Department of Geological Sciences, Faculty of Sciences
Masaryk University/Brno & Czech Geological Society

September 12-14, 2011

Short Course on Geological Hazards

Day 2 (Tue PM), Lecture 4:

(Topic 4 of Original Announcement)

PSHA for Critical Facilities: NPP and NHLW-DGR, with Examples from Japan, ENAM (US & CA SCR), CZ

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Corporate Location Guide

Advantage 2 : A safe and Secure Industrial Infrastructure

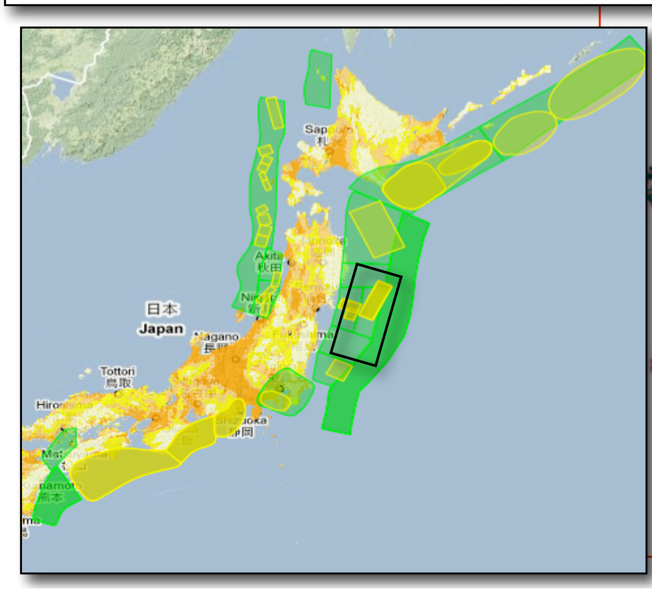
Fukushima supplies a stable industrial infrastructure with few earthquakes and disasters, as well as plentiful water resources.

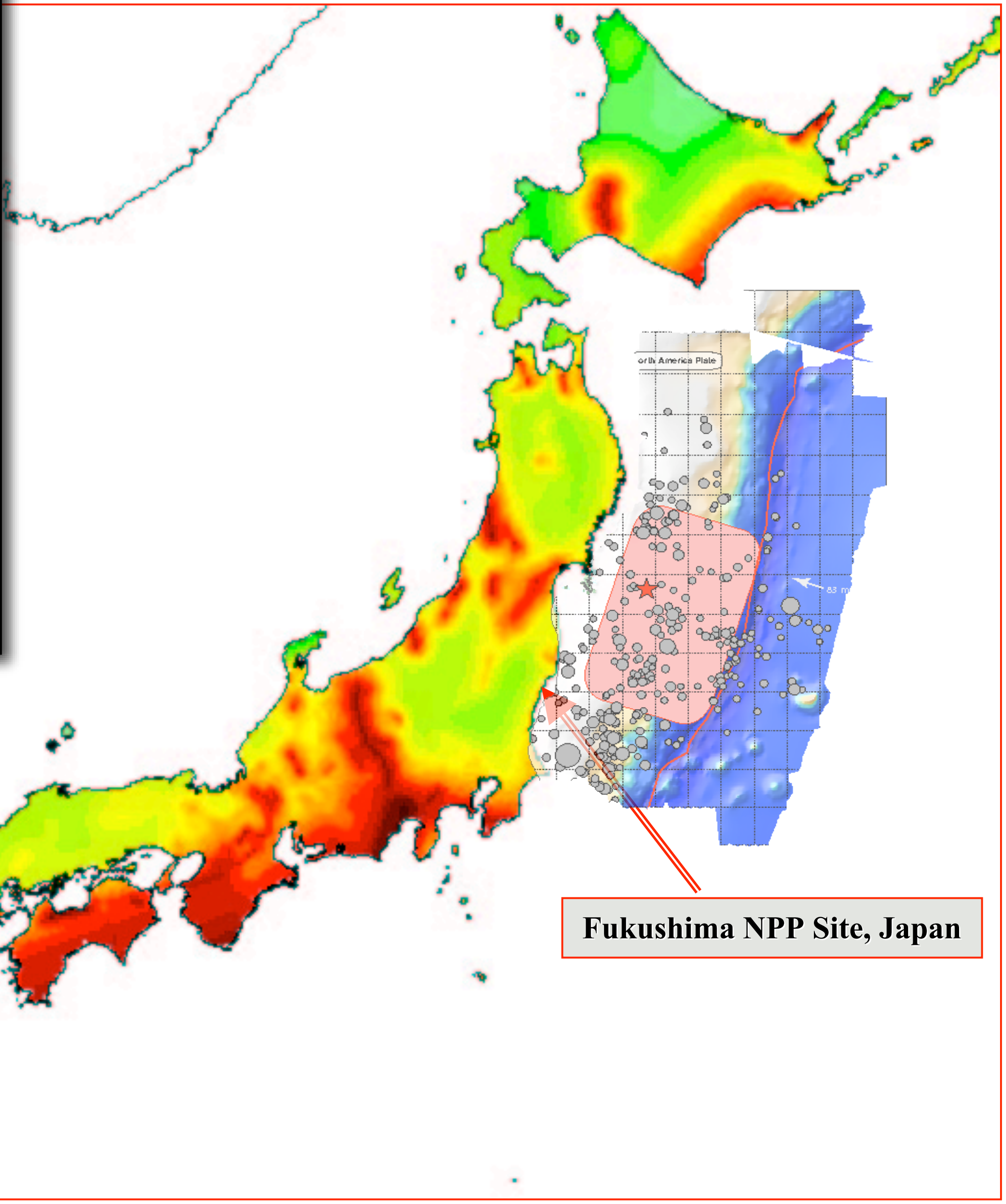
With firm geological foundations and major earthquakes rare, Fukushima is a safe and secure place to do business.

Fukushima is known for its low incidence disasters such as earthquakes and typhoon-related flooding, and is regarded as one of the best location in Japan for corporate risk-management perspective.

It is believed that the probability of anything above earthquakes that are slightly under 6 degree level occurring in Fukushima within the next 30 years is low, and the geologic foundations of the Abukuma Highlands in particular are said to be solid with few fault lines, making the area extremely earthquake-safe.

Probabilistic Seismic Hazard Map(published 2009)





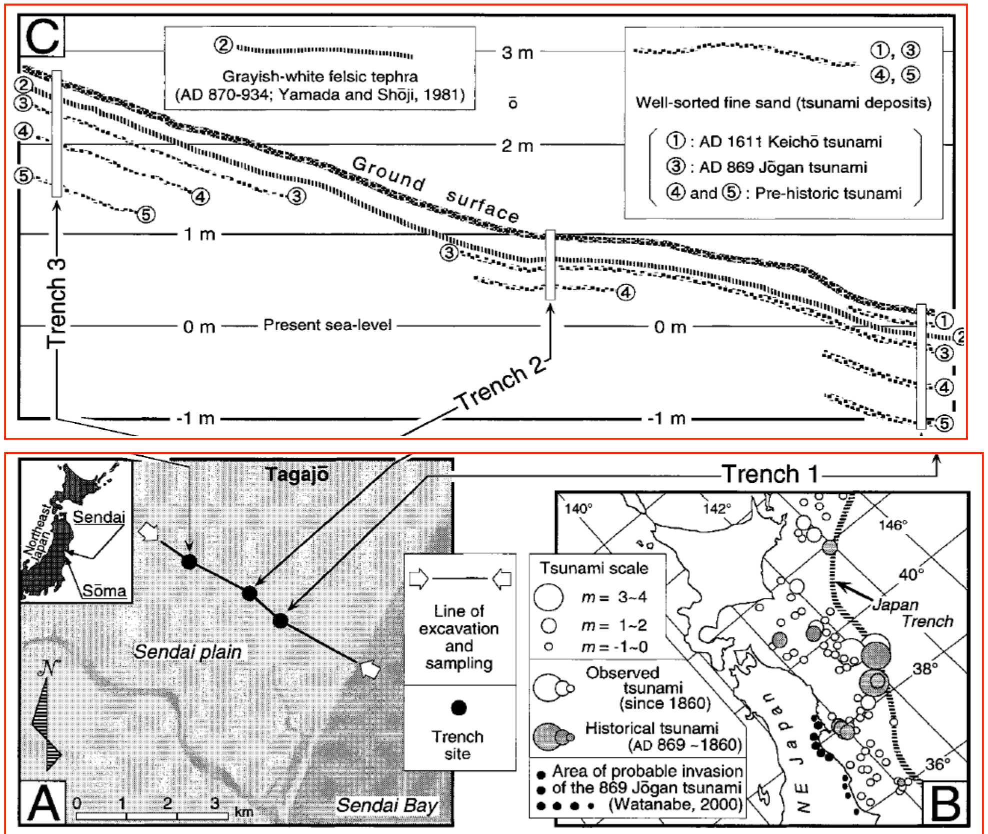
Fukushima NPP Site, Japan

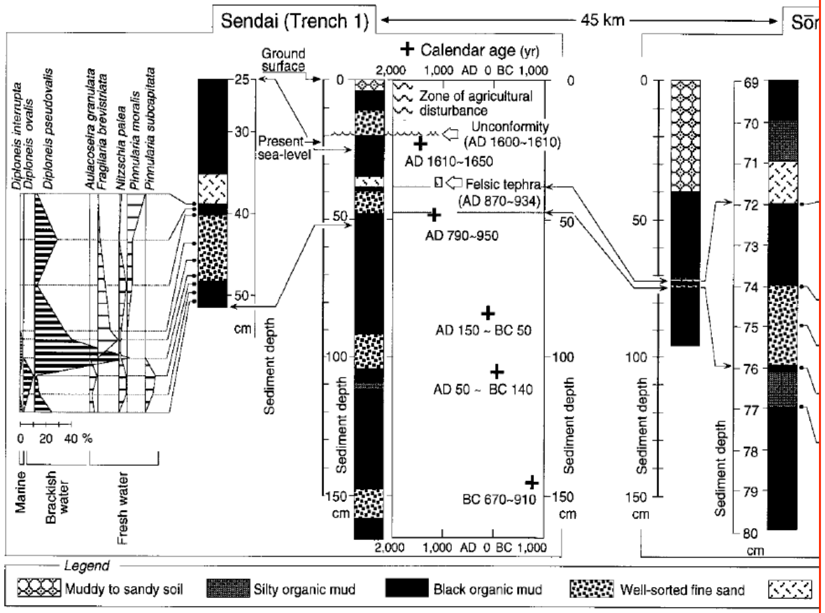
2001

The 869 Jōgan tsunami deposit and recurrence interval of large-scale tsunami on the Pacific coast of northeast Japan

K. Minoura
Institute of Geology and Paleontology, Graduate School of Science,
Tohoku University, Sendai 980-0845, Japan
F. Imamura
Disaster Control Research Center, Graduate School of Engineering,
Tohoku University, Sendai 980-8579, Japan

Two thin layers of arkosic sand that underlie the Jōgan tsunami deposit can be traced inland from the coast for more than 4 km (Fig. 1). Continuity landward tapering, and the sediment-fining pattern indicate a tsunami origin for these sand layers. We believe that the scale of the two early tsunami suggested by sand layers ④ and ⑤ is equal to that of the Jōgan tsunami and that they also were associated with widespread flooding. The depositional ages inferred from ^{14}C dating suggest that gigantic tsunamis occurred three times during the last 3000 years (Fig. 2). The respective calendar age ranges of the lower two layers are BC 140 - AD 150 and ca. B.C. 670-910 (1 σ range). The recurrence interval for a large-scale tsunami is 800 to 1100 years. More than 1100 years have passed since the Jōgan tsunami and, given the reoccurrence interval, the possibility of a large tsunami striking the Sendai plain is high. Our numerical findings indicate that a tsunami similar to the Jōgan one would inundate the present coastal plain for about 2.5 to 3 km inland.





nature geoscience
LETTERS
PUBLISHED ONLINE: 18 JANUARY 2009 | DOI: 10.1038/NGEO421

Interplate seismogenic zones along the Kuril–Japan trench inferred from GPS data inversion

Chihiro Hashimoto[1*†], Akemi Noda[1], Takeshi Sagiya[2] and Mitsuhiro Matsu'ura[1]

2009

vertical velocities from global positioning system data. For the seismically calm period between 1996 and 2000, we obtain a precise distribution of slip-deficit rates on the interface between the North American and Pacific plates around Japan, which reveals a trench-parallel belt of slip deficit with six peaks in the depth range of 10–40 km. These peaks agree with the source regions of past large interplate earthquakes along the Kuril–Japan trench. We conclude that the slip-deficit zones identified with our method are potential source regions of large earthquakes.

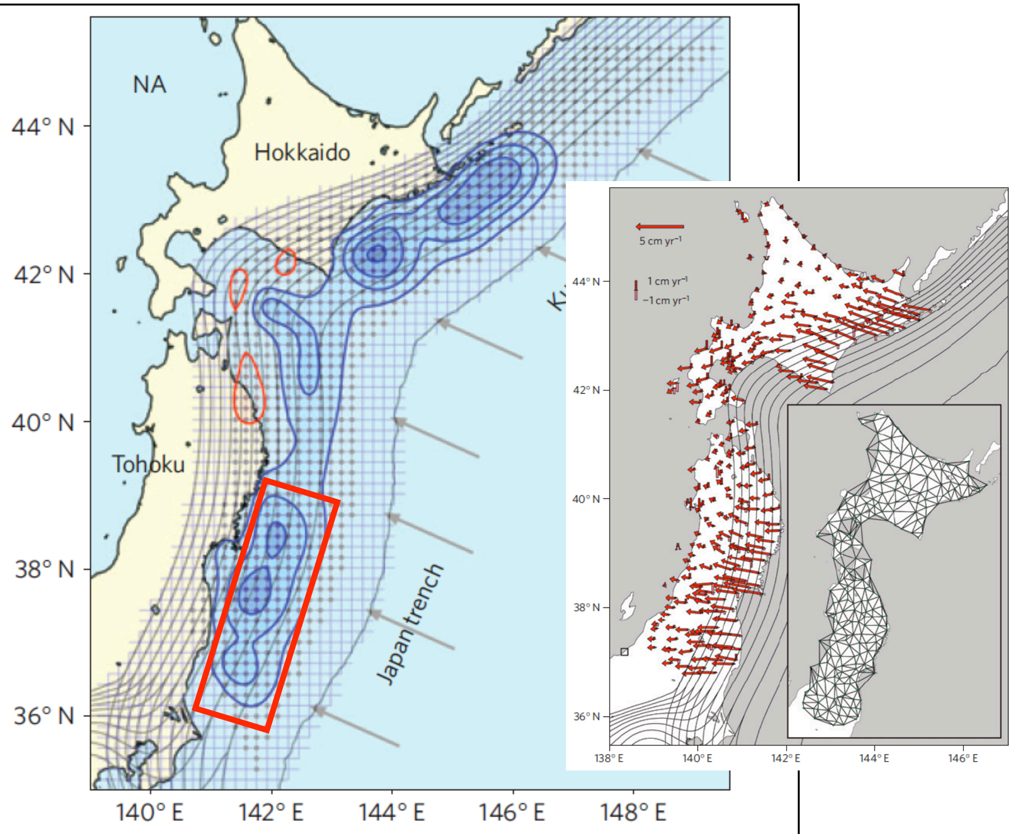


Figure 3 | Inverted slip-deficit rate distribution. The blue and red contours show, respectively, the inverted slip-deficit and slip-excess rates

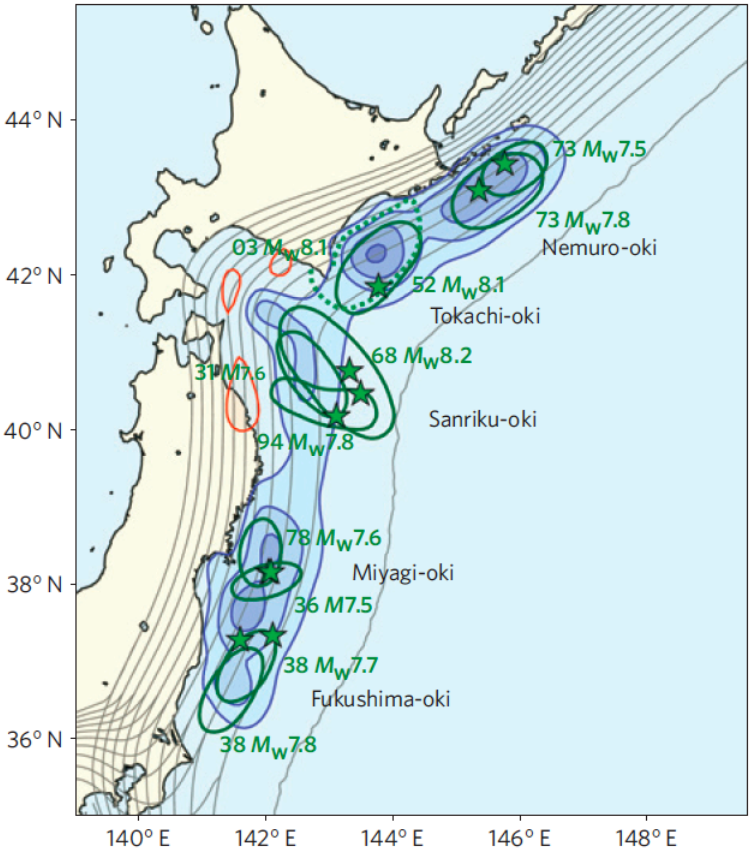
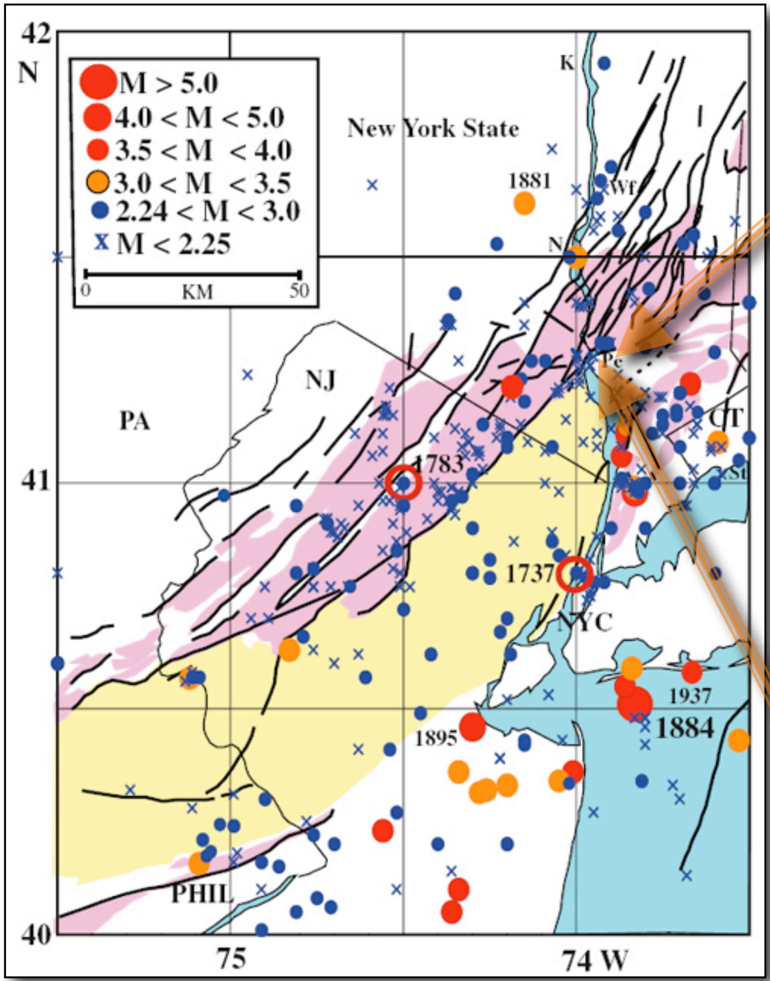


Figure 4 | Comparison of slip-deficit zones and tsunami source regions.

