EARTHQUAKE DISASTERS IN INDIA

MANAGEMENT AND MITIGATION MEASURES

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OVERVIEW

- Introduction
- Summary of past earthquakes
- Integrated disaster management
  - Research
  - Promotion of retrofitting
  - Awareness
- Conclusions

PART I

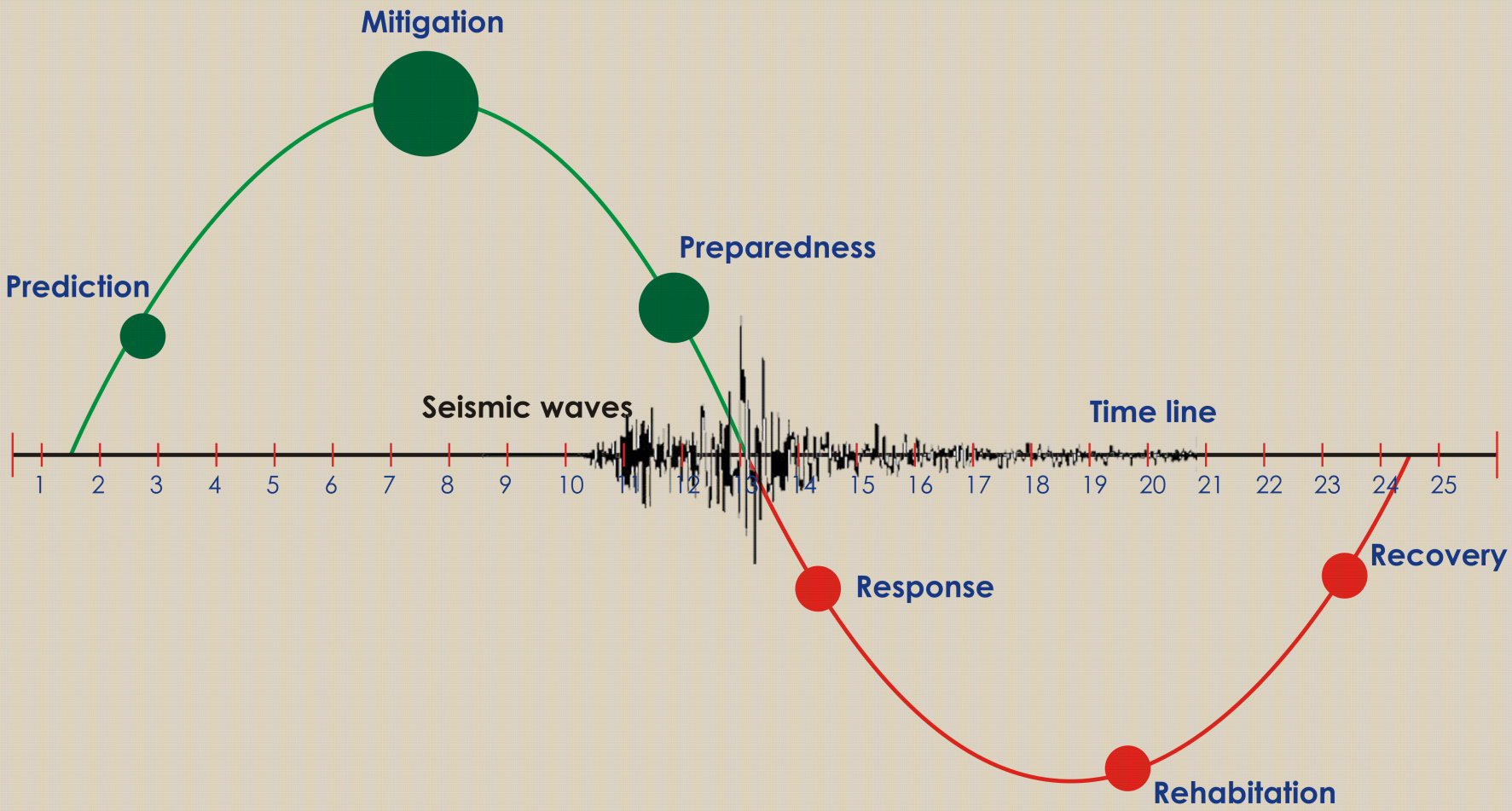
Introduction

NATURAL DISASTERS

- Earthquakes
  - liquefaction
  - **tsunami**
  - landslide
- Volcano
- Fire
- Floods
- Cyclone
- Drought

Can we predict an earthquake?

- Prediction of Size
- Prediction of place
- Prediction of time
- It is possible to estimate where big earthquakes are likely in the next 50 to 100 years, based on geological investigations and the historical record of earthquakes.
- However, it is not yet possible to accurately predict the time and location of the next earthquake.
- A very small number of earthquakes have been successfully predicted. The most notable success was near Haicheng, China in 1975, where 90,000 people were evacuated a few hours before an earthquake that destroyed 90 percent of the buildings.


Mitigation
Preparedness
Prediction
Seismic waves
Time line
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Response
Recovery
Rehabitation

EARTHQUAKES

- There is no way that one can stop earthquake. We should learn to live with it.
- These natural calamities cause intensive loss to property and life.
- Property loss can be recovered to some extent but life loss cannot.
- Life loss is mainly due to structural failure.
- It is very important to know that when and how the structure fails.

- Latur sep 1993 4:00 am M6.2 10,000 people died because they are inside home
- Northridge 1995 morning M7.9 30 people because they were inside

- 1960 30% developed 70% developing
- 2000 1% developed 99% developing

An earthquake is essentially a sudden and transient motion or series of motions of the earth's surface originating in a limited underground region, due to disturbance of the elastic equilibrium of the rock mass and spreading from there in all directions.

Causes

- Tectonic activity
- Volcanic activity
- Land-slides
- Bursting in mines
- Nuclear explosions

