

# ***CHANGES IN SEISMIC RESPONSE DUE TO GROUND SURFACE SUBSIDENCE IN MEXICO CITY***

***RAÚL AGUILAR BECERRIL***

***MEXICO***



**Sociedad Mexicana  
de Ingeniería  
Geotécnica**

El cimiento de la Ingeniería Mexicana

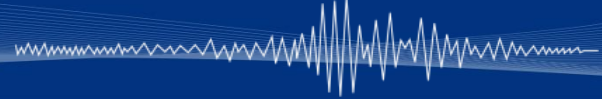


**FEDERACION DE COLEGIOS  
DE INGENIEROS CIVILES  
DE LA REPÚBLICA MEXICANA**

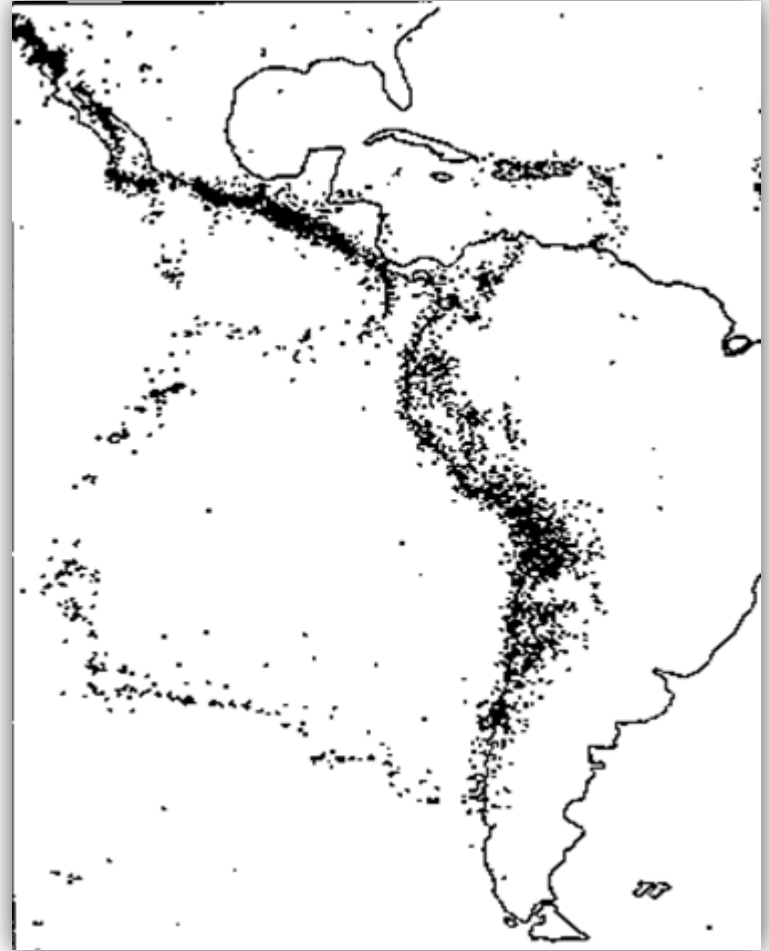
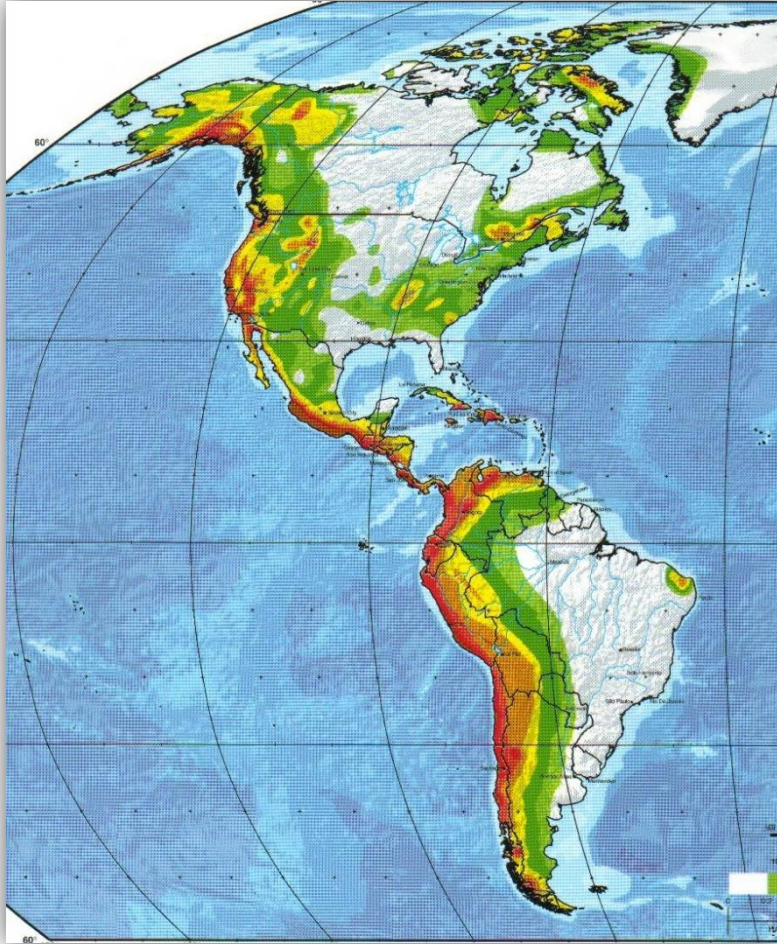
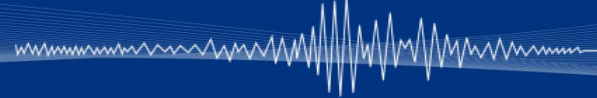


**SÍSMICA DE SUELOS**

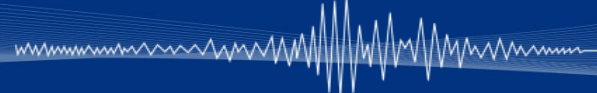
**MAY-2014**

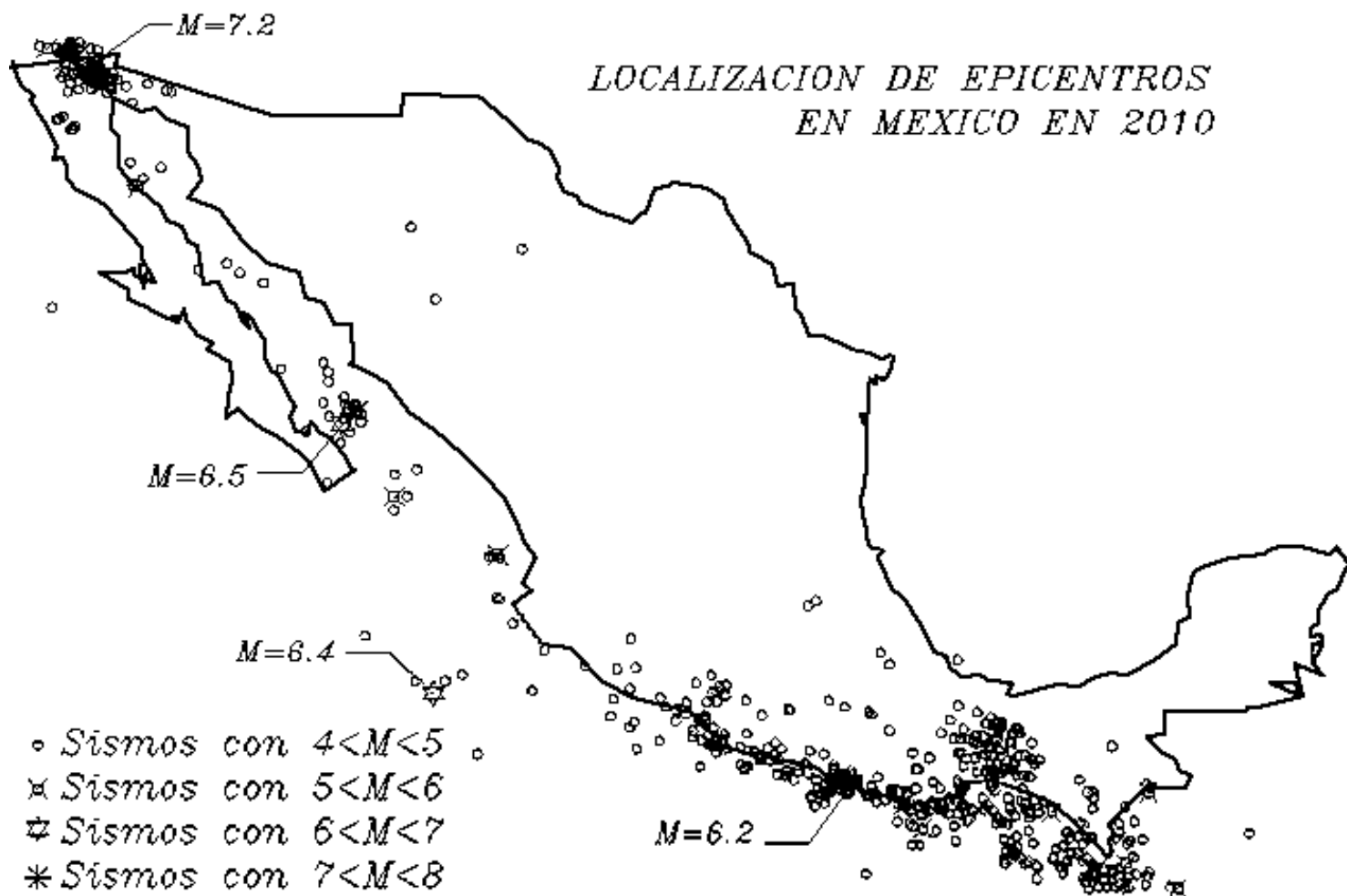
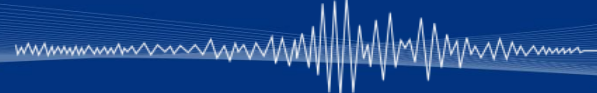


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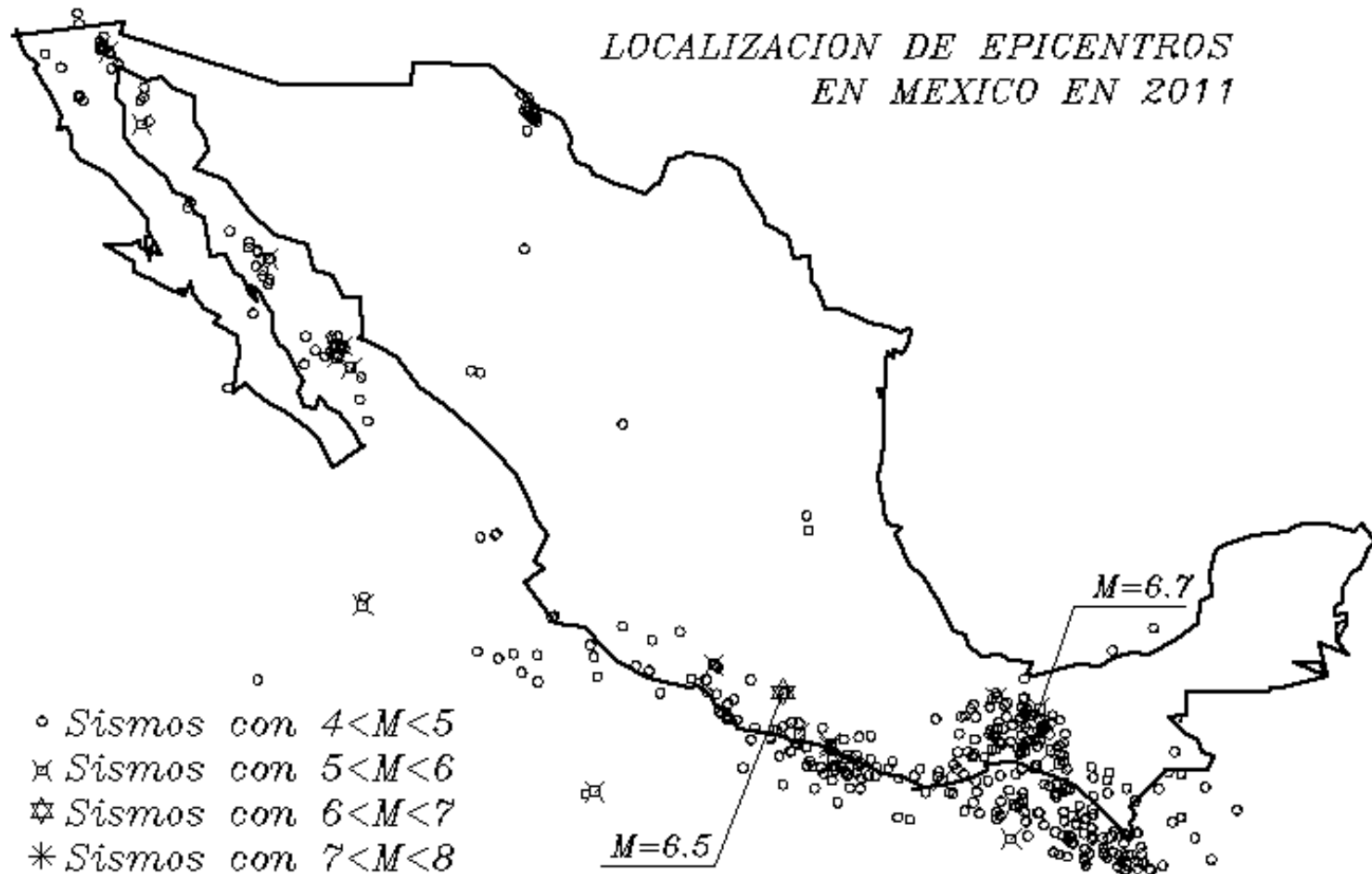


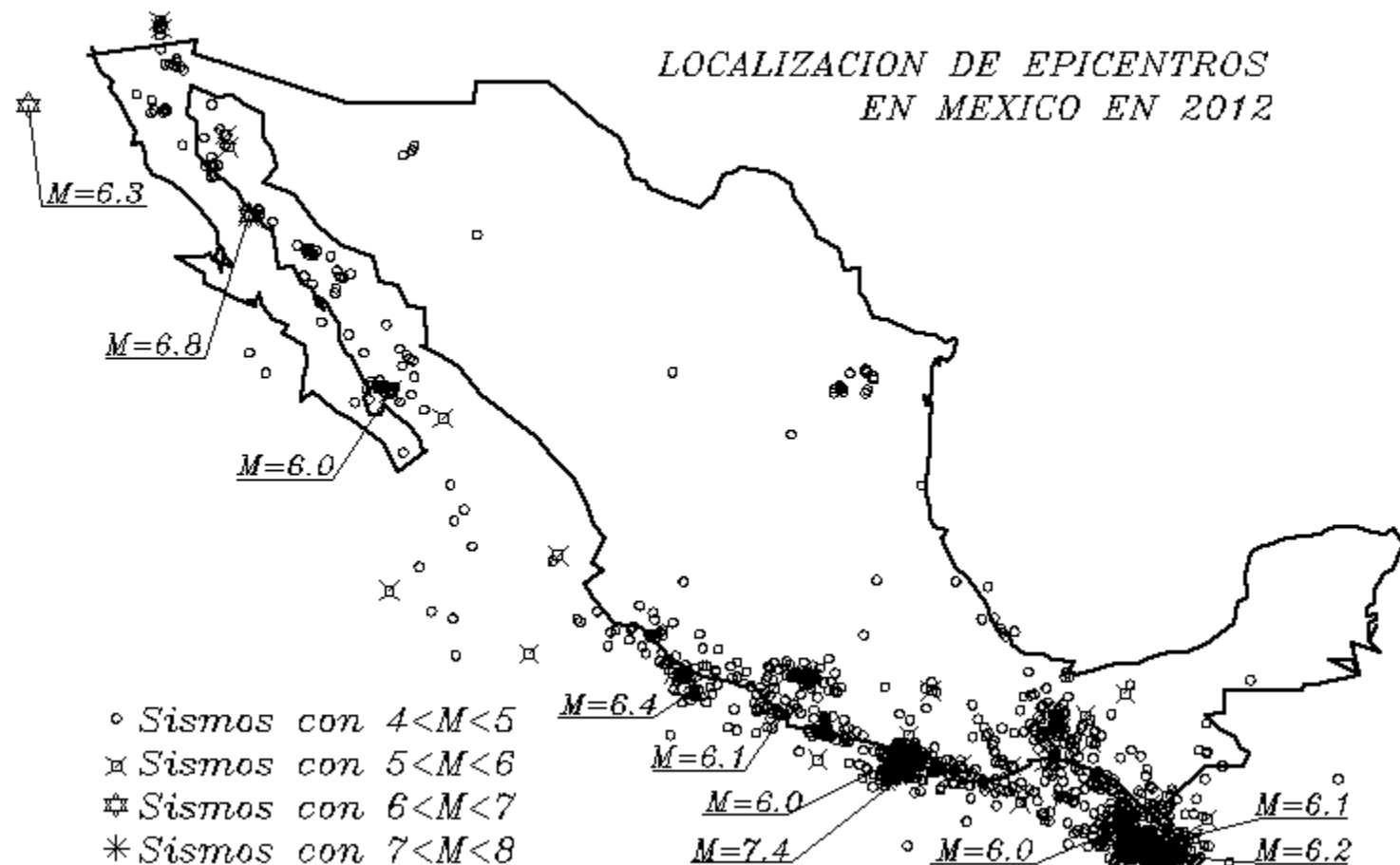
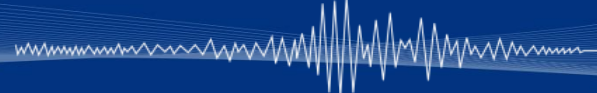






LOCALIZACION DE EPICENTROS  
EN MEXICO EN 2011

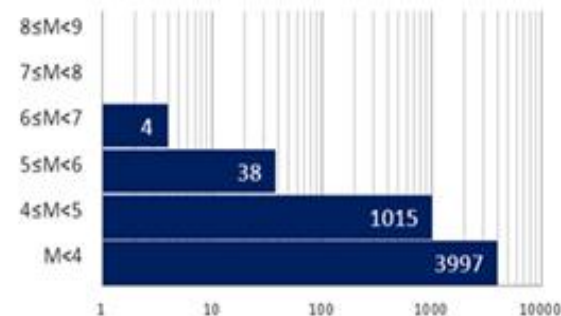






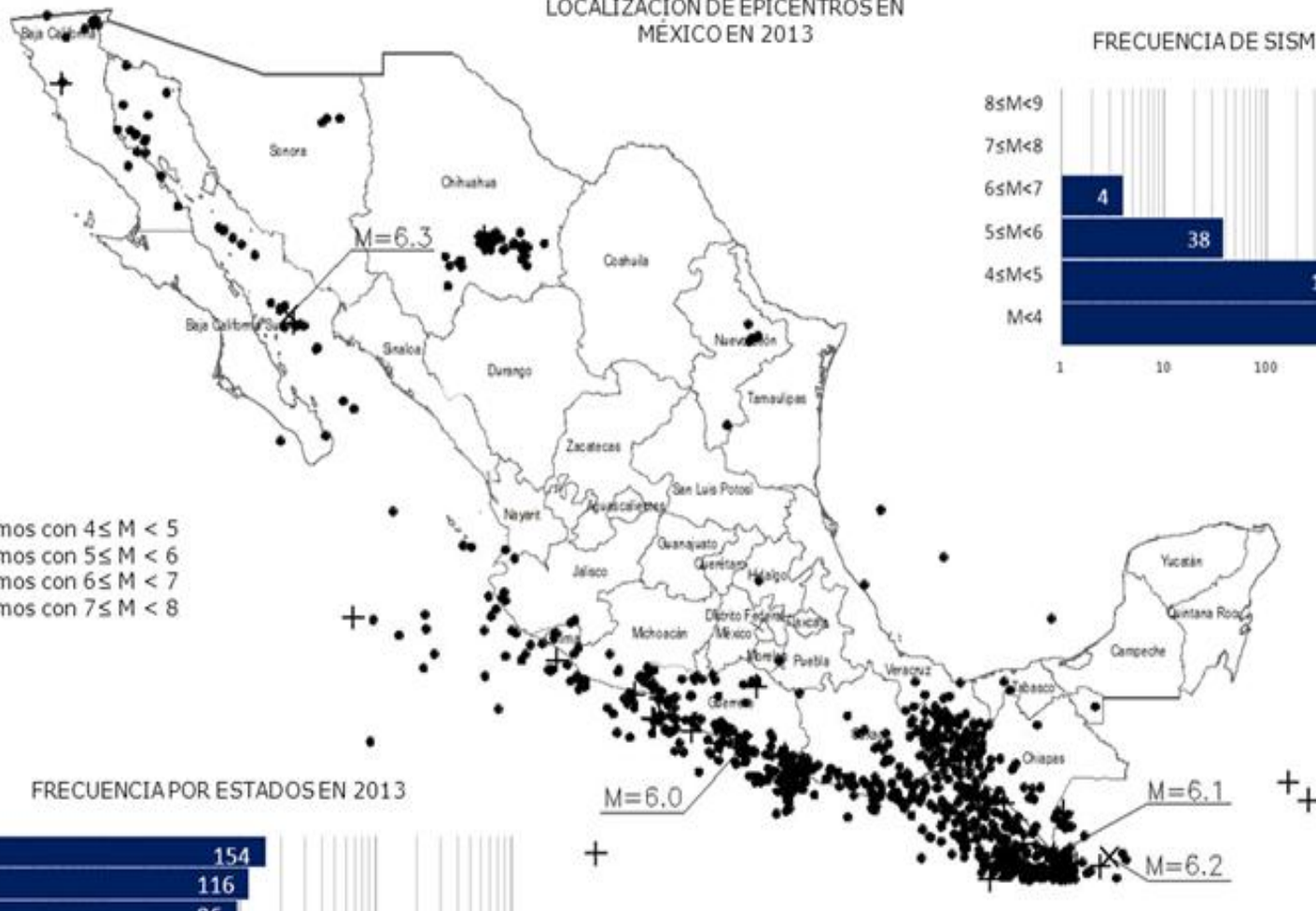
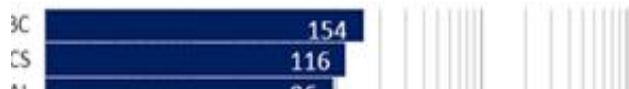
LOCALIZACIÓN DE EPICENTROS EN MÉXICO EN 2013

FRECUENCIA DE SISMOS EN 2013



- Sismos con  $4 \leq M < 5$
- + Sismos con  $5 \leq M < 6$
- x Sismos con  $6 \leq M < 7$
- \* Sismos con  $7 \leq M < 8$

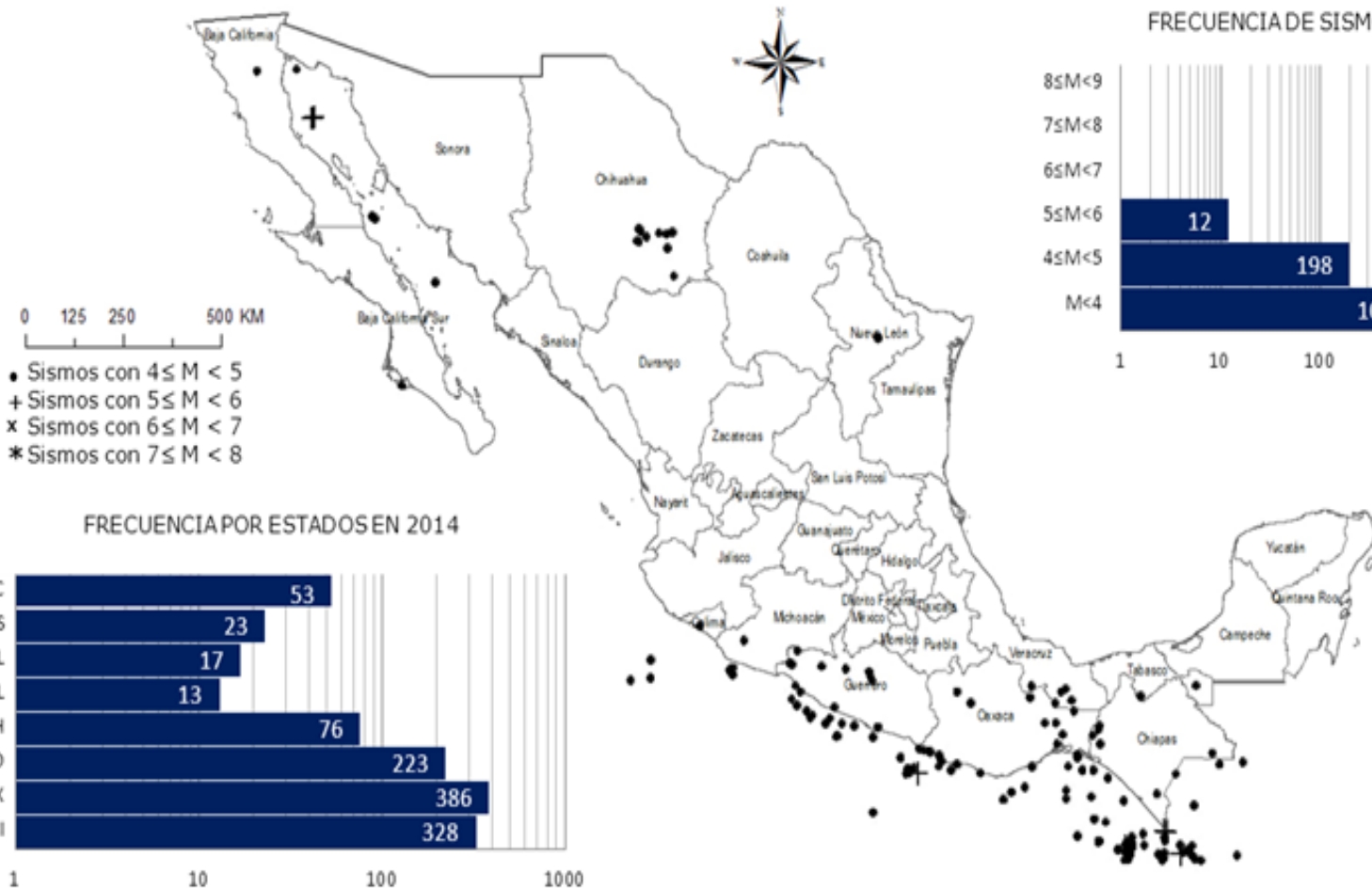
FRECUENCIA POR ESTADOS EN 2013

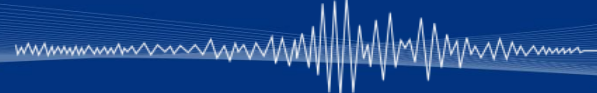




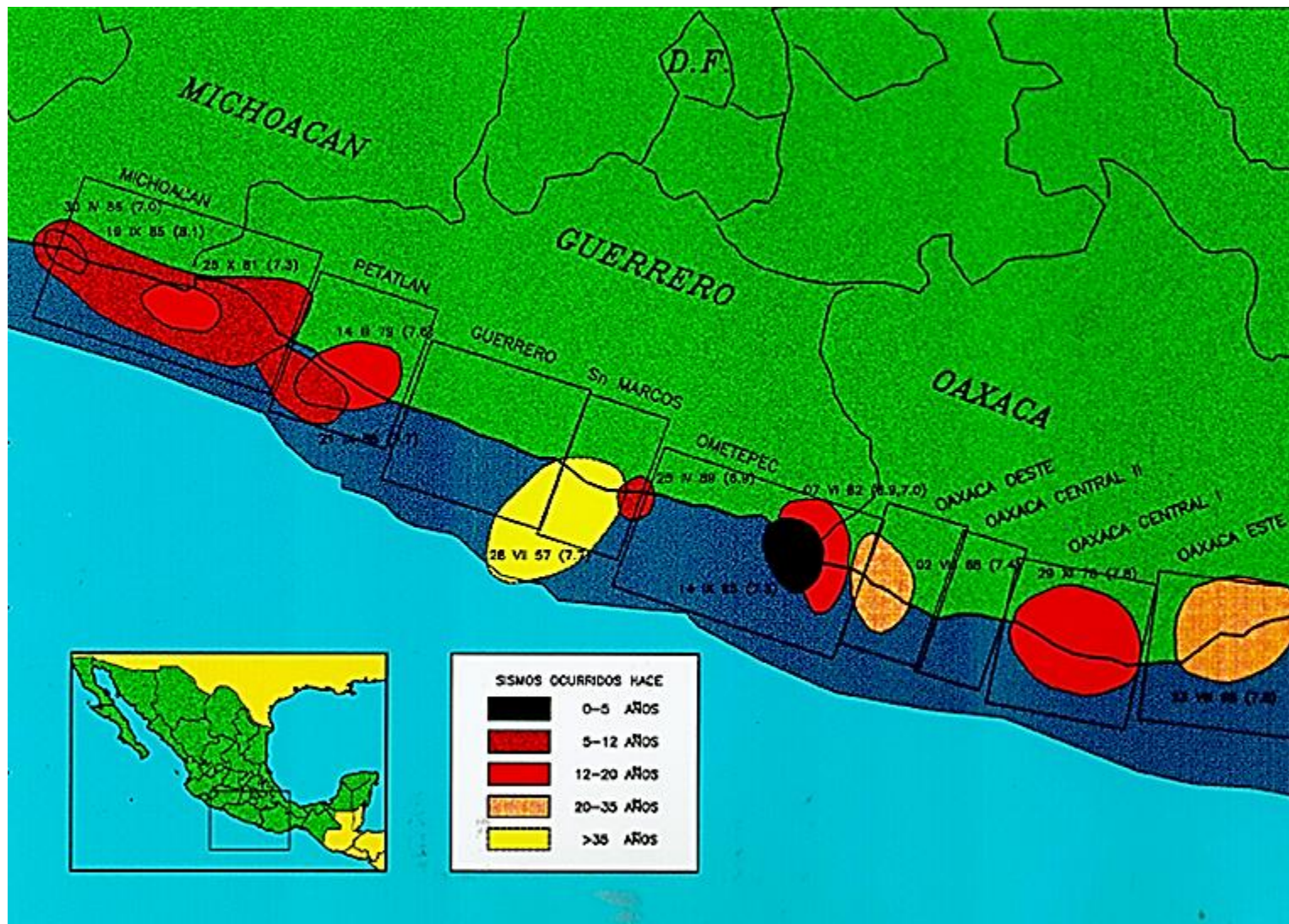


## LOCALIZACIÓN DE EPICENTROS EN MÉXICO EN 2014

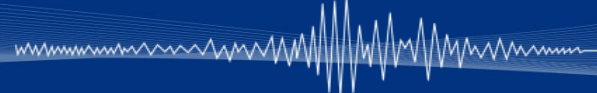




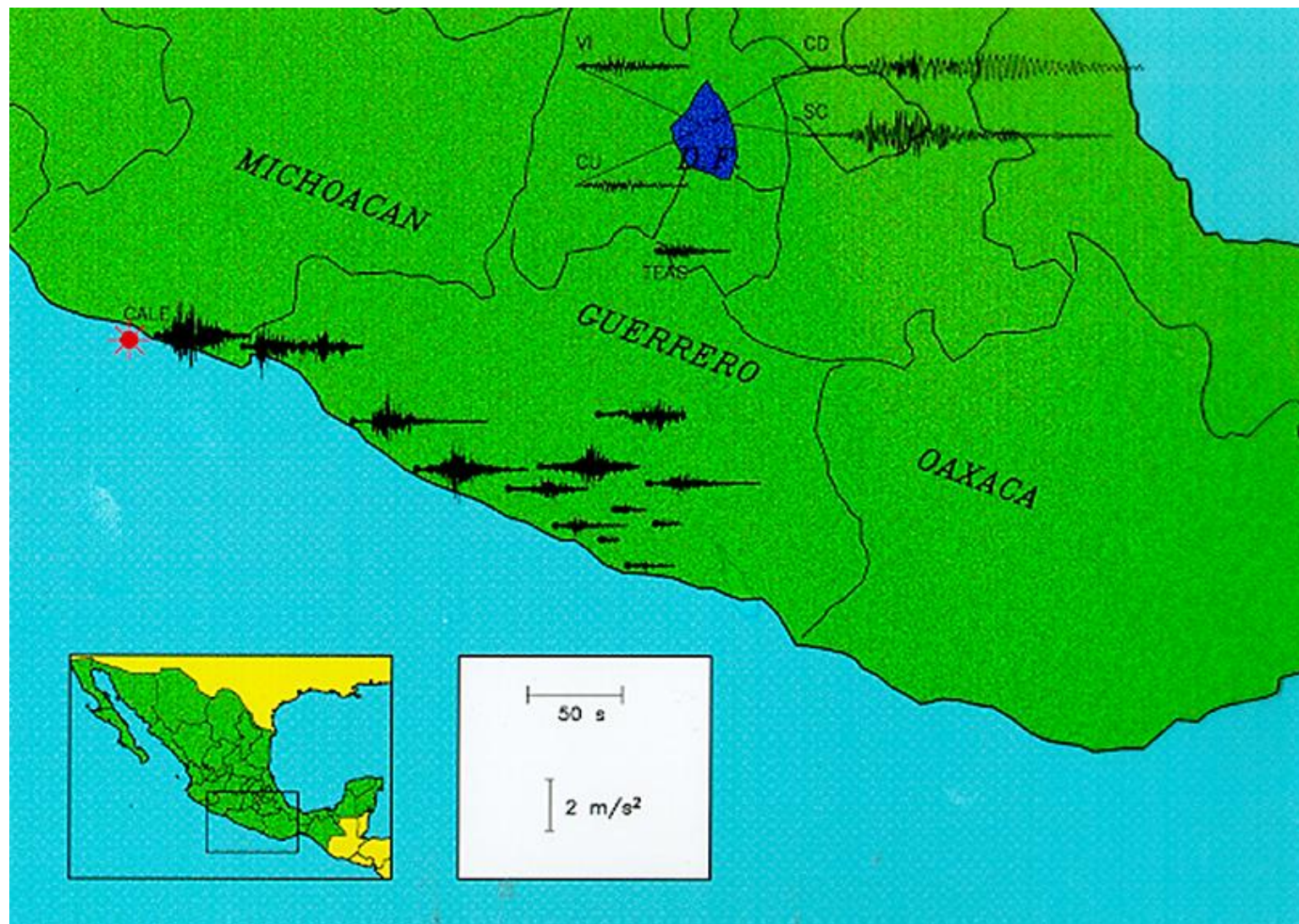
CHANGES IN SEISMIC RESPONSE

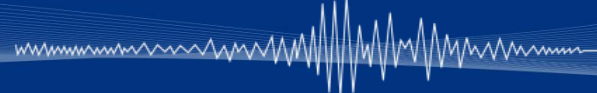




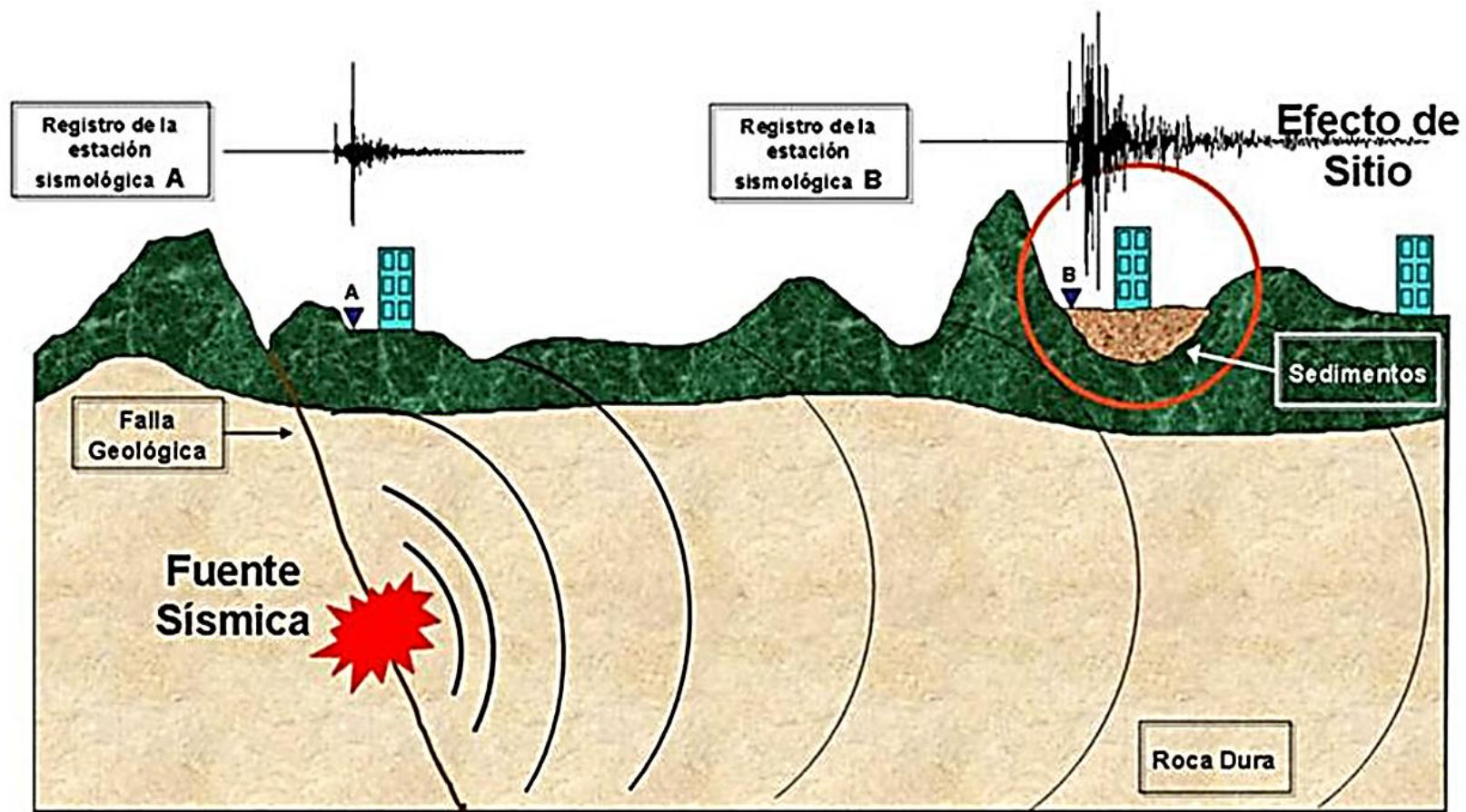


CHANGES IN SEISMIC RESPONSE

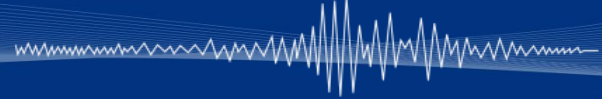




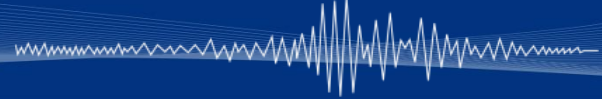
CHANGES IN SEISMIC RESPONSE





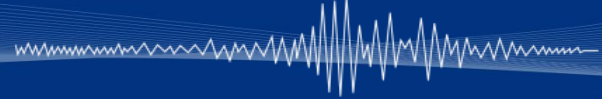


**1985, MEXICO EARTHQUAKE,  $M=8.1$**



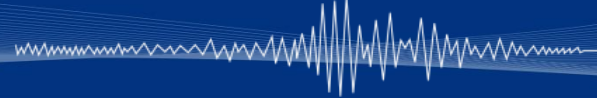
**1999, TEHUACAN EARTHQUAKE,  $M=6.7$**





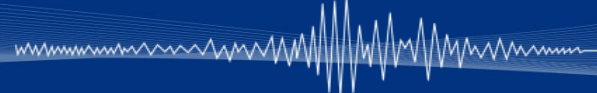
**1999, TEHUACAN EARTHQUAKE,  $M=6.7$**

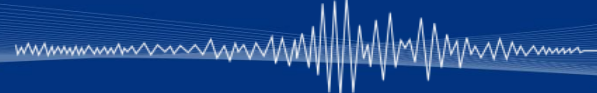




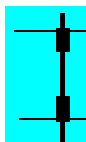
**1999, TEHUACAN EARTHQUAKE,  $M=6.7$**







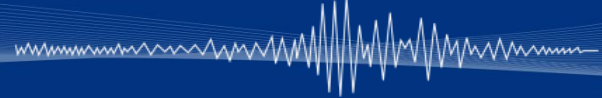
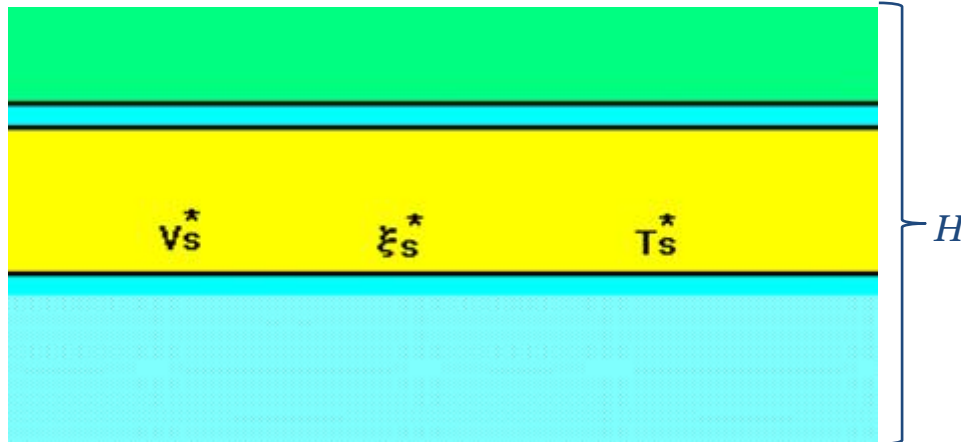
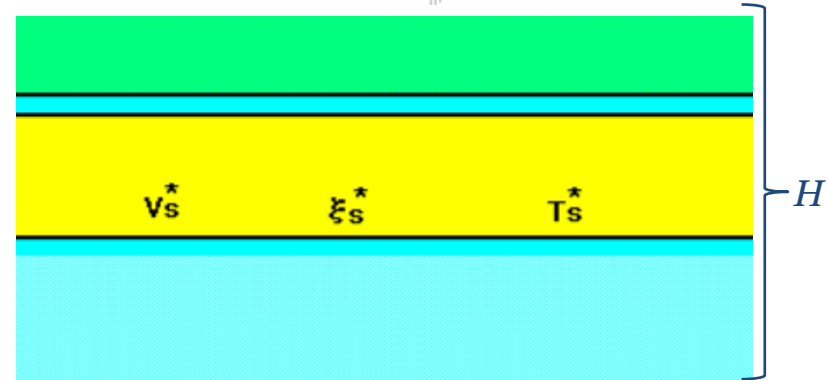
1910



2010

**GROUND SURFACE SUBSIDENCE**

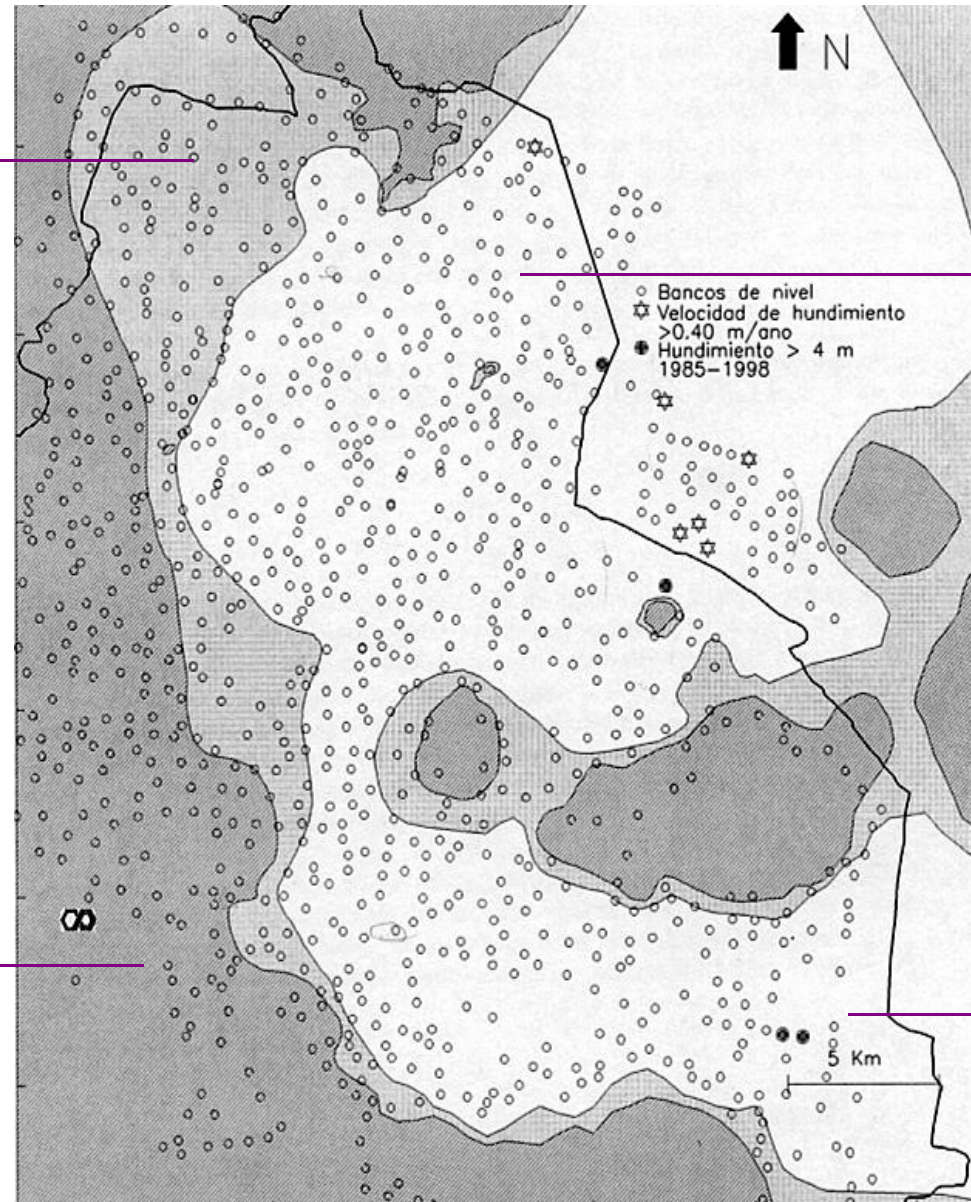


**BEFORE****AFTER****- THICKNESS****- SHEAR WAVE VELOCITY****- MATERIAL DAMPING****- FUNDAMENTAL PERIOD****EFFECT IN SOIL DYNAMICS PROPERTIES**



TRANSITION ZONE

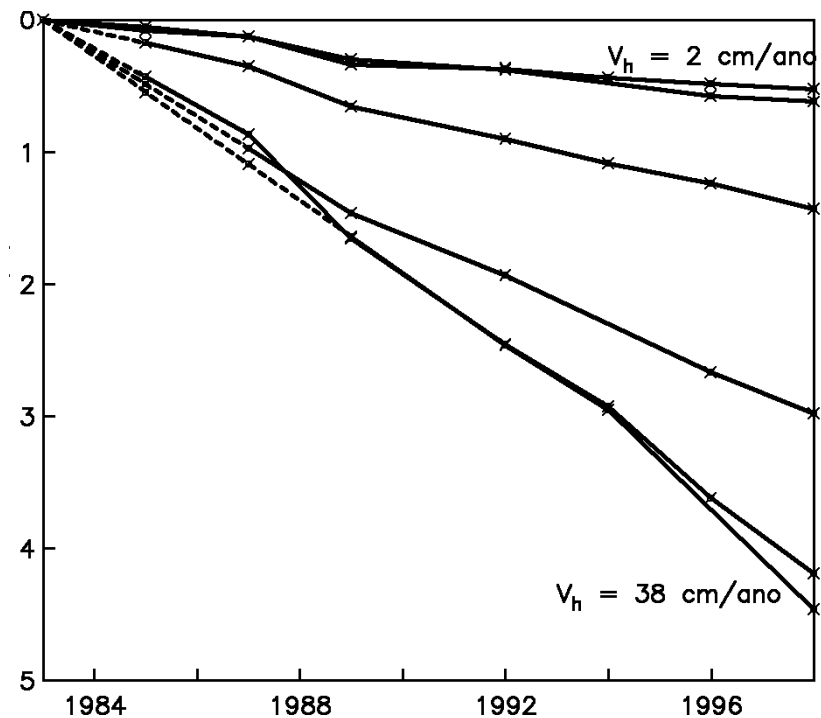
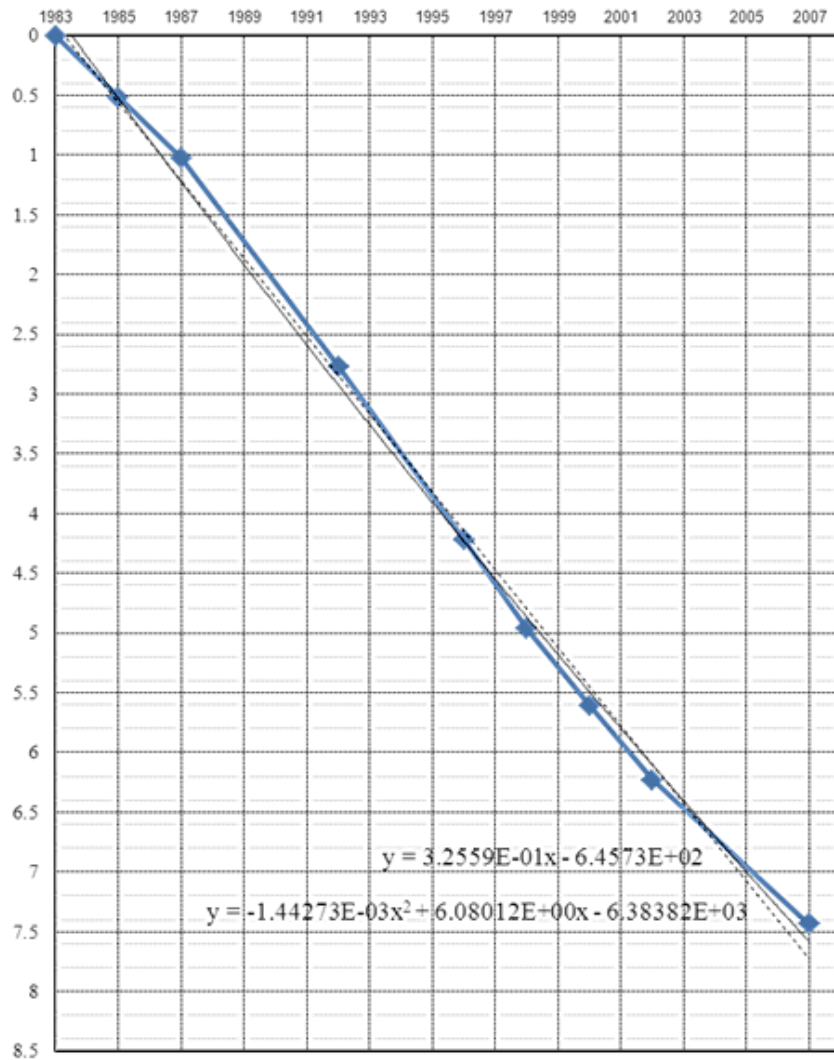
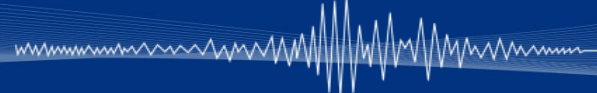
HILL ZONE

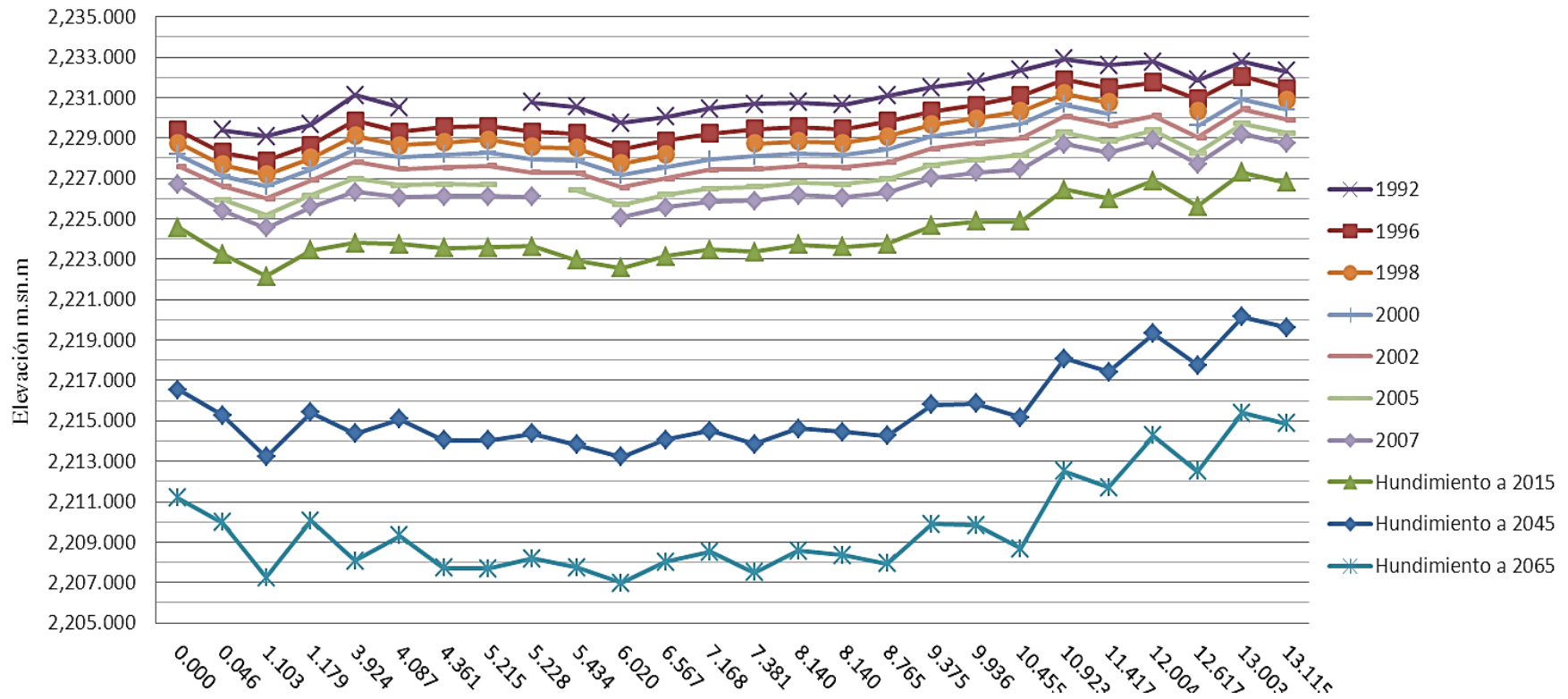


LAKE ZONE  
HIGHLY  
COMPRESSIBLE  
CLAYS

LAKE ZONE  
HIGHLY  
COMPRESSIBLE  
CLAYS

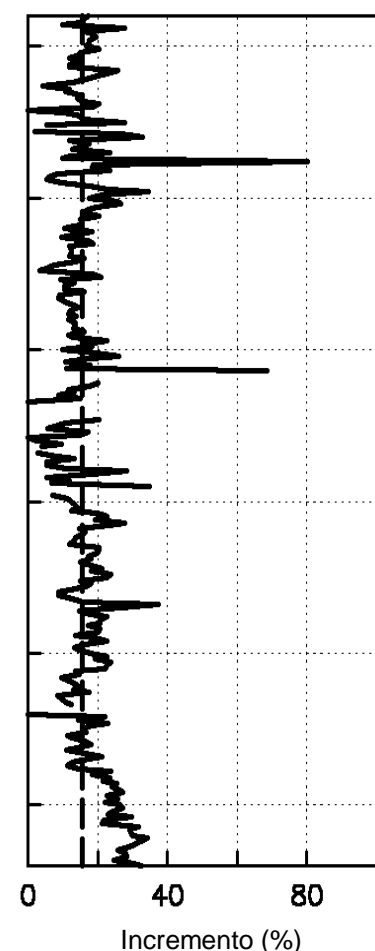
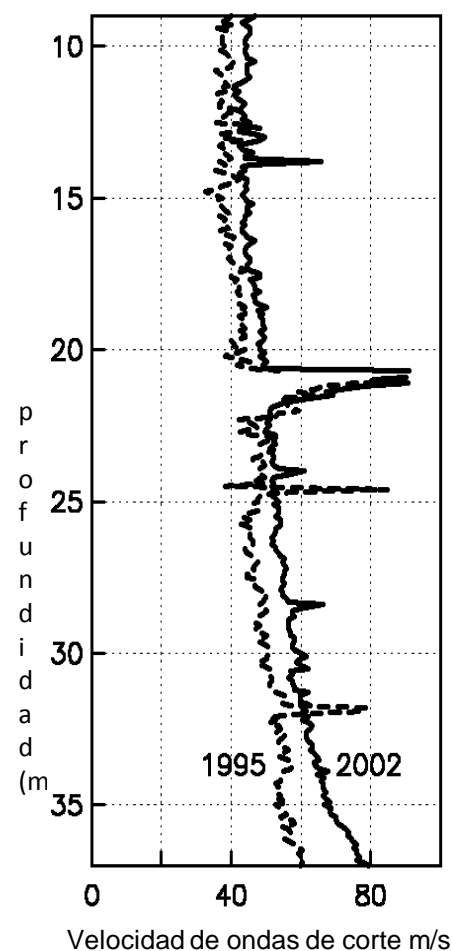
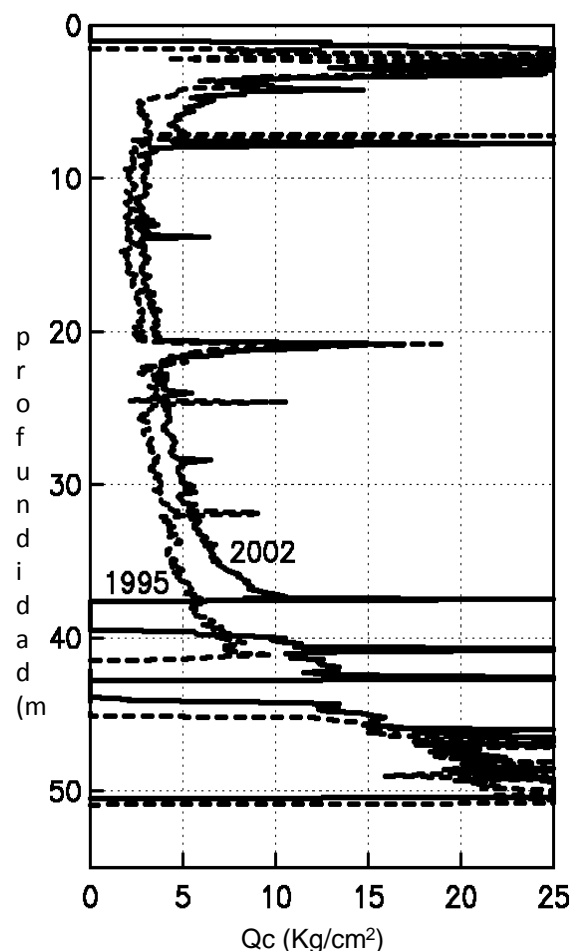








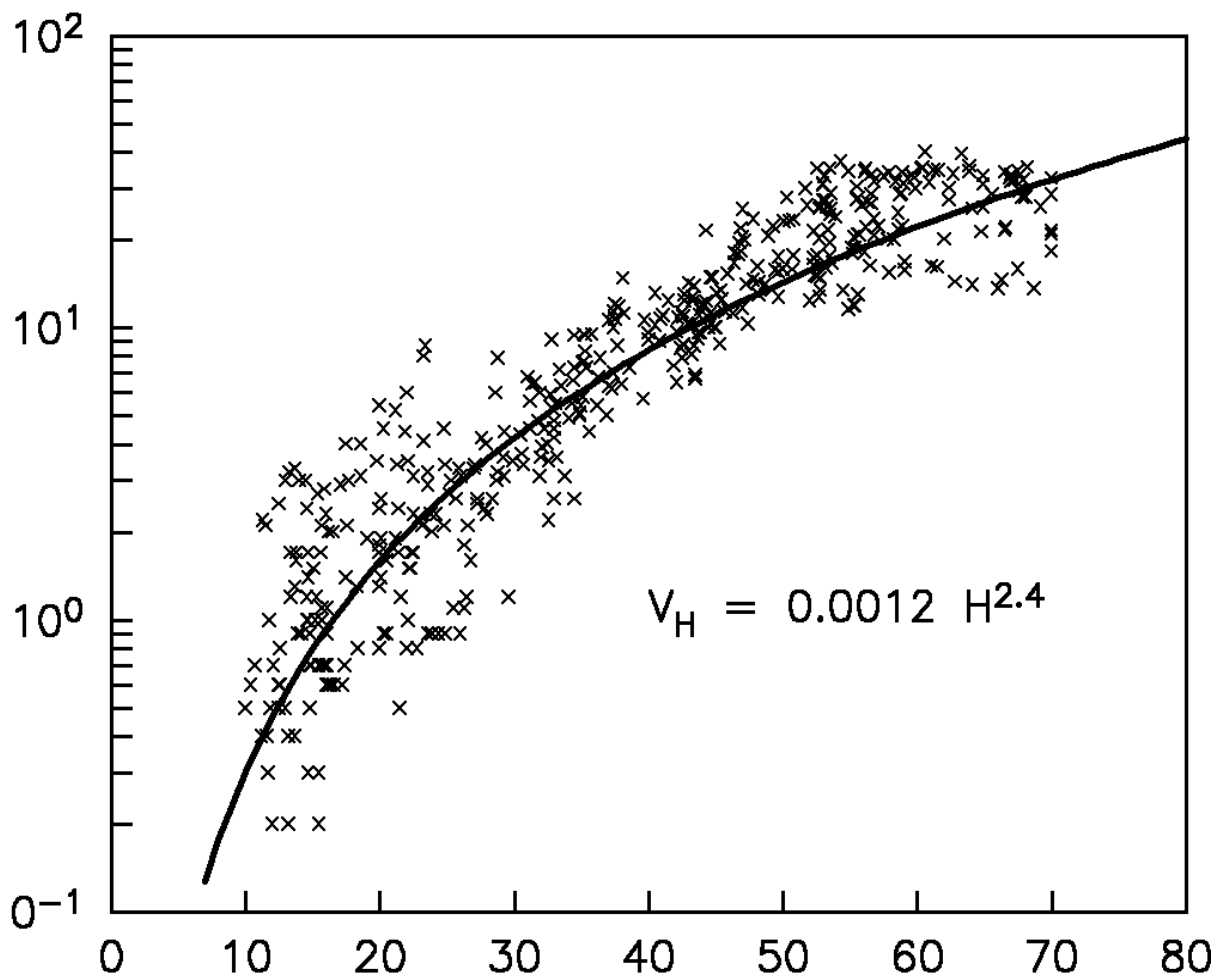
CHANGES  
IN  
SEISMIC  
RESPONSE





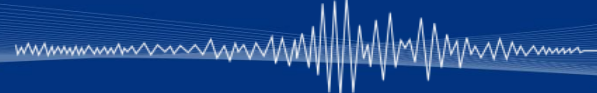


Settlement  
Velocity  
(cm/year)



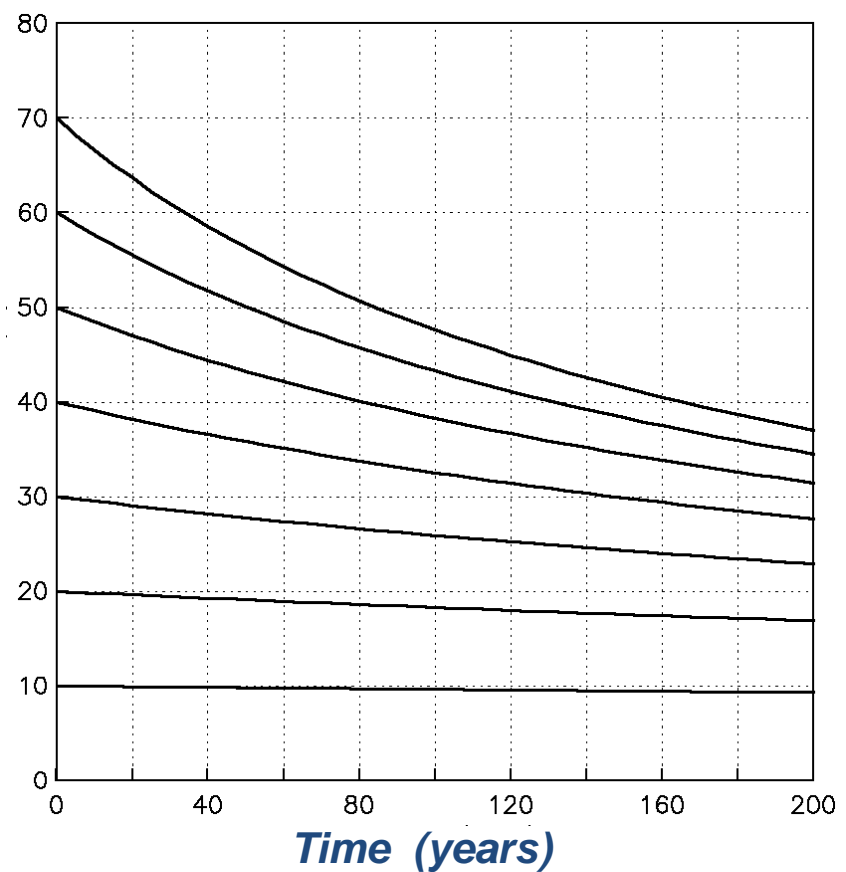
Thickness compressible layer (m)

**THICKNESS LAYER AND SETTLEMENT VELOCITY**

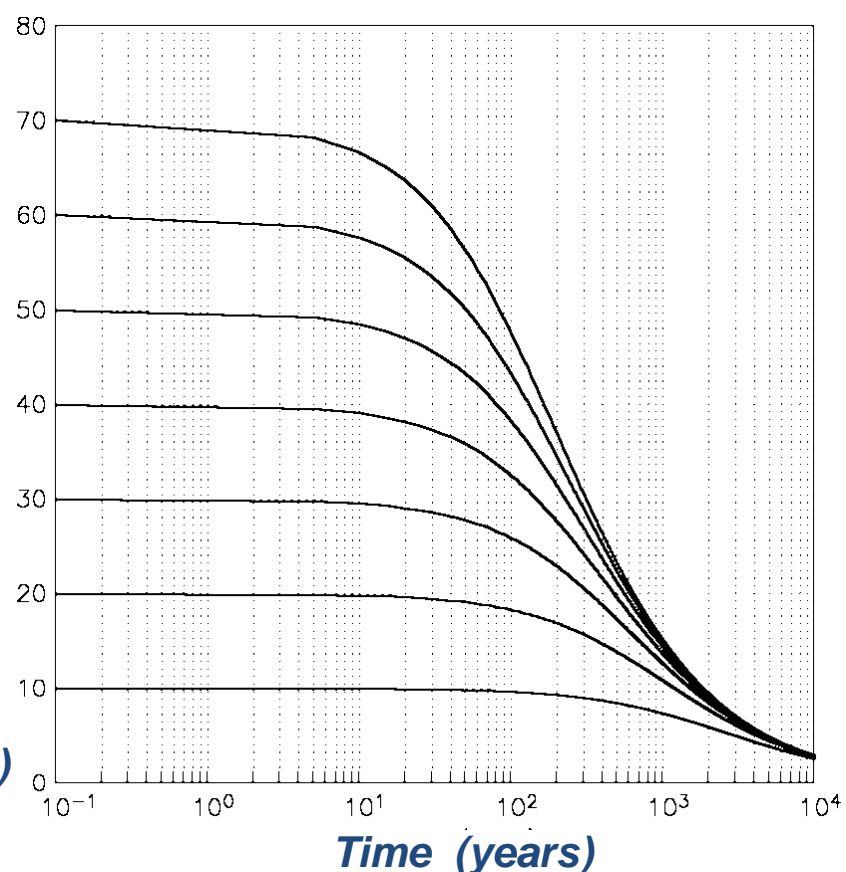


CHANGES IN SEISMIC RESPONSE

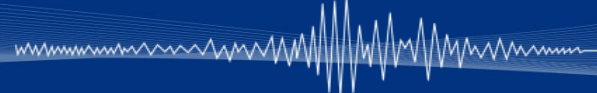
Thickness (m)



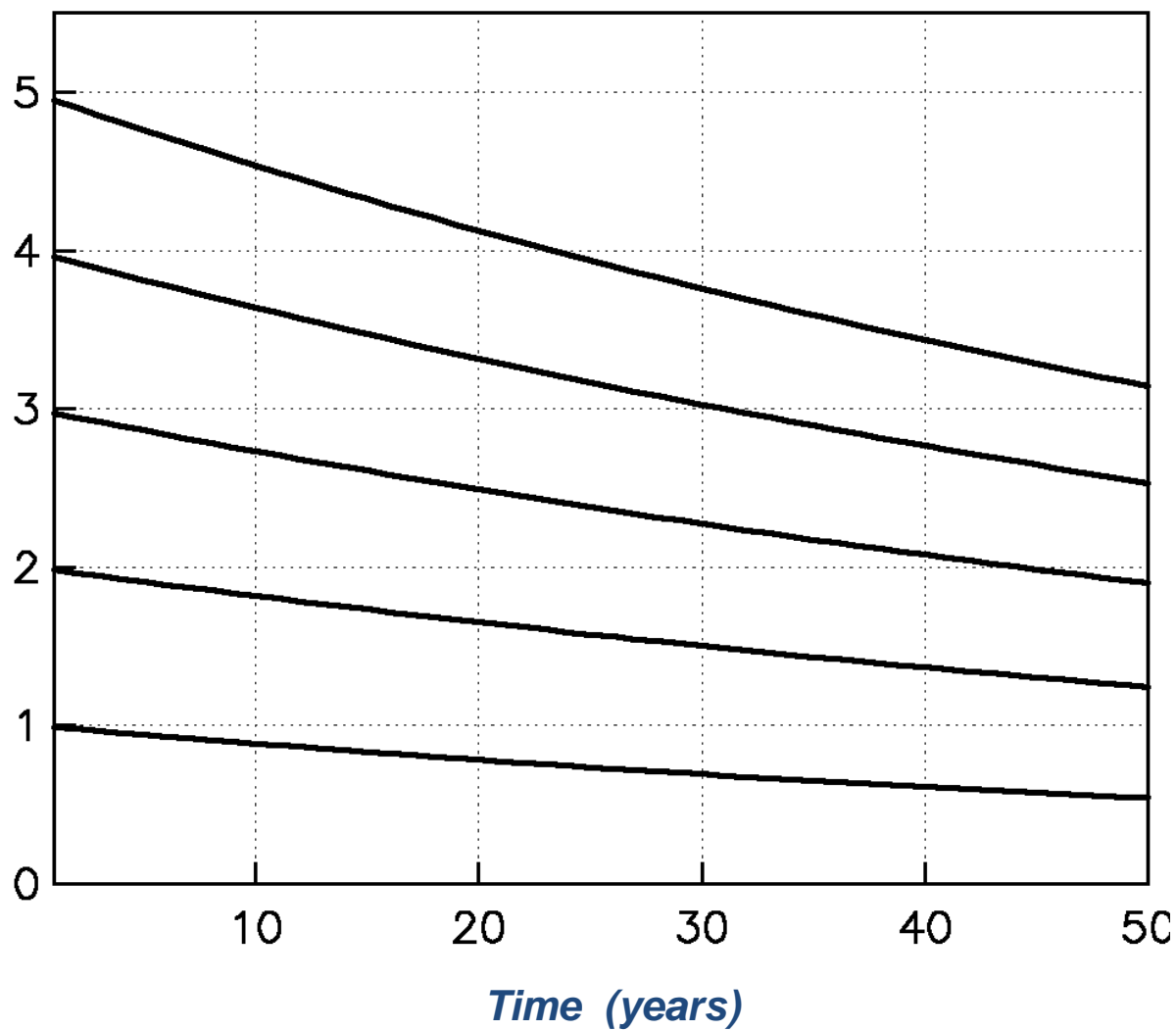
Thickness (m)

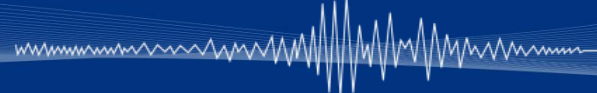




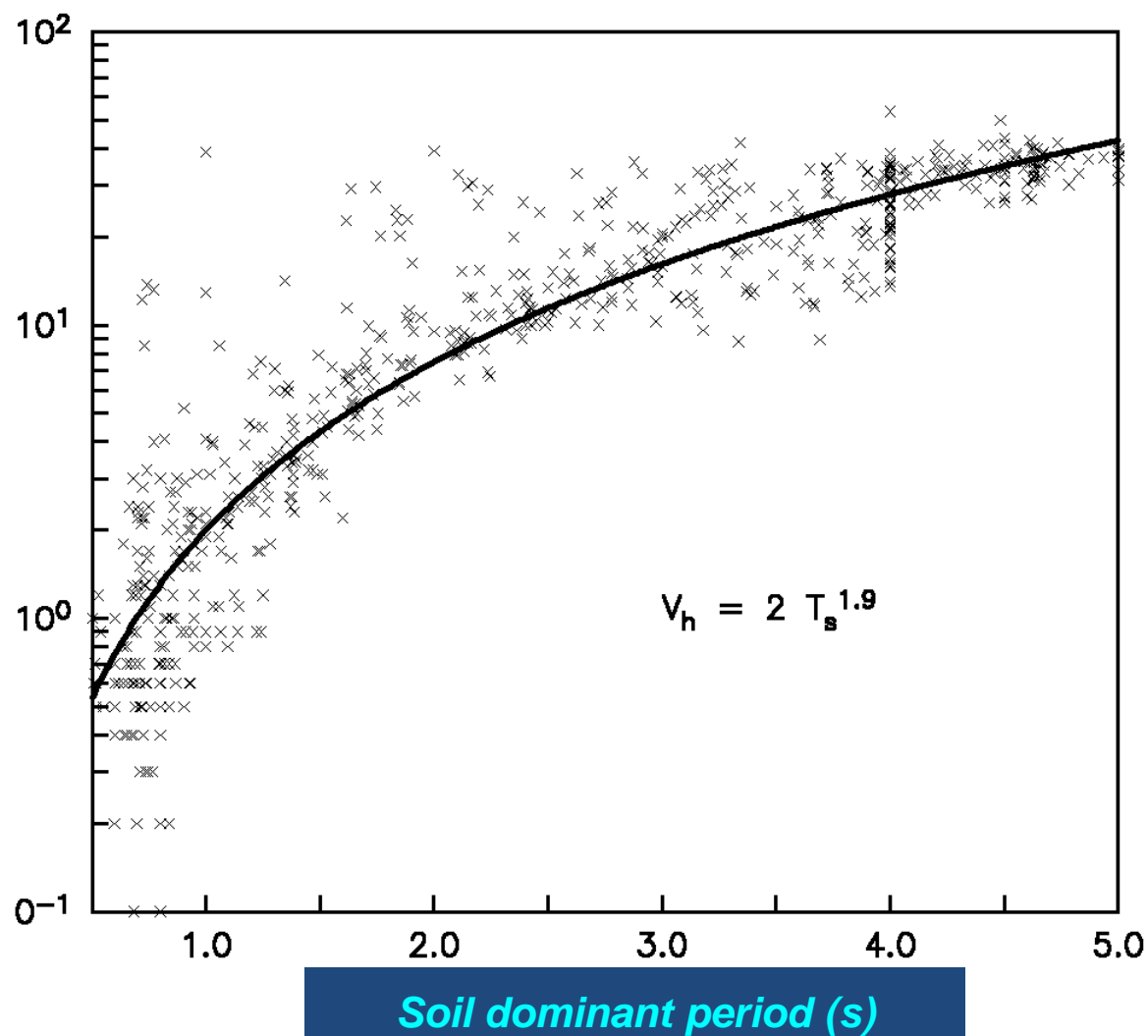


**Soil  
Dominant  
Period  
(s)**





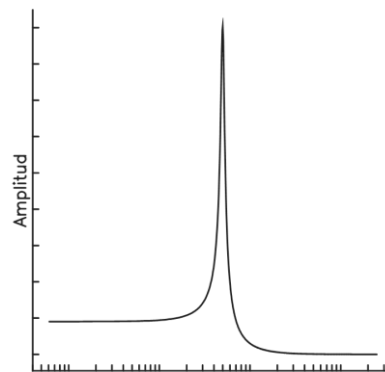
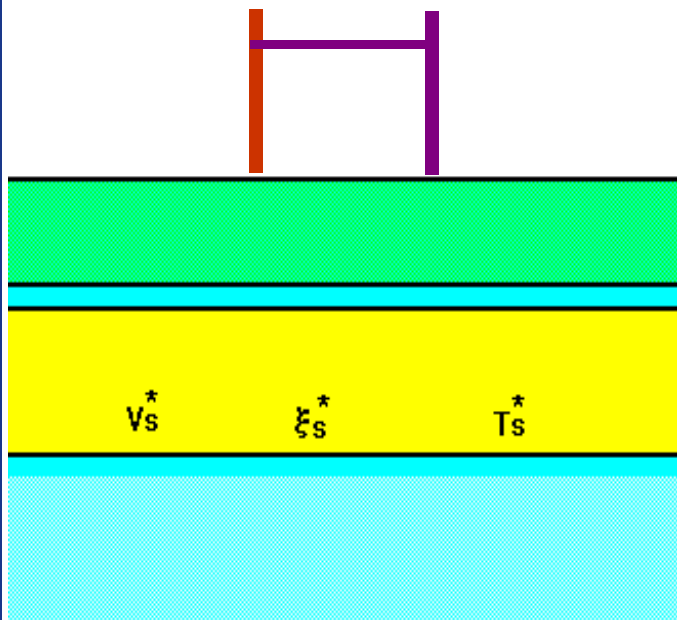
Settlement  
velocity  
(cm/year)



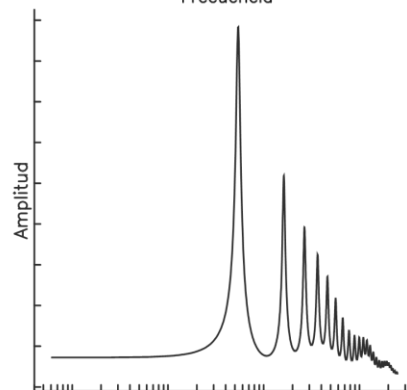




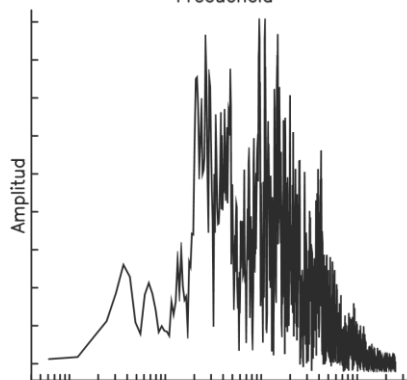
CHANGES  
IN  
SEISMIC  
RESPONSE



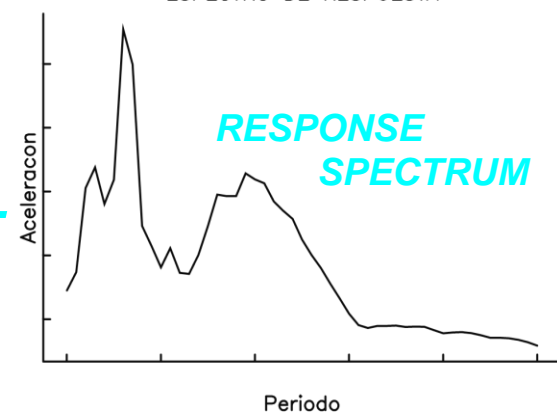
Frecuencia



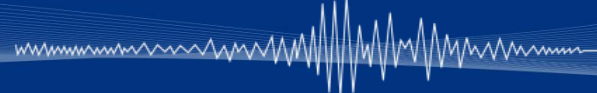
Frecuencia



Frecuencia

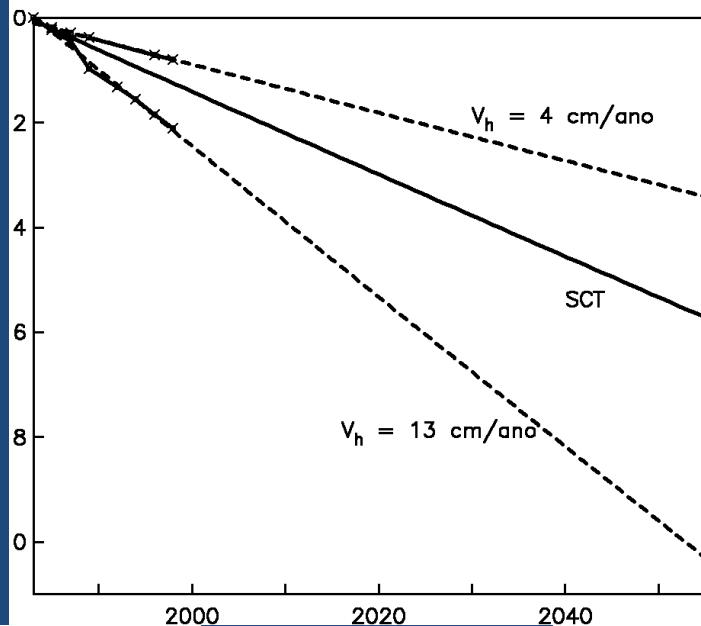


**SOIL DYNAMICS RESPONSE**



CHANGES IN SEISMIC RESPONSE

Settlement



Time (years)

BEFORE

AFTER

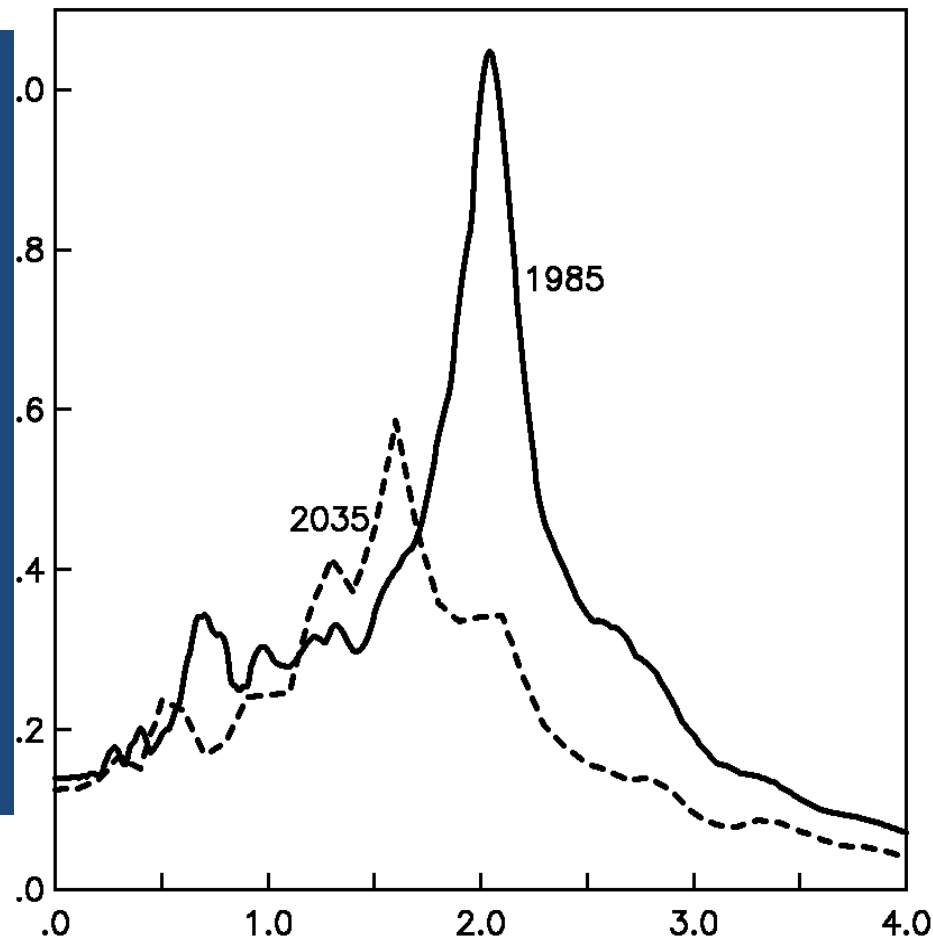
$H = 40 \text{ m} \dots\dots H^* = 36 \text{ m}$

$V_s = 80 \text{ m/s} \dots\dots V_s^* = 84 \text{ m/s}$

$T_s = 2 \text{ s} \dots\dots T_s^* = 1.6 \text{ s}$

Acceleration

(g)



Period (s)

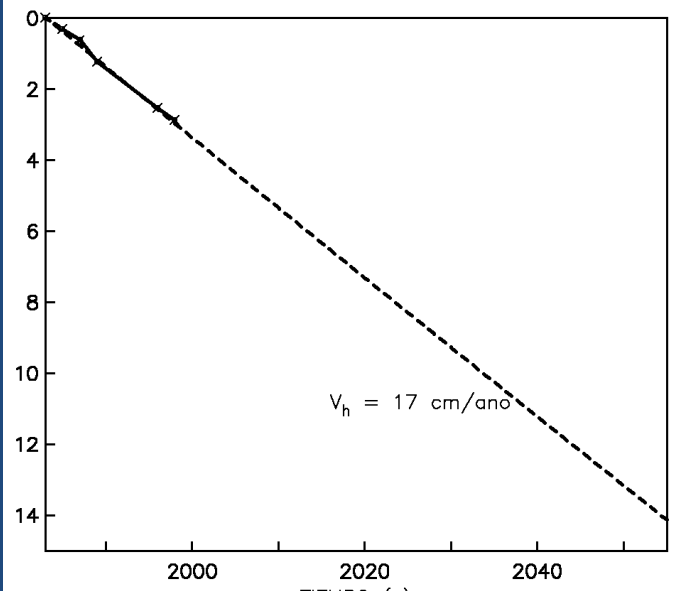
SEISMIC RESPONSE IN A SITE WITH  $T_s = 2 \text{ s}$





CHANGES IN SEISMIC RESPONSE

Settlement



Time (years)

BEFORE

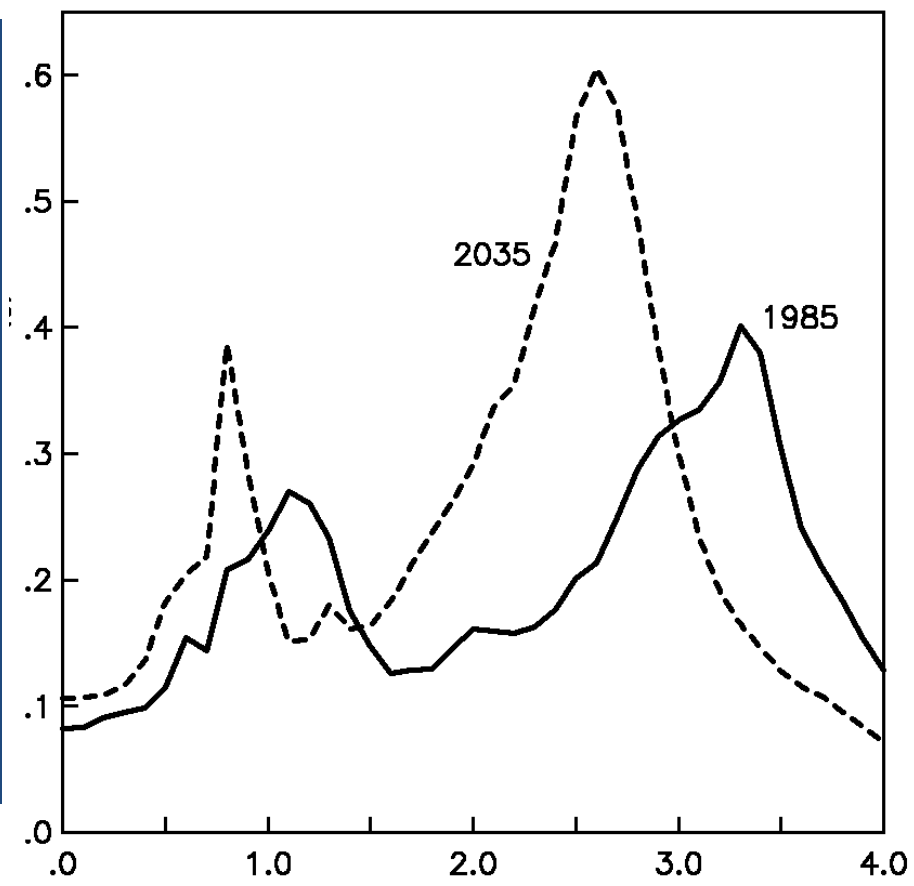
AFTER

$H = 51 \text{ m} \dots\dots H^* = 41 \text{ m}$

$V_s = 63 \text{ m/s} \dots V_s^* = 67 \text{ m/s}$

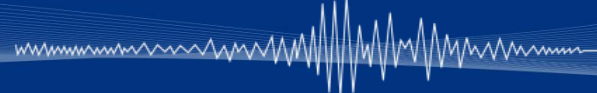
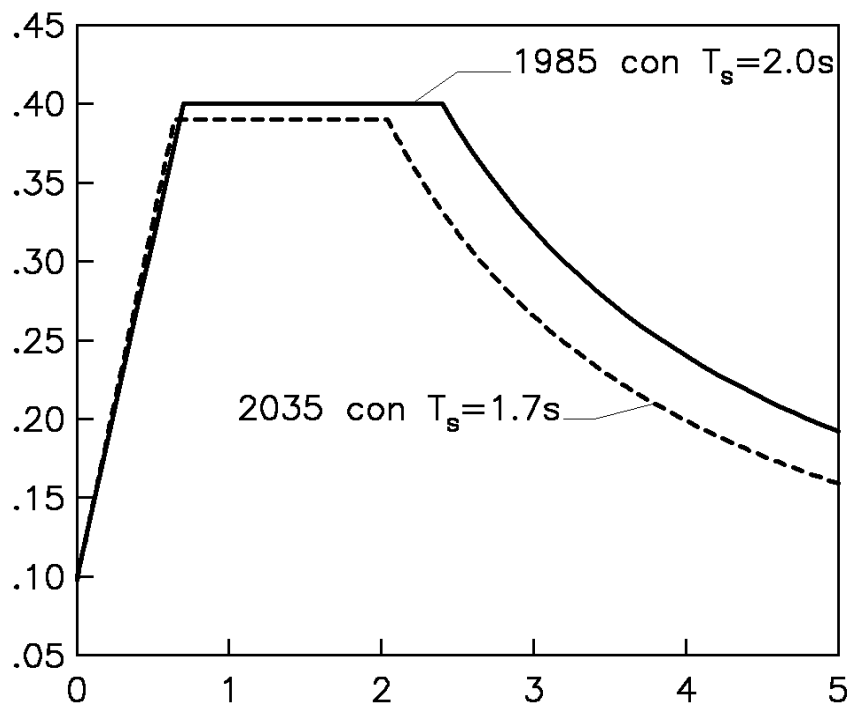
$T_s = 3.3 \text{ s} \dots\dots\dots T_s^* = 2.4 \text{ s}$

Acceleration (g)

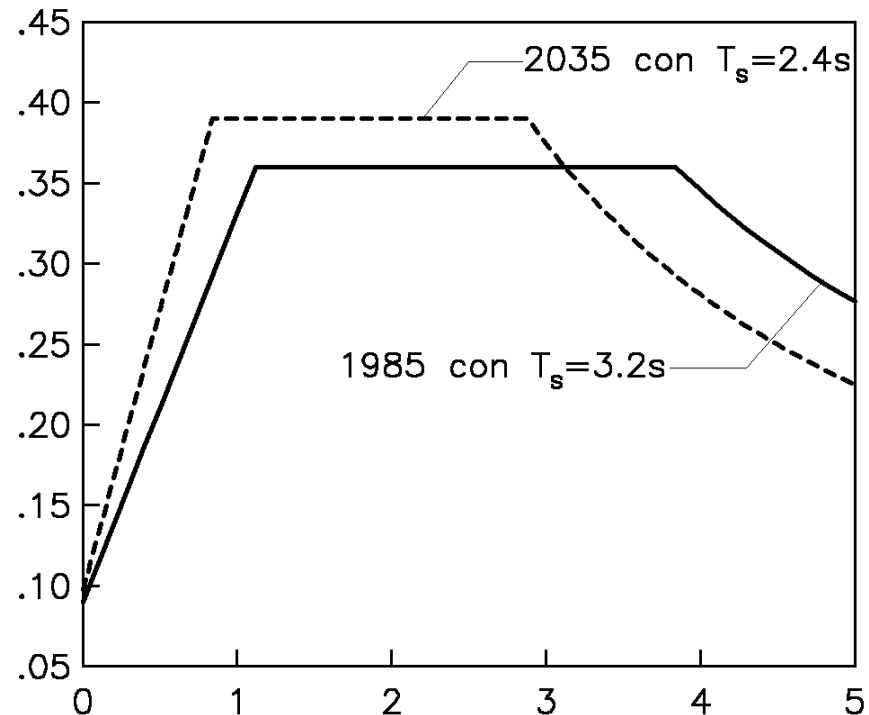


Period (s)

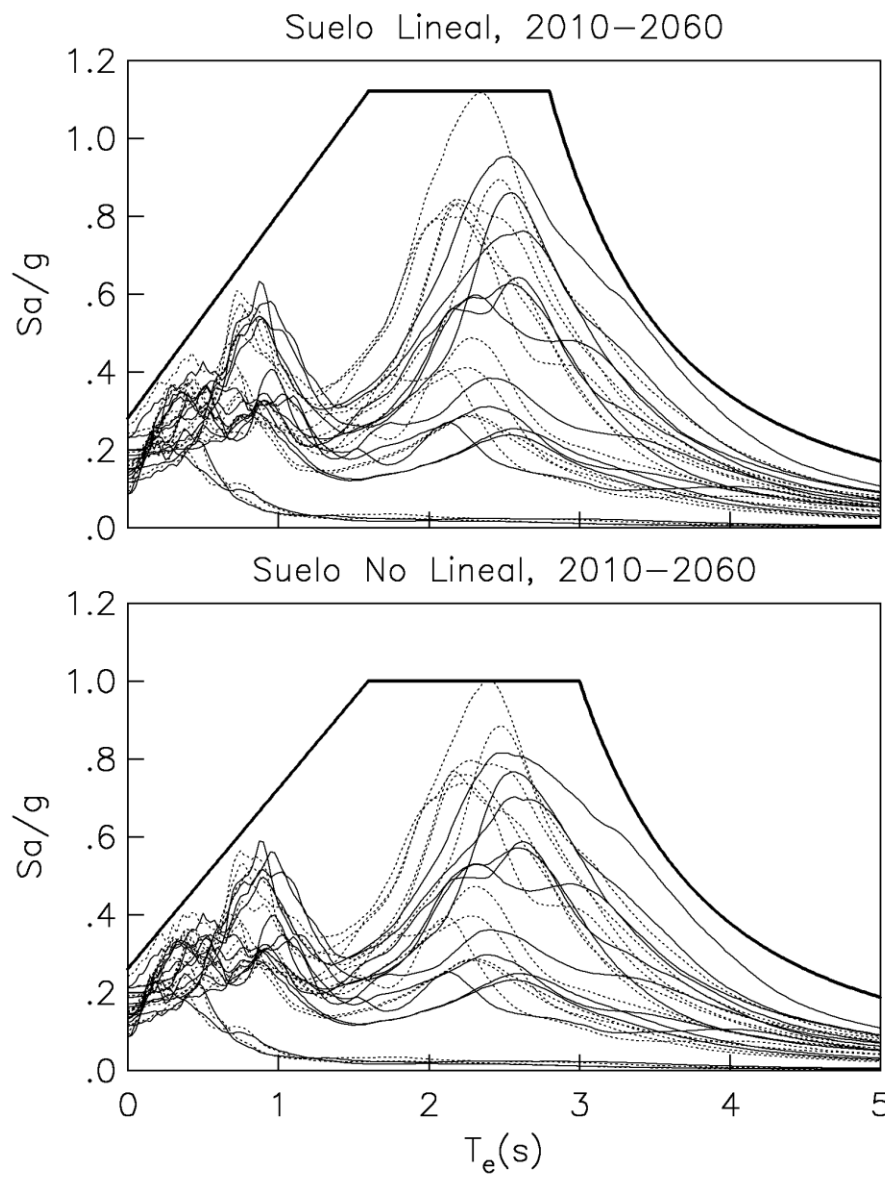
SEISMIC RESPONSE IN A SITE WITH  $T_s = 3.3 \text{ s}$

SITE WITH  $T_s = 2.0$  s

Period (s)

SITE WITH  $T_s = 3.2$  s

Period (s)

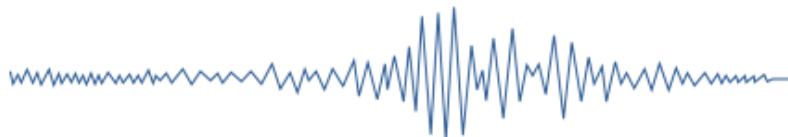




## CONCLUSIONS

### IN MEXICO CITY:

1. **THE GROUND SURFACE SUBSIDENCE AFFECTS SOIL DYNAMICS PROPERTIES**
2. **THE CHANGES OF THE SHEAR WAVE VELOCITY AND THICKNESS LAYER IN THE TIME, CONTROL THE SOIL DYNAMIC RESPONSE**
3. **THE DOMINANT PERIOD AND THE SOIL DYNAMIC RESPONSE COULD STRONGLY CHANGE DURING THE LIFE SERVICE OF STRUCTURES**
4. **IN FUTURE, SOME STRUCTURES IN MEXICO'S VALLEY COULD BE IN DANGER DUE TO CHANGES IN SOIL DYNAMIC PROPERTIES AND ITS RESPONSE**
5. **TODAY THE CODE IS BEEN IMPROVED TO TAKE IN COUNT THIS PHENOMENON**



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**THANKS FOR YOUR ATENTION**