ENVIRONMENTAL EFFECTS, CAUSED BY THE M_s 6.7, M_b 6.9, NOVEMBER 19th, 1912, ACAMBAY EARTHQUAKE, MEXICO

Reassessment of intensity and macroseismic field with the ESI-07 scale

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ACAMBAY EARTHQUAKE

NOVEMBER, 19th,1912

MAGNITUDE: M_s 6.7, M_b 6.9 (Suter et al., 1996)

EPICENTRAL MACROSEISMIC INTENSITY: MM = XI (Suter et al., 1996)

LOCATION: Acambay graben, Mexico

TIME: 07:55, local time (13:55, UTC)

COORDINATES: 19.93 ºN, 99.83 ºW (SSN)

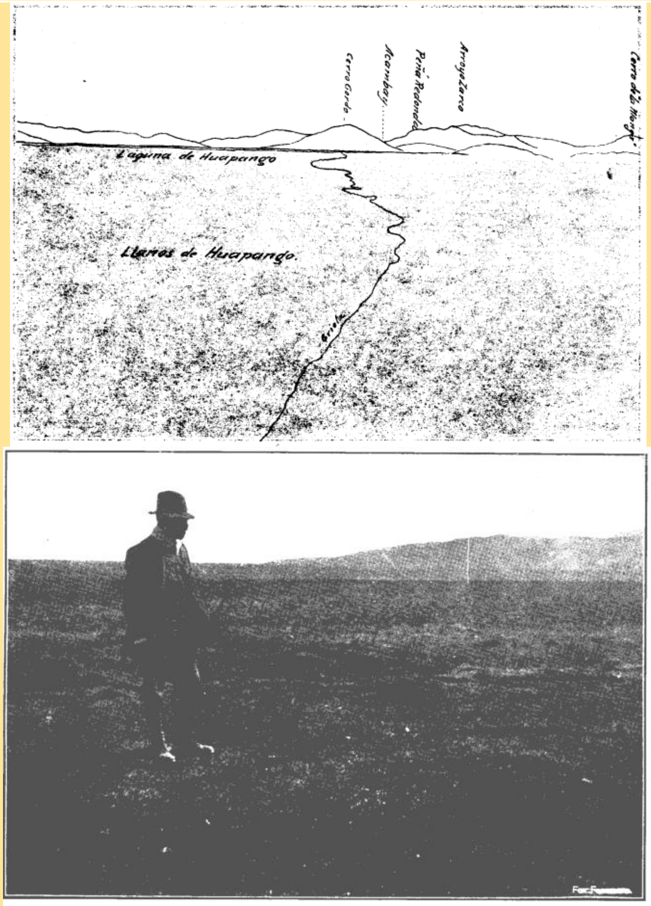
HYPOCENTRAL DEPTH: 5 – 15 km (Suter et al., 1996)

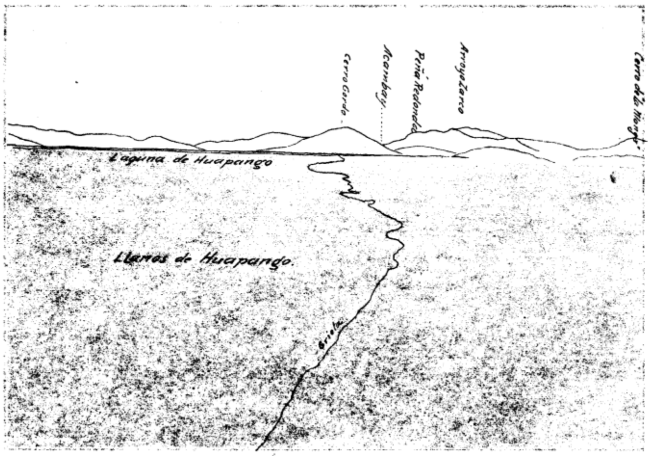
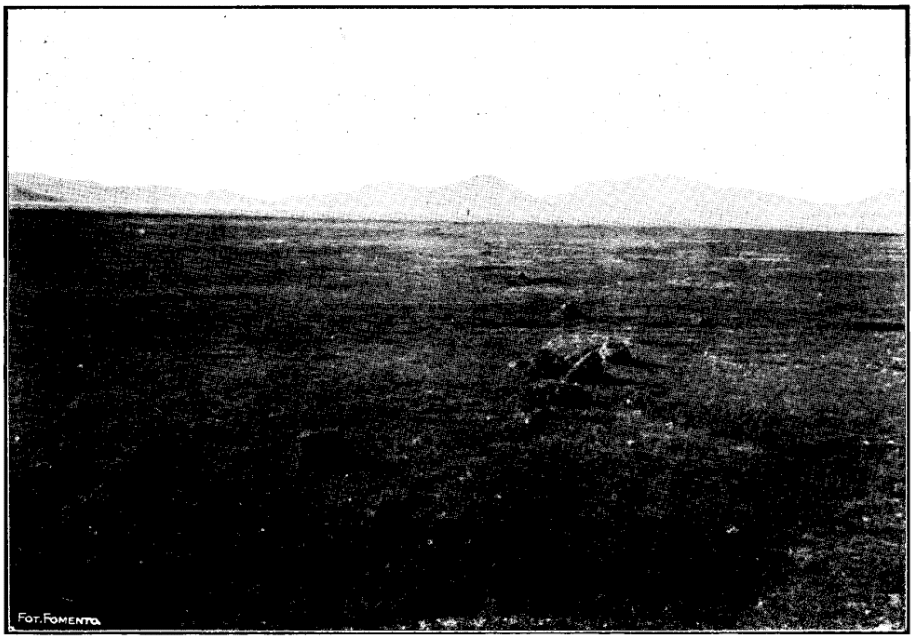
SOURCE: Acambay – Tixmadejé Fault