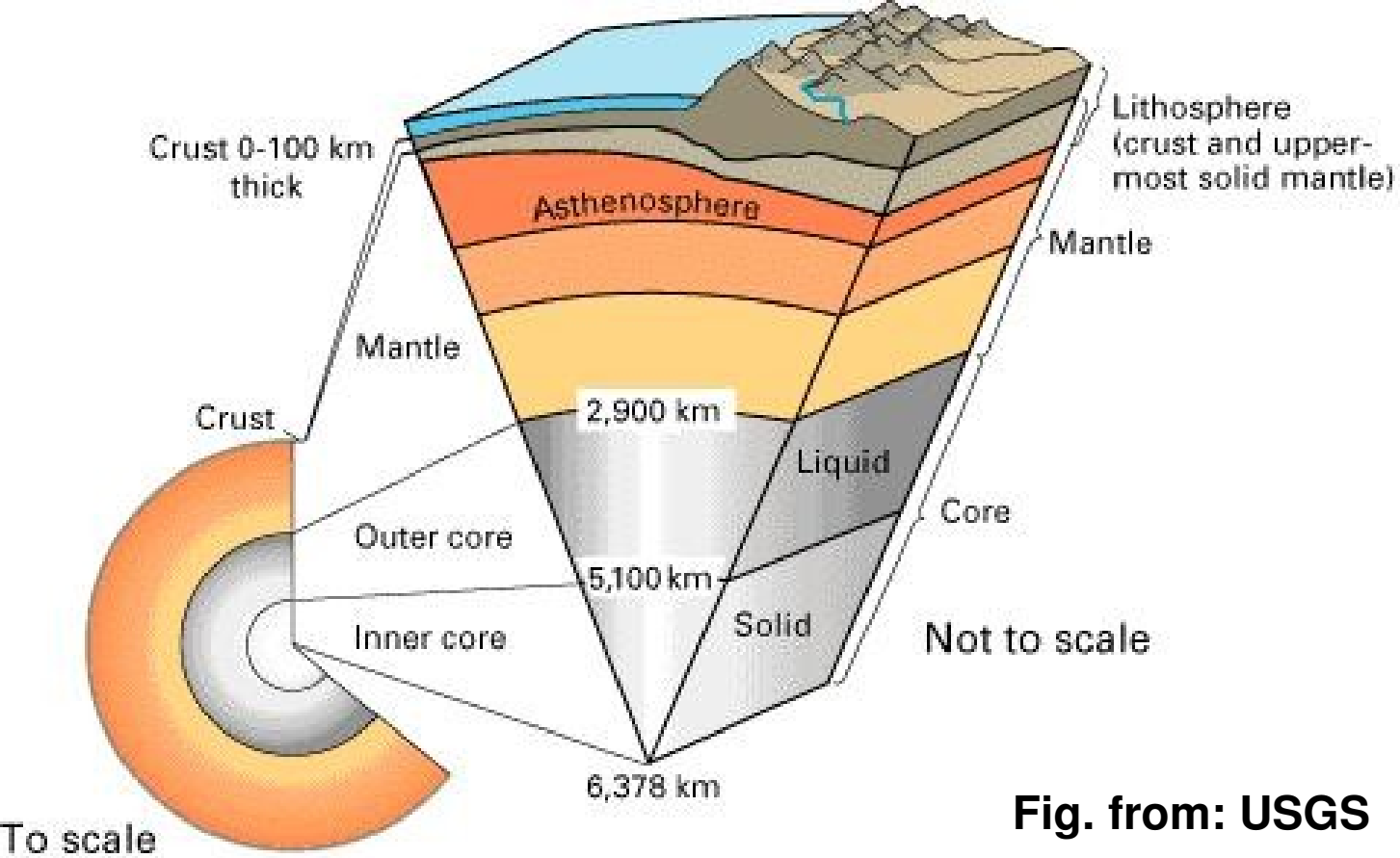


Fig. from: USGS

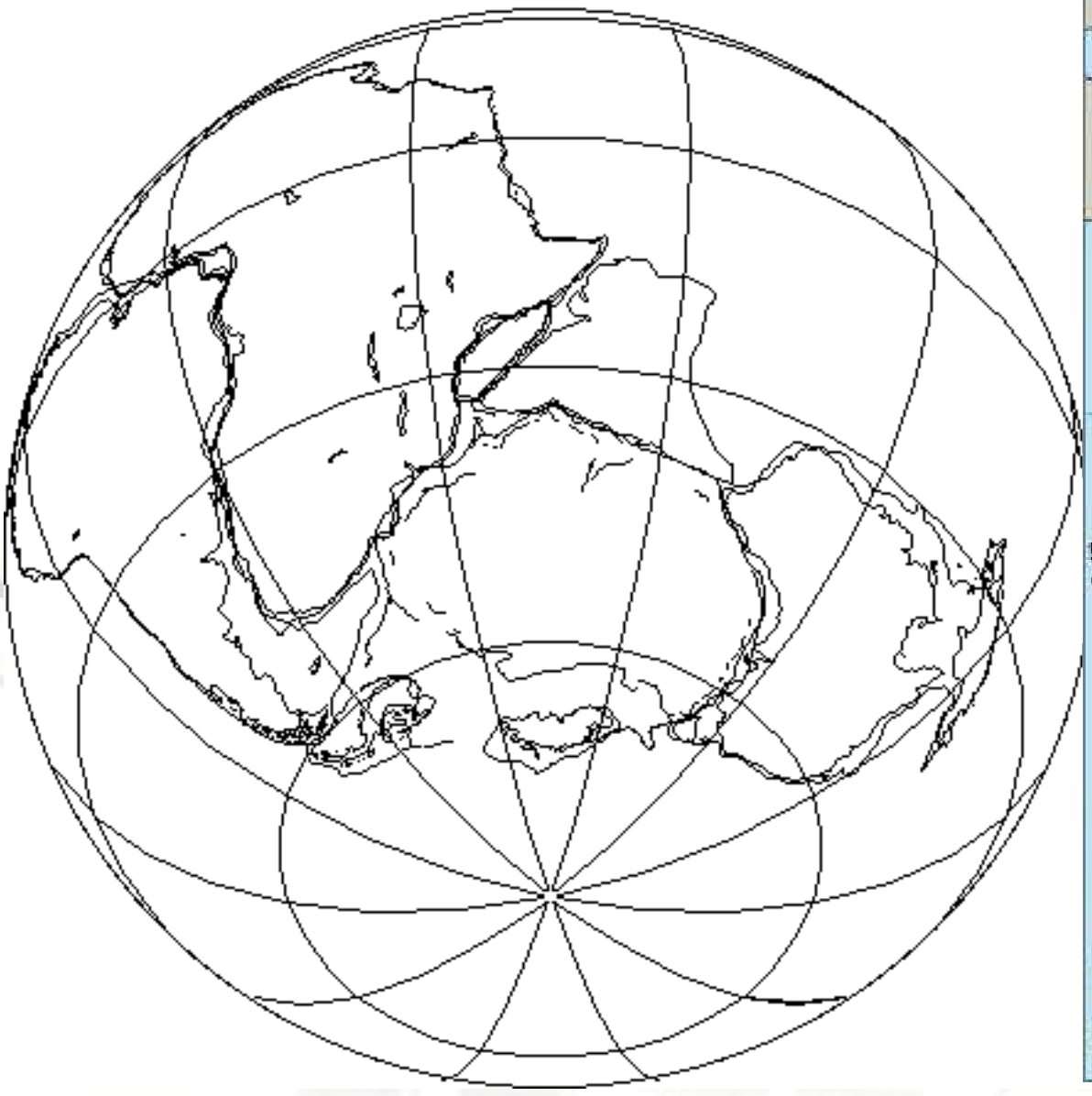
SOME FACTS

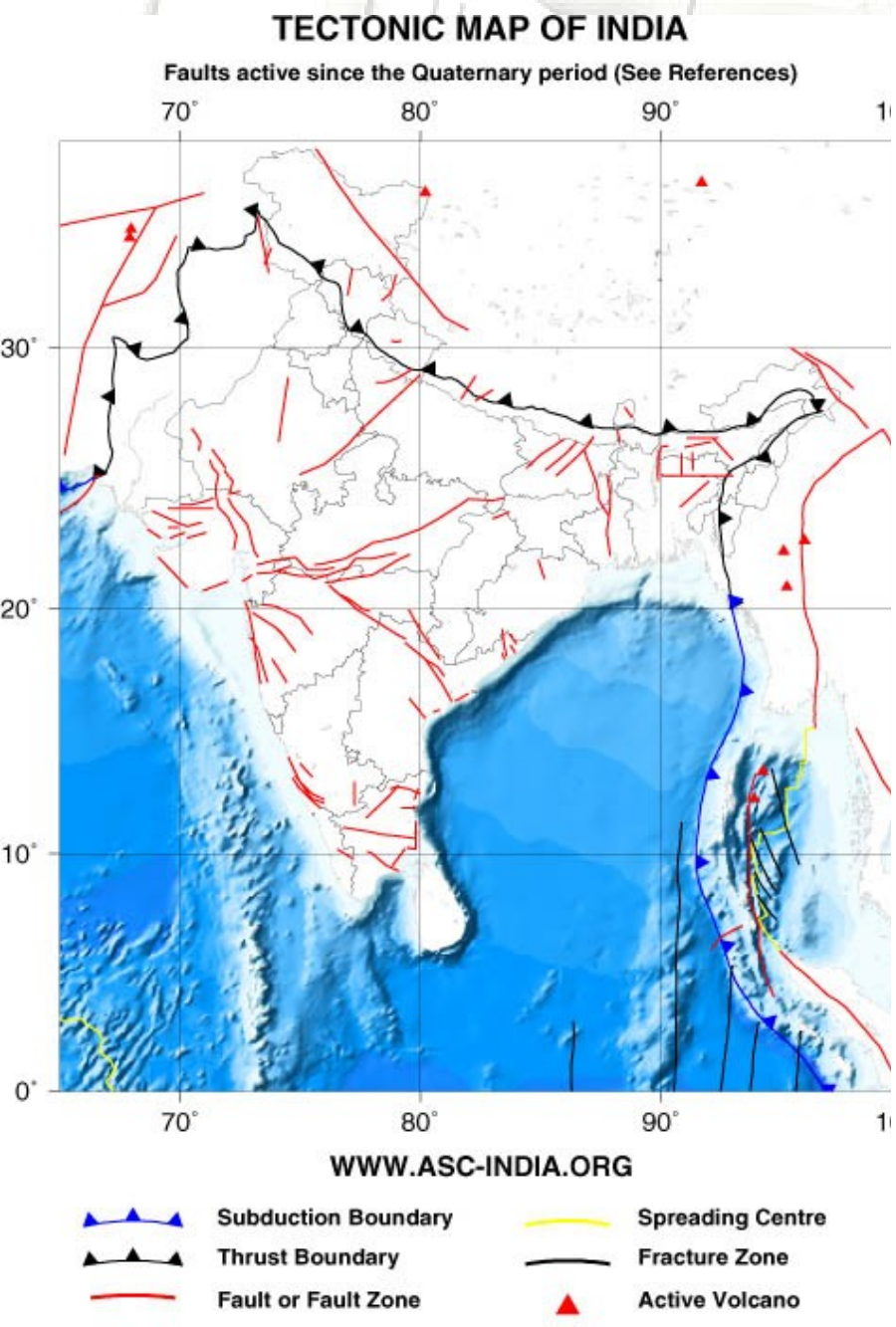
