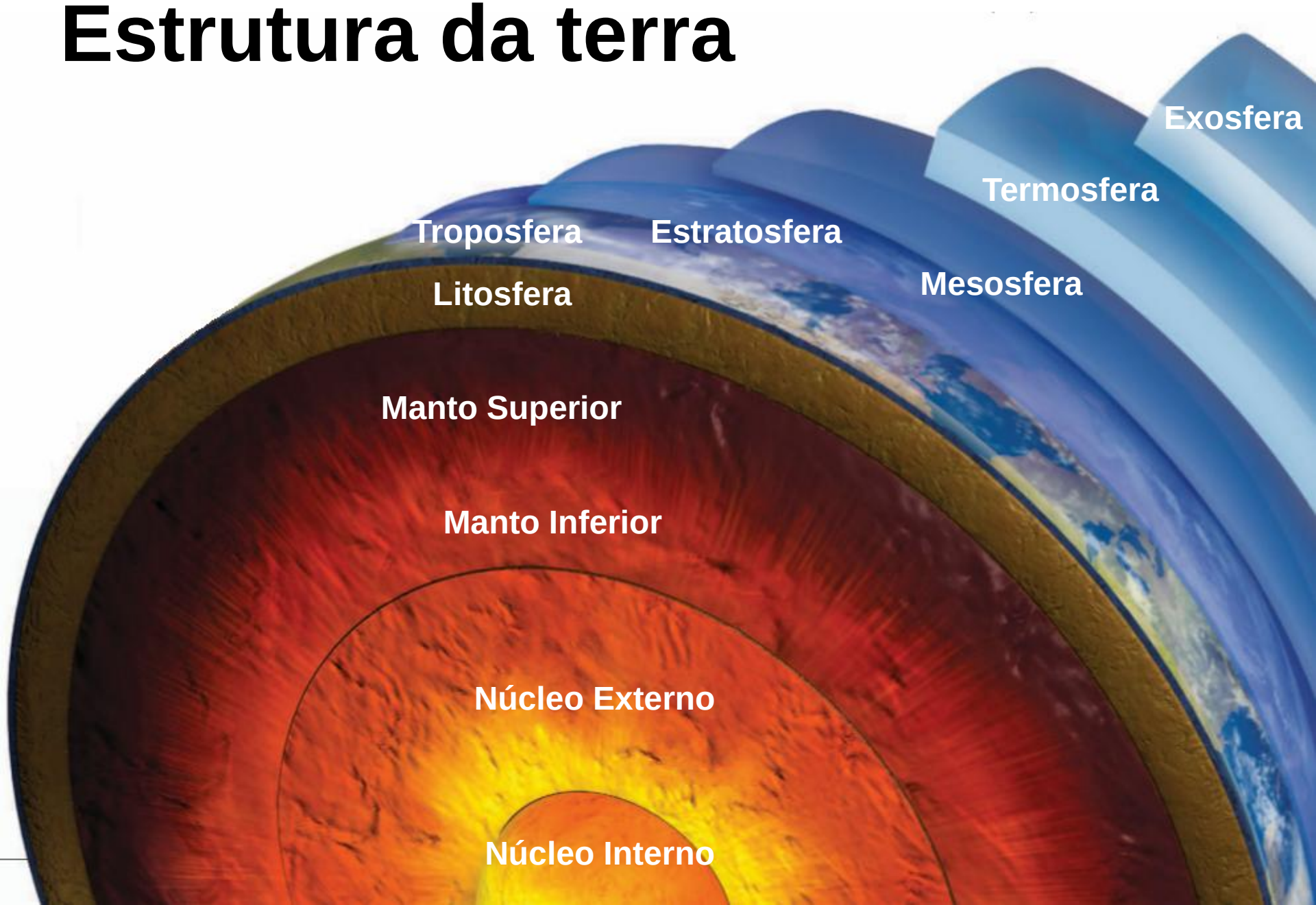
IAG - USP

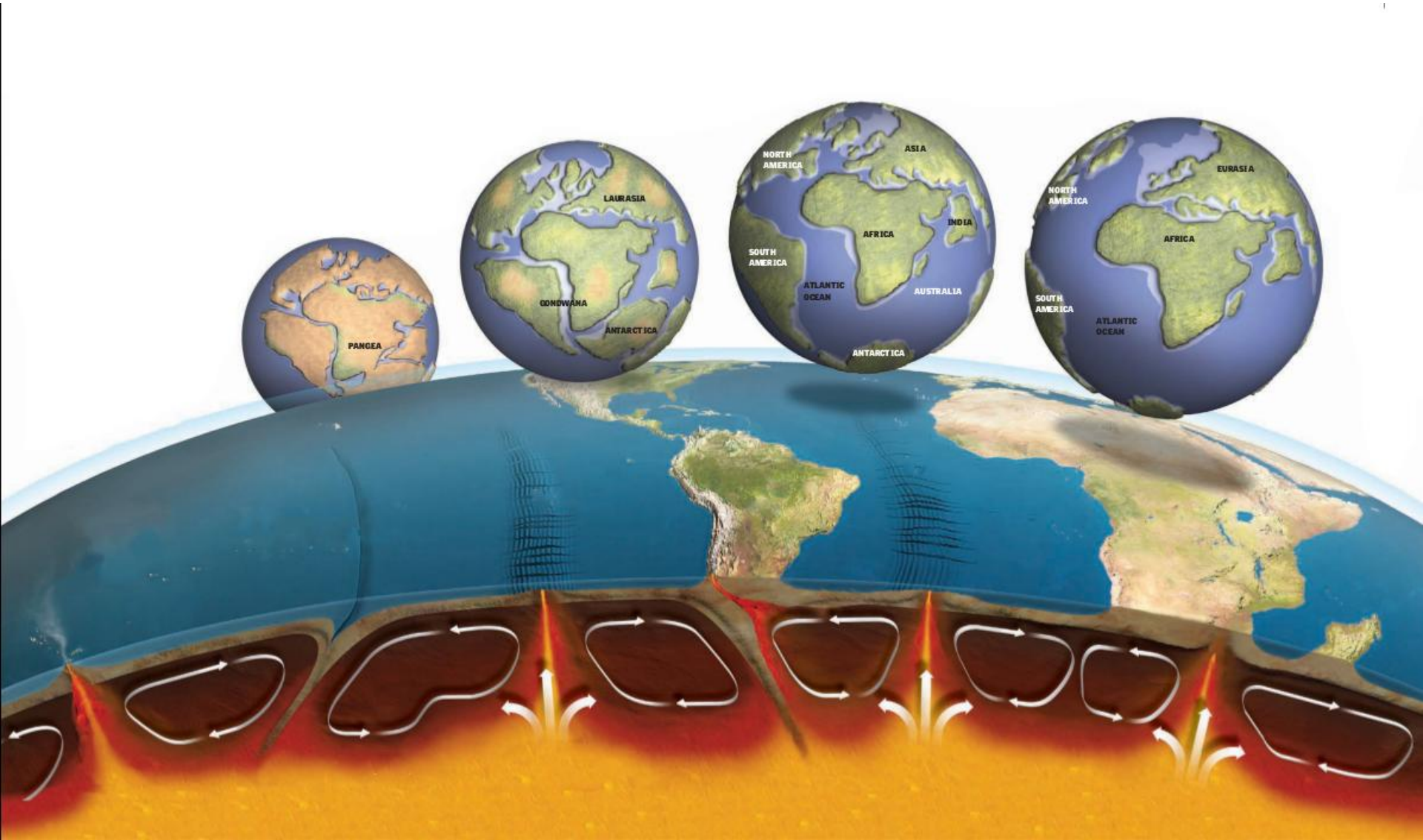
GEO FÍSICA

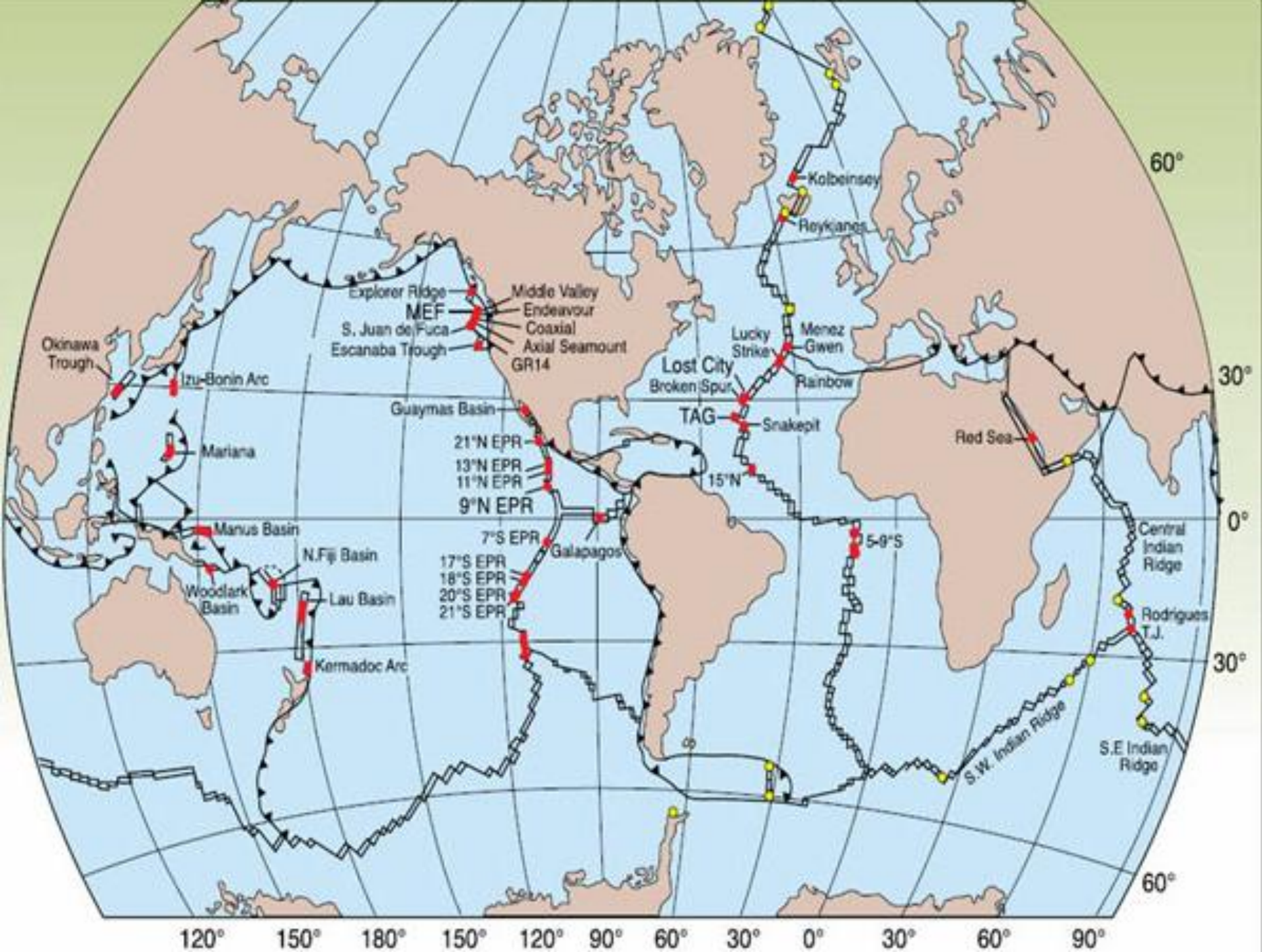
SISMOLOGIA E GEODESIA NO MONITORAMENTO SISMICO

Estrutura da terra

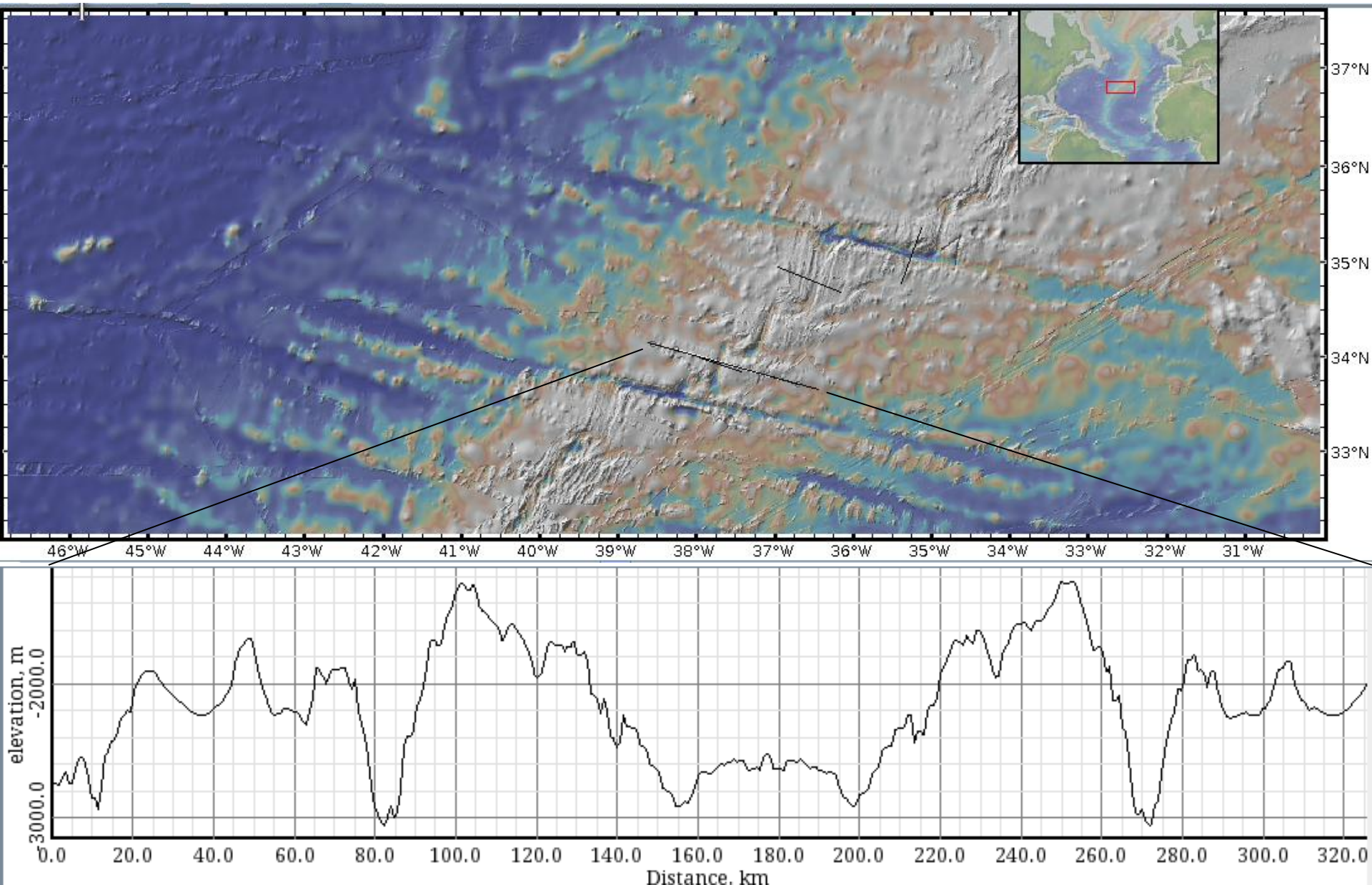


Tectónica de placas




Kolbeinsey
Reykanes
Explorer Ridge
Middle Valley
MEF
Endeavour
S. Juan de Fuca
Coaxial
Escanaba Trough
Axial Seamount
GR14
Okinawa Trough
Izu-Bonin Arc
Lucky Strike
Menez Gwen
Lost City
Broken Spur
