



UNIVERSIDAD MICHOACANA DE SAN NICOLÁS DE HIDALGO



INSTITUTO DE INVESTIGACIONES EN CIENCIAS DE LA TIERRA

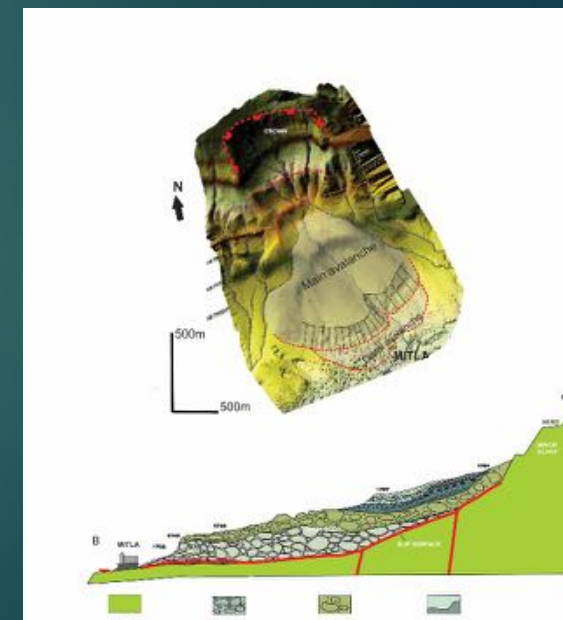
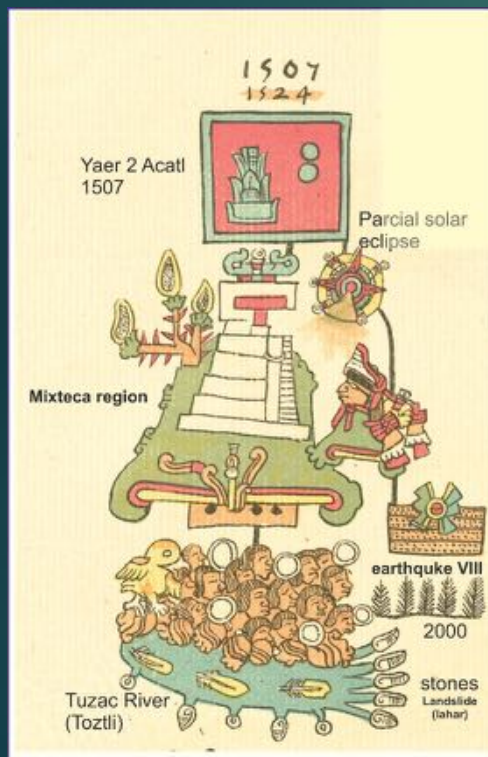
Dipartimento di Scienze della Terra - Geologia applicata

STUDI DI ARCHEOSISMOLOGIA IN MESSICO: LA FRANA DI MITLA

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Prima di iniziare il mio seminario, vogliamo ringraziare Prof. Nicola Casagli e Stefano e tutti voi...

A questo séminario.....

- 1. Tectonic setting associated with paleoseismology and archeo-seismology studies**
- 2. Earthquakes poorly studied and misunderstood**
- 3. Pre-Columbian cultures and earthquakes**
- 4. Paleoseismology and Archeoseismology in the TMVB**
- 5. Mitla Fault and LANDSLIDE**
- 6. A Nahuatl intensities scale (before Mercalli.....)**

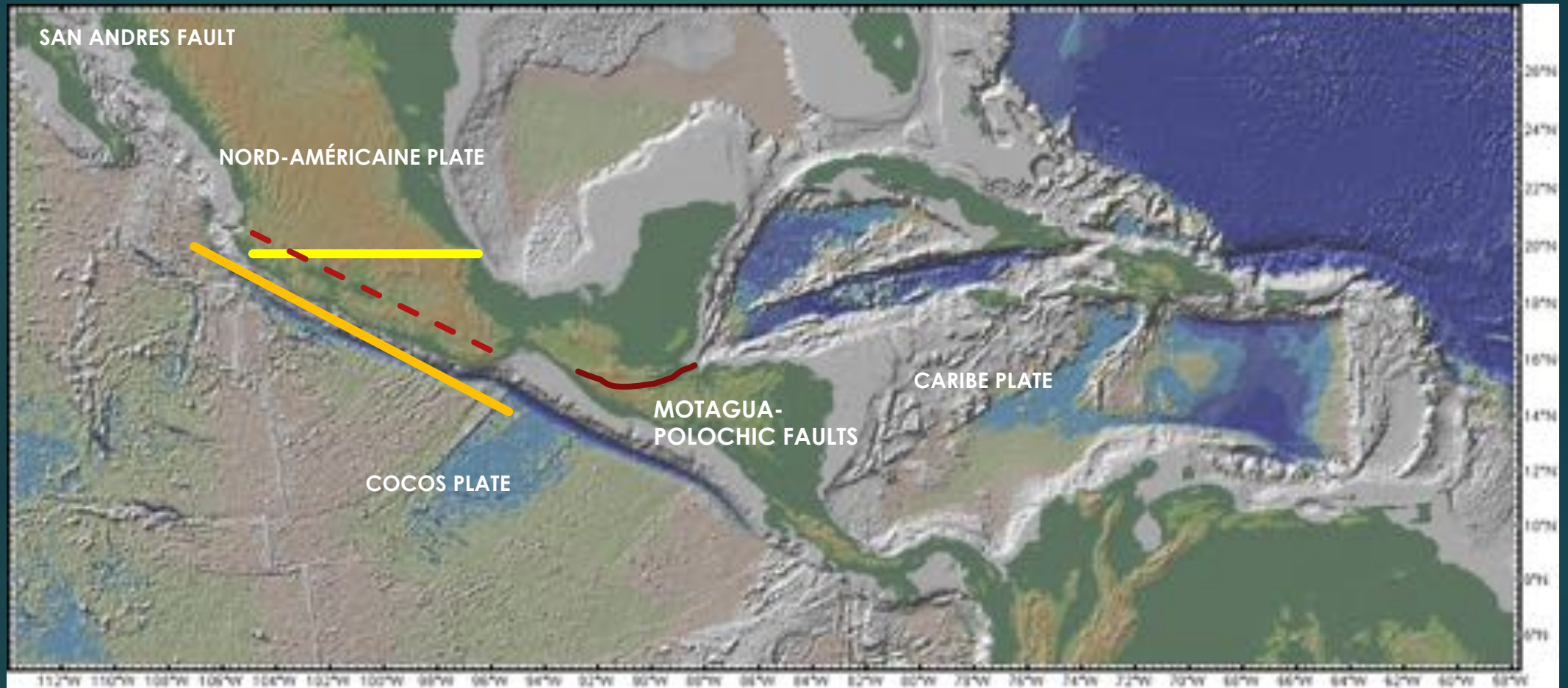
CASA NOSTRA.. MORELIA, MICHOACÁN



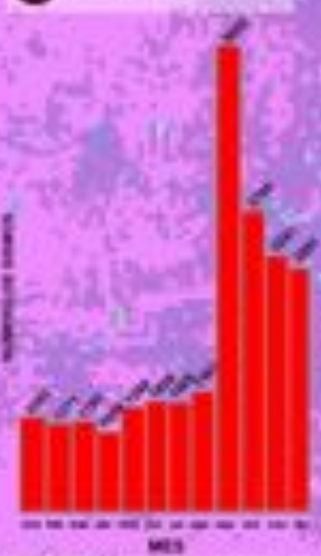
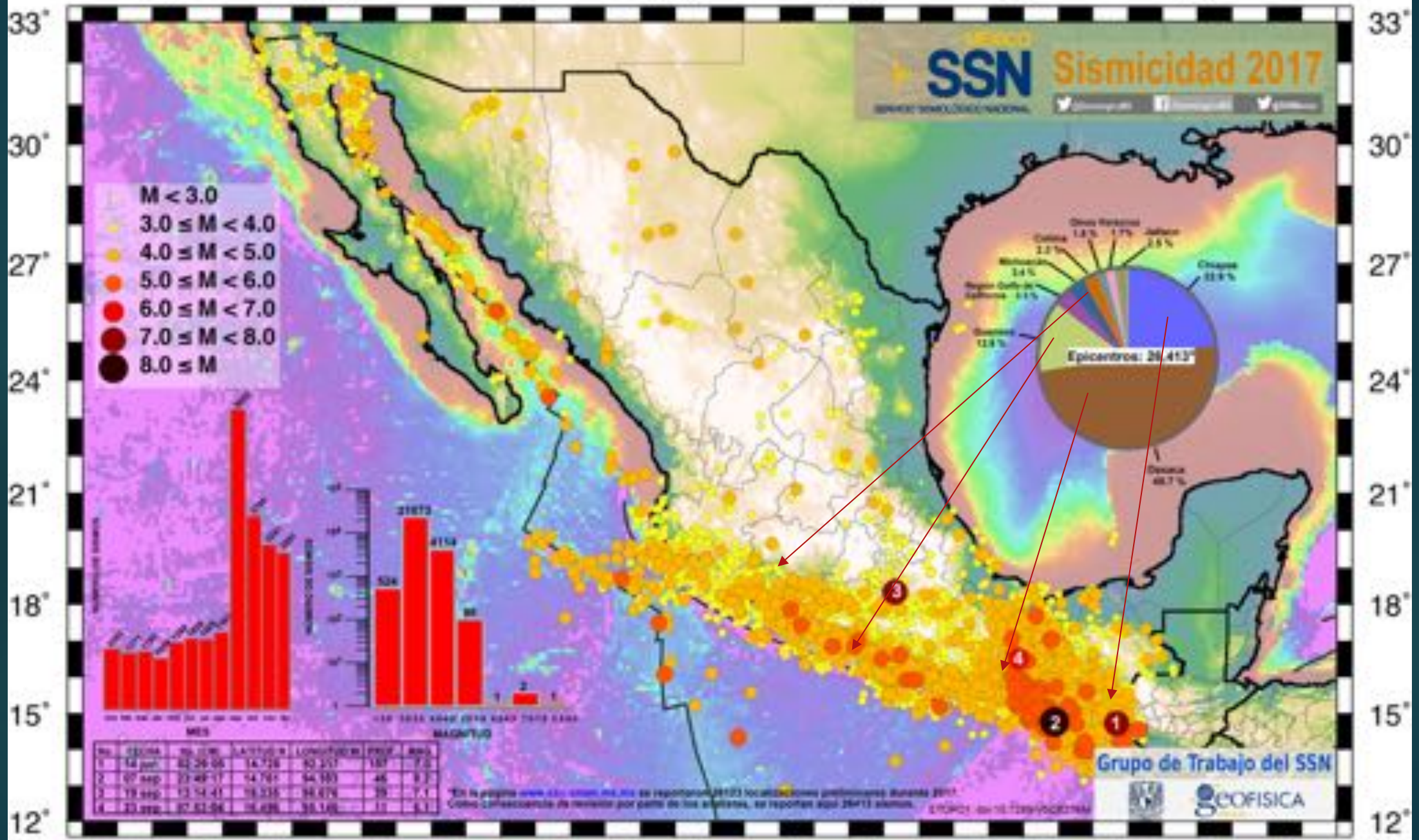
Universit  Michoac n de San Nicolas de Hidalgo AVEC 50,000 STUDENTI



PRINCIPAL TECTONIC SCENARIO OF MEXICO



-120° -115° -110° -105° -100° -95° -90°



No.	REGIÓN	No. EPOC	LAITUD N	LONGITUD O	PROF.	MO
1	14 reg.	82,246,96	14,726	82,237	187	7.2
2	07 reg.	33,497,17	14,761	64,183	46	5.3
3	19 reg.	13,14,41	18,236	38,874	39	7.1
4	23 reg.	87,63,96	18,626	38,146	17	6.1

En la página www.csi.cinvestav.mx se reportaron 26123 localizaciones preliminares durante 2017. Como consecuencia de revisión por parte de los estados, se reportan aquí 26412 eventos.

Place	Date	Magnitude
Oaxaca	23 August 1696	7.5
Oaxaca	21 December 1701	
Oaxaca	9 March 1845	8
Oaxaca	5 May 1854	8
Oaxaca-Chiapas	13 January 1903	7.6
Crucecita	21 March 1928	7.5
Miahuatlan	16 June 1928	7.6
Tlaxiaco	4 August 1928	7.4
Rio Grande	8 October 1928	7.5
Miahuatlan	14 January 1931	7.8
Tlaxiaco	23 December 1937	7.4
Tlaxiaco	6 January 1948	7
Tlaxiaco	14 December 1950	7.2
Matias Romero	11 December 1951	7
Crucecita	23 August 1965	7.4
Pinotepa Nacional	2 August 1968	7.3
Tierra Blanca	28 August 1973	7.3
San Pedro Pochutla	29 November 1978	7.6
Acatlán de Osorio - Huajuapán de León	24 October 1980	7.1
Ometepec	7 June 1982	7
Ometepec	14 September 1995	7.3
Pinotepa Nacional	24 February 1996	7.1
S. Gabriel Chilac	15 June 1999	7
Puerto Escondido	30 September 1999	7.4
Ometepec-Pinotepa Nacional	20 March 2012	7.5
Tehuantepec	7 September 2017	8.2
Chiautla de Tapia	19 September 2017	7.1
Pinotepa Nacional	16 February 2018	7.2





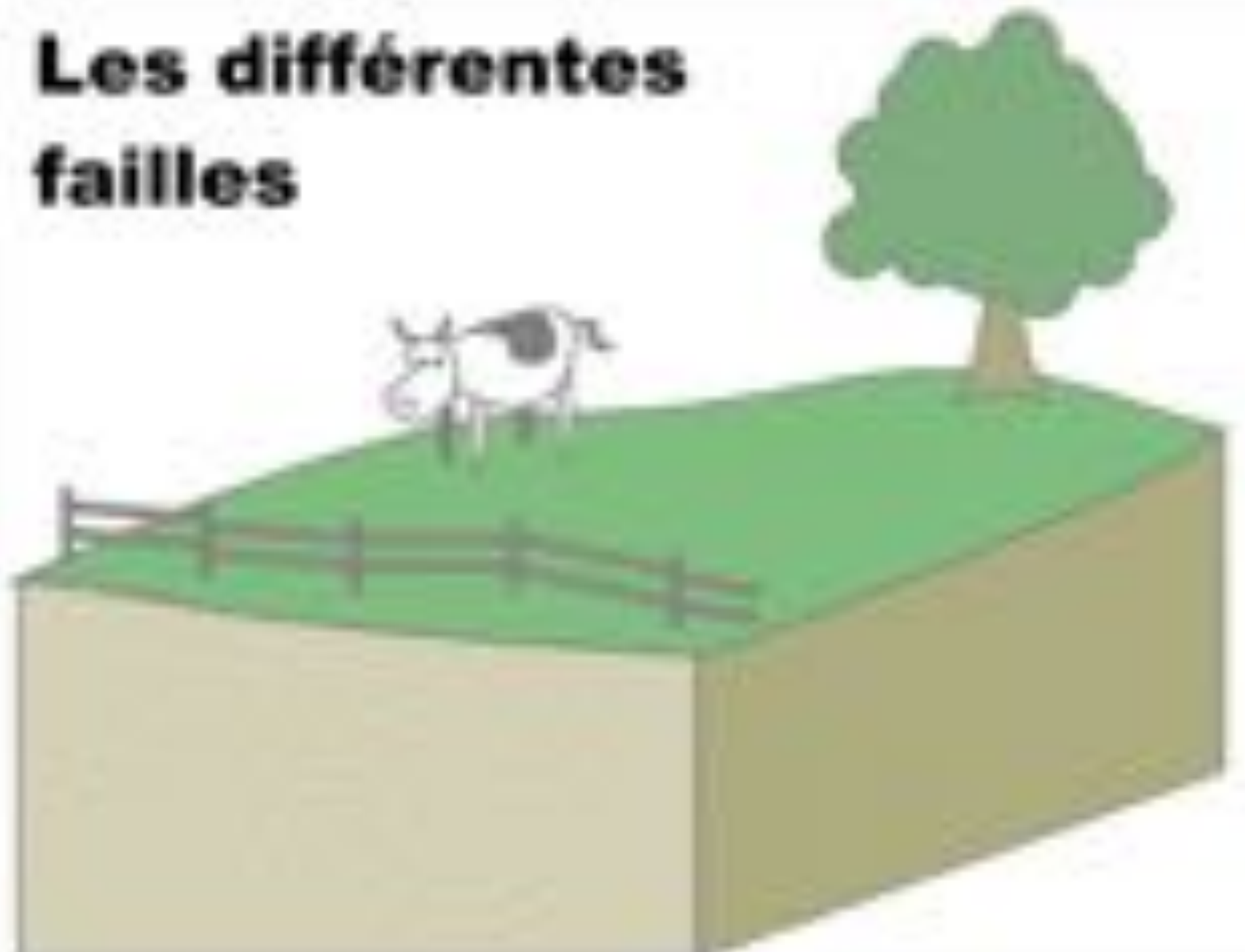
EFFETTI: SISMO IN NUOVA ZELANDA 2016

Le mucche hanno
capito...



WHAT IS A
EARTHQUAKE?

Les différentes failles

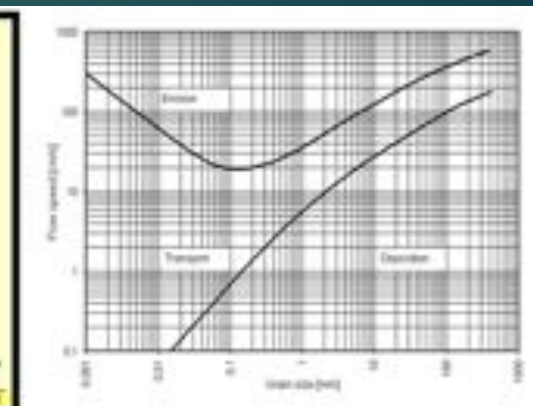
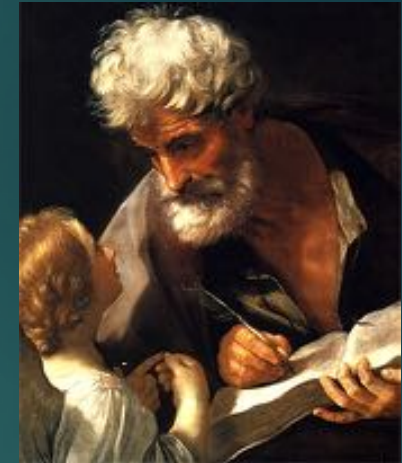


SAN MATEO 6:34

**24. ANYONE, THEREFORE, THAT HE HEARS THESE WORDS,
AND HE DOES THEM, I WILL COMPARE YOU TO A PRUDENT MAN,
THAT I BUILD YOUR HOME ON ROCK.**

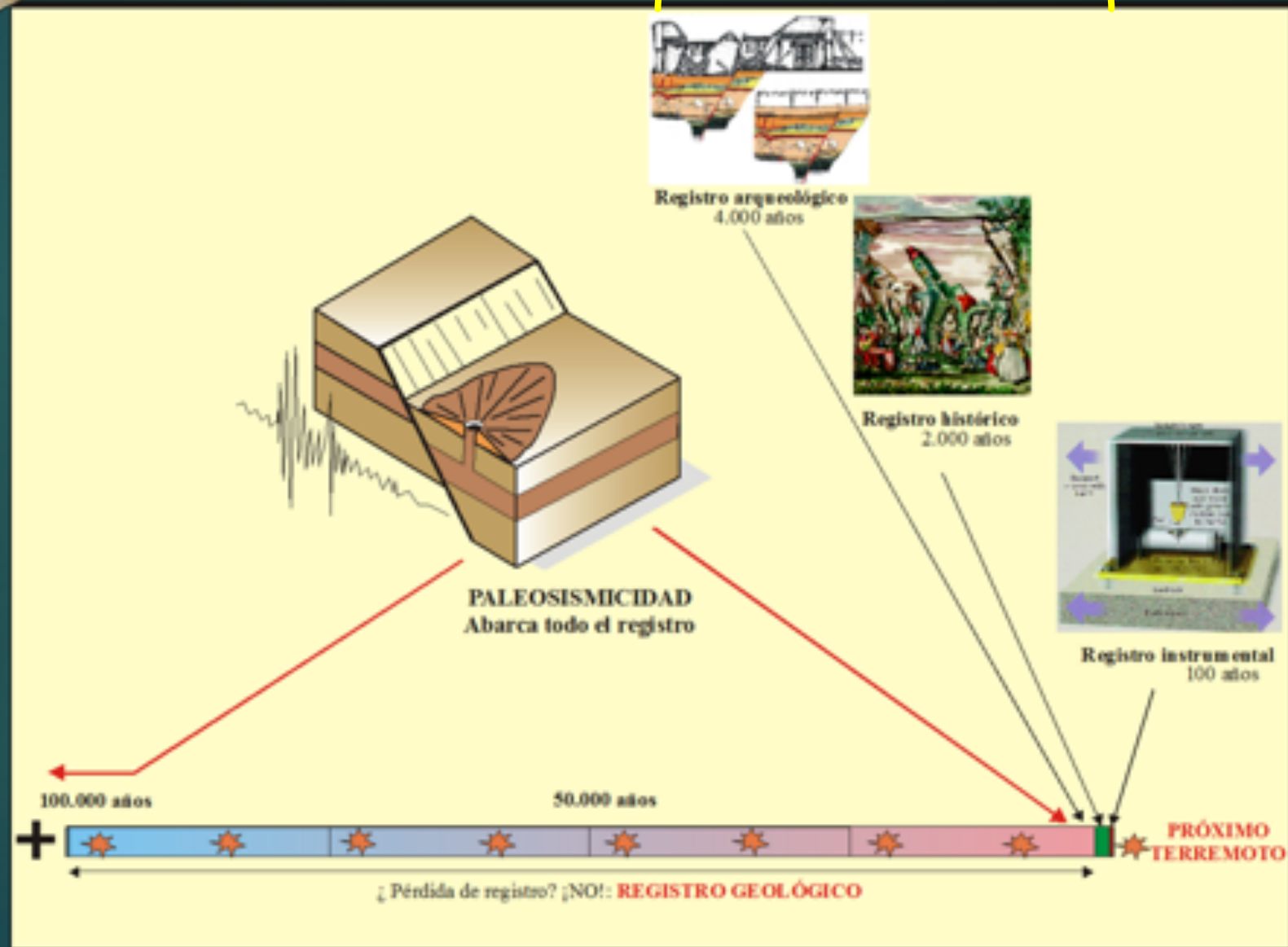
25. The rain descended, and the rivers came, and the winds blew, and they beat against those houses; and it did not fall, because They were founded on rock.