Public Concern Rekindled since the Japan M9.0 Earthquake:

- Is the Indian Point Nuclear Power Plant Safe from Earthquakes?
- Should Licenses be extended for another 20 years?
- Should both reactors perhaps be shut down now?

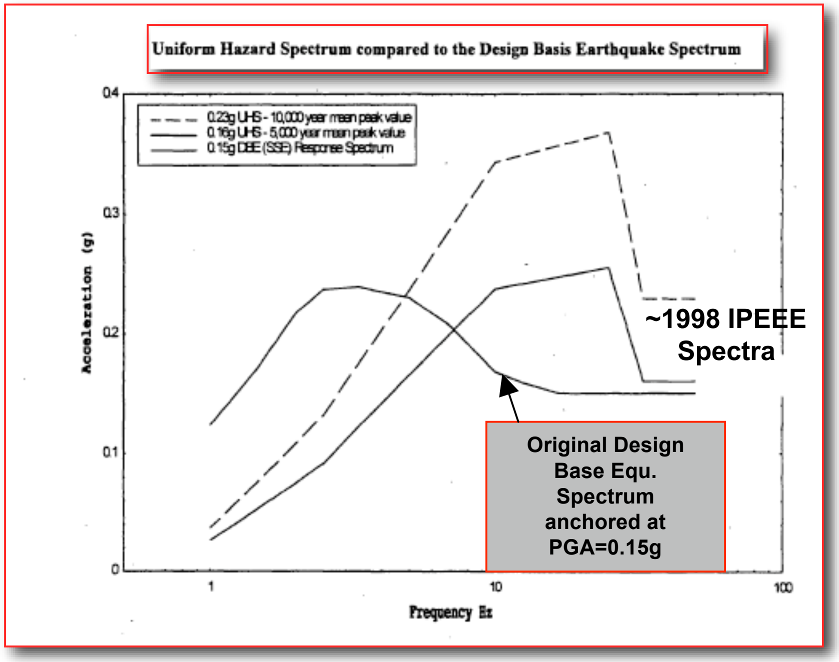


Sykes et al., 2008

Indian Point NPP Site is located 50km N of Manhattan, NYC.

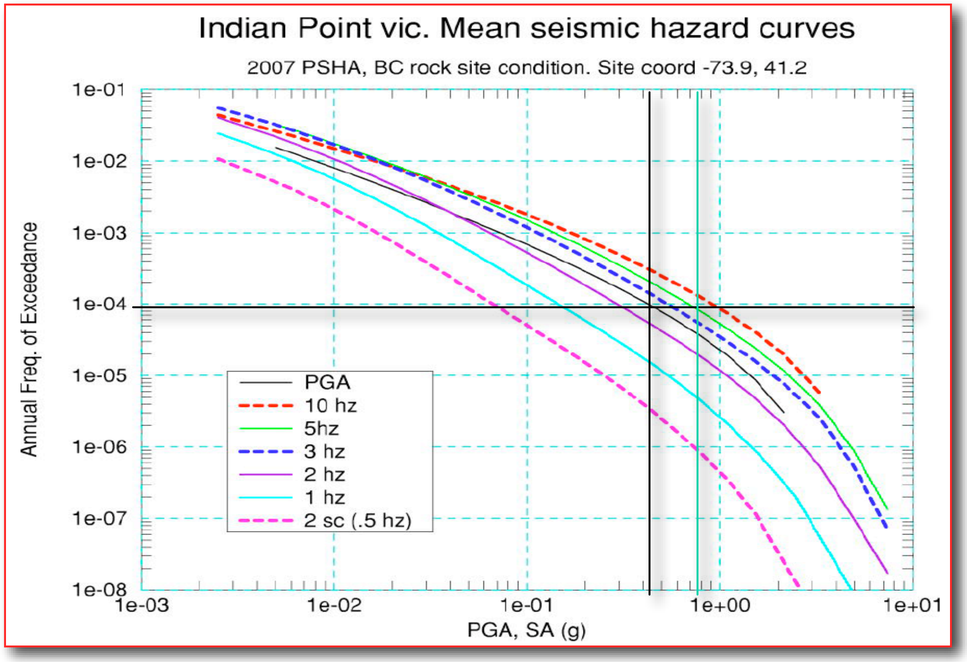
The IP Issues:

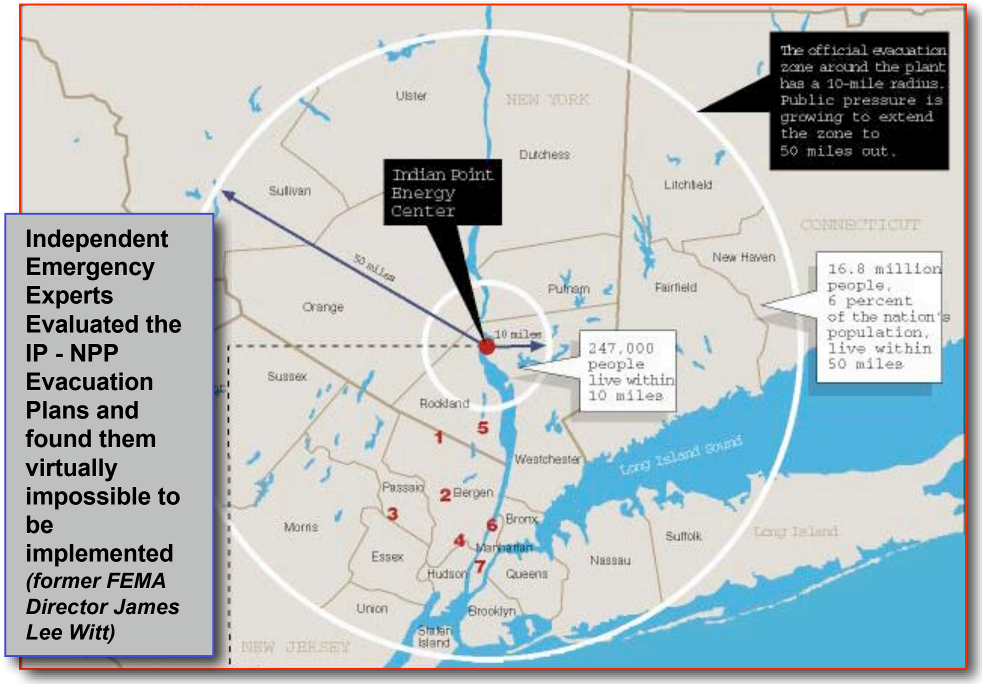
1. The original 40-yr licenses of IP NPP Units #2 & 3 run out in 2013 and 2015, respectively.
2. Both units were built in the 1960s-70s with <u>Western</u> US ground motion design spectra underestimating the high-frequency content of EUS earthquake ground shaking.
3. Using USGS Probabilistic Seismic Hazard Assessments based on modern Eastern US (high frequency) Ground Motion Relations; and combined with Industry's own Fragility Assessments of the reactors, the US NRC determined the earthquake-induced CORE DAMAGE FREQUENCY (CDF) to be ~10^{-4}/yr, which is the HIGHEST among all 104 NPPs in the US!
4. The lowest critical elevations of control systems are at elevations of at most 3.3-5.0m. What is the related risk from Hurricane storm surges or rare large Atlantic Tsunamis?
5. US NRC made the administrative decision, that new seismic information will <u>not</u> be allowed for license extension decisions (nor terrorism or other external events, hurricanes, surges, etc.). Only "Ageing" of the plants and usage of cooling water from the Hudson and related environmental effects can be considered.



~1998 IPEEE Spectra

Original Design Base Equ. Spectrum anchored at PGA=0.15g



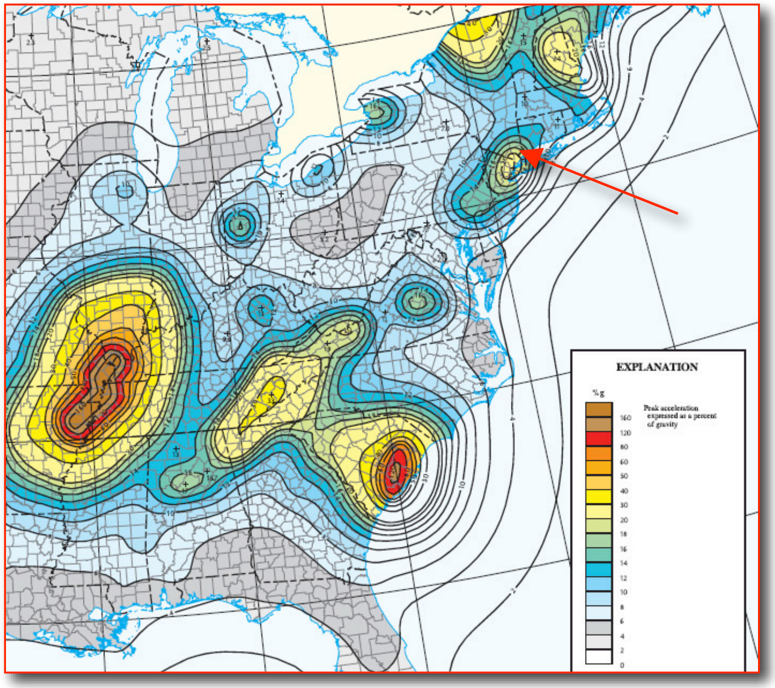


The official evacuation zone around the plant has a 10-mile radius. Public pressure is growing to extend the zone to 50 miles out.

247,000 people live within 10 miles

16.8 million people, 6 percent of the nation's population, live within 50 miles

Independent Emergency Experts Evaluated the IP - NPP Evacuation Plans and found them virtually impossible to be implemented ***(former FEMA Director James Lee Witt)***



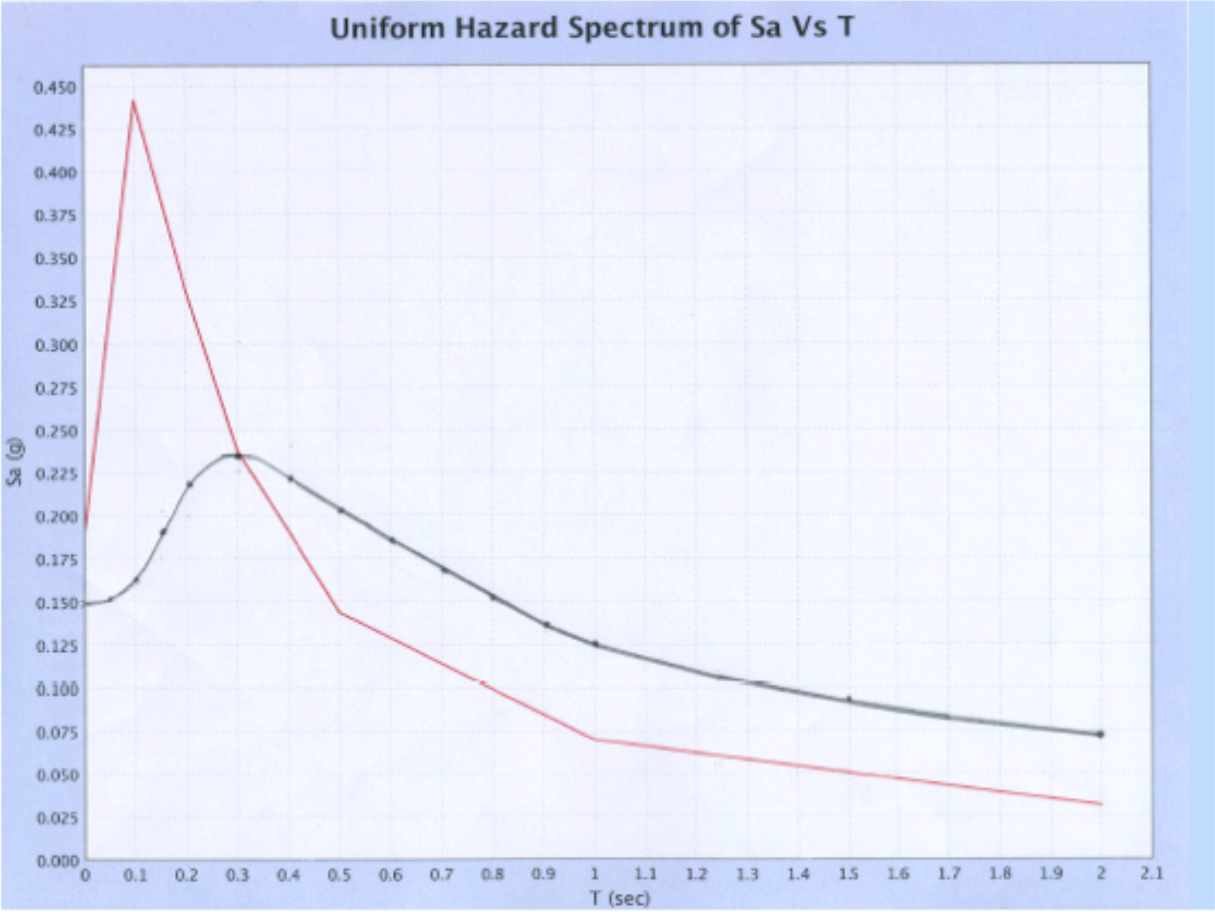
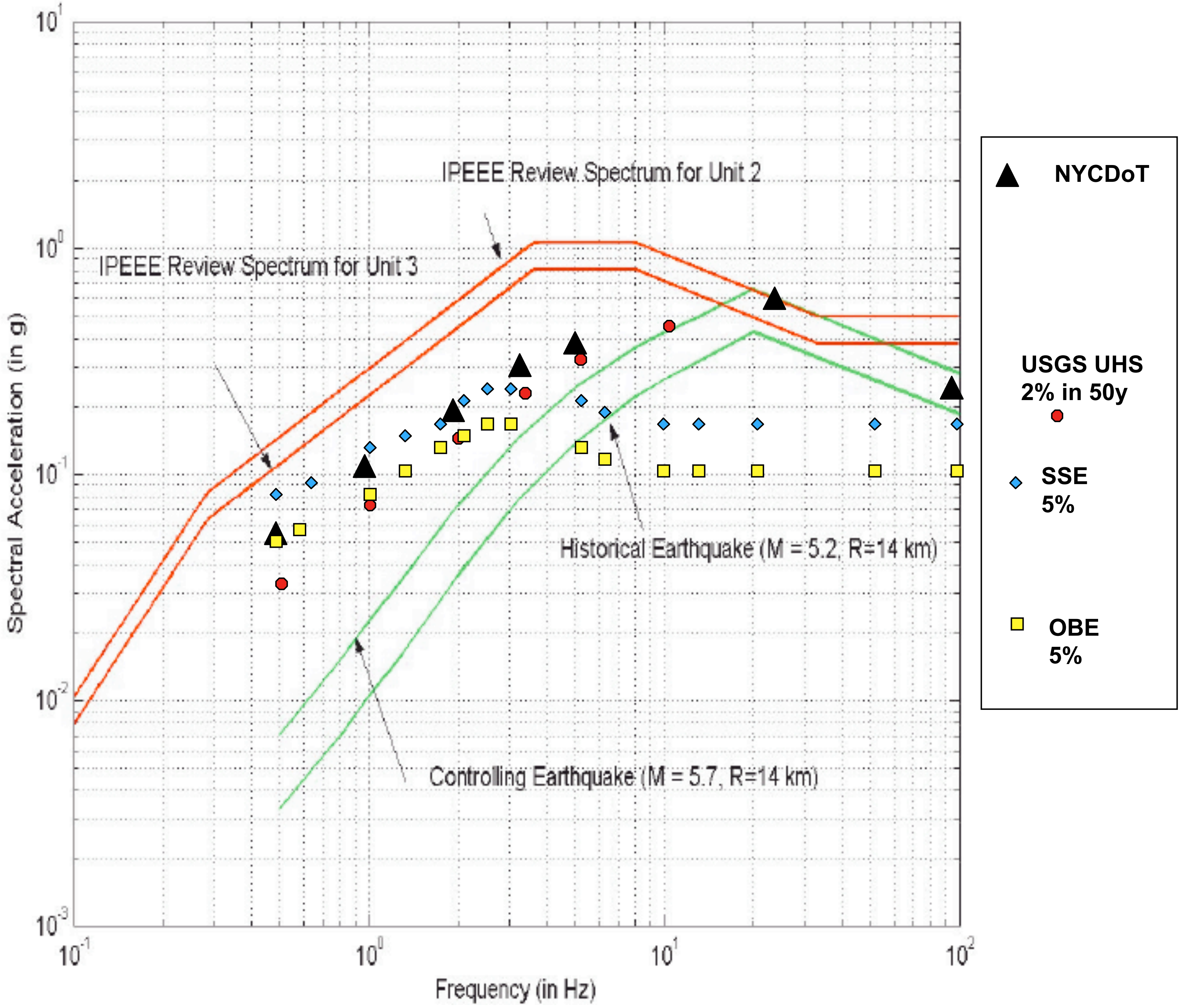


Figure 2-4: USGS Uniform Hazard Spectrum (UHS, in red) vs. IP2/3 SSE Design Response Spectrum, both for 5% damping. The UHS spectrum is for a probability of 2% in 50 years and for B/C-boundary site conditions which are used by the USGS as a national reference standard for US-wide hazard mapping. No unique probability level for the IP spectrum can be assigned, nor has there been assigned a site class, according to NEHRP standards.