Age 4.5 billion years

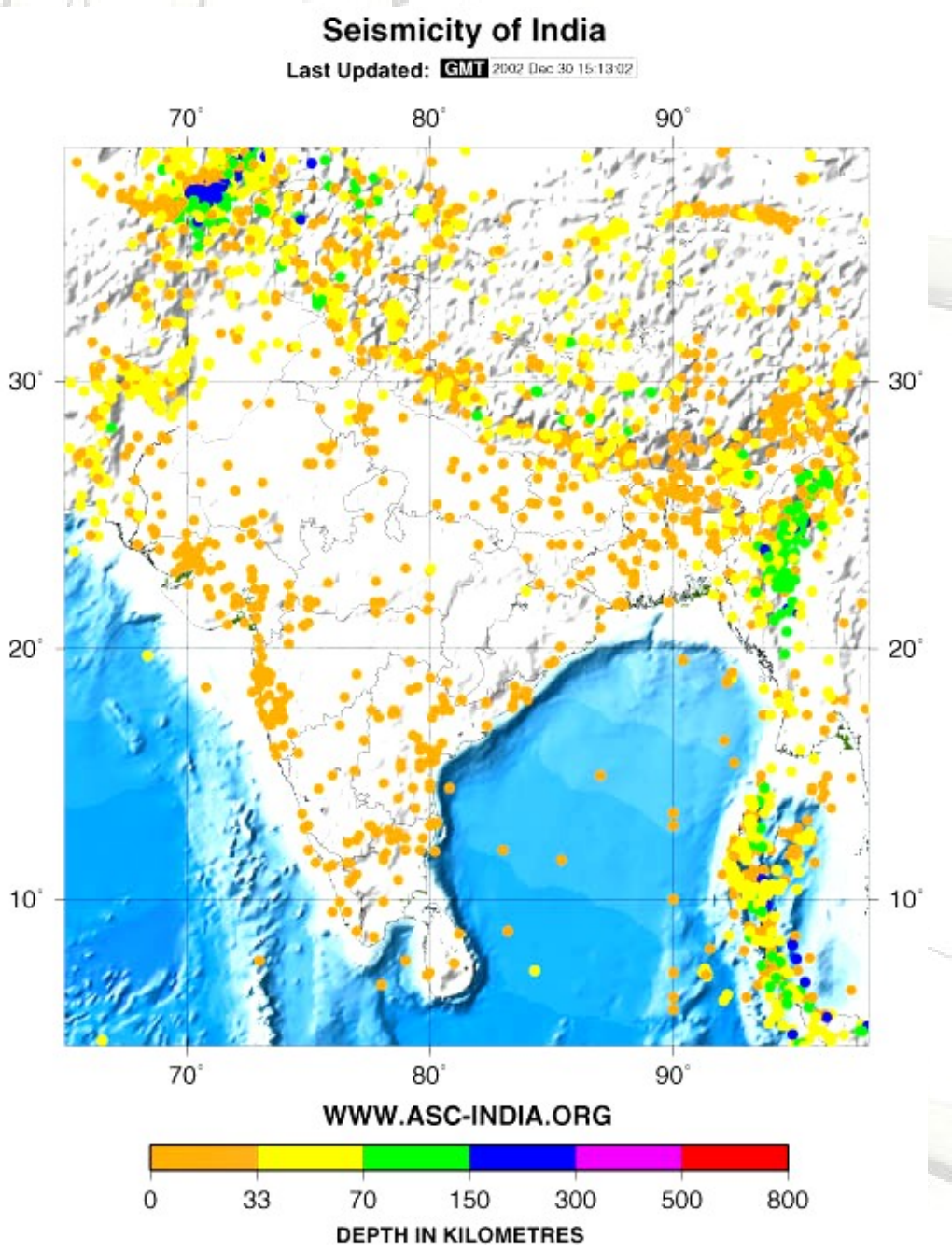
Radius 6370 km

Temperature: 3870^{o}c (20^{0}/km)