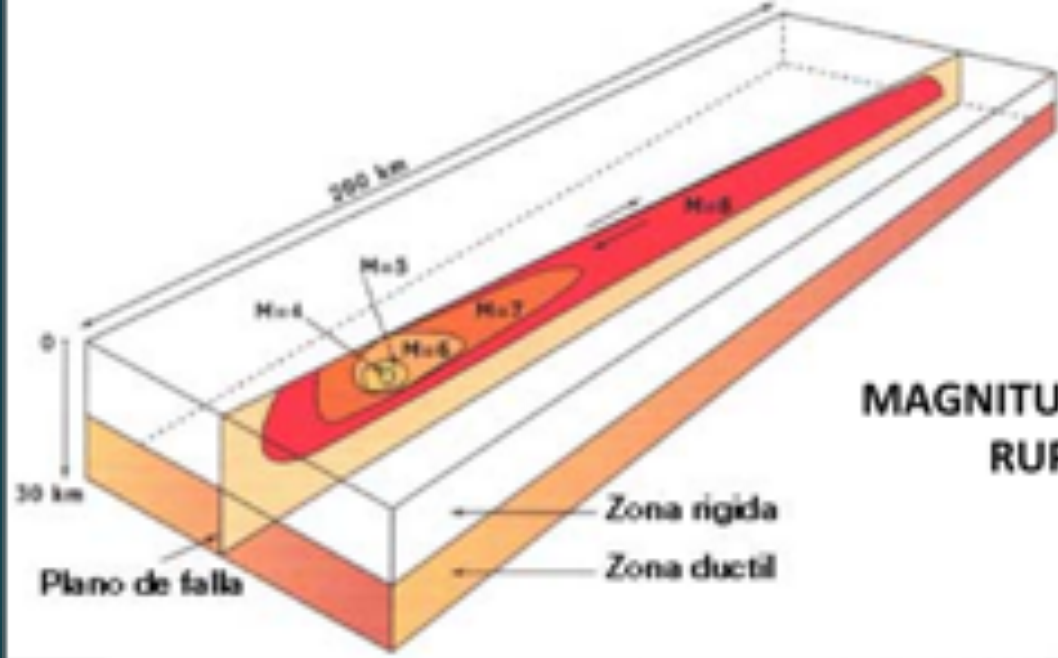
26. *But whoever hears these words and does not do them, what I will compare a foolish man who built his house on sands.*



Los rangos de la Paleosismología

Arqueosismología

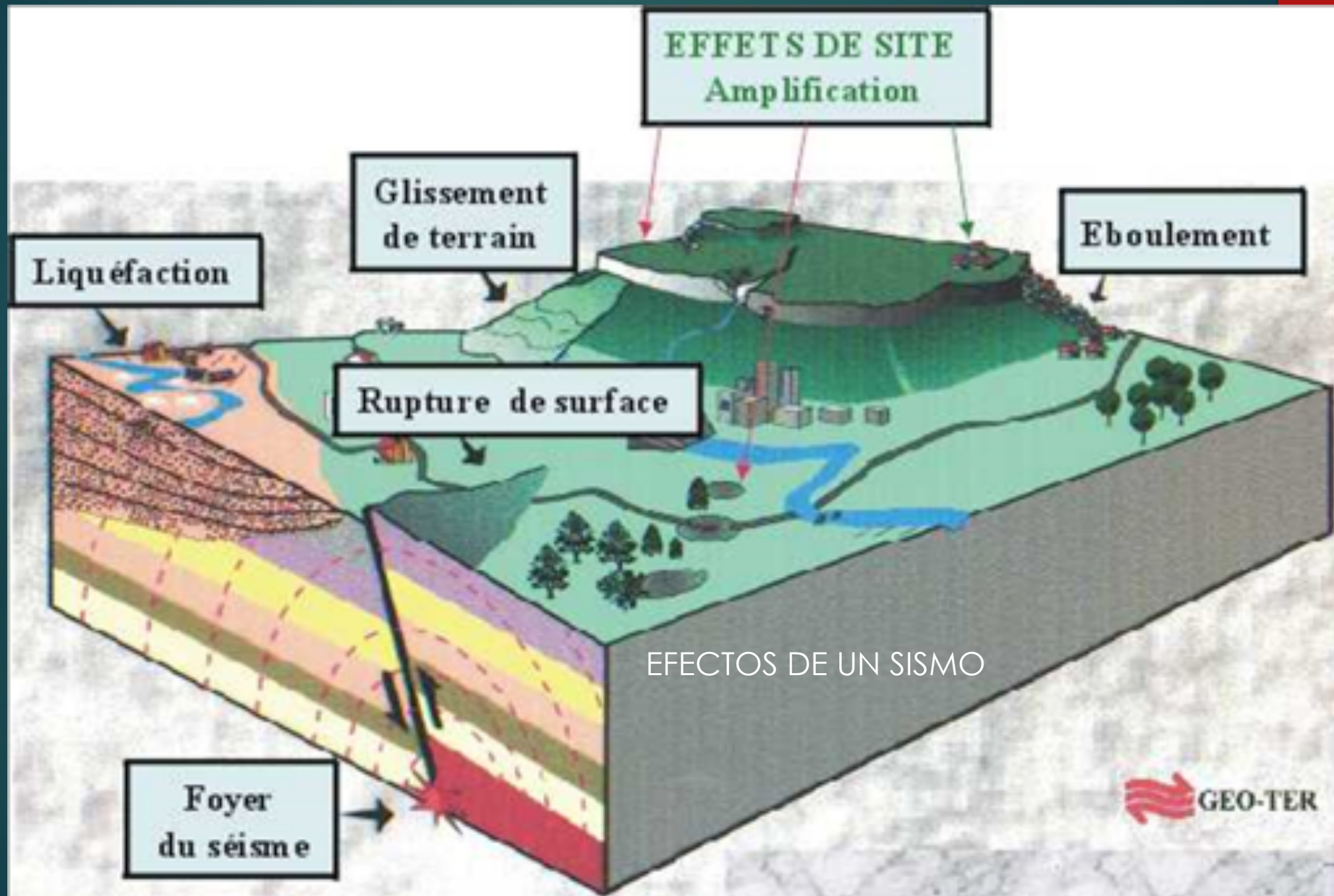


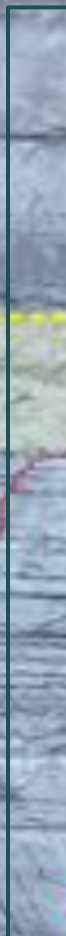
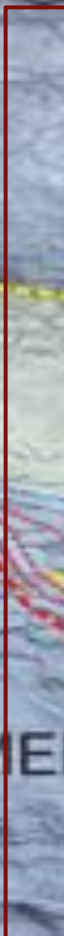
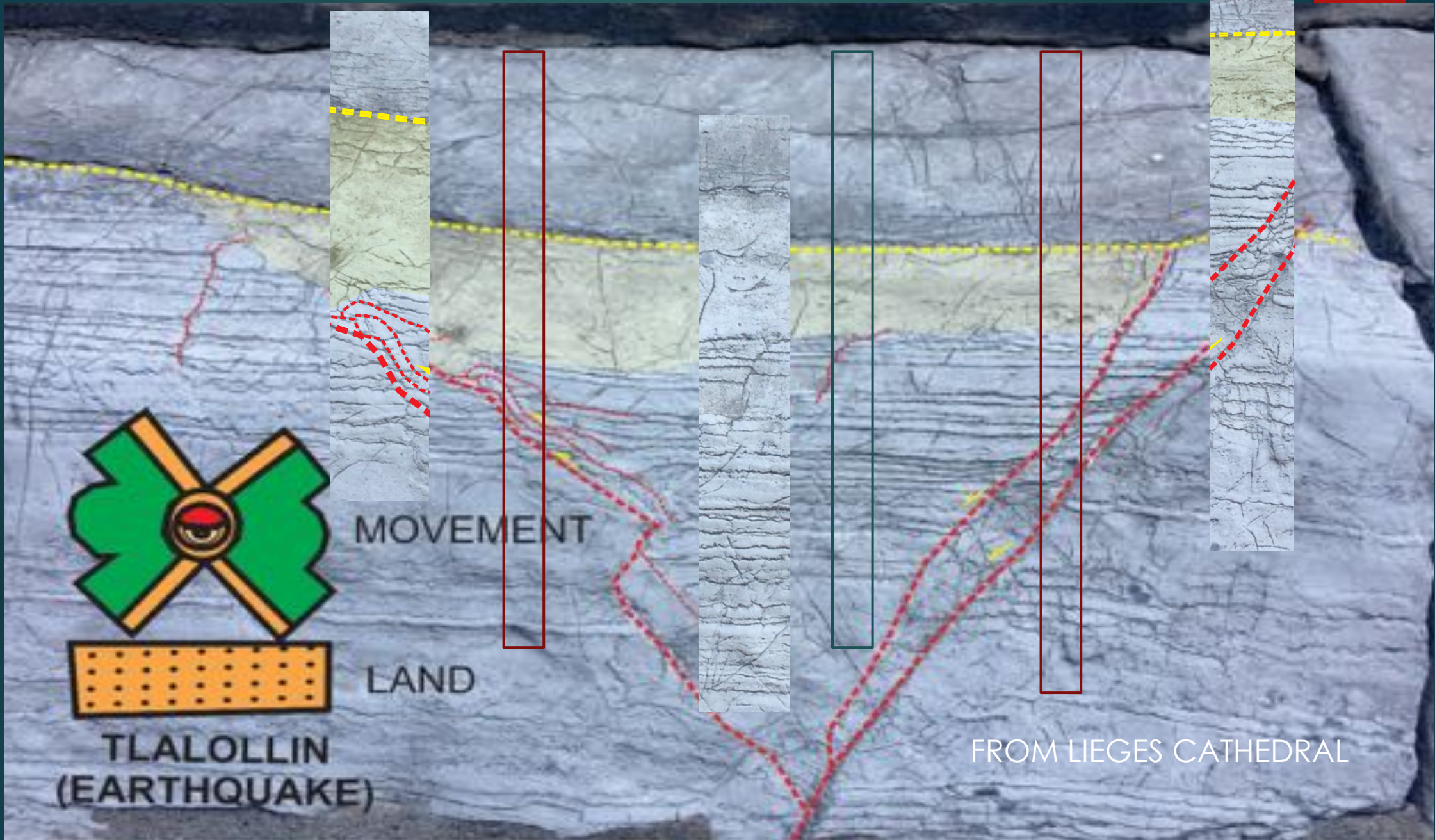


MAGNITUD Y AREA DE RUPTURA



FALLAS y TERREMOTOS





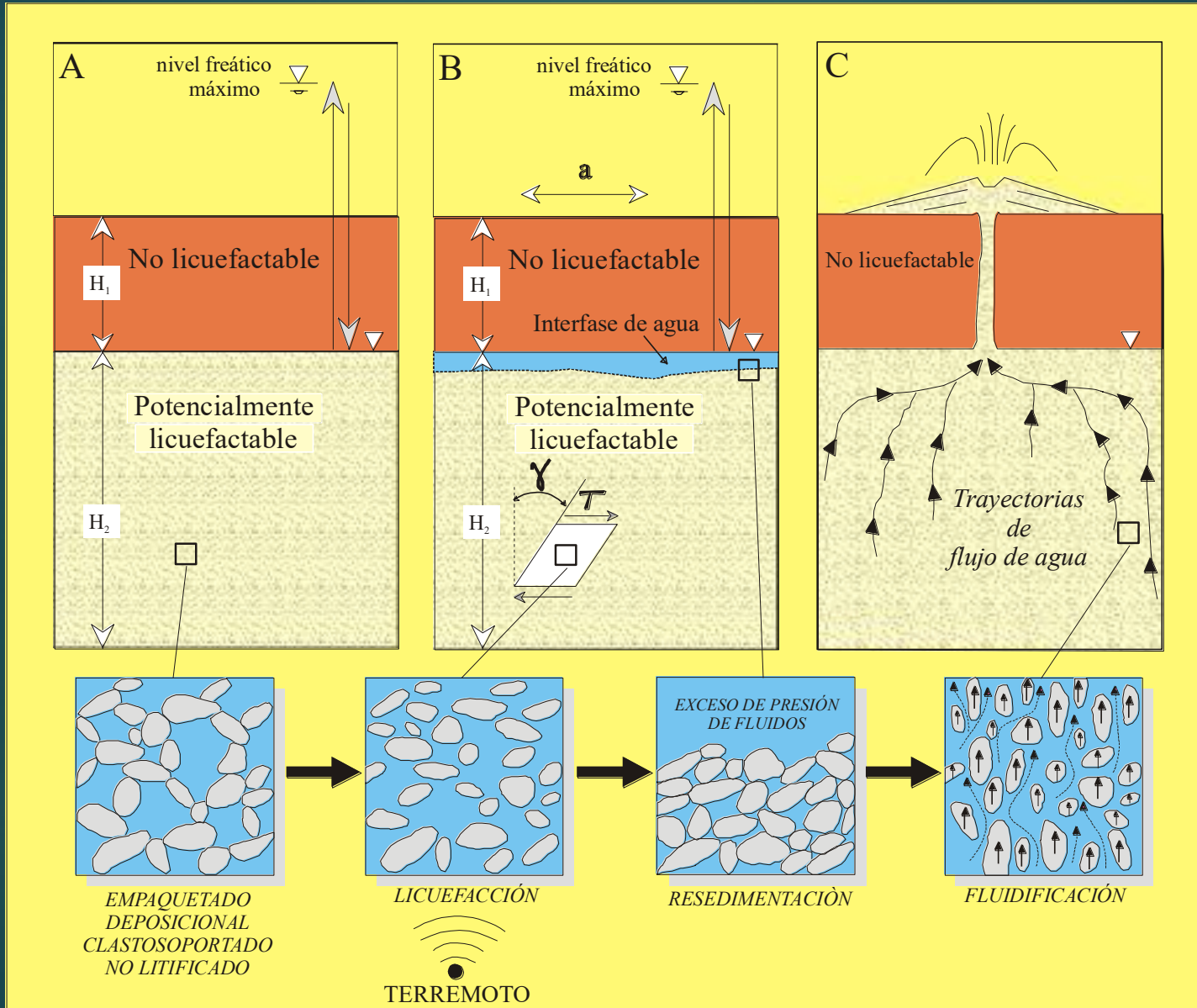
MOVEMENT

LAND

TLALOLLIN
(EARTHQUAKE)

FROM LIEGES CATHEDRAL

LICUEFACTION



THE EVIDENCE OF ARCHEOSISMOLOGY





Il Faro di Alejandria Sarà abbattuto dagli effetti di un terremoto all'inizio del XIV secolo.

MIRACLE OR TSUNAMI?



Templo de Ramesses II





Ciao veloce, c'è il Faraon Ramses, che una parti delle pyramid è crollata dopo il terremoto



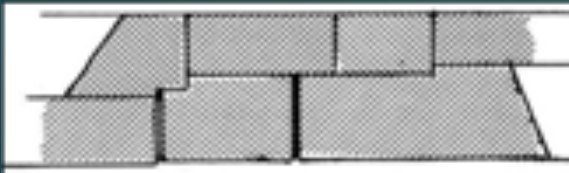
Tecnica anti sismicas



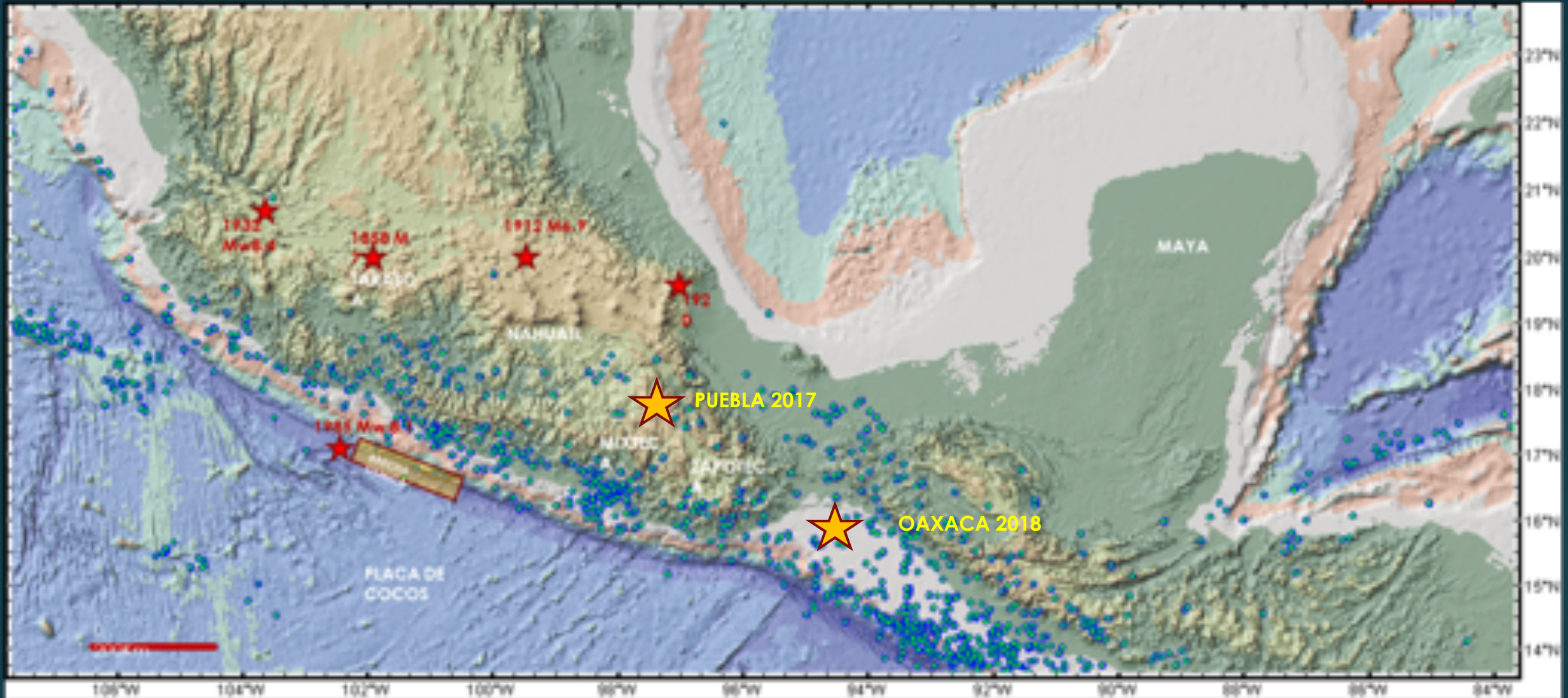
Égipto

Puepechas

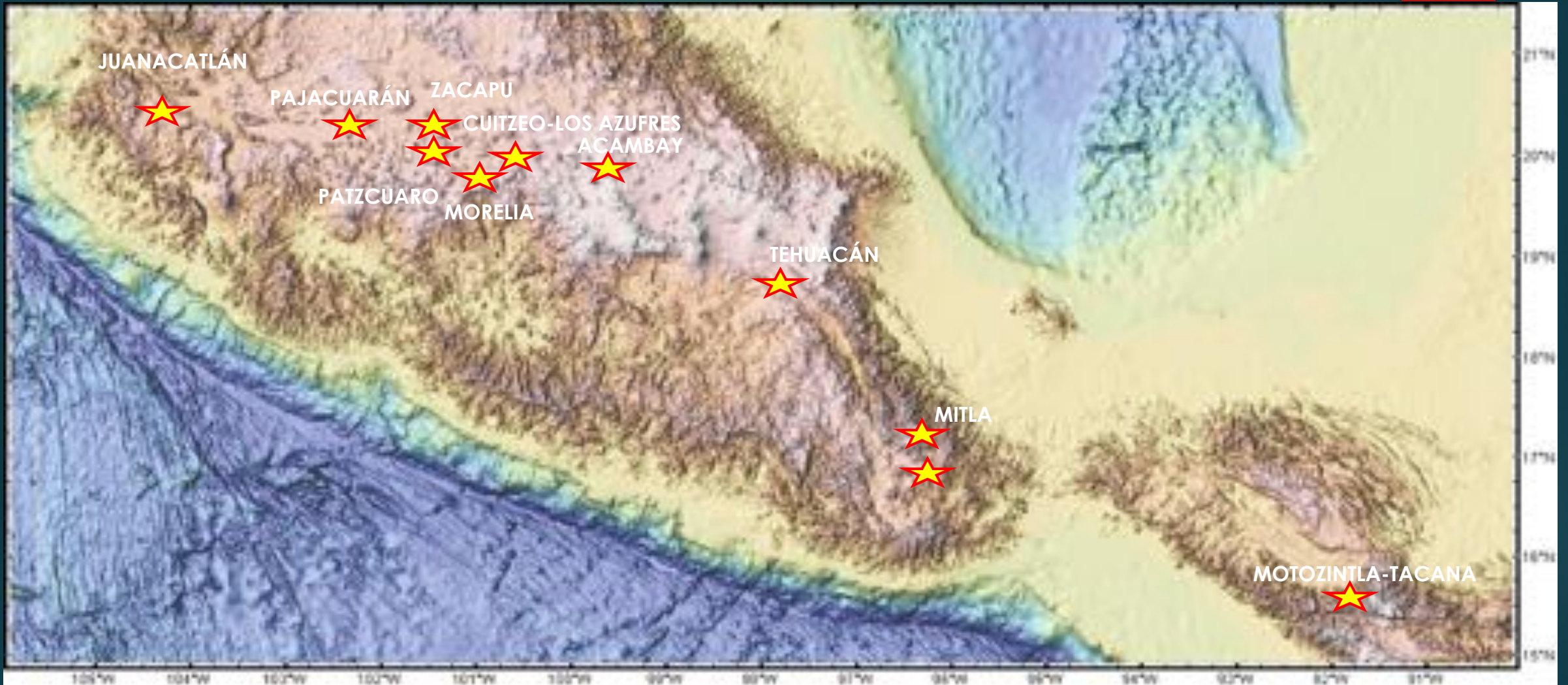
Incas



Mesoamerica coexists with the dynamics of the Cocos plate and the intraplate faults of Northamerica plate

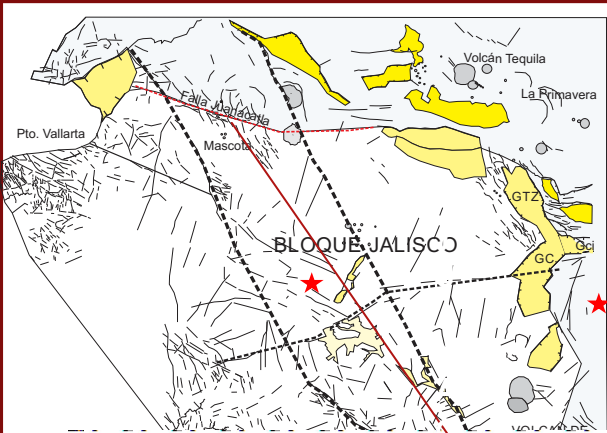


WHERE WE ARE STUDING WITH ARCHEOSISMOLOGY AND PALEOSISMOLOGY

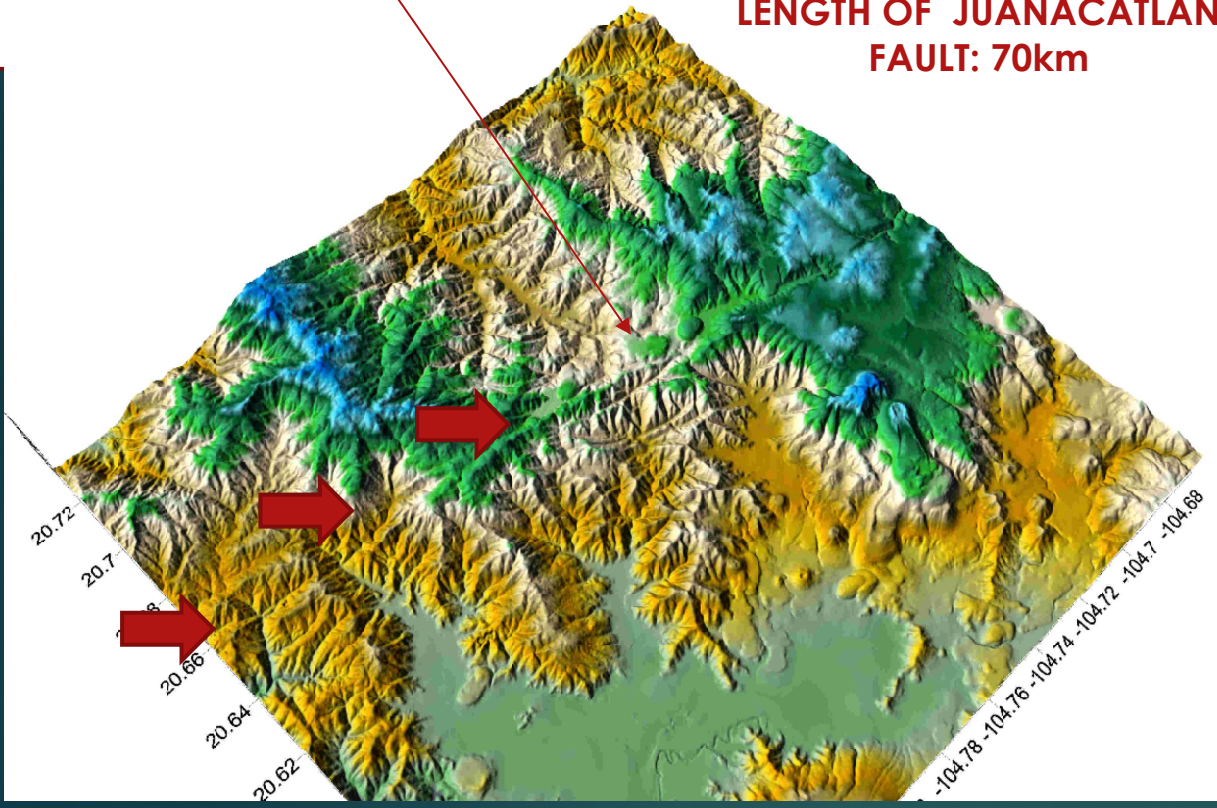


EVIDENCE OF EARTHQUAKES IN JUANACATLANLA FAULT, JAL.

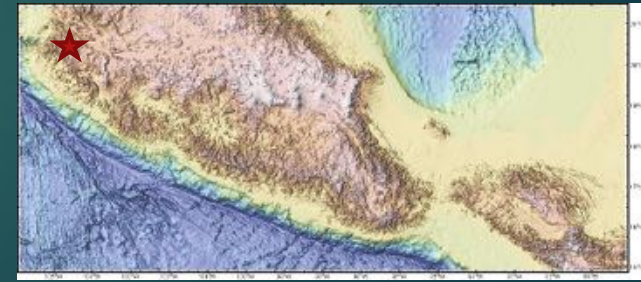
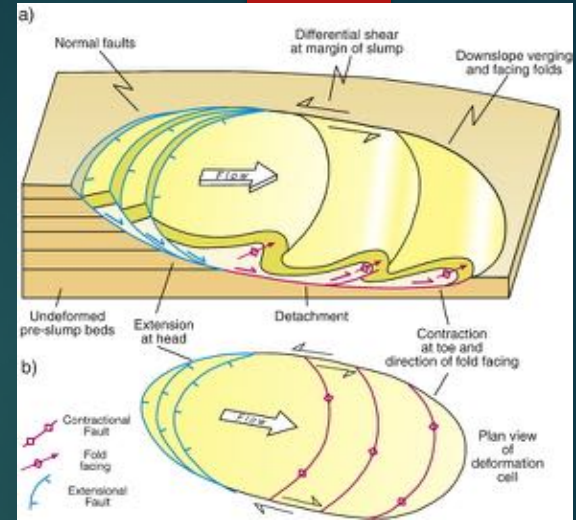
SARA METCALE, NOTTINGHAM UNIVERSITY

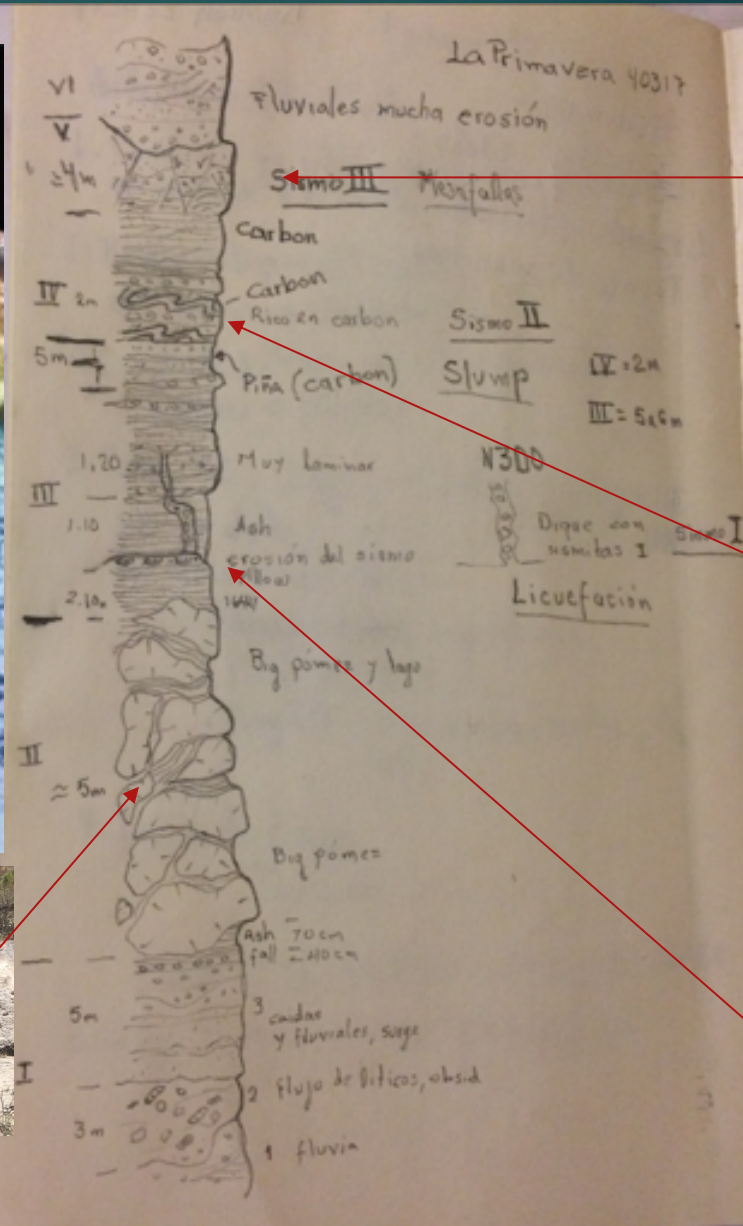
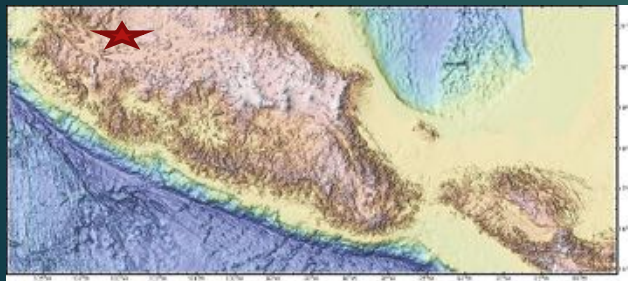
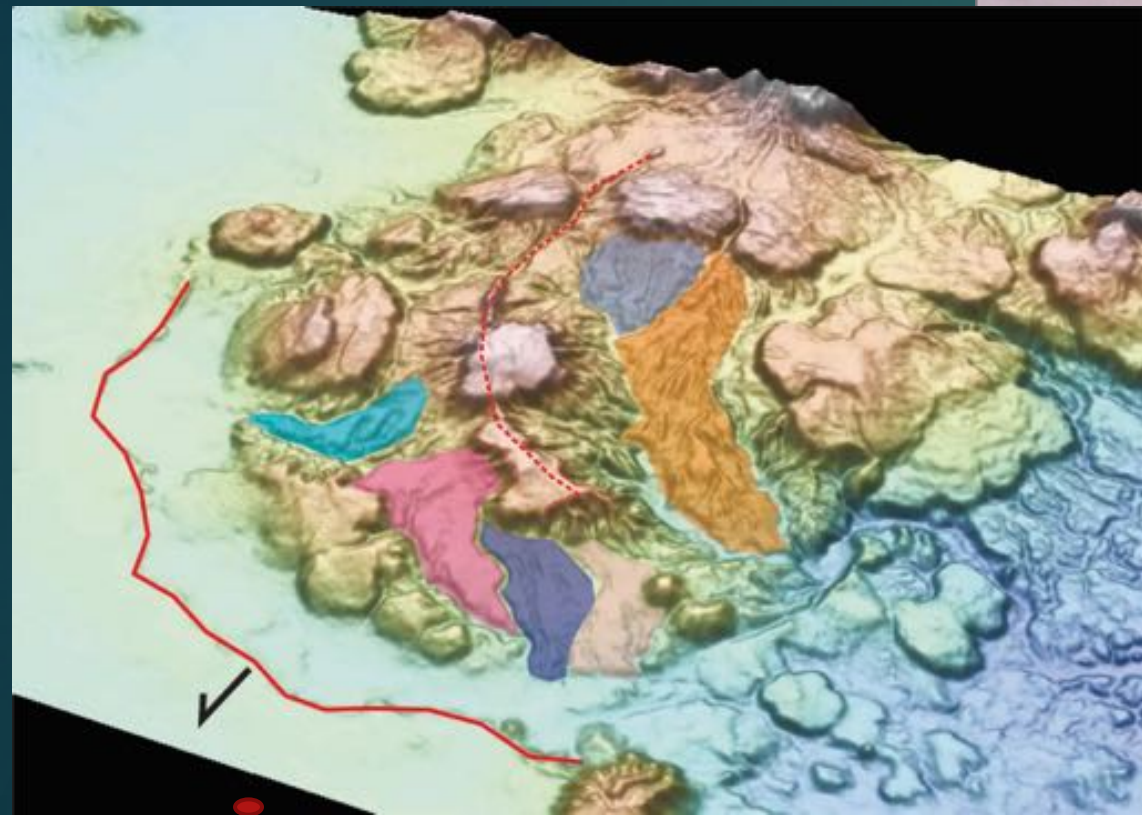


LENGTH OF JUANACATLAN FAULT: 70km



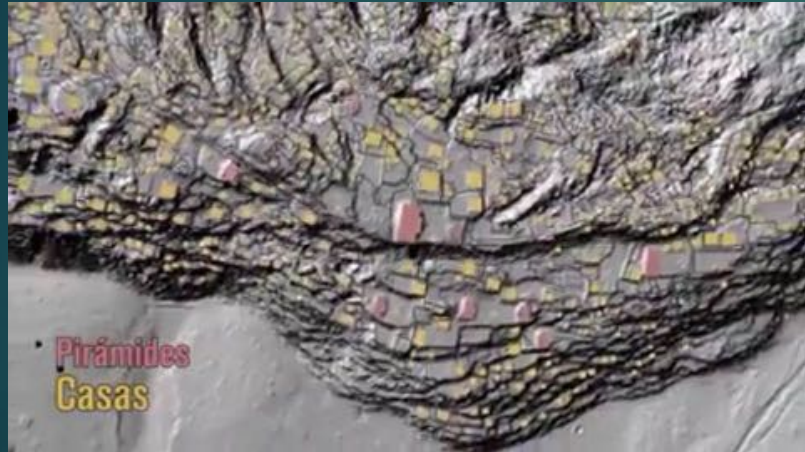
SLUMP



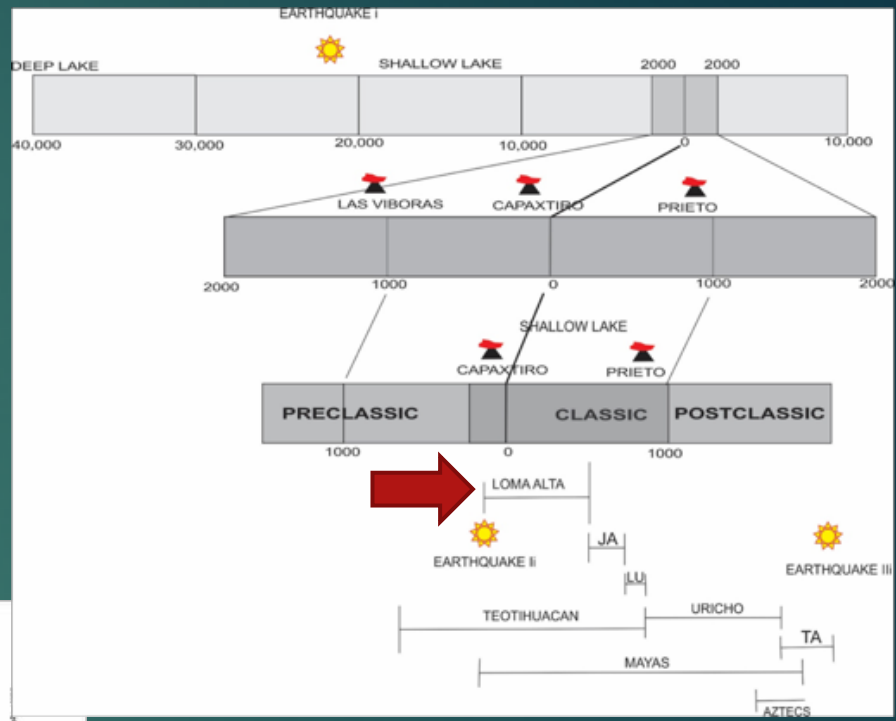
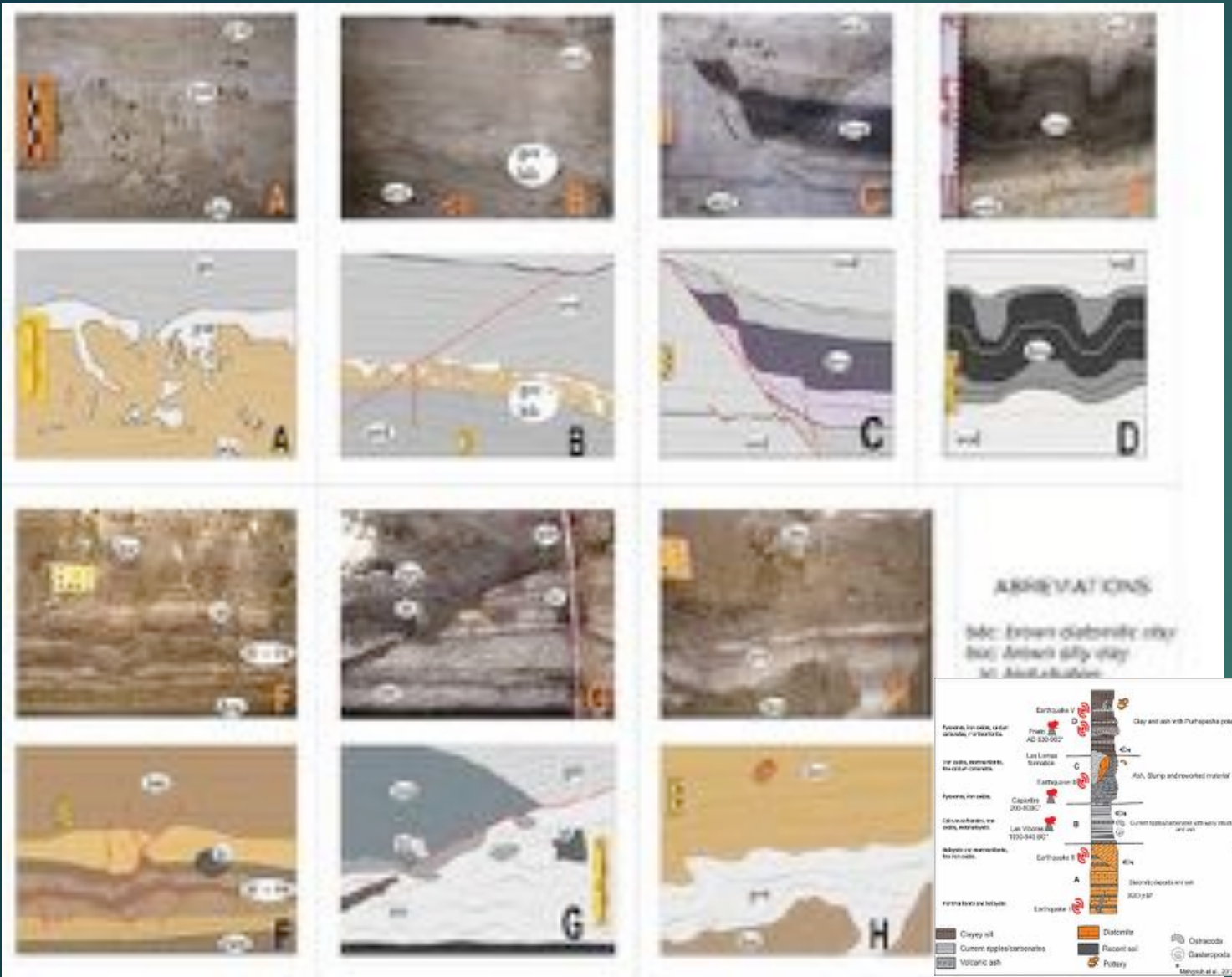


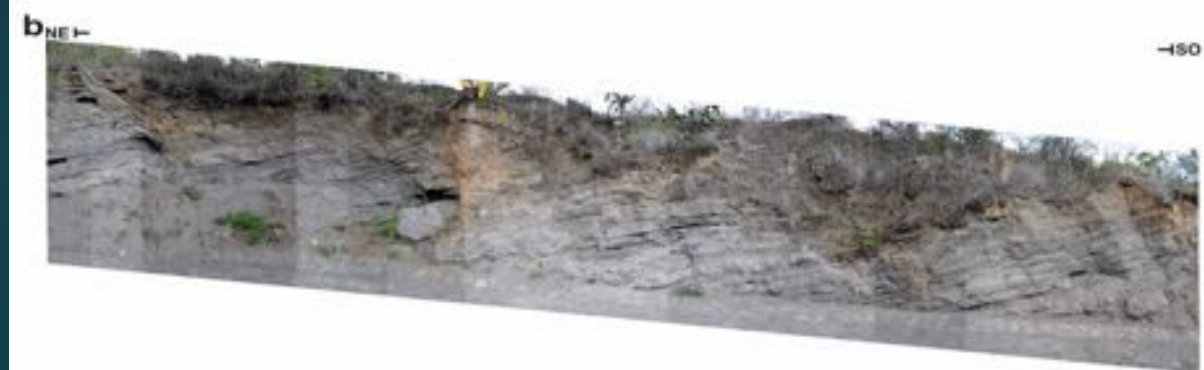
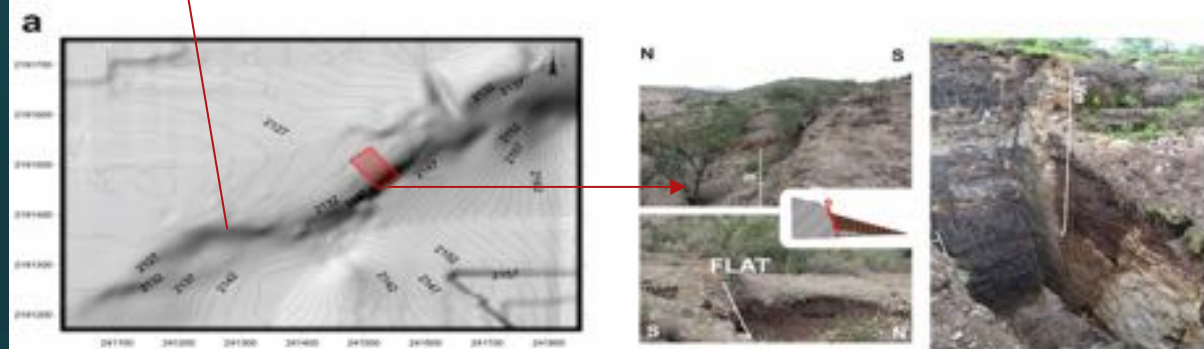
PALEOSEISMOS IN LA PRIMAVERA CALDERA, JAL > 50,000y

ZACAPU AND PATZCUARO



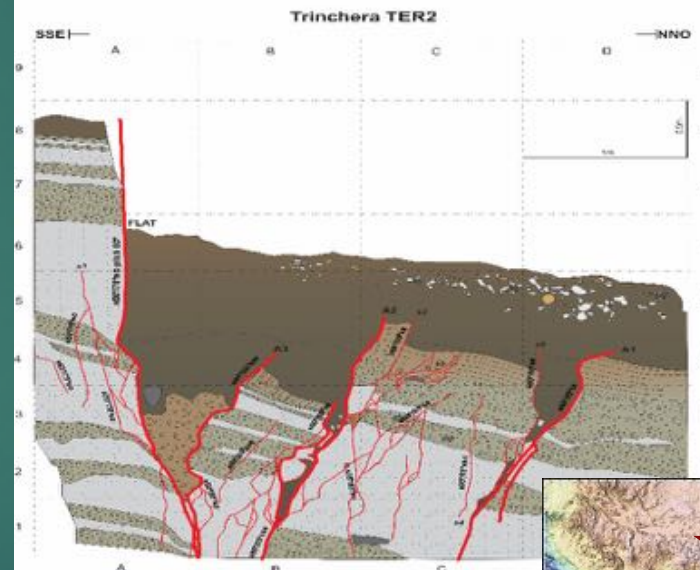
Liquefaction and secondary effects of shallow earthquakes in Zacapu



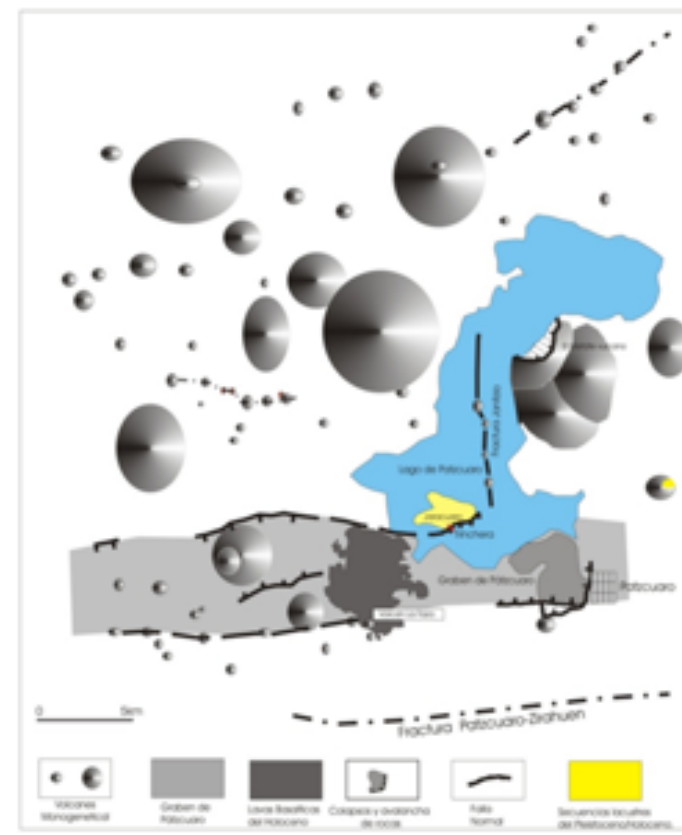
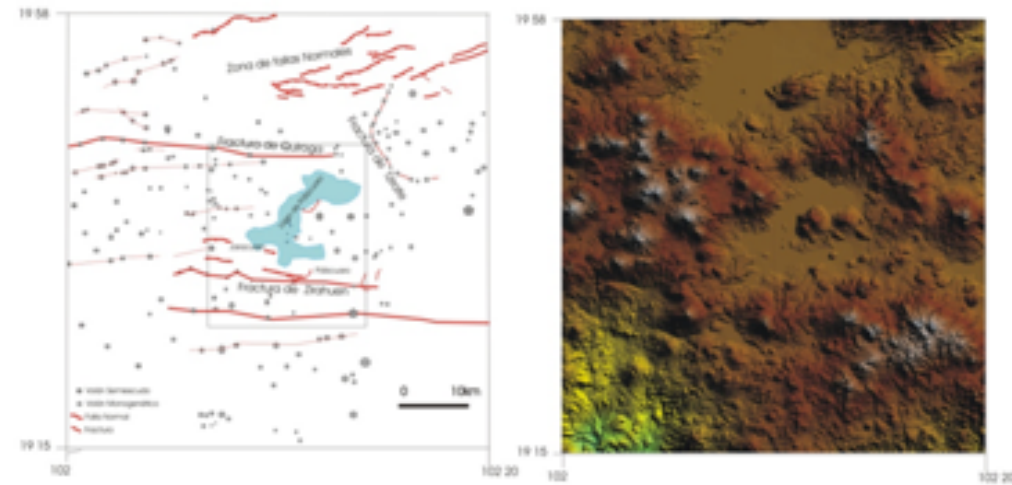
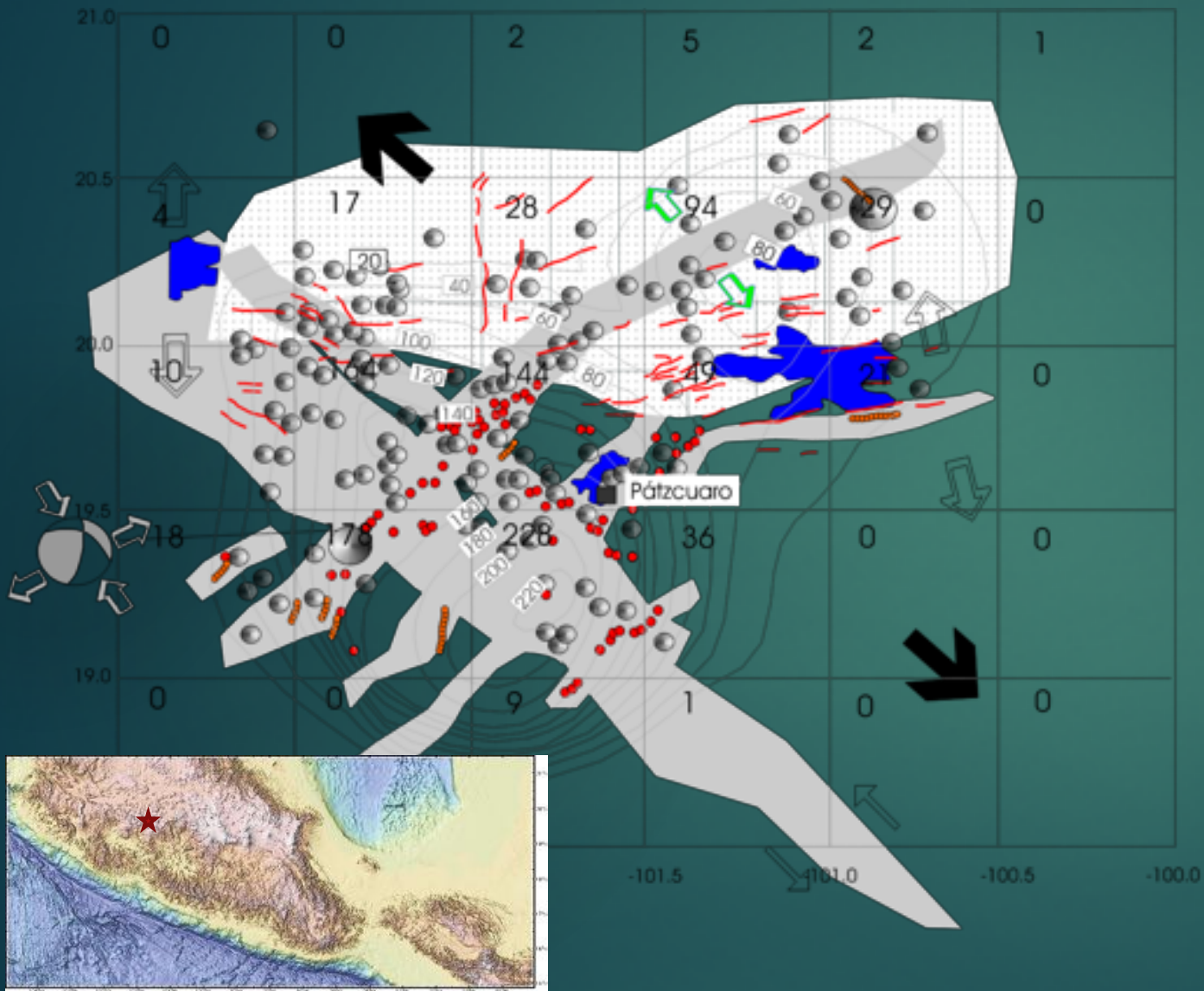


RECURRANCE
 $7,784 \pm 81y$

Mw=6.6-7.3



IN MICHOACAN THERE ARE MORE OF 2000 MONOGENETICAL VULCANOES

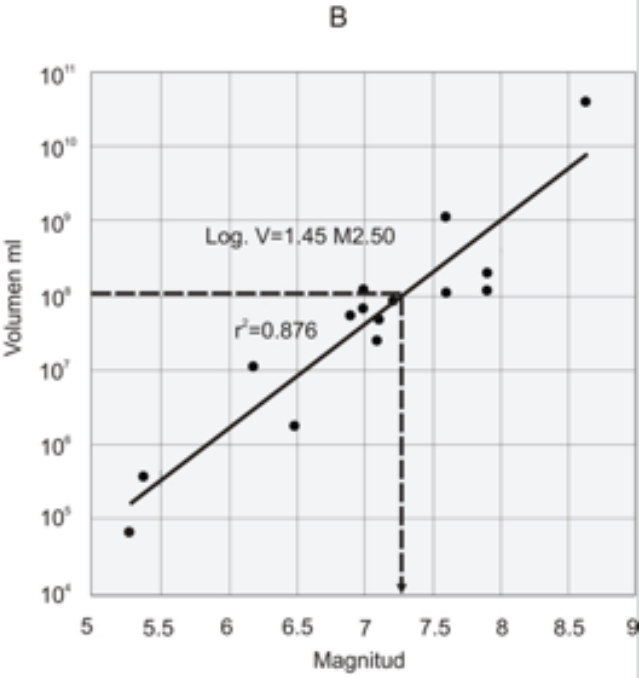
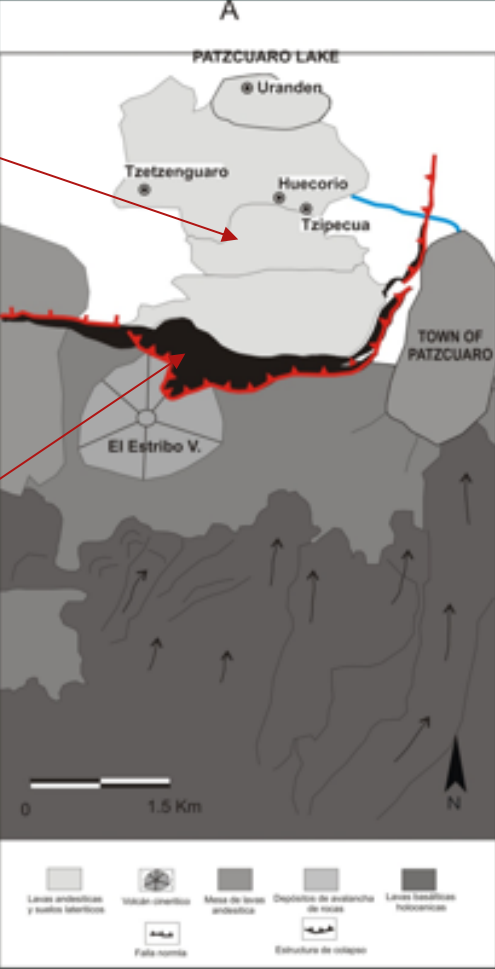


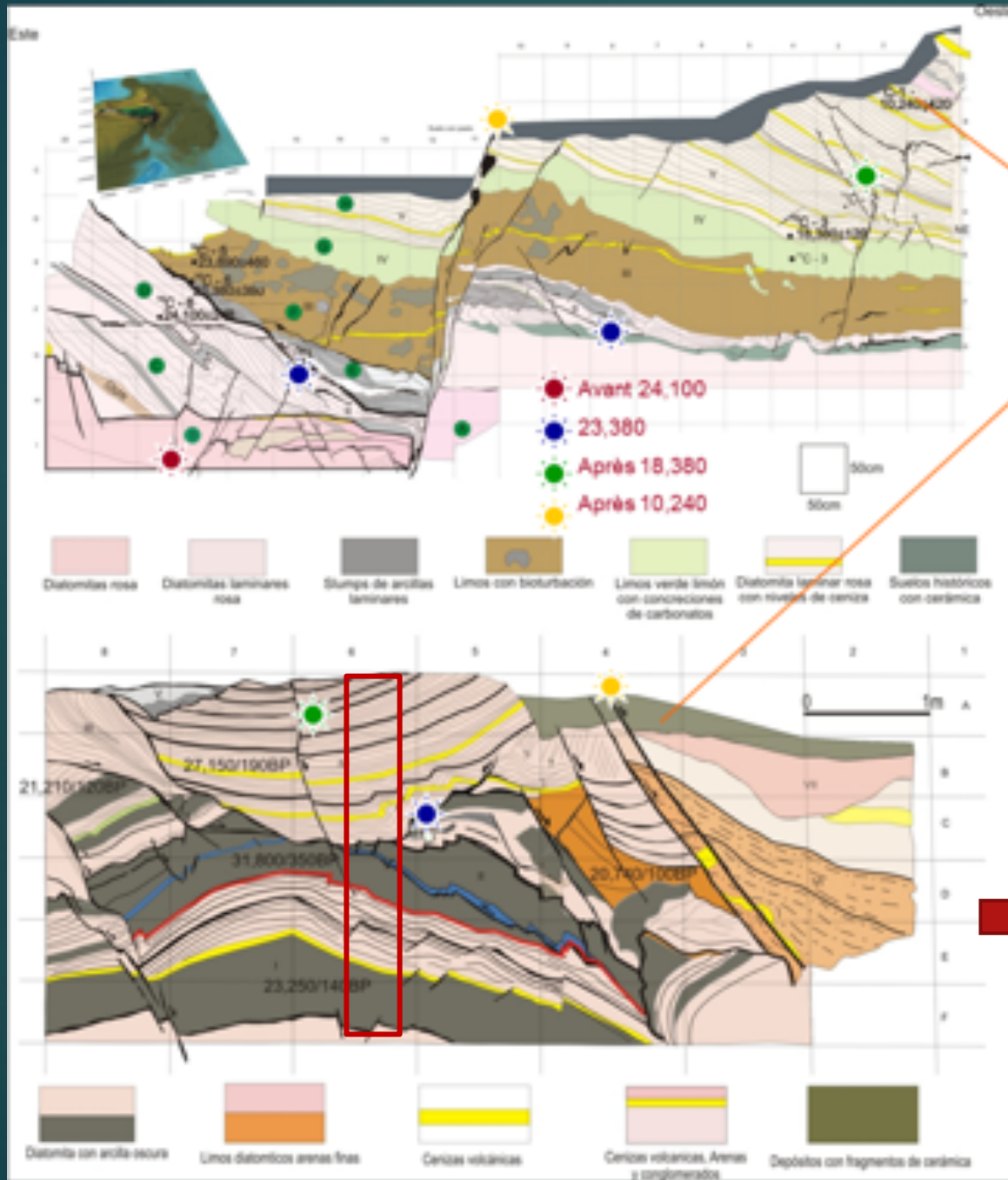
EL ESTRIBO COLLAPSE Mw 7.3 Lake Pátzcuaro

Avallanche and hummoks



collapse



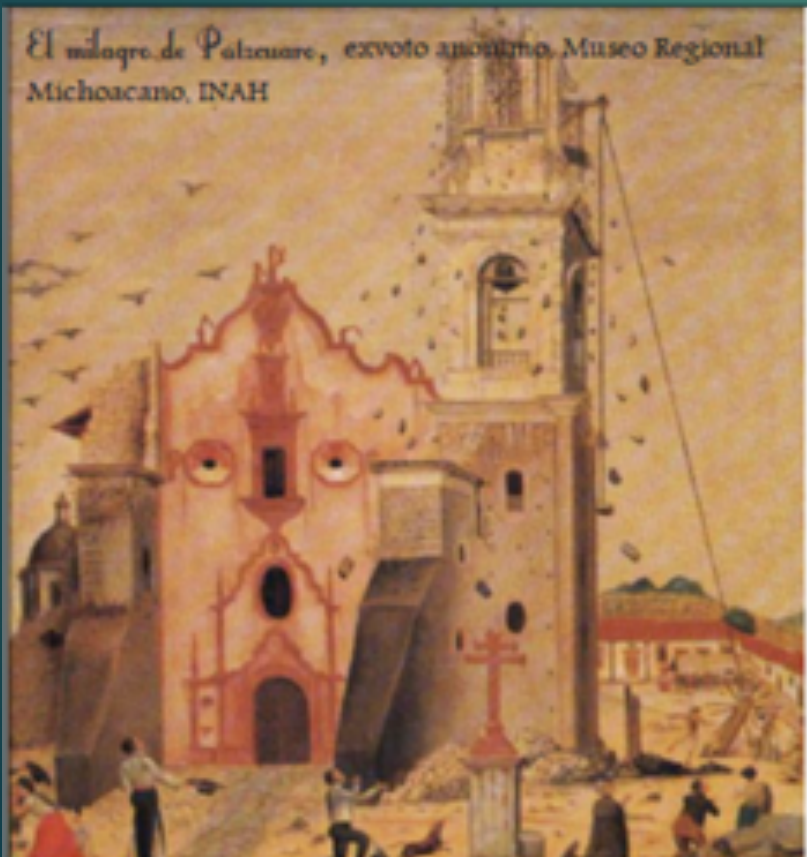


JARACUARÓ





1858
EARTHQUAKE
EFFECTS IN
PATZCUARO
INTENSITY IX

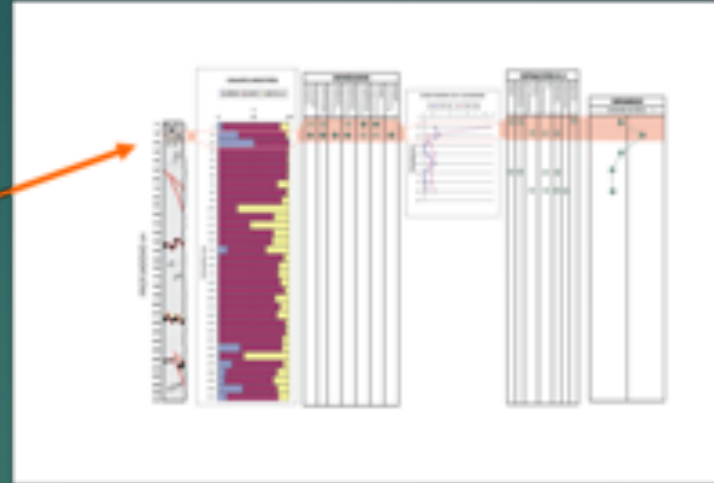


EFFECTOS DEL SISMO DE 1858



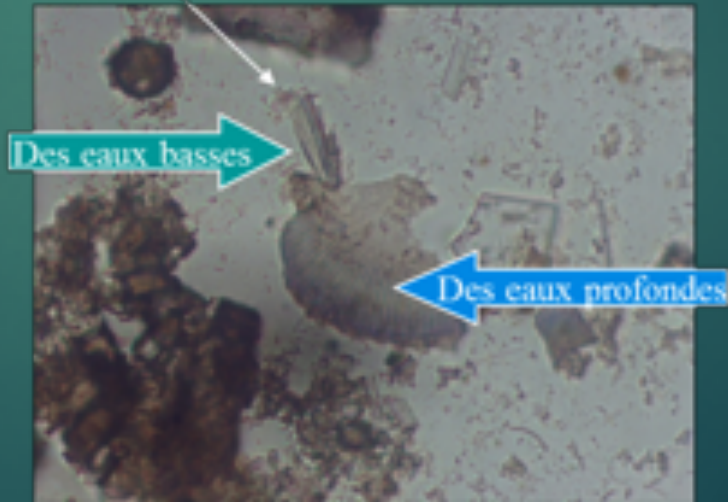


Restos de cerámica Purépecha



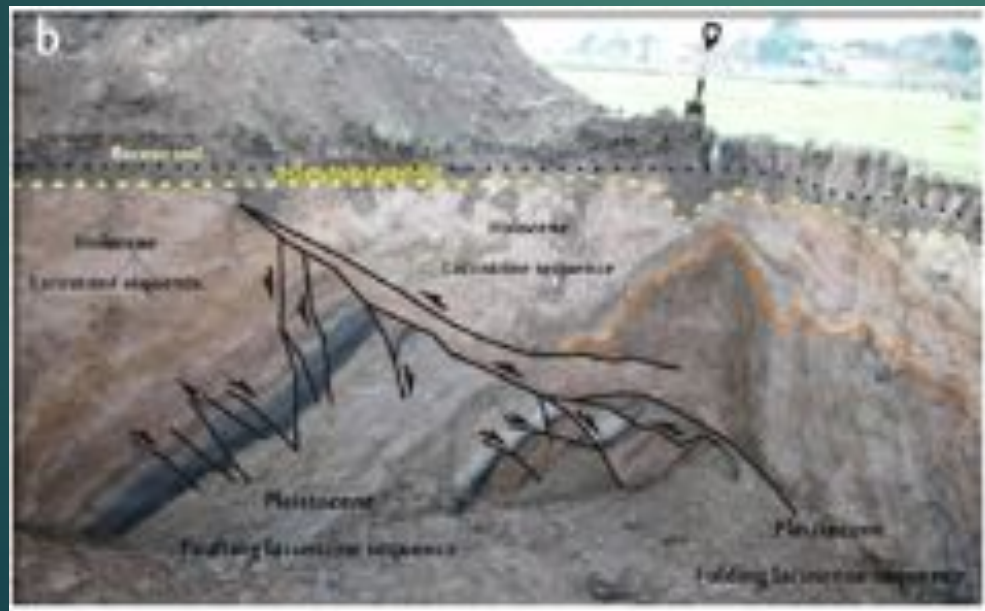
Mezcla de diatomeas y ostrácodos

THE TSUNAMI EFFECT 1858





**PALEOSEISMS AND 1858
TSUNAMI IN JARACUARO
(PLACE THAT APPEARS)**





SOME DATA IN THE MESOAMERICA LANGUAGE

Comet in the sky

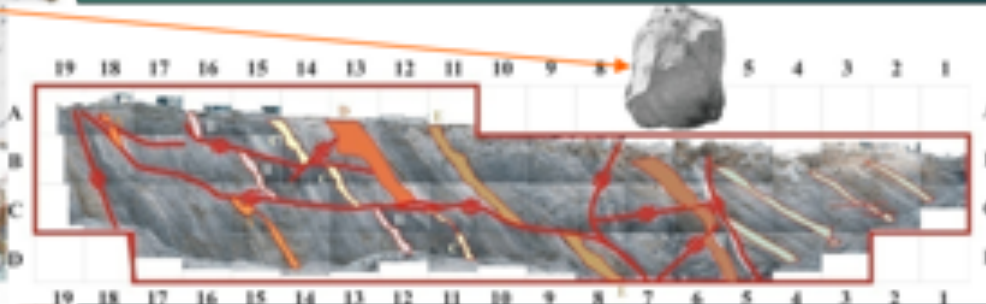
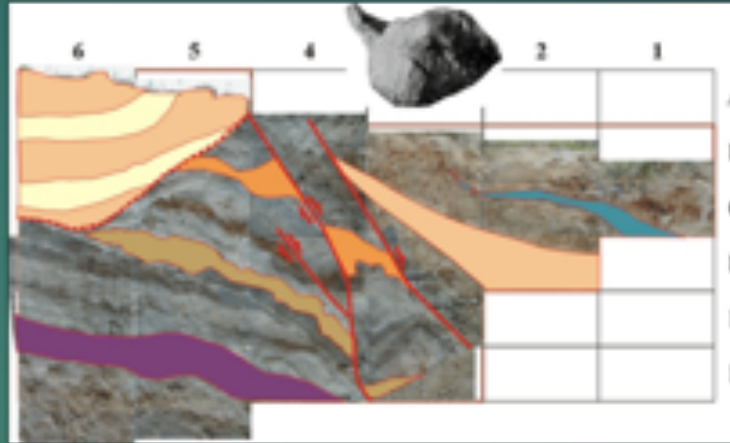
collapsing pyramid

sacrifices

Relación falla / bloque

THE MEANING OF JARACUARO IS: PLACE THAT APPEARS

these blocks come from a distance of 3km out of the lake and were placed in the hanging block and over the fault



a stone well prepared
for

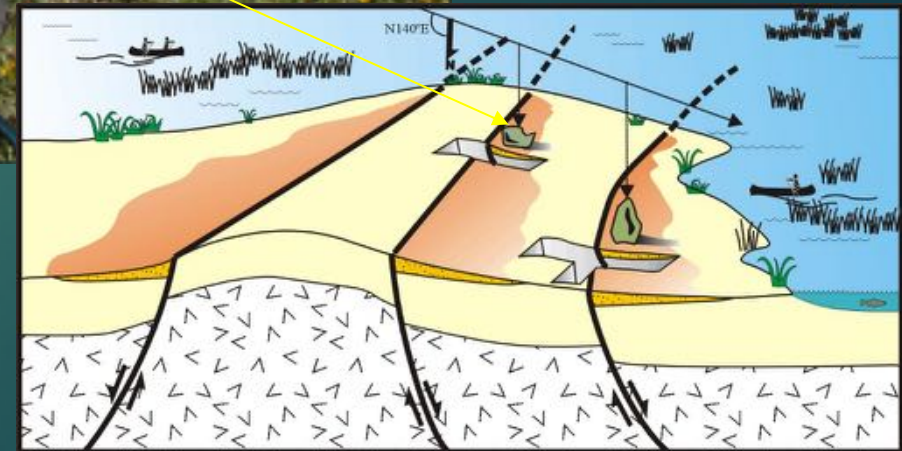




Fig. 6. La piedra de La Silla relacionada con un posible lugar de sacrificios.



NORMAL FAULT

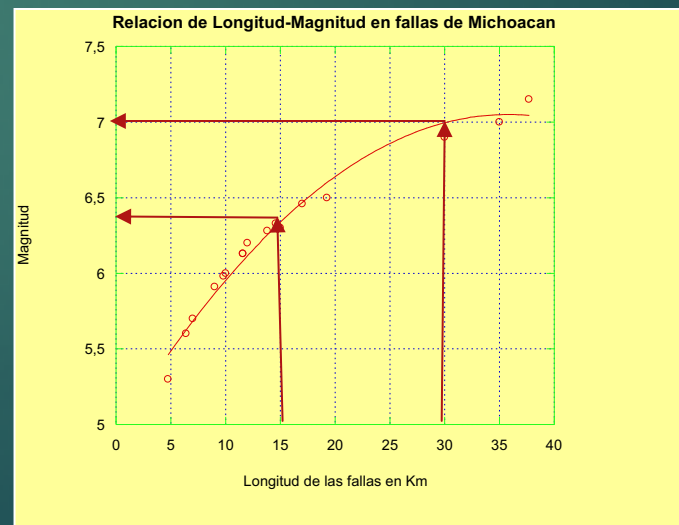


- | | |
|---|--|
|  Sedimentos lacustres |  Basamento volcánico |
|  Sedimentos fluvio-lacustres |  Bloque basáltico SE ("La Silla") |
| |  Bloque basáltico NO |

in this photograph of the 40's you can see the La Paloma fault with at least three relevant ruptures

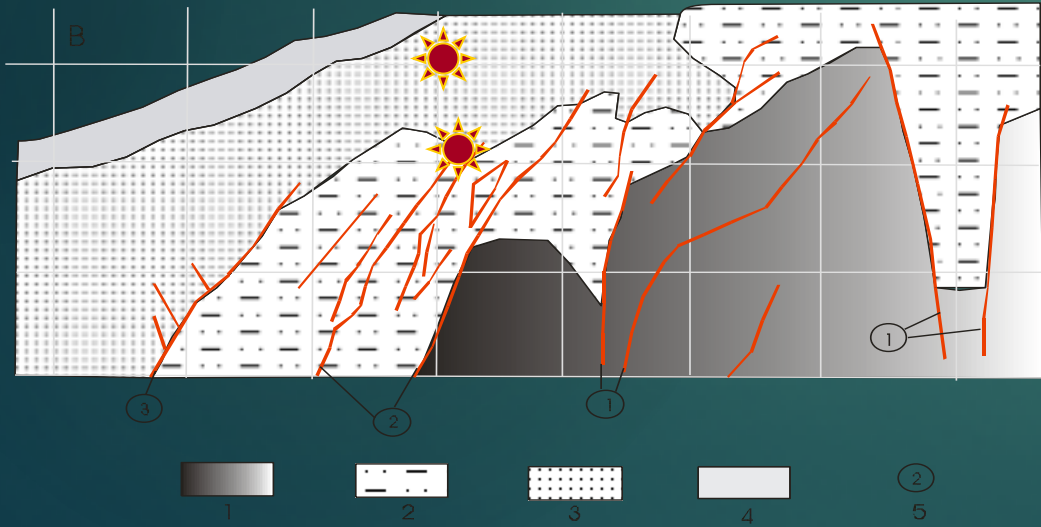


evidence of holocentric ruptures,
lavas with impressions of maize ears 3000 years, (Islebe 2018)



Seismically active faults and their expected magnitude (Mw 6-7)

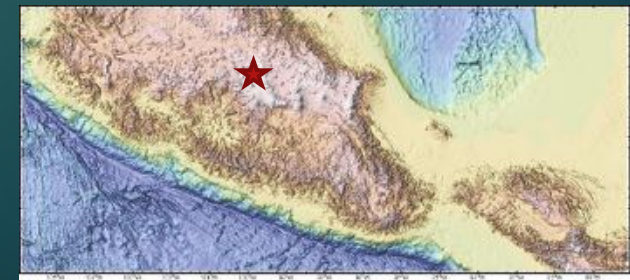
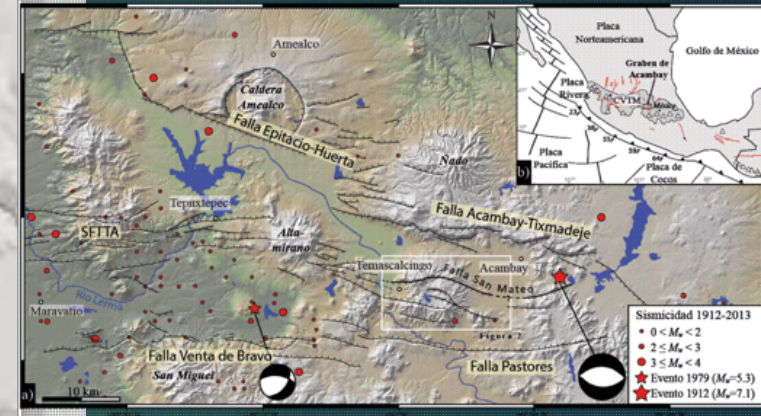
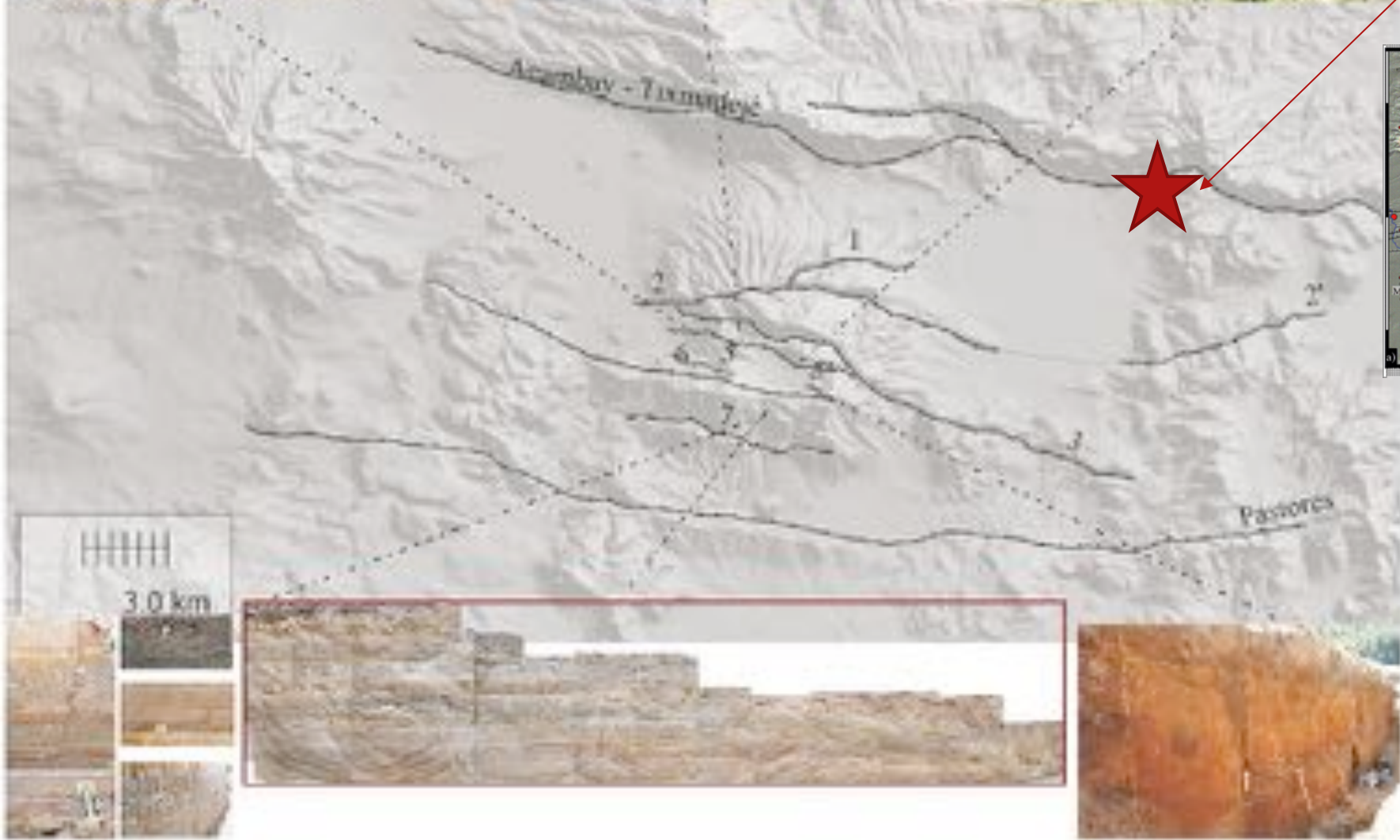
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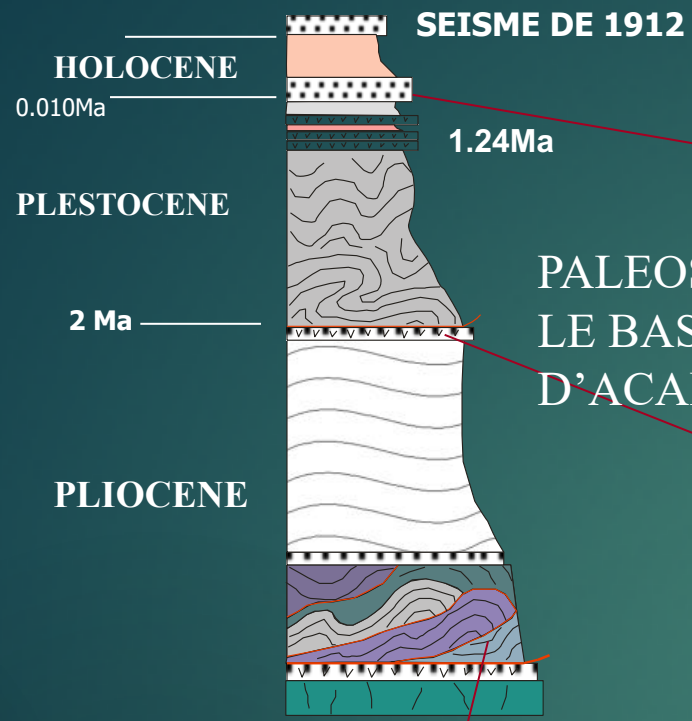


Dry landslide

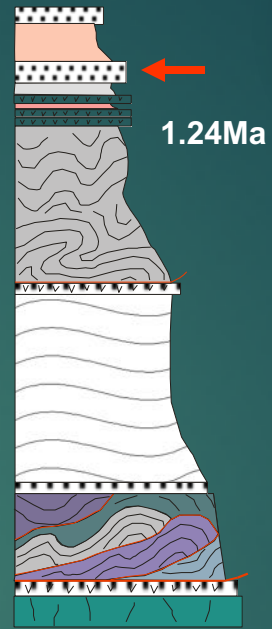


1912 earthquake Mw6.9





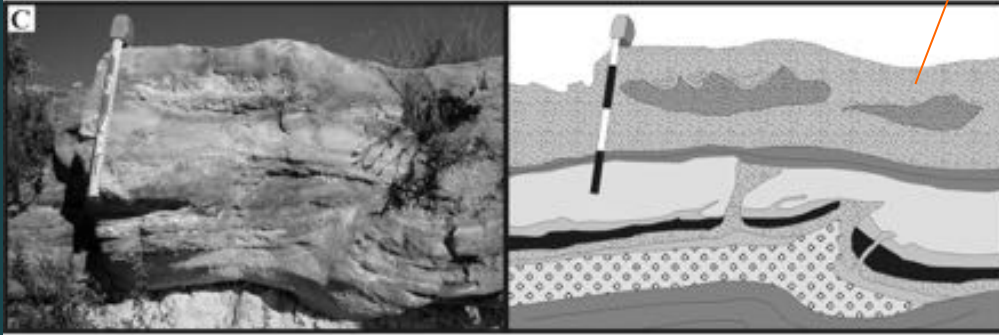
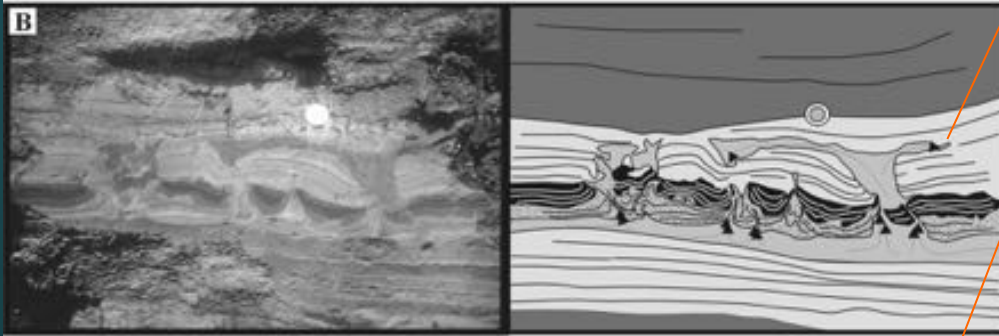
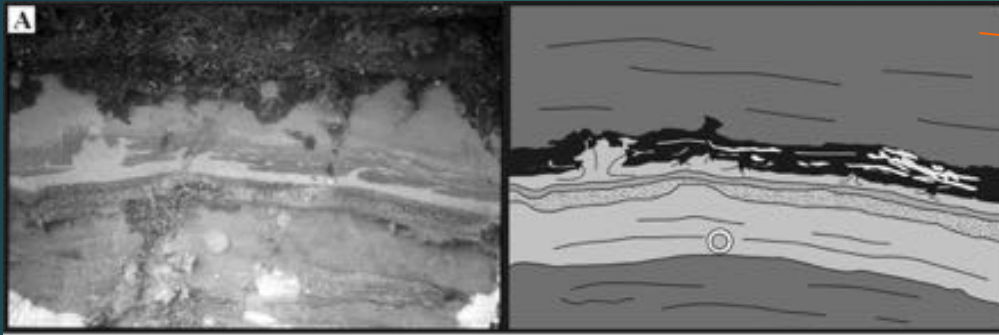
ALL EARTHQUAKES MUST HAVE A SPACE DISTRIBUTION



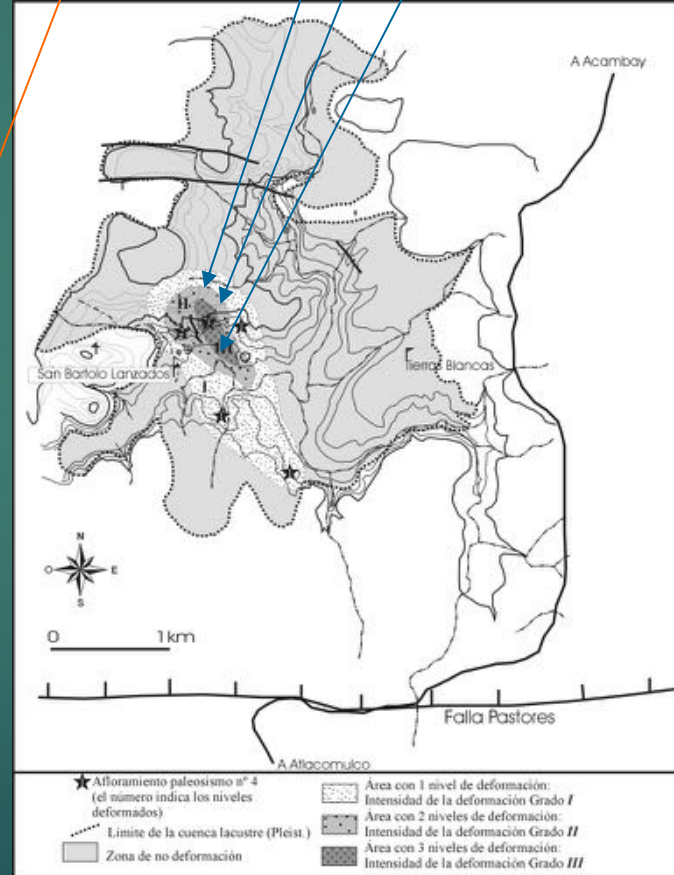
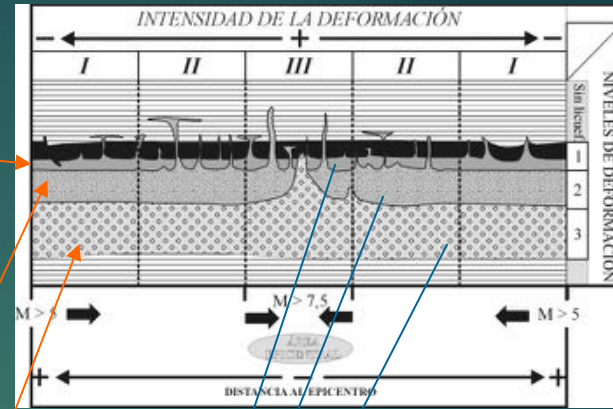
Liquafaction in volcanic sand

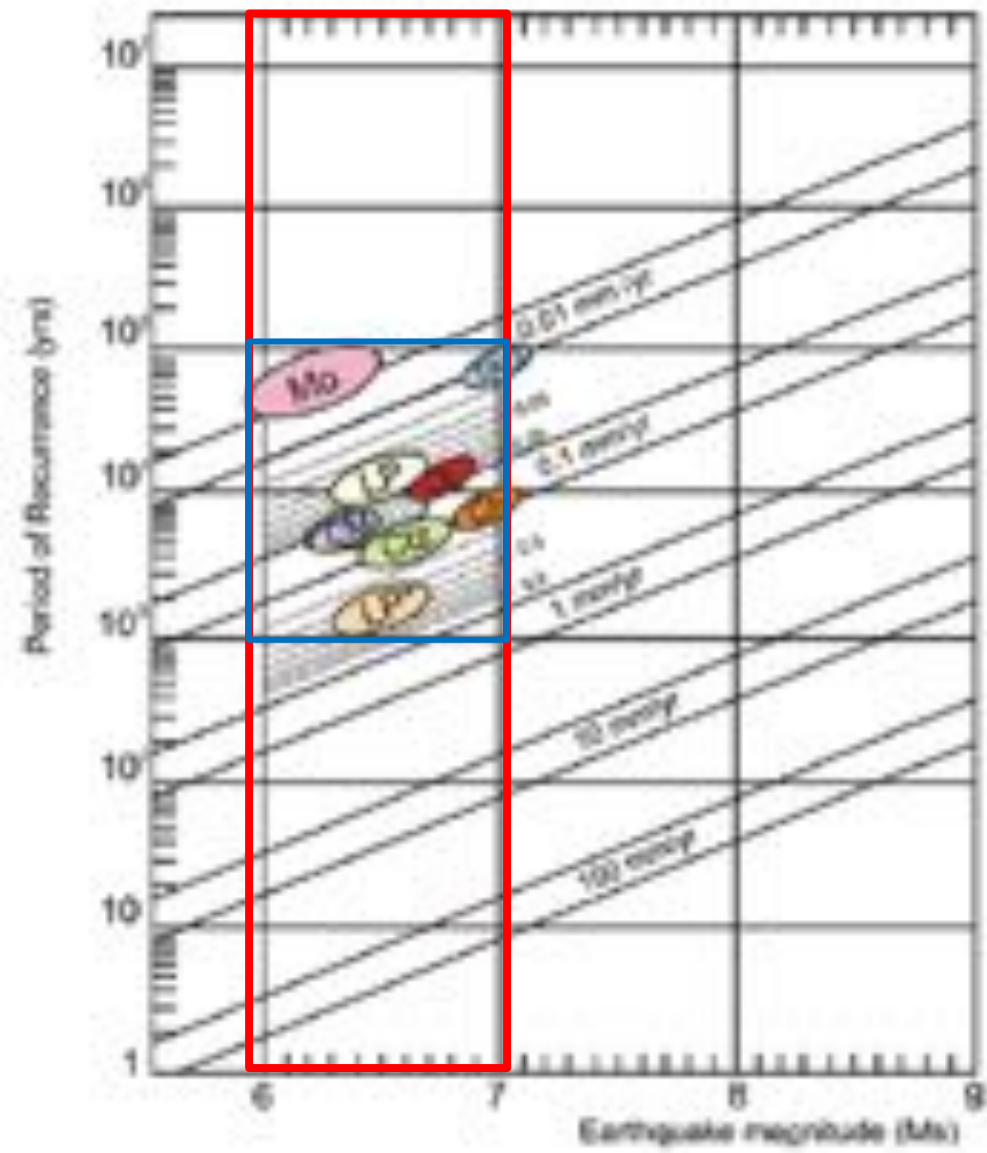


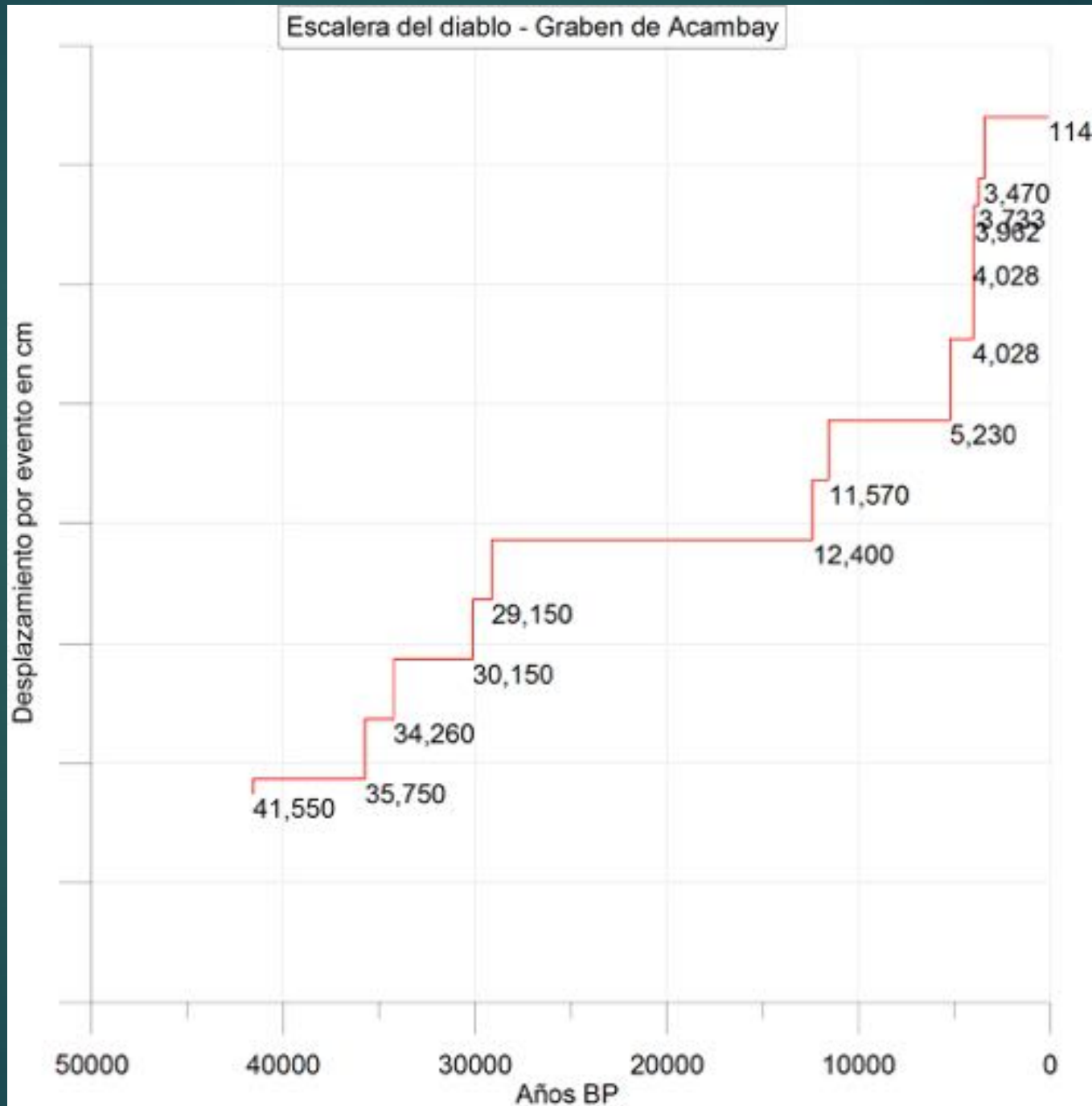
Mexican liquefaction

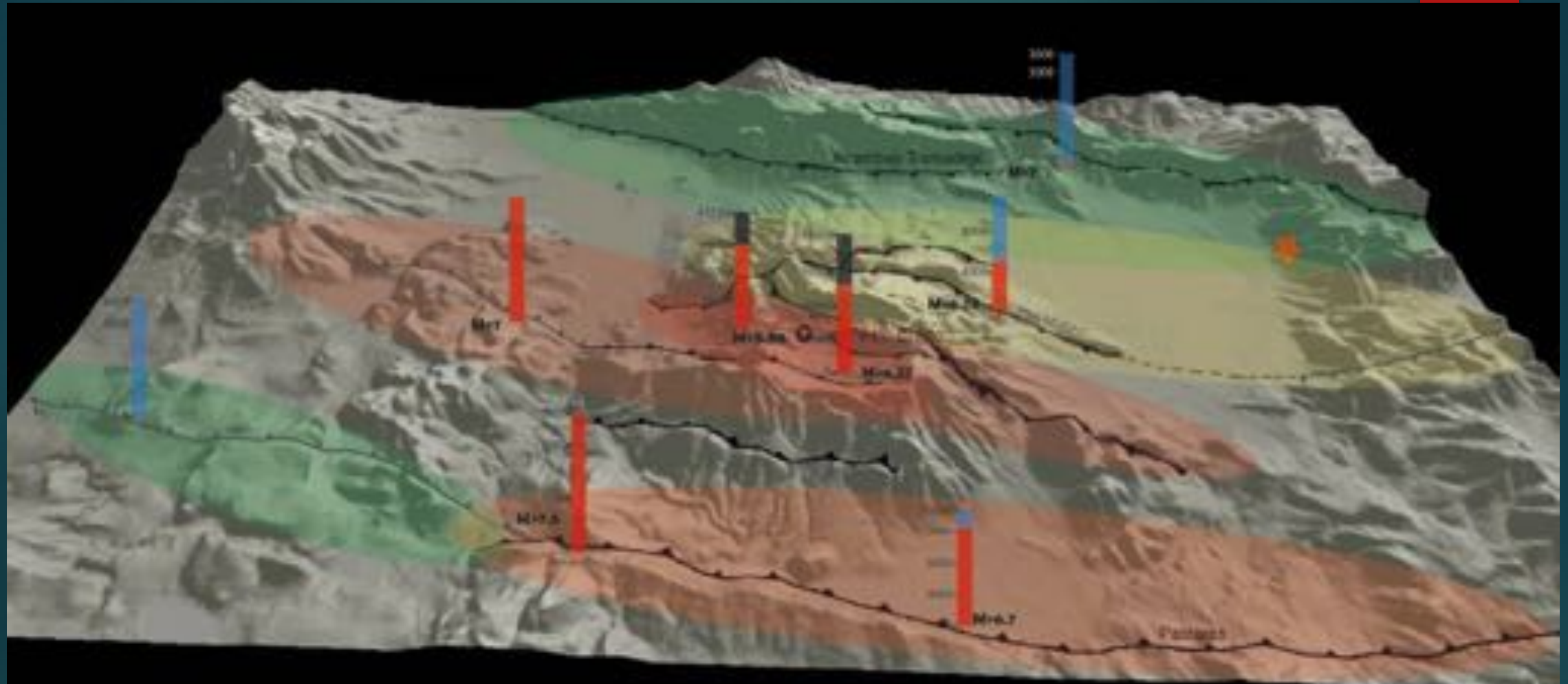


- Limos ■ Conglomerados ■ Capas no deformadas
- Arenas ■ Arcillas con alto contenido en materia orgánica









Velázquez -Bucio 2017

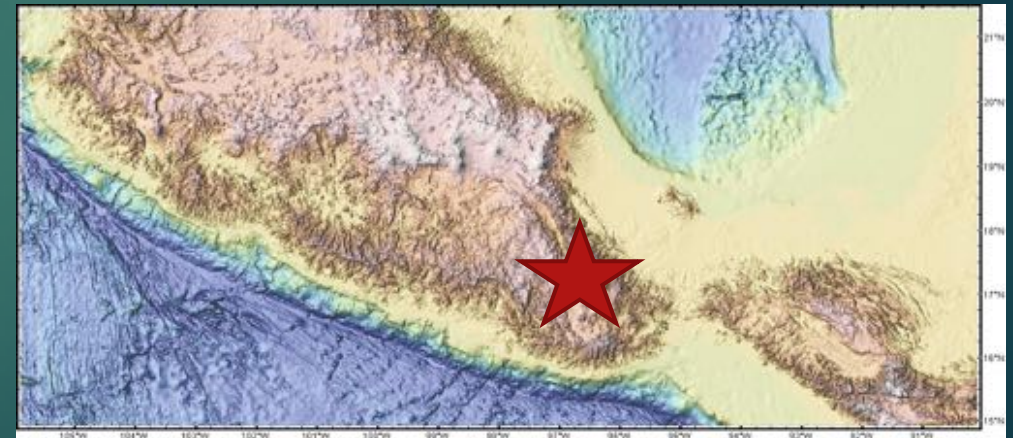
MITLA LANDSLIDE



A

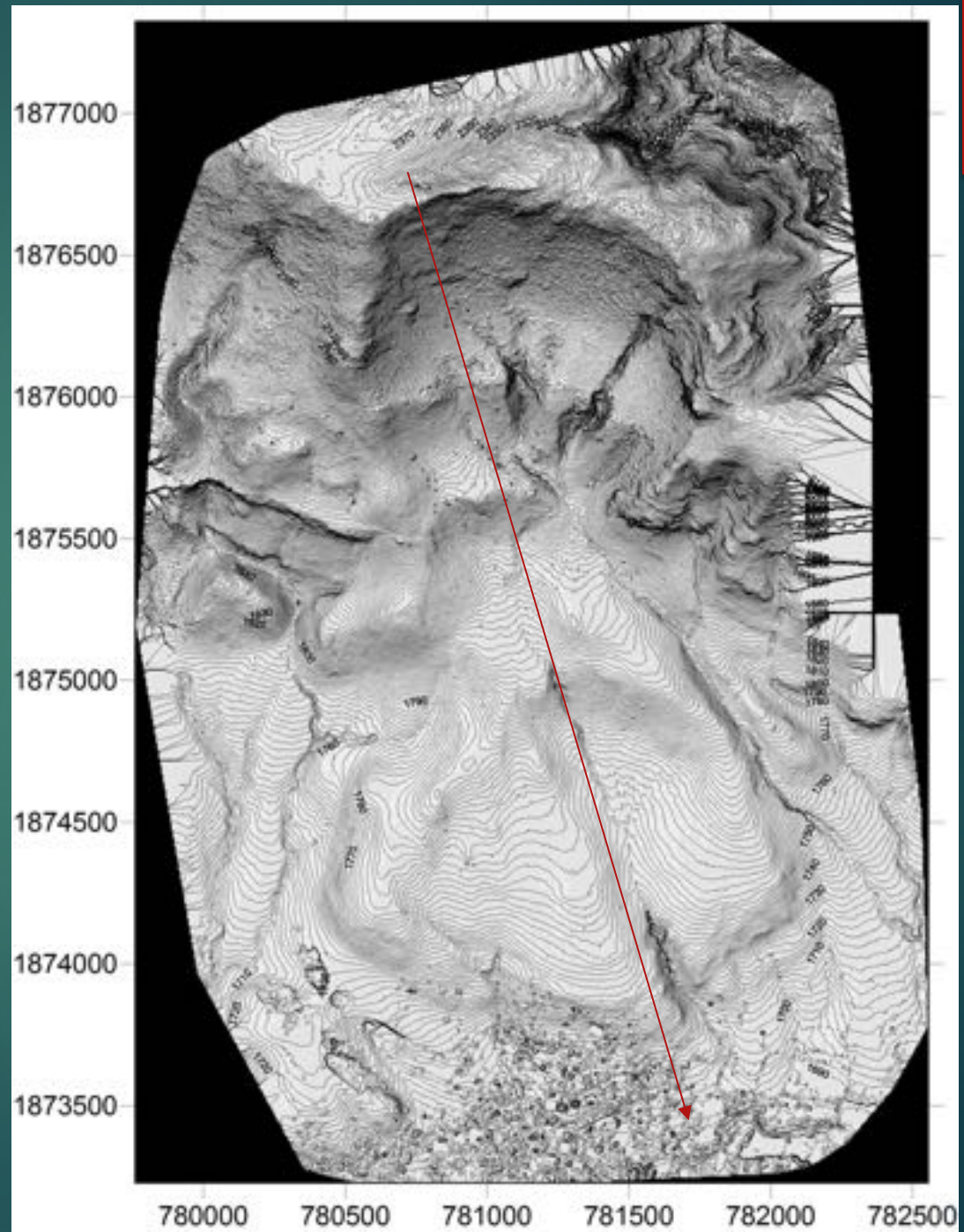
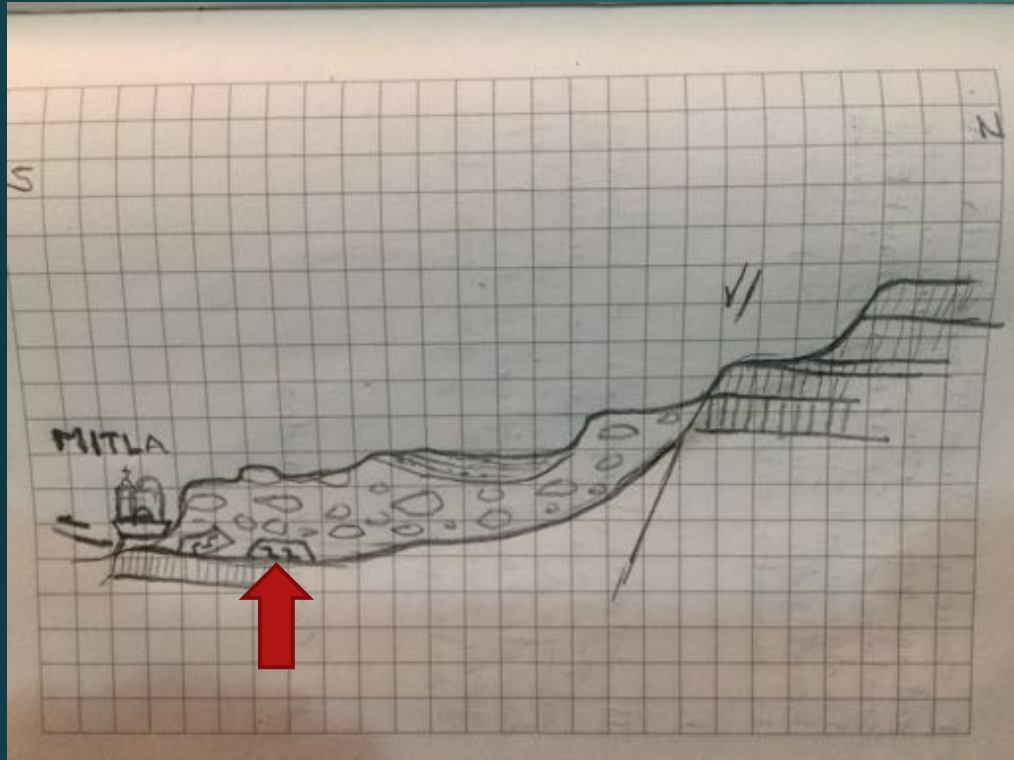