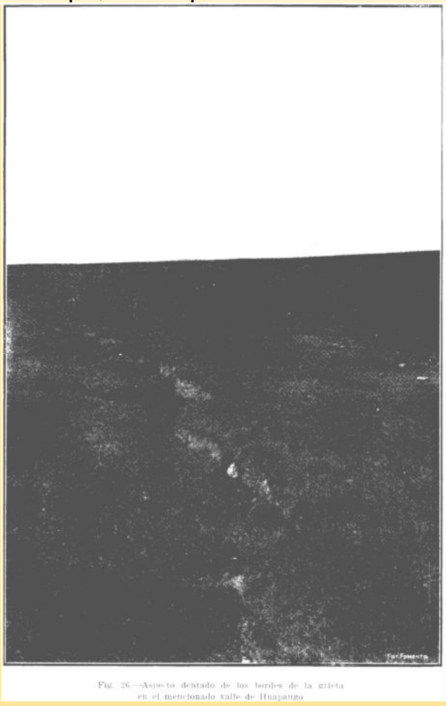
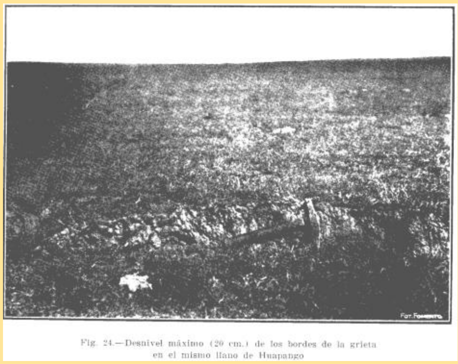
This document presents a collection of Earthquake Environmental Effects (EEEs) triggered by the Ms 6.7, Mb 6.9, (Urbina and Camacho, 1913; Suter et al., 1996), Acambay, Mexico earthquake, occurred on 19th November 1912; Cancani intensity = X (Urbina and Camacho, 1913); I_0 ESI= X (Velázquez-Bucio et al., this document). Data derive from original and new field surveys, historical and photographic archives, published reports and papers. Most descriptions of EEEs are *verbatim* translations of the original publications.

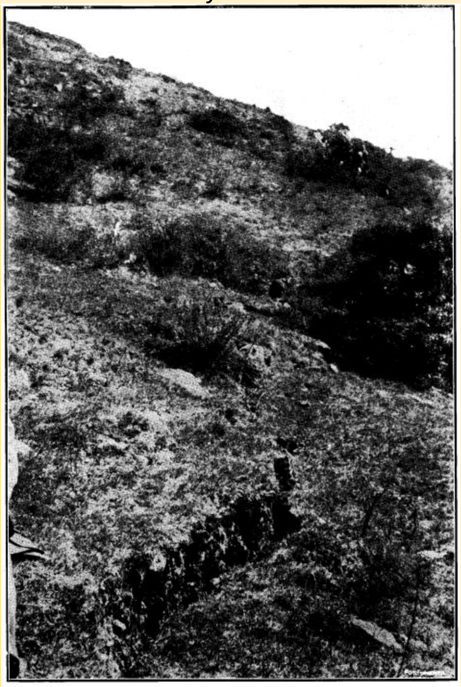
For each site where an EEE has been documented, the following information are provided:

•Latitude and longitude;
•Locality, i.e., geographic place where the EEE occurred;
•EEE type;
•Description of the observed effect;
•Local intensity assessed using the ESI-07 (Environmental Seismic Intensity) scale;
•Photographic documentation (for sites and effects without an image available, an image of their location taken from Google Earth is added;
•Reference (Only the main reference bibliography for each EEE is included in the forms).