IPEEE Review Spectrum for Unit 2
IPEEE Review Spectrum for Unit 3
Historical Earthquake (M = 5.2, R=14 km)
Controlling Earthquake (M = 5.7, R=14 km)
Spectral Acceleration (in g)
Frequency (in Hz)
10^{1}
10^{0}
10^{-1}
10^{-2}
10^{-3}
10^{-1}
10^{0}
10^{1}
10^{2}
▲ NYCDoT
USGS UHS 2% in 50y ●
◆ SSE 5%
▢ OBE 5%

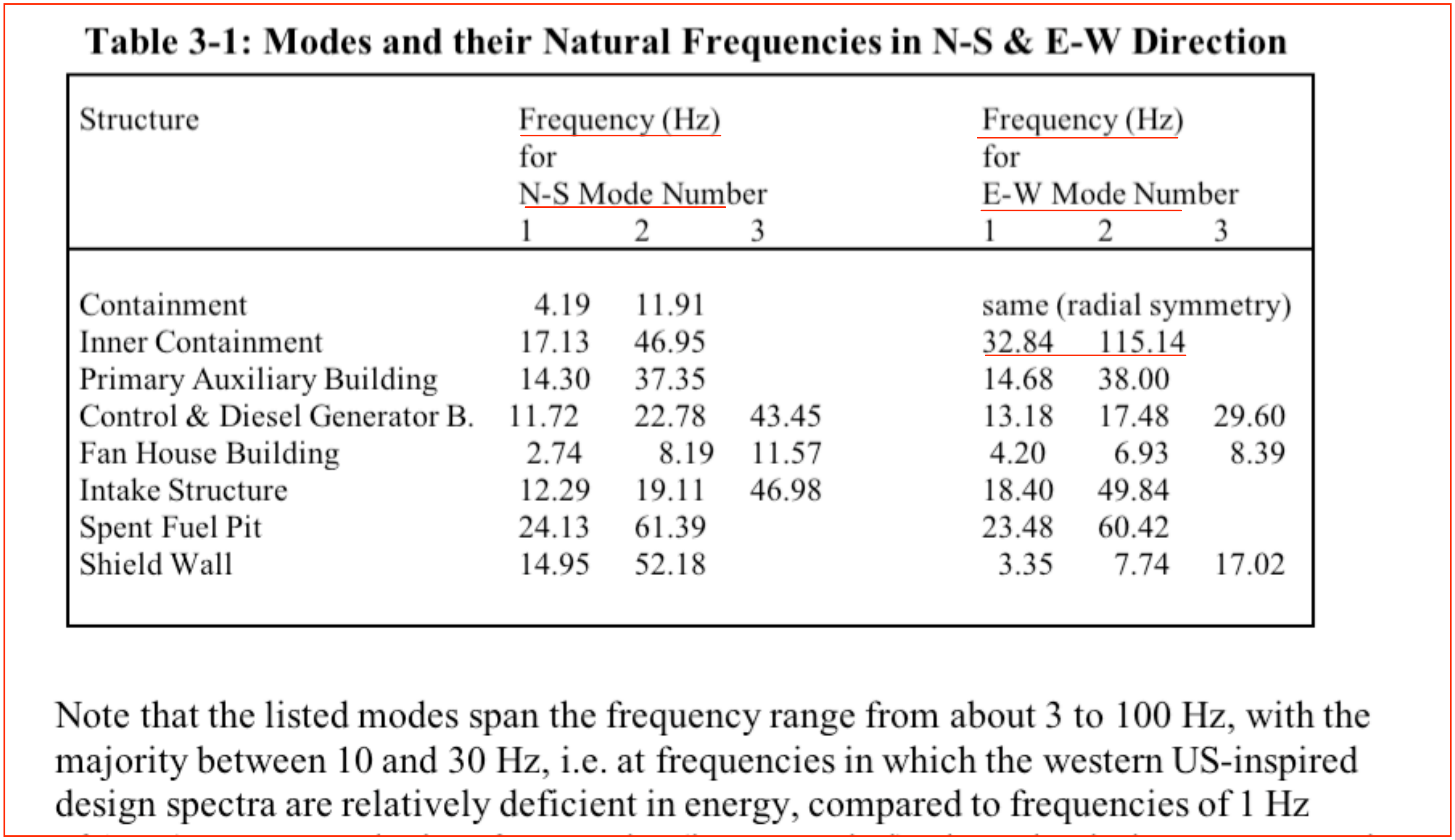


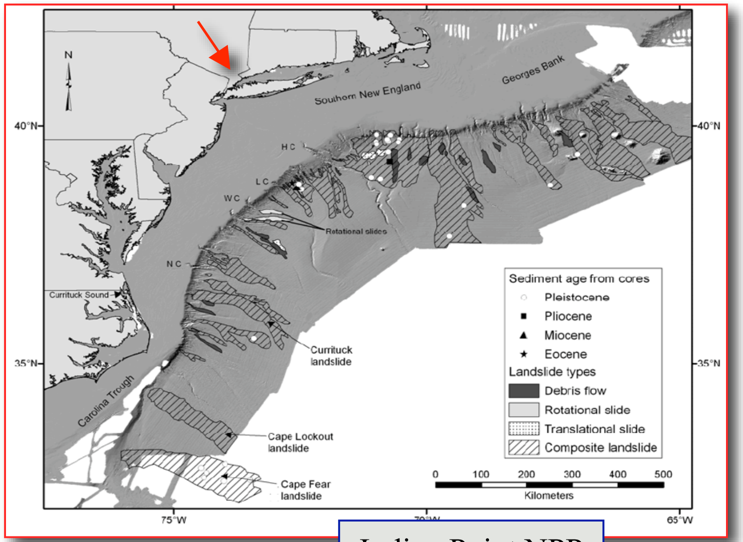
Table 3-1: Modes and their Natural Frequencies in N-S & E-W Direction

Structure	Frequency (Hz) for N-S Mode Number			Frequency (Hz) for E-W Mode Number		
	1	2	3	1	2	3
Containment	4.19	11.91		same (radial symmetry)		
Inner Containment	17.13	46.95		32.84	115.14	
Primary Auxiliary Building	14.30	37.35		14.68	38.00	
Control & Diesel Generator B.	11.72	22.78	43.45	13.18	17.48	29.60
Fan House Building	2.74	8.19	11.57	4.20	6.93	8.39
Intake Structure	12.29	19.11	46.98	18.40	49.84	
Spent Fuel Pit	24.13	61.39		23.48	60.42	
Shield Wall	14.95	52.18		3.35	7.74	17.02

Note that the listed modes span the frequency range from about 3 to 100 Hz, with the majority between 10 and 30 Hz, i.e. at frequencies in which the western US-inspired design spectra are relatively deficient in energy, compared to frequencies of 1 Hz

Note: This Table is not for the IP NPP but for similar LWR NPP, except that E-W and N-S need to be interchanged for IP NPP.

Submarine Landslides cause Tsunamis, e.g.1929 Grand Banks Earthquake ~M7



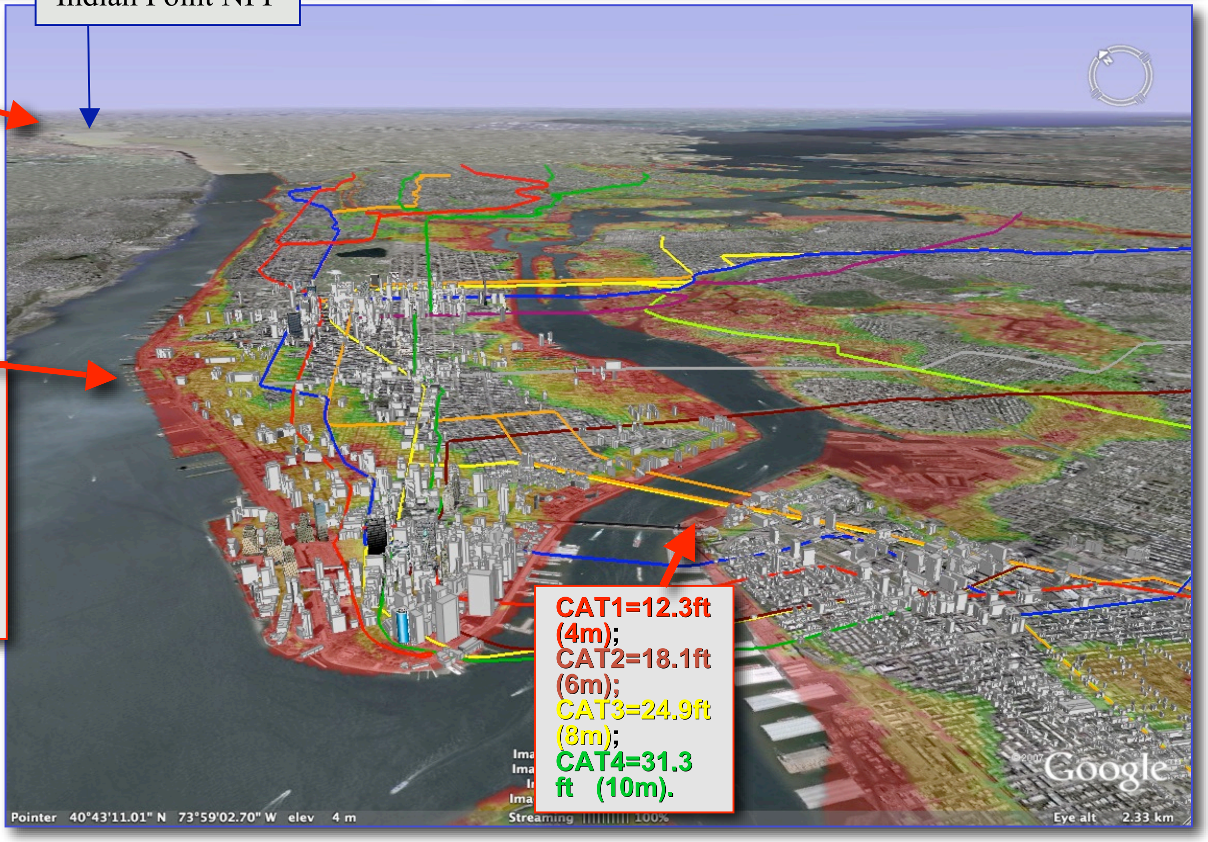
Indian Point NPP

CAT1=2.00ft (0.66m); CAT2=6.6 ft (2.1m); CAT3=7.8ft (2.6m); CAT4=13.7 ft (4.6m)

Hurricanes Produce Coastal Storm Surges. The Surge moves up the Hudson River with about the same speed [$V=(gh)^{-1/2}$] as the tides do, i.e. ≥ 17m/h

CAT1=7.80ft (2.6m); CAT2=11.8 ft (4m); CAT3=16.6 ft (5.5m); CAT4=22.7 ft (7.5m)

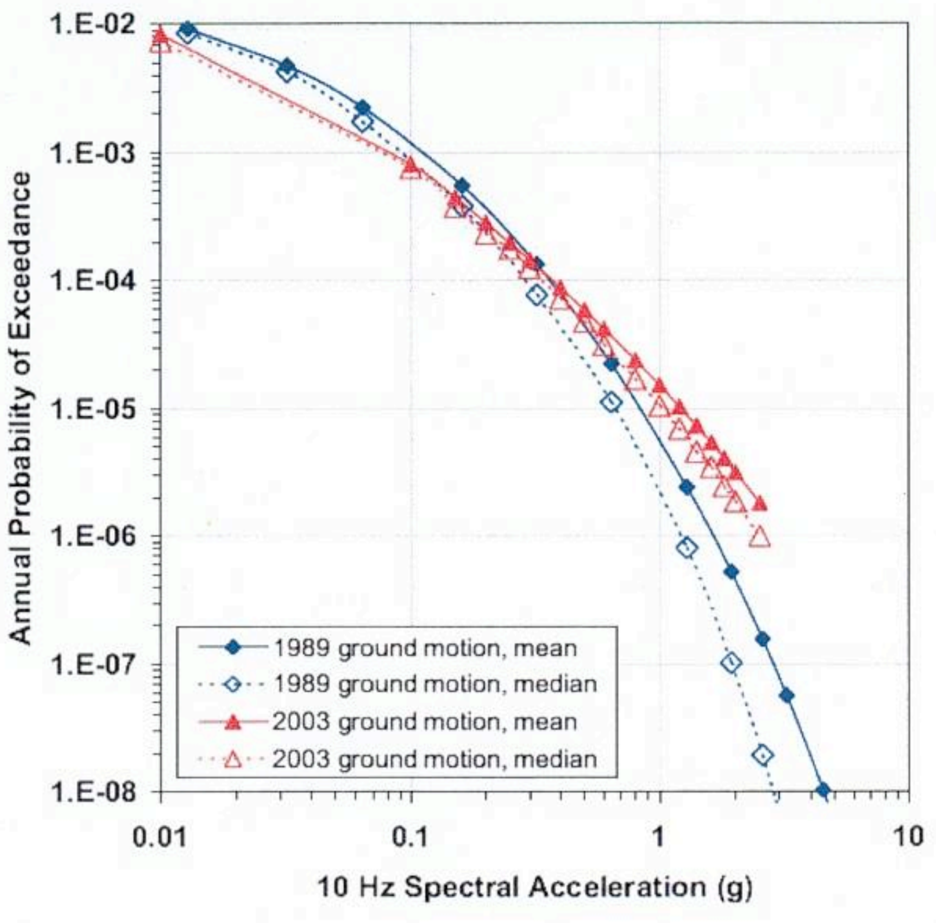
CAT1=12.3ft (4m); CAT2=18.1ft (6m); CAT3=24.9ft (8m); CAT4=31.3 ft (10m).



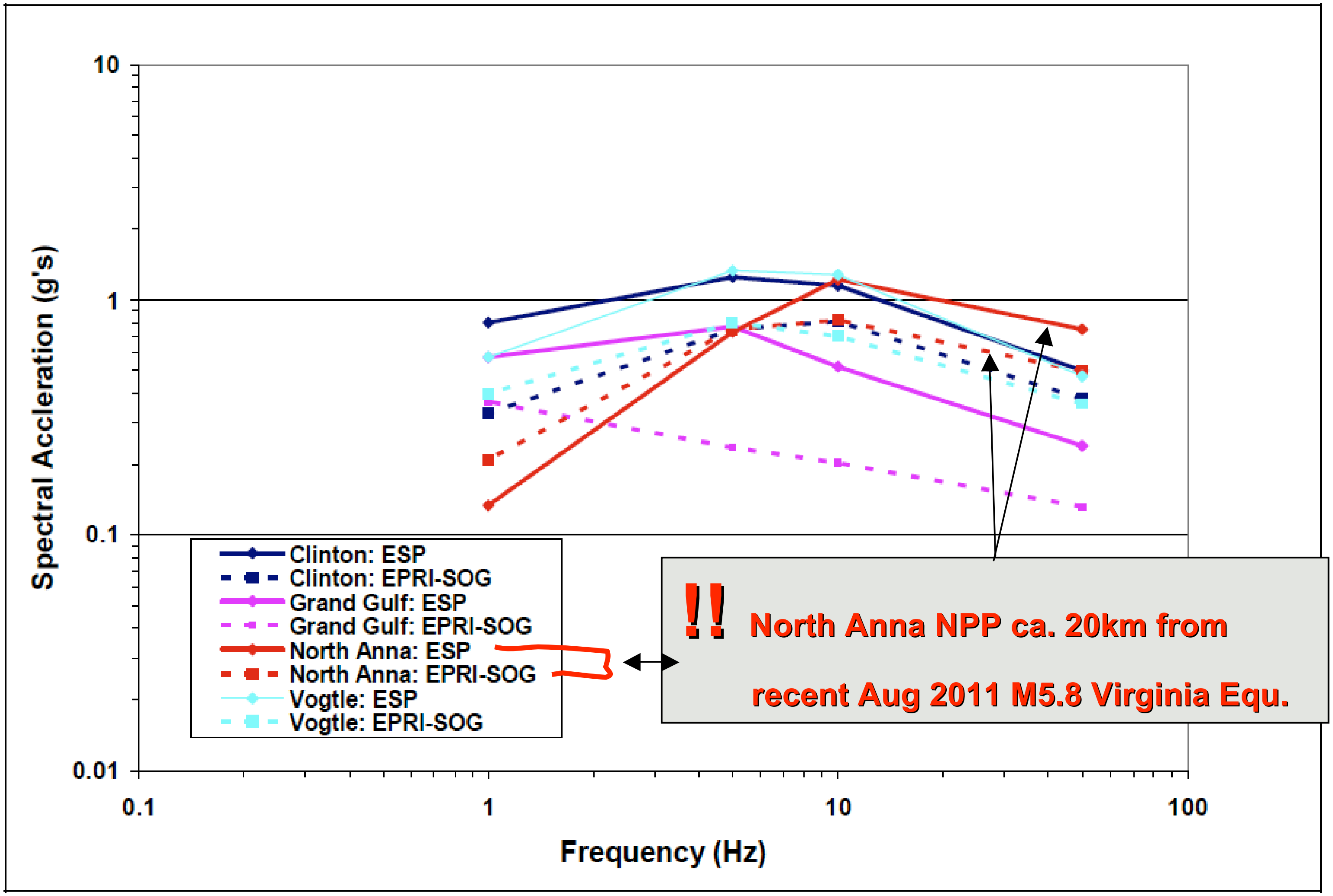
Conclusions from NPP examples:

1. **Hazard Assessments for Critical Structures must strive for the Longest Possible Records to catch Low-Probability / High-Consequence Events (that make up the "Tails" of Probability Distributions).**
2. **Systematic Monitoring of New Geo-Science Findings that can be Relevant to Updating Disaster Hazards and Risks Is an Essential Government Function**
3. **Decision Makers and Regulators need to have Protocols in Place, and Prudently Exercise them, to Incorporate these New Findings in a Timely, Socially Responsible, and Effective Way**

GI-199: Implications of Updated Seismic Hazard Estimates



igure 2.5-44. Sensitivity of 10 Hz Seismic Hazard to 1989 and 2003 Ground Motion Models



!! North Anna NPP ca. 20km from

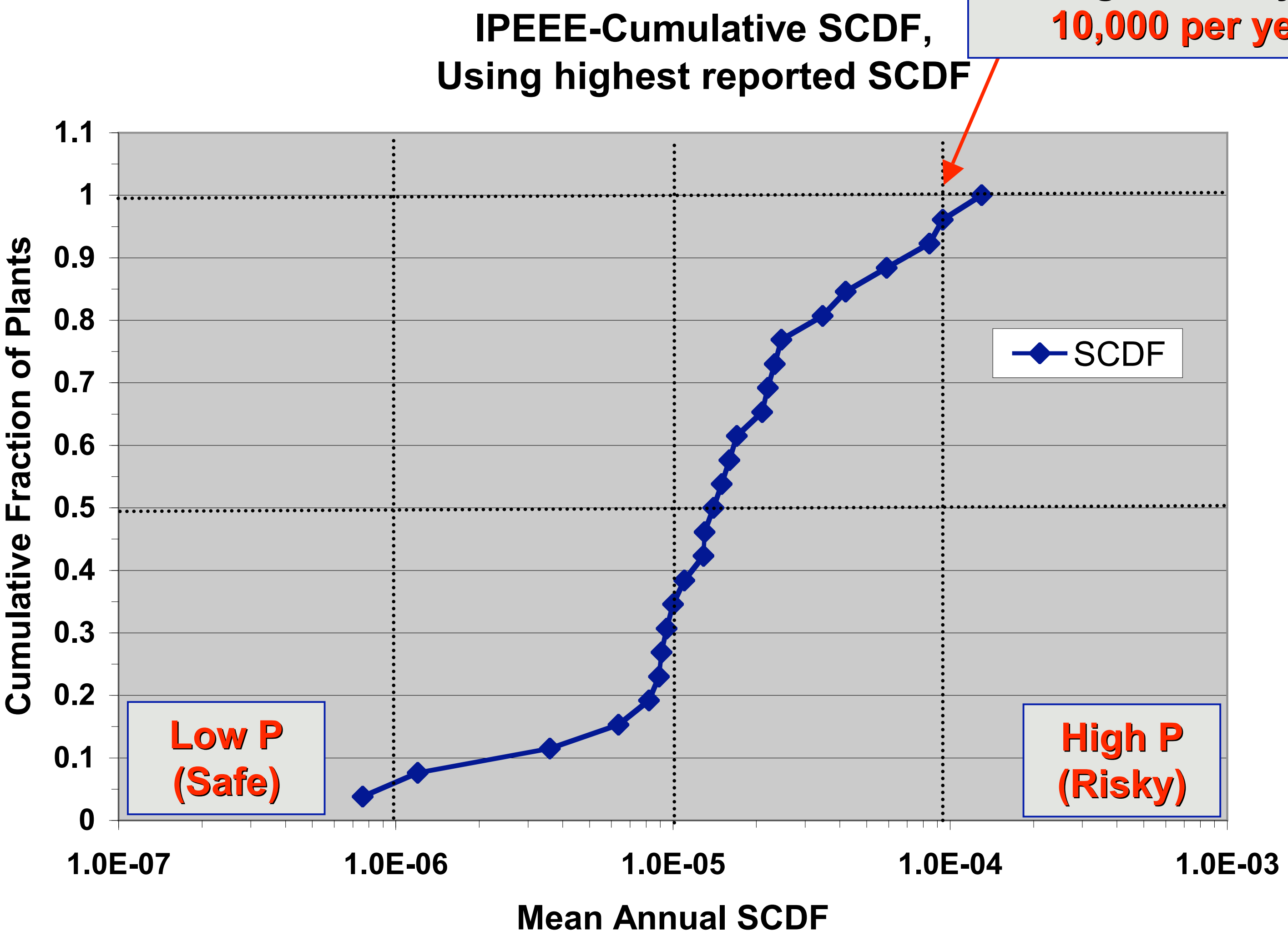
recent Aug 2011 M5.8 Virginia Equ.

Figure 1. Comparison of Seismic Hazard Results for Four Early Site Permit Submittals (Solid Lines) to 1989 EPRI-SOG Results (Dashed Lines). Curves are response spectral values (5-percent damping) at an annual exceedance frequency of 10^{-5}.