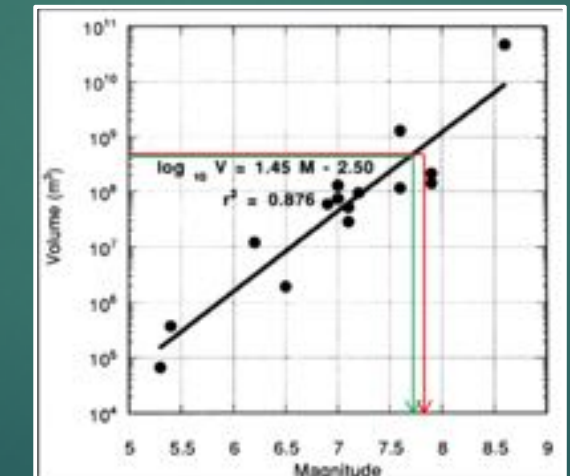
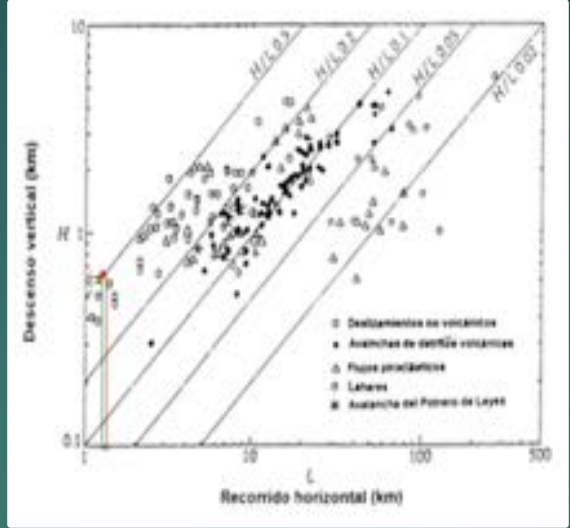
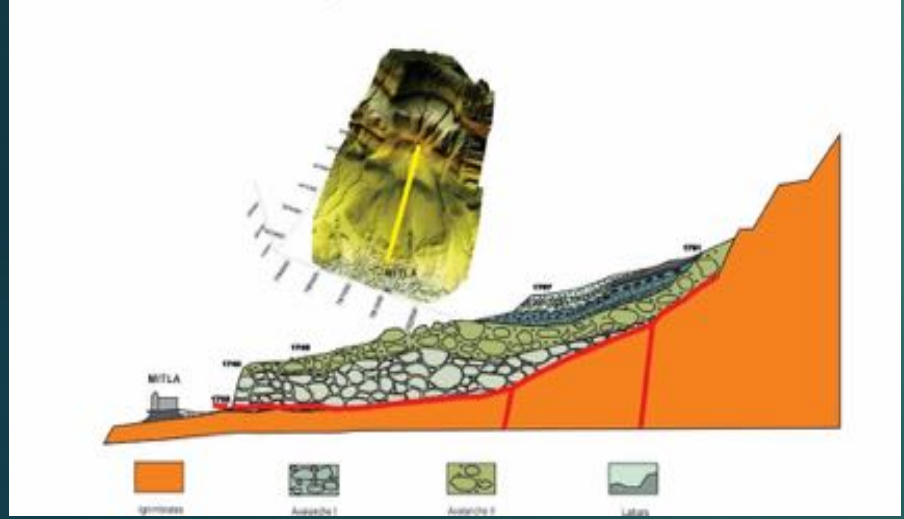
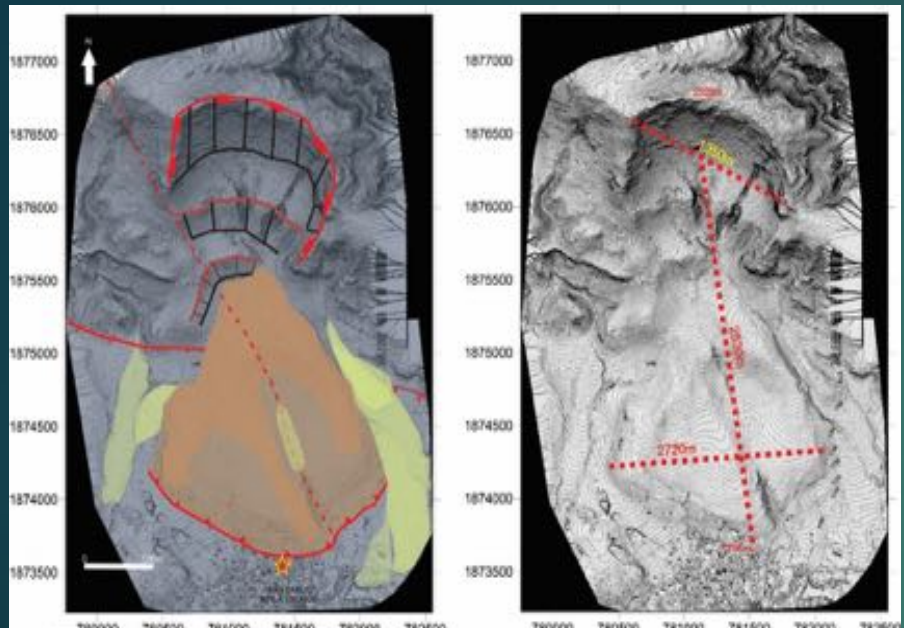
B



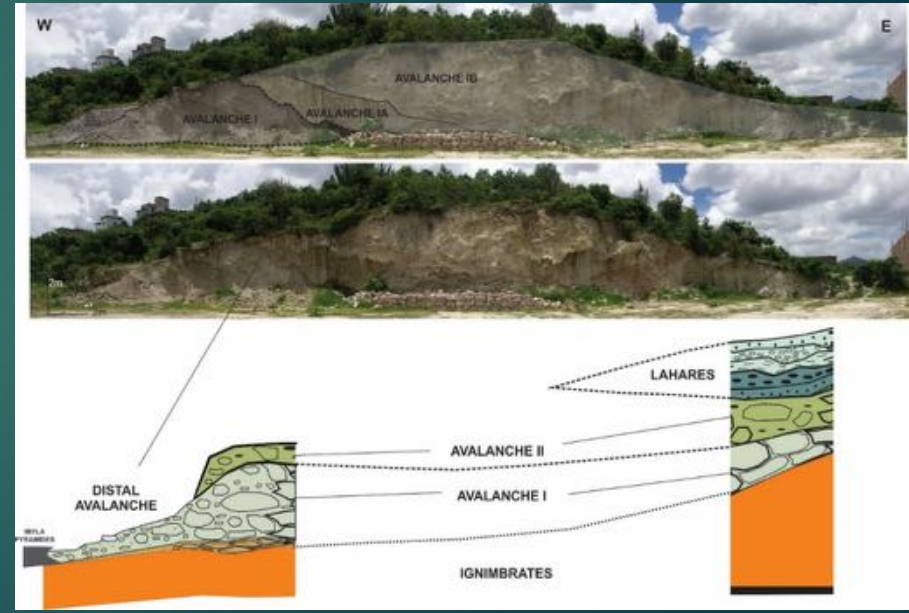


DEM FROM MITLA LANDSLIDE

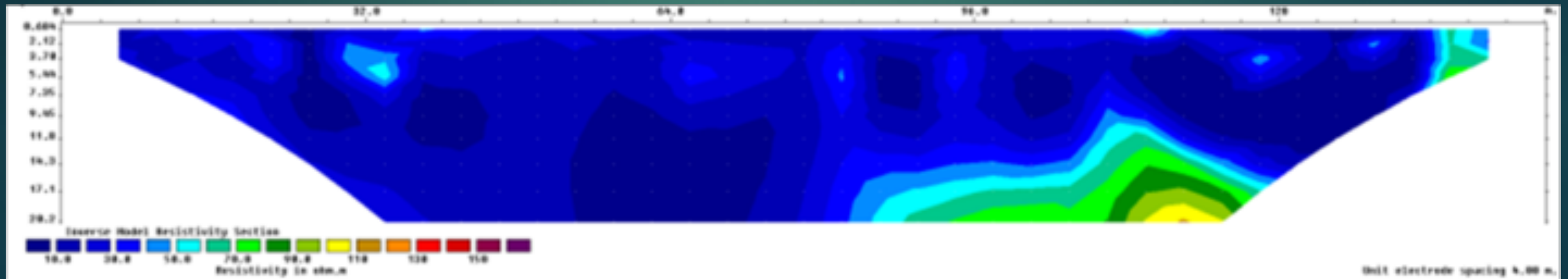
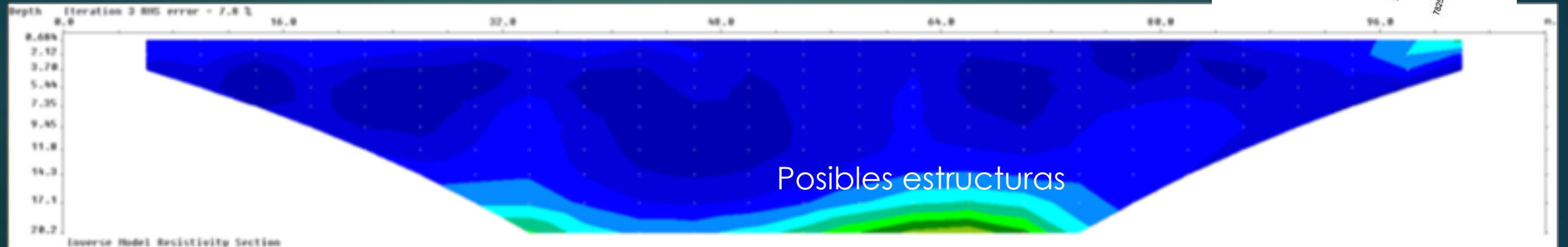
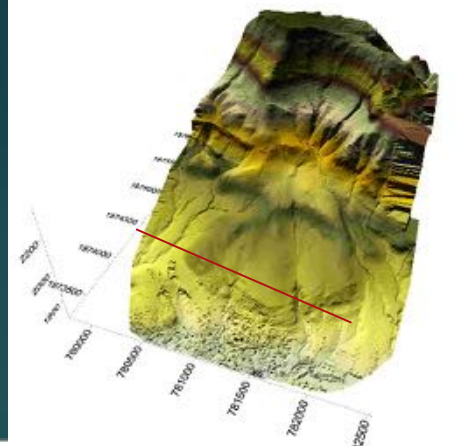




Deslizamiento	Área (m²)	Volumen (m³)	Área (km²)	Volumen (km³)
Principal (1)	19 132	546 000 000	0.019	0.546
Secundario (2)	17 418	497 000 000	0.017	0.497



GEOPHYSICAL EXPLORATION , ELECTRICAL TOMOGRAPHY





LOOKING FOR
CHARCOALS



10,000 habitantes

MITLA

Google earth

3043

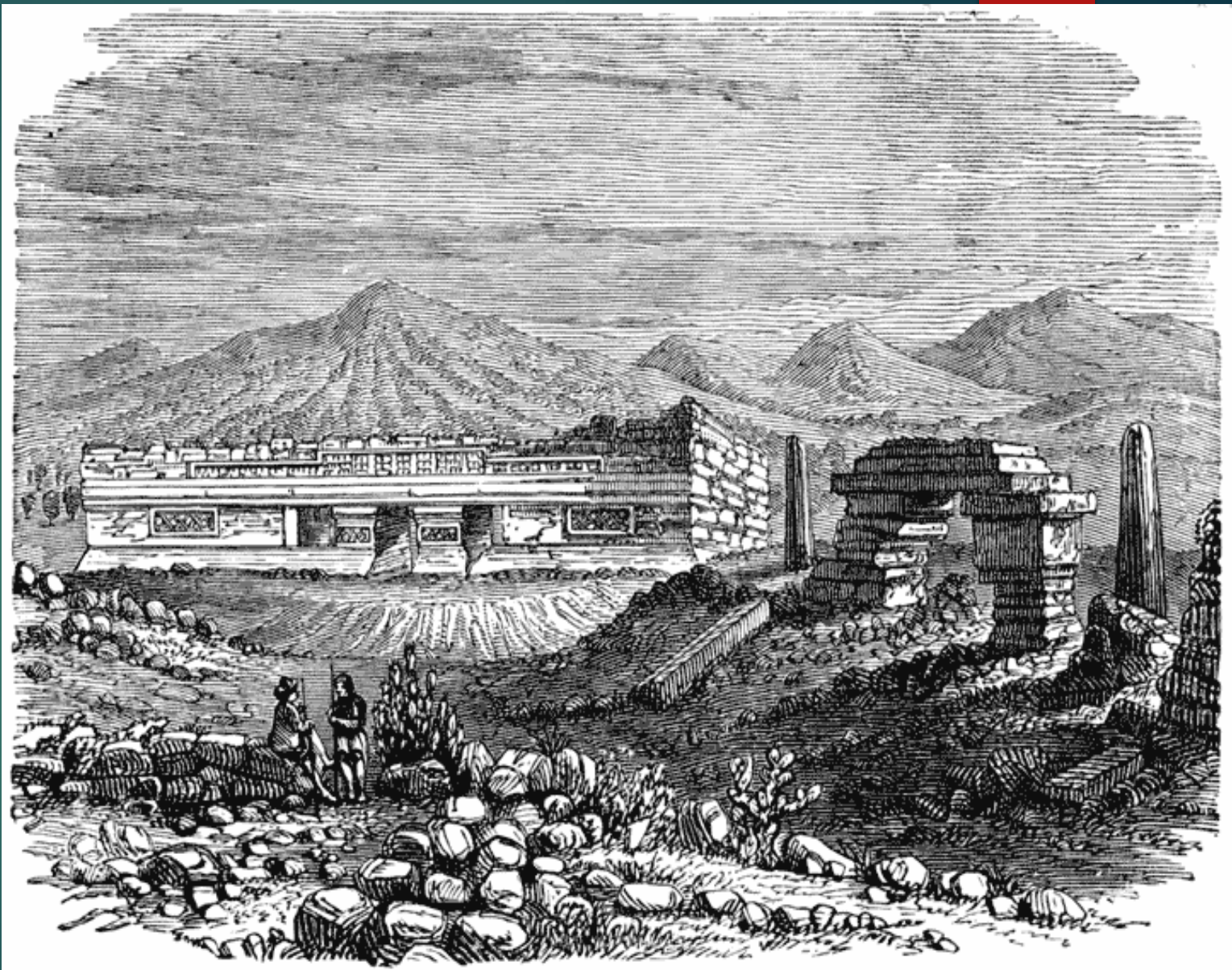
0 500 m

el grupo de edificios
del grupo de edificios
del grupo de edificios

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N del p. sur aus Mi Ha Tula
Oaxaca
Mi Ha 13509

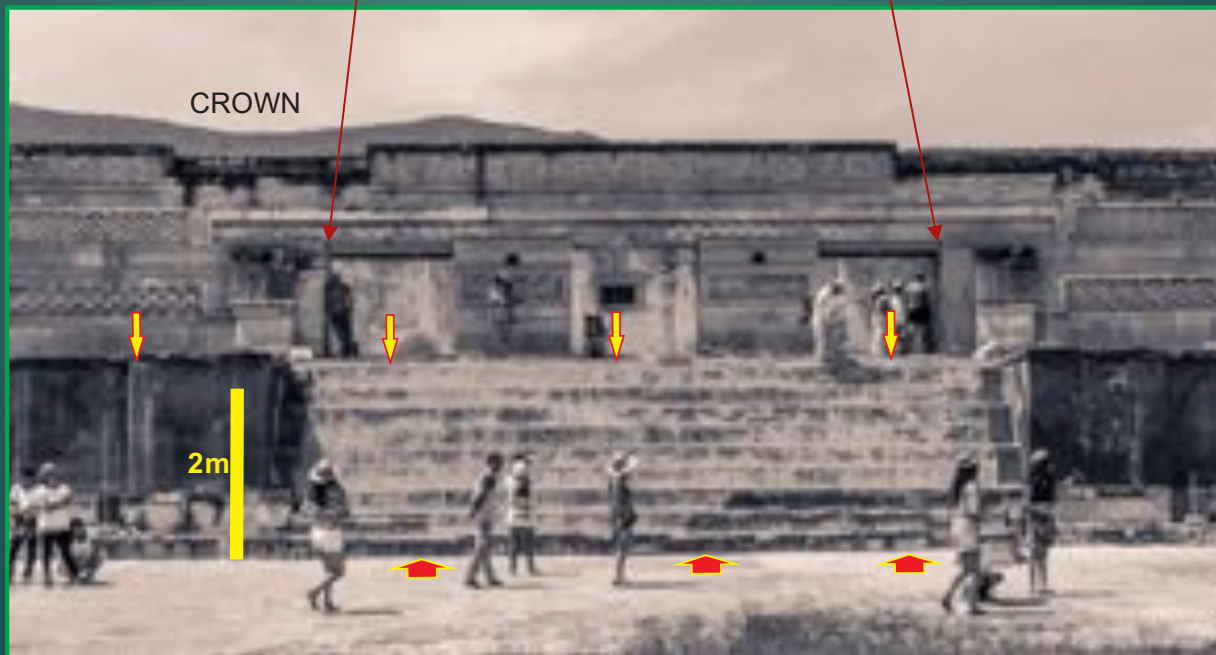
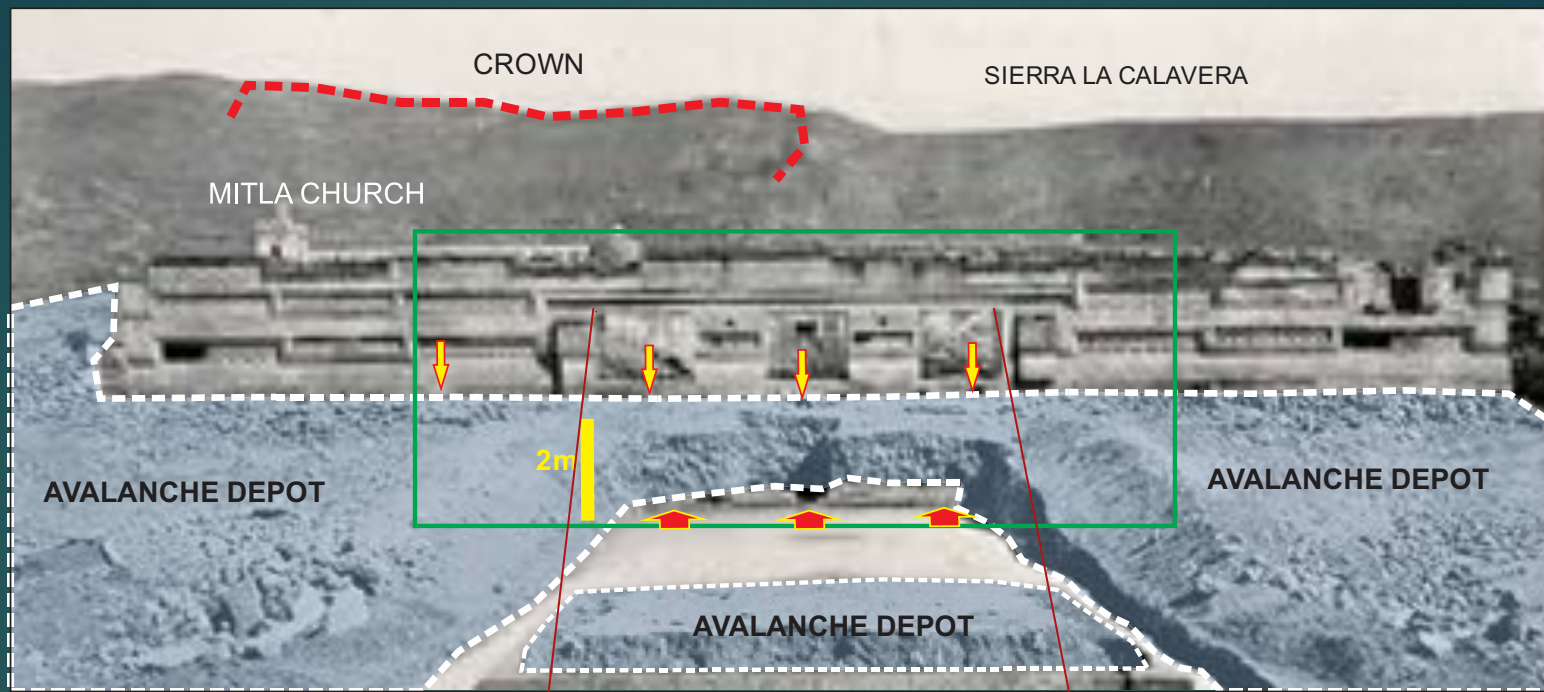
Arguedo
L. Schauf

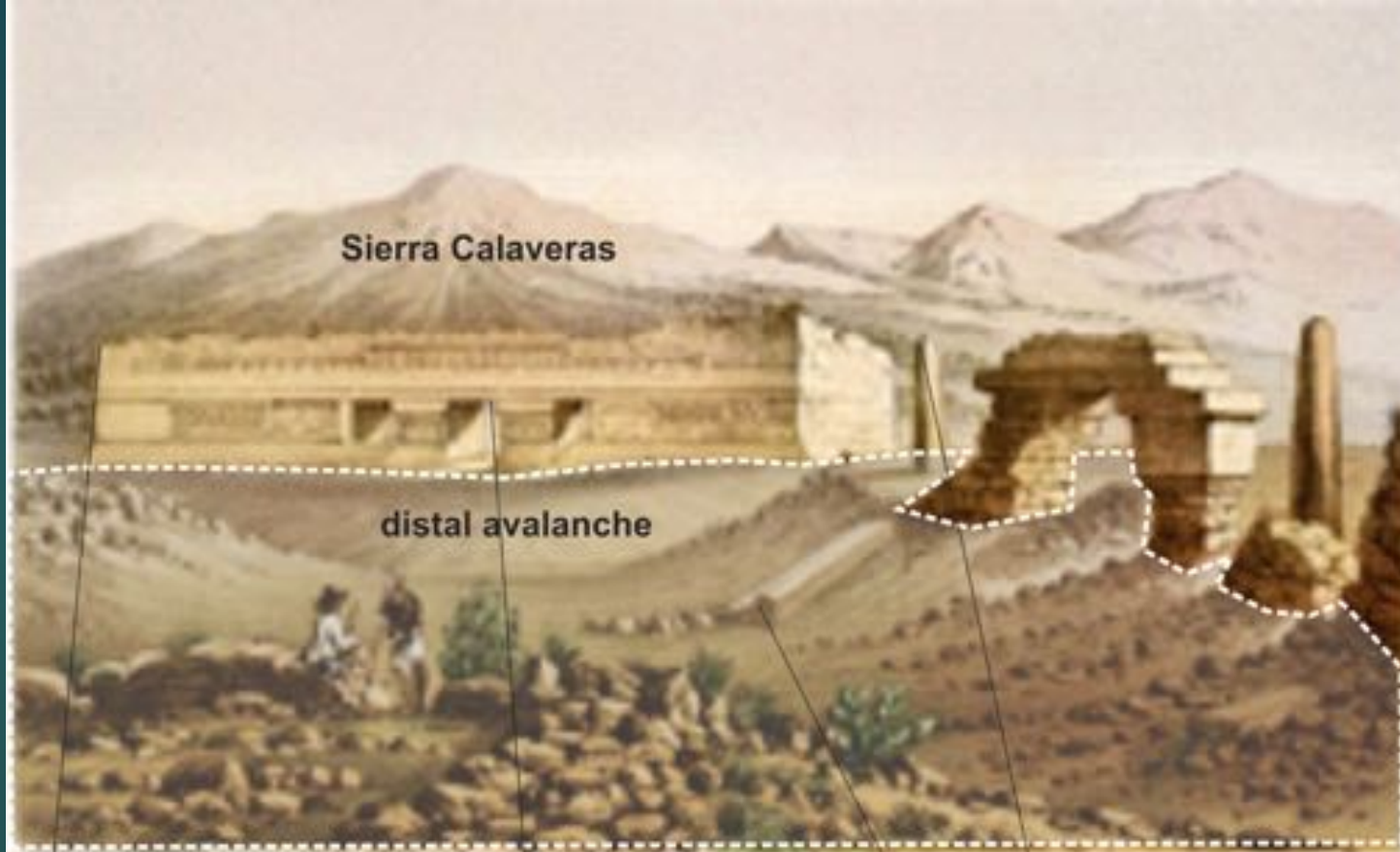


J. K 171. México.
Regist.

Estado de Oaxaca: Iglesia en Milla.

mexico  enFotos







Tlacuilo = Hombre escribano.
Código Mendocino, siglo XVI, detalle.

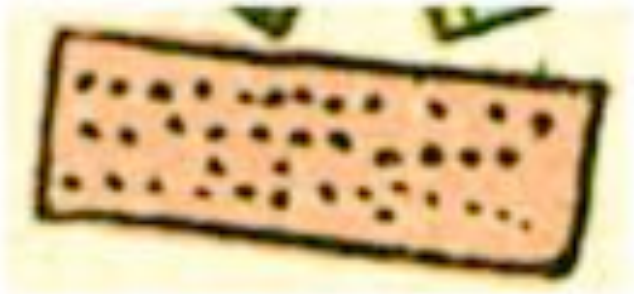


Cihuatlacuilo = Mujer escribana.
Código Talleriano Remensis, siglo XVI, detalle.

LOS TLACUILOS



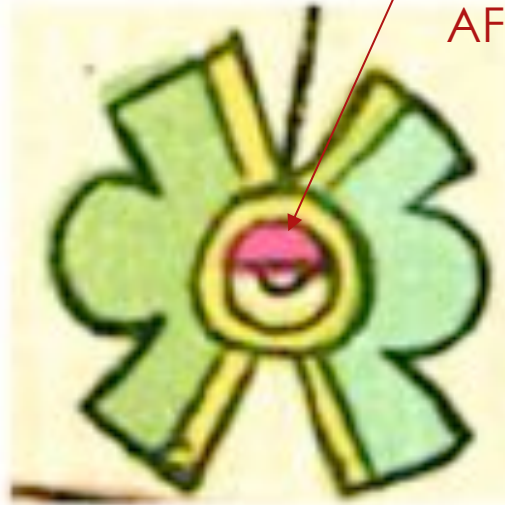
arqueología
MEXICANA



tlalli LAND

THE SMALLEST VALUE IS V

+



ollin SHAKING

=



EARTHQUAKES

THE EARTHQUAKE
OCCURRED IN THE
AFTERNOON

$$V + I + I = VII$$



tlalli = VII

$$V + I = VI$$



tlalli = VI

$$V = V$$



tlalli = V



MOVEMENT

LAND

TLALOLLIN
(EARTHQUAKE)

1507
~~1524~~

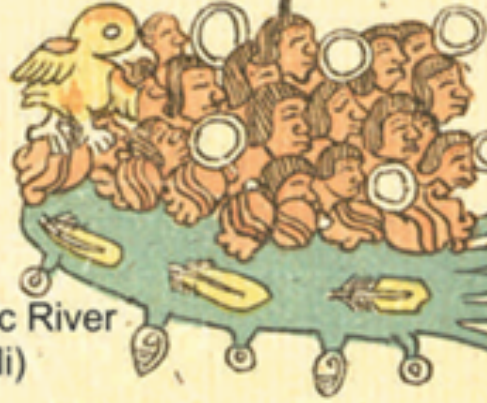
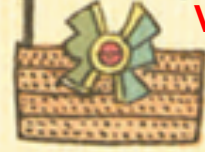
Yaer 2 Acatl
1507



Parcial solar
eclipse



Earthquake
VIII



400

2000

stones

Tuzac River
(Toztli)




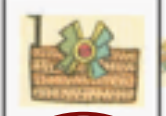


Number	Tlalolin	Symbol associated	Years	ESI 2007 scale	Tellariano Remensis scale	Observation
12				VIII	X tali	human migrations
11				V-VI	VI tali	stellar activity
10				V-VI	VI tali	stellar activity
9				V-VI	VI tali	
8				V-VI	VII tali	trees sway
7				VII	VI tali	stellar activity snow and mortality
6				VII-VIII	VIII tali	stellar activity partial eclipse, 2000 warrior killed by a lahar in the river Tuzac
5				V-VI	VI tali	mortality
4				V-VI	V tali	
3				V-VI	V tali	
2				V-VI	VI tali	

CHART OF THE INQUA ENVIRONMENTAL SEISMIC INTENSITY SCALE 2007 - ESI 07 (Modified from Silva et al., 2008 and Reicherter et al., 2009)

ES I-2007	PRIMARY EFFECTS		SECONDARY EFFECTS WITH GEOLOGICAL AND GEOMORPHOLOGICAL RECORD				OTHER SECONDARY EFFECTS		TELLERIANO REMENSIS INTENSITY SCALE
	SURFACE RUPTURES	TECTONIC UPLIFT/SUBSID	GROUND CRACKS	SLOPE MOVEMENTS	LIQUEFACTION PROCESSES	ANOMALOUS WAVES AND TSUNAMIS	HYDROGEOLOGICAL ANOMALIES	TREE SWAKING	
I-III	Offset	Length	Width	Length	ENVIRONMENTAL EFFECTS ARE VERY RARE AND CANNOT BE USED AS DIAGNOSTIC				
COSMOGENIC	IV		Rare and local						tlalli = V
	ABSENT		ABSENT						tlalli = VII
DAMAGING	VII		Rare and local	Permanent ground dislocations ($\times 10\text{ cm}$)					tlalli = VIII
	VIII								tlalli = IX
DESTRUCTIVE	X								
	XI								
VERY DESTRUCTIVE	XII								
	XII								
DESCRIPTOR & ICONS	Dip and strike-slip offset of coseismic ruptures	Permanent ground dislocation	Width and length of cracks and fractures in soils and rocks	Bulk volume of mobilized material	Dimension of liquified levels and sand boils	Transitory sea-level changes, storms and Tsunamis			

KEY REFERENCES

Mitchell et al., 2007. Environmental Seismic Intensity scale - ESI 2007. *Memorie Descrittive della Carta Geologica d'Italia*, 74. Servizio Geologico d'Italia, Roma.

Silva et al., 2008. Catalogue of the geological and environmental effects of earthquakes in Spain in the ESI-2007 Macroseismic scale. *Cong. Geol. Esp.* 6.

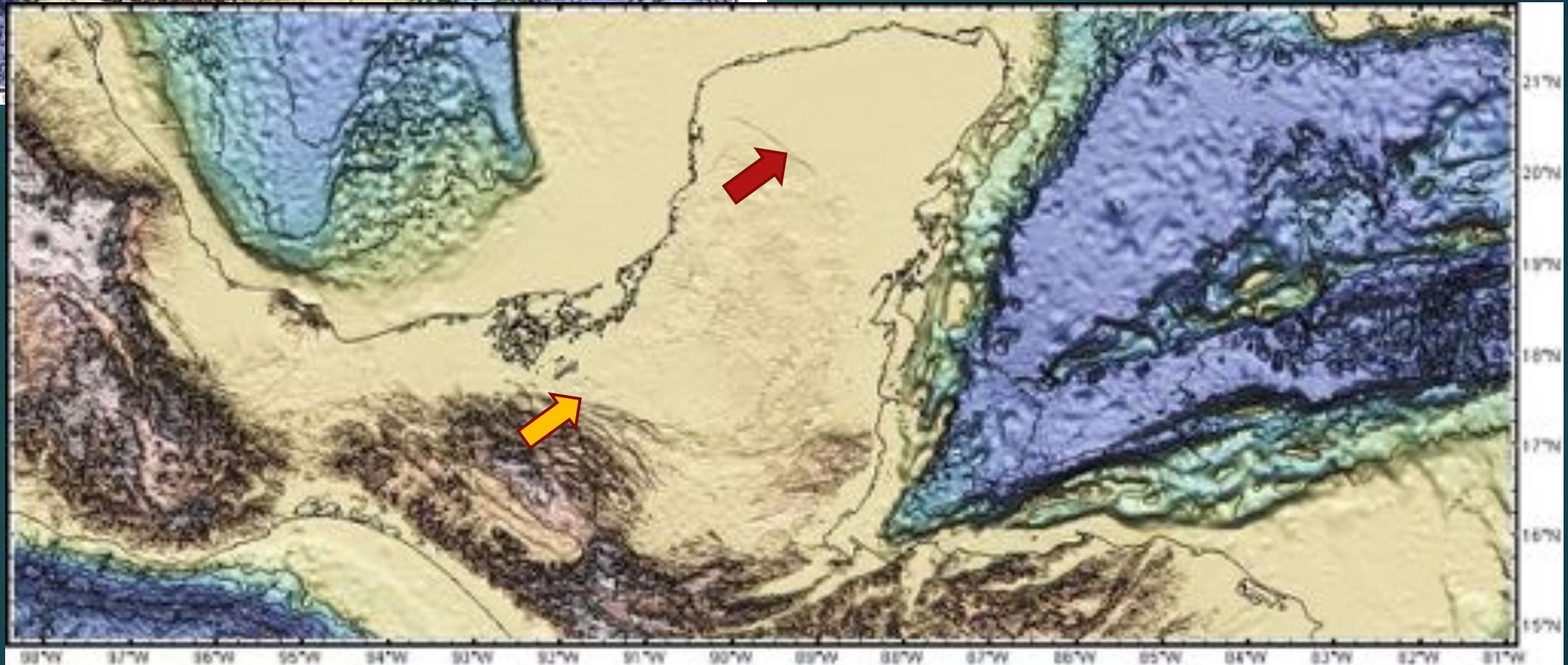
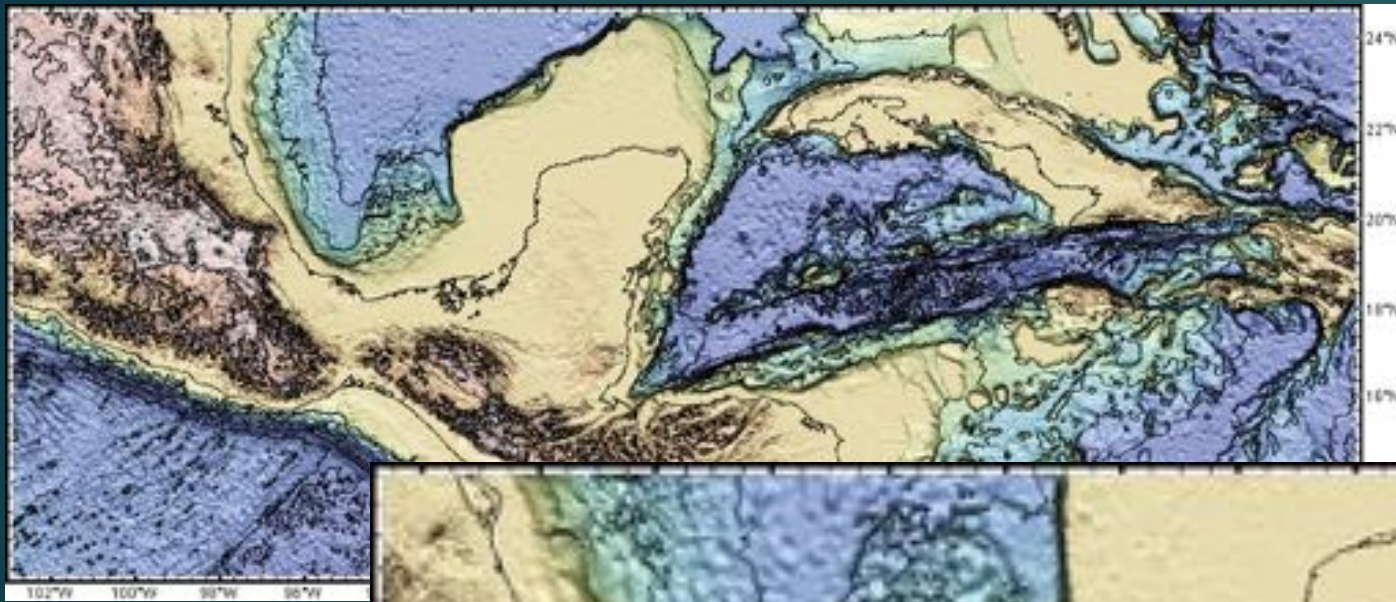
Reicherter, K., Mitchell, A.W., Silva, P.G., 2009. *Palaeoseismology: Historical and Prehistorical Record of Earthquake Ground Effects*. Geol. Soc. London.

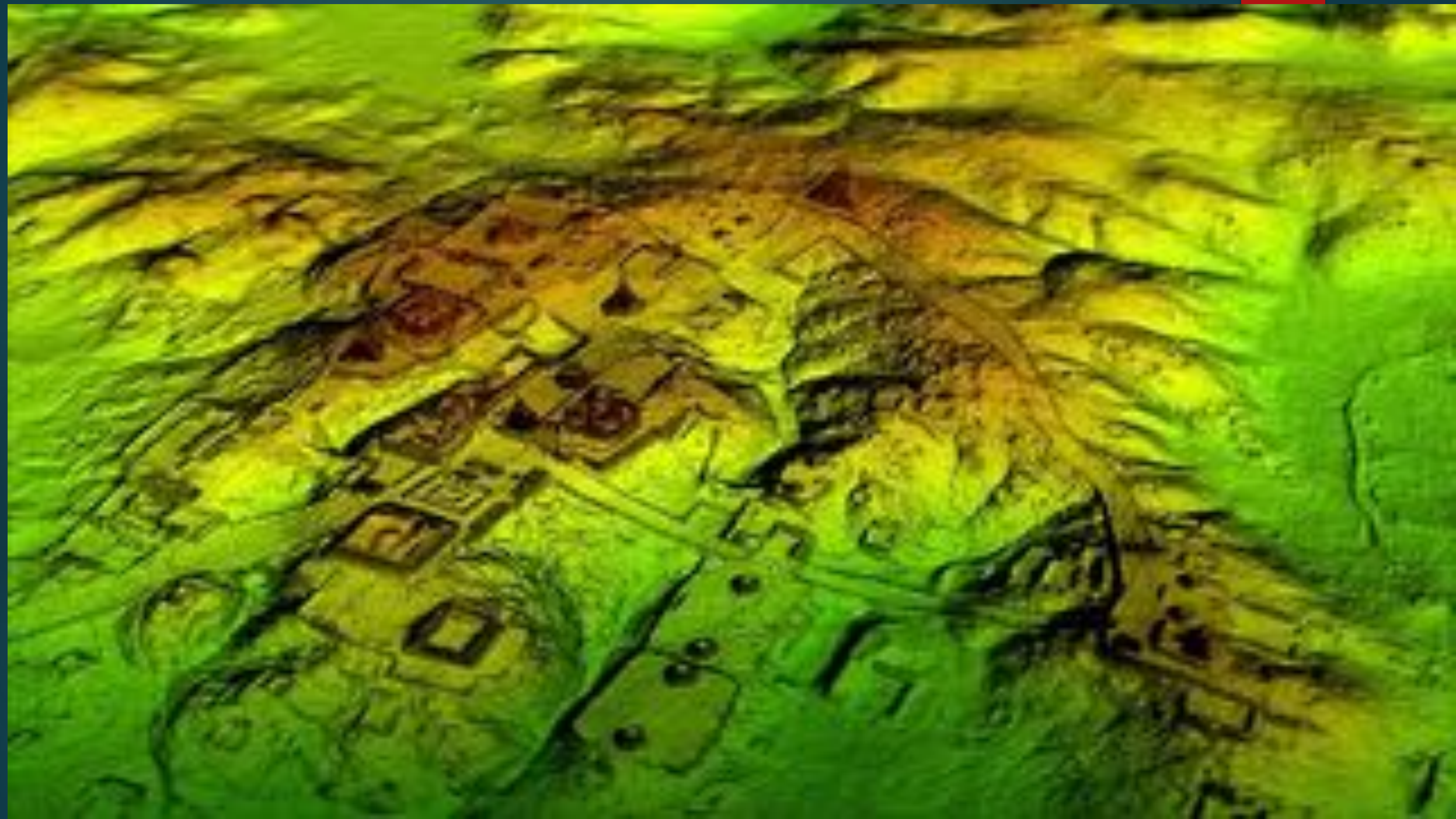
This chart is a contribution of the INQUA Focus Area on



Working Group of AEGIA, 2008-2010

The earthquakes and the Mayas?







MESO-AMERIQUE





WE WILL HAVE UNDERSTOOD, WHERE DO WE LIVE? UNTIL NOW EARTHQUAKES OF Mw9. THERE WILL BE BIGGER

THANK YOU AND WE WILL CONTINUE MOVING ... **GRACIAS**