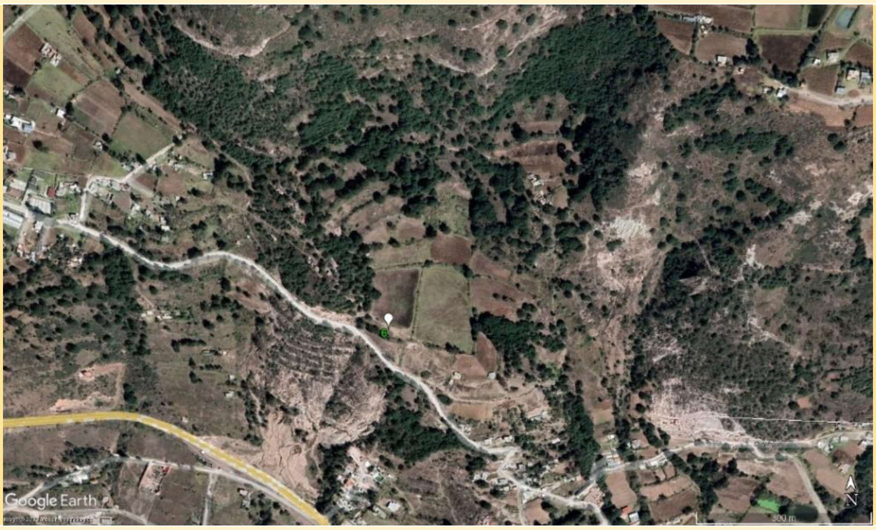
Site number	001
Latitude	2199870.73
Longitude	424178.73
Distance from epicenter	11.64 km
Locality	31-Huapango Valley I Rancho de “El Fresno”
Type of effect	Tectonic Surface rupture
Description	Starts with a width of 12 centimeters and unevenness of 5 centimeters towards the West, spanning a length of 75 meters; it changes its course in N. 12° W and with the same width for more than 20 meters, observing in this part an unevenness of 14 centimeters, revealed later by a system of several parallel cracks of approximately 3 meters equidistance.
ESI intensity	IX
Geomorphologic setting	It begins at the drainage line of the portion of the valley bounded to the north by the hills of Palos and El Pelón and to the south by those of Enitzí and Ñatejé of the Sierra de San Andrés Timilpan.
Photographic documentation	 Fig. 22, plate XIV in Urbina and Camacho (1913). Branched part of the crack of the northern system, in the plain of Huapango, ranch of "El Fresno".
References	Urbina and Camacho, 1913.

Site number	002
Latitude	2199852.50
Longitude	424137.54
Distance from epicenter	11.87 km
Locality	31-Huapango Valley II
Type of effect	Tectonic Surface rupture
Description	Vertical displacement of 3 cm and 6 cm width.
ESI intensity	VIII
Geomorphologic setting	This one begins to the N of the previous one, with direction N 21° W, parallel to the drainage line and later with a curved part of concavity towards Timilpan.
Photographic documentation	  Fig. 23.—Bordes saltados de la grieta y curso sinuoso de la misma en el mencionado llano de Huapango
sources	Urbina and Camacho, 1913.

Site number	**003**
Latitude	2201401.73
Longitude	425849.24
Distance from epicenter	13.02 km
Locality	31-Huapango Valley III
Type of effect	Tectonic Surface rupture
Description	Its general shape is of a concavity curve turned like the previous one towards San Andrés Timilpan. Maximum vertical displacement of 20 cm and 8 cm width.
ESI intensity	IX
Geomorphologic setting	It connects directly with those found on the slopes of the Dongú hills, north of Acambay, it begins 300 meters N. 85° W. from Cerro de Palos, with a general course N. 50° W. It stops shortly before reaching the Huapango lagoon, south of Tiupa; in this part the crack has different widths.
Photographic documentation	  Fig. 24. Maximum unevenness (20 cm) of the edges of the crack in the same plain of Huapango Fig. 26. Jagged appearance of the edges of the crack in the aforementioned Huapango Valley
sources	Urbina and Camacho, 1913.

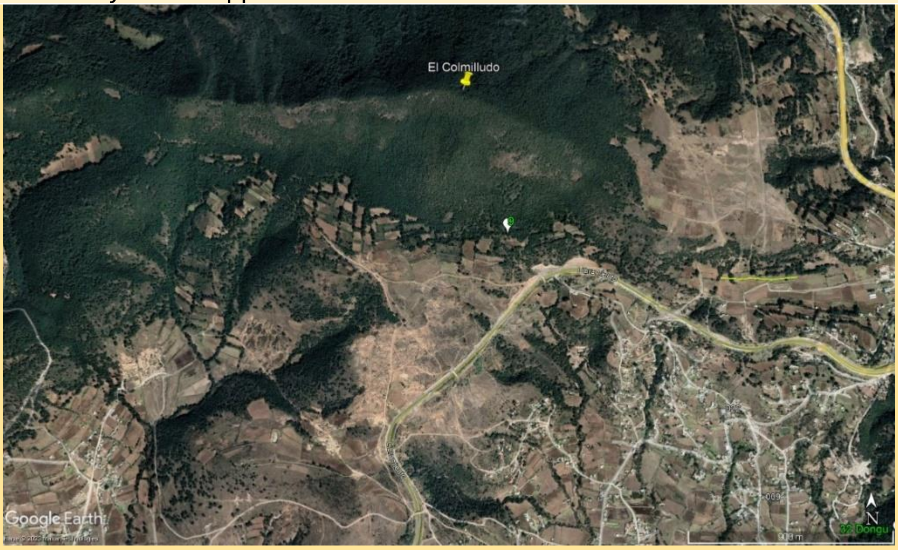
Site number	004
Latitude	2206676.1
Longitude	417526.1
Distance from epicenter	12.31 km
Locality	1.Acambay Valley (At the foot of Peña Larga - La Joya Hill)
Type of effect	Tectonic Surface rupture
Description	Displacement of 15 centimeters and a width of 10.
ESI intensity	IX
Geomorphologic setting	A system of "cracks" in the Acambay valley is subdivided into parallel cracks, of which the most important are those at the foot of Peña Larga, on a slope of 36°, (fig. 27, plate XVII), and then pass north of Acambay.
Photographic documentation	 Fig. 25.—Grieta en la ladera meridional del cerrito de "La Joya," al N.W. de Acambay (sistema septentrional) Fig. 25. Crack on the southern slope of "La Joya" hill to the N.W. of Acambay (northern system). Fig. 27. The same crack of fig. 25 taken longitudinally to also show the slope of the terrain.  Fig. 27.—La misma grieta de la fig. 25. tomada longitudinalmente para mostrar también la pendiente del terreno
sources	Urbina and Camacho, 1913.

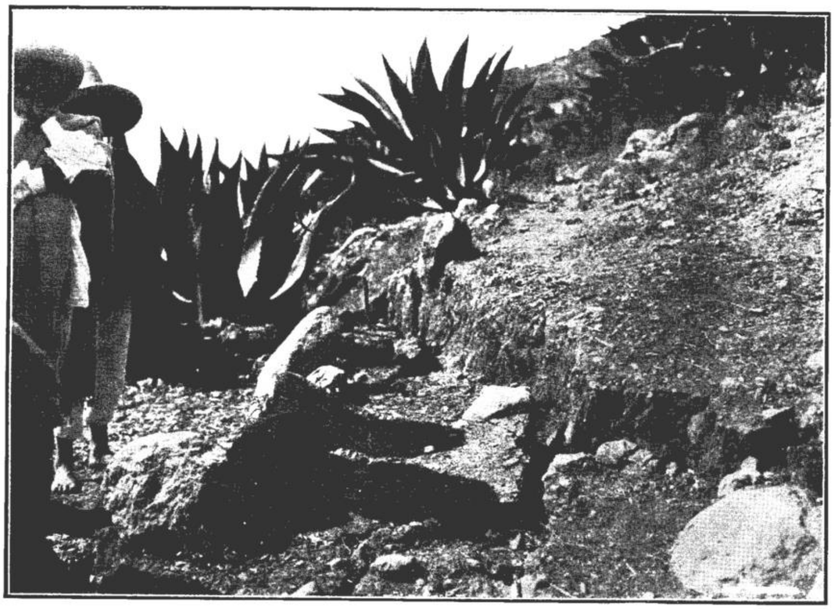
Site number	**005**
Latitude	2208314.35
Longitude	410845.59
Distance from epicenter	4.92 km
Locality	“La Jolla”
Type of effect	Tectonic Surface rupture
Description	Segmented crack of several tens in length, semi-parallel to the streams, subdivided into small parallel cracks with a separation of 5-9 m. Maximum vertical unevenness of the edges of 17 cm.
ESI intensity	IX
Geomorphologic setting	In the Acambay valley.
Photographic documentation	
sources	Urbina and Camacho, 1913.

Site number	006
Latitude	2208277.41
Longitude	410791.31
Distance from epicenter	4.91 km
Locality	Dongú (Bomú stream)
Type of effect	Tectonic Surface rupture
Description	Parallel to and near a stream (Bomú) heading N 76° W, 15 cm wide and 20 cm uneven. It changes direction to N 15° W and cuts off the road to Dongú and branches off.
ESI intensity	IX
Geomorphologic setting	Near the stream. It branches.
Photographic documentation	
sources	Urbina and Camacho, 1913

Site number	007
Latitude	2209180.93
Longitude	409571.03
Distance from epicenter	6.33 km
Locality	Dongú valley
Type of effect	Tectonic Surface rupture
Description	Same orientation of the valley (E-W), on the northern edge and the Huamango road. 200 m long, 25 cm wide.
ESI intensity	IX
Geomorphologic setting	In the Dongú valley, at the foot of a labradorite stream.
Photographic documentation	
sources	Urbina and Camacho, 1913

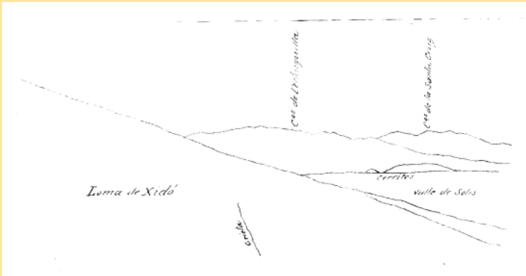
Site number	**008**
Latitude	2209635.75
Longitude	408941.00
Distance from epicenter	7.07 km
Locality	Peña de Huamango
Type of effect	Tectonic Surface rupture
Description	Crack 100 meters long and 6 centimeters wide, oriented S 10° E. This crack serves as a link with the general system. In a section, an oval-shaped hole was formed due to the effect of the earthquake, elongated from east to west, with an approximate area of one square meter, inclined and quite deep.
ESI intensity	X
Geomorphologic setting	The descent of the hill is steep (34° slope) and is covered by loose cultivated land.
Photographic documentation	 Fig. 29.—Hundimiento de terreno flojo, en fuerte pendiente, a consecuencia del temblor, situado al W. de la Peña de Huamango, cerca de un ramal de la grieta septentrional y donde nace un arroyo. “Fig. 29. Subsidence of loose ground, on a steep slope, as a result of the earthquake, located to the W of the Peña de Huamango, near a branch of the northern crack and where a stream is born.”
sources	Urbina and Camacho, 1913

Site number	009
Latitude	2210000.90
Longitude	406985.22
Distance from epicenter	8.87 km
Locality	El Colmilludo
Type of effect	Tectonic Surface rupture
Description	In the stratified tuffs, there are joints oriented from East to West.
ESI intensity	X
Geomorphologic setting	Inside the valley of "El Colmilludo". Here, the cracks belonging to the same northern system reappear.
Photographic documentation	
sources	Urbina and Camacho, 1913

Site number	**010**
Latitude	2208906.79
Longitude	401783.00
Distance from epicenter	12.4 km
Locality	Top of Santa María Tixmadejé
Type of effect	Tectonic Surface rupture
Description	Crack with direction E-W, 50 meters with a width of 15 centimeters and unevenness of 50 centimeters from the southern edge. Next to the crack, a system that is divided into terraces.
ESI intensity	X
Geomorphologic setting	Crosses a fallow land, inclined 30°, above the town of Santa María Tixmadejé.
Photographic documentation	BOLETIN NUM. 32 INSTITUTO GEOLOGICO DE MEXICO LAMINA XVIII  Fig. 28.—La grieta del sistema septentrional que pasa por la falda meridional del cerro "Tixmadeje," la más cercana al pueblo del mismo nombre, con desnivel de 50 cm., en terreno inclinado 30°. Fig. 28. The crack of the northern system that passes through the southern slope of the "Tixmadejé" hill, the closest to the town of the same name, with a drop of 50 cm, on 30° inclined terrain.
sources	Urbina and Camacho, 1913

Site number	011
Latitude	2209287.50
Longitude	401818.64
Distance from epicenter	12.52 km
Locality	Cerro Santa María Tixmadejé
Type of effect	Tectonic surface rupture
Description	System of cracks that extends from the top of Santa María Tixmadejé to the western end of the Acambay-Tixmadeje mountain massif. 10 - 40 cm wide and 50 cm uneven. 2900 masl.
ESI intensity	X
Geomorphologic setting	On the side of the hill, with a 30° slope and parallel to the crack in the town of Santa María Tixmadejé, there is a crack at 2,900 meters above sea level and another at 3,030 meters above sea level.
Photographic documentation	
sources	Urbina and Camacho, 1913

Site number	**012**
Latitude	2209476.19
Longitude	401440.96
Distance from epicenter	13.26 km
Locality	Cerro Santa María Tixmadejé
Type of effect	Tectonic Surface rupture
Description	System of cracks that extends from the top of Santa María Tixmadejé to the western end of the Acambay-Tixmadeje mountain massif. 10 - 40 cm wide and 50 cm uneven. 3030 masl.
ESI intensity	X
Geomorphologic setting	On the side of the hill, with a 30° slope and parallel to the crack in the town of Santa María Tixmadejé, there is a crack at 2,900 meters above sea level and another at 3,030 meters above sea level.
Photographic documentation	
sources	Urbina and Camacho, 1913

Site number	013
Latitude	2210265.02
Longitude	397259.79
Distance from epicenter	17.09 km
Locality	Xidó
Type of effect	Tectonic Surface rupture
Description	Crack following the stratification plane of the tuffs. 8 cm wide and very little unevenness. The crack cuts the stream transversely, at the bottom it is lost and reappears on the opposite bank heading N. 76° W. (fig. 31, lam. XIX).
ESI intensity	VIII
Geomorphologic setting	On the Xidó hill, on the southern slope of the Botí or Las Palomas hill, the crack formed in the tuffs and lapilli; in the dislocations raised towards the North. The rupture crosses the path parallel to the stream, from north to south, cutting through the tuffs and at the bottom of its bed it runs over the igneous gap with obsidian fragments.
Photographic documentation	  Fig. 30.—Aspecto de la grieta en la falda de Xidó, sobre el camino de Solís al Agostadero, perteneciente al sistema septentrional  Fig. 31.—Curso de la misma grieta, fotografiado en el sentido longitudinal para mostrar la inclinación del terreno
sources	Urbina and Camacho, 1913

Site number	014
Latitude	2202358.88
Longitude	395058.88
Distance from epicenter	19.80 km
Locality	Temascalcingo
Type of effect	Tectonic Surface rupture
Description	Its length is 660 meters, its width and maximum difference in level between the edges are 10 cm.
ESI intensity	IX
Geomorphologic setting	Originating within of Temascalcingo town, caused vertical fractures in the walls it traverses, then proceeds westward, and cuts the path to "El Oro." Its course skirts through the tuffs to the south, navigating the terrain around the hills of "El Calvario" and "Endemejé." Before reaching the river, it meanders and dissipates amidst the fallow lands.
Photographic documentation	
sources	Urbina and Camacho, 1913

Site number	015
Latitude	2201781.37 - 2201557.39
Longitude	392879.75 - 394230.54
Distance from epicenter	20.56 km
Locality	El Cristo – Solís – Barranca de los Gatos
Type of effect	Tectonic Surface rupture
Description	The width and maximum difference in level of the crack, is 30 cm, before bifurcating.
ESI intensity	IX
Geomorphologic setting	From west to east, this rupture starts at the "El Cristo" hill, in the Solís hacienda. It descends into the valley, crosses the Lerma Rriver 50 meters downstream. Here, the river aligns from south to north, obliquely concerning the line of maximum slope at an angle of 30 degrees. The rupture follows its course on the slope of the hill "Chato, Andaró or Puente" approaching more its general direction, east to west. Upon reaching a length of 1,050 meters, it forks: the upper branch continues along the side of "El Puente" hill and then descends to disappear into the "Los Gatos" ravine, situated south of Temascalcingo.
Photographic documentation	
sources	Urbina and Camacho, 1913

Site number	016
Latitude	2201649.09
Longitude	394230.54
Distance from epicenter	19.36 km
Locality	Boquí-Bondoré
Type of effect	Tectonic Surface rupture
Description	400 meters long. The width and the maximum unevenness of the crack, 30 cm.
ESI intensity	IX
Geomorphologic setting	This other branch of the rupture, continues from “El Cristo – Solís” heading N. 64° E. It descends toward the ravine nestled between the hills of Boquí and Bondoré, dissipating into the loose terrain.
Photographic documentation	
sources	Urbina and Camacho, 1913

Site number	017
Latitude	2200620.08
Longitude	394652.90
Distance from epicenter	18.91 km
Locality	Cerro Chato or Andaró – El Aguaje
Type of effect	Tectonic Surface rupture
Description	“Crack” (rupture) that crosses the road from Temascalcingo to the springs of Pastores
ESI intensity	X
Geomorphologic setting	It originates between the Andaró hill and the Santa Cruz hill (2680 masl) with a prevailing direction S. 75° E. The rupture skirts the north of the Santa Cruz and Xelles hills, entering the valley of San Pedro El Alto. Subsequently, it ascends the slope of the "El Aguaje" hill, reaching its summit at an elevation of 3040 m. As it progresses, it fractures blocks of hiperstena, andesite. Maintaining its overall trajectory to the east, traverses the mountainous barrier that separates the valleys of Acambay and Toxi, extending its reach from east to west.
Photographic documentation	 Fig. 32.—Grieta del sistema central en la cima del cerro de “El Aguaje.” Aparece en un afloramiento de andesita de hiperstena Fig. 32. Crack in the central system at the top of "El Aguaje" hill. It appears in a block of hypersthene andesite.
sources	Urbina and Camacho, 1913

Site number	**018**
Latitude	2201092.13
Longitude	400520.64
Distance from epicenter	14.03 km
Locality	Etzá – San Pedro EL Alto
Type of effect	Tectonic Surface rupture
Description	Parallel to the previous surface rupture, between the Etzá hill and the San Pedro El Alto dam, two others are formed: one with a width of 15 cm (described in the cracks and fractures section) and the other, which produced ejection of mud and ends near the dam.
ESI intensity	IX
Geomorphologic setting	Formed between the hill of Etzá and the dam of San Pedro el Alto.
Photographic documentation	
sources	Urbina and Camacho, 1913

Site number	**019**
Latitude	2200522.51
Longitude	399600.04
Distance from epicenter	14.26 km
Locality	San Pedro El Alto
Type of effect	Tectonic Surface rupture
Description	Gravity graben in volcanoclastic sequence. Cracking and uplift ground like in Huapango valley. 15 cm width and unevenness of 30 cm. Mud ejections.
ESI intensity	IX
Geomorphologic setting	Formed between the hill of Etzá and the dam San Pedro El Alto.
Photographic documentation	 Fig. 33.—Despedazamiento del terreno en el extremo de una grieta del sistema central, en el fondo del valle de San Pedro el Alto, cerca de la presa del mismo nombre.  Breaking up of the land at the end of a crack in the central system, at the bottom of the San Pedro El Alto valley, near the dam of the same name.
sources	Urbina and Camacho, 1913

Site number	020
Latitude	2196079.70
Longitude	393796.27
Distance from epicenter	20.89 km
Locality	Batán - Maye
Type of effect	Tectonic Surface rupture
Description	It is the main rupture of the southern system, situated on the northern incline of the Batán hill. Its reach extends westward to the "Puertecito" and eastward beyond the Xomejé shack, ultimately concluding in the Maye area. It mirrors the dimensions and orientation observed in the faults of the northern and central systems, with the distinctive feature that, in this system, the northern edge it is the one that goes down when there is unevenness. The effect it produced on the margins of the Lerma River is similar, but more intense than in Huapango, Tixmadeje and San Pedro El Alto.
ESI intensity	X
Geomorphologic setting	Above San Pedro Potla, it has taken shape within the deposits situated at the base of cliffs and tuffs. At certain points, it disappears as it traverses fallow lands and the floor of the Toxi valley. As the Lerma River passes at the foot of the cliffs of El Batán, its banks seem to have been subjected to intense shaking, to judging by the state of cracking with great unevenness in which it is found.

Photographic documentation

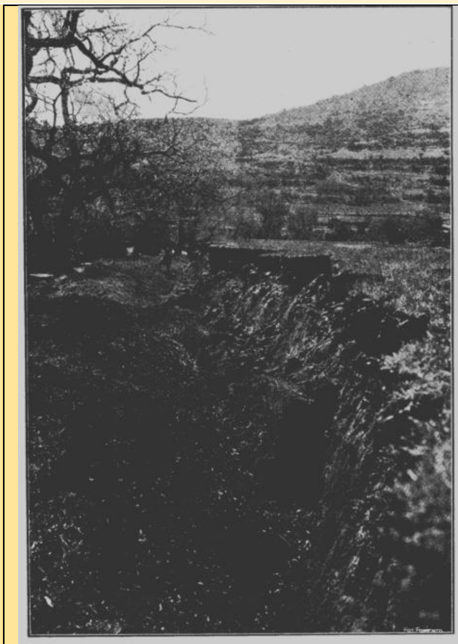


Fig. 35.—Hundimiento de la margen derecha del río Lerma, antes de tomar la dirección E.-W., entre la Hacienda de Toxi y el "Puente Grande."

Fig. 35. Subsidence of the right bank of the Lerma River, before taking the direction E - W, between the Toxi Hacienda and "Puente Grande".

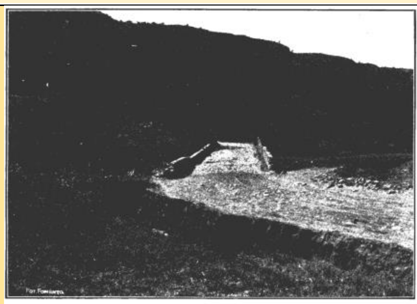


Fig. 36.—Continuación del mismo hundimiento de la fotografía anterior, antes de atravesar el "Puente Grande" y donde el río vuelve hacia el W.

Fig. 36. Continuation of the same collapse of the previous photograph, before crossing the "Puente Grande" and where the river returns to the W.

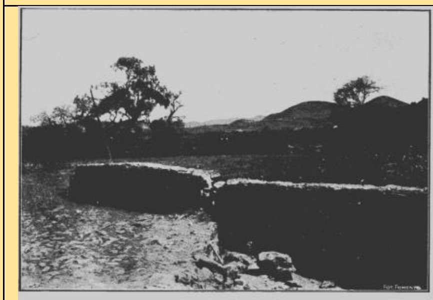


Fig. 37.—Efecto del hundimiento mencionado sobre el "Puente Grande"

Fig. 37. Effect of the aforementioned sinking on the "Puente Grande"

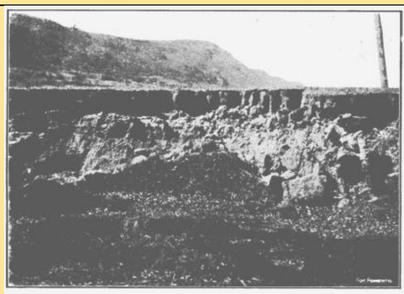


Fig. 38.—Aspecto del hundimiento, visto de frente, en su desnivel máximo

Fig. 38. Appearance of the subsidence seen from the front, at its maximum unevenness.

Fig. 39.—Continuación del hundimiento, cuando el curso del río ha tomado la dirección E.-W., en la margen derecha

Fig. 39. Continuation of sinking. When the course of the river has taken the direction E - W on the right bank

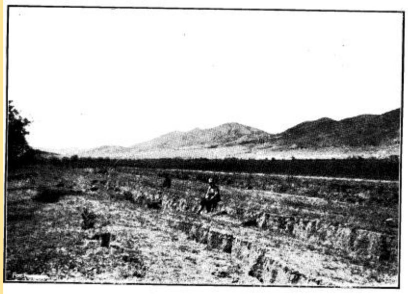


Fig. 40.—Terrazas escalonadas producidas paralelamente al curso del río, de E. a W. por el hundimiento de la margen derecha

Fig. 40. Stepped terraces, produced parallel to the course of the river, from E to W by the subsidence of the right bank.

Fig. 41.—Agrietamientos y hundimientos en la margen izquierda del mismo río, al pie y paralelamente a los acantilados del cerro de "El Batán."

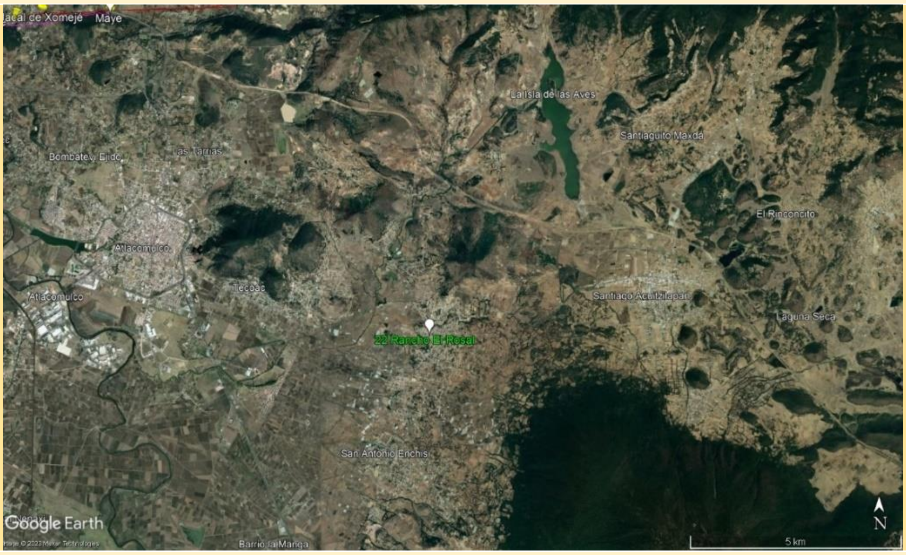
Fig. 41. Cracks and subsidence on the left bank of the same river, at the foot and parallel to the cliffs of "El Batán" hill.

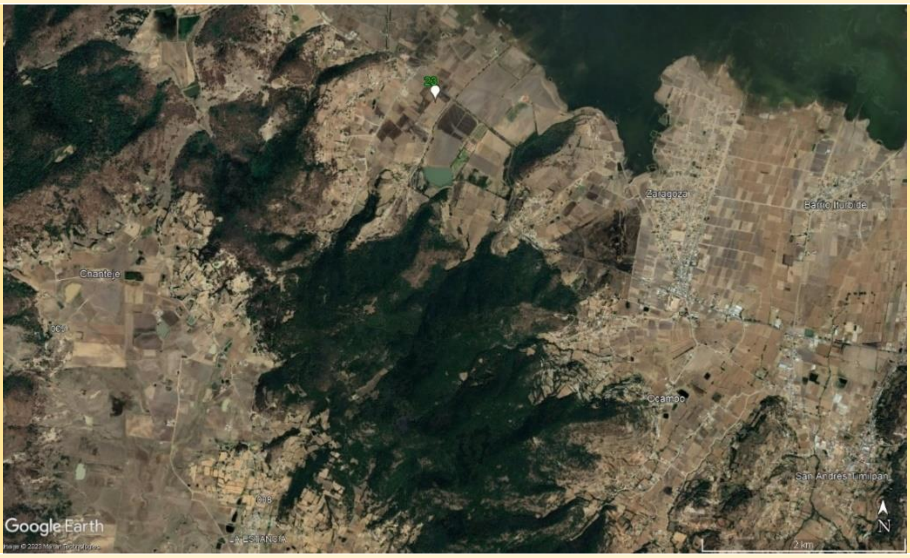
Fig. 42.—Agrietamiento y hundimiento con derrumbe parcial de los bordes, producidos entre el borde del camino y la margen derecha del mismo río.

Fig. 42. Cracking and sinking with partial collapse of the edges, produced between the edge of the road and the right bank of the same river.

sources	Urbina and Camacho, 1913

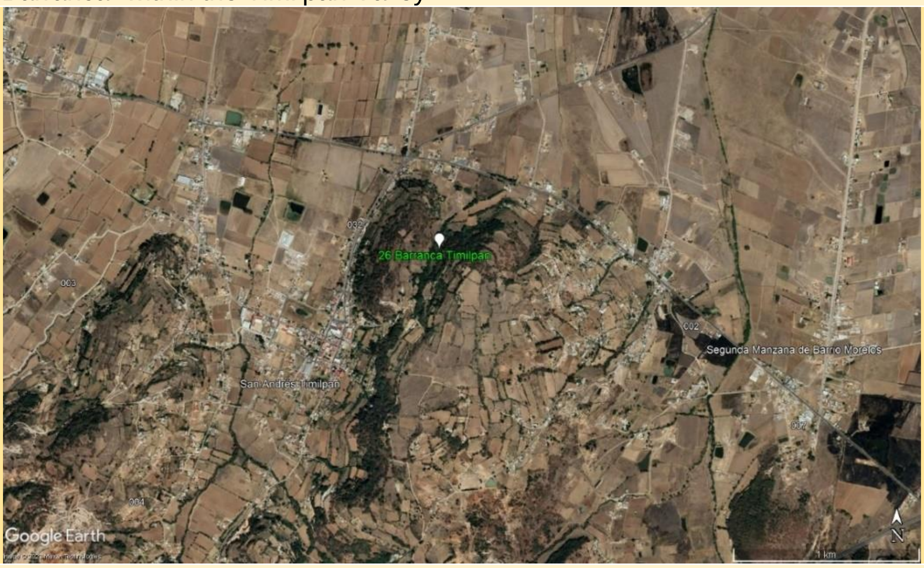
Site number	021
Latitude	2200505.89
Longitude	399802.45
Distance from epicenter	13.86 km
Locality	Etzá – San Pedro El Alto
Type of effect	Ground crack
Description	It is the furthest crack from the megaseismic zone, it is located on the land of Rancho del Rosal, southwest of Atlacomulco; 300m long and 6 cm wide and was formed on fairly flat terrain.
ESI intensity	VIII
Geomorphologic setting	Localizada en el Valle de San Pedro; a 190 metros sobre el Valle de Acambay, en lo que fue una cuenca cerrada.
Photographic documentation	
sources	Urbina and Camacho, 1913

Site number	022
Latitude	2187293.61
Longitude	414696.30
Distance from epicenter	16.73 km
Locality	Rancho del Rosal
Type of effect	Ground crack
Description	It is located on the land of Rancho del Rosal, southwest of Atlacomulco; 300m long and 6 cm wide and was formed on fairly flat terrain.
ESI intensity	VIII
Geomorphologic setting	Located on the right bank of the Lerma River.
Photographic documentation	
sources	Urbina and Camacho, 1913

Site number	023
Latitude	2201529.85
Longitude	418887.47
Distance from epicenter	6.28 km
Locality	Acambay - San Andrés Timilpan
Type of effect	Lateral spreading
Description	Described as "slide cracks." Located on the southern fault line of the macroseismic field. Formed in sediments and rock and in the contact between them. Sandy clay.
ESI intensity	VII
Geomorphologic setting	In the proximity to streams, in gullies, in channels, edges of dams, etc.
Photographic documentation	
sources	Urbina and Camacho, 1913

Site number	**024**
Latitude	2203452.00
Longitude	418446.27
Distance from epicenter	5.33 km
Locality	Venta de San Lucas
Type of effect	Lateral spreading
Description	Described as "slide cracks." Located on the southