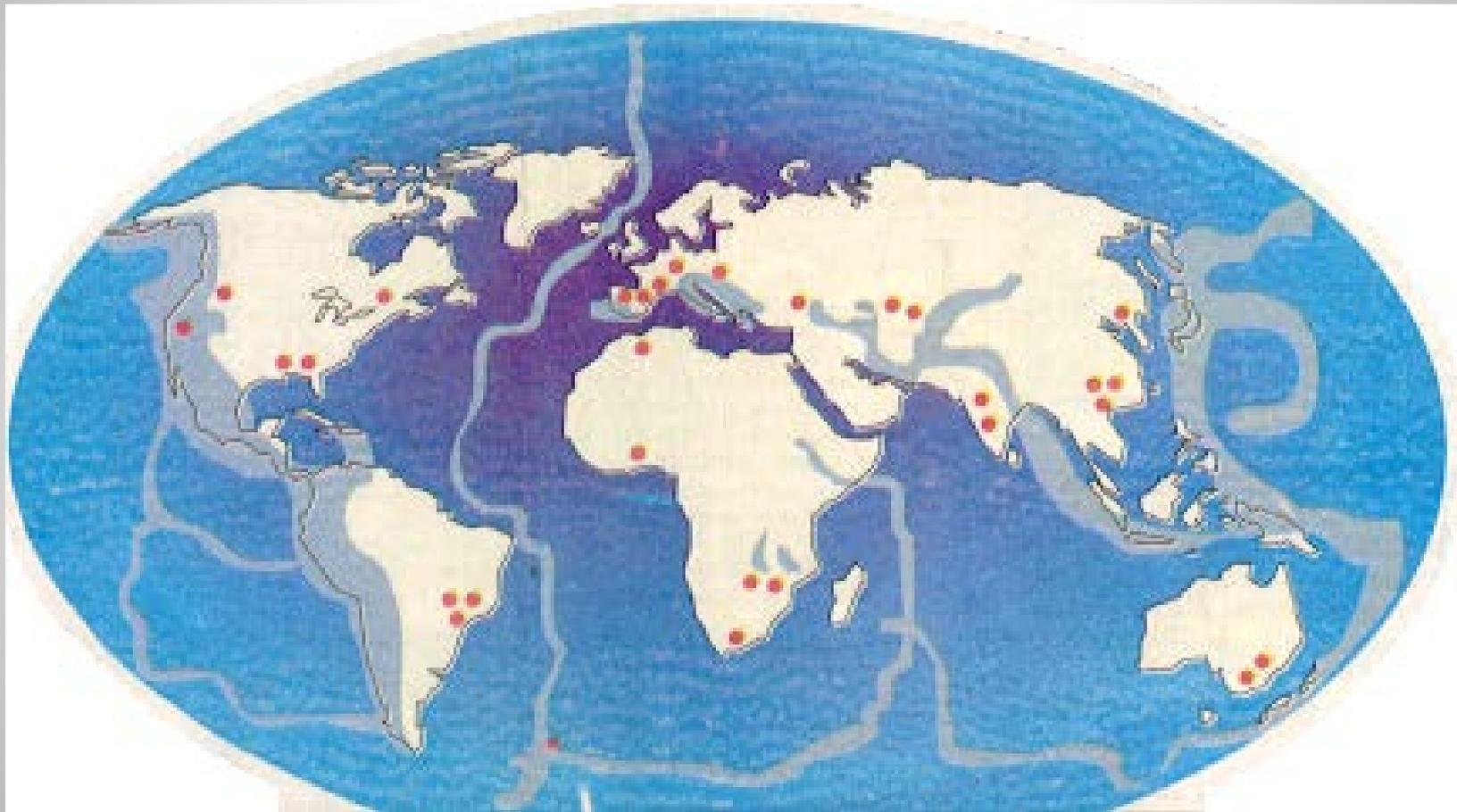


**ЗЕМЕТРЕСЕНИЯ - ОСНОВНИ ПОНЯТИЯ И ПАРАМЕТРИ.
СЕИЗМИЧНИ НАТОВАРВАНИЯ ВЪРХУ ЯЗОВИРНИТЕ
СТЕНИ - НОРМАТИВНИ ПРЕДПИСАНИЯ.**



Проф. д-р инж. ВАНГЕЛ ВАСИЛЕВ

1. Що е земетресение ?

- A= Образуването на нов разлом → E1
- A'= Разместването на скалните масиви около съществуващ разлом → E1'
- B= Допълнително пукнатинообразуване в зоната → E2
- C= Разпространението на сеизмични вълни → E3

A+B+C = ЗЕМЕТРЕСЕНИЕ

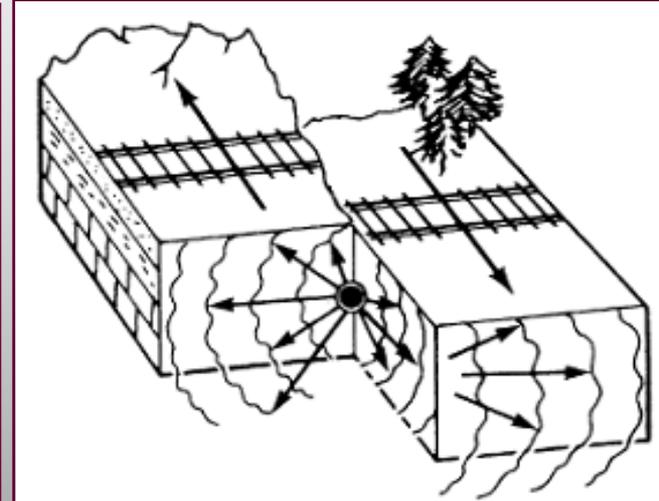
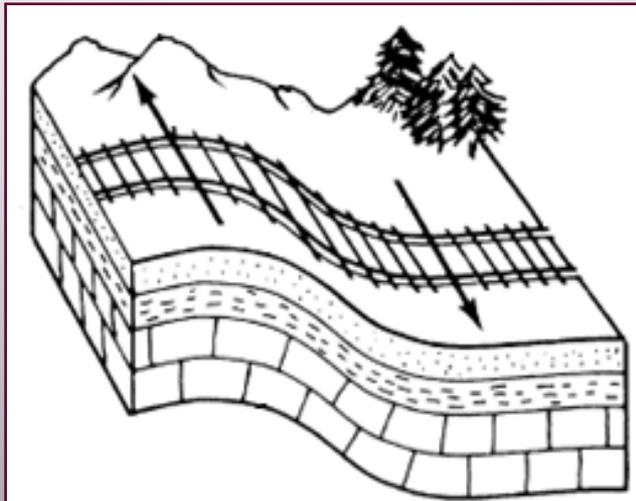
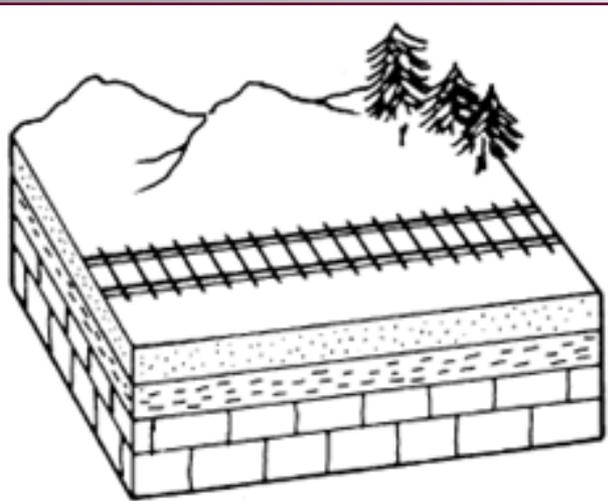
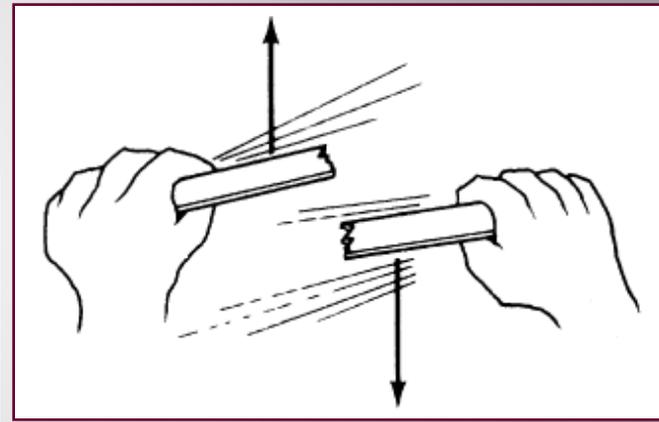
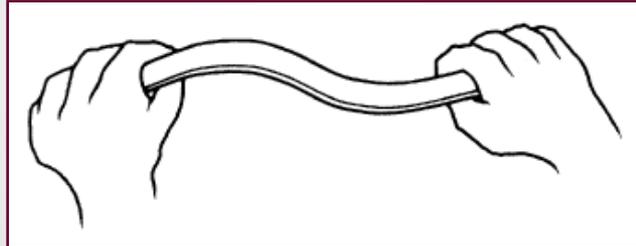
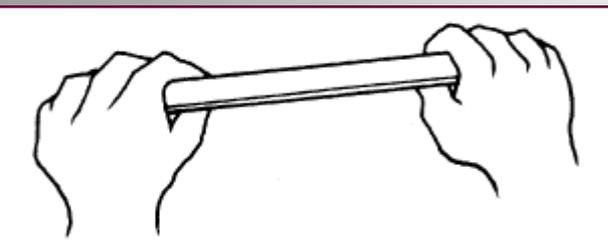
E1 > E2 > E3

I. ОСНОВНИ ПОНЯТИЯ

(2-6)

2. Основни теории

2.1 Теория на Райд за еластичното разтоварване при земетресения (Henry Reid, Elastic-rebound theory of earthquakes)

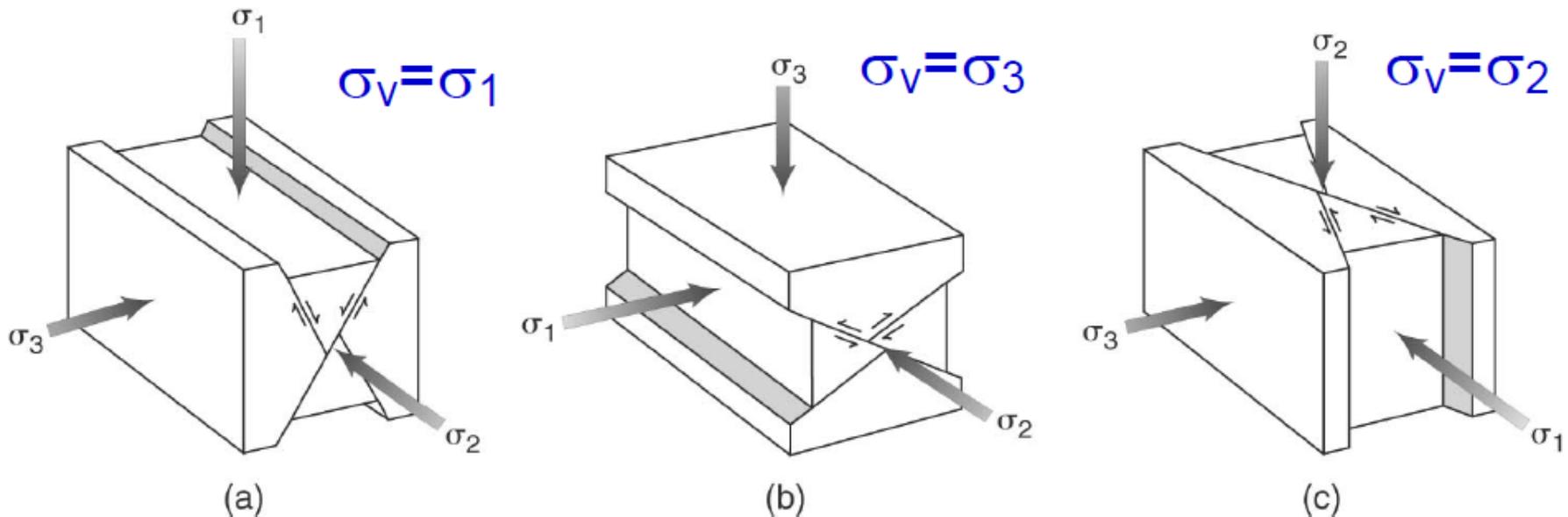


I. ОСНОВНИ ПОНЯТИЯ

(3-6)

2.2 Теория на Андерсън за разломяването (Anderson's theory of faulting)

1. Разломяване има ако $\sigma_s = (\sigma_1 - \sigma_3)/2$ не е равно на нула!
2. Разломът започва като пукнатина на срязване по закона на **Coulomb**.