GI-199: Implications of Updated Seismic Hazard Estimates

All CEUS NPPs

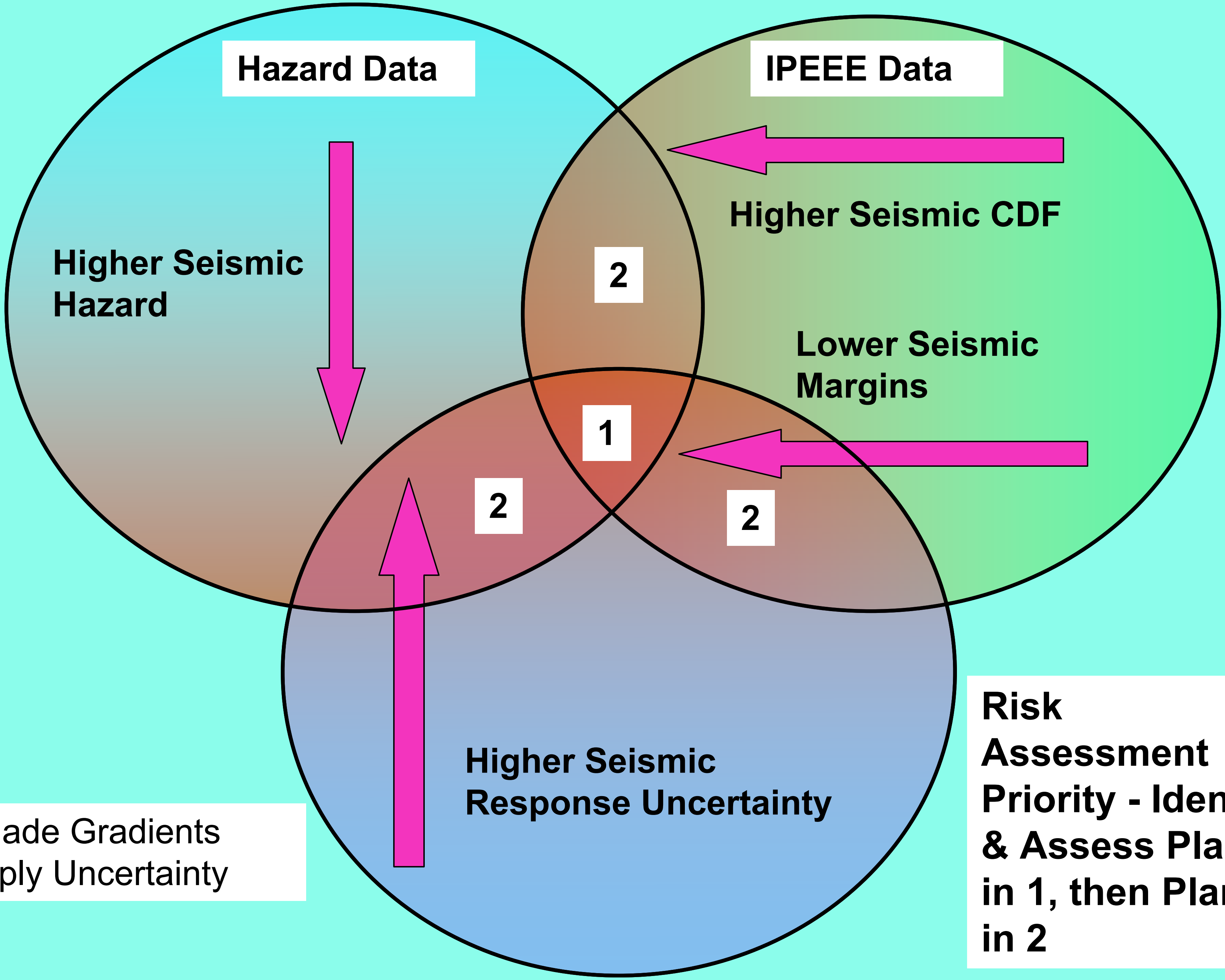
Target: $<10^{-4}$/y = 1 in 10,000 per year ??



Low P (Safe)

High P (Risky)

SCDF = Seismic (Nuclear Reactor-) Core-Damage Frequency



Hazard Data

Higher Seismic Hazard

IPEEE Data

Higher Seismic CDF

Lower Seismic Margins

Higher Seismic Response Uncertainty

Shade Gradients
Imply Uncertainty

Risk Assessment Priority - Identify & Assess Plants in 1, then Plants in 2

Industry Comments With Regard to Limit of 25 Hz for Structure Model Adequacy Used for Development of ISRS

Industry/NRC Meeting
February 13, 2007

Robert P. Kennedy

Based on the Industry white paper and the sample evaluations performed by Westinghouse, the Industry position is that spectral accelerations at frequencies in excess of 25 Hz are of consequence only for high frequency (HF) sensitive components

Structure Model Adequacy

- The industry position is that standard structural modeling has sufficient refinement to generate accurate ISRS up to at least 25 Hz
- ISRS would be generated beyond the 25 Hz limit (up to 100 Hz) but the computed values might be less accurate
- Thus, the concept of screening of HF sensitive equipment by test input motions with 25-50 Hz content was proposed
- The 50 Hz upper limit was intended to be a filter where the amplitudes begin to decrease as a function of frequency

Refined Structural Models

- An alternate approach is to develop highly refined structural models that can generate ISRS with accuracy up to 50 Hz or greater
- These ISRS can then be used as a Test Response Spectrum (TRS) for supplementary testing of HF sensitive equipment

High Frequency Sensitive Mechanical & Electrical Equipment/Components

Issue 1: Selection of 50 Hz as an acceptable upper limit for the HF screening evaluation.

Staff Guidance: The concept of using a set number as an example in industry guidance is acceptable from a generic standpoint. However, if the generic limit is used in an application, it will have to be justified for the specific design in the DCD or a topical report.

High Frequency Sensitive Mechanical & Electrical Equipment/Components

Issue 2: Screening process to identify high frequency sensitive equipment/components, and use of existing test data.

Staff Guidance: The applicant's procedure is expected to clearly identify the basis and criteria for screening in a manner such that the basis for screened-in or screened-out equipment/components is documented and the process repeatable.

High Frequency Sensitive Mechanical & Electrical Equipment/Components

To allow use of existing test data, industry has to demonstrate that proper frequency contents with sufficient energy were used for the input to shake table testing.

High Frequency Sensitive Mechanical & Electrical Equipment/Components

Issue 3: Generic tests of 5 g and 15 g spectral accelerations between 25 Hz and 50 Hz to demonstrate performance of high-frequency sensitive equipment/components.

High Frequency Sensitive Mechanical & Electrical Equipment/Components

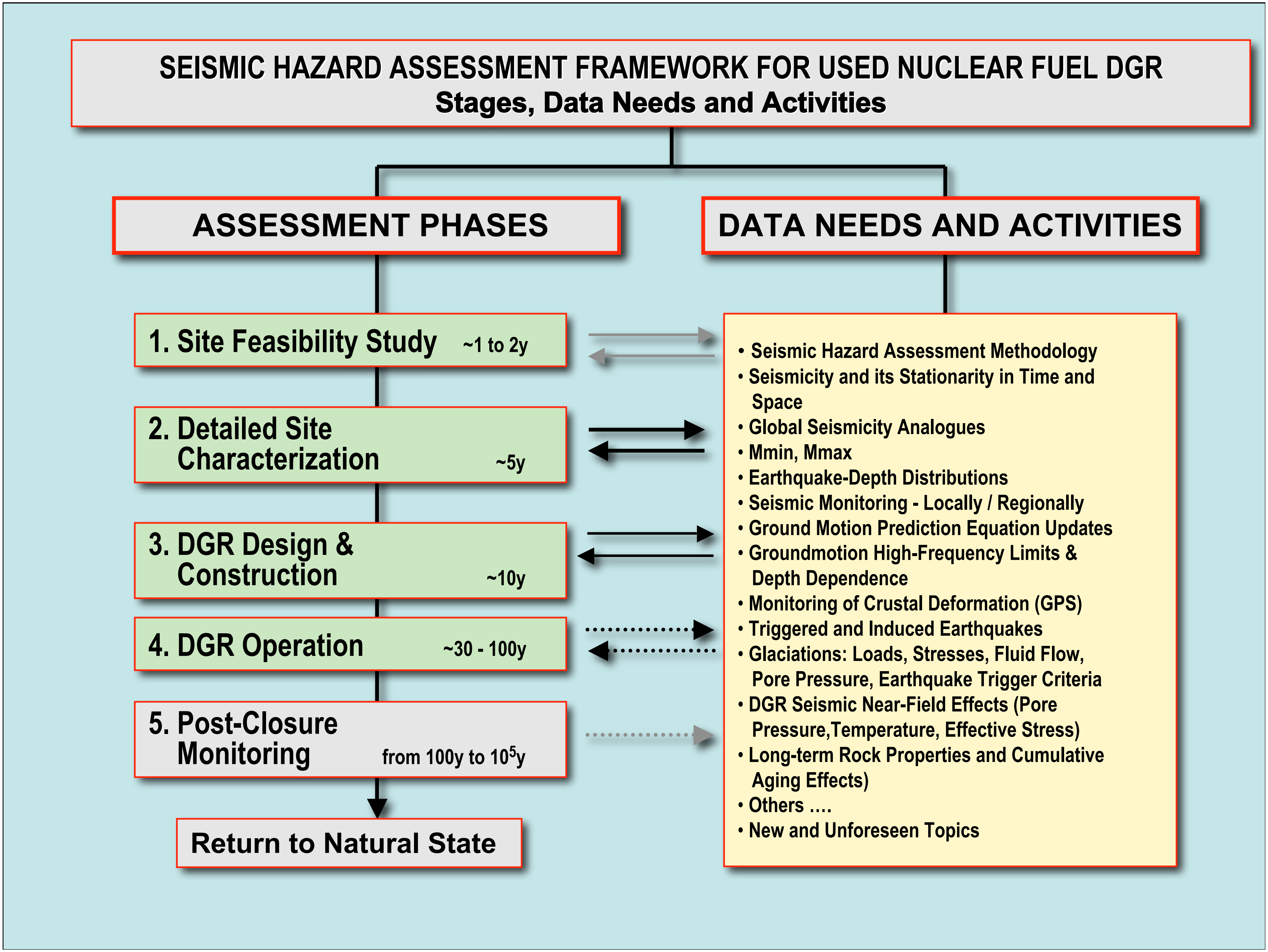
<u>Staff Guidance:</u> The applicability of generic testing will have to be justified based on design-specific considerations, ensuring adequate consideration of in-structure response or in-cabinet response amplifications, and that the test response spectra envelop the required response spectra at the specific locations of the equipment/components.

Questions?

4a NPPs

SHA Issues for Spent/Used-Nuclear Fuel / HL-Waste Deep Geological Repositories

Sample Guideline:
Draft of “Road Map” prepared in 2010 for the NWMA of Canada



SEISMIC HAZARD ASSESSMENT FRAMEWORK FOR USED NUCLEAR FUEL DGR

Stages, Data Needs and Activities

ASSESSMENT PHASES

1. Site Feasibility Study ~1 to 2y
2. Detailed Site Characterization ~5y
3. DGR Design & Construction ~10y
4. DGR Operation ~30 - 100y
5. Post-Closure Monitoring from 100y to 10^5y

Return to Natural State

DATA NEEDS AND ACTIVITIES

- Seismic Hazard Assessment Methodology
- Seismicity and its Stationarity in Time and Space
- Global Seismicity Analogues
- Mmin, Mmax
- Earthquake-Depth Distributions
- Seismic Monitoring - Locally / Regionally
- Ground Motion Prediction Equation Updates
- Groundmotion High-Frequency Limits & Depth Dependence
- Monitoring of Crustal Deformation (GPS)
- Triggered and Induced Earthquakes
- Glaciations: Loads, Stresses, Fluid Flow, Pore Pressure, Earthquake Trigger Criteria
- DGR Seismic Near-Field Effects (Pore Pressure,Temperature, Effective Stress)
- Long-term Rock Properties and Cumulative Aging Effects)
- Others ....
- New and Unforeseen Topics

NWMA CA: Technical Sequemce & Steps for SHA

- Geologic History and Tectonic Setting
- Seismic Environment and Quantification of Seismicity
- Choice of Ground Motion Prediction Equations (GMPE)
- PSHA Computations, Hazard Curves, Uncertainty Treatment
- Uniform Hazard Spectra => Design Spectra
- Sensitivity Studies
- Deaggregation of Seismic Hazard for M, d, ε
- Hazard-Consistent Time-Domain Ground Motion Records
- Ground Motion Linearity and Capping Issues
- Faulting Hazard

NWMA Canada: Data and Research Needs:

- **SHA Methodology** (Adjust for Below-Ground Conditions & Tr ≥ 100,000 yr)
- **Seismicity and its Stationarity in Time and Space**
- **Global Seismic Analogues** (Replace Sampling Time by Space)
- **Mmin, Mmax**
- **Earthquake Depth Distributions**
- **Seismic Monitoring: Locally/Regionally**
- **GMPE Updates and Adjustments to Below-Ground.**
- **GM High-Frequency Limits and Depth Dependence**
- **Monitoring of Crustal Deformations - GPS**
- **Triggered & Induced Earthquakes**
- **Glaciations:** Loads, Stresses, Fluid Flow, Pore Pressure, Eq. Trigger Criteria.
- **DGR Seismic Near-Field Effects:** Pore Pr., Temperat., Effective Stress
- **Long-term Rock Properties** & Non-linear, Cumulative Ageing Effects
- **Others ....**
- **Allow for New & Unforeseen Ones**

There will be 5 Stages during which SHA needs to be conducted:

1. Site Feasibility Evaluation
2. Detailed Site Characterization
3. Design and Construction Phase
4. UNF DGR Operational Phase
5. Post-Closure Monitoring Phase

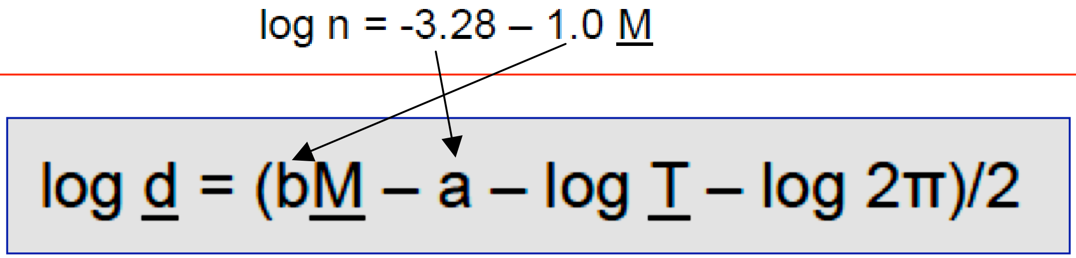
During all 5 Phases the following SHA Tasks need to be identified:

- Objectives
- Process & expected products to achieve the objectives
- Monitoring, data and information collection activities

Table 1: Expected median epicentral distances d (km) of earthquakes with magnitude M as a function of annual probability p(per year). Values assume a seismicity typical for Northern Ontario. See legend below for details.

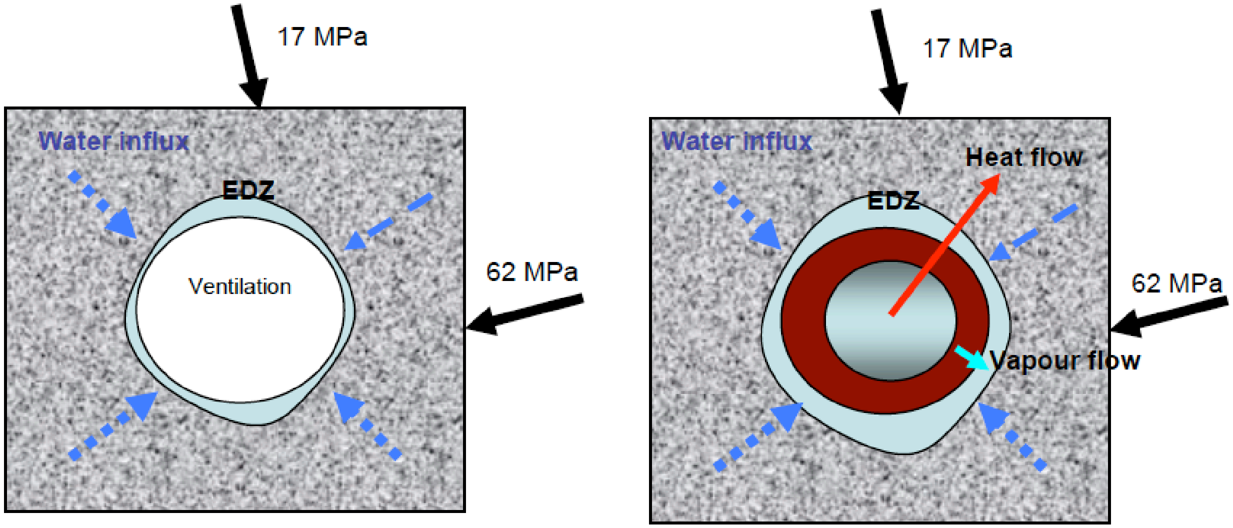
p (per year) M	10^{-2}	10^{-3}	10^{-4}	10^{-5}	10^{-6}	10^{-7}
3	55 km	17	5.5	1.7	0.550	0.170
4	170	55	17	5.5	1.7	0.550
5	550	170	55	17	5.5	1.7
6	*1700*	550	170	55	17	5.5
7		*1700*	550	170	55	17
8			*1700*	550	170	55

The median epicentral distances d (km) of Table 1 become shorter, for a given moment magnitude M, with diminishing annual probability p; and they increase, for a given annual probability p, with increasing magnitude M. These relations apply under the assumptions listed below. The basis of this Table is the G-R magnitude frequency relationship,



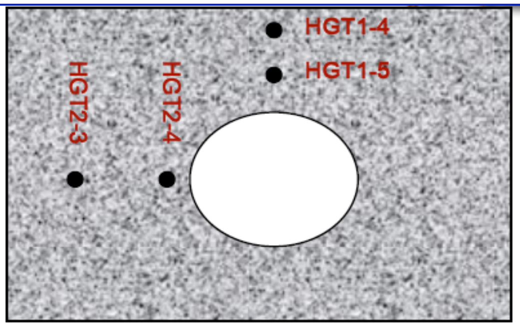
$$\log n = -3.28 - 1.0\, M$$

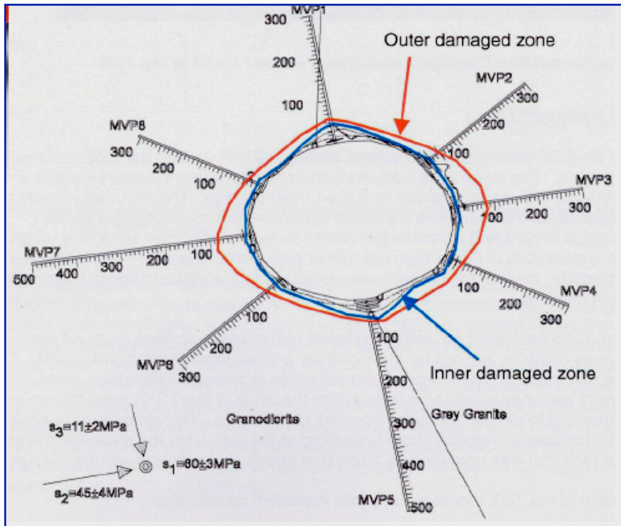
$$\log d = (bM - a - \log T - \log 2\pi)/2$$

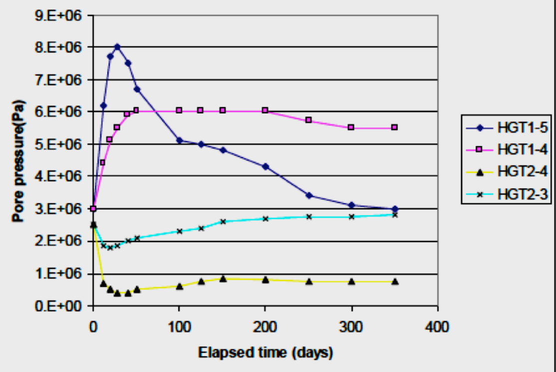


a) Excavation

b) Post-emplacement







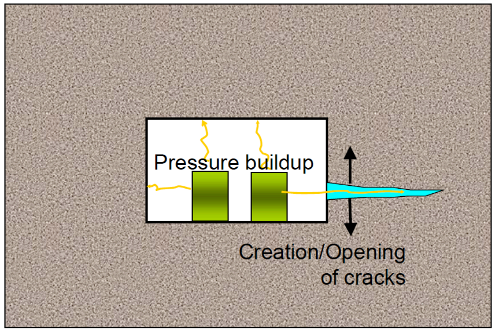
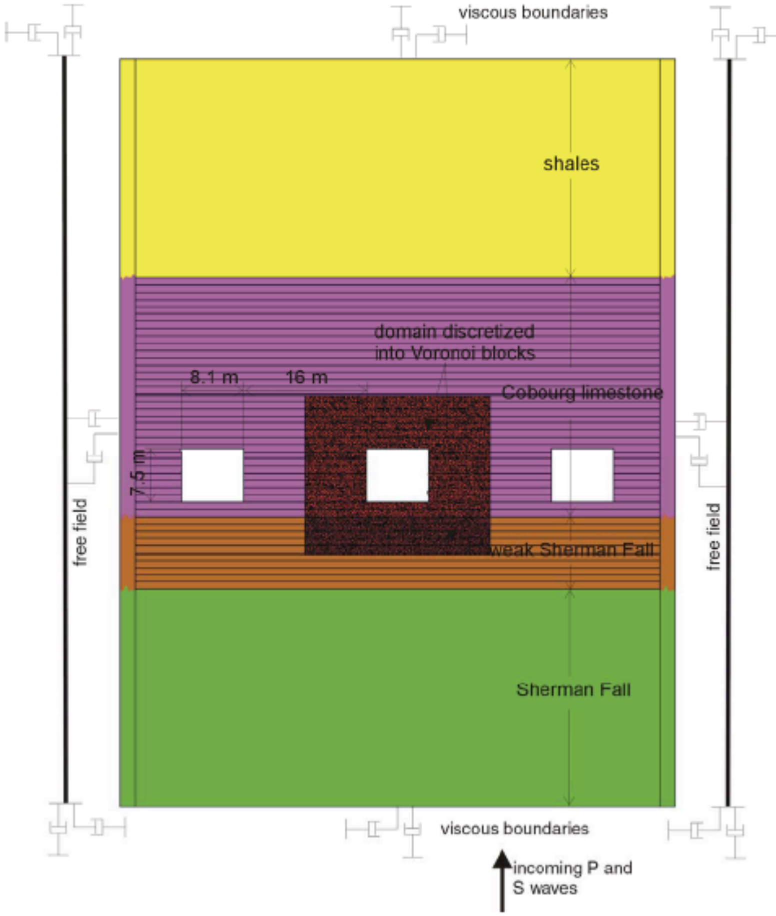


Table 12. Seismic event scenarios

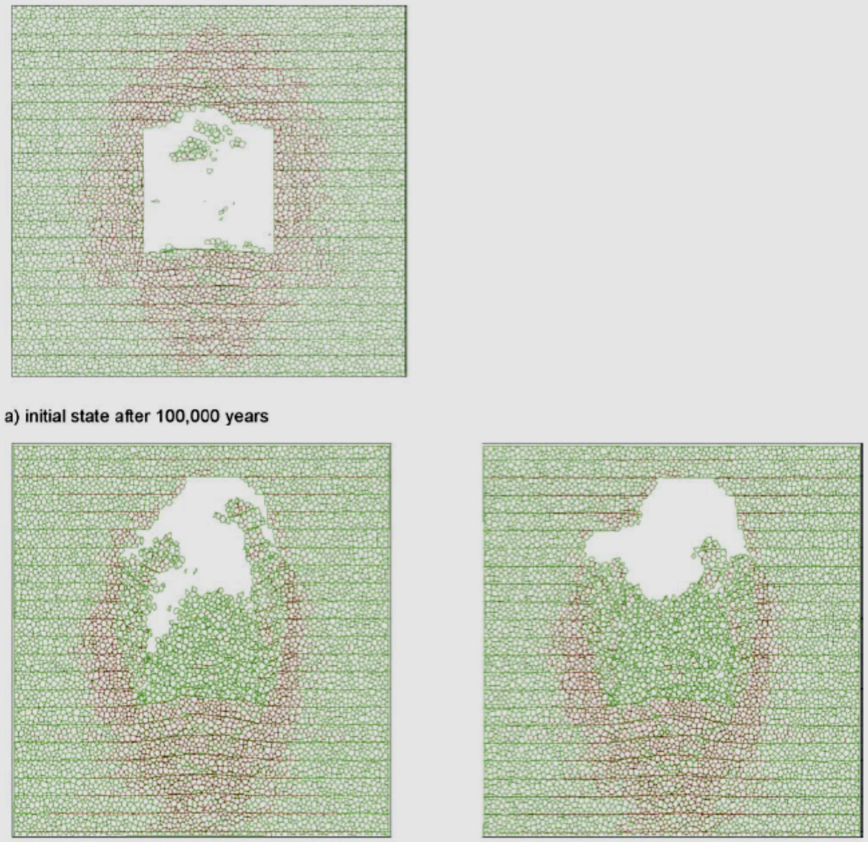
Scenario	Magnitude	Distance	Frequency range where it matches UHS	Ground motions
1	**M**5.5	15 km	>2 Hz	1,2,3
2	**M**7	50 km	<2 Hz	4,5,6

The duration of the ground motions from the first event scenario is approximately 3 s. The peak ground accelerations (PGAs) are in the range between 0.2 g and 0.3 g. The ground motions from the second event scenario last longer, between 12 s and 15 s, but the PGAs are lower than in the first set, generally in the range between 0.1 g and 0.2 g. The velocity histories, obtained by integration of the accelerograms, are shown in Figure 27 and Figure 28for the first and second set of the ground motions, respectively.



Note: Colors correspond to different model materials (as denoted in Figure 4)

Figure 35. Geometry and boundary conditions of the model used in dynamic analysis



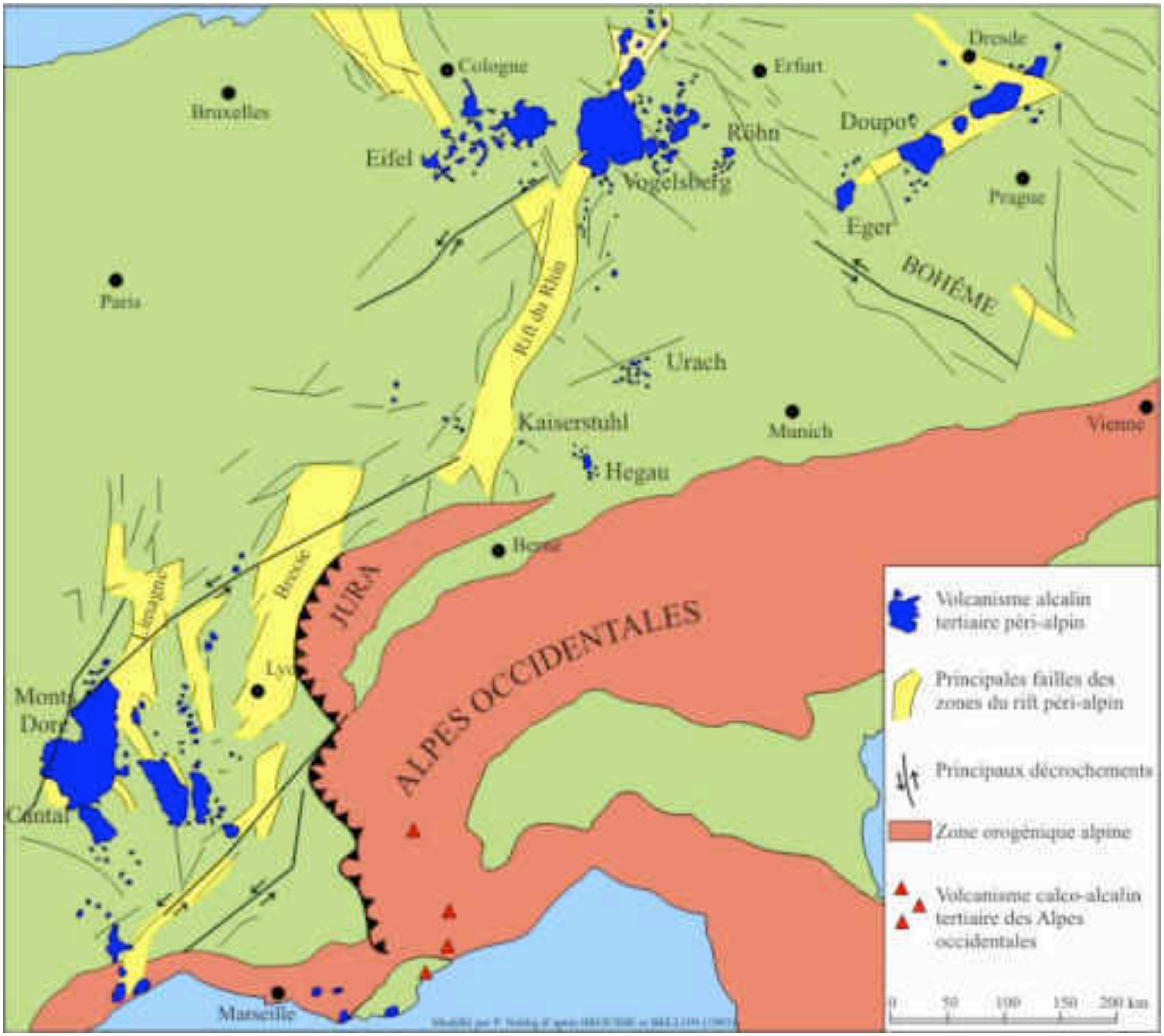
a) initial state after 100,000 years

b) ground motion M5.5 at 15 km

c) ground motion M7 at 50 km

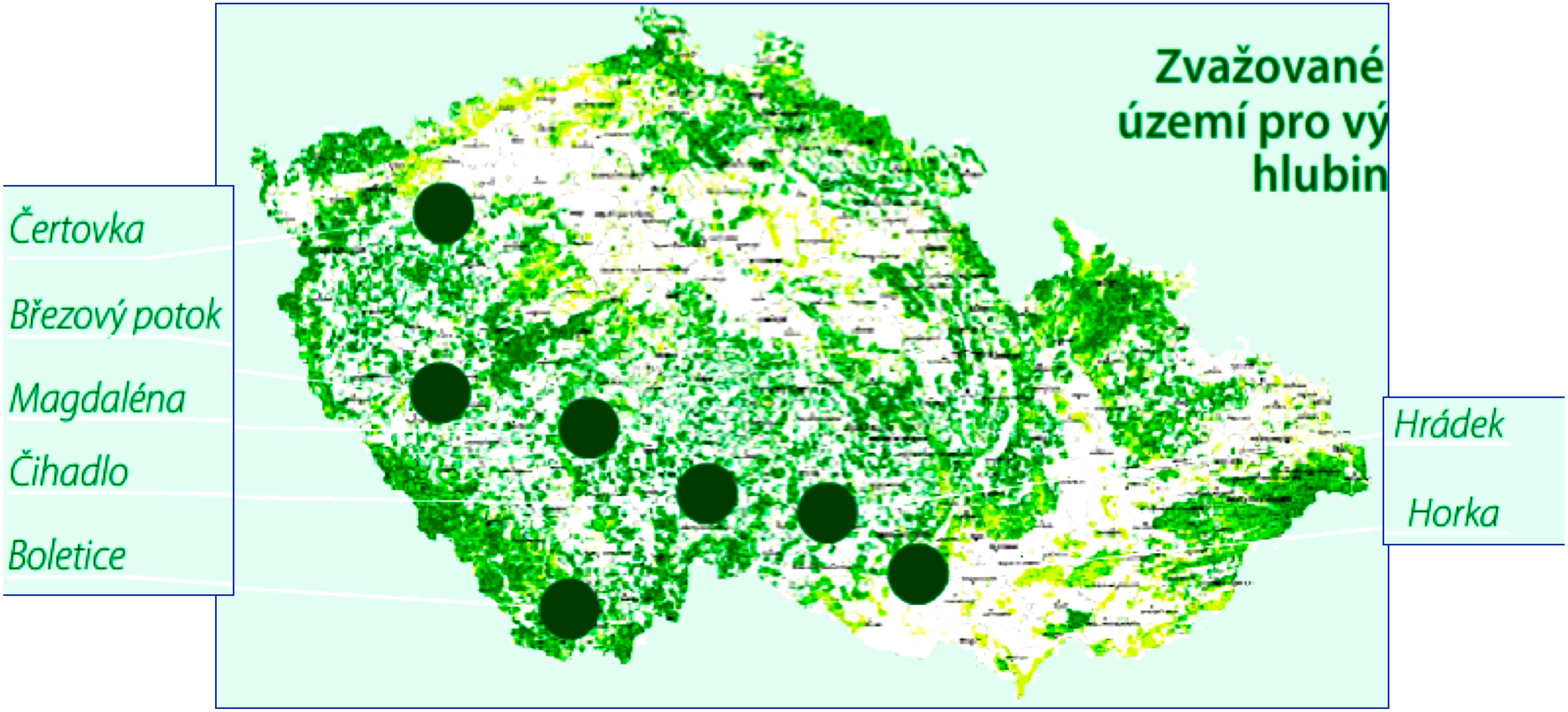
Note: Red lines indicate locations of fractures.

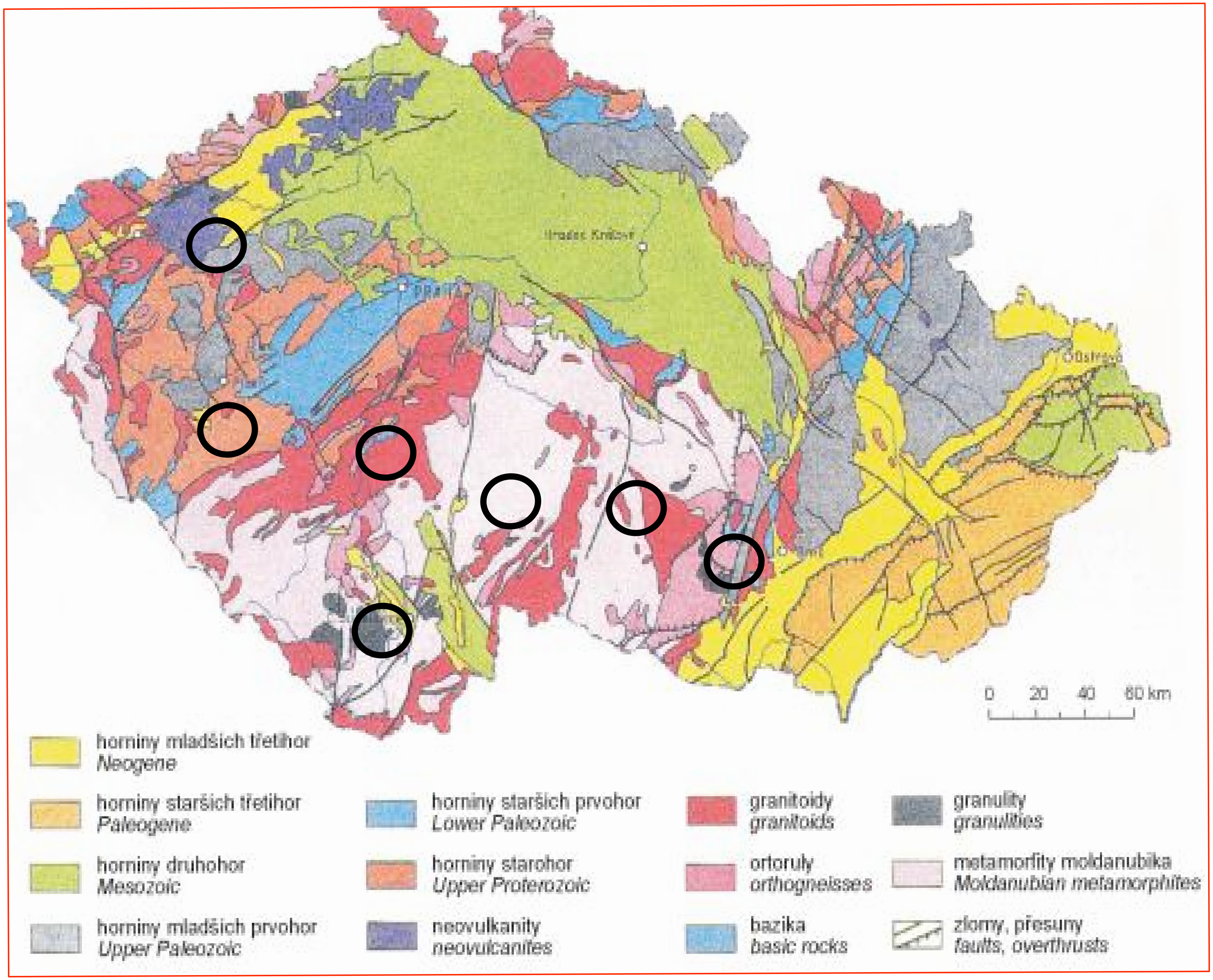
Figure 38. Effects of seismic ground motions after 100,000 years of time-dependent strength degradation


Bruxelles
Cologne
Erfurt
Dresde
Eifel
Rühn
Doupov
Vogelsberg
Prague
Eger
BOHÊME
Paris
Rift du Rhin
Urach
Kaiserstuhl
Munich
Vienne
Hegau
Berne
Bresse
Limagne
JURA
ALPES OCCIDENTALES
Lyon
Mont Dore
Cantal
Marseille
Volcanisme alcalin tertiaire péri-alpin
Principales failles des zones du rift péri-alpin
Principaux décrochements
Zone orogénique alpine
Volcanisme calco-alcalin tertiaire des Alpes occidentales
0
50
100
150
200 km

CZ: Seven Potential Target Sites

Considered for further Study to Assess their Geological Suitability as a DGR




Hradec Králové
Praha
Ostrava
0 20 40 60 km
horniny mladších třetihor
Neogene
horniny starších třetihor
Paleogene
horniny druhohor
Mesozoic
horniny mladších prvohor
Upper Paleozoic
horniny starších prvohor
Lower Paleozoic
horniny starohor
Upper Proterozoic
neovulkanity
neovulcanites
granitoidy
granitoids
ortoruly
orthogneisses
bazika
basic rocks
granulity
granulites
metamorfity moldanubika
Moldanubian metamorphites
zlomy, přesuny
faults, overthrusts

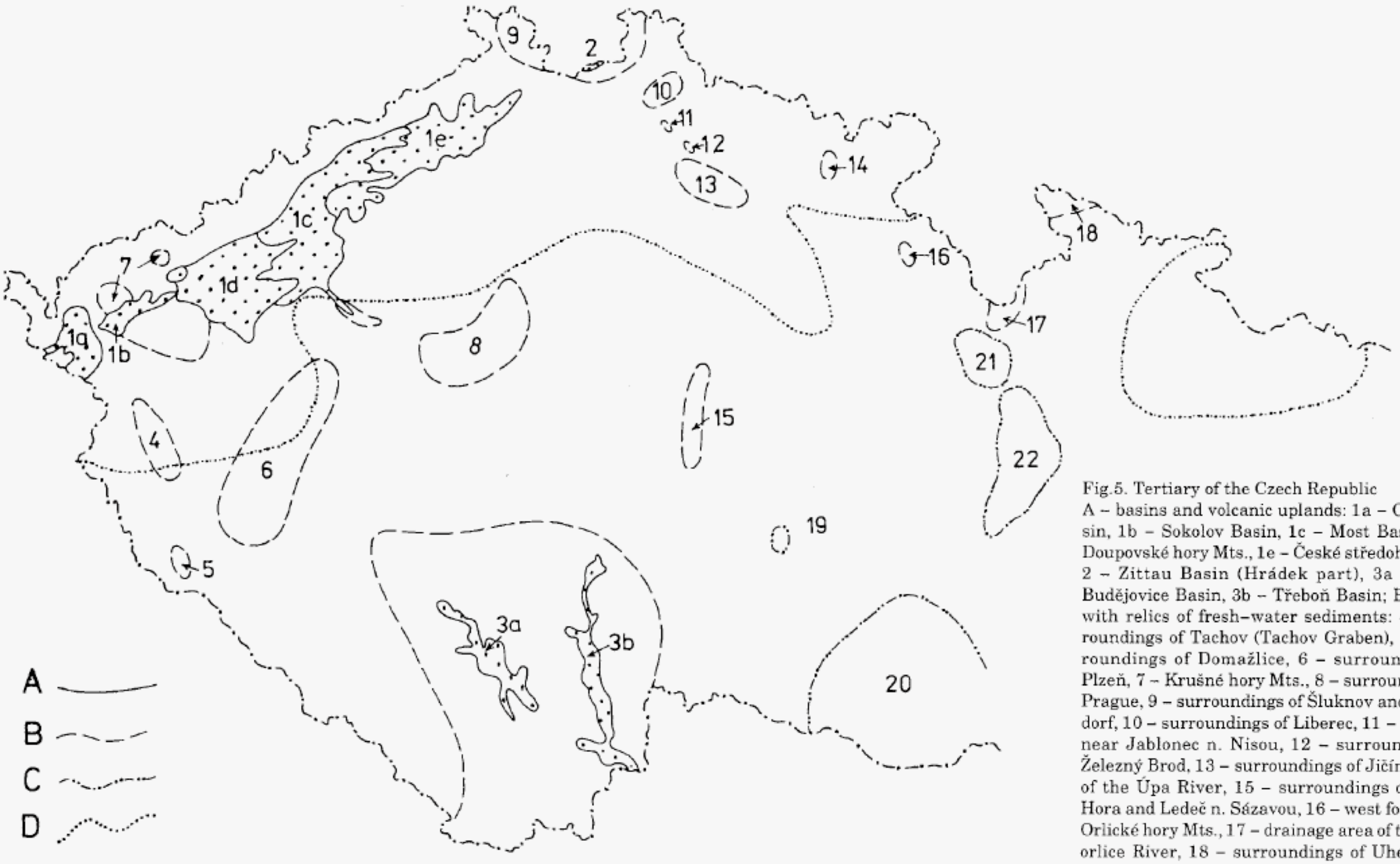
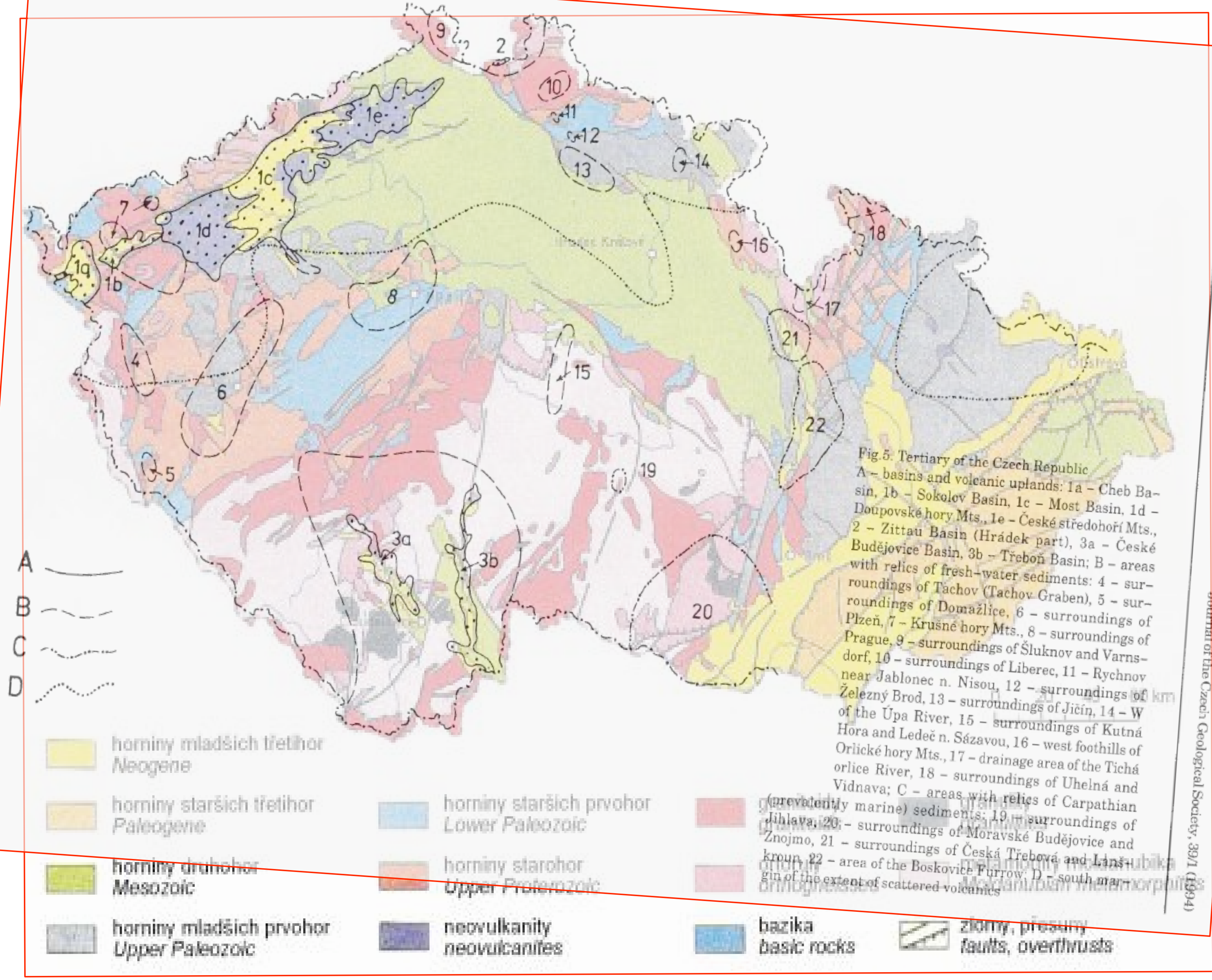


Fig.5. Tertiary of the Czech Republic
A – basins and volcanic uplands: 1a – Cheb Basin, 1b – Sokolov Basin, 1c – Most Basin, 1d – Doupovské hory Mts., 1e – České středohoří Mts., 2 – Zittau Basin (Hrádek part), 3a – České Budějovice Basin, 3b – Třeboň Basin; B – areas with relics of fresh-water sediments: 4 – surroundings of Tachov (Tachov Graben), 5 – surroundings of Domažlice, 6 – surroundings of Plzeň, 7 – Krušné hory Mts., 8 – surroundings of Prague, 9 – surroundings of Šluknov and Varnsdorf, 10 – surroundings of Liberec, 11 – Rychnov near Jablonec n. Nisou, 12 – surroundings of Železný Brod, 13 – surroundings of Jičín, 14 – W of the Úpa River, 15 – surroundings of Kutná Hora and Ledeč n. Sázavou, 16 – west foothills of Orlické hory Mts., 17 – drainage area of the Tichá orlice River, 18 – surroundings of Uhelná and Vidnava; C – areas with relics of Carpathian (prevalently marine) sediments: 19 – surroundings of Jihlava, 20 – surroundings of Moravské Budějovice and Znojmo, 21 – surroundings of Česká Třebová and Lanškroun, 22 – area of the Boskovice Furrow; D – south margin of the extent of scattered volcanics



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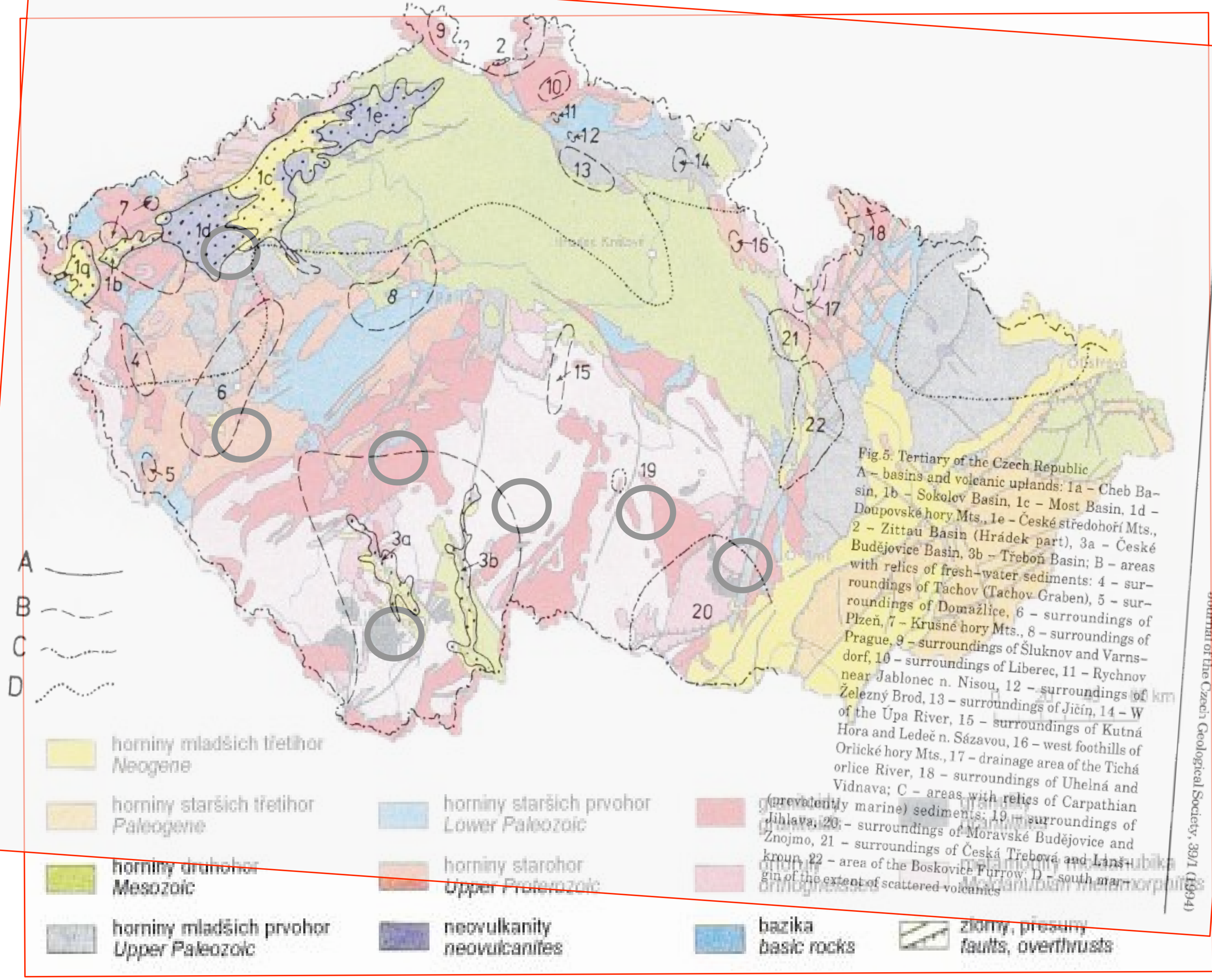

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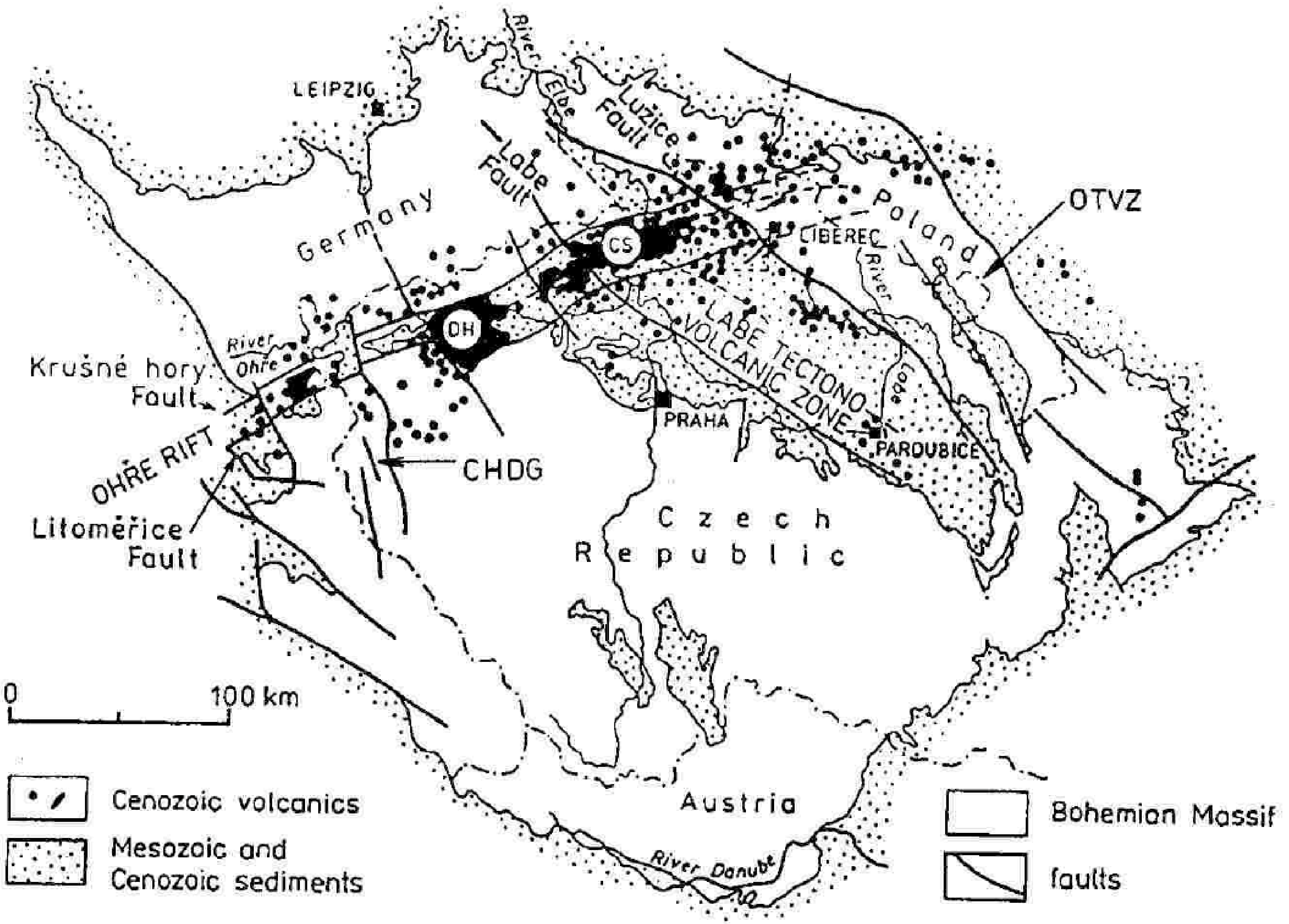


Fig. 1. A sketch of taphrogenic structures and associated Cenozoic volcanism of the Bohemian Massif (adapted from Kopecký 1978). DH – Doupovské hory Mts.; CS – České středohoří Mts.

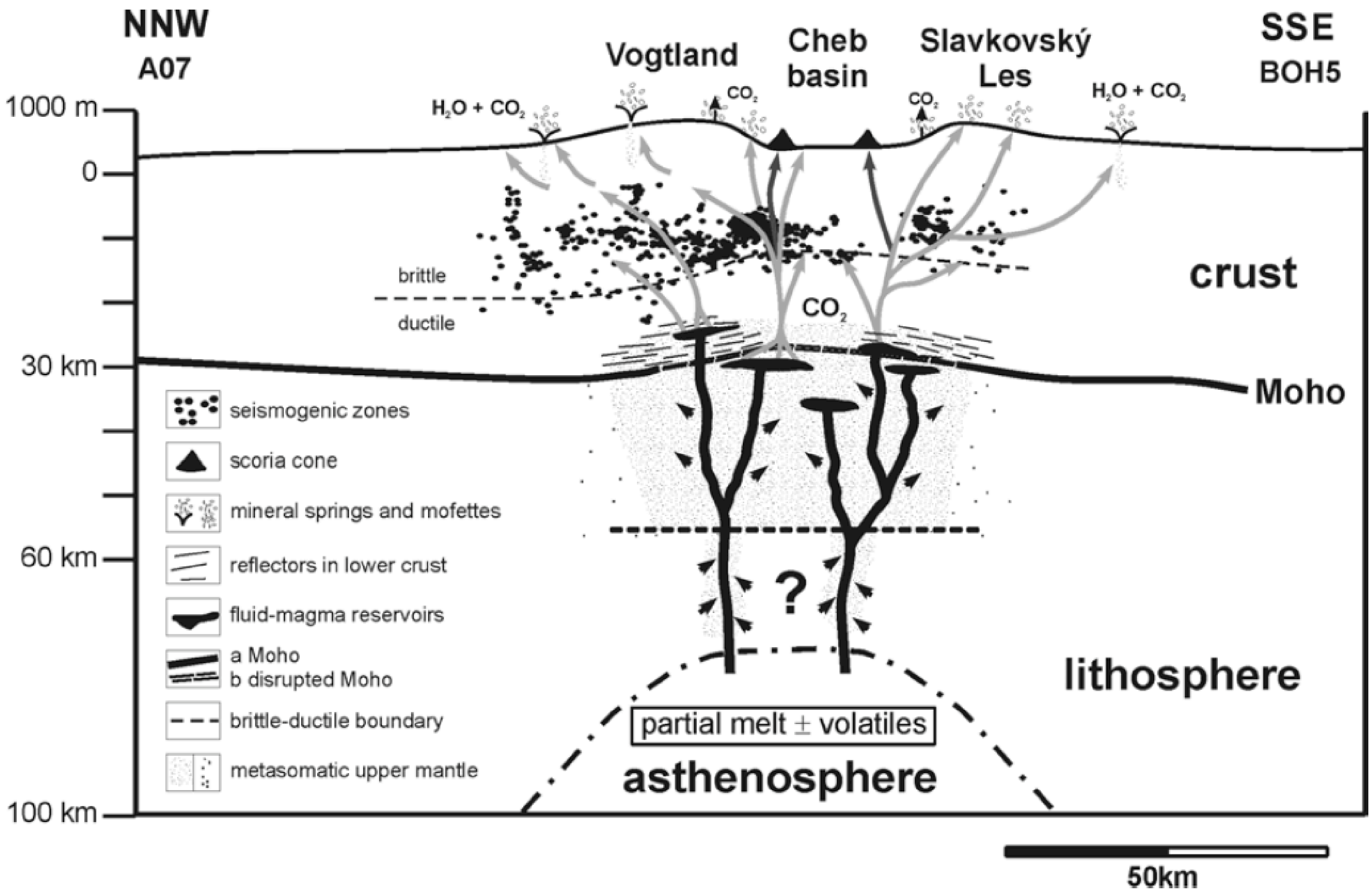


Figure D.2
Cartoon illustrating the asthenosphere-lithosphere interaction in the Vogtland/NW-Bohemia region.

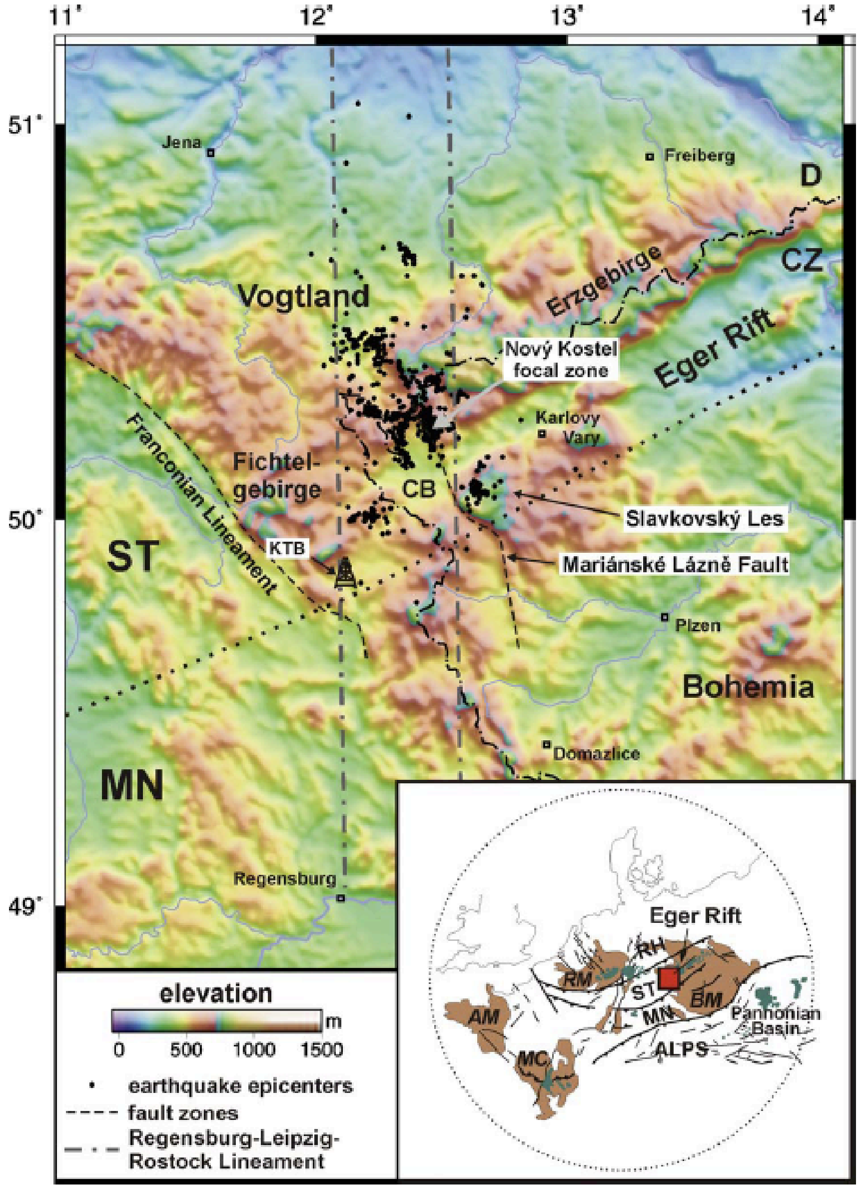


Figure A.1
Topographic map (GTOPO30 from USGS EROS DATA Center) of the northwestern part of the Bohemian Massif with earthquake epicentres 1985-1997 (black dots, according to *Neunhöfer* [2000] and SZGRF Vogtland Bulletin). Main earthquake swarm activity is concentrated in the Nový Kostel focal zone. Inset map: Position of the study area within the western and central European volcanic provinces modified after *Wilson and Downes* [1991] (read square – study area, green – Cainozoic volcanics, brown – basement massifs).
KTB – location of the German Continental Deep Drilling Boreholes (KTB), CB – Cheb Basin, MC – Massif Central, AM – Armorican Massif, RM – Rhenish Massif, BM – Bohemian Massif, MN – Moldanubian zone, RH – Rhenohercynian zone, ST – Saxothuringian zone.

B. Quaternary of the accumulation areas

This unit is subdivided into 1. Areas of the continental glaciation and 2. Extraglacial areas.

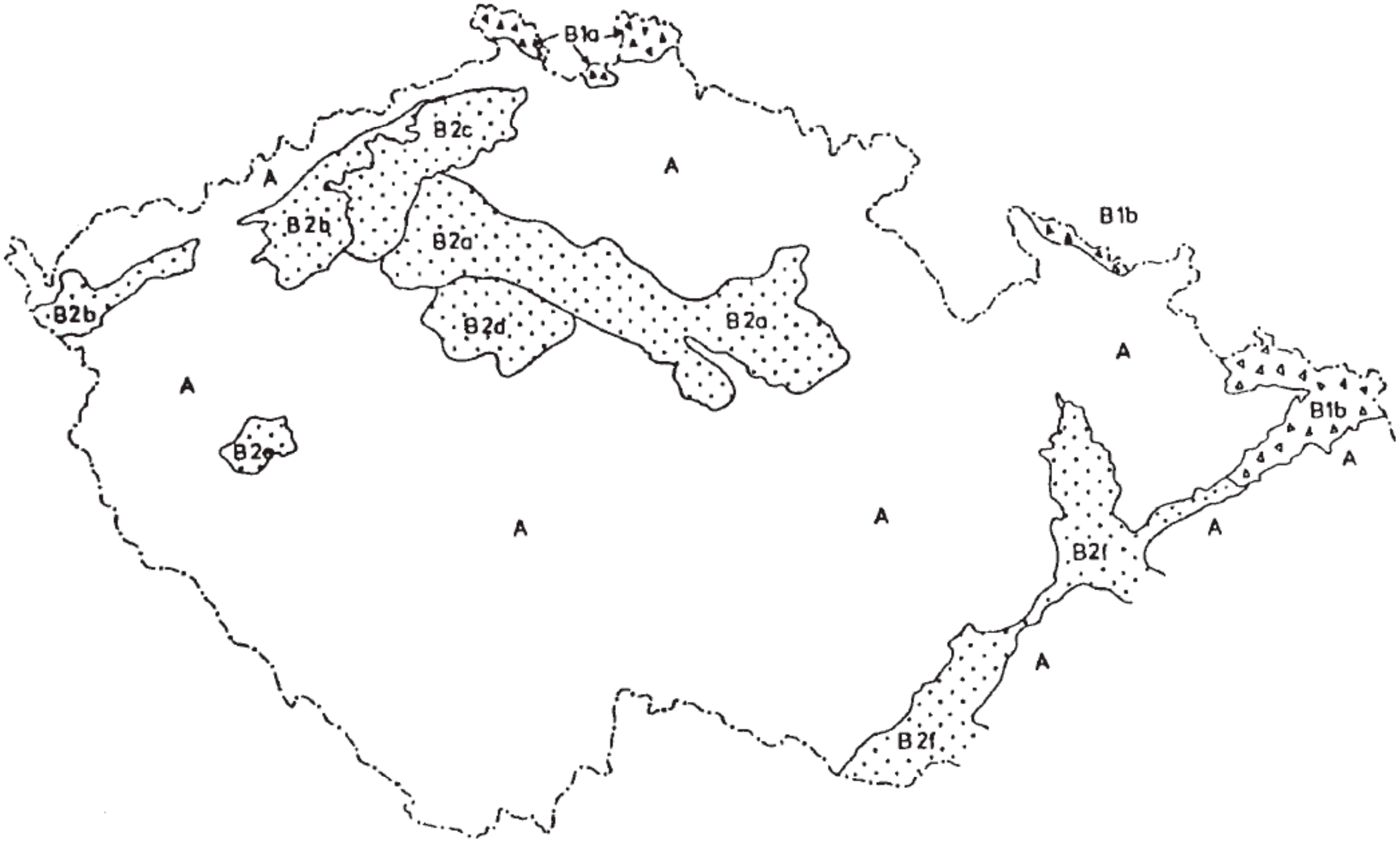


Fig. 6. Quaternary of the Bohemian Massif
A – Quaternary of the denudation areas; B – Quaternary of the accumulation areas: Quaternary of the continental glaciation: B1a – Northern Bohemia, B1b – Odra area. Quaternary of the extraglacial areas: B2a – middle course of Labe, B2b – West Bohemian Tertiary Basins, B2c – České středohoří Mts., B2d – Prague plateau, B2e – Plzeň Basin, B2f – Moravian Basins

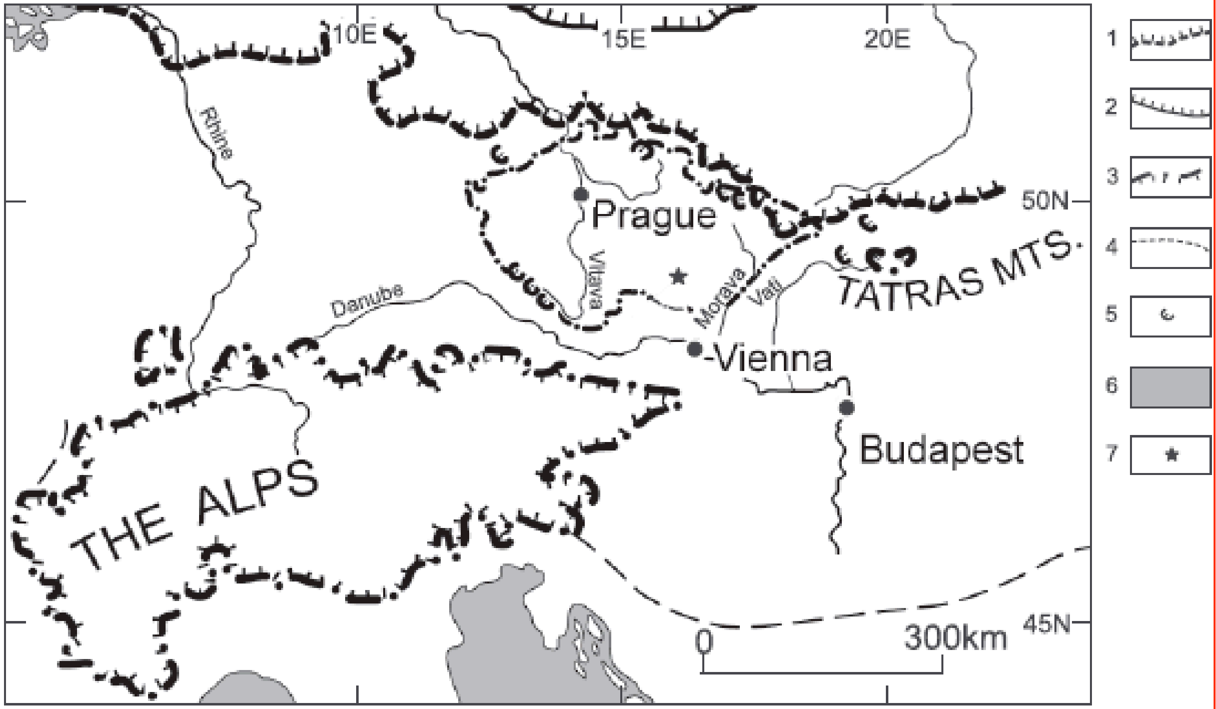


Figure 1. Map of Quaternary glaciated and unglaciated area and periglacial region of Middle Europe. Modified after *Kaiser* [1960]. 1) Southern limit of the Fennoscandinavian glacier during the peak of glaciation in Elsterian glaciation. 2) Southern limit of the Fennoscandinavian glacier of the last Weichselian glaciation. 3) Limit of mountain glaciers. 4) Inferred southern limit of permafrost zone. 5) Small-scale mountain glaciers. 6) Sea. 7) Dolni Vestonice section.

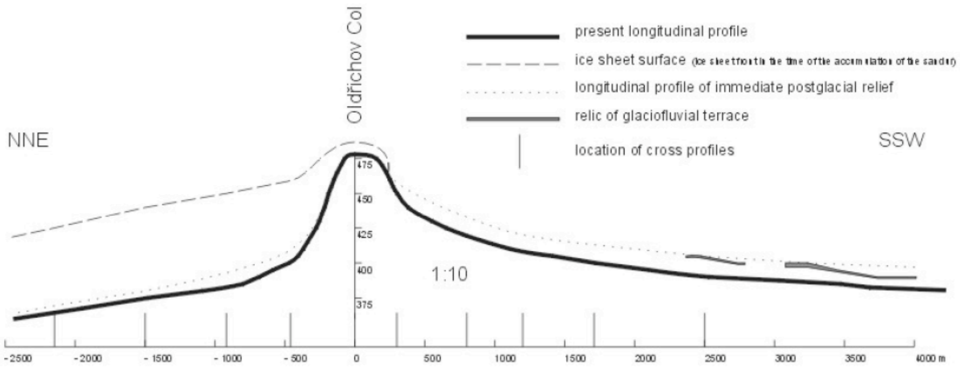
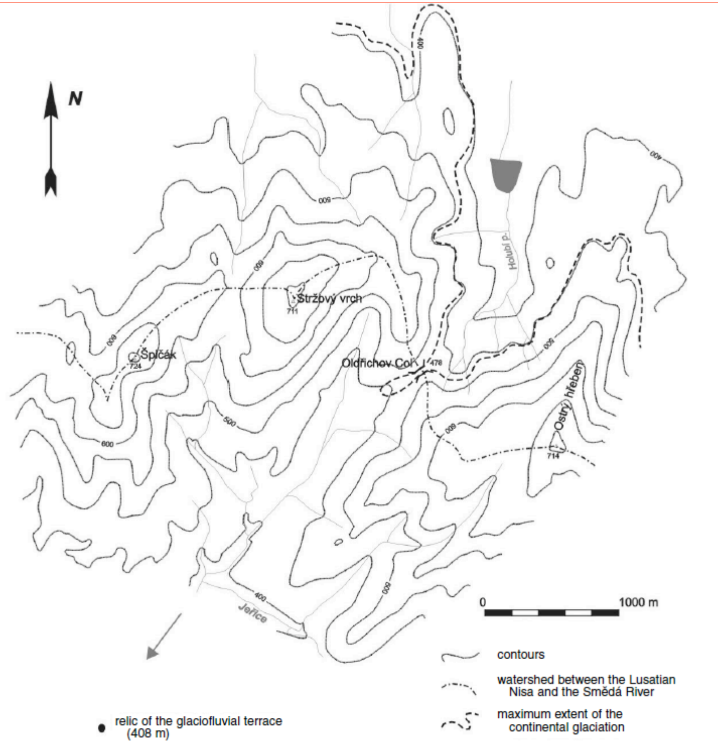


Figure 6: Longitudinal profile through the Oldřichov Highland with the position of the glaciofluvial terrace, ice sheet surface, longitudinal profile of the immediate postglacial relief and with the locations of cross profiles in fig. 7.



igure 8: Hypsographic map of the Oldřichov Highland, with the position of the glaciofluvial terrace and the maximum extent of the continental glacier.

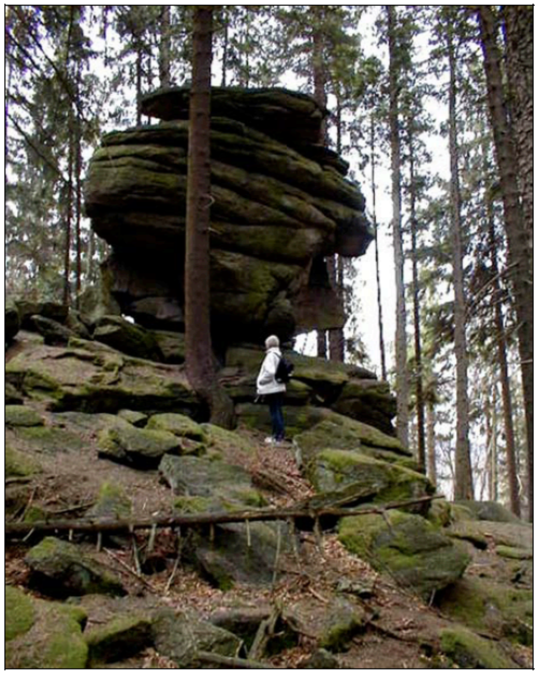
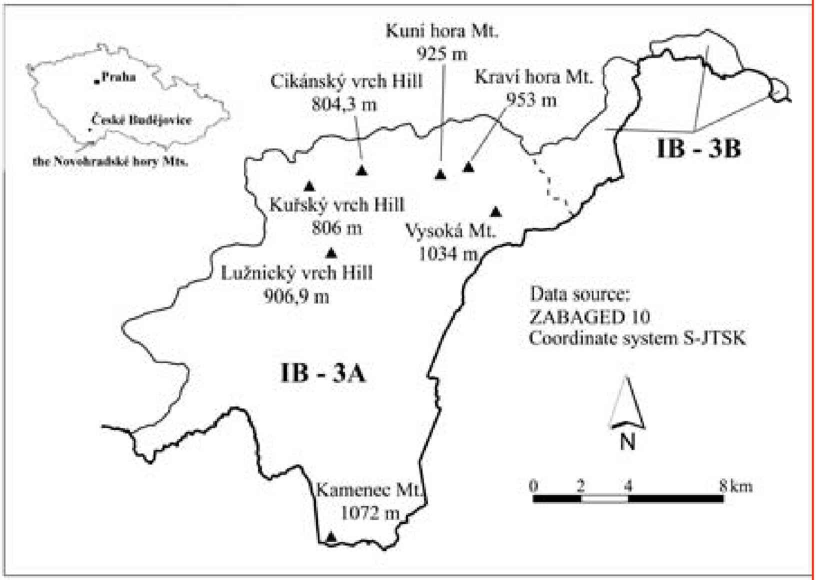
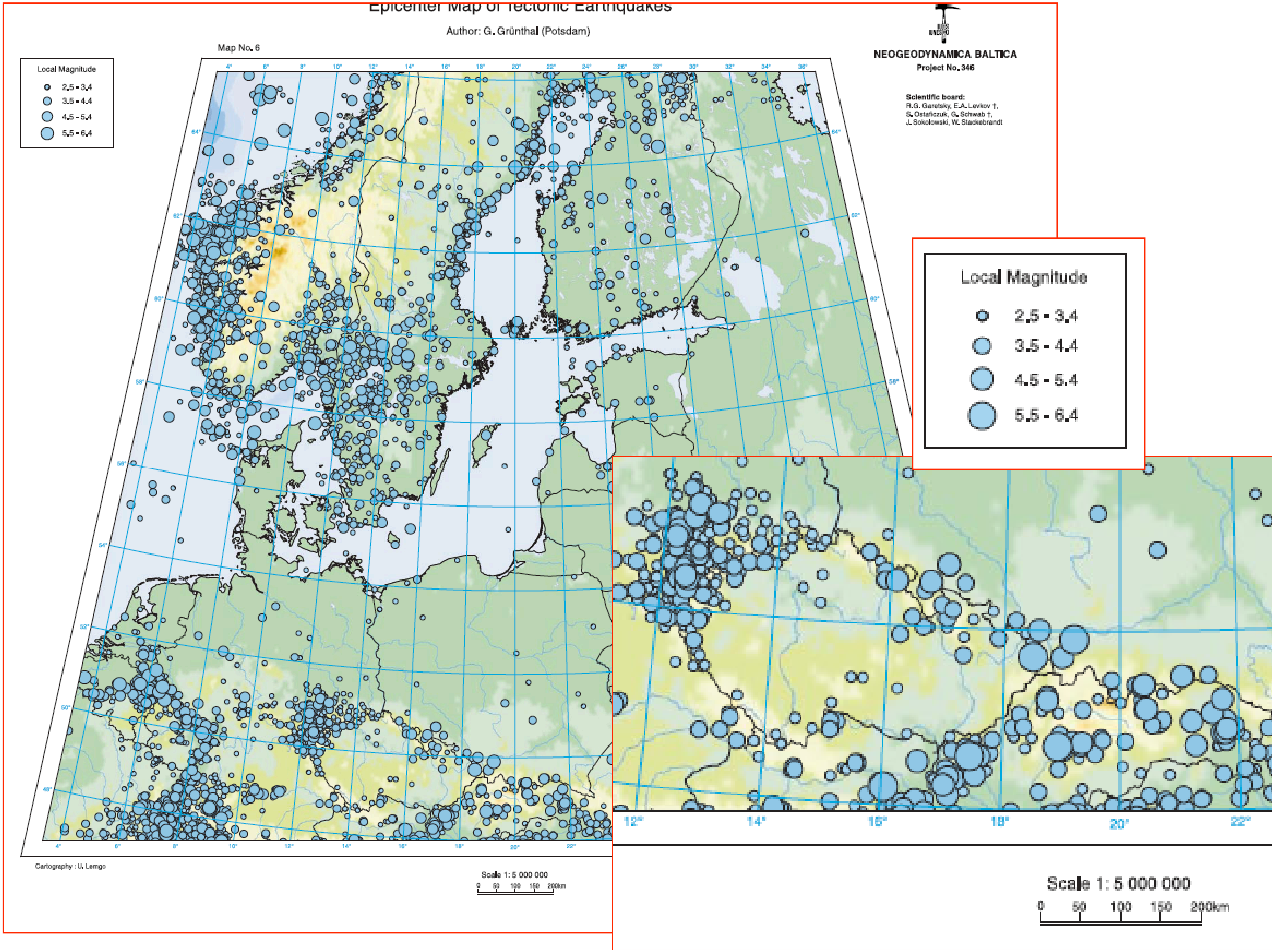
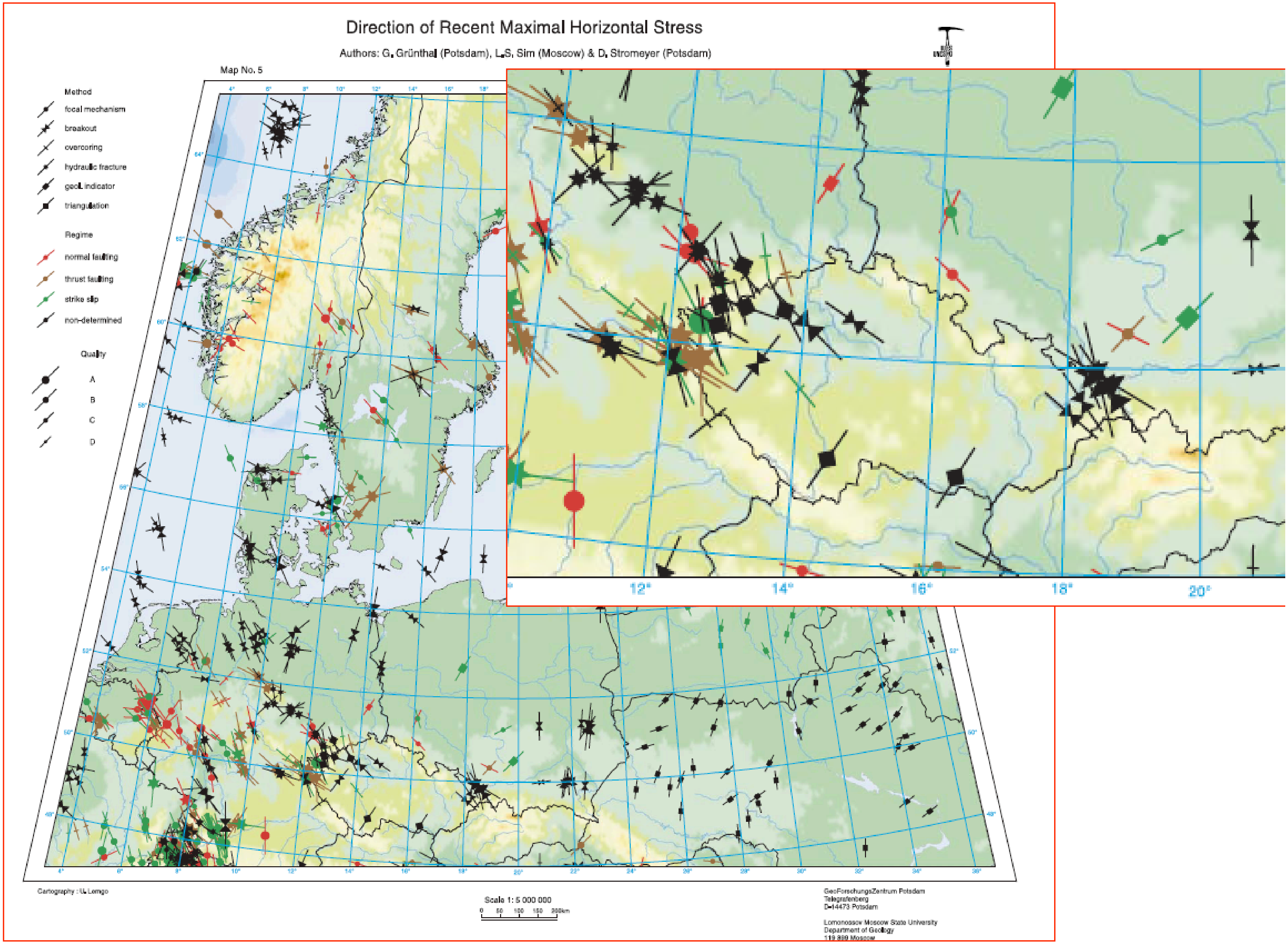


