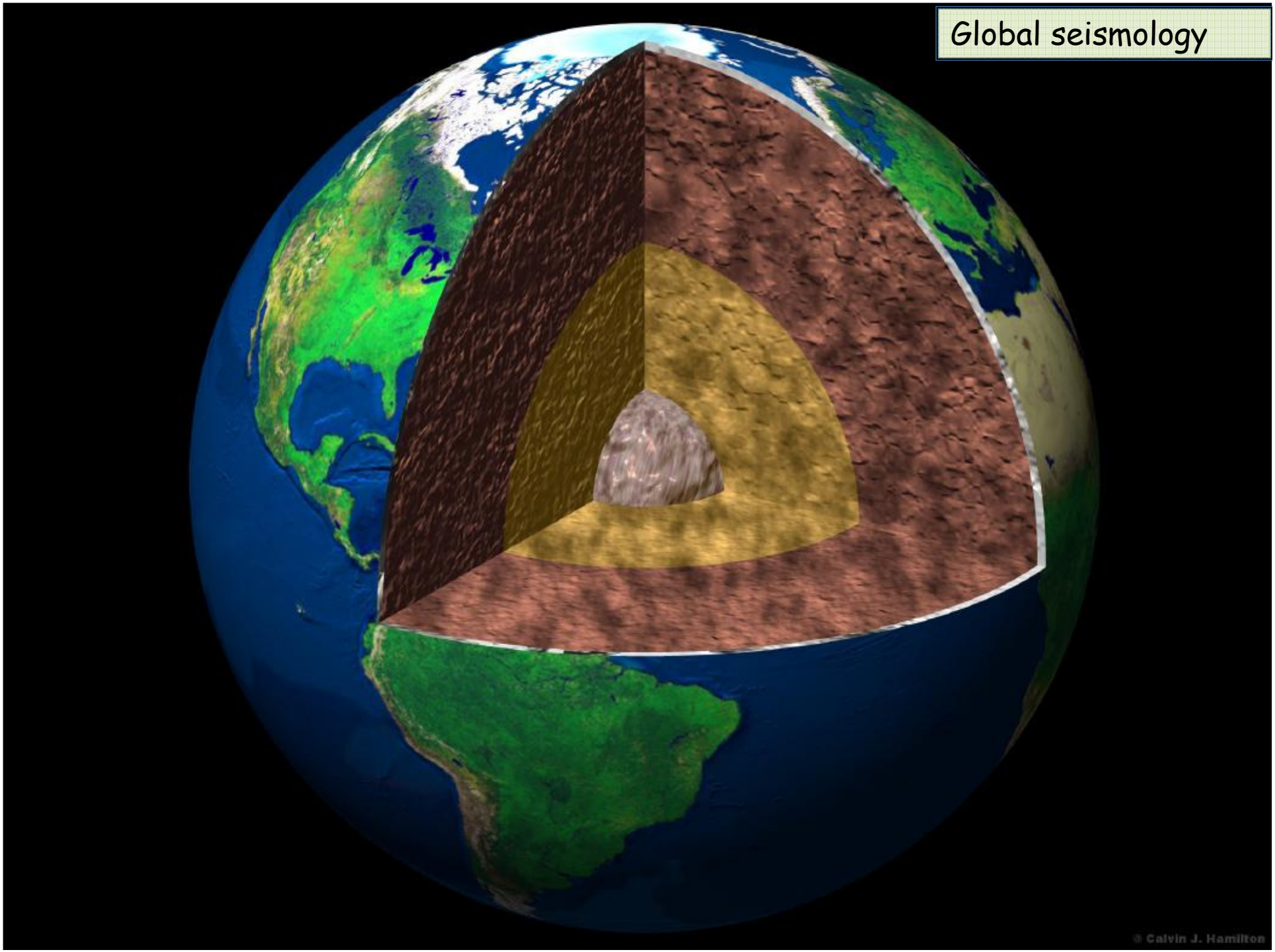
Geological and Geophysical Institute of Hungary



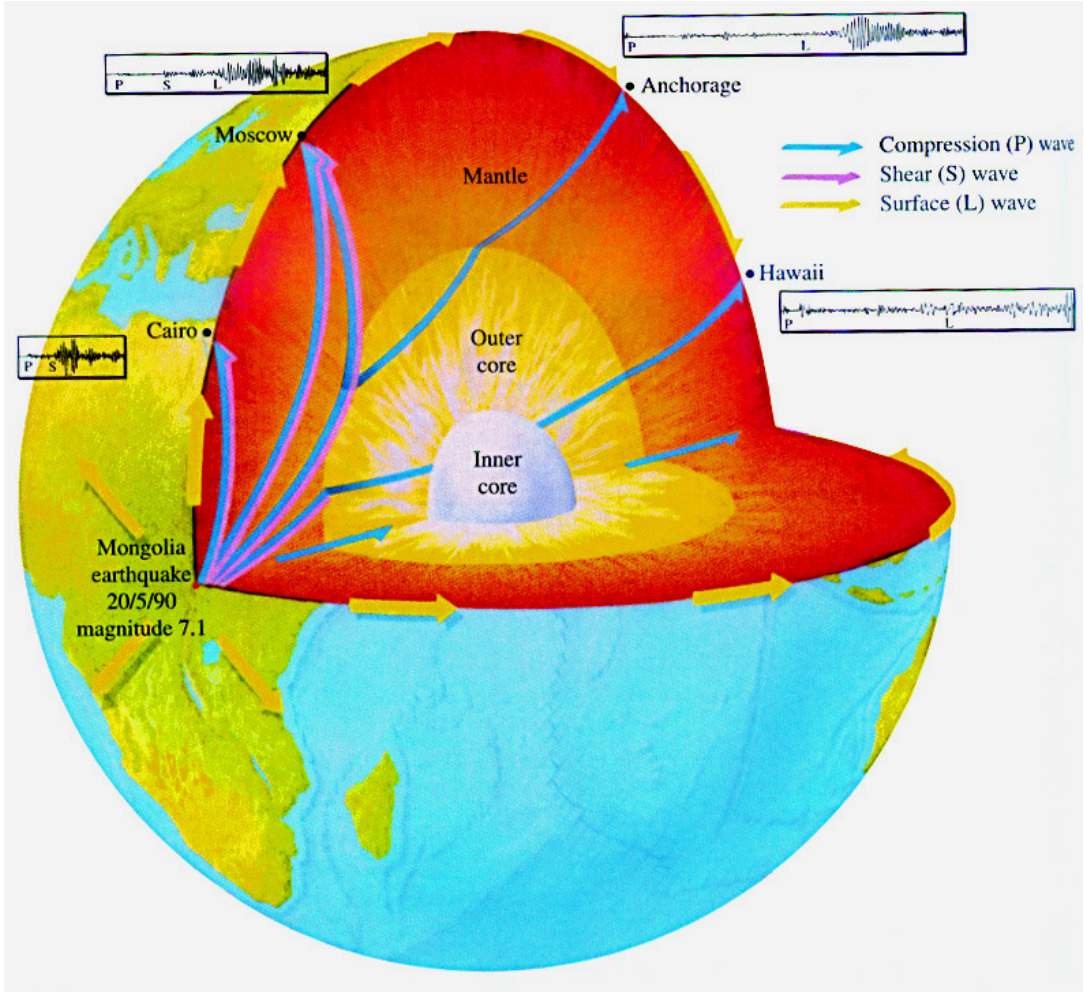
Outline

- Seismology: theory and events behind
- Seismic activity of the Middle East and Europe
- Earthquake hazard assesment
- Seismic codes and base isolation