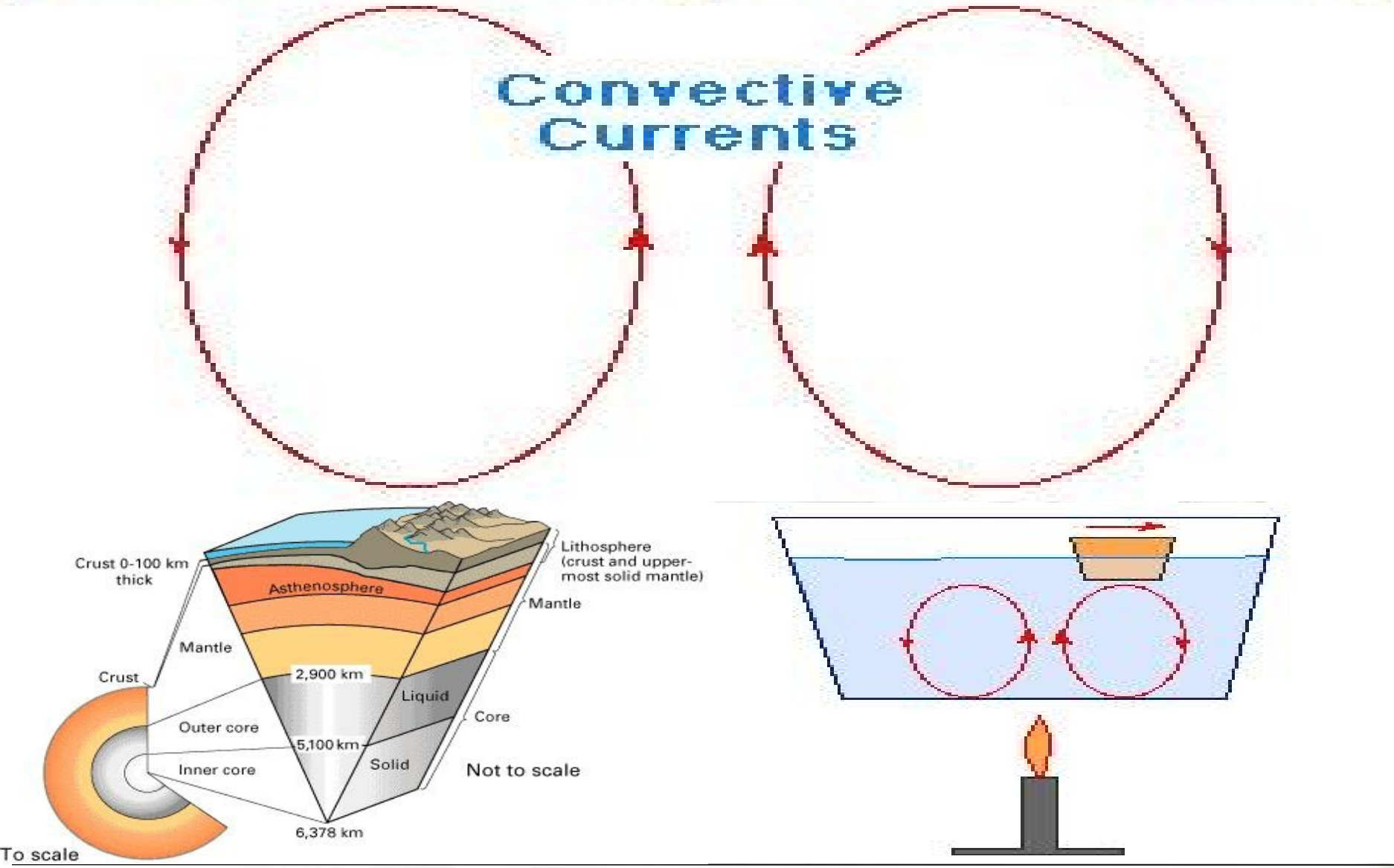
CONTINENTAL DRIFT




TECTONIC MAP OF INDIA
Faults active since the Quaternary period (See References)
70°
80°
90°
30°
20°
10°
0°
WWW.ASC-INDIA.ORG
Subduction Boundary
Thrust Boundary
Fault or Fault Zone
Spreading Centre
Fracture Zone