Rainbow
TAG
Snakepit
Guaymas Basin
21°N EPR
13°N EPR
11°N EPR
9°N EPR
15°N
Red Sea
Mariana
Manus Basin
7°S EPR
Galapagos
5-9°S
Central Indian Ridge
N.Fiji Basin
17°S EPR
18°S EPR
20°S EPR
21°S EPR
Woodlark Basin
Lau Basin
Rodrigues T.J.
Kermadoc Arc
S.W. Indian Ridge
S.E Indian Ridge
60°
30°
0°
30°
60°
120°
150°
180°
150°
120°
90°
60°
30°
0°
30°
60°
90°

Margens Oceânicas



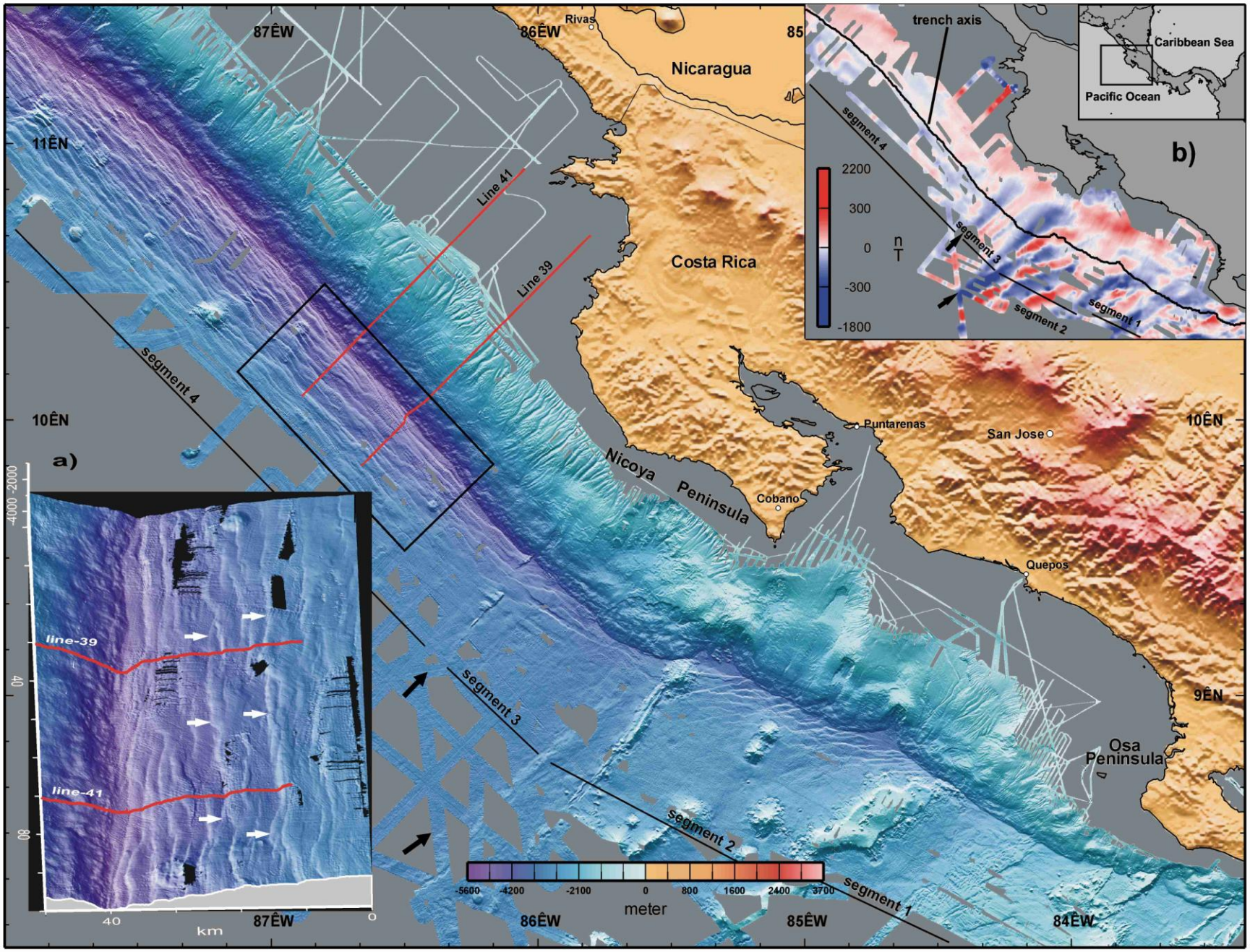
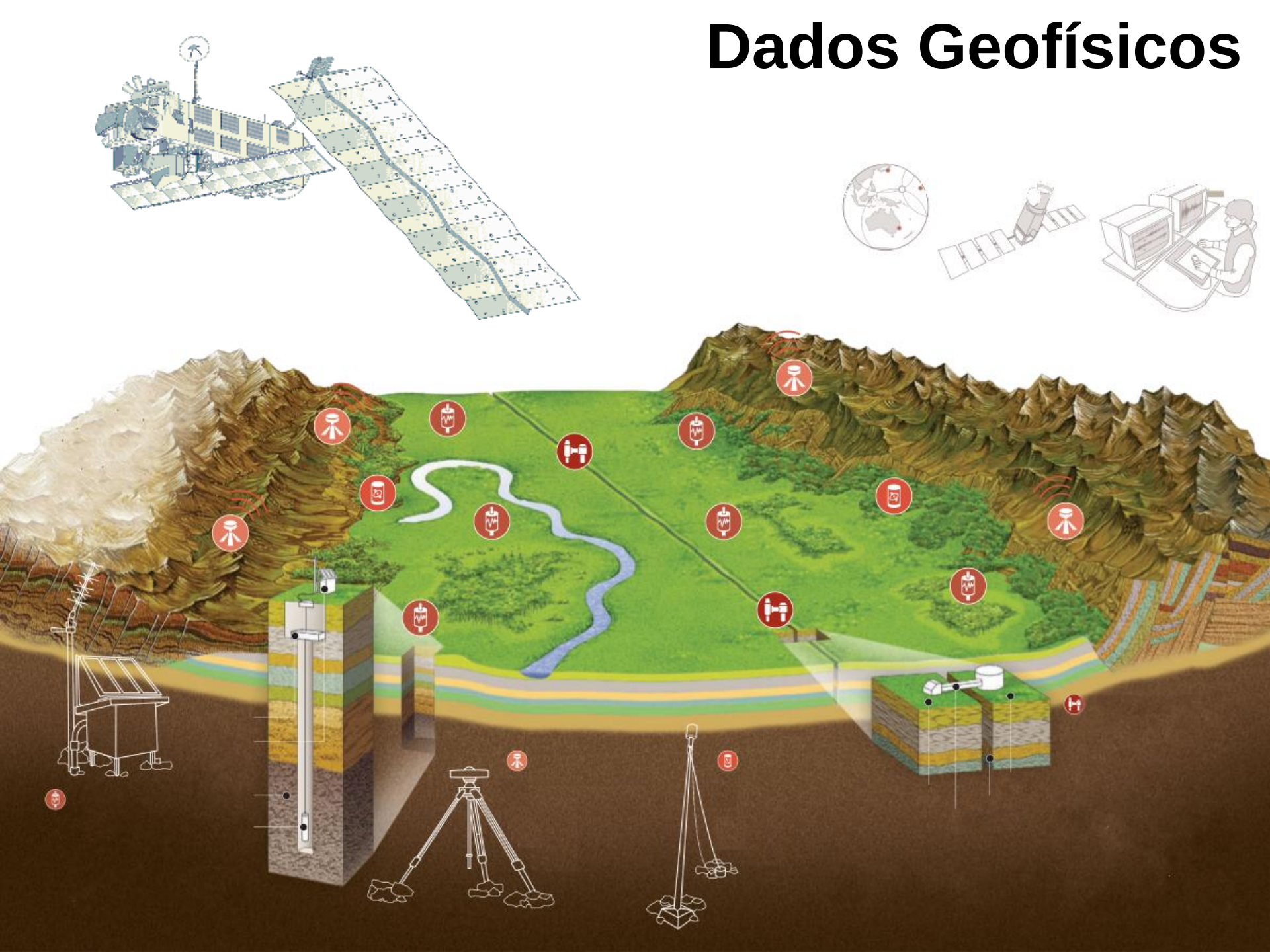


Fig. 1 Ranero et al.