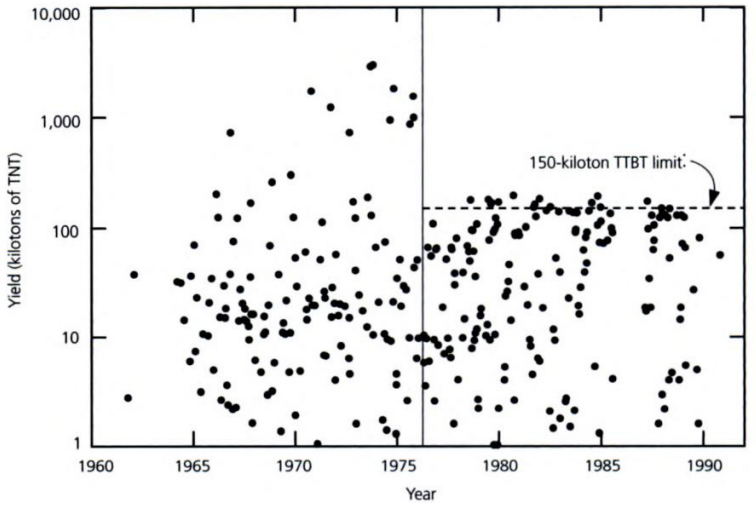
Global seismology



Global seismology

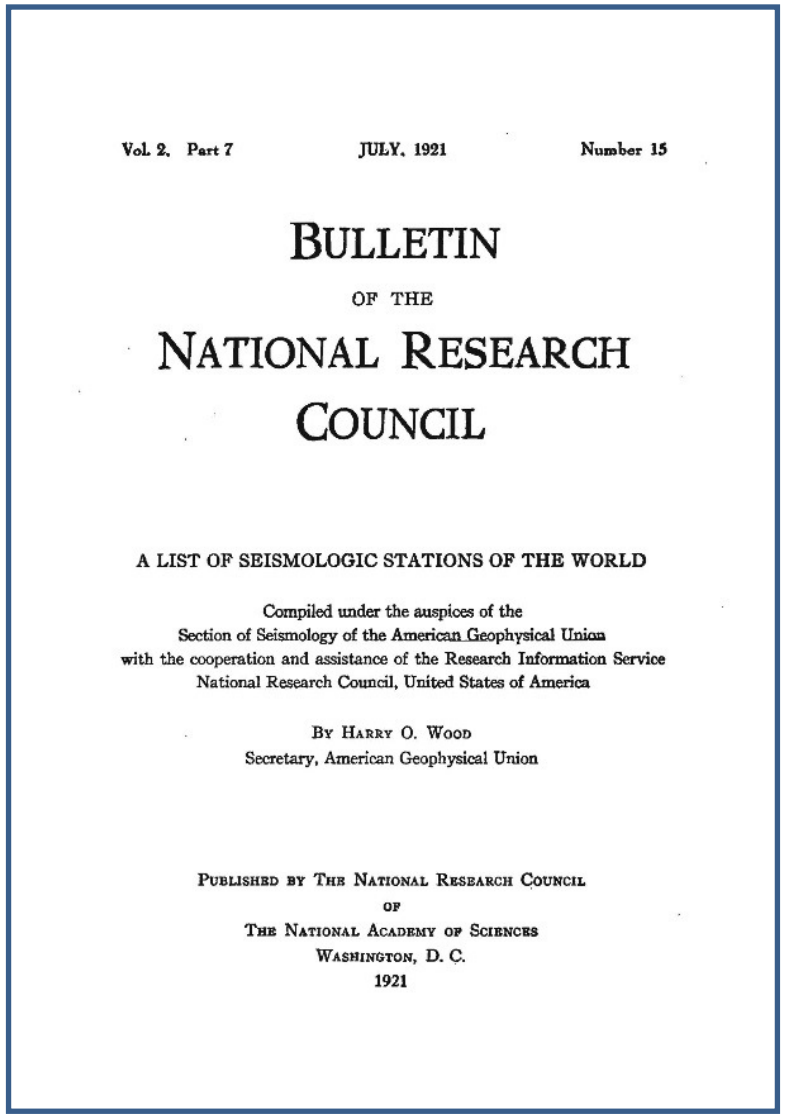


Test bean Treates



Number of seismologic stations throughout the world 1921 - 2013

Global seismology



Vol. 2, Part 7 JULY, 1921 Number 15

BULLETIN

OF THE

NATIONAL RESEARCH

COUNCIL

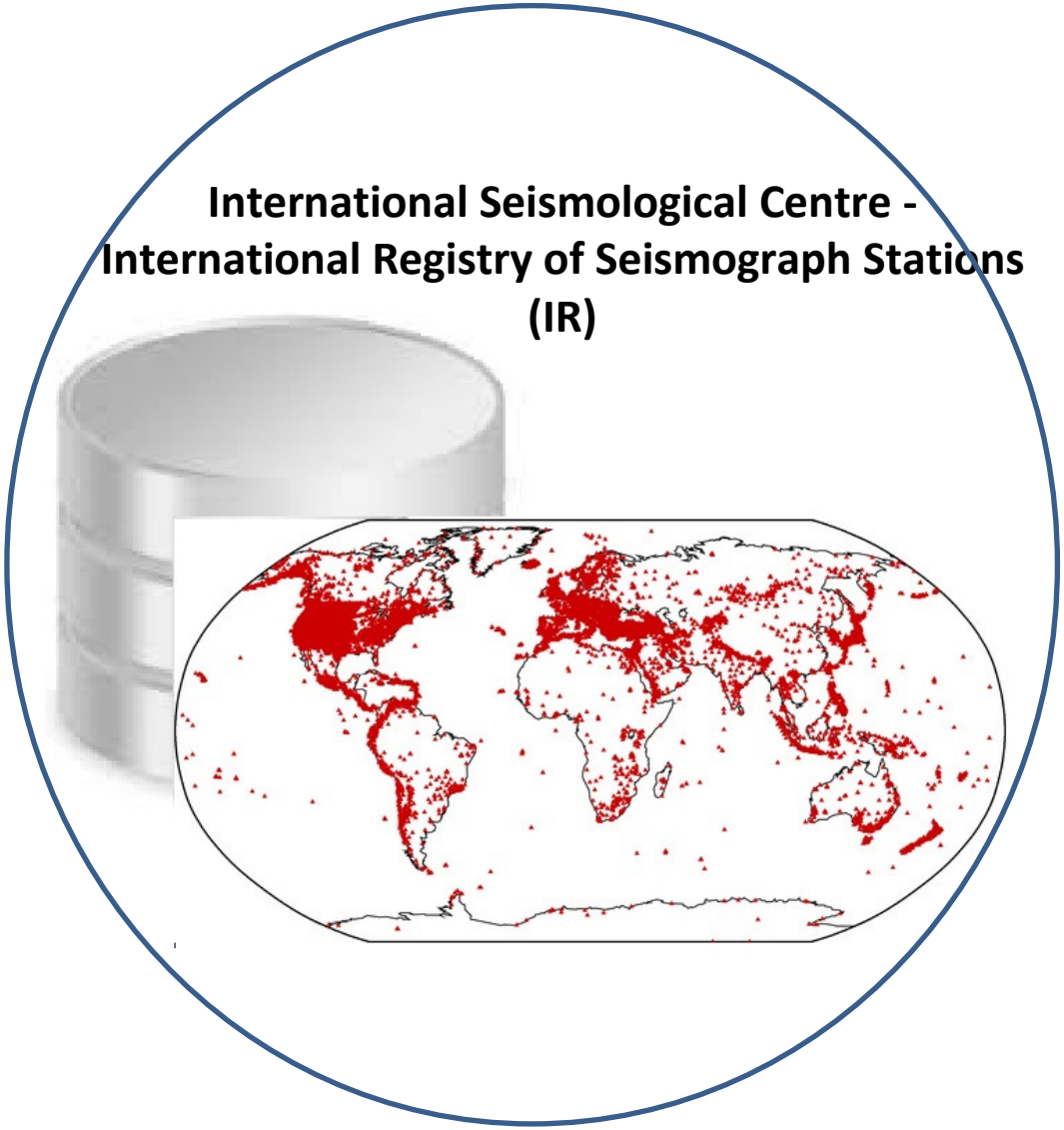
A LIST OF SEISMOLOGIC STATIONS OF THE WORLD

Compiled under the auspices of the
Section of Seismology of the American Geophysical Union
with the cooperation and assistance of the Research Information Service
National Research Council, United States of America

By Harry O. Wood
Secretary, American Geophysical Union

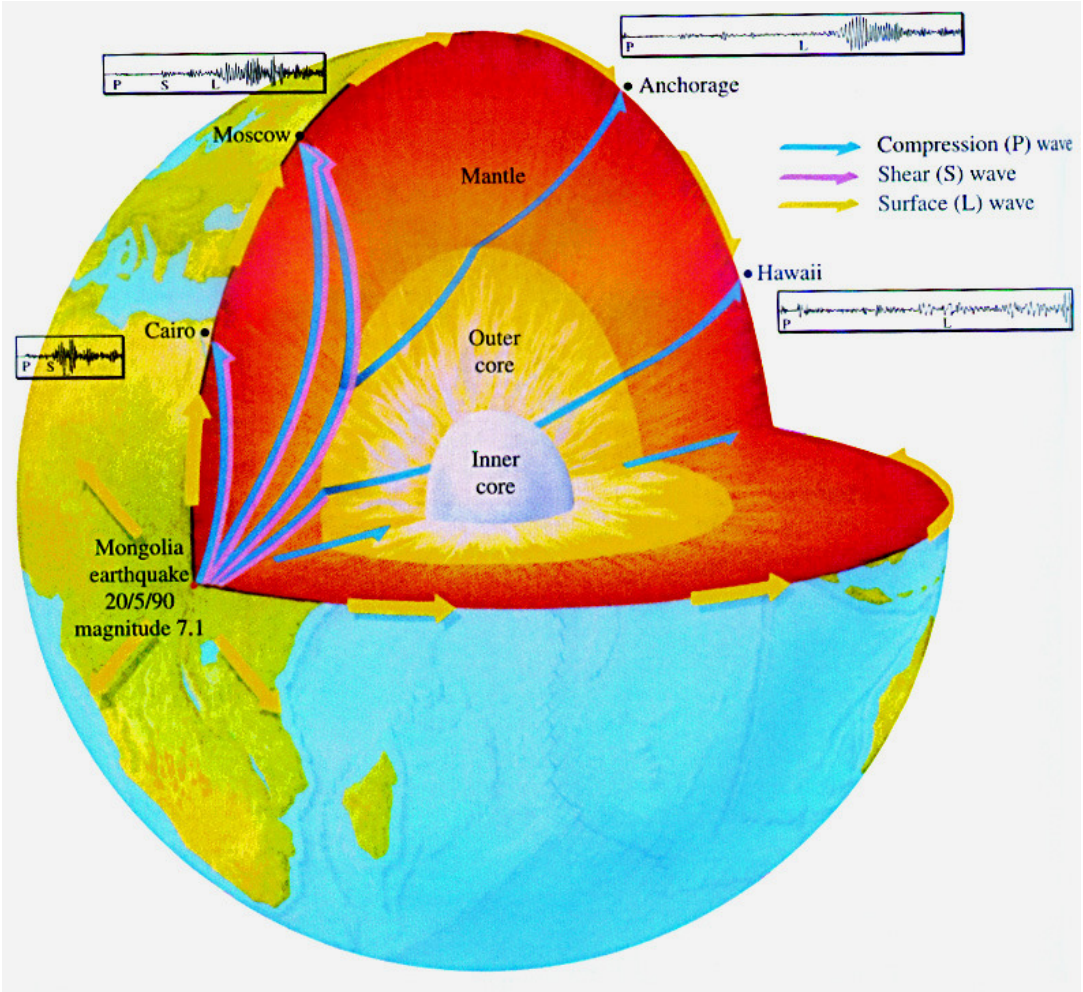
Published by The National Research Council
of
The National Academy of Sciences
Washington, D. C.
1921

The number of seismic observatories incl. is about 340



Number of registered stations ~ 19 000 pcs

Global seismology



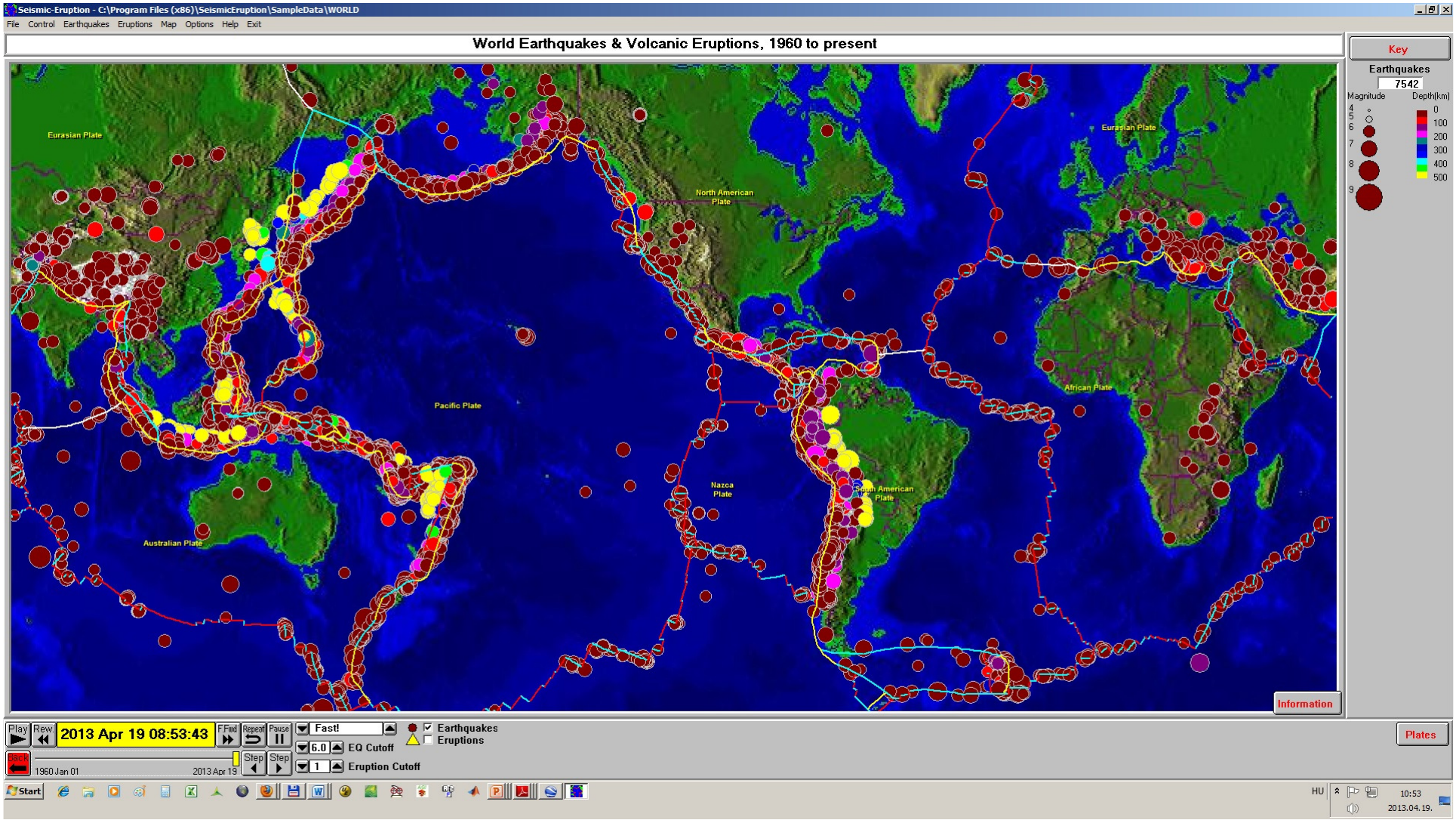
- approx. 50 felt earthquakes/day
- approx. ~10 worldwide registered /day
- approx. 20 000 seismological stations

The joy of being a seismologist comes to you, when you find something new about the earth's interior from the observation of seismic waves obtained on the surface, and realize that you did it without penetrating the earth or ouching or examining it directly."

Global seismology

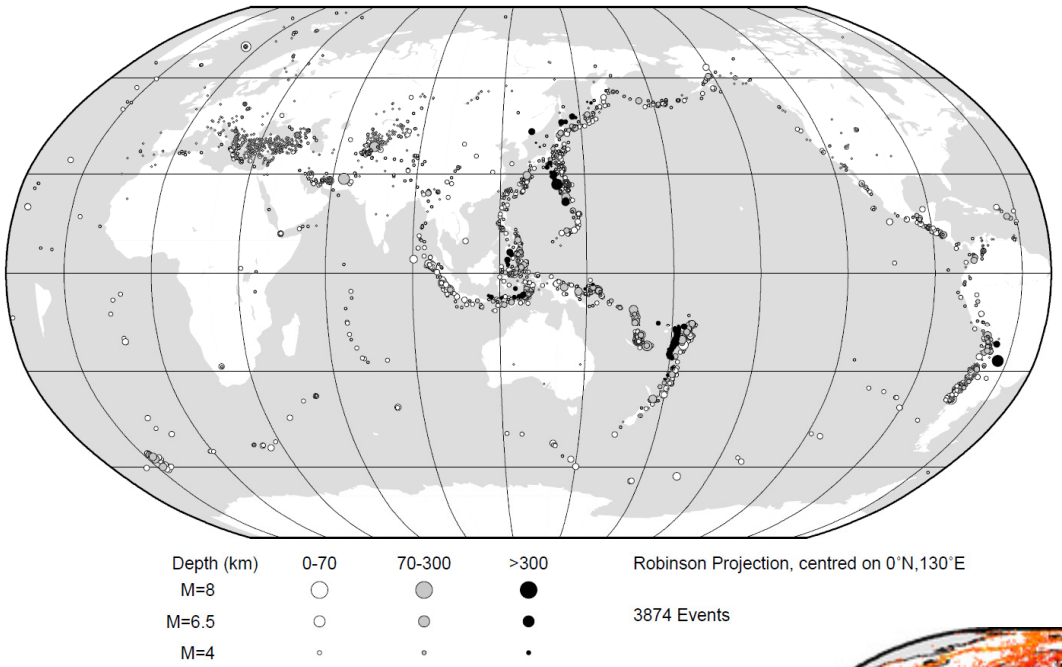
Seismic/Eruption

Alan Jones, State University of New York at Binghamton

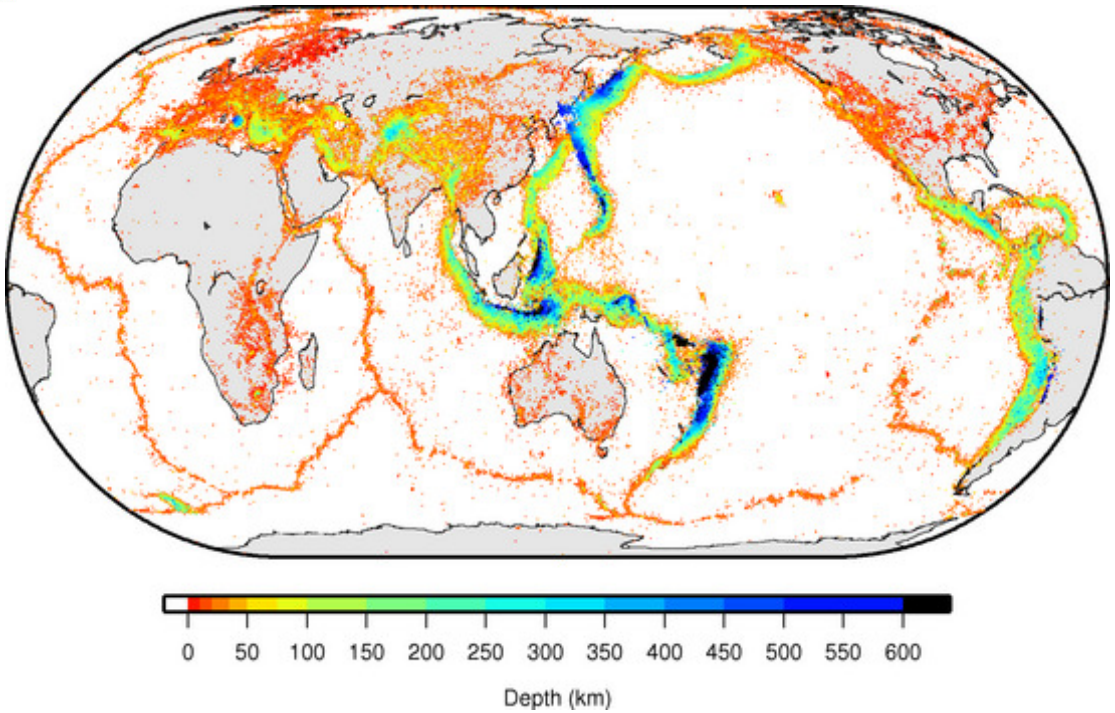


Global seismology

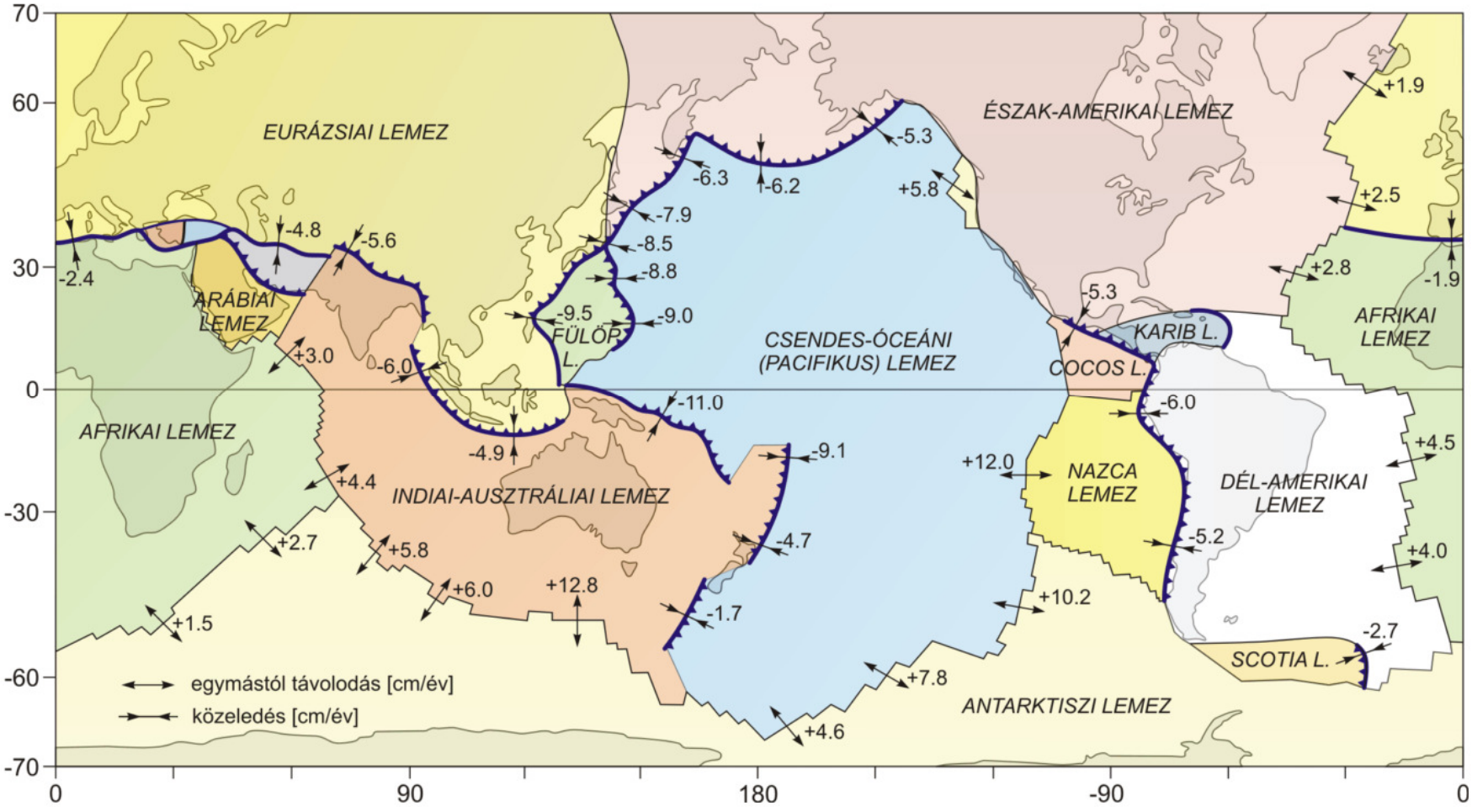
ISC 2011



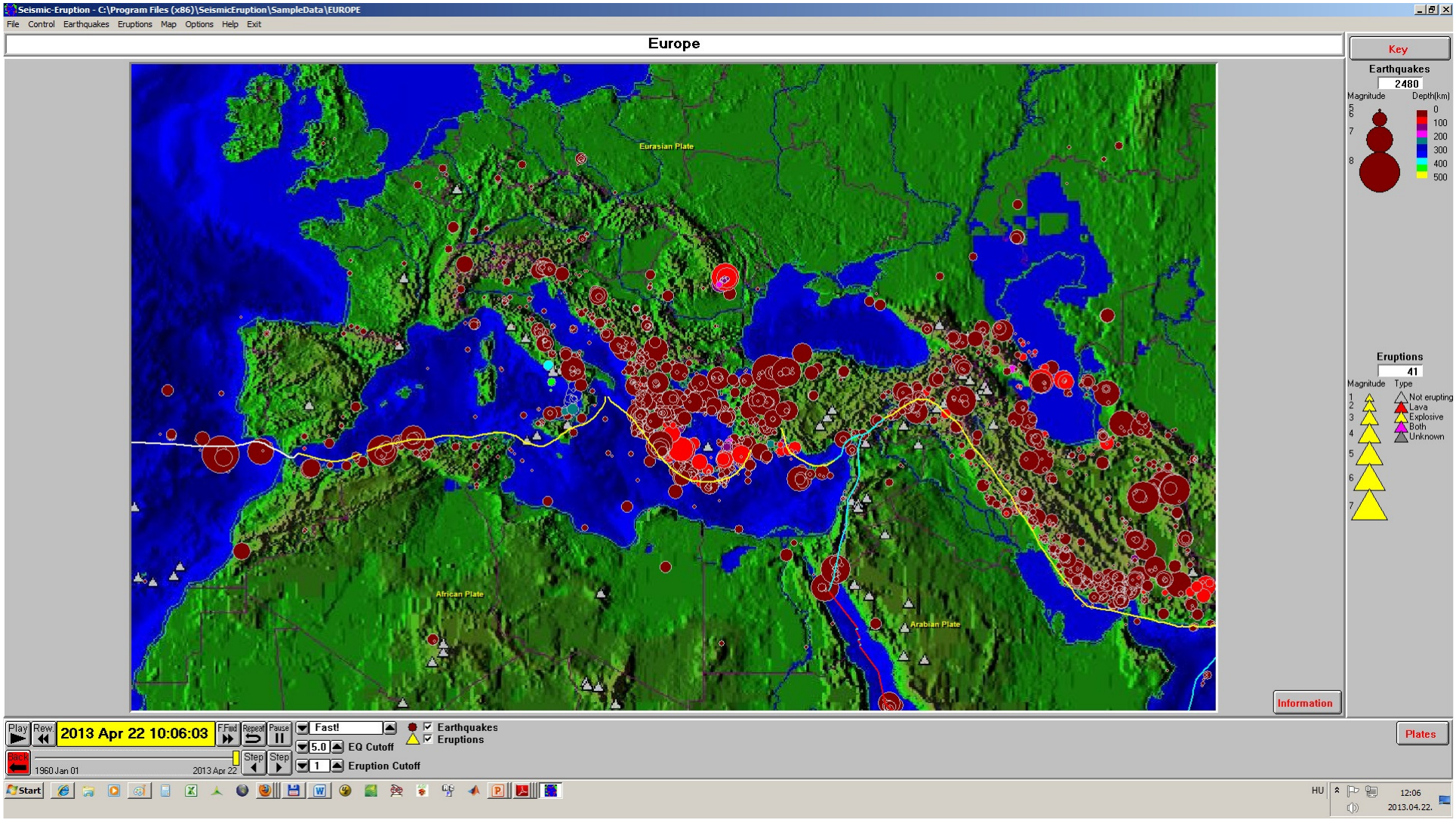
ISC 1960-2011



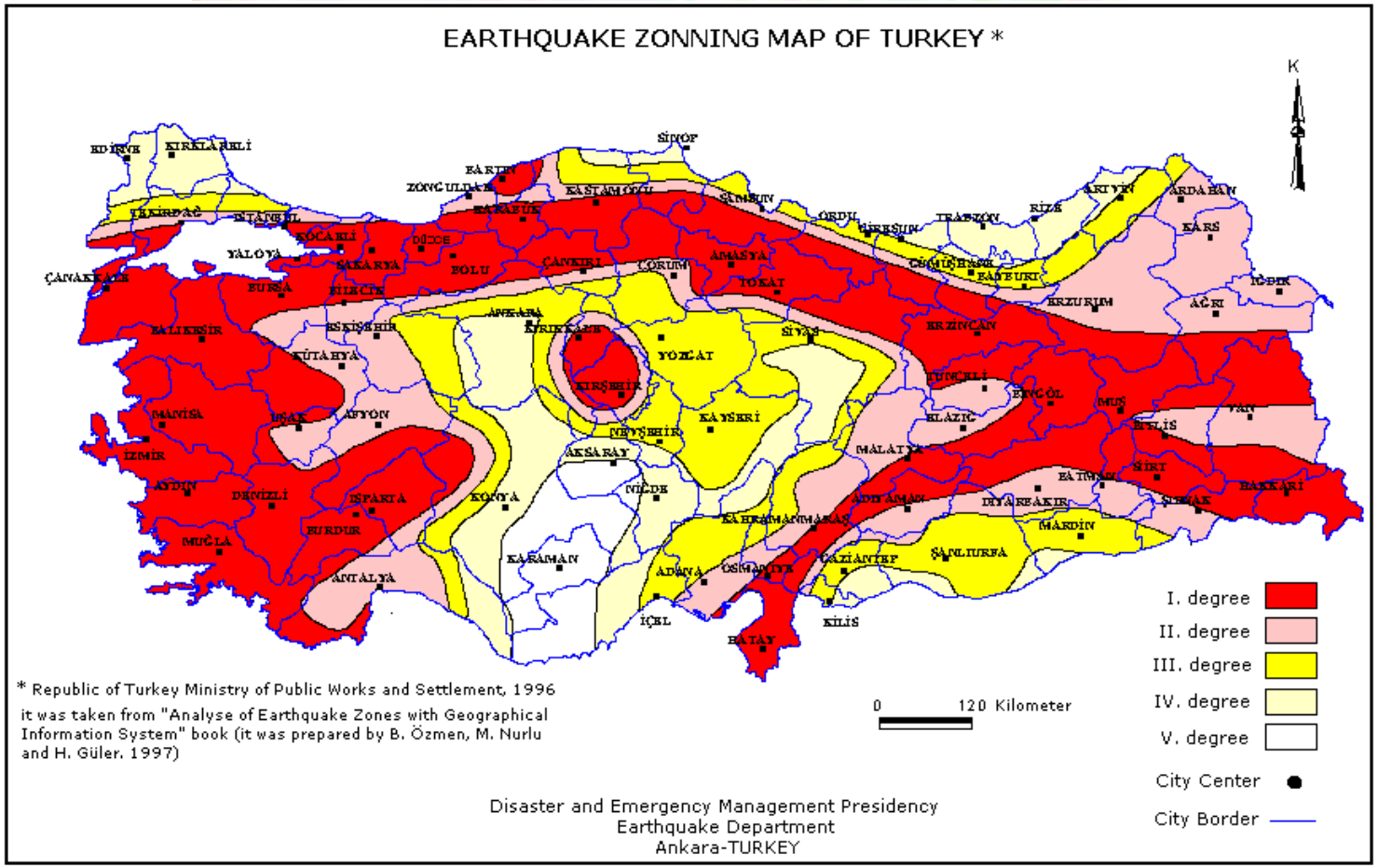
Global seismology

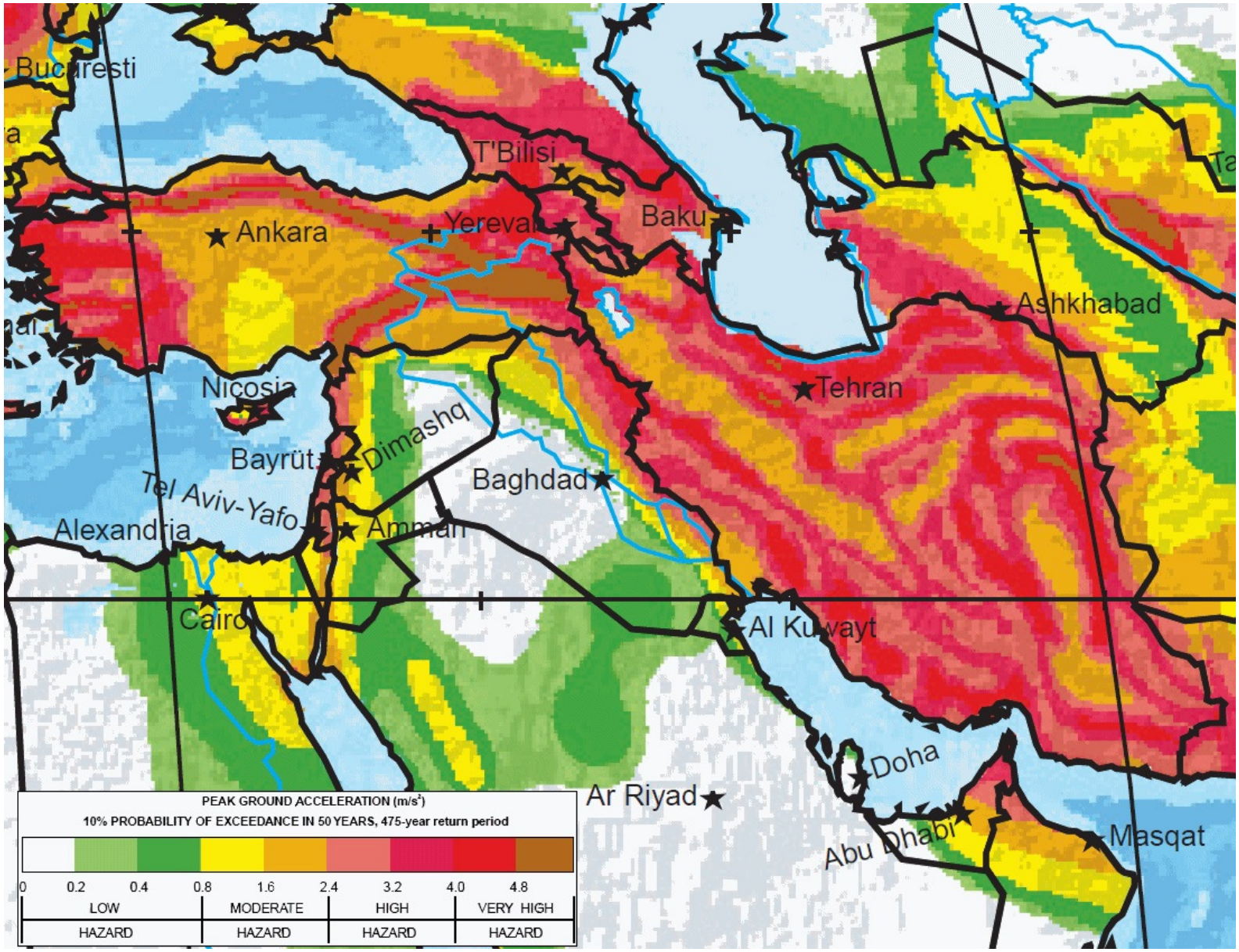


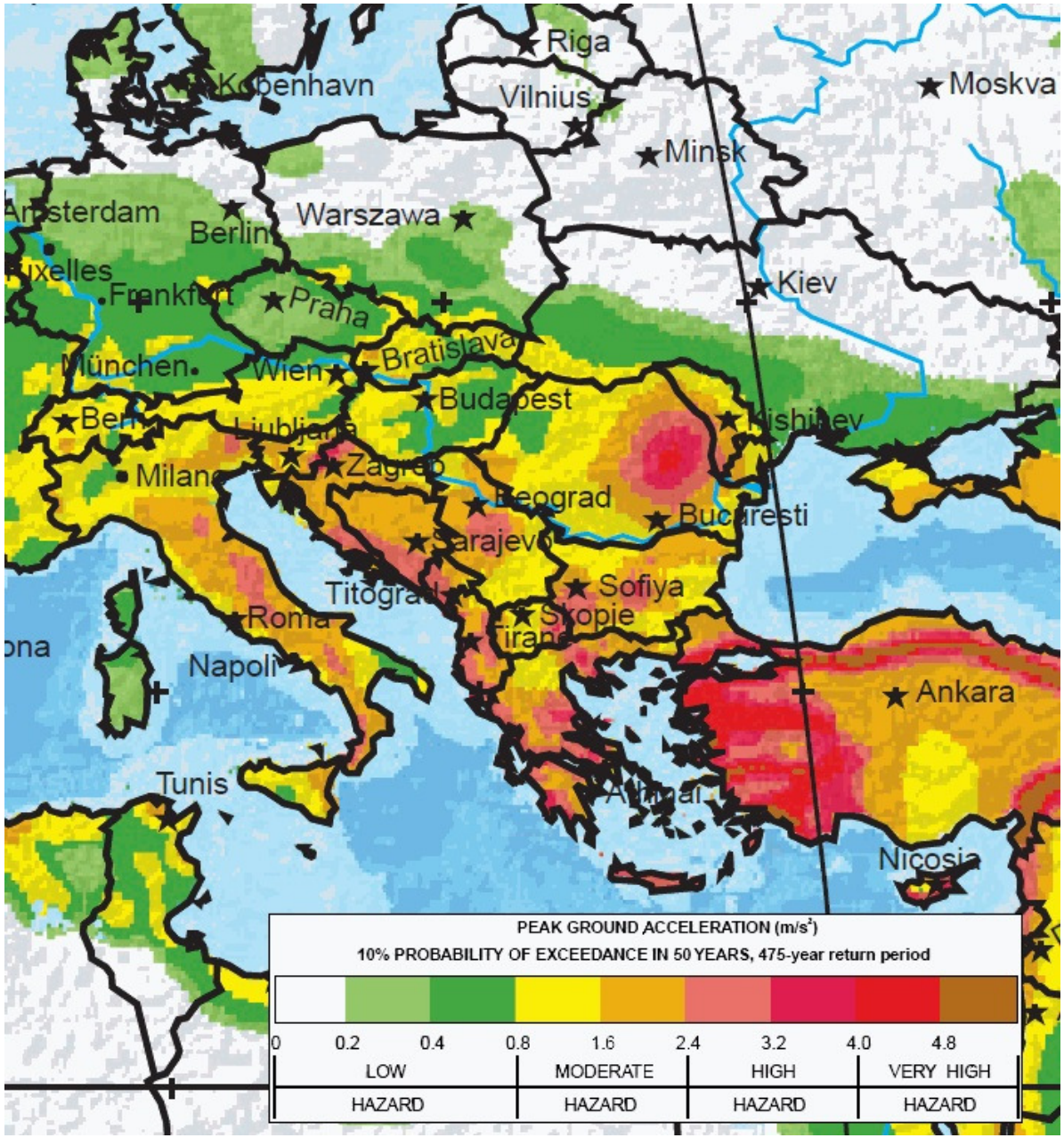
Seismology of Europe and the Middle East



Seismology of Europe and the Middle East




Bucuresti
T'Bilisi
Ankara
Yerevan
Baku
Ashkhabad
Nicosia
Tehran
Dimashq
Bayrūt
Baghdad