Photo 3. The mushroom rock – the Napoleon´s head on the Kraví Hora Mt. (phot. by J. Rypl)
Fot. 3. Grzyb skalny – Czapka Napoleona na wierzchołku Kraví Hora (phot. by J. Rypl)




Epicenter Map of Tectonic Earthquakes
Author: G. Grünthal (Potsdam)
Map No. 6
Local Magnitude
2.5 - 3.4
3.5 - 4.4
4.5 - 5.4
5.5 - 6.4
NEOGEODYNAMICA BALTICA
Project No. 346
Scientific board:
R.G. Garetsky, E.A. Levkov †,
S. Ostaficzuk, G. Schwab †,
J. Sokolowski, W. Stackebrandt
Cartography : U. Lemgo
Scale 1: 5 000 000
0 50 100 150 200km
12° 14° 16° 18° 20° 22°



Direction of Recent Maximal Horizontal Stress

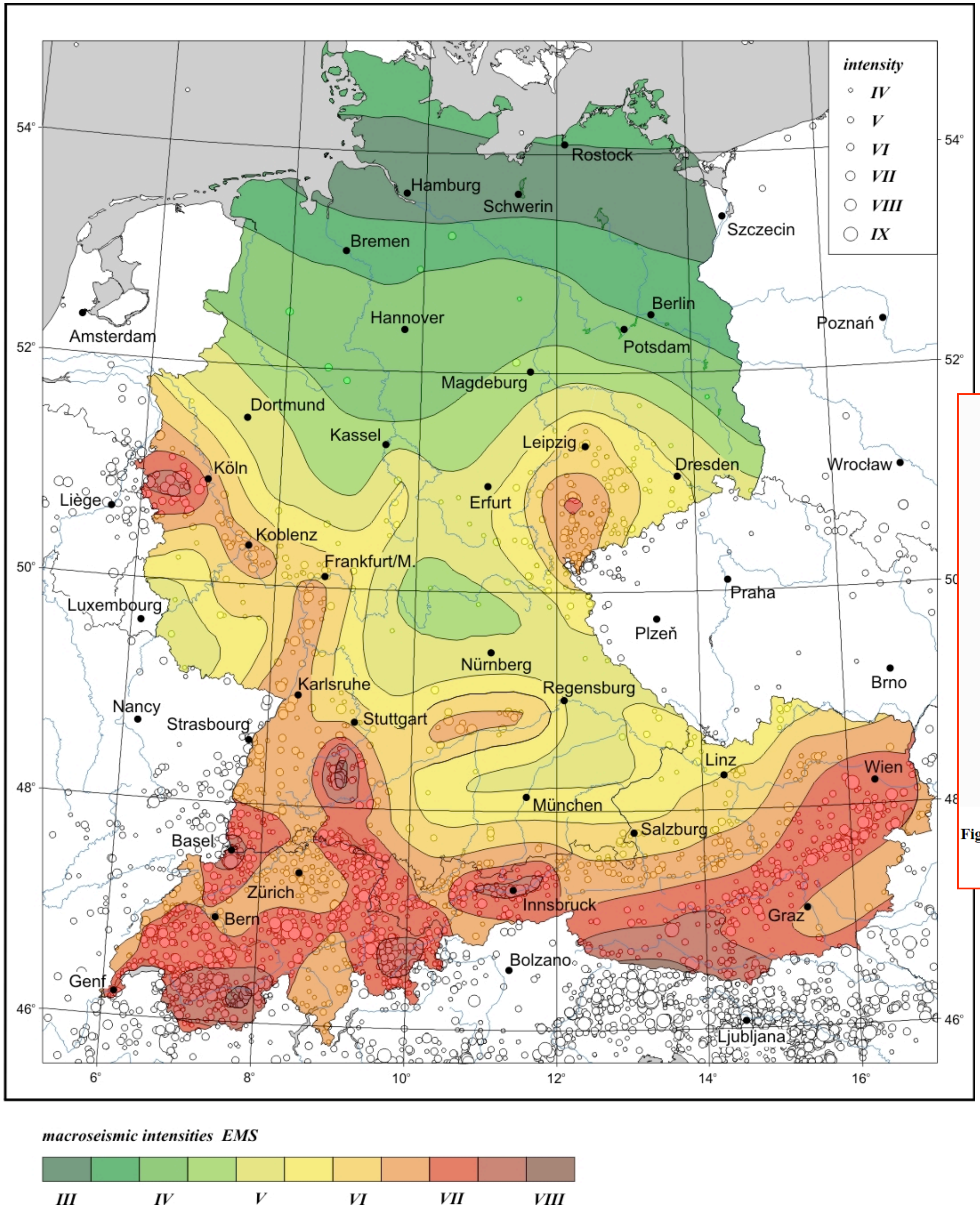
Authors: G. Grünthal (Potsdam), L.S. Sim (Moscow) & D. Stromeyer (Potsdam)

Map No. 5

Cartography : U. Lemgo

GeoForschungsZentrum Potsdam
Telegrafenberg
D-14473 Potsdam

Lomonossow Moscow State University
Department of Geology
119 899 Moscow



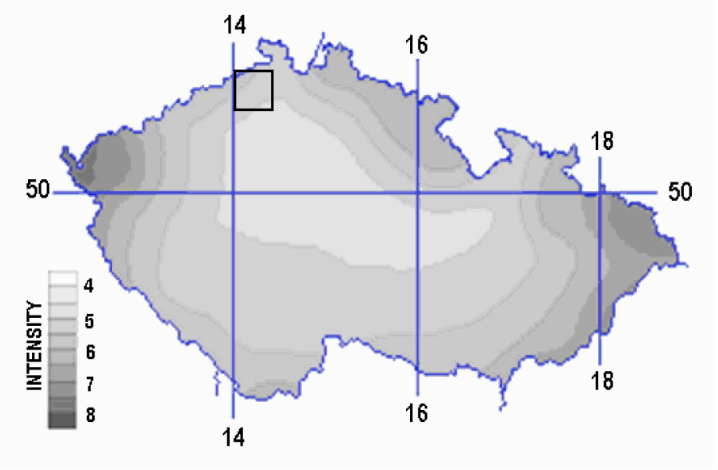


Fig. 1 Earthquake hazard map for the Czech Republic with the 90% non-exceedance probability of a given macroseismic intensity within 50 years, i.e. for the return period of 475 years; frame – area of the vicinity of Ústí nad Labem town.

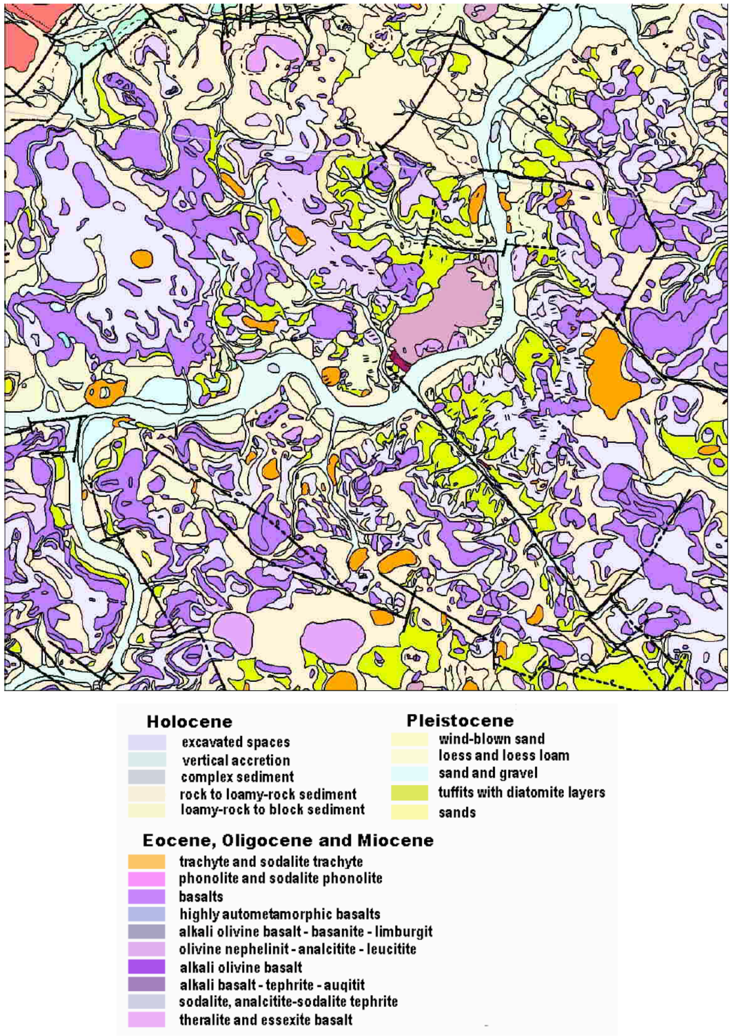
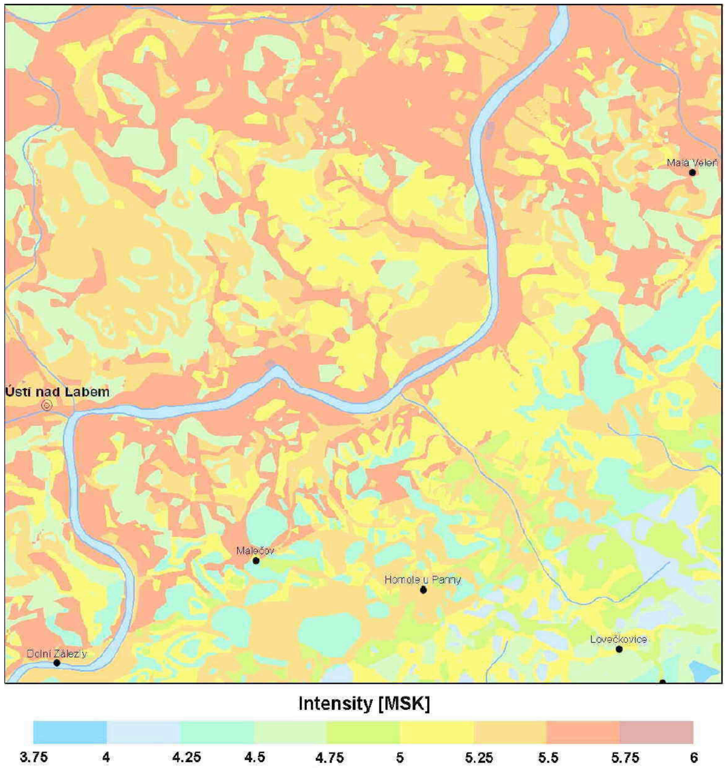
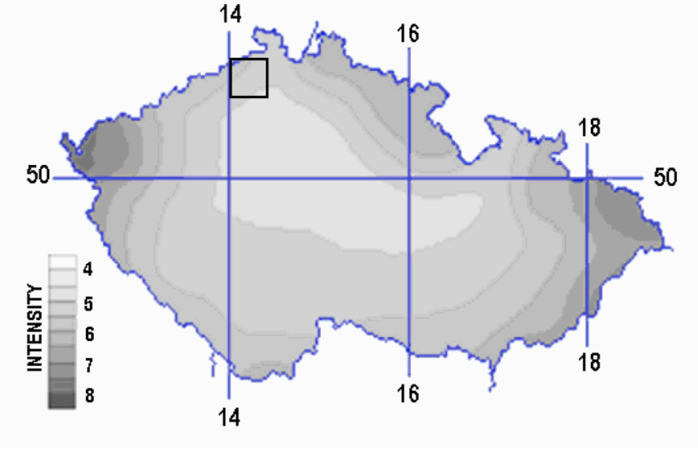


Fig. 3 Geological map of the vicinity of Ústí na Labem town, the scale 1:50 000 (Geological map for the CR, sheet 02-41).





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EARTHQUAKE HAZARD FOR THE CZECH REPUBLIC CORRECTED ON LOCAL GEOLOGY EFFECTS

Grant project of the Czech Science Foundation No. 205/05/2287

Main investigator: Vladimír Schenk

Scientific collaborators: Zdeňka Schenková, Richard Pichl and Zuzana Jechumtálová

Institute of Rock Structure and Mechanics, Academy of Sciences of the Czech Republic, v.v.i.,
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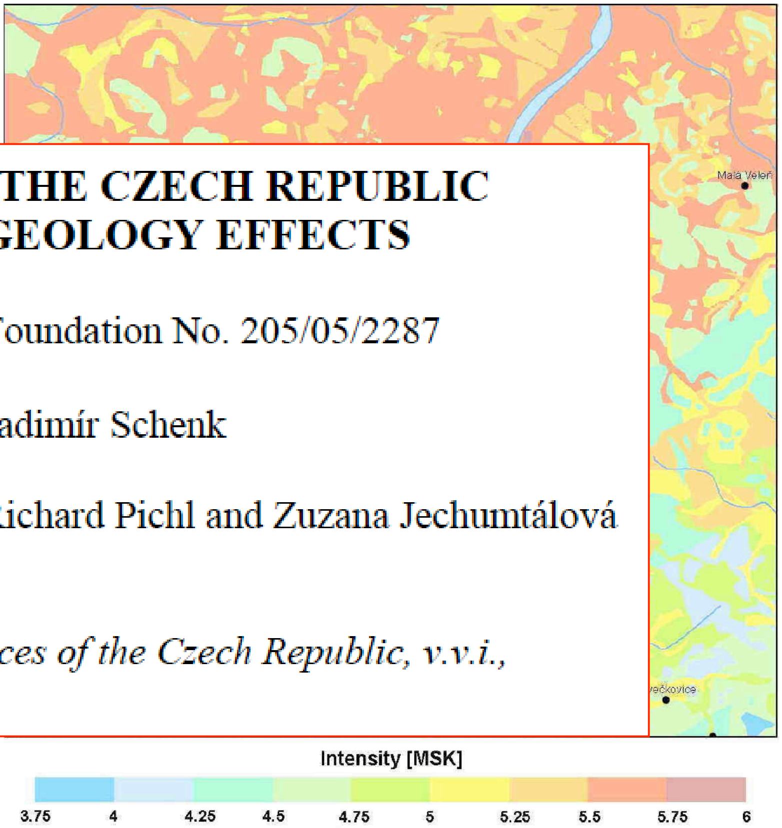
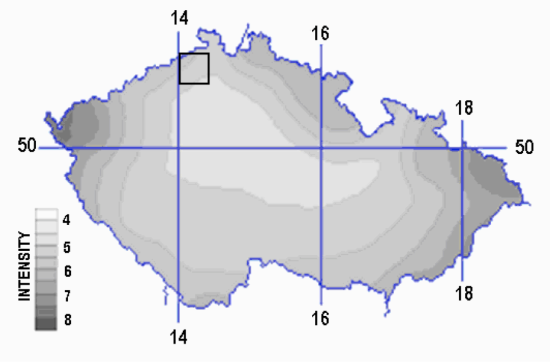


Fig. 2 Example of earthquake hazard map for vicinity of Ústí nad Labem town corrected on effects of local geology. The hazard values are in the terms of macroseismic intensities calculated for return period of 475 years.



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Potential SHA Issues for Czech NPPs:

1. Is PSHA Methodology being considered in CZ and/or EU? (It was in CH, but CH will phase out its NPP operations as per recent post-Fukushima decisions)
2. Are the data needed for a PSHA available for CZ?
3. Are the seismic vulnerabilities (fragilities) of current VVER reactors, and of future designs, sufficiently well understood to allow a seismic CDF to be determined with reasonable confidence?
4. If not, what Program and Time is needed to collect such data?
5. Is the Time Frame for collecting the needed data consistent with renewing the Czech NPP fleet?
6. Are the communities near the target sites for DGRs involved in planning and decision making?

Potential SHA Issues for Czech HLNW DGRs:

1. Is PSHA Methodology being considered in CZ and/or EU? (Yes in CH, but CH will phase out its NPP operations as per recent post-Fukushima decisions)
2. Are the data needed for a PSHA available for CZ DGR sites?
3. If not, what Program and Time is needed to collect such data?
4. Is the Time Frame for collecting the needed data consistent with the anticipated schedule for establishing one or more Czech DGRs to accommodate the spent-fuel-HLNW currently stored (and more accumulating in the future) mostly at the 2 sites of operating NPPs.
5. Are the communities near the target sites for DGRs involved in planning and decision making?
6. Are the 2 alternate sites under military control suitable on geological grounds? What if not?

Questions?

4a NPPs