Active Volcano


Seismicity of India
Last Updated: GMT 2002 Dec 30 15:13:02
70°
80°
90°
30°
20°
10°
WWW.ASC-INDIA.ORG
0
33
70
150
300
500
800
DEPTH IN KILOMETRES

Plates of the Lithosphere



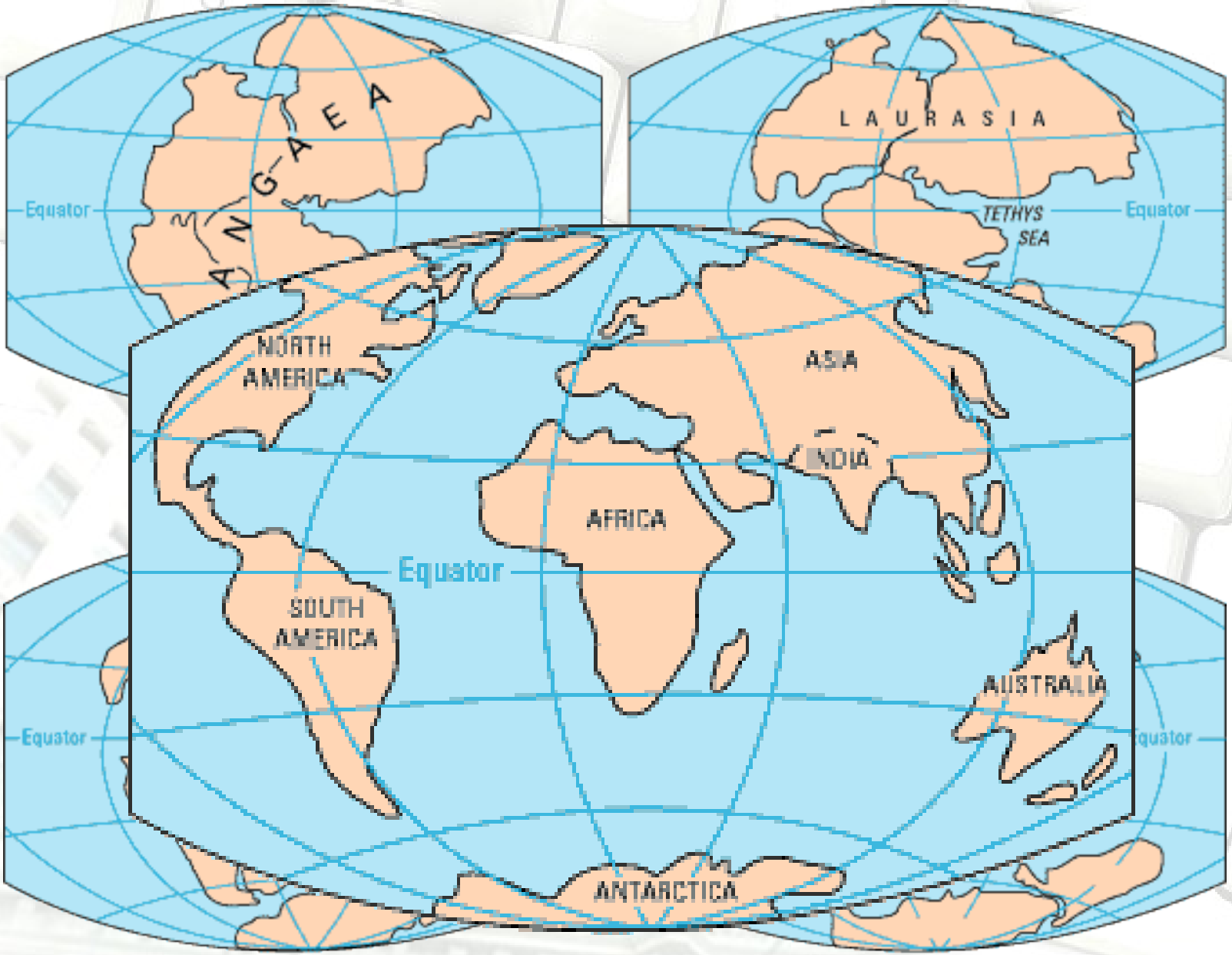
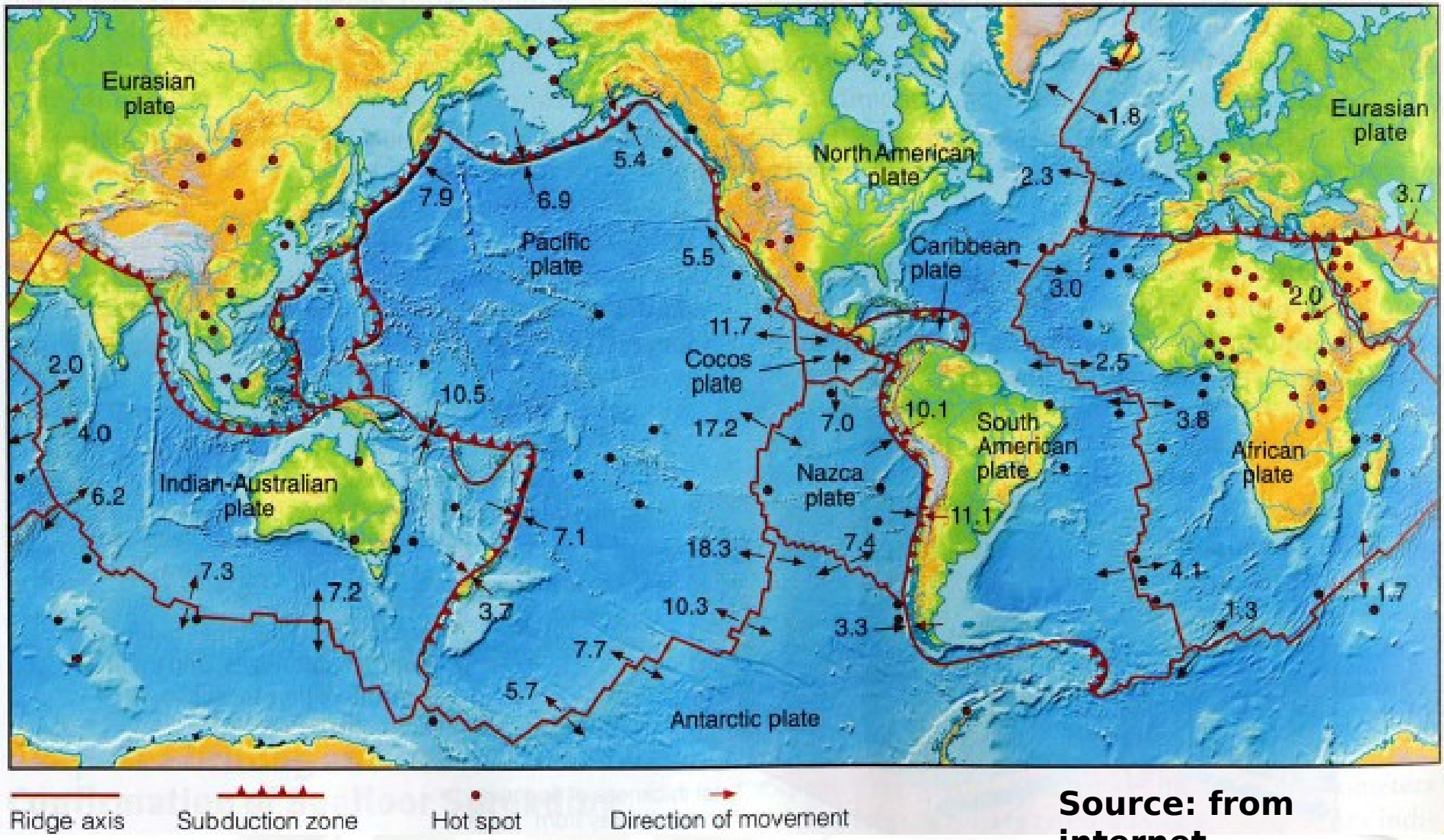


Fig. from: USGS

Rates of Plate Motion



Source: from internet

FREQUENCY OF EARTHQUAKE OCCURRENCE

M			
	> 8		2
7	-	7.9	20
6	-	6.9	100
5	-	5.9	3000
4	-	4.9	15,000
3	-	3.9	>100,000

From: Bolt, B.

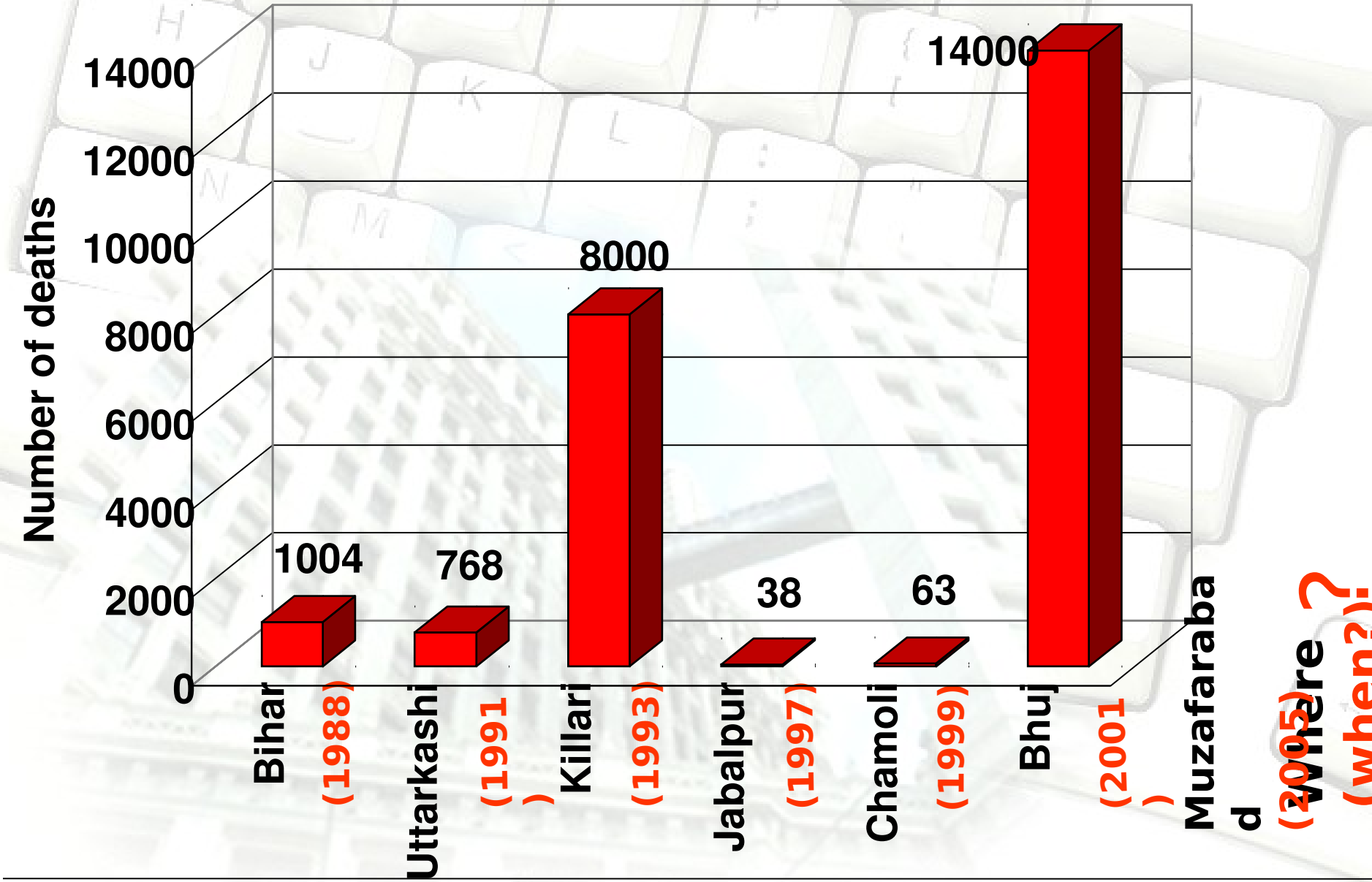
PART III

Summary of past earthquakes

List of Significant Earthquakes in India and its Neighborhood

DATE	EPICENTRE		LOCATION	MAGNITUDE
	Lat(Deg N)	Long(Deg E)		
1819 JUN 16	23.60	68.60	KUTCH,GUJARAT	8.0
1869 JAN 10	25.00	93.00	NEAR CACHAR, ASSAM	7.5
1885 MAY 30	34.10	74.60	SOPOR, J&K	7.0
1897 JUN 12	26.00	91.00	SHILLONGPLATEAU	8.7
1905 APR 04	32.30	76.30	KANGRA, H.P	8.0
1918 JUL 08	24.50	91.00	SRIMANGAL, ASSAM	7.6
1930 JUL 02	25.80	90.20	DHUBRI, ASSAM	7.1
1934JAN 15	26.60	86.80	BIHAR-NEPALBORDER	8.3
1941 JUN 26	12.40	92.50	ANDAMAN ISLANDS	8.1
1943 OCT 23	26.80	94.00	ASSAM	7.2
1950 AUG 15	28.50	96.70	ARUNACHAL PRADESH-CHINA BORDER	8.5
1956 JUL 21	23.30	70.00	ANJAR, GUJARAT	7.0
1967 DEC 10	17.37	73.75	KOYNA, MAHARASHTRA	6.5
1975 JAN 19	32.38	78.49	KINNAUR, HP	6.2
1988 AUG 06	25.13	95.15	MANIPUR-MYANMAR BORDER	6.6
1988 AUG 21	26.72	86.63	BIHAR-NEPAL BORDER	6.4
1991 OCT 20	30.75	78.86	UTTARKASHI, UP HILLS	6.6
1993 SEP 30	18.07	76.62	LATUR-OSMANABAD, MAHARASHTRA	6.3
1997 MAY 22	23.08	80.06	JABALPUR,MP	6.0
1999 MAR 29	30.41	79.42	CHAMOLI DIST, UP	6.8
2001 JAN 26	23.40	70.32	BHUJ, GUJARAT	6.9

Casualties during past events



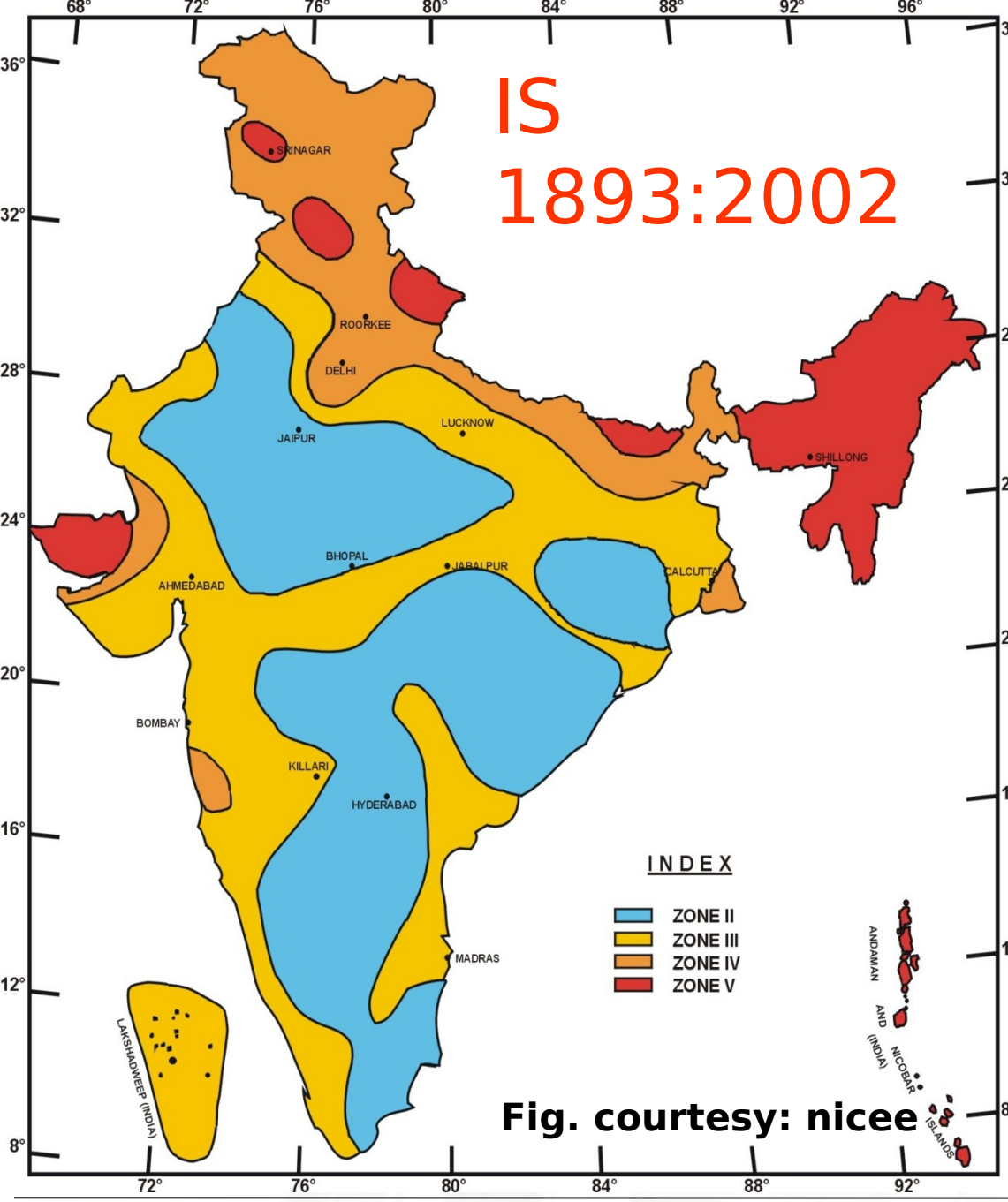


Fig. courtesy: nicee

More than 60 % area is earthquake prone.

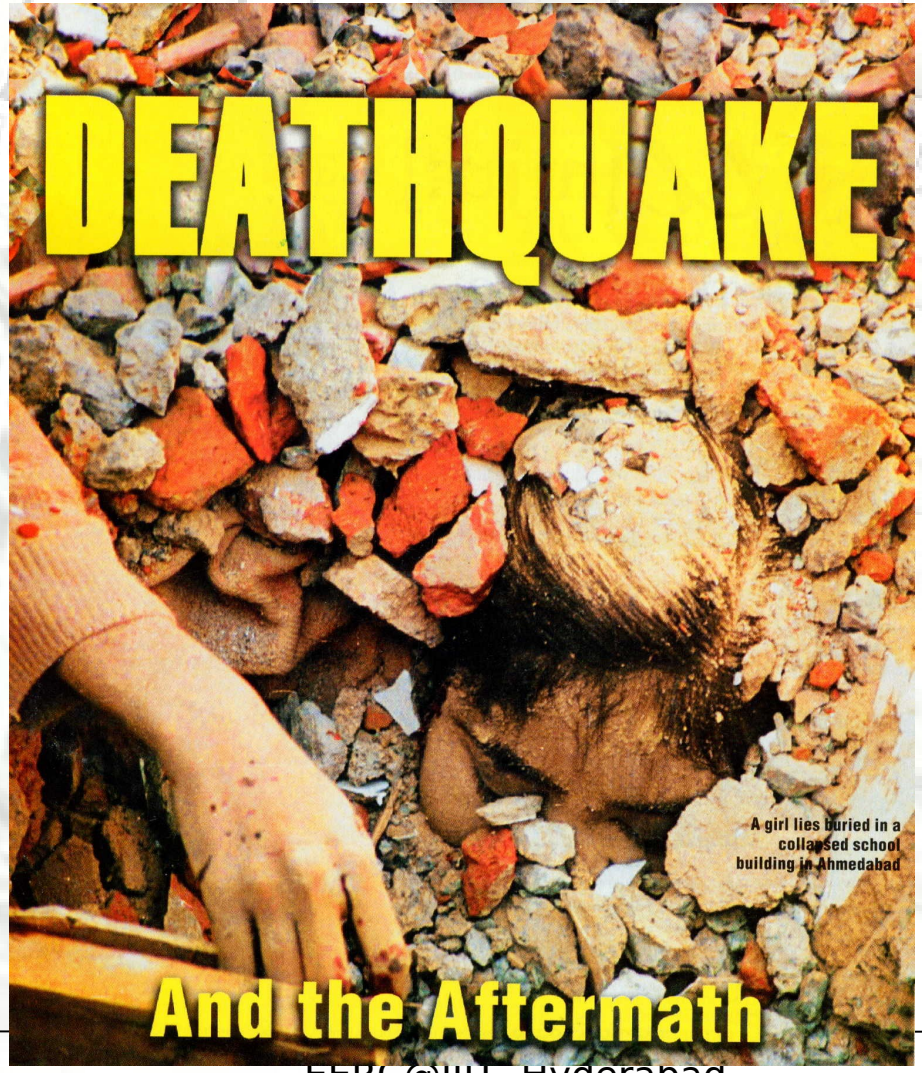
Zone V 12 %

Zone IV 18 %

Zone III 26 %

Zone II 44 %

A BRIEF OVERVIEW ON THE 26 JAN, 2001 BHUJ



BHUJ EARTHQUAKE

Date:	**26th Jan, 2001**
Magnitude:	**6.9 on Richter Scale**
Duration:	**110 Seconds**
Epicenter:	**Near Chaubari, 30 Kms from Bhachau**
Focal Depth:	**23.6 km**
Casualty:	**14,000**
Injured:	**167,000**

Satellite view of Kachchh

PERFORMANCE OF BUILDINGS

Common site destruction in meizoseismal area

Why the difference in damage pattern ?

Damage in Anjar situated on hill

Essentials of Earthquake Resistant Design

- Configuration
- Strength
- Stiffness
- Ductility

Extensive damage occurred in non-engineered structures

Many casualties occurred in stone masonry buildings

Large blocks piled up using weak bond

Out of plane failure of brick masonry walls

Soft bottom storey

Pan cake collapse

Surprise for common man:

Adjoining buildings with radically different performances

Poor reinforcement detailing

Insufficien
t detailing

Weak joint

Spalling of cover

Elevated water tanks performed well where as the adjacent buildings collapsed

Earlier too it was the same story only the places were different like Bihar, Uttarkashi, Killari, Jabalpur, Chamoli, etc.

- No social impact due to the previous events.
- More attention: Middle and upper middle class people affected.

REASONS FOR HIGH CASUALTY

- Increasing urbanization / higher densities
- Habitat into unsuitable vulnerable areas
- Poor constructions – no traditional skill
- Belief that it will not happen here
- Unauthorized vertical buildings
- Code is not mandatory
- Construction as such is governed by municipal bye-laws
- Seismic provisions are not incorporated yet

Post-disaster reactive approach to Pre-disaster pro-active approach

Problems after an earthquake

- Casualties
- Disruption of community
- Refugee camps
- Temporary shelters
- Psychological problems of people
- Demolition and disposal of collapsed structures
- Ill function of social and lifeline systems due to heavy demand
- Local economy and business interruption
- Problems during recovery and reconstruction
- and many more……

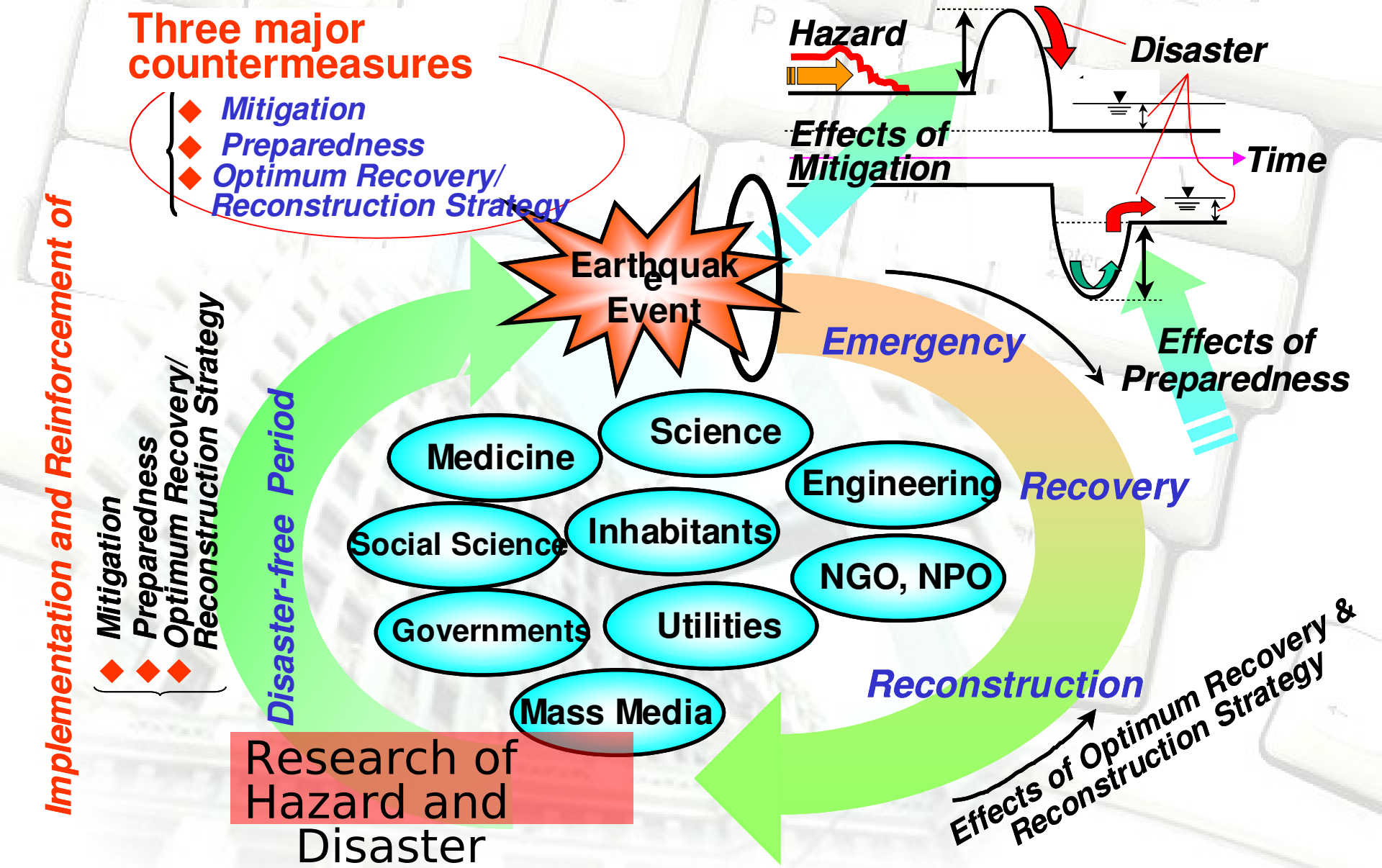
Time when the casualties were killed due to Kobe Earthquake (in Kobe City)

Time of death	No. of Casualties: by Medical Examiners		by Ordinary Doctors		Total Number
1/17 ~ 6:00	2,221	2,221 (91.9%)	719	719 (58.2%)	2,940 (80.5%)
~ 9:00	16	2,237 (92.6%)	58	777 (62.9%)	3,014 (82.6%)
~ 12:00	47	2,284 (94.5%)	61	838 (67.9%)	3,122 (85.5%)
~ 23:59	12	2,296 (95.0%)	212	1,050 (85.0%)	3,346 (91.6%)
unidentify	110	2,406 (99.6%)	84	1,134 (91.8%)	3,540 (97.0%)
1/18	5	2,411 (99.8%)	62	1,196 (96.8%)	3,607 (98.8%)
1/19		2,411 (99.8%)	13	1,209 (97.9%)	3,620 (99.2%)
1/20	2	2,413 (99.9%)	8	1,217 (98.5%)	3,630 (99.4%)
1/21	1	2,414 (99.9%)	6	1,223 (99.0%)	3,637 (99.6%)
1/22	1	2,415 (100.0%)	1	1,224 (99.1%)	3,639 (99.7%)
1/24		2,415 (100.0%)	1	1,225 (99.2%)	3,640 (99.7%)
1/25	1	2,416 (100.0%)	1	1,226 (99.3%)	3,642 (99.8%)
1/26		2,416 (100.0%)	2	1,228 (99.4%)	3,644 (99.8%)
1/27		2,416 (100.0%)	1	1,229 (99.5%)	3,645 (99.8%)
1/28		2,416 (100.0%)	1	1,230 (99.6%)	3,646 (99.9%)
2/4		2,416 (100.0%)	1	1,231 (99.7%)	3,647 (99.9%)
No record		2,416 (100.0%)	4	1,235 (100.0%)	3,651 (100.0%)
Total Number	2,416		1,235		3,651

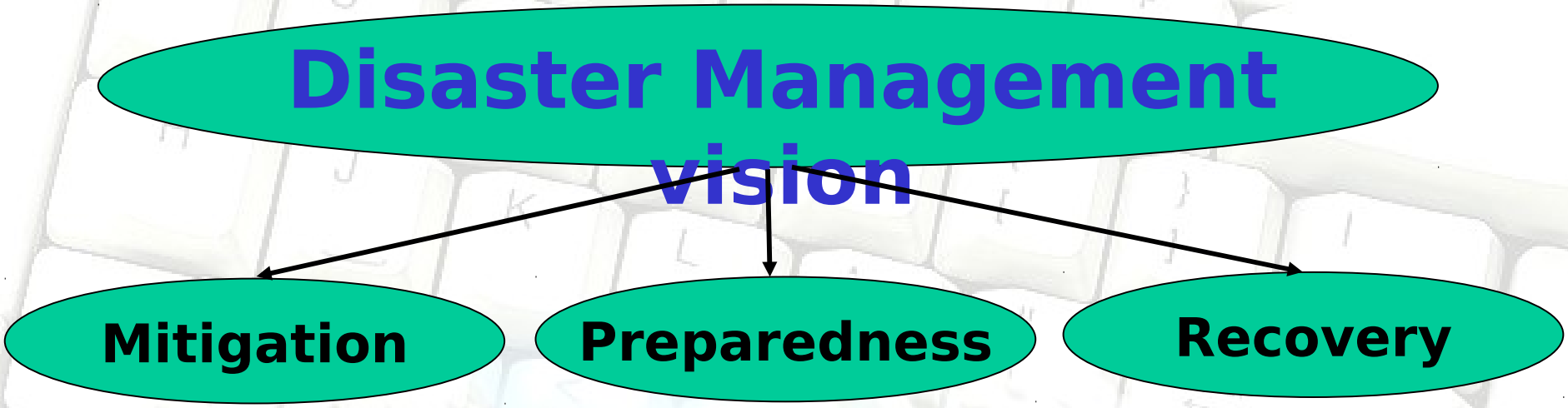
PART IV

Integrated disaster management

Integrated Earthquake Disaster Reduction System



Disaster Management vision



- Risk analysis
- Hazard assessment
- Vulnerability

- Awareness
- Warning
- Evacuation
- Disaster response plan

- Rescue
- Rehabilitation
- Reconstruction

Technology up-gradation rather than crisis management

Converting Research level Ideas to Application Products

Some Application areas

a) Building response during earthquake.

b) Furniture behavior.

c) Human evacuation behavior.

Promotion of retrofitting

System for promotion of retrofitting of existing pre-code revision structure

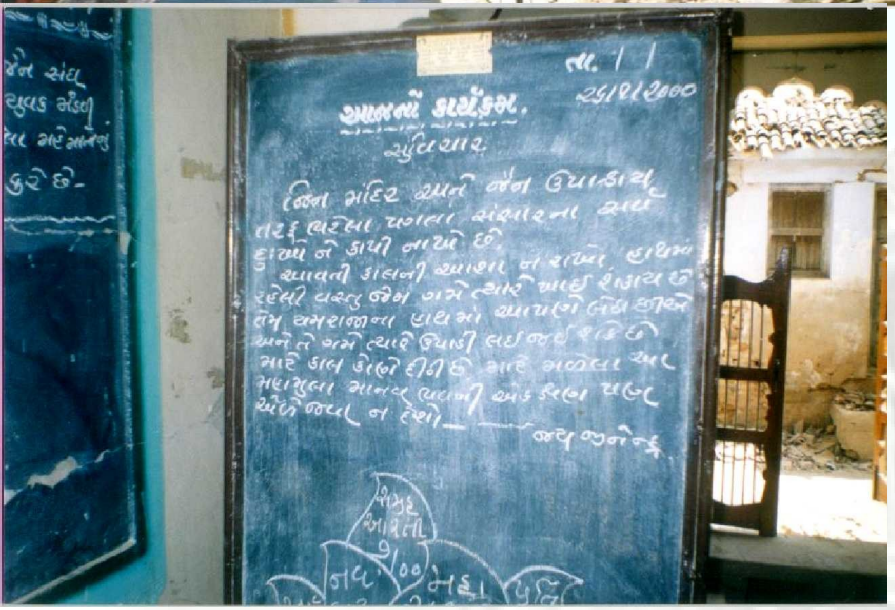
Who is responsible ?

- Scientists?
- Engineers ?
- Architects ?
- Builders ?
- Bureaucracy ?
- Legislation ?
- People ?

Earthquake itself never kills people, it's the badly planned and constructed buildings that kill.

CHAIN OF EARTHQUAKE SAFETY

- Sensitization of public and the decision makers to earthquake safety
- Mandatory nature of earthquake codes
- Technical competence for design and construction
- Enforcement mechanisms
- A vibrant academic system



"Do not keep too many hopes for future.

Things which are in your hand, you can eat them as and when you want.

Similarly, our life is in the hands of YAMRAJ and he can have it whenever he wants.

Who can see the future?

So precious is human birth, not a single moment of it should be wasted"

Jai Jinendra

CONCLUSION

Let us all work
aiming to achieve

A Disaster Resistant
India

Thank you

Ramancharla Pradeep Kumar