Tel Aviv-Yafo
Alexandria
Amman
Cairo
Al Kuwayt
Doha
Ar Riyad
Abu Dhabi
Masqat
PEAK GROUND ACCELERATION (m/s²)
10% PROBABILITY OF EXCEEDANCE IN 50 YEARS, 475-year return period
0 0.2 0.4 0.8 1.6 2.4 3.2 4.0 4.8
LOW HAZARD
MODERATE HAZARD
HIGH HAZARD
VERY HIGH HAZARD


Riga
Moskva
Vilnius
Minsk
Warszawa
Berlin
Kiev
Praha
Bratislava
Wien
Budapest
Zagreb
Beograd
Bucuresti
Sofiya
Roma
Napoli
Ankara
Tunis
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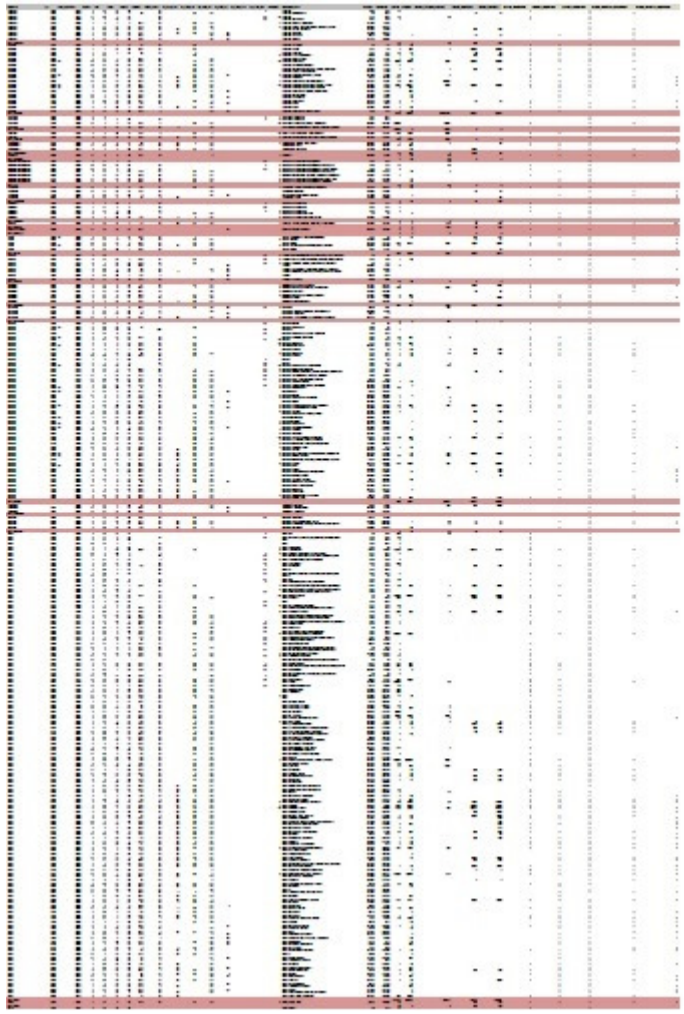
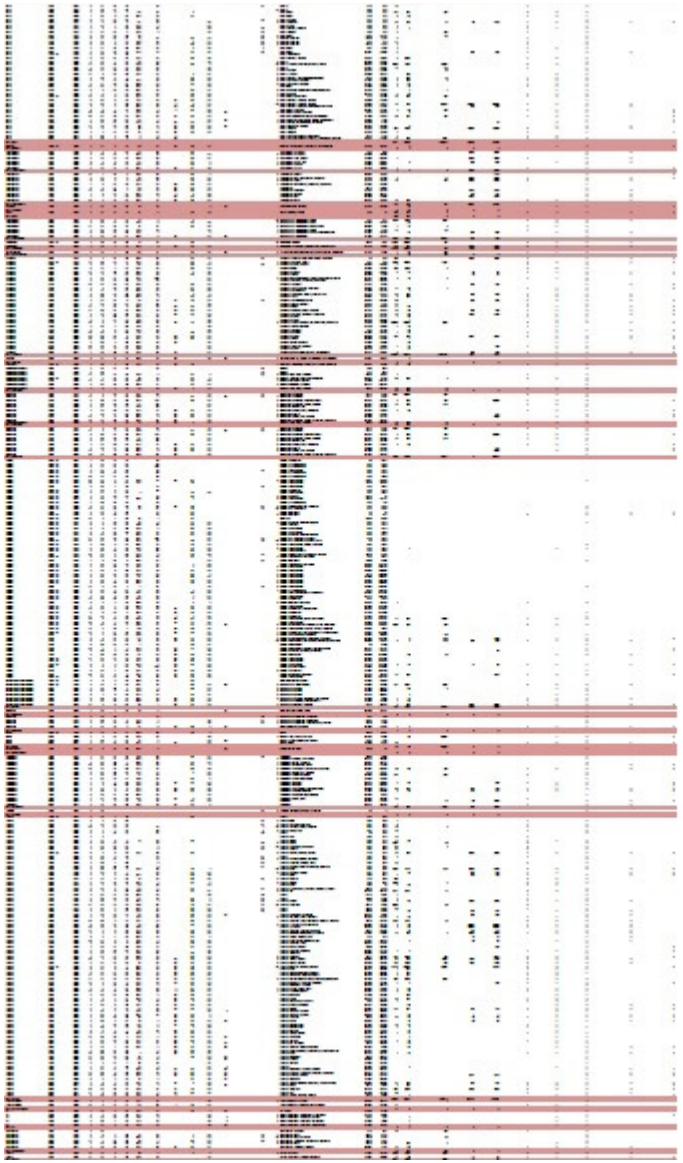
0 0.2 0.4 0.8 1.6 2.4 3.2 4.0 4.8
LOW HAZARD
MODERATE HAZARD
HIGH HAZARD
VERY HIGH HAZARD

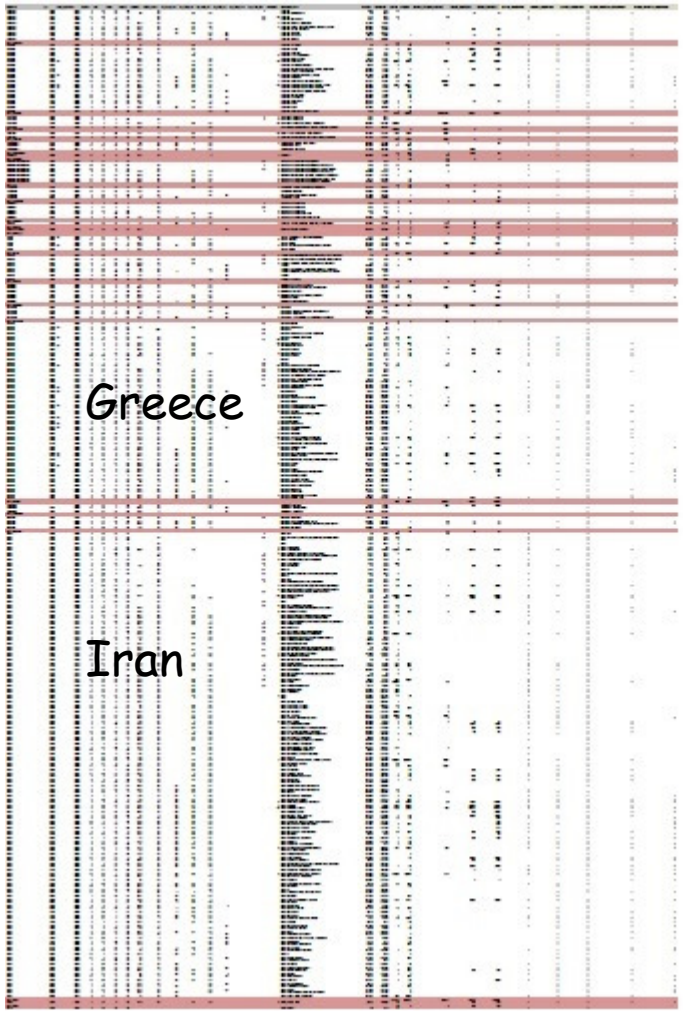
LOCATION_NAME	LATITUDE	LONGITUDE	DEATHS	INJURIES	DAMAGE_MILLIONS_DOLLARS	HOUSES_DESTROYED	HOUSES_DAMAGED	DEATHS_DESCRIPTION
ALBANIA	40.9	19.5	15					1
ALBANIA: GJIROKASTEV	40	20.2				77	77	
ALBANIA	41.5	20.5	18		20			1
ALBANIA: SOUTHERN	40.7	19.8	1					1

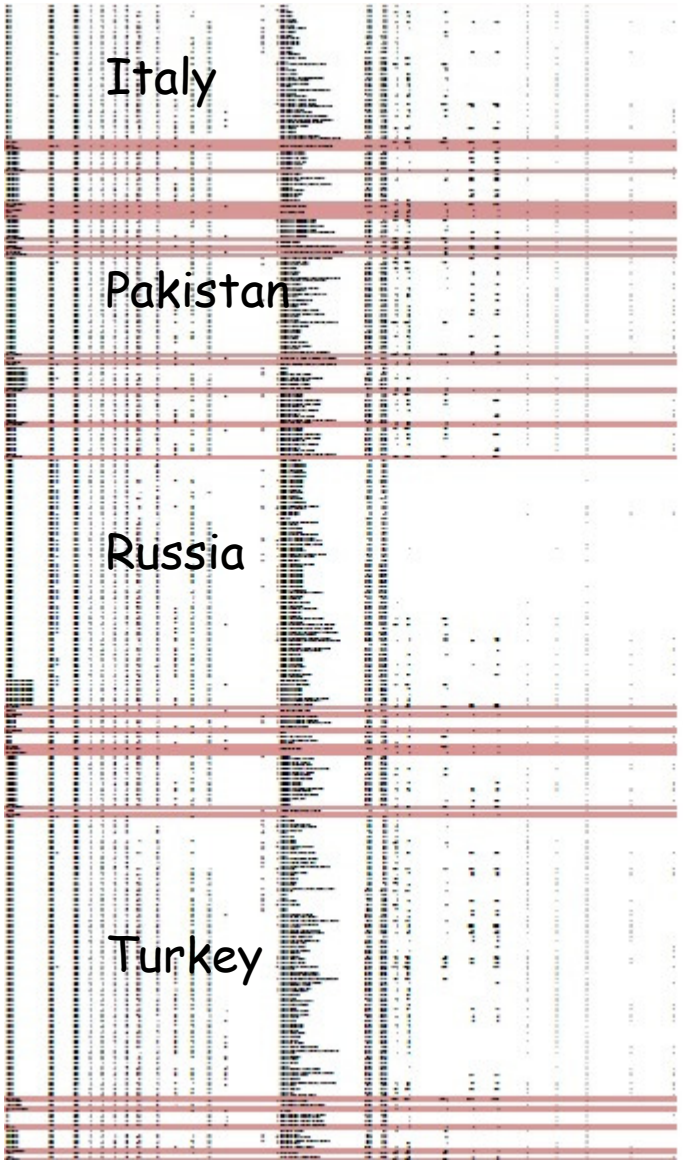


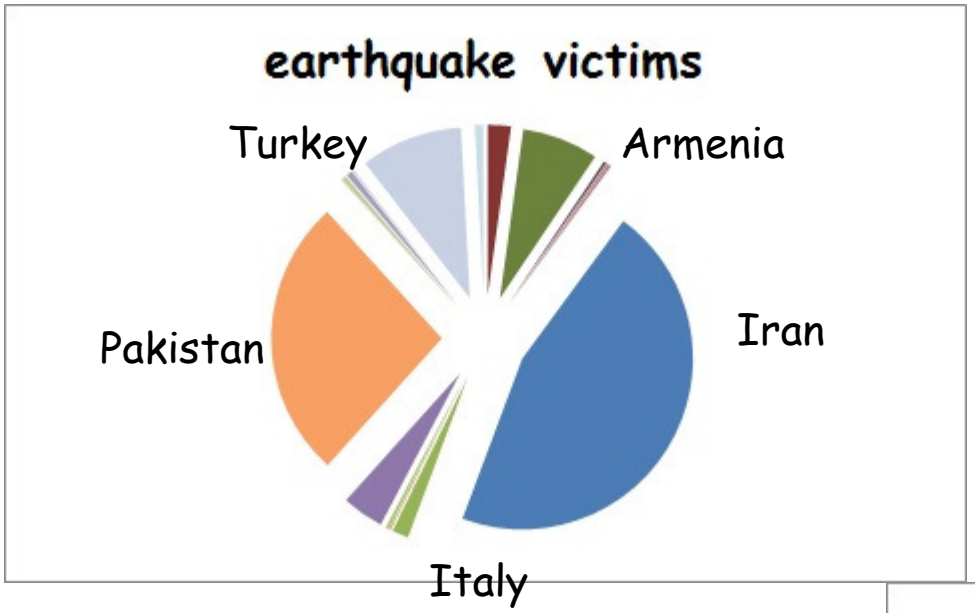


Source:
National Geophysical Data Center / World Data Service (NGDC/WDS) Significant Earthquake Database

Seismology of Europe and the Middle East

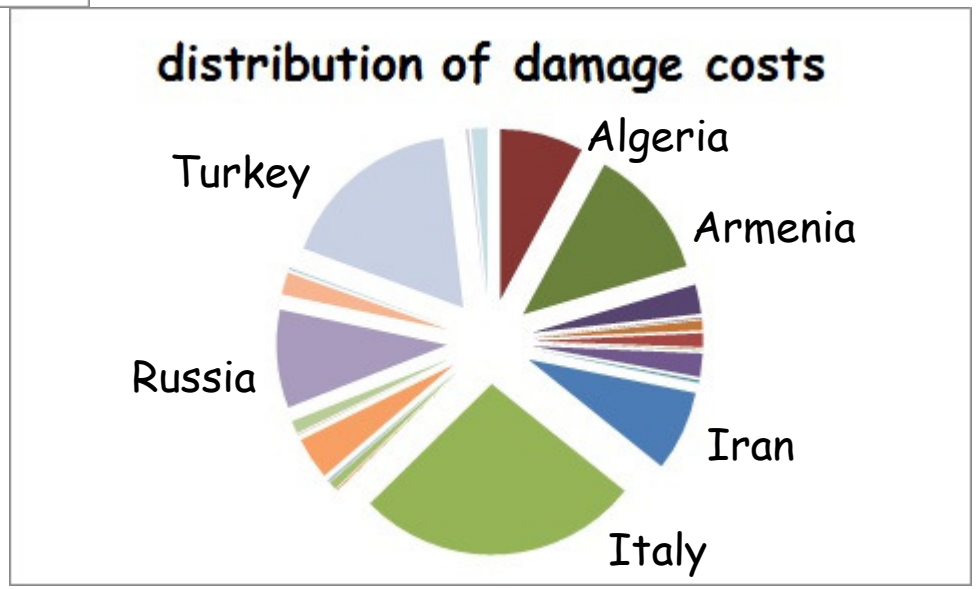






Total: 346 000

Total: 130 B USD



Cliche against feeling remorse?

Earthquakes don't kill people, buildings do. (Charles Richter?)

The possible effects of earthquakes depend on:

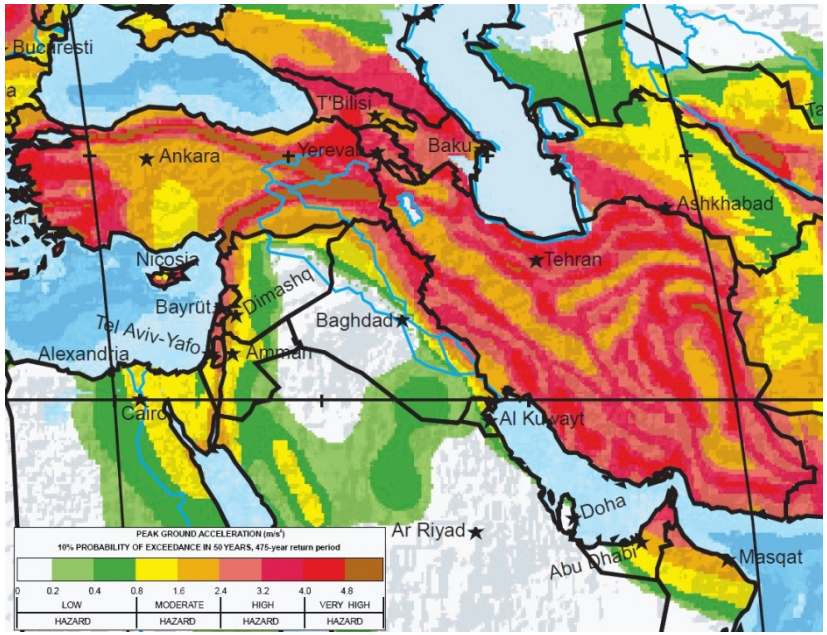
- Seismicity
- Population density of areas hit by the earthquakes
- Quality of buildings
- Secondary effects (Fukushima)
- Other effects (tsunamis, landslides)

The possible effects of earthquakes depend on:

- Seismicity — seismic hazard analysis
- Population density of areas hit by the earthquakes — conditions?
- Quality of buildings — seismic hazard calculations and design
- Secondary effects (industrial facilities, Fukushima) — seismic hazard calculations and design
- Other effects (tsunamis, landslides) — seismic hazard calculations and design

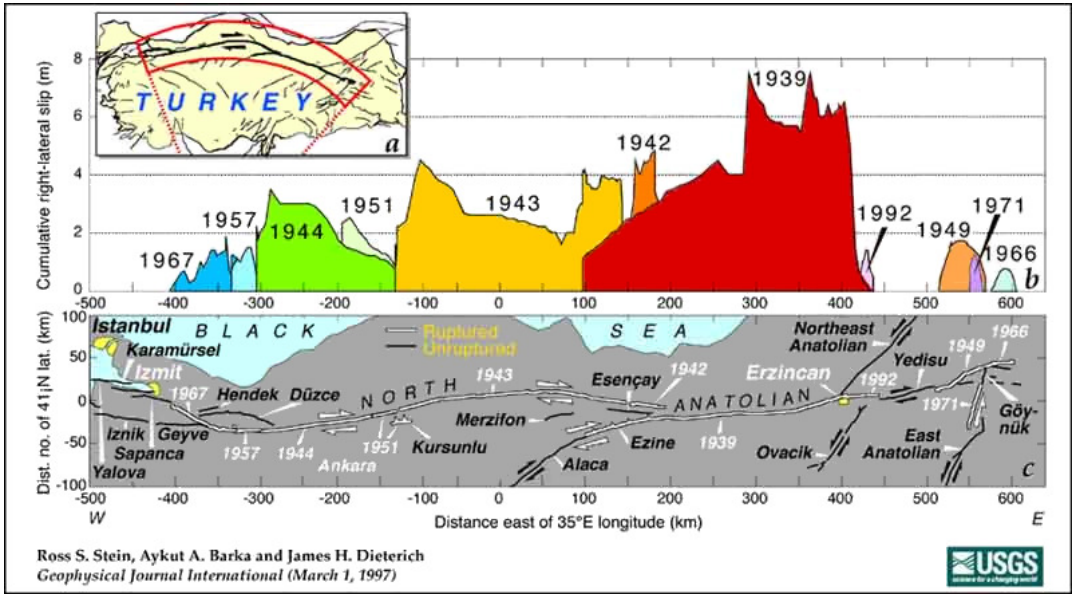
The possible effects of earthquakes depend on:

- Seismicity — seismic hazard analysis
- Population density of areas hit by the earthquakes — conditions?
- Quality of buildings — seismic hazard calculations and design
- Secondary effects (Fukushima) — seismic hazard calculations and design
- Other effects (tsunamis, landslides) — seismic hazard calculations and design

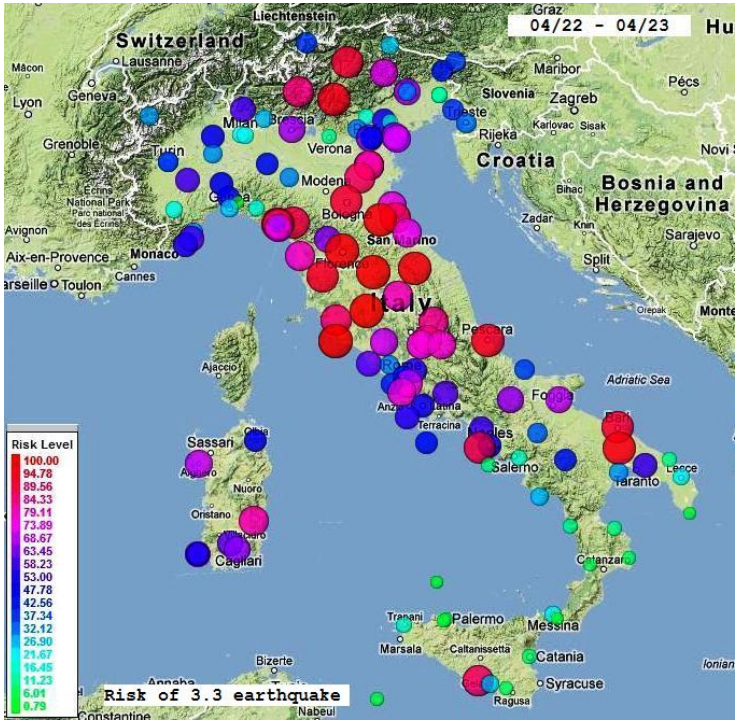


Risk ⟷ Hazard

Predictions of earthquakes?

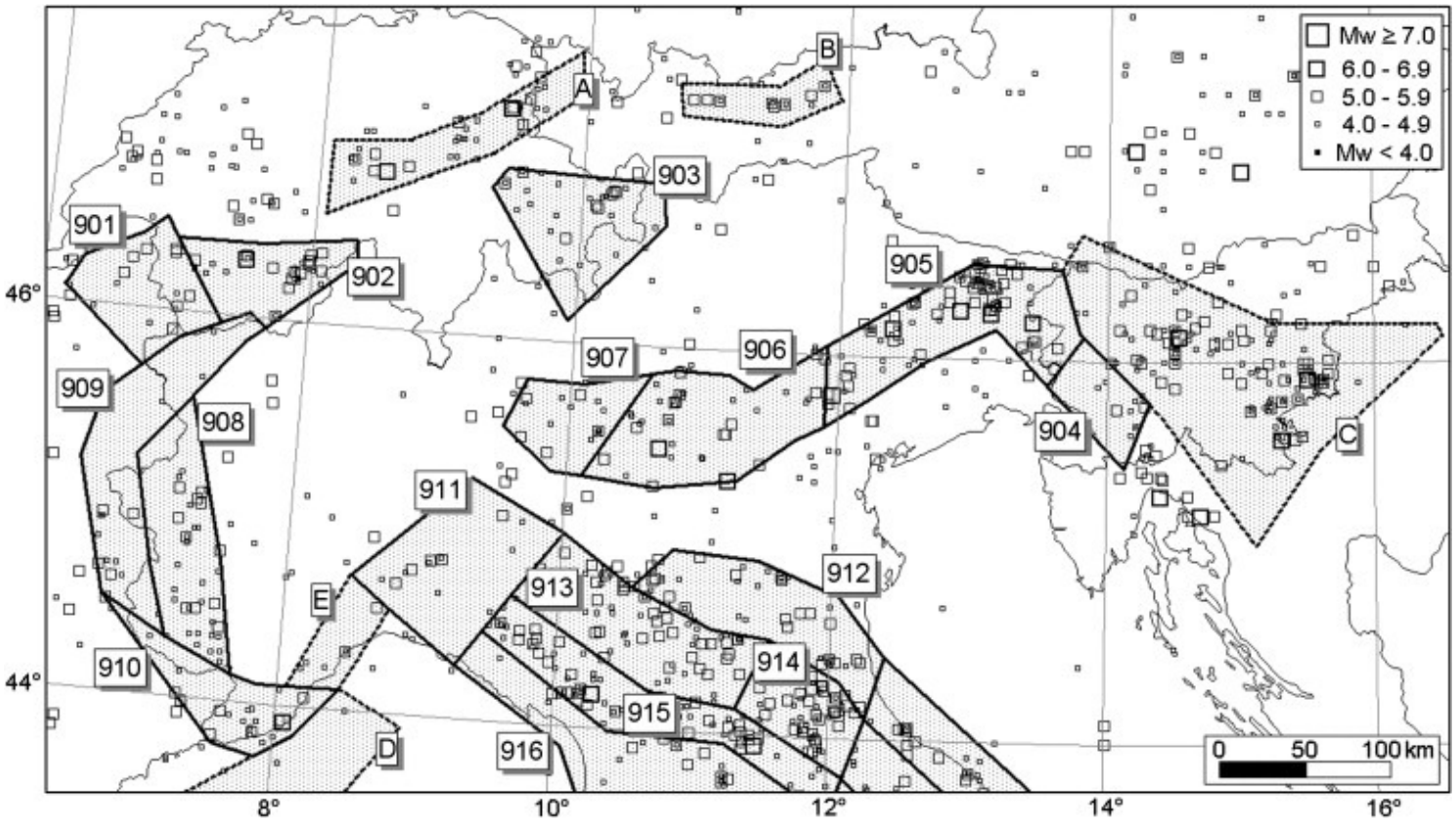


Importance of good design !!!



~~Prediction of earthquakes?~~ Calculation of earthquake hazard!

Definition of source zones



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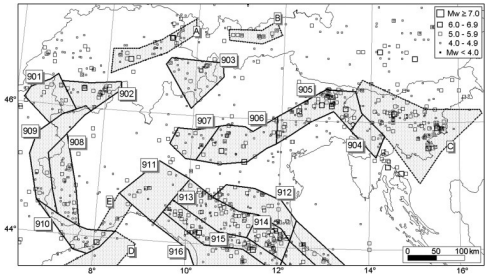
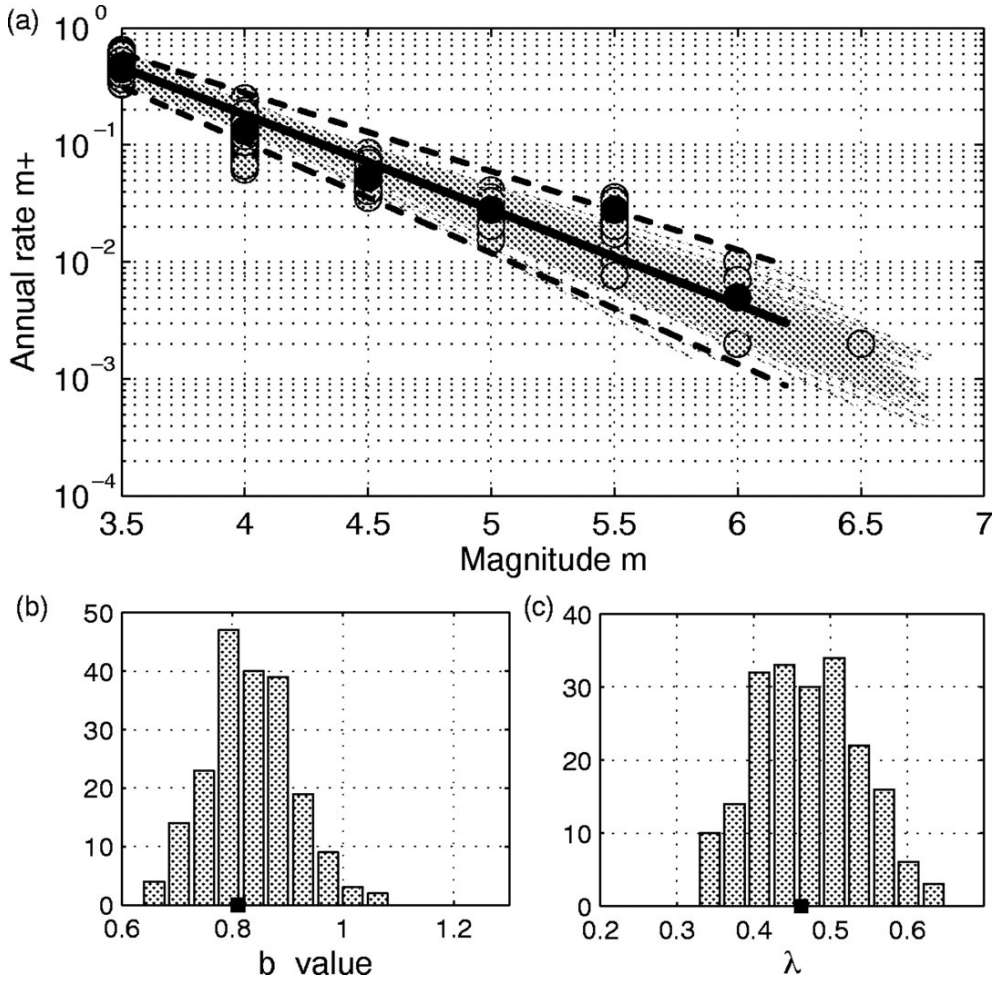


Magnitude – frequency equations



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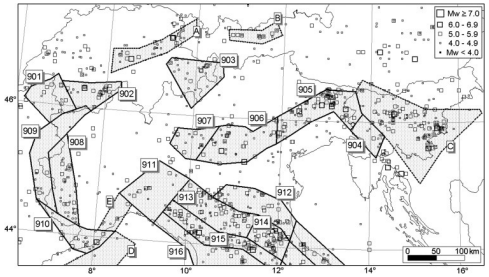

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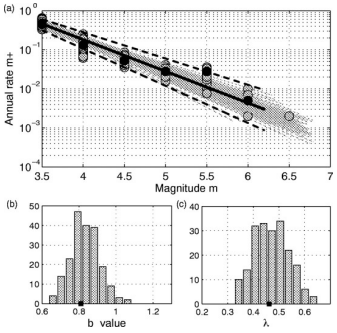
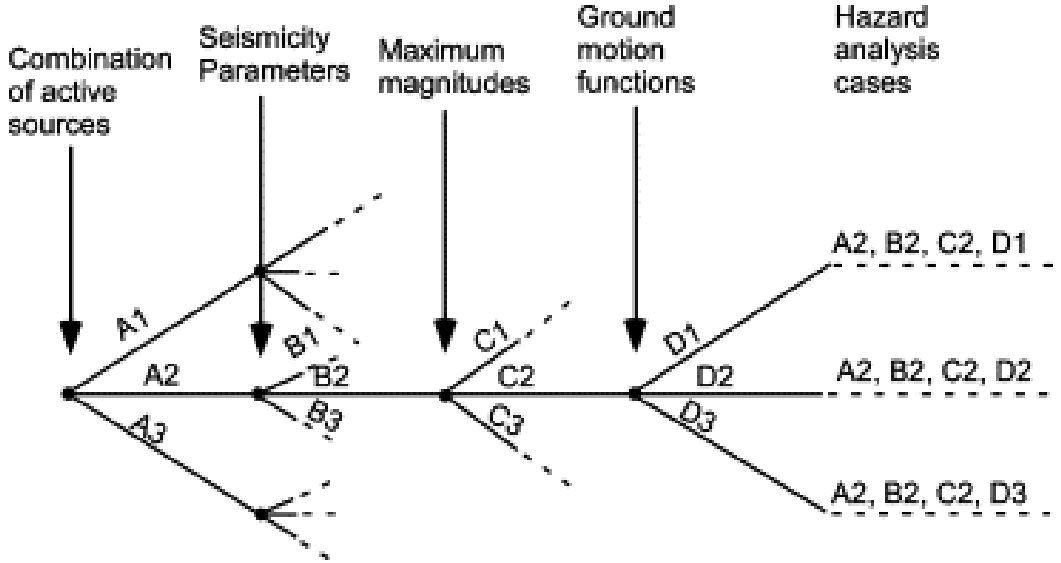


Logic tree representation of uncertain parameters



~~Prediction of earthquakes?~~ Calculation of earthquake hazard!

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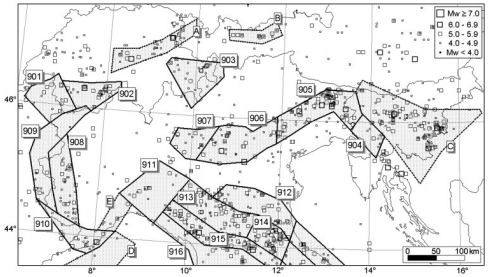

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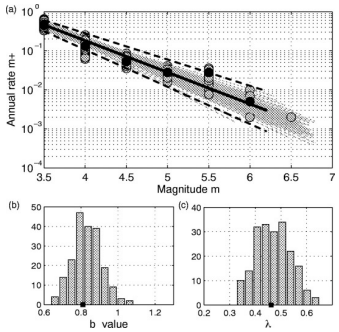
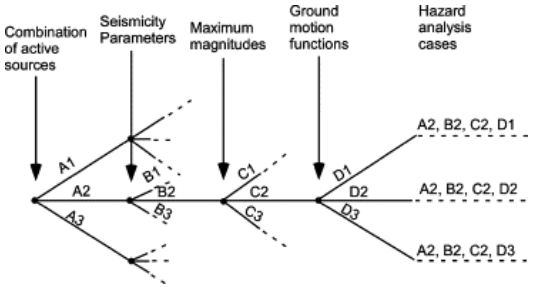
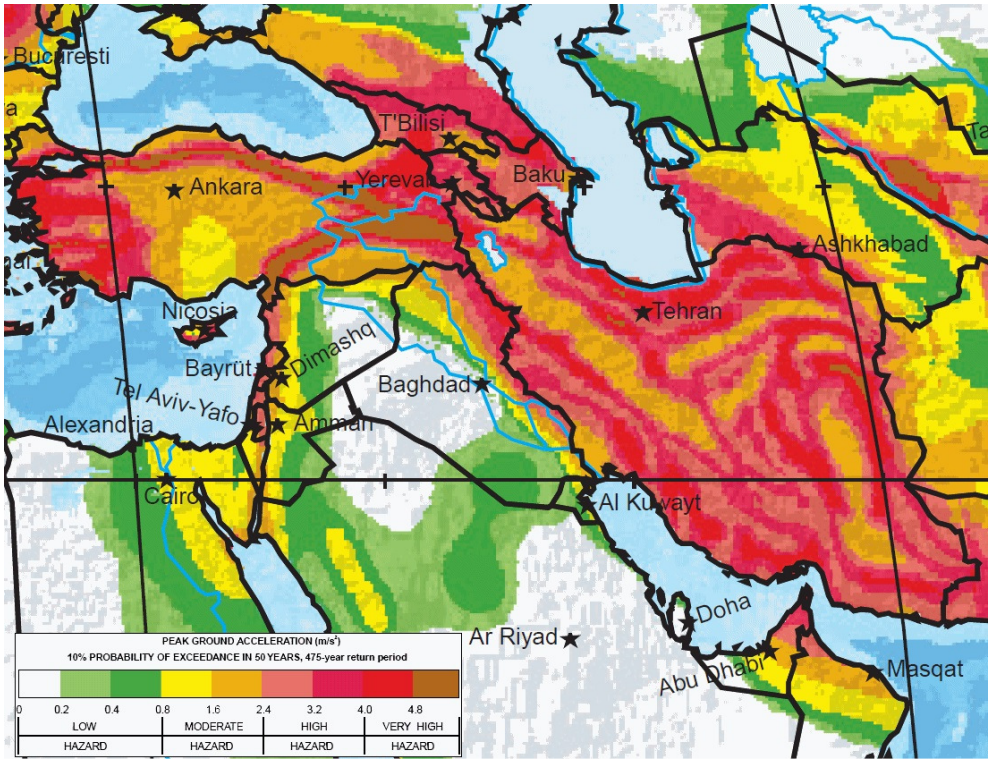


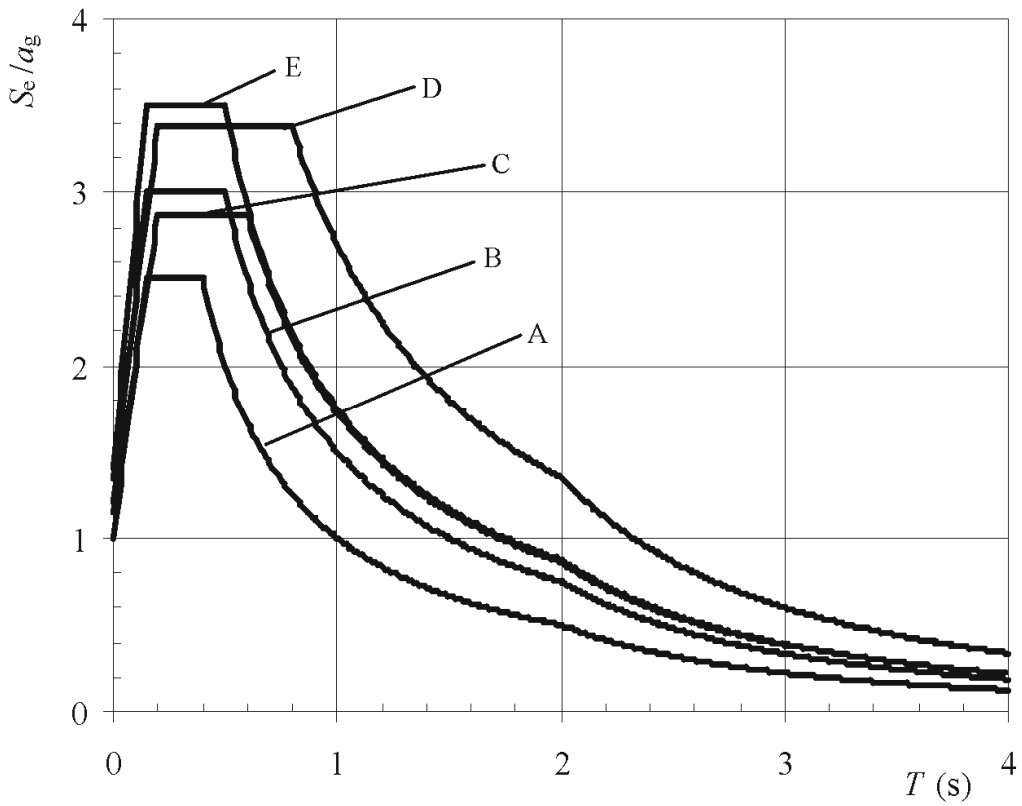
Logic tree representation of uncertain parameters



Hazard maps — the base of seismic zone definitions



Response spectra — normalized sesimic loads for modal calculations



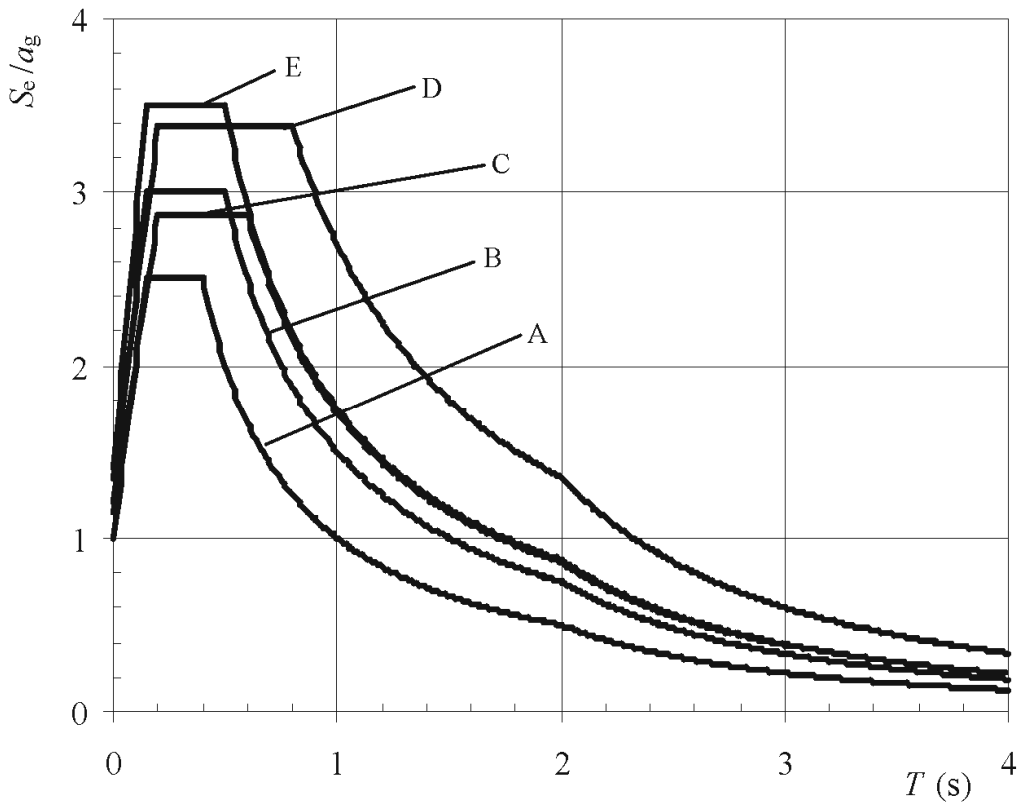
Linear elastic case

$$T_B \leq T \leq T_C : \; S_e(T) = a_g \cdot S \cdot \eta \cdot 2.5$$

Non-linear response of a structure

$$T_B \leq T \leq T_C : \; S_d(T) = a_g \cdot S \cdot \frac{2.5}{q}$$

Response spectra — normalized sesimic loads for modal calculations



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q — behaviour factor

Non-linear response of a structure

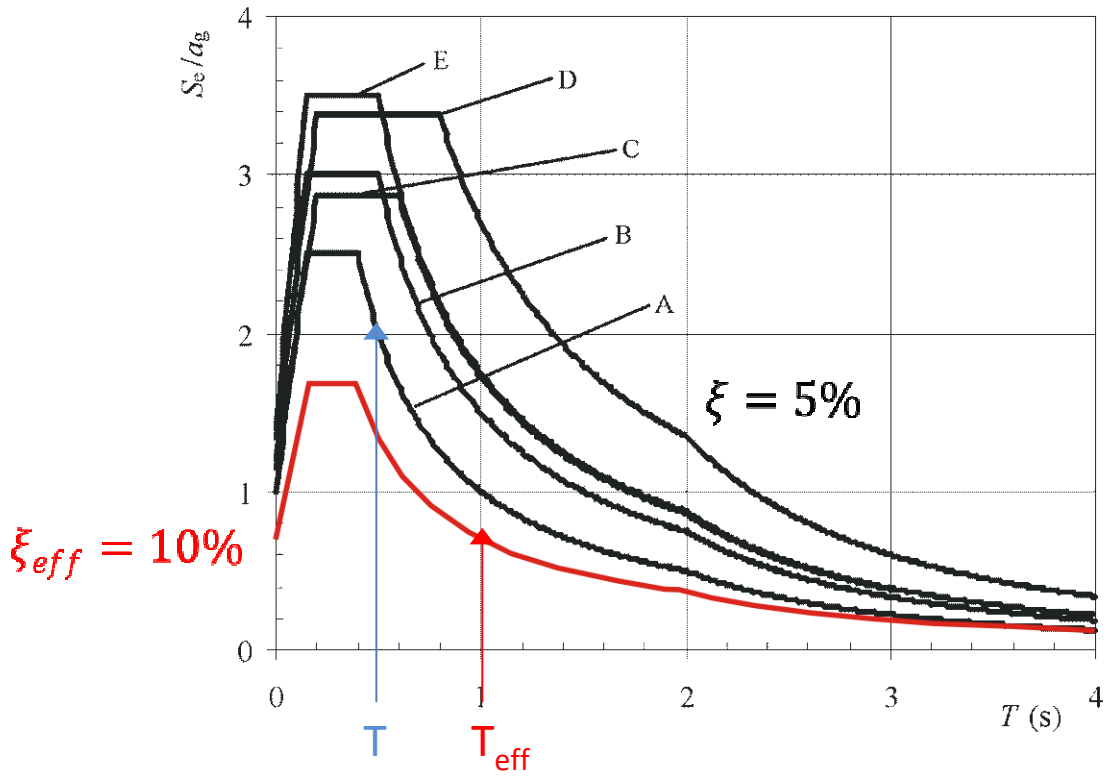
$$T_B \leq T \leq T_C : \; S_d(T) = a_g \cdot S \cdot \frac{2.5}{q}$$

behaviour factor

Value of q ~ 1-5
Depends on:

- material,
- structural system,
- design procedures.

Response spectra — normalized sesimic loads for modal calculations



Linear elastic case

$$T_B \leq T \leq T_C : \; S_e(T) = a_g \cdot S \cdot \eta \cdot 2.5$$

$$\eta = \frac{10}{5+\xi} \geq 0{,}55 \qquad \xi = 5\%$$

damping correction factor viscous damping ratio

Effects of base isolation

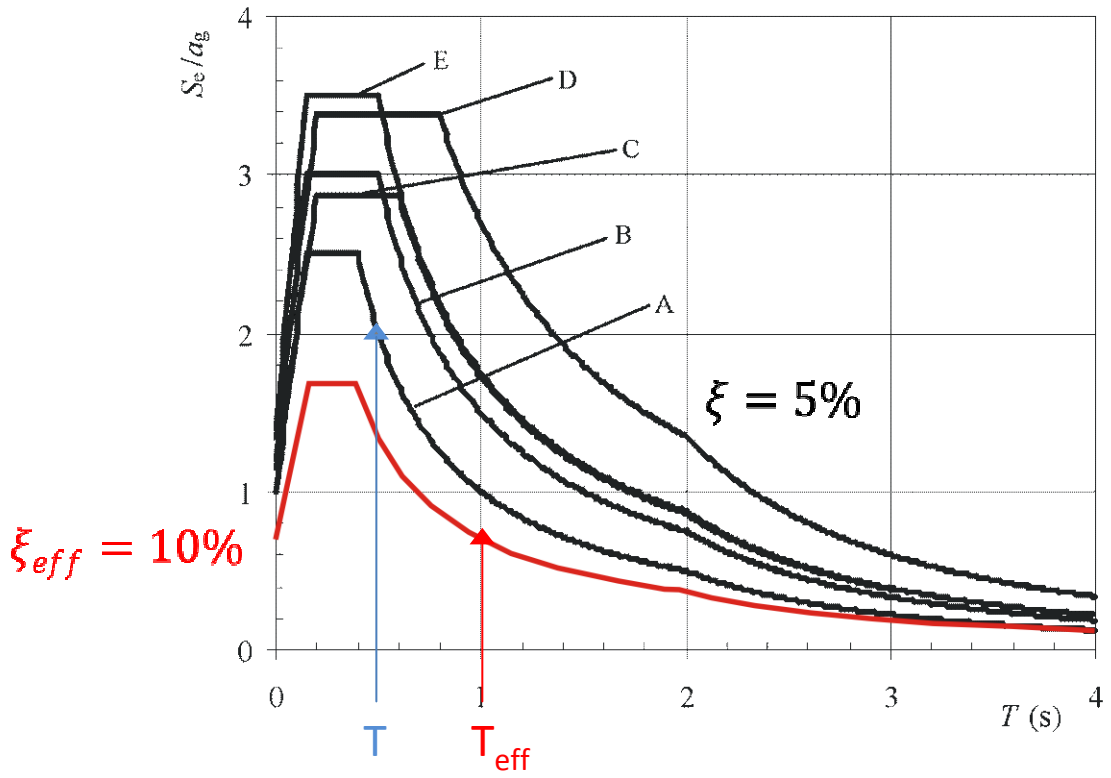
„Tuning the structure"

$T \longrightarrow T_{eff}$

Modifying the damping factor

$\xi \longrightarrow \xi_{eff}$

Response spectra — normalized sesimic loads for modal calculations



Reduce the effect of quakes on

- Non structural elements
- Equipments

Effects of base isolation

„Tuning the structure"

$T \longrightarrow T_{eff}$

Modifying the damping factor

$\xi \longrightarrow \xi_{eff}$

UBC 1997

Turkish Code 1997

Specification for Structures to be Built in Disaster Areas

PART III - EARTHQUAKE DISASTER PREVENTION
(Chapter 5 through Chapter 13)

Issued on: 2.9.1997, Official Gazette No.23098
Effective from: 1.1.1998
Amended on: 2.7.1998, Official Gazette No.23390

ENGLISH TRANSLATION
PREPARED UNDER THE DIRECTION OF

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Kandilli Observatory and Earthquake Research Institute
81220 Cengelkoy, Istanbul, Turkey
E-mail : aydinogn@boun.edu.tr

1999 Kocaeli earthquake

↓

Draft
Seismic Isolation Specification

Turkish Association for Seismic Isolation

Georgia Code 1999

Georgian Building Code

Earthquake Engineering

(PN 01.01-09)

Chapter I. General

Item 1. Sphere of application

Because of all the territory of Georgia is located in seismic active zone, these Building Codes and Rules are spread on all its territory and it concerns with design of buildings and structures of dwelling houses, social housing and manufacturing facilities both under construction and to be strengthened and restored.

Item 2. Terms and definitions

1.The Building site design seismic intensity – design value of seismic effect expressed in intensities according to the scale of seismic intensity, accelerations or other physical values.

2. Seismic resistance of buildings and structures - the capacity of buildings and structures to maintain the strength and steadiness, considered in design after design earthquake action, that excludes the global or partial failure of the building that can cause the human victims or damages.

3. Aseismic measures - complex of structural and design solutions based on demands of seismic codes providing the seismic resistance level, regulated by codes.

4. Seismic isolation - decreasing of seismic loads, acting on structure using the special structural elements. Such elements are:

a) elements, increasing the structure self-oscillation and ductility (ductile bars, rubber-steel supports etc.);

b) elements, increasing the seismic oscillation energy absorption (dissipation) capacity (absorbers of dry friction, sliding supports, hysteresis, ductile absorbers);

c) standby switch off elements;

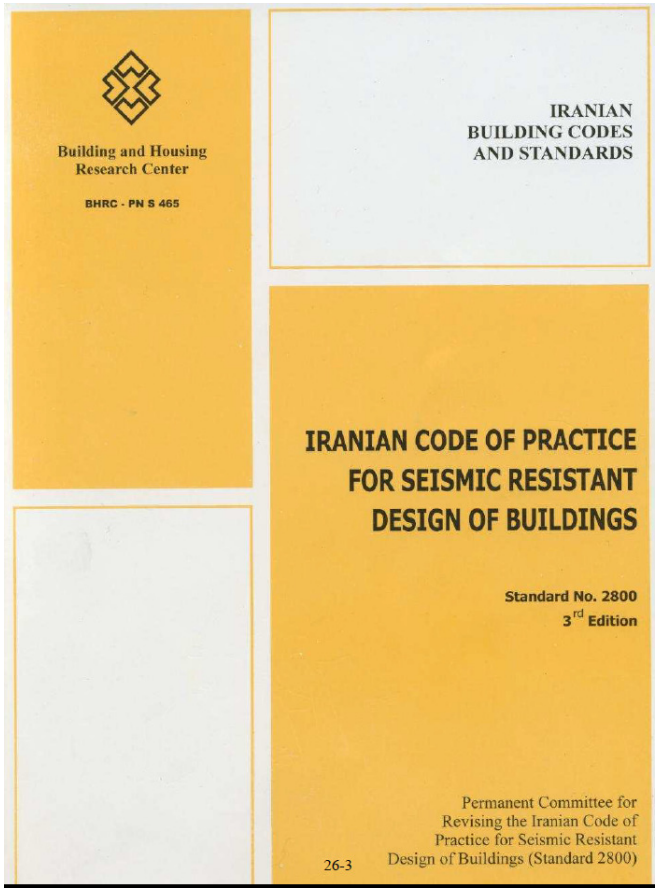
d) The limiting supports of the horizontal displacement.

5. Frame buildings - buildings with bearing frames which undertake the whole horizontal and vertical loads.

6. Framed and braced system – the system containing the skeleton frames and vertical diaphragms - walls or stiffening cores, which bear the horizontal and vertical loads. At that,

Seismic Codes

Iranian Code 1999



Algerian Code 2003

ALGERIAN EARTHQUAKE RESISTANT REGULATIONS « R P A 99/Version 2003»

CHAPTER I – GENERAL

1.1 SCOPE

The present technical regulations set the rules for the conception and the earthquake resistant design of constructions in seismic prone areas.

1.2. OBJECTIVES

The present regulations aim at giving an acceptable protection for human lives and constructions against the adverse effects of seismic actions through an appropriate design and detailing.

- For current constructions, the aimed objectives are to provide the structure with :

- - a sufficient strength and stiffness in order to limit the non structural damages and to avoid the structural ones through an essentially elastic behavior of the structure while facing a relatively frequent moderate seismic event.

- - an adequate ductility and capacity of energy dissipation to allow the structure to undergo inelastic displacements with limited damages and no collapse nor loss of stability while facing a rare major seismic event.

- For certain important constructions, the aimed protection is even more severe since the construction should stay in operation immediately after a major seismic event.

1.3. APPLICATION FIELD

The present regulations are applicable to all current constructions. On the other hand, they are not directly applicable to constructions such as:

- constructions and facilities for which the consequences of an even light damage might be of an exceptionnal gravity : nuclear power plants, LNG facilities, installations for manufacturing and stocking flammables, explosive, toxic or polluting products.

-civil engineering works (dams, marine works, bridges, tunnels,...).

-buried networks and constructions.

-plates and thin shells structures.

Source: http://www.iaee.or.jp/worldlist.html

No data: Pakistan, Armenia etc.

Adoptation?

Last notice …

Earthquake-Resistant Construction of Adobe Buildings: A Tutorial

Images from El Salvador : top-Manuel Lopez Menjivar; bottom-PRISMA

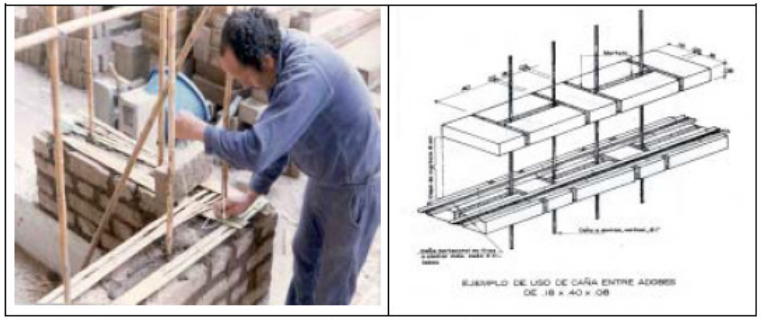


Figure 11 – Construction of Cane Reinforcement In Peru (Blondet et al, 2002)

Figure 12 – Construction of Cane Reinforcement In El Salvador (Dowling, 2002)

Several research studies on adobe buildings reinforced with cane have been performed at the Catholic University of Peru (PUCP), Lima, Peru (Blondet et al, 2002). The first research project developed at the PUCP in 1972 consisted of the experimental study of several alternatives for structural reinforcement of adobe houses, made with materials available in rural regions. The models were built on top of a concrete platform. Testing consisted of slowly tilting the platform and measuring the tilt angle at collapse. The lateral component of the weight of the model was then used to quantify the maximum seismic force. The main

Thank You for your attention!