I. ОСНОВНИ ПОНЯТИЯ

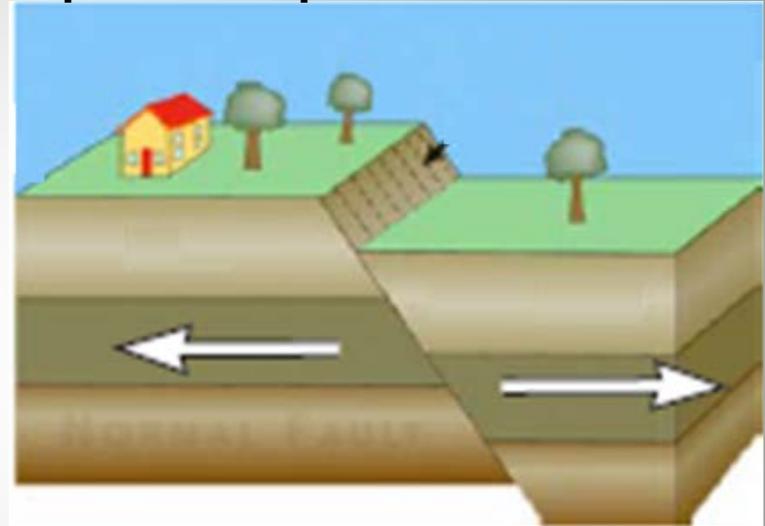
(4-6)

3. Видове разломяване

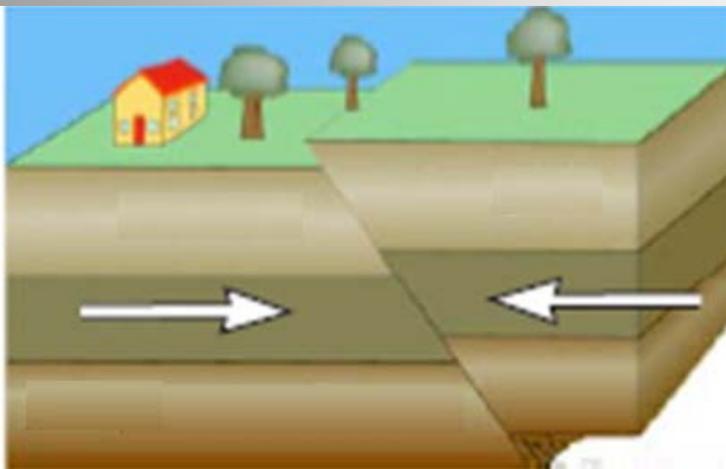
Преди разломяване



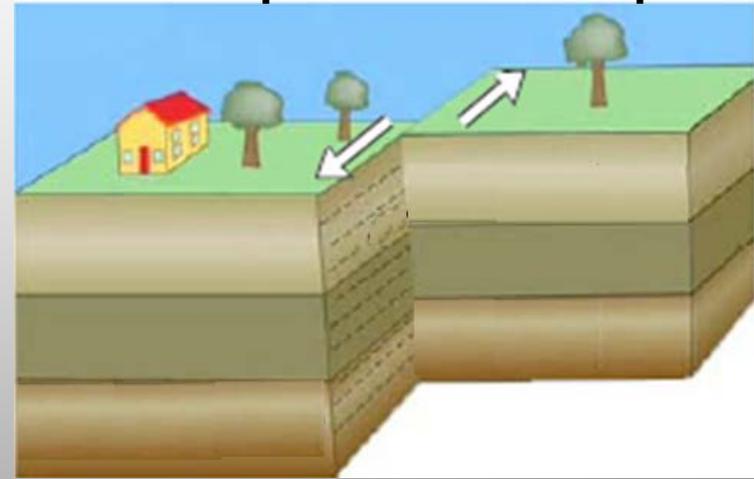
Вертикално разместване - опън



Вертикално разместване - натиск



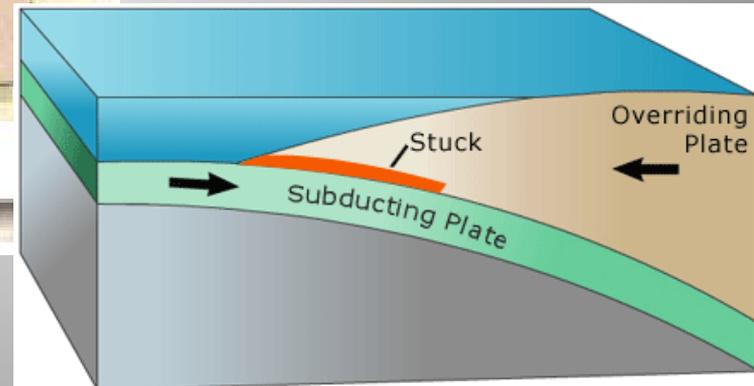
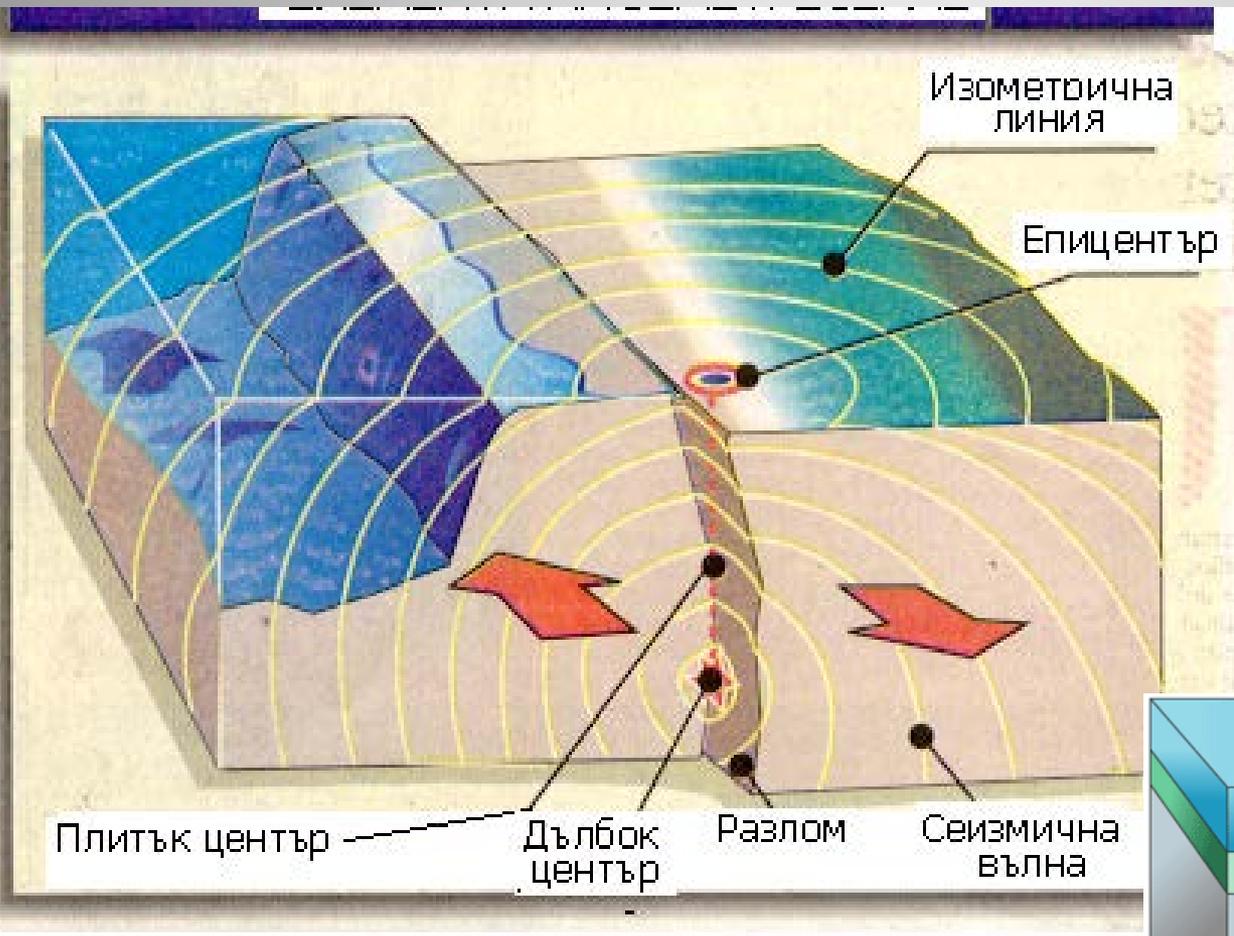
Хоризонтално разместване - срязване



I. ОСНОВНИ ПОНЯТИЯ

(5-6)

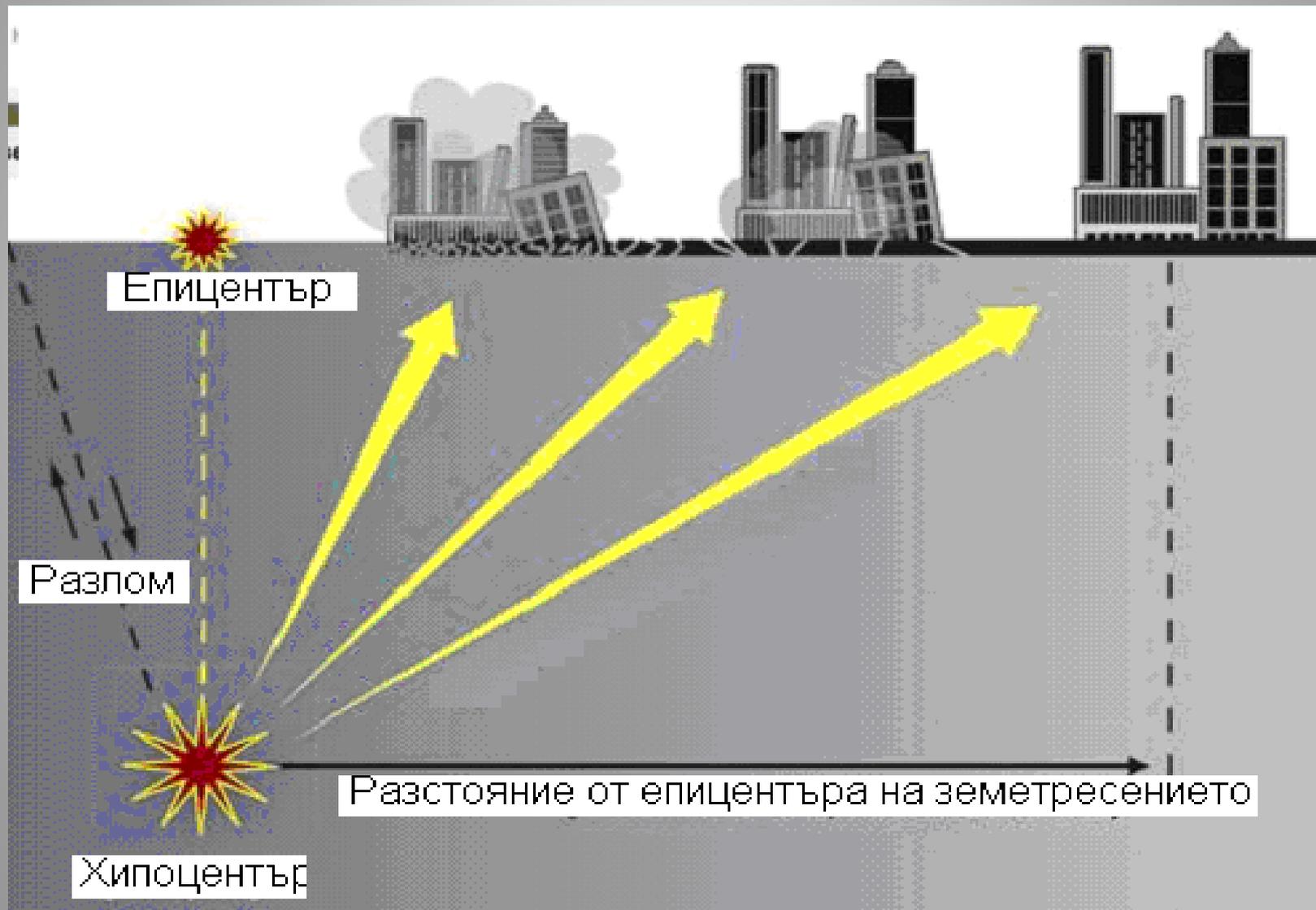
4. Параметри на земетресение - 1



I. ОСНОВНИ ПОНЯТИЯ

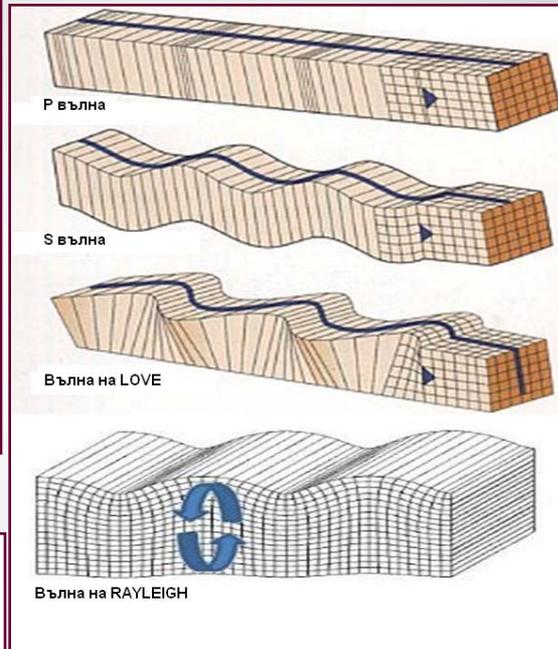
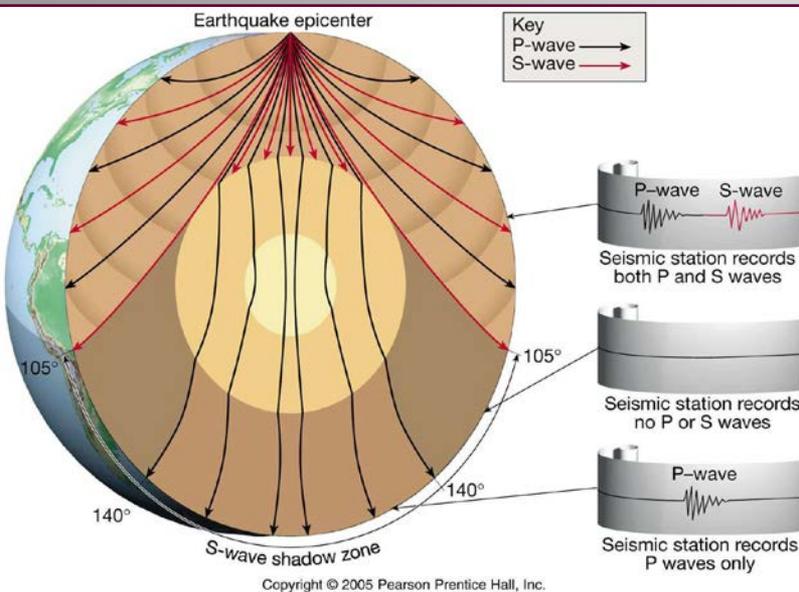
(6-6)

4. Параметри на земетресение - 2



II. СЕЙЗМИЧНИ ВЪЛНИ

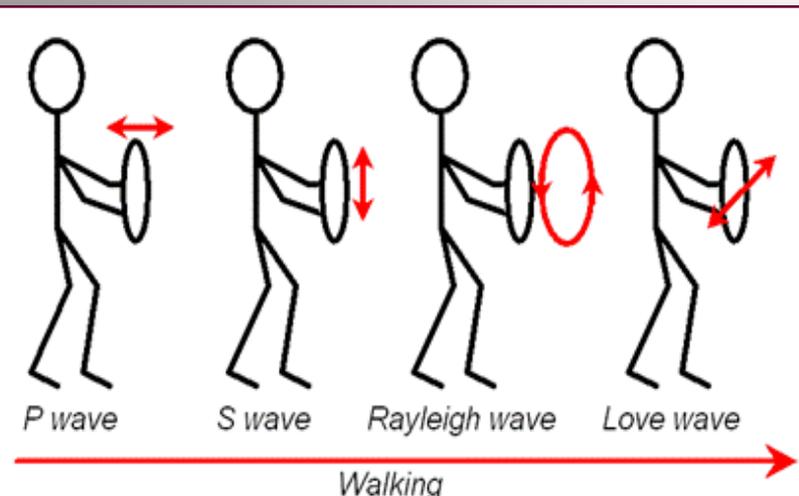
(1-5)



$$V_p = \sqrt{\frac{(1-\nu)E}{(1-\nu-2\nu^2)\rho}}$$

$$V_s = \sqrt{\frac{G}{\rho}}$$

$$G = E/[2(1+\nu)]$$



$$V_p = 4.0 - 7 \text{ km/sec (з. кора)}$$

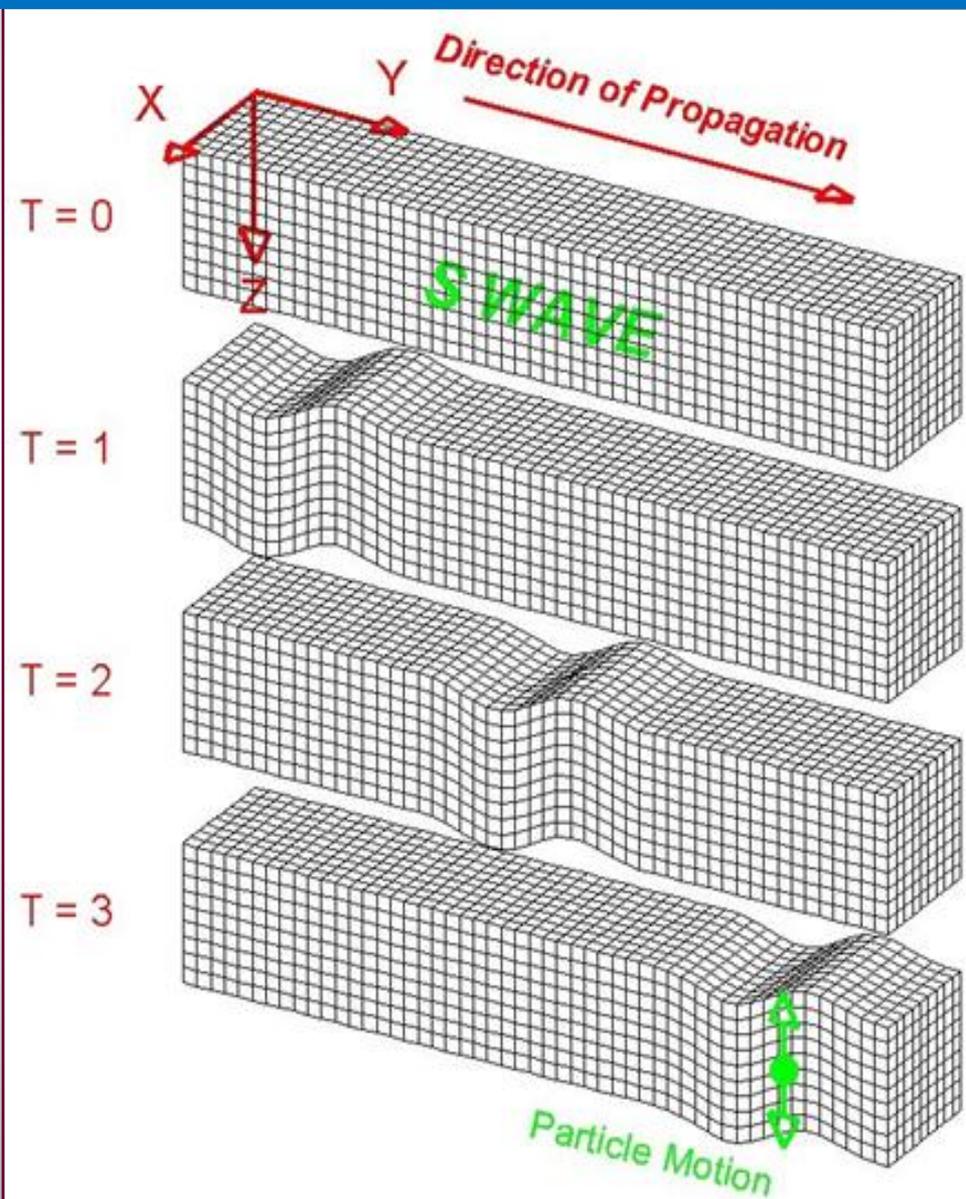
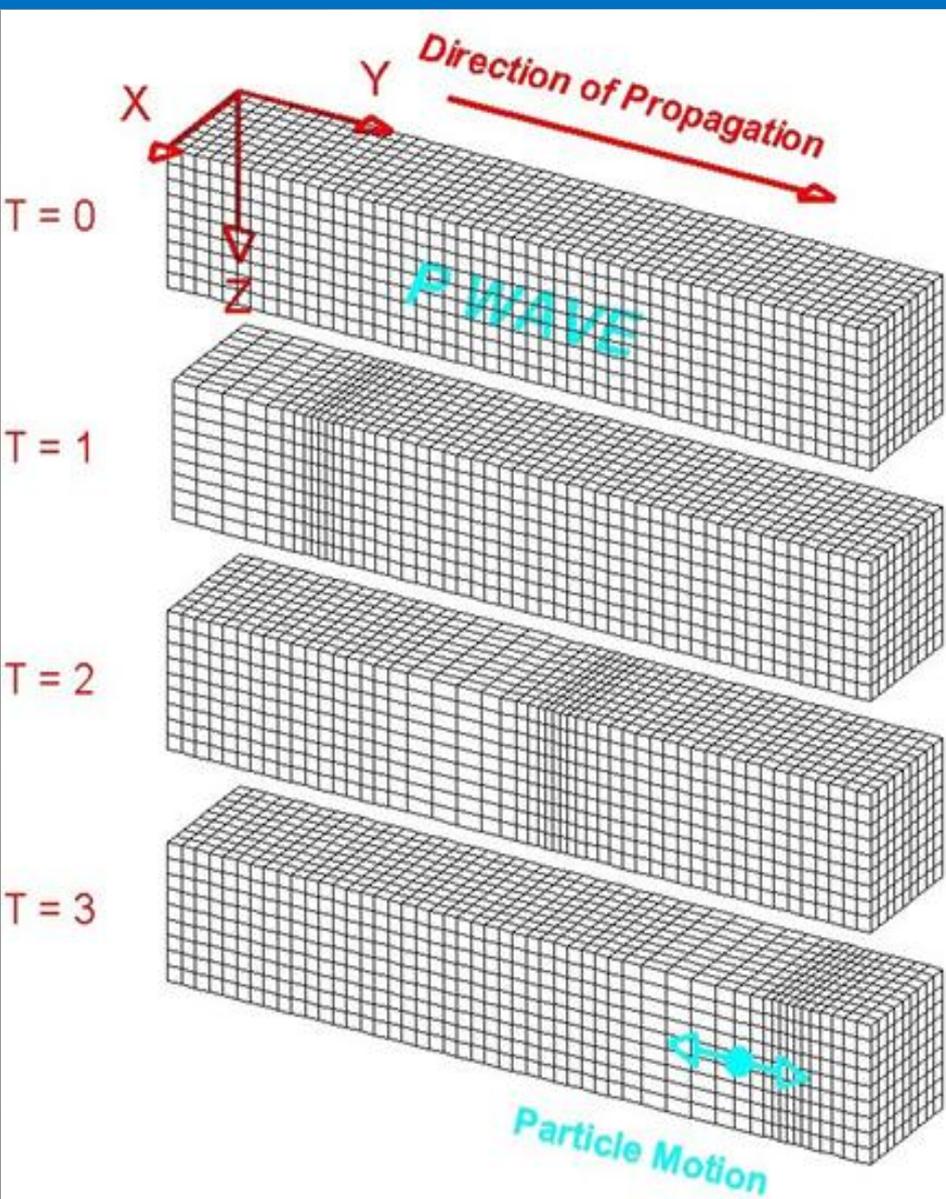
$$V_p = 8.0 - 8.5 \text{ km/sec (мантия)}$$

$$V_s = 2.0 - 4.0 \text{ km/sec (з. кора)}$$

$$V_s = 4.5 - 5.0 \text{ km/sec (мантия)}$$

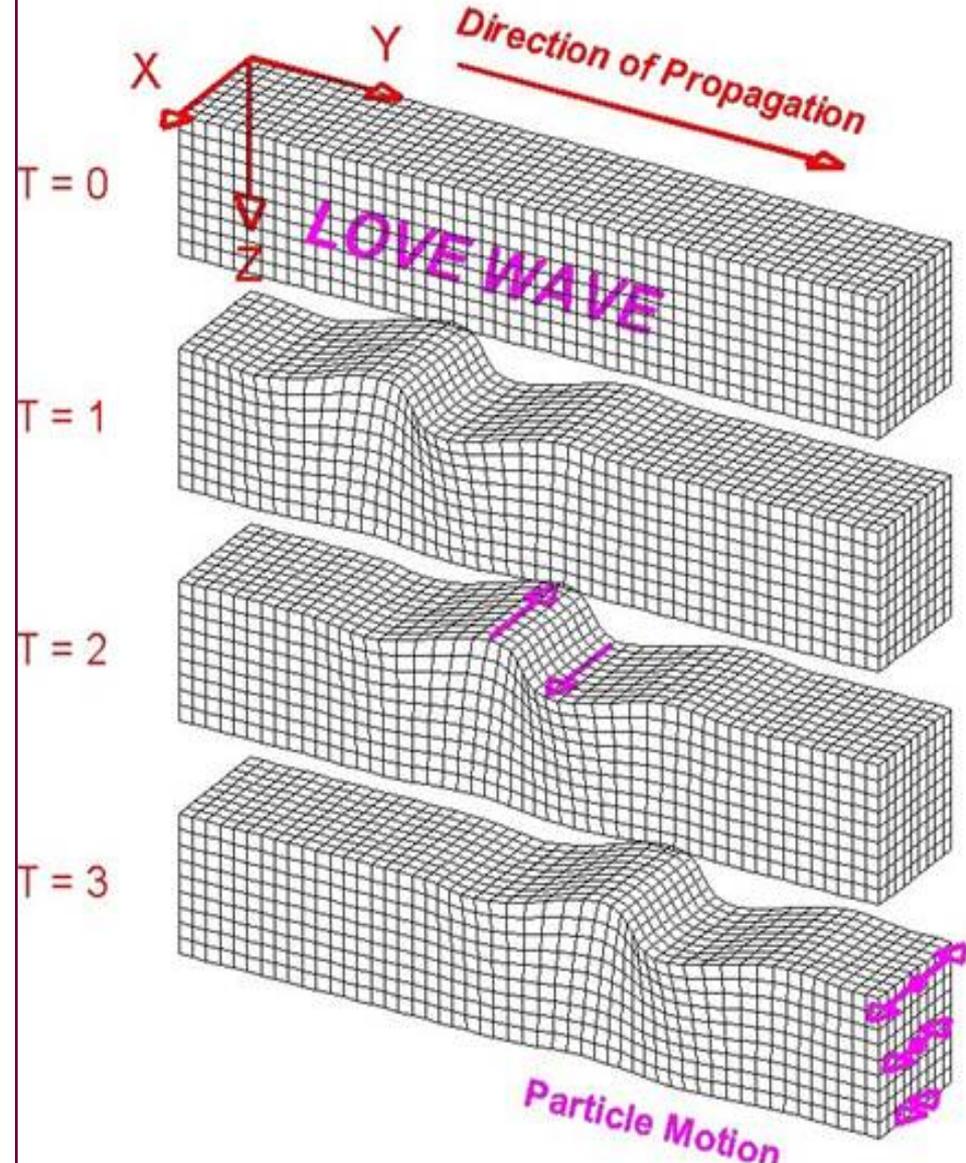
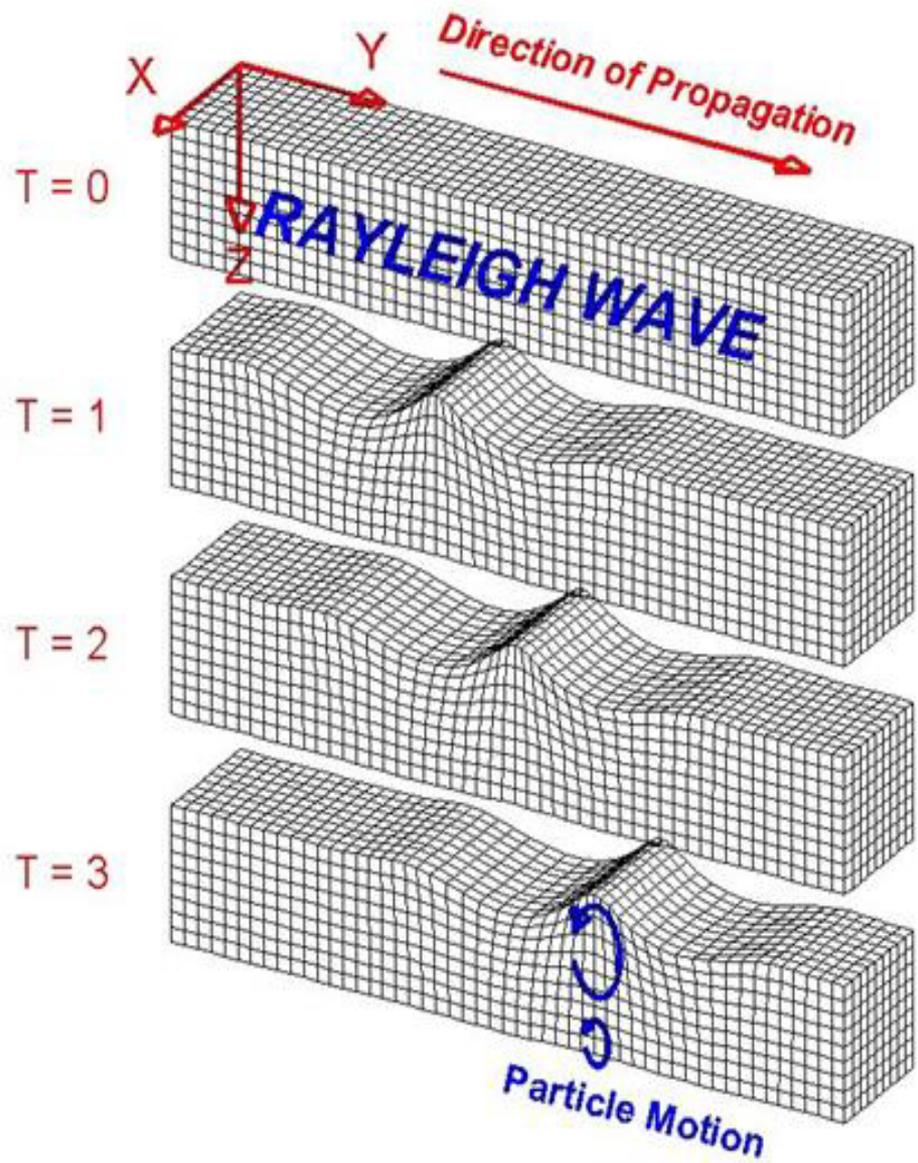
II. СЕИЗМИЧНИ ВЪЛНИ

(2-5)



II. СЕИЗМИЧНИ ВЪЛНИ

(3-5)



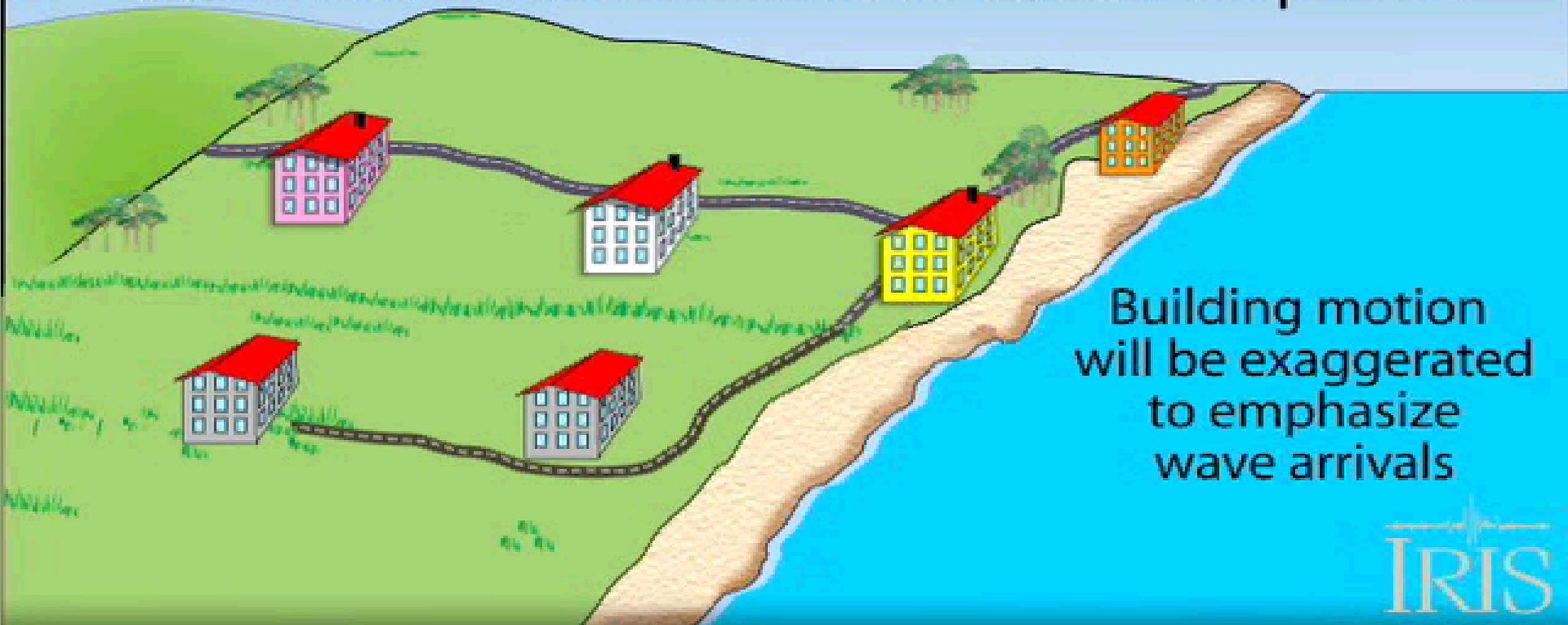


Respuesta de una estructura onda sísmica simplificada



Escalas
exageradas

How will 3 buildings, engineered equally, on different bedrock react to an earthquake?

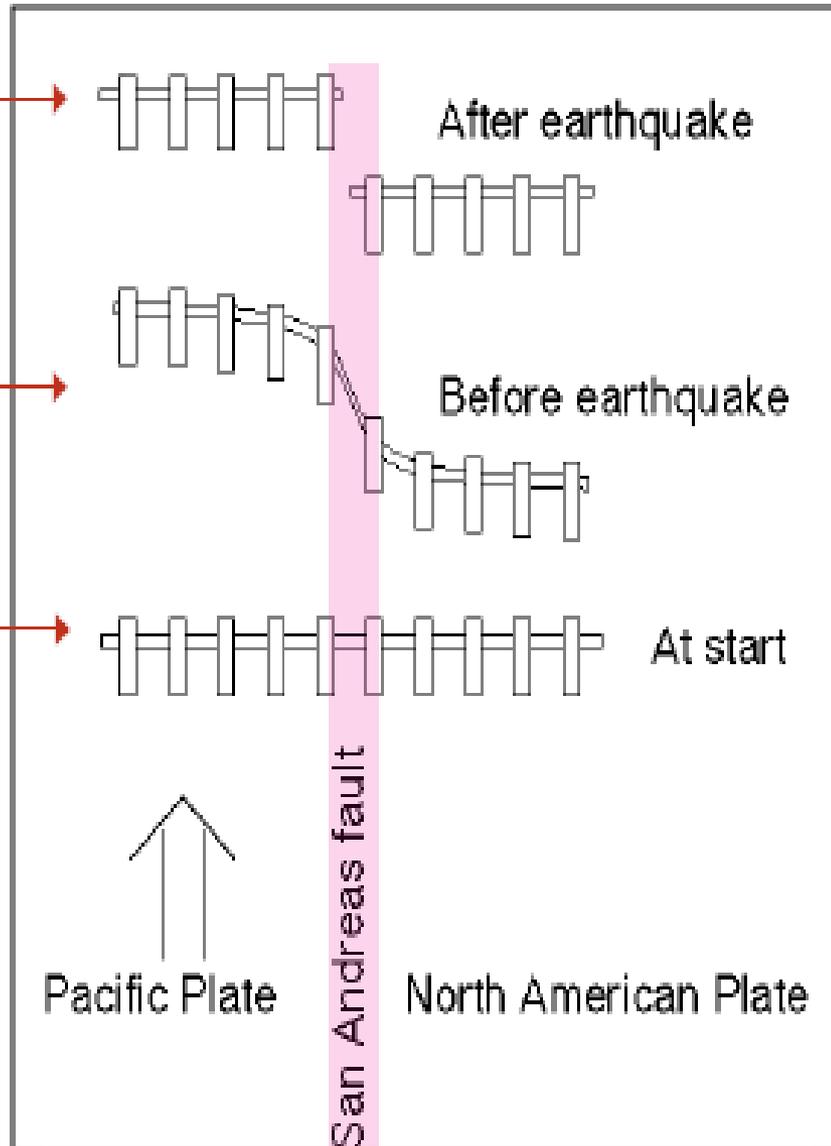


Two variables affect damage during earthquake:

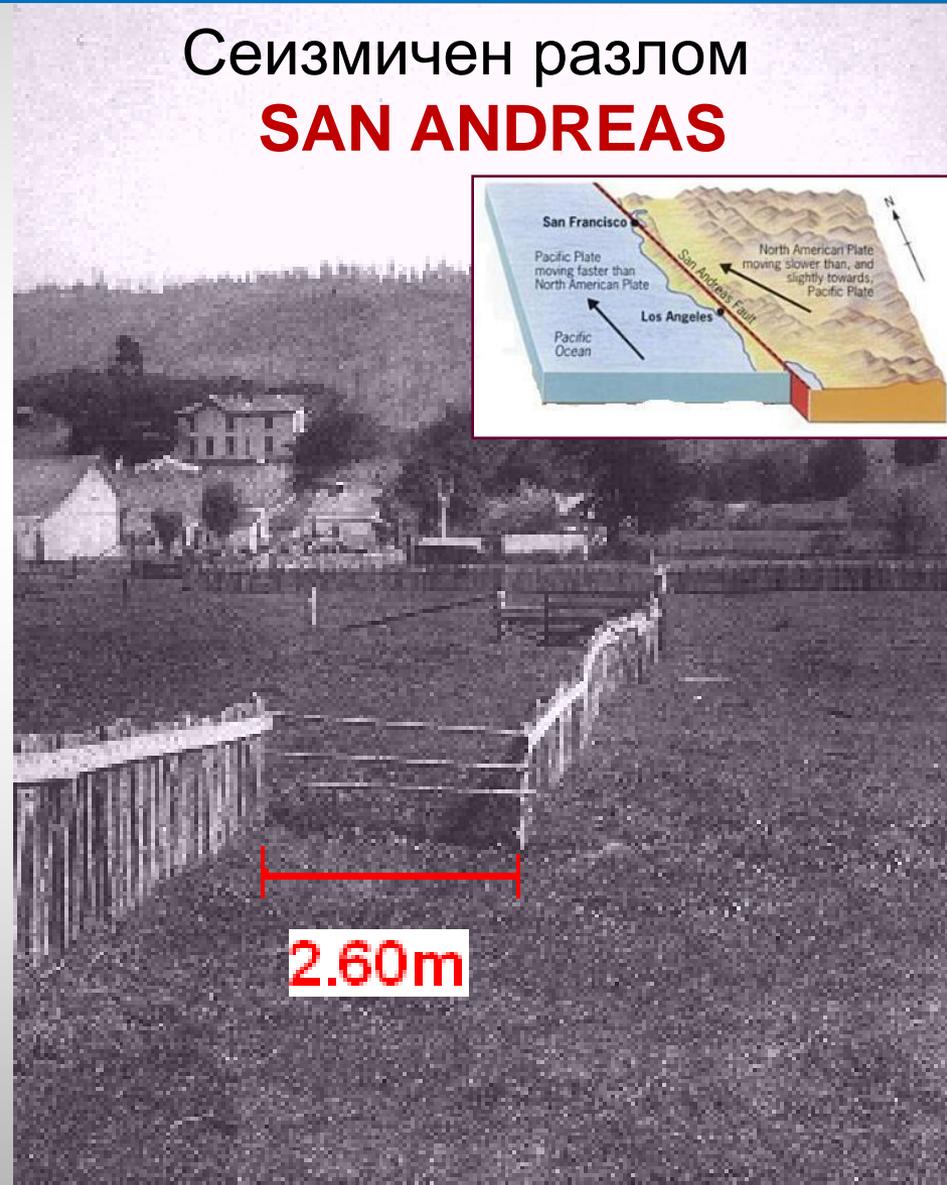
- 1) Intensity of shaking (*felt motion, not magnitude*)
- 2) engineering

III. ПРИМЕРИ НА РАЗЛОМИ (1-2)

(1-2)



Сеизмичен разлом **SAN ANDREAS**



III. ПРИМЕРИ НА РАЗЛОМИ

(2-2)

Земетресение в Южная Осетия, 1991 г. Свличане на 30 млн мЗ.

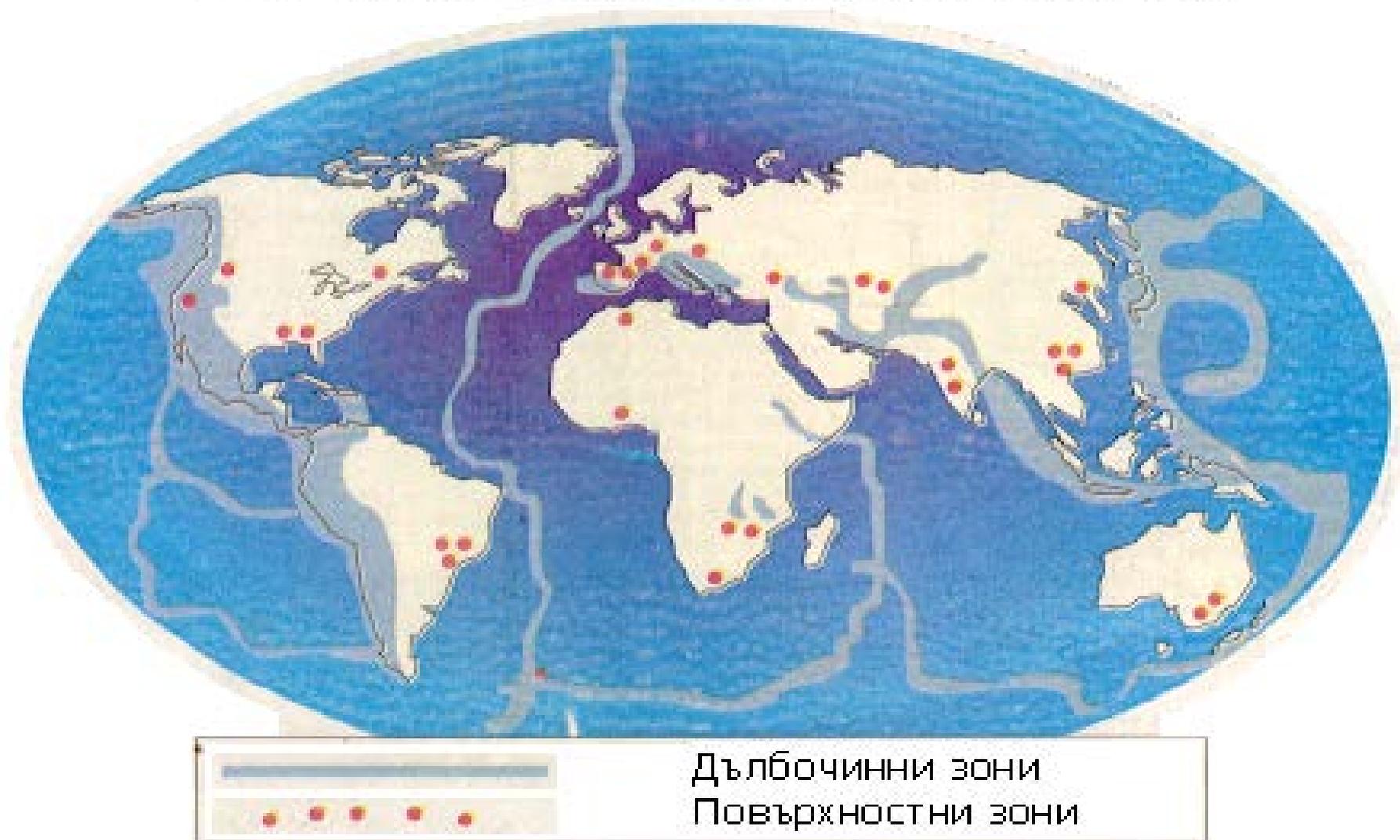


Сеизмичен разлом.
Земетресение в Алтай 2003 г.,

IV. СЕИЗМИЧНА ОПАСНОСТ

(1-7)

1. РАЗПРЕДЕЛЕНИЕ НА ЗЕМЕТРЪСНИТЕ ЗОНИ В СВЕТА



IV. СЕИЗМИЧНА ОПАСНОСТ

(2-7)

2. Сеизмична опасност (Средиземноморски район)

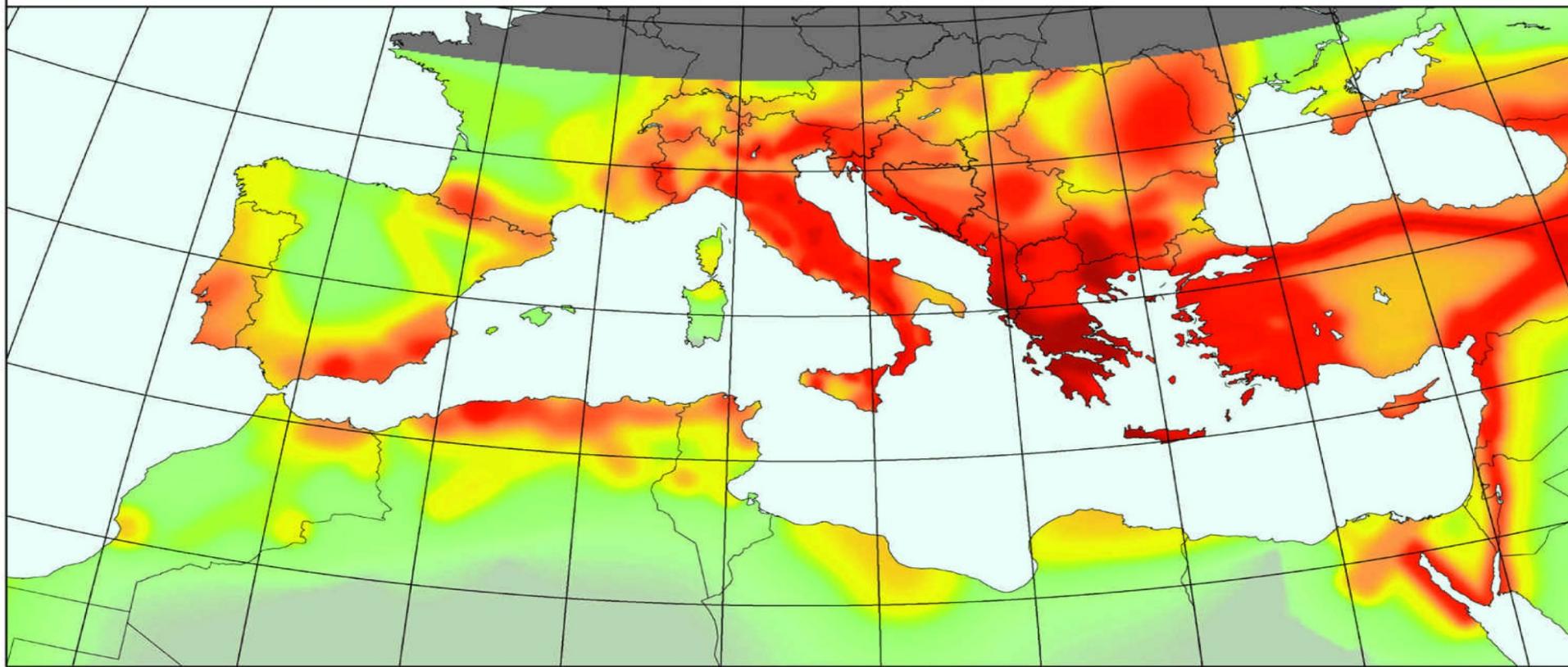
IGCP-382 SESAME

SEISMIC HAZARD MAP

ESC WG-SHA

10% PROBABILITY OF EXCEEDANCE IN 50 YEARS

Peak Horizontal Ground Acceleration (g)
stiff soil



IV. СЕИЗМИЧНА ОПАСНОСТ

(3-7)

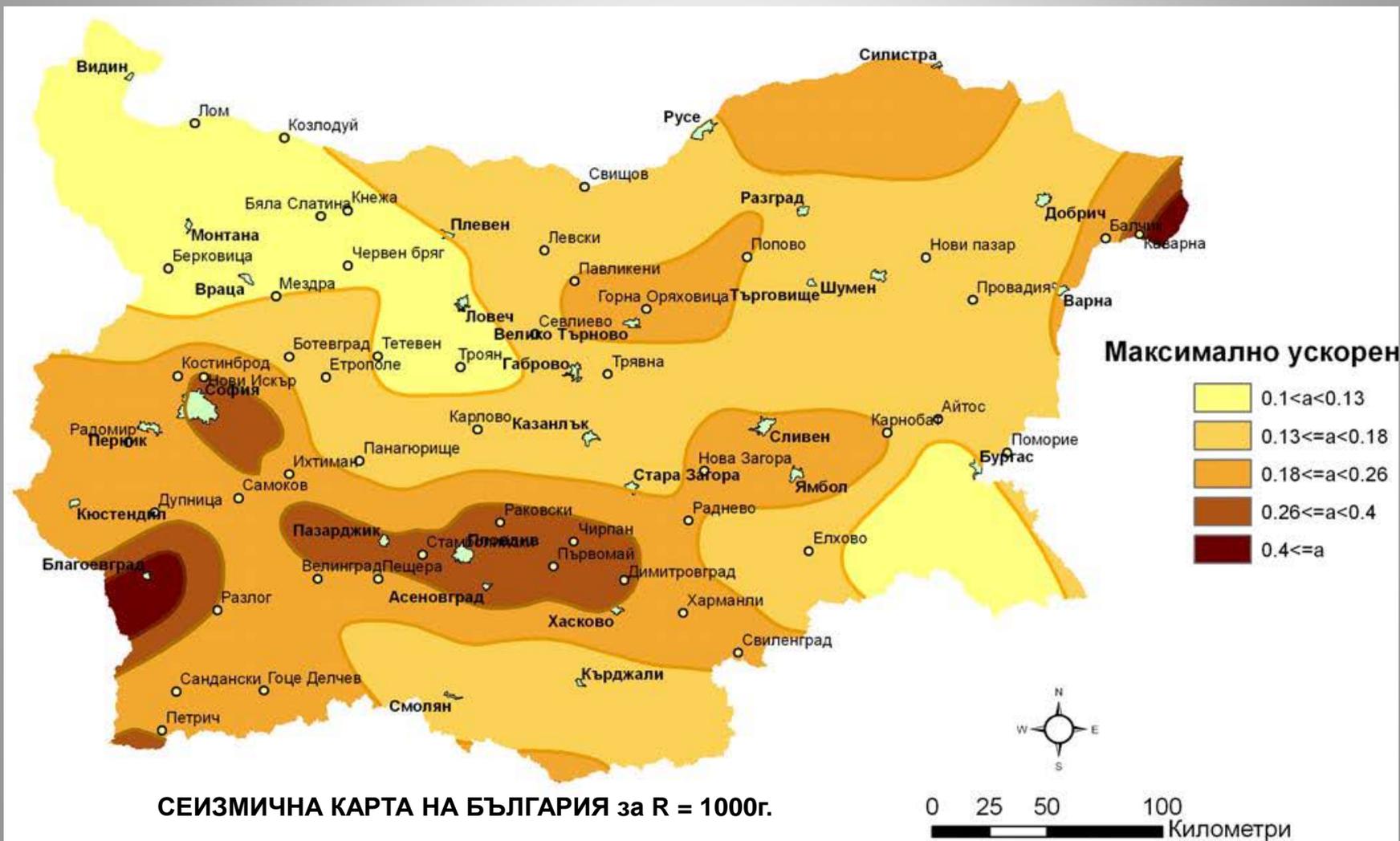
3. Европейска макросеизмична скала (EMS - 98)

| Short form | EUROPEAN MACROSEISMIC SCALE = EMS-98 | Richter Scale | Approx. Acceleration [cm/s ²] | Approx. Mercalli equivalent |
|-----------------------------|--|---------------|---|-----------------------------|
| I. Not felt | Not felt, even under the most favourable circumstances. | | | |
| II. Scarcely felt | Vibration is felt only by individual people at rest in houses, especially on upper floors of buildings. | | | |
| III. Weak | The vibration is weak and is felt indoors by a few people. People at rest feel a swaying or light trembling. | | | |
| IV. Largely observed | The earthquake is felt indoors by many people, outdoors by very few. A few people are awakened. The level of vibration is not frightening. Windows, doors and dishes rattle. Hanging objects swing. | <3.5 | < 1 | I |
| V. Strong | The earthquake is felt indoors by most, outdoors by few. Many sleeping people awake. A few run outdoors. Buildings tremble throughout. Hanging objects swing considerably. and glasses clatter together. The vibration is strong. Top heavy objects topple over. Doors and windows swing open or shut. | 3.5 | 2.5 | II |
| | | 4.2 | | III |
| VI. Slightly damaging | Felt by most indoors and by many outdoors. Many people in buildings are frightened and run outdoors. Small objects fall. Slight damage to many ordinary buildings. | 4.5 | 10 | IV |
| | | 4.8 | 25 | V |
| VII. Damaging | Most people are frightened and run outdoors. Furniture is shifted and objects fall from shelves in large numbers. Many ordinary buildings suffer moderate damage: small cracks in walls; partial collapse of chimneys. | 5.4 | 50 | VI |
| | | 6.1 | 100 | VII |
| VIII. Heavily damaging | Furniture may be overturned. Many ordinary buildings suffer damage: chimneys fall; large cracks appear in walls and a few buildings may collapse. | 6.5 | 250 | VIII |
| | | 6.9 | | IX |
| IX. Destructive | Monuments and columns fall or are twisted. Many ordinary buildings partially collapse and a few collapse completely. | 7.3 | 500 | X |
| X. Very destructive | Many ordinary buildings collapse. | 8.1 | 750 | XI |
| XI. Devastating | Most ordinary buildings collapse. | > 8.1 | 980 | XII |
| XII. Completely devastating | Practically all structures above and below ground are heavily damaged or destroyed. | | | |

IV. СЕИЗМИЧНА ОПАСНОСТ

(4-7)

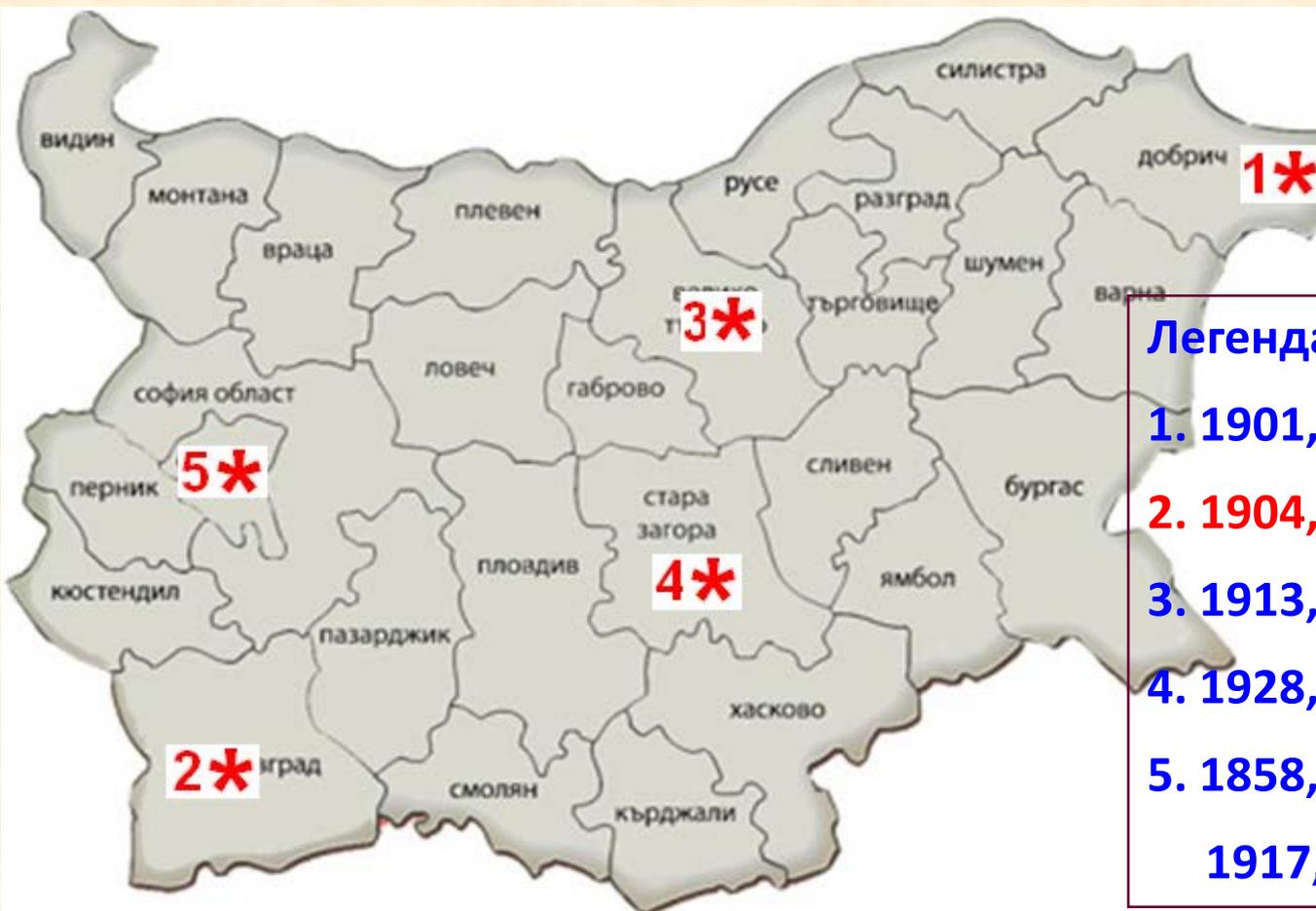
4. Карта на сеизмичната опасност за България



IV. СЕИЗМИЧНА ОПАСНОСТ

(5-7)

5. Силни земетресения в България



Легенда:

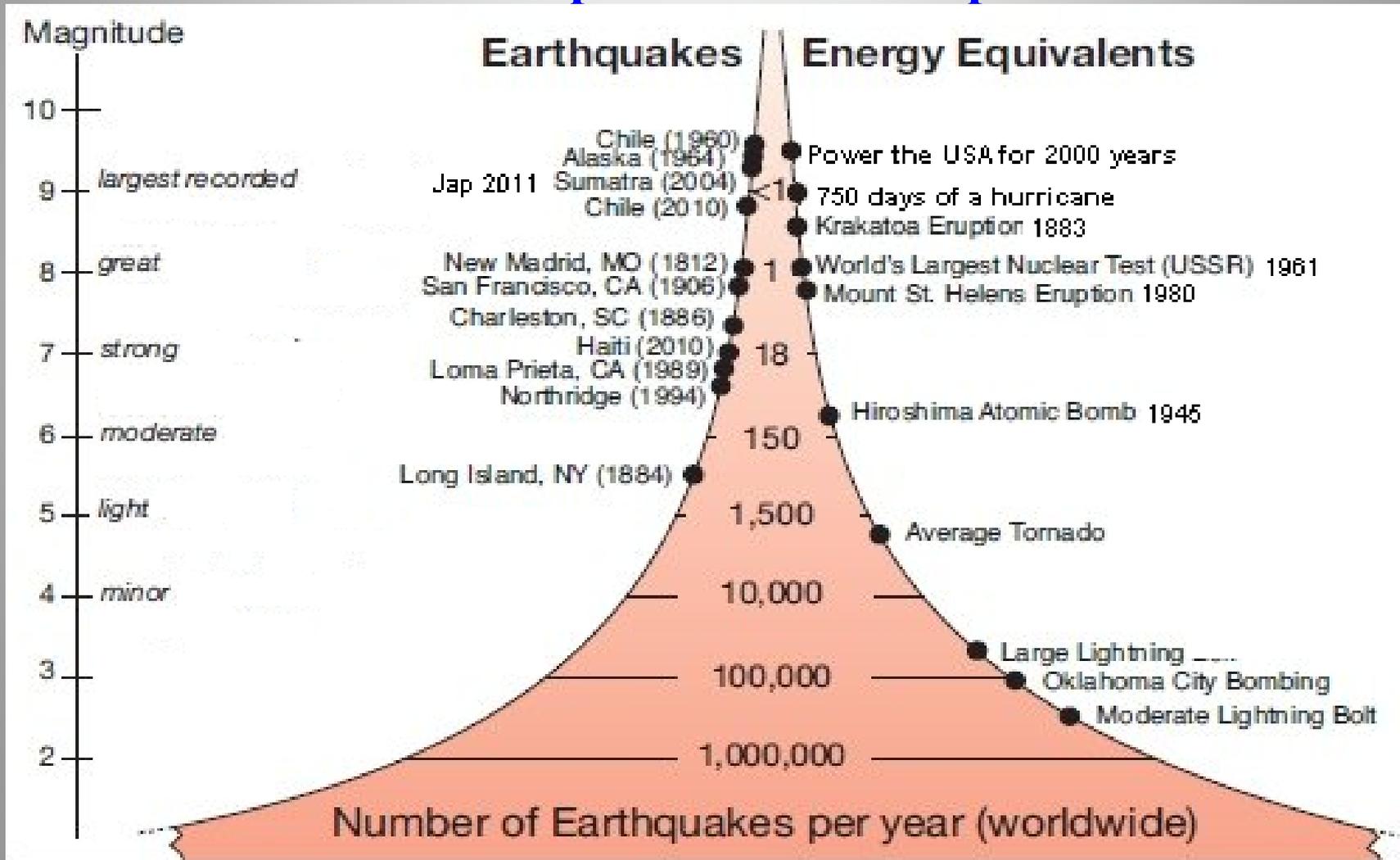
1. 1901, Шабла, $M=7.2$, $I=9-10$
2. 1904, Кресна, $M=7.8$, $I=10-11$
3. 1913, Г.Орях., $M=7.0$, $I=9-10$
4. 1928, Чирпан, $M=7.0$, $I=9-10$
5. 1858, София, $M=6.6$, $I=9-10$
1917, София, $M=5.2$, $I=7-8$

IV. СЕИЗМИЧНА ОПАСНОСТ

(6-7)

6. Ще има ли земетресение (СИЛНО) у нас и кога?

Невъзможност за прогноза на земетресение!

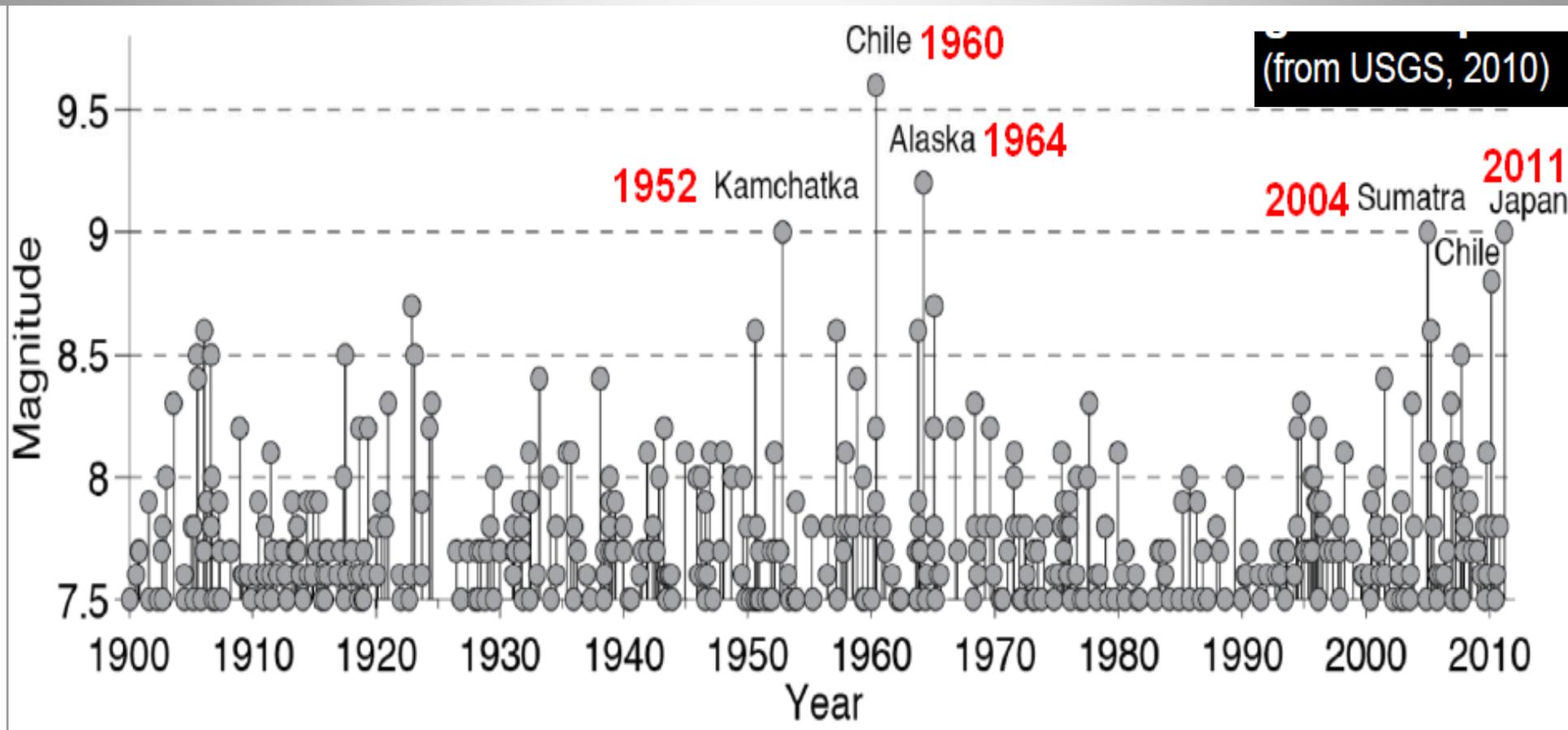


IV. СЕИЗМИЧНА ОПАСНОСТ

(6-7)

6. Ще има ли земетресение (СИЛНО) у нас и кога?

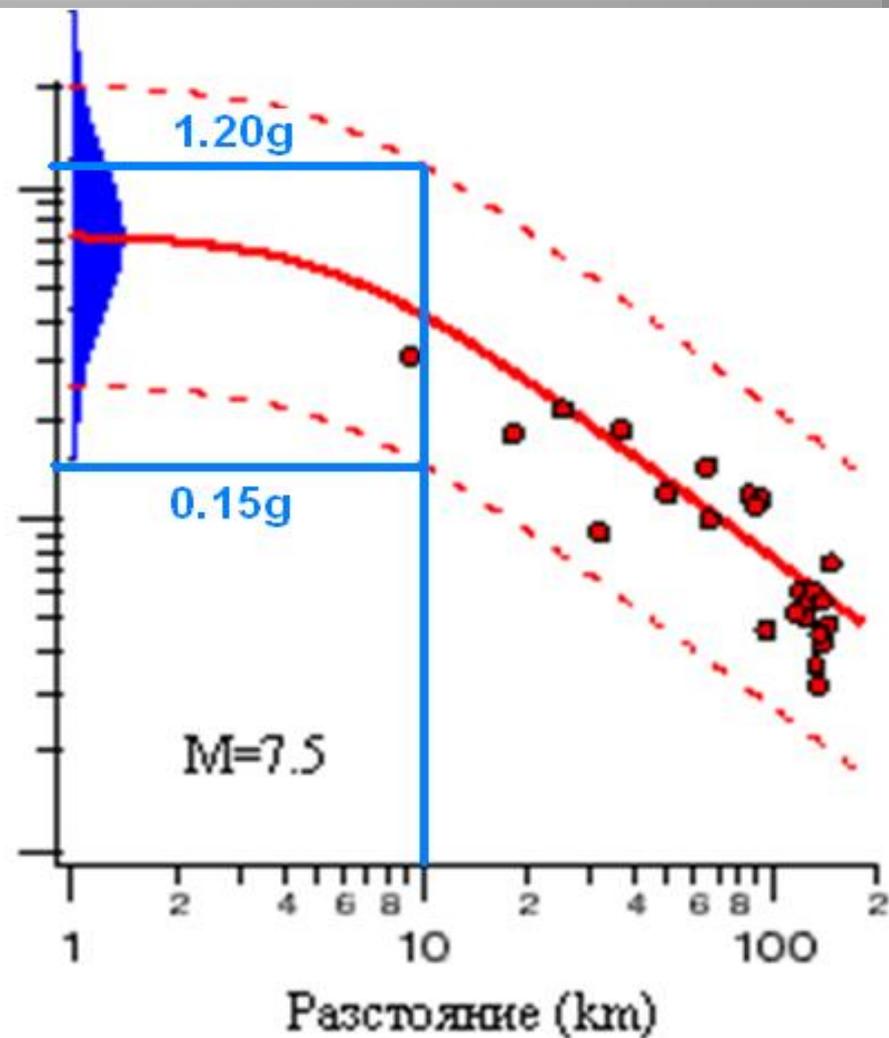
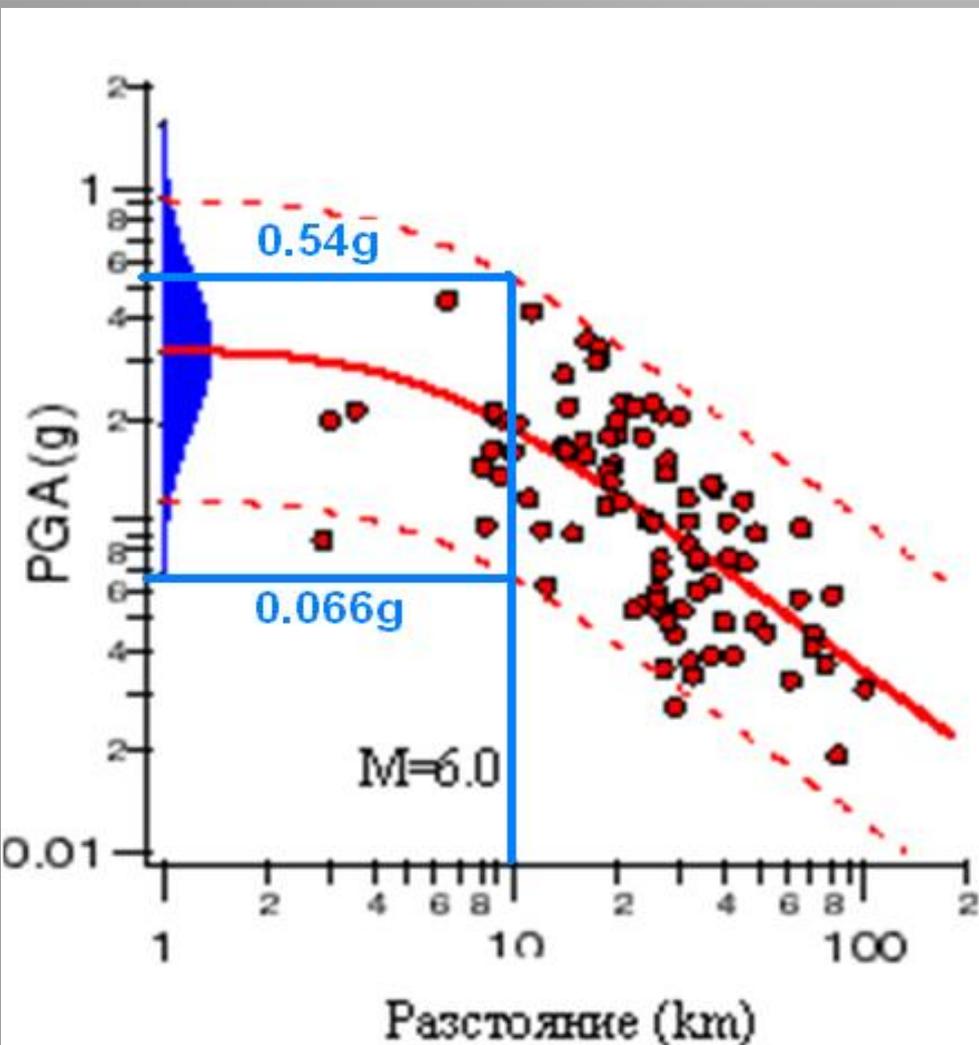
Невъзможност за прогноза на земетресение!



IV. СЕИЗМИЧНА ОПАСНОСТ

(7-7)

7) Неопределеност на сеизмичното въздействие



V. НИВА НА СЕИЗМИЧНОСТ ПРИ ИЗСЛЕДВАНЕ НА ЯЗОВИРНИТЕ СТЕНИ – ПРЕПОРЪКИ НА ICOLD

ICOLD Bulletin 72, 2010

SELECTING SEISMIC PARAMETERS FOR LARGE DAMS Guidelines:

1. Дефинирани са две нива на земетресения:

▶ **Operating Basis Earthquake (OBE)** - изисква по-скоро икономическа обосновка при избора му;

▶ **Safety Evaluation Earthquake (SEE)** - при стени с тежки последствия при евентуална катастрофа, се дефинира като:

максимално възможното (при детерминистична оценка)

или

с период на повторение от около 10000 години
(при вероятностна оценка).

2. От методологична гледна точка няма разлика при избора на сеизмичното ниво за проектирането на нови язовирни стени или при проверката на сеизмичната сигурност на стени в експлоатация.

*****ЕС 8 – не третира язовирни стени; R = 145г, 475г.**

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ICOLD (2014) “Selecting Seismic Parameters for Large Dams, Guidelines”, *Bulletin 148, Committee on Seismic Aspects of Dam Design, International Commission on Large Dams (ICOLD), Paris.*

Jyr-Ching Hu(2013), *Mechanics of faulting* , Dept. Geosciences National Taiwan University, *MEF, 2013*

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Д.Солаков, С.Симеонова Земетръсна опасност и намаляване на сеизмичния риск за България.