Dados Geofísicos

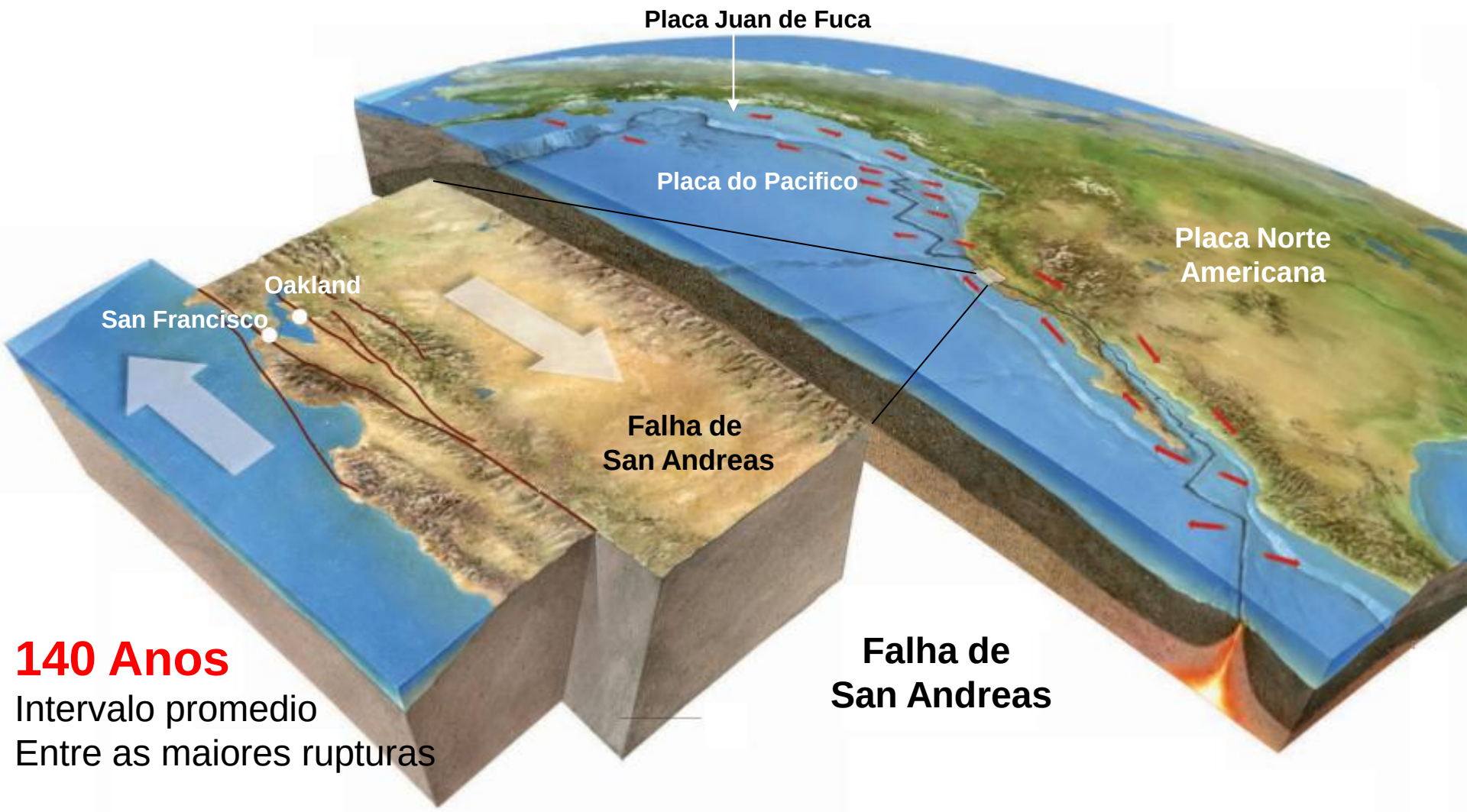


IAG - USP

GEOFÍSICA

SISMOLOGIA

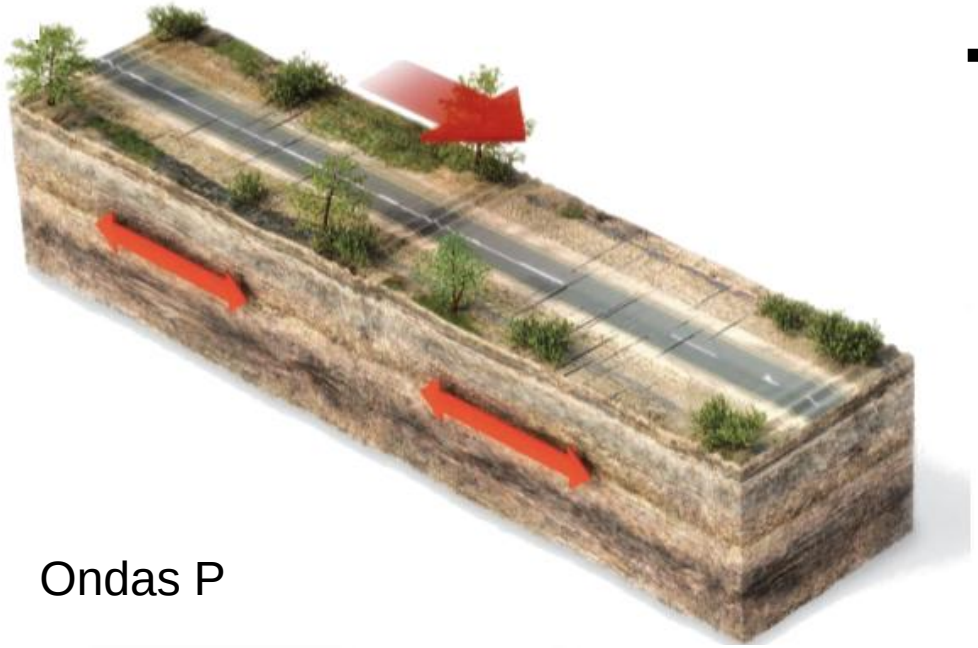
Terremotos e sismos



140 Anos

Intervalo promedio
Entre as maiores rupturas

Tipos de Ondas



Ondas P

Ondas Rayleigh

Ondas S

Ondas Love

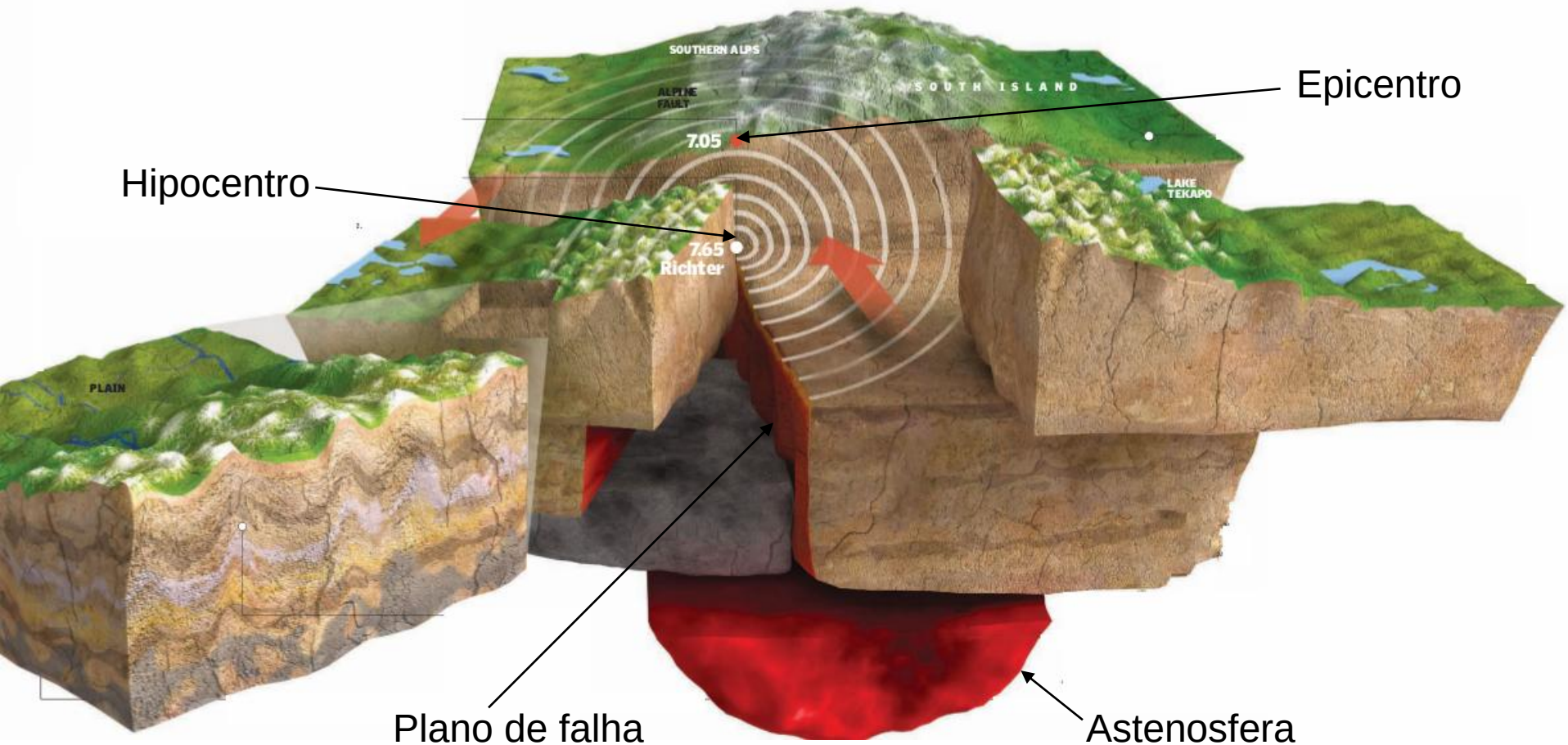
Tipos de Falhas

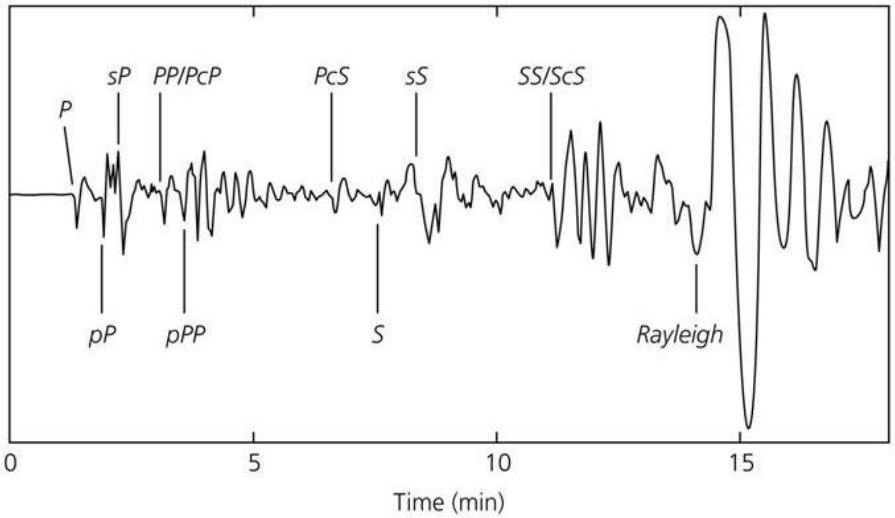
Falha Normal

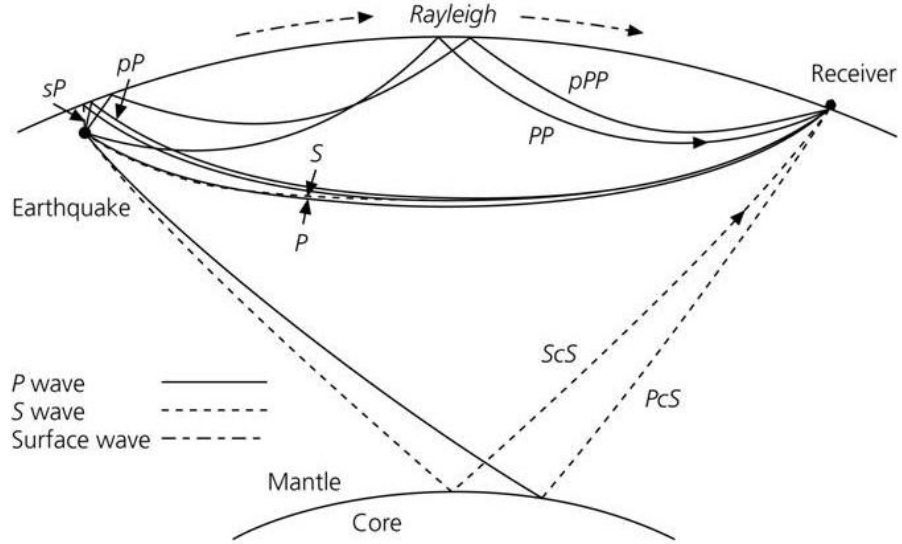
Falha Obliqua

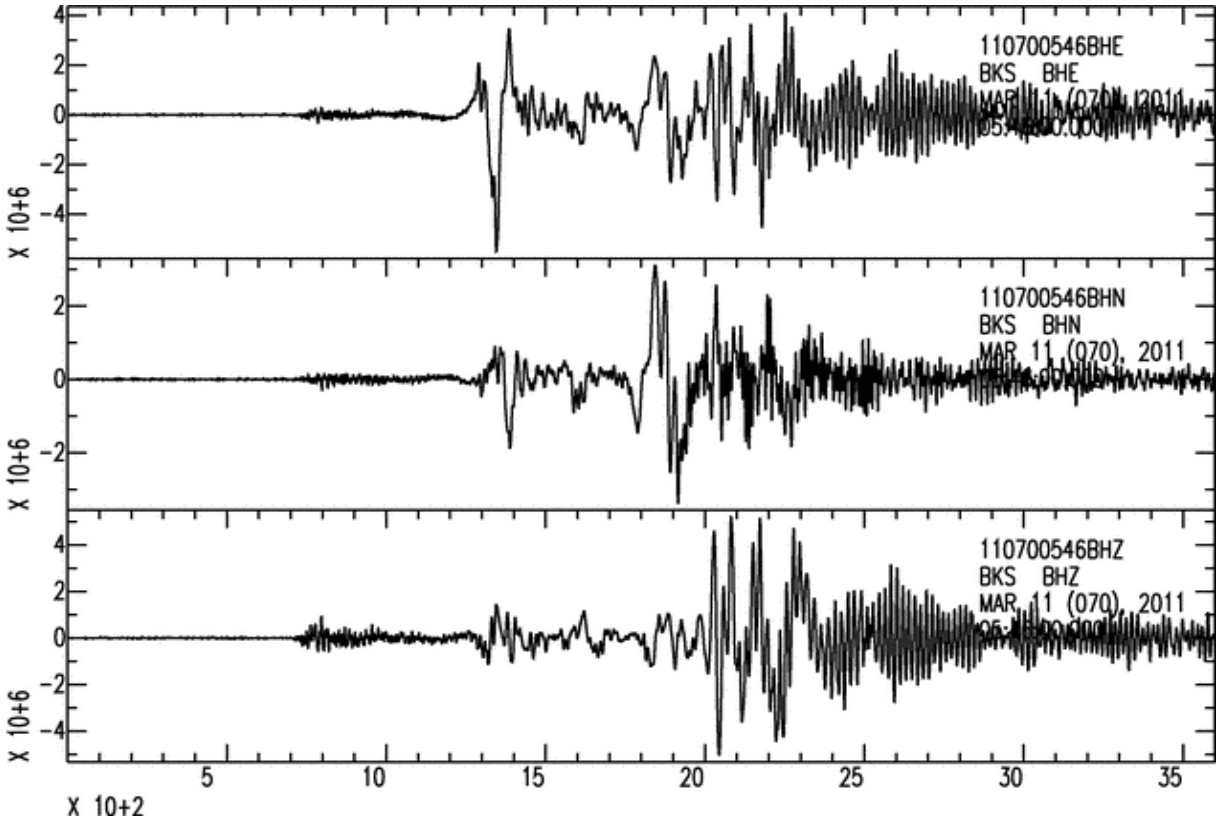
Falha Inversa

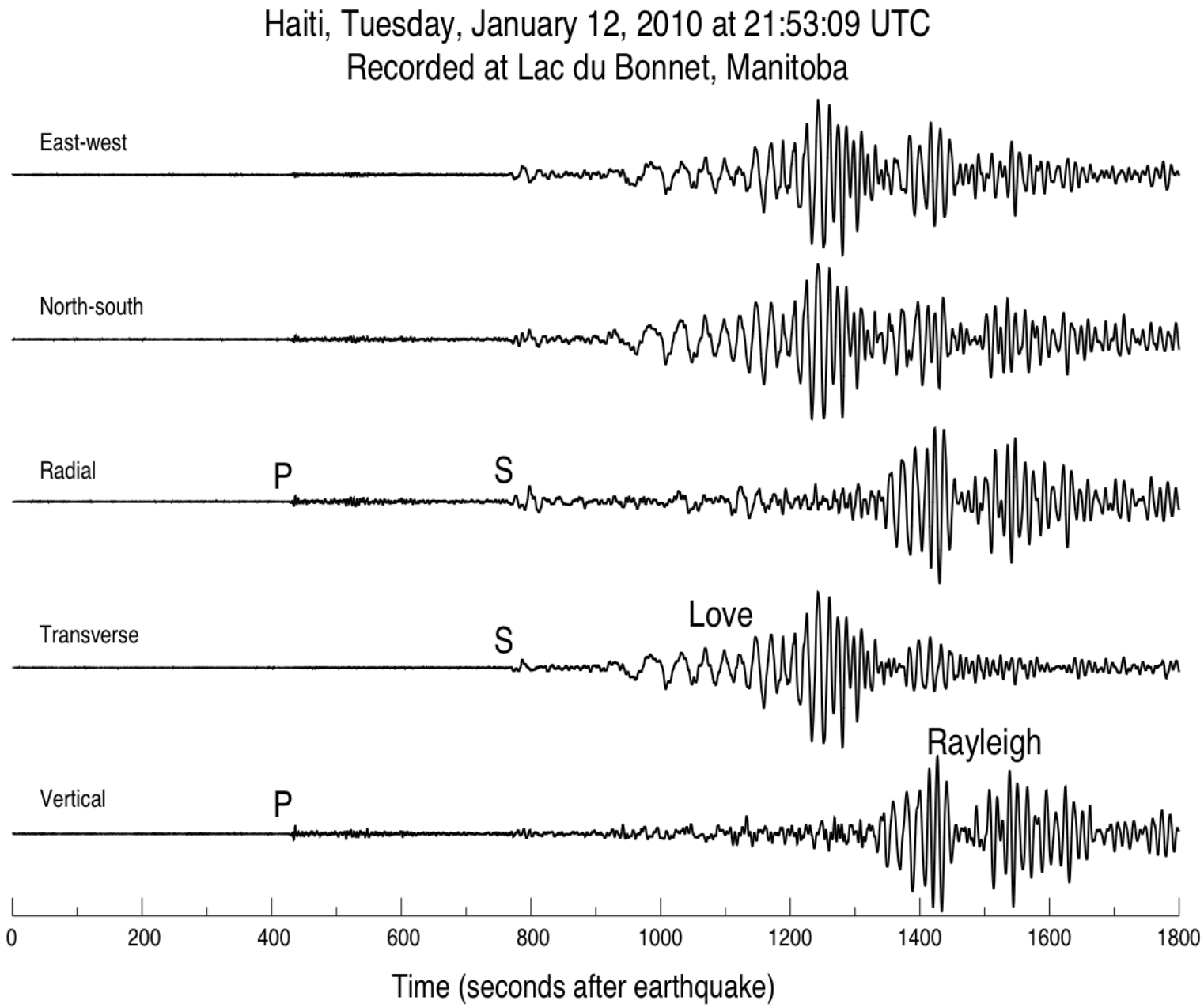
Anatomia de um sismo




P
sP
PP/PcP
PcS
sS
SS/ScS
pP
pPP
S
Rayleigh
0
5
10
15
Time (min)

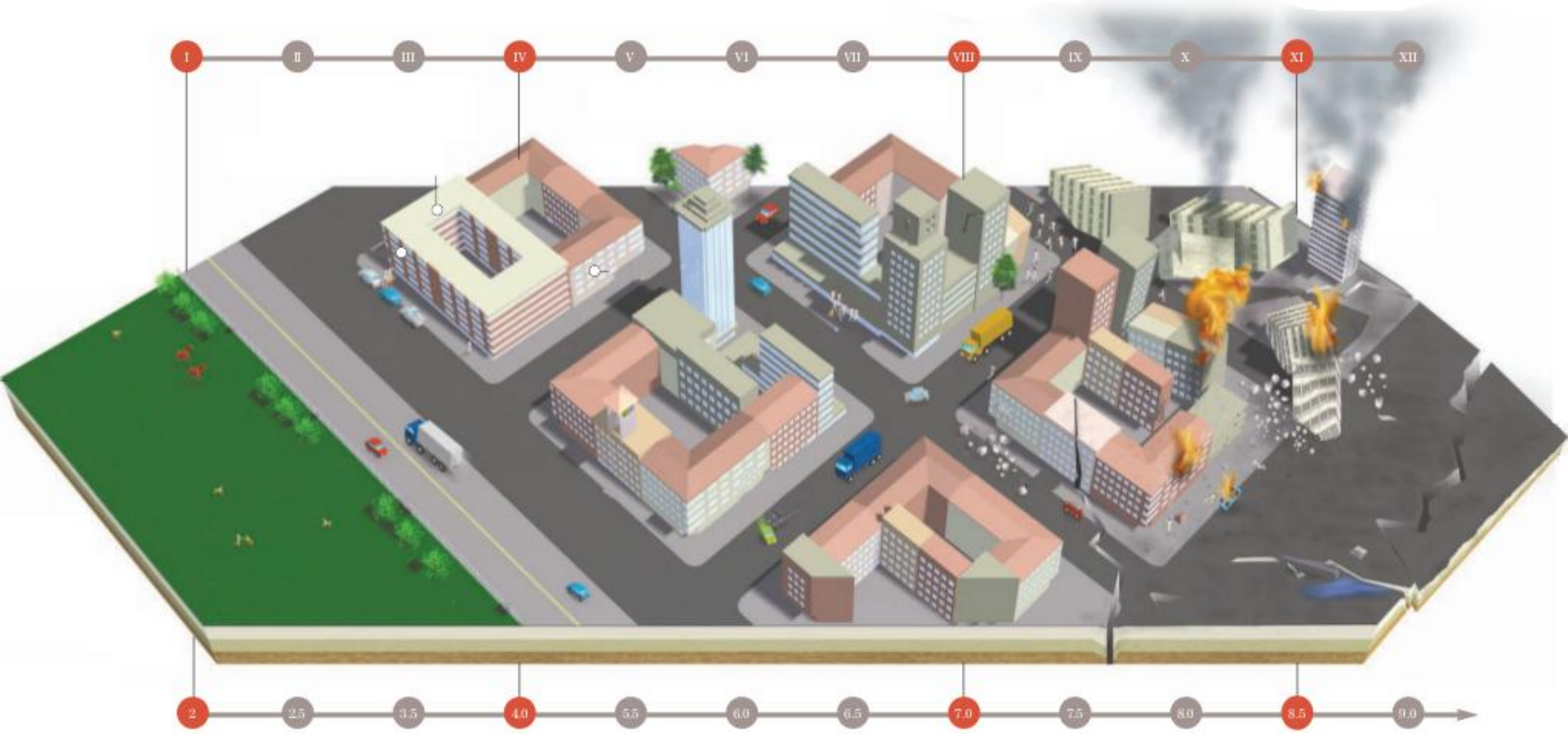

Rayleigh
sP
pP
pPP
Receiver
PP
S
Earthquake
P
ScS
PcS
P wave
S wave
Surface wave
Mantle
Core


110700546BHE
BKS BHE
110700546BHN
BKS BHN
MAR 11 (070), 2011
110700546BHZ
BKS BHZ
MAR 11 (070), 2011
X 10+6
X 10+2
5
10
15
20
25
30
35


Haiti, Tuesday, January 12, 2010 at 21:53:09 UTC
Recorded at Lac du Bonnet, Manitoba
East-west
North-south
Radial
P
S
Transverse
S
Love
Vertical
P
Rayleigh
0
200
400
600
800
1000
1200
1400
1600
1800
Time (seconds after earthquake)

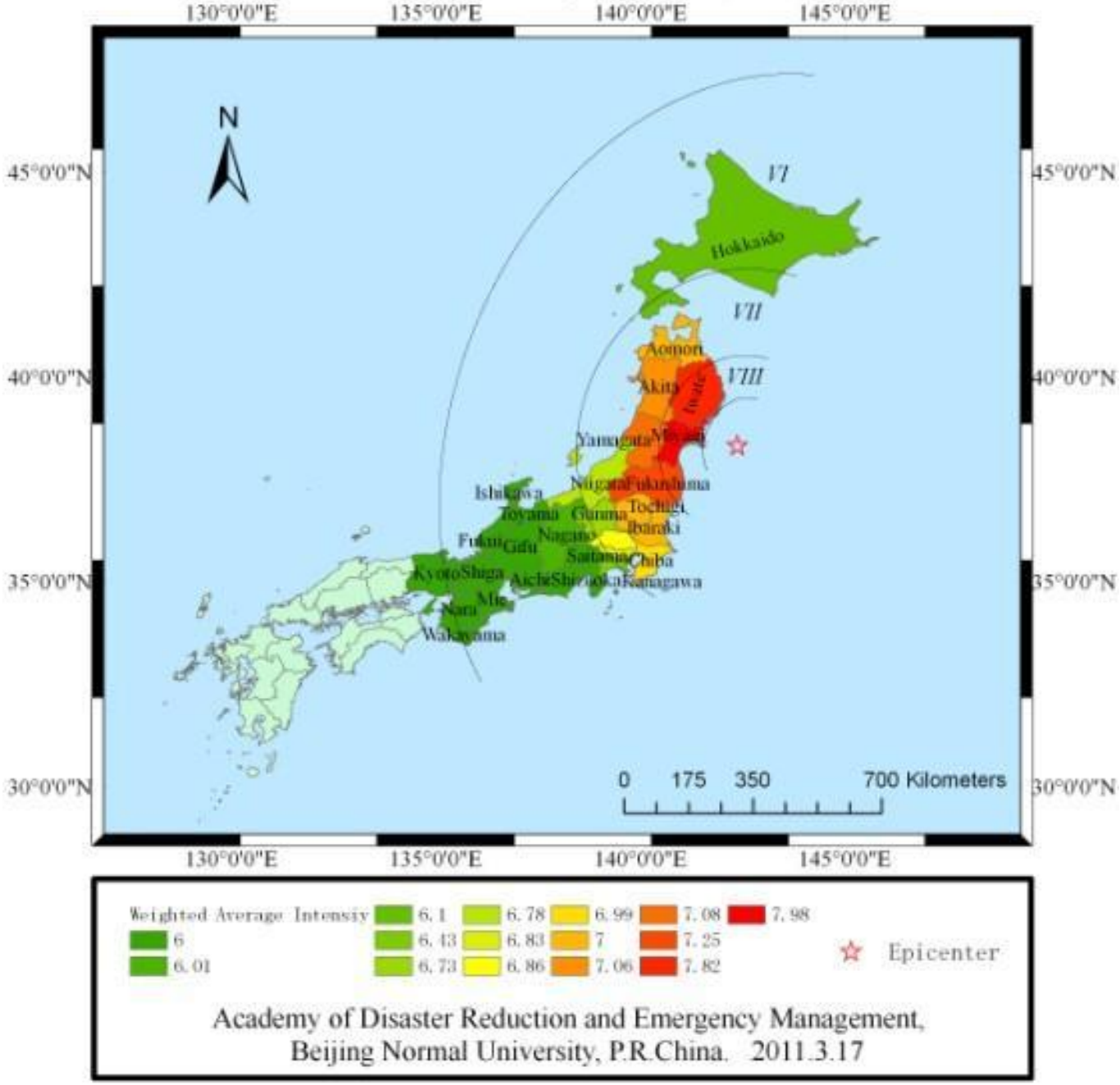
Intensidade e Magnitude

Intensidade



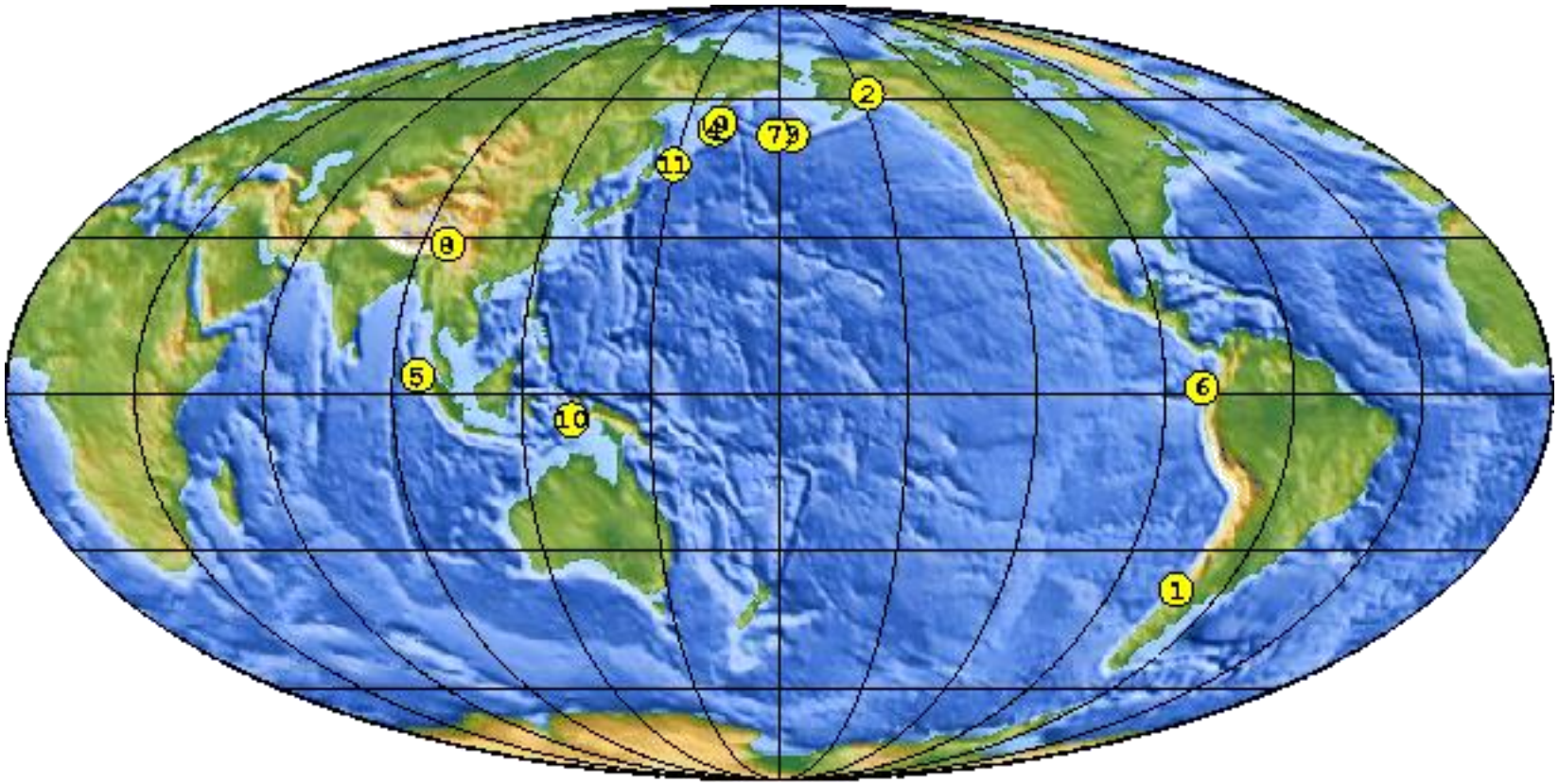
Magnitude

The Weighted Average Seismic Intensity Map of Affected Prefectures on Japan Earthquake (MS9.0)



Academy of Disaster Reduction and Emergency Management, Beijing Normal University, P.R.China. 2011.3.17

Sismos mais fortes, 1900-2004



USGS National Earthquake Information Center

Evento	Mag
1960 Chile	9.5
1964 Alaska (P. William Snd)	9.2
1957 Alaska (Andreanof Isl.)	9.1
1952 Kamchatka	9.0
2004 Indonesia (Sumatra)	9.0 – 9.2
1906 Colombia-Ecuador	8.8
1965 Alaska (Rat Islands)	8.7
1950 Tibet (Assam)	8.6
1923 Kamchatka	8.5
1938 Indonesia (Banda Sea)	8.5
1963 Kurile Islands	8.5

* USGS National Earthquake Information Center

Frequencia dos Eventos

Magnitude	Número por ano	Energía Liberada (j/yr, aprox.)
>8	1	1,000
7 - 7.9	12	100
6 - 6.9	110	30
5 - 5.9	1400	5
4 - 4.9	13,500	1
3 - 3.9	>130,000	0.2
2 - 2.9	> 1,300,000	< 0.05
Stein & Wysession, 2003		

IAG-USP 2010 & Future

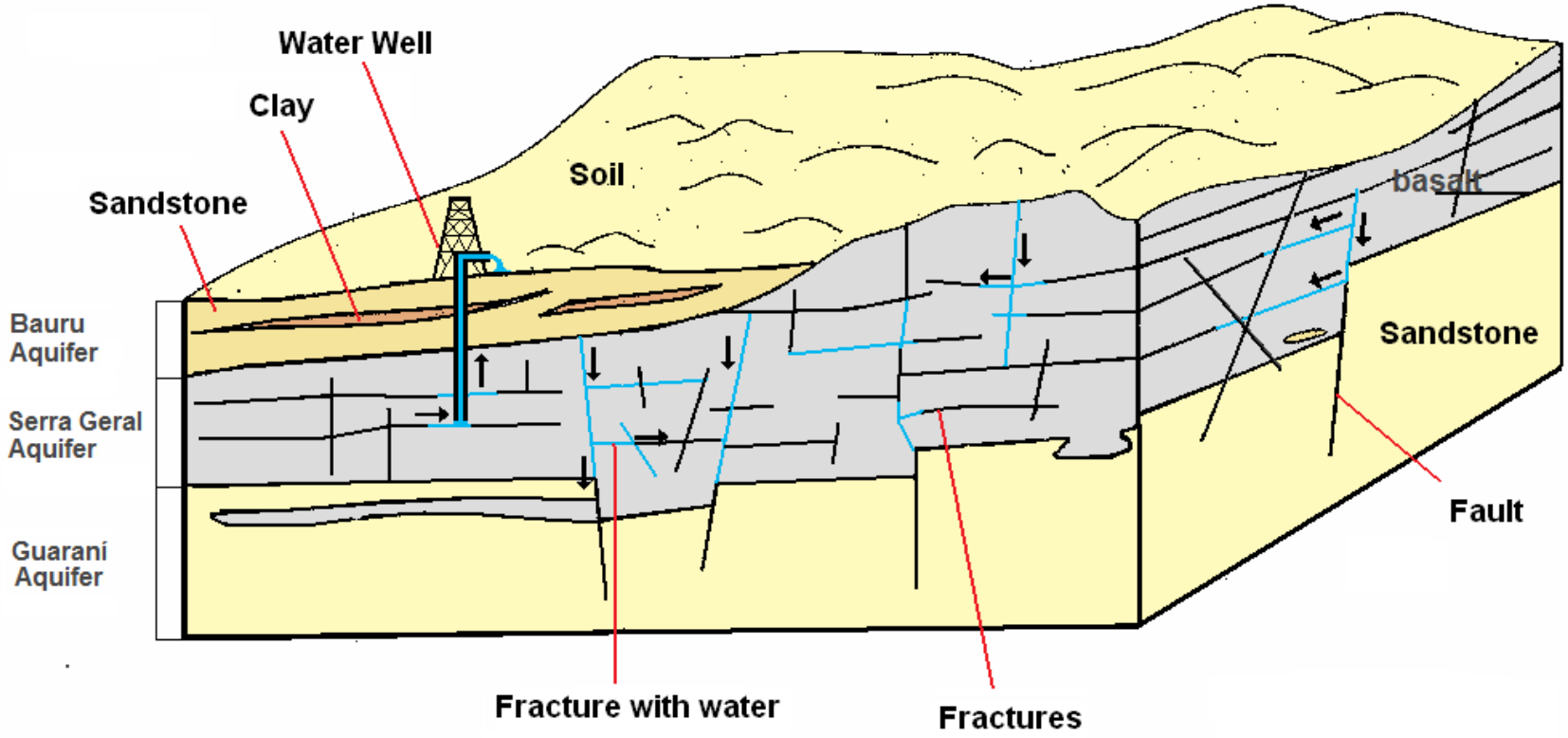
BRASIS Project:

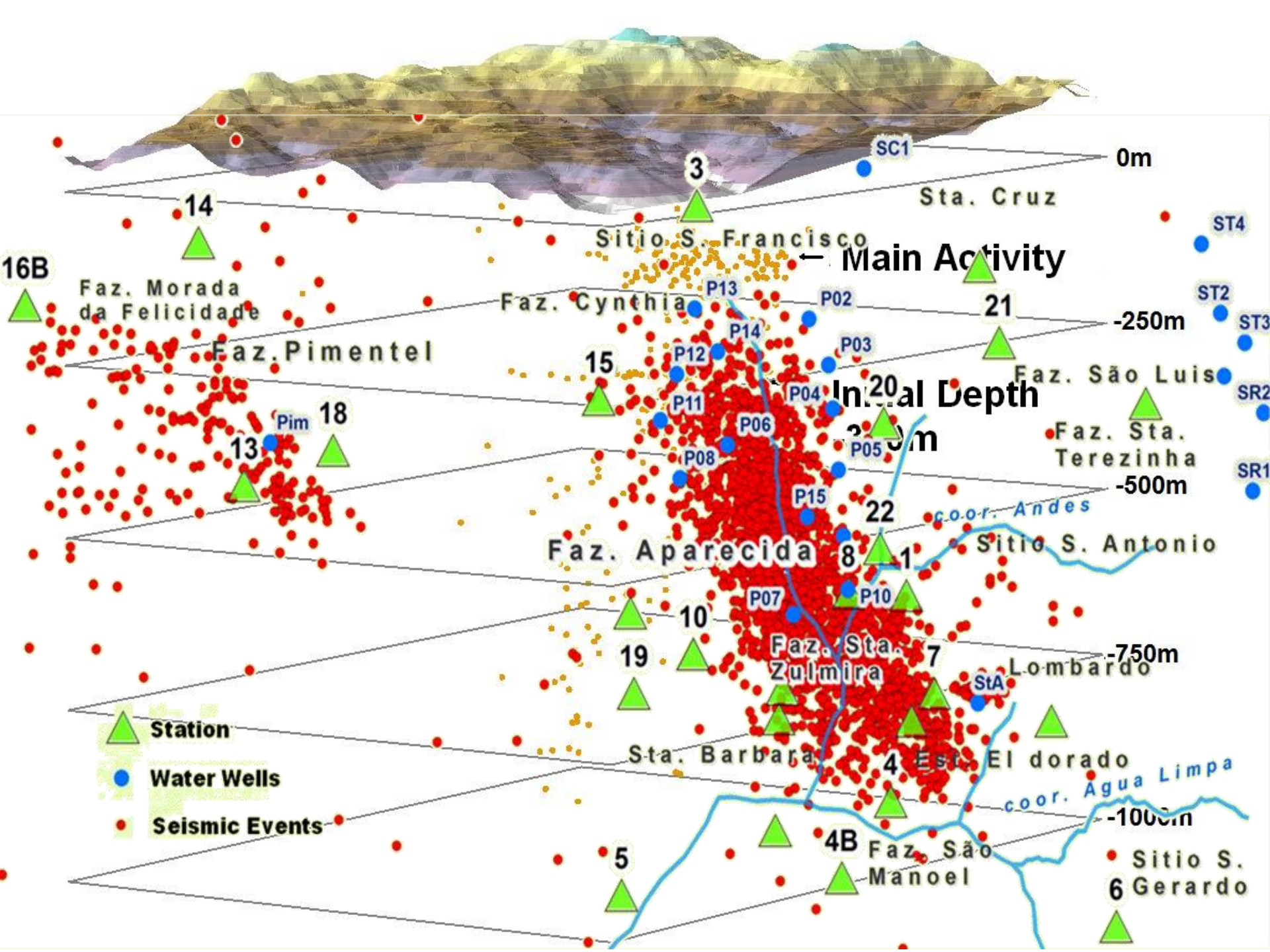
- 55 BB permanent real-time stations to be installed by four institutions

-Study Brazilian seismicity, locating all magnitudes 3+

-Studies of crust and upper mantle structure.

Ex: Módelo Geológico Bebedouro, SP



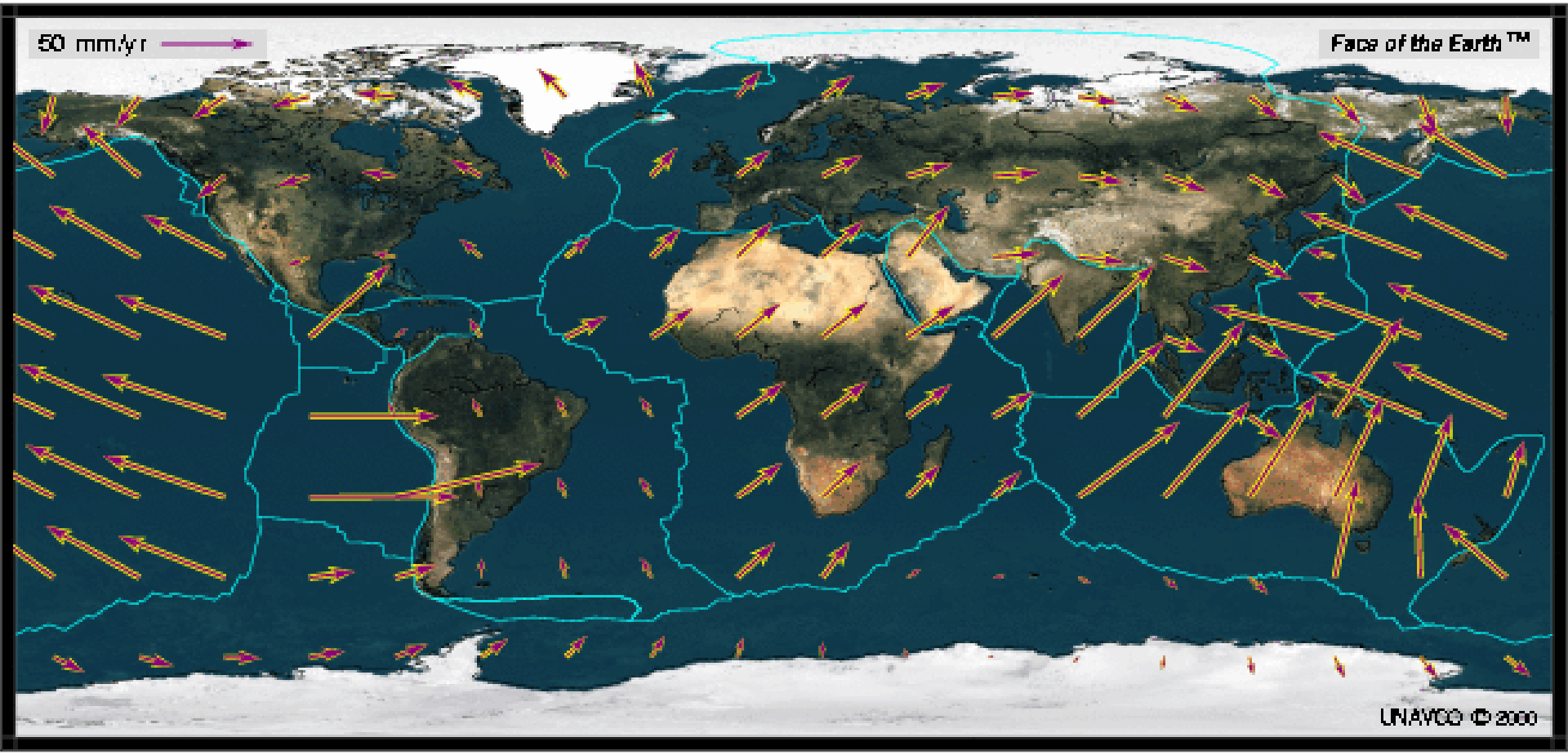

0m
-250m
-500m
-750m
-1000m
Main Activity
Initial Depth
Sta. Cruz
Sitio S. Francisco
Faz. Morada da Felicidade
Faz. Cynthia
Faz. Pimentel
Faz. São Luis
Faz. Sta. Terezinha
Faz. Aparecida
Sitio S. Antonio
Faz. Sta. Zulmira
Lombardo
Sta. Barbara
Est. El dorado
Faz. São Manoel
Sitio S. Gerardo
coor. Andes
coor. Agua Limpa
SC1
ST4
ST2
ST3
SR2
SR1
P13
P02
P14
P03
P12
P04
P11
P06
P05
P08
P15
P07
P10
Pim
StA
3
14
16B
15
18
13
21
20
22
8
1
10
19
7
4
4B
5
6
Station
Water Wells
Seismic Events

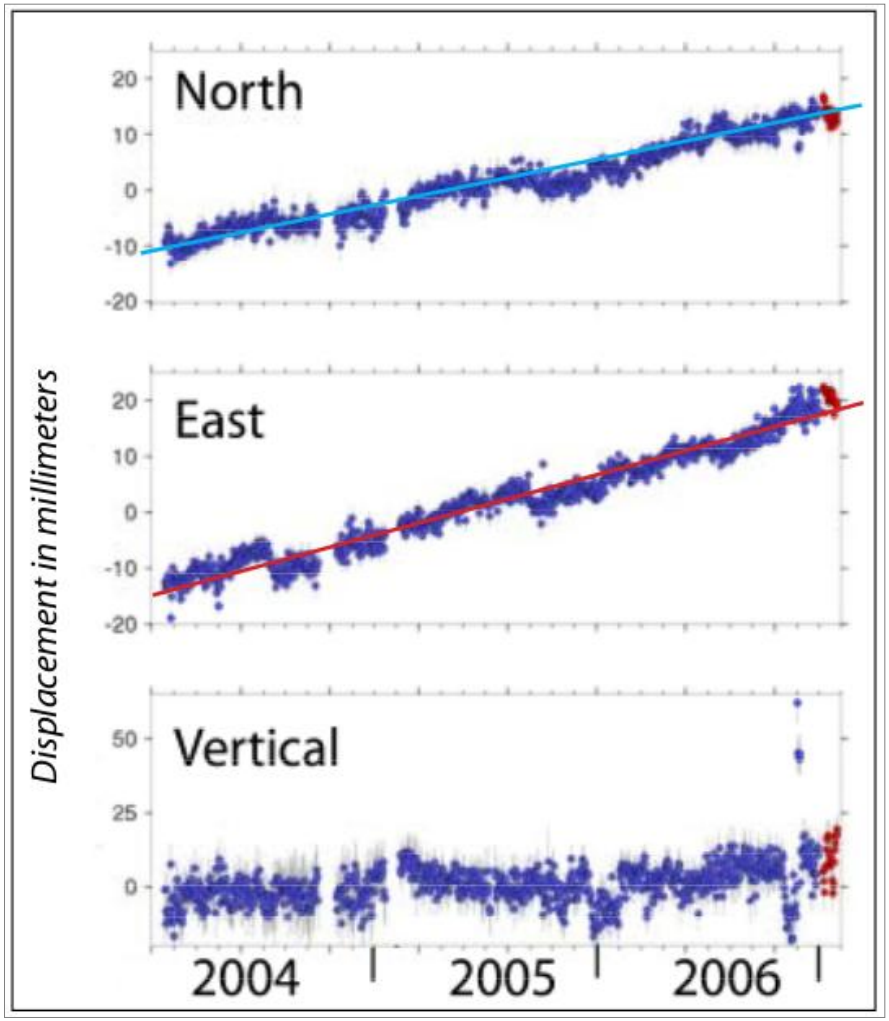
IAG - USP

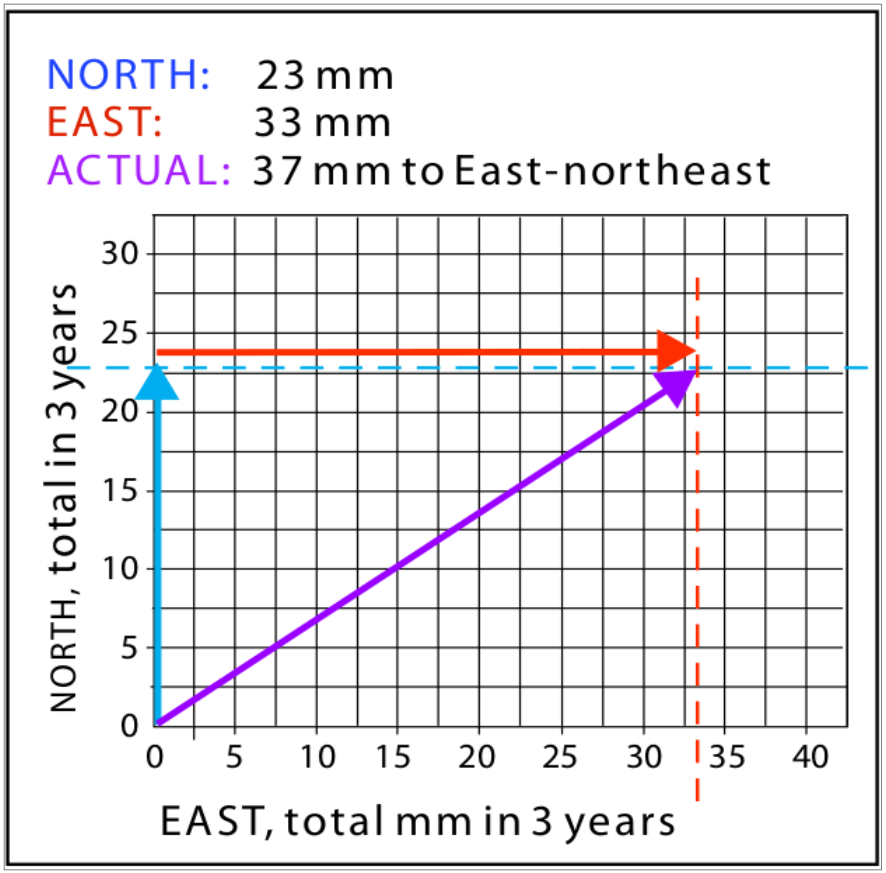
GEO FÍSICA

GEODESIA

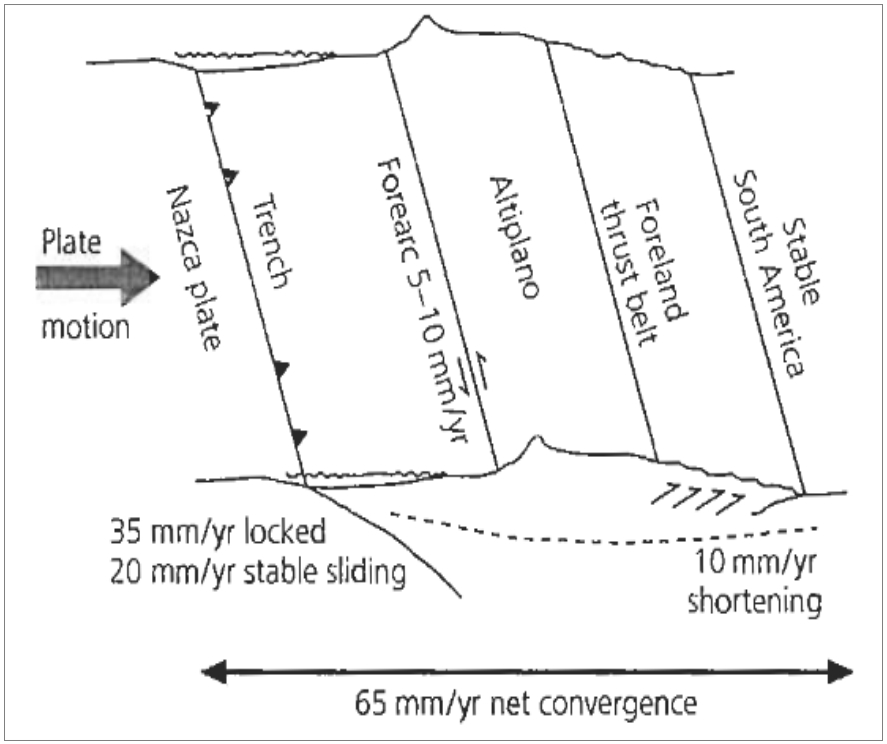
Uso do GPS no monitoramento do deslocamento das placas tectônicas.

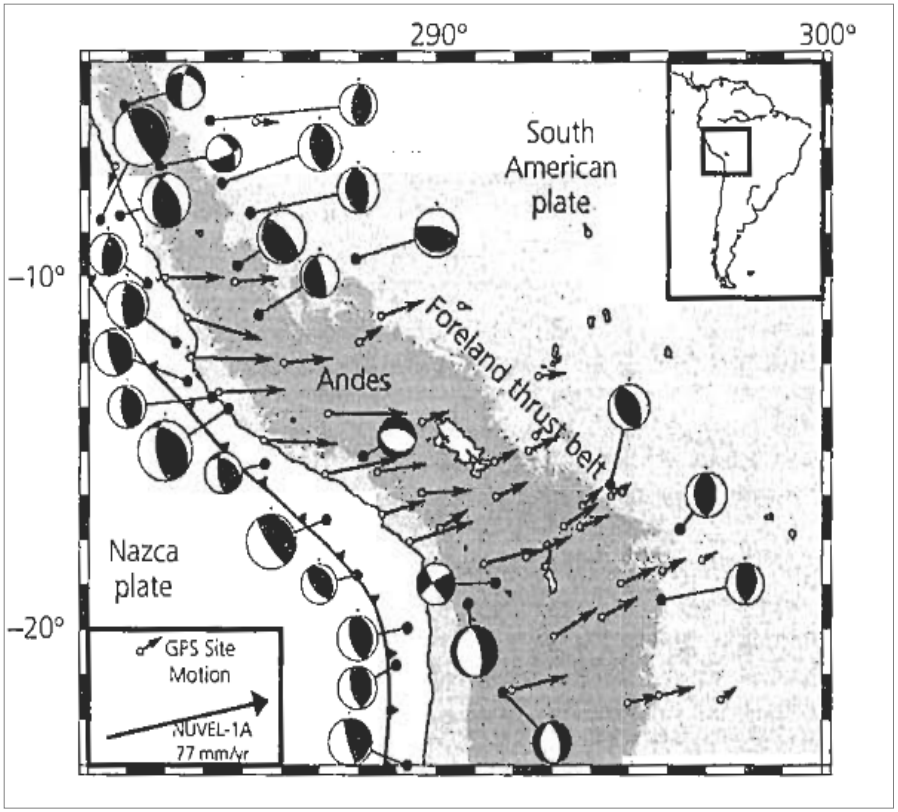






O movimento registrado numa estação de GPS no estado de Washington, USA. Mostrando que esta area esta sendo empurrada de volta para o nordeste pela subducção da placa de Juan de Fuca





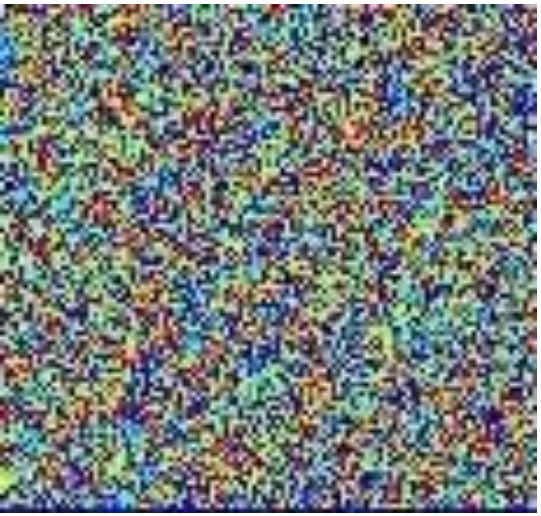
Velocidades de deslocamento em relação ao estável placa Sulamericana (Norrabuena et al, 1998. Science 279, 358-62, 1998), model Nuvel 1A (DeMets et al., 1994)

Seção cruzada mostrando a distribuição das velocidades inferidas de dados GPS. Figuras adaptadas de Stein e Wysession, (2003)

Interferometria InSAR

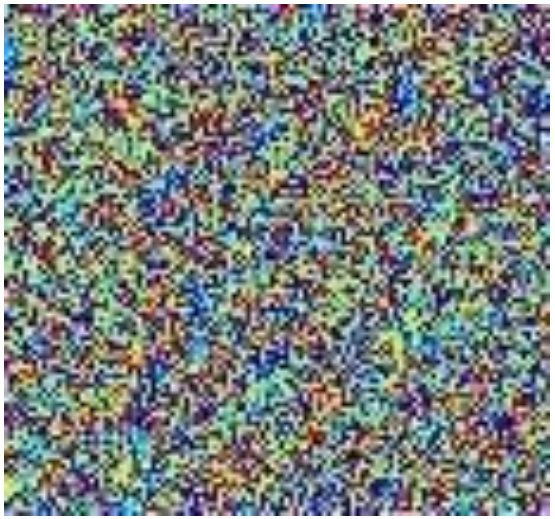
Proceso para obter um interferograma

fase “master”



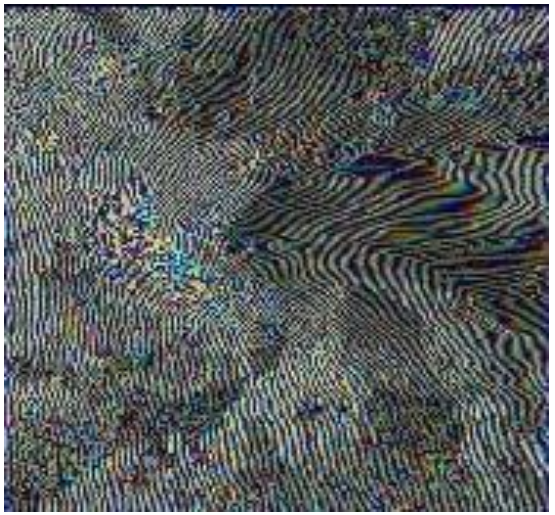
-

fase “slave”

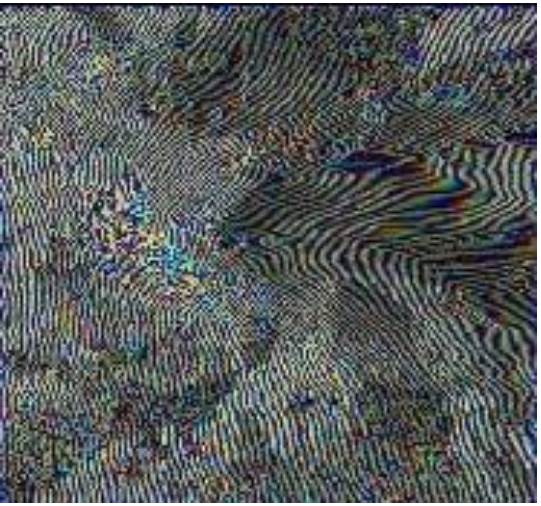


=

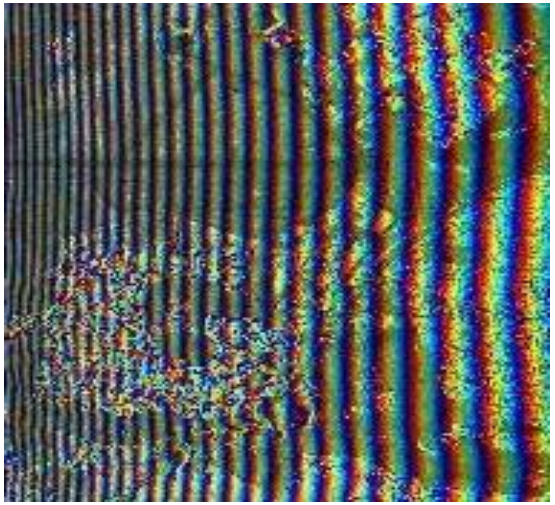
Interferograma de fase



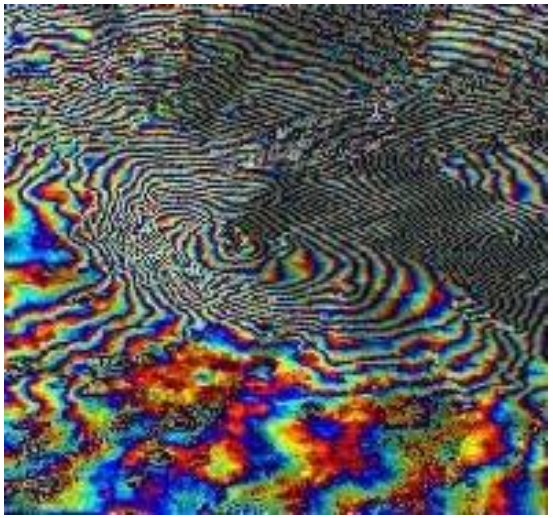
Próximo remover o efeito de terra plana ao interferograma e fase.



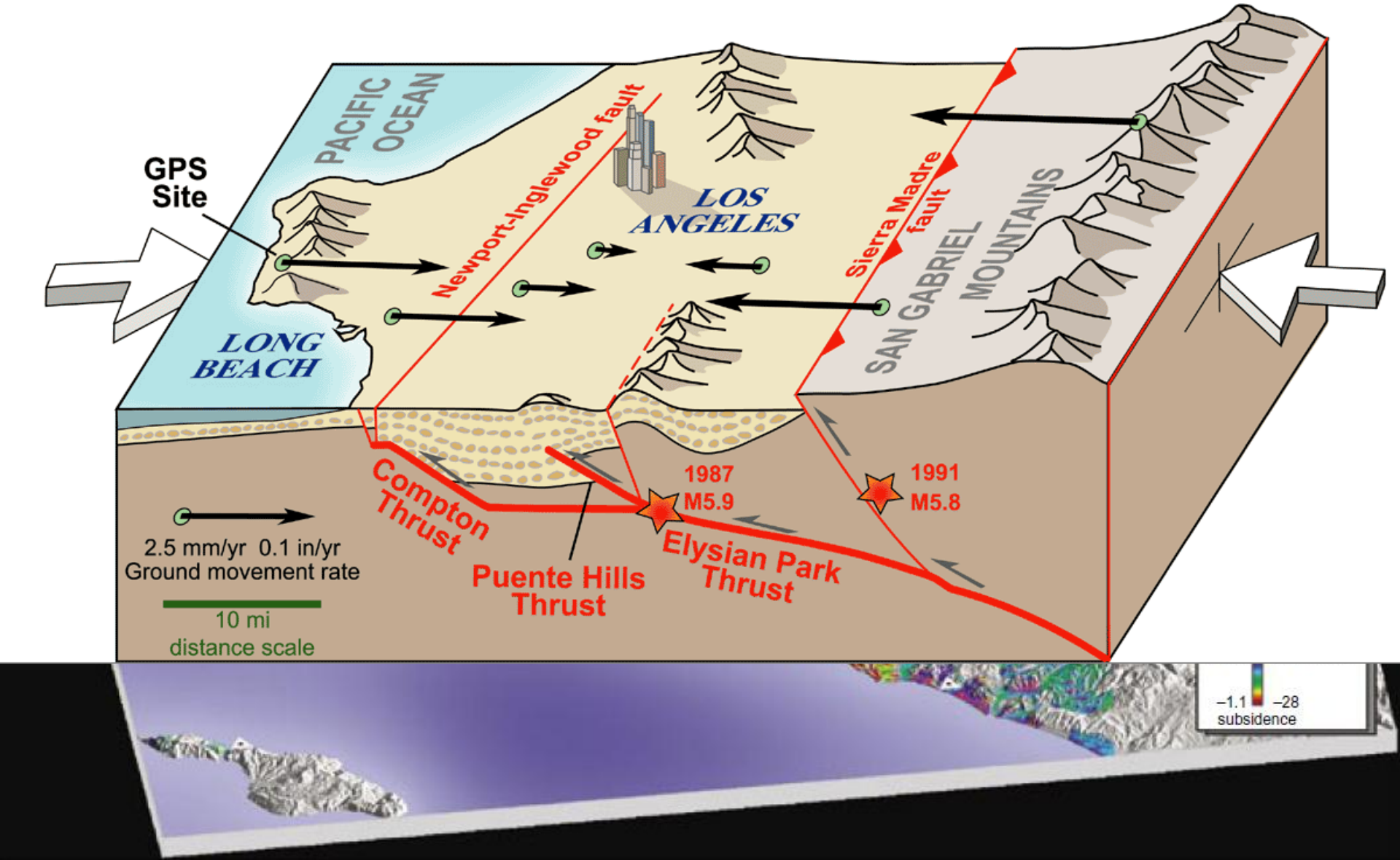
-



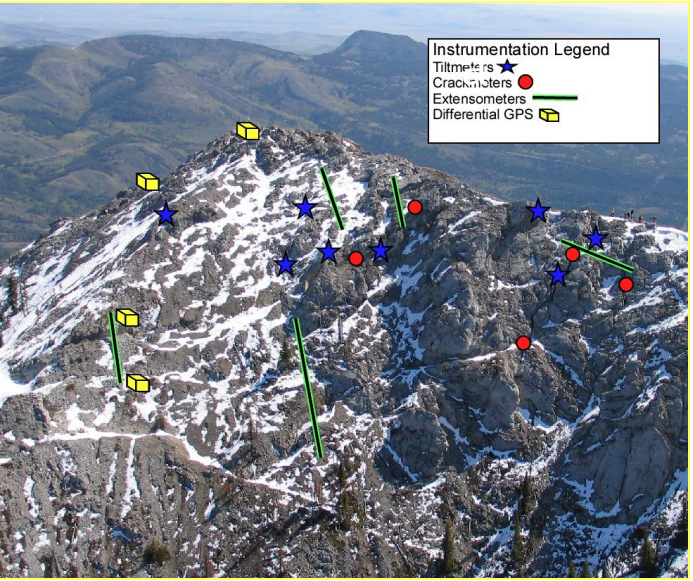
=



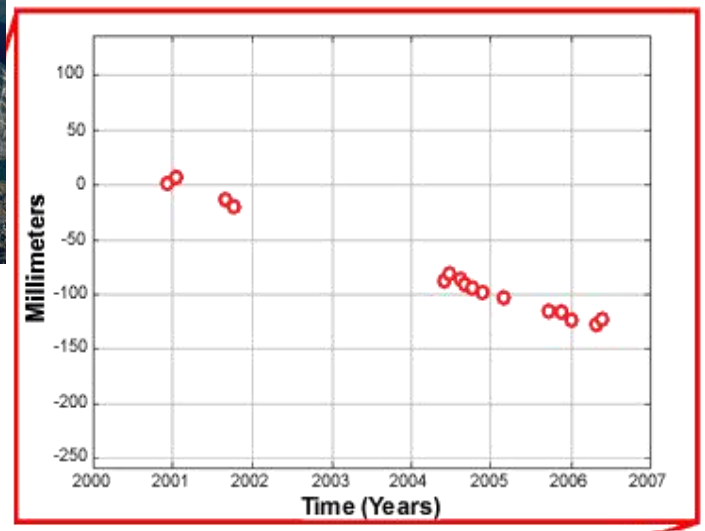
Exemplo de Interferometria InSAR



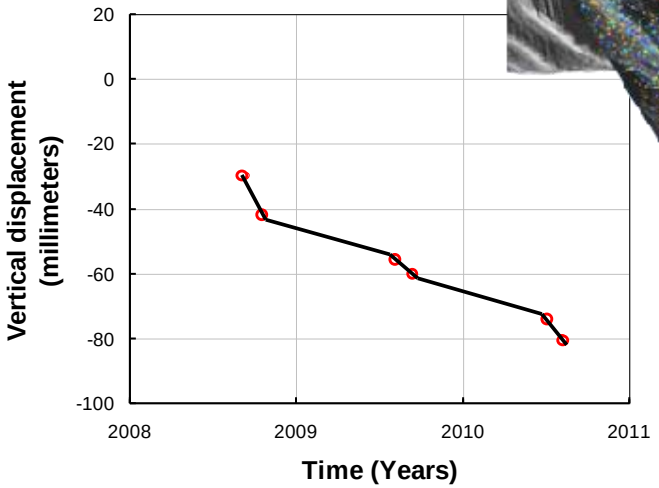
Monitorando subsidencia com InSAR

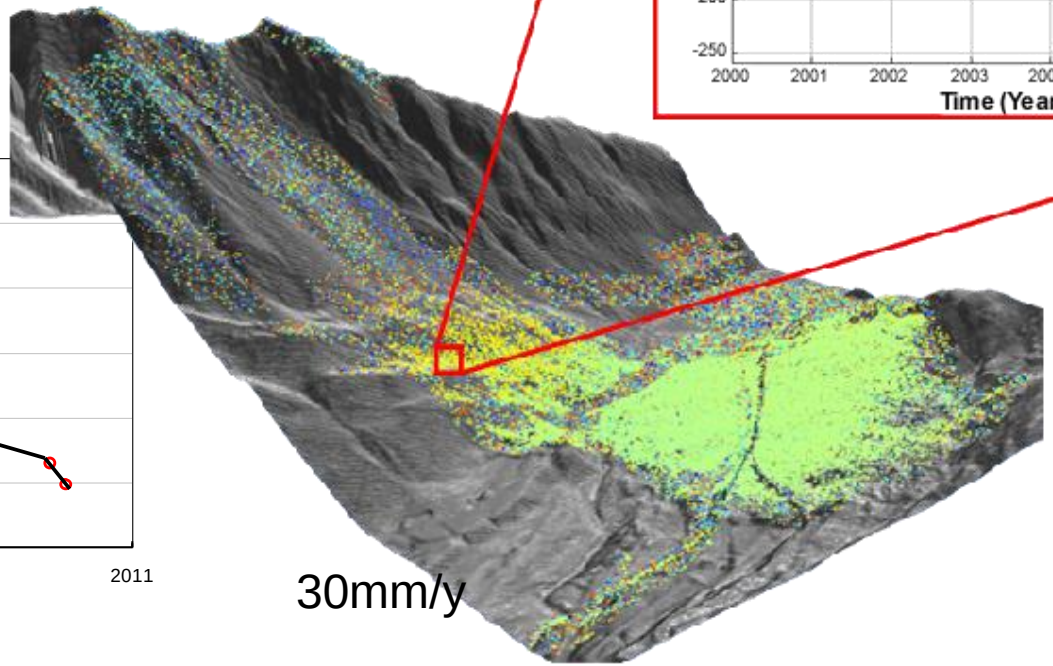


RADARSAT-1

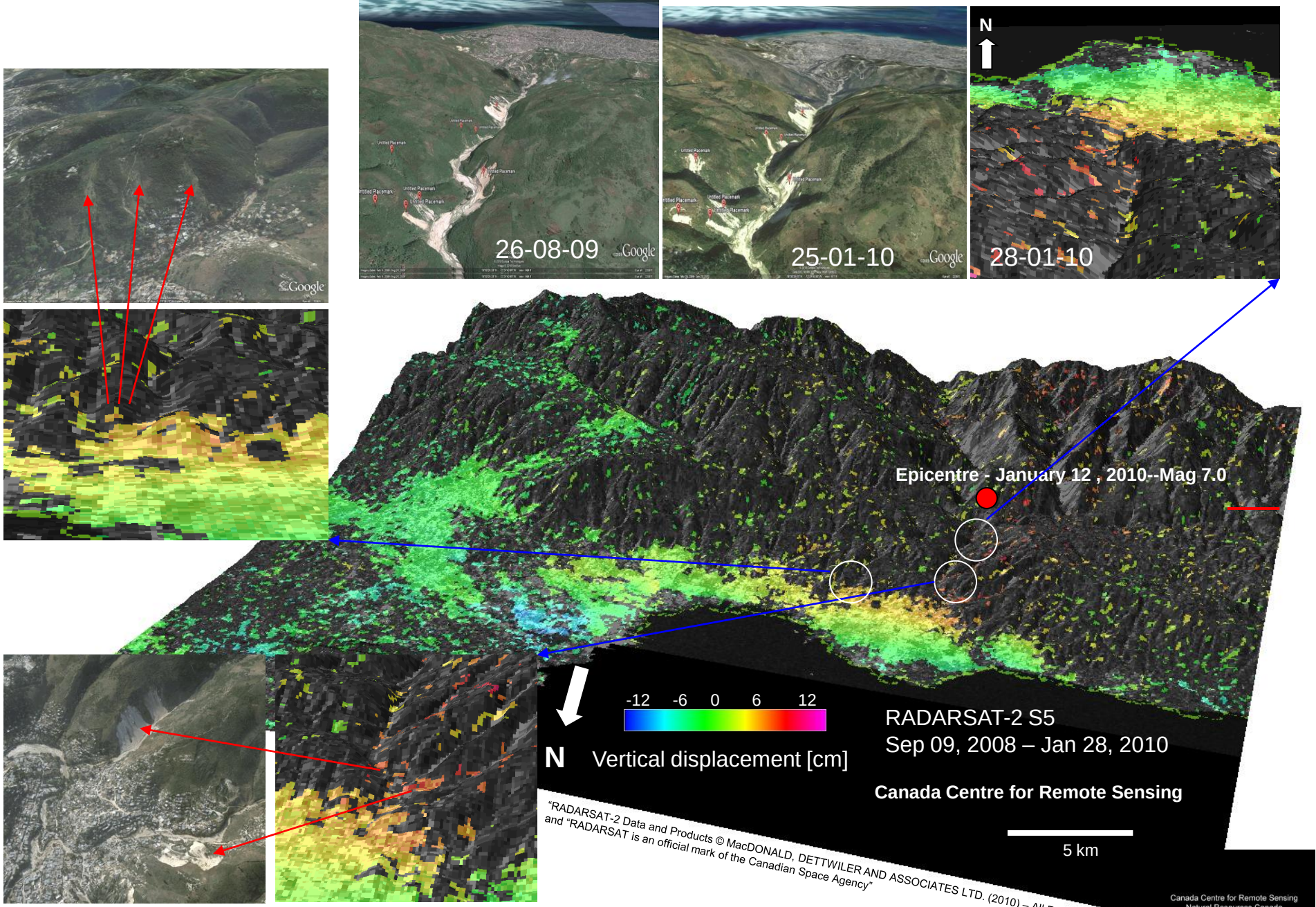


RADARSAT 2





30mm/y



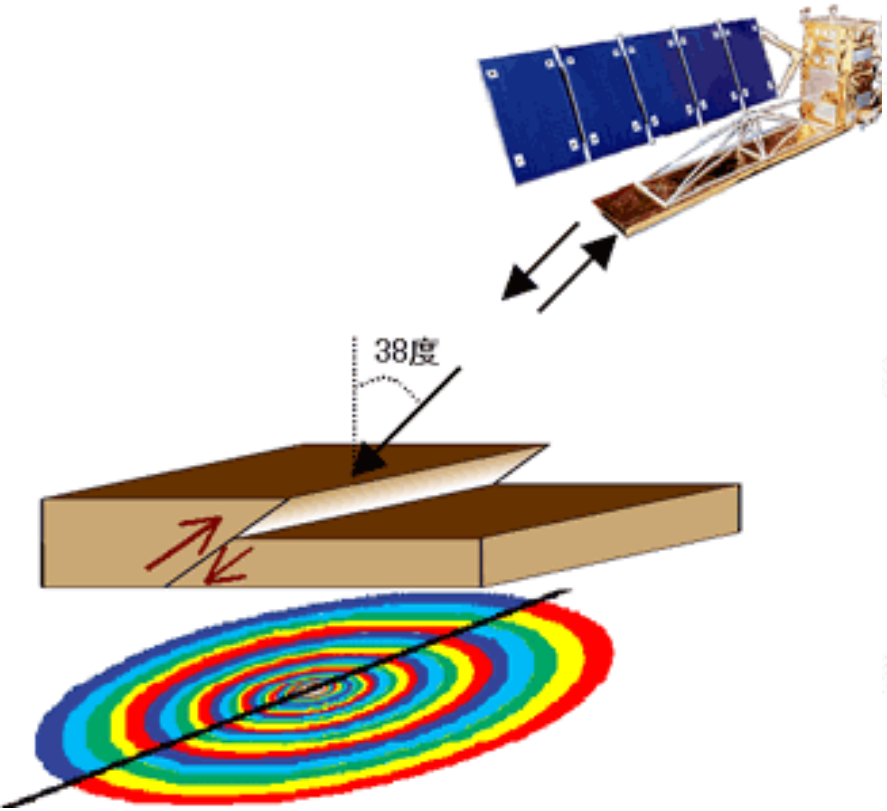
"RADARSAT-2 Data and Products © MacDONALD, DETTWILER AND ASSOCIATES LTD. (2010) – All Rights Reserved"
and "RADARSAT is an official mark of the Canadian Space Agency"

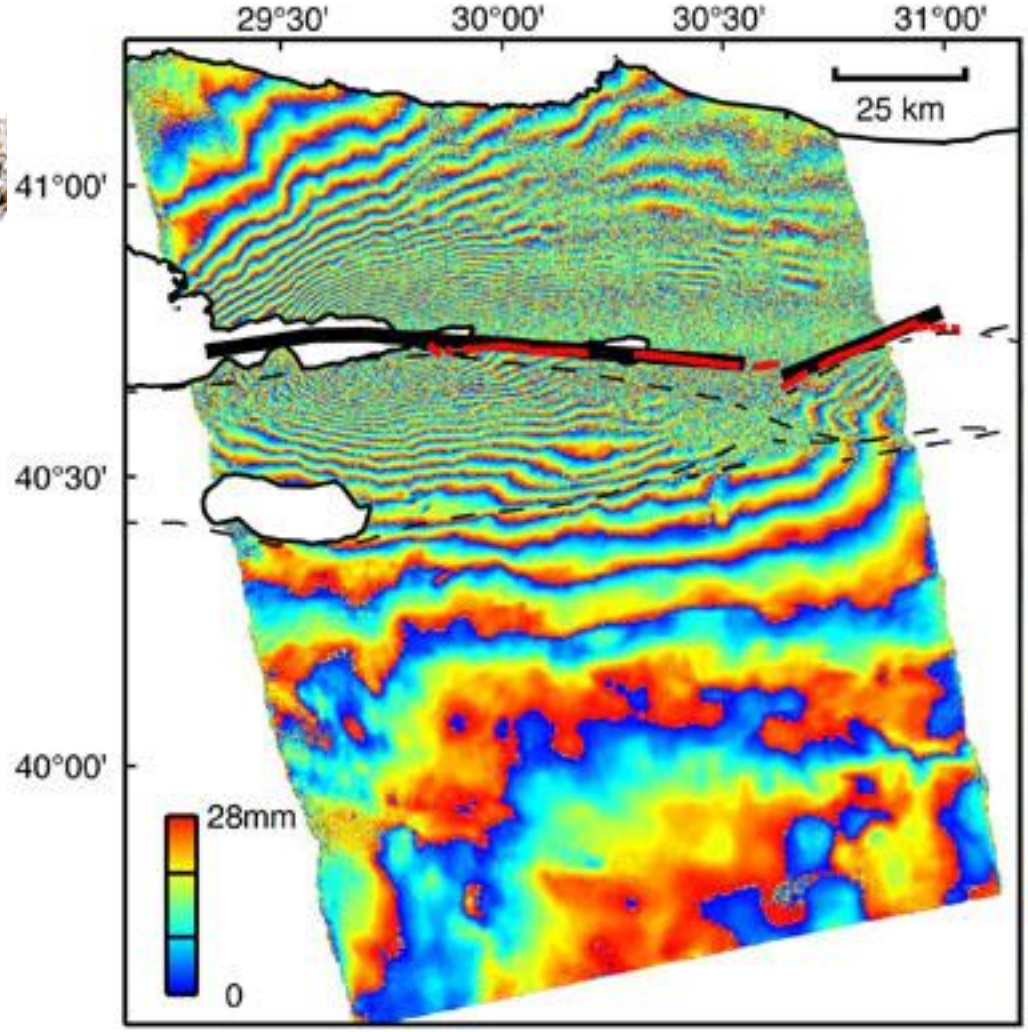
RADARSAT-2 Vertical Displacement Map – Port-au-Prince - Haiti

Singhroy and Pavlic, CCRS, Feb 2010

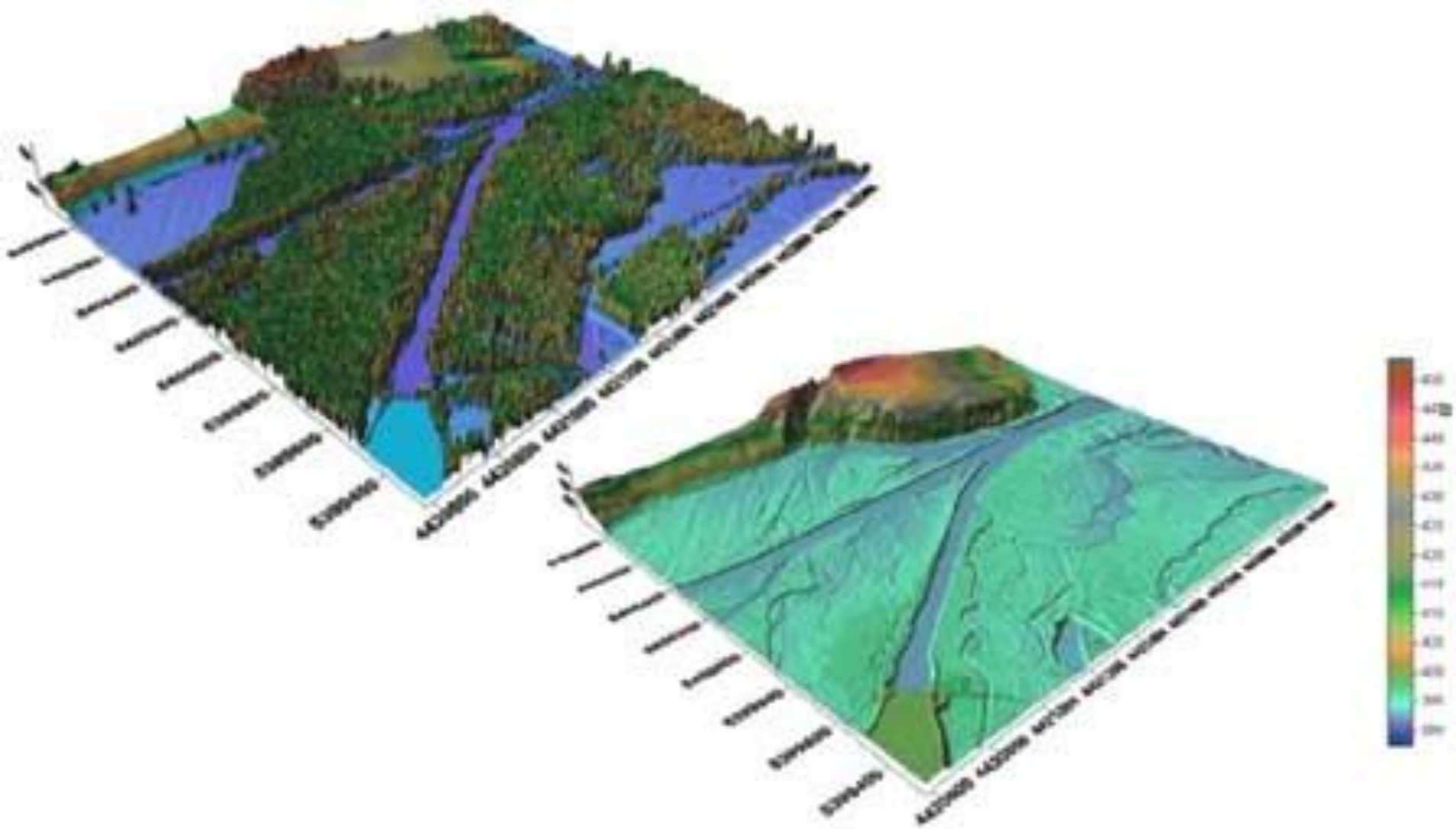
Canada Centre for Remote Sensing
Natural Resources Canada
Canada
Centre canadien de télédétection
Ressources naturelles Canada

Izmit – Turkey, 1999





DEM e DTM Usando SAR



http://www.gisdevelopment.net/technology/rs/ma03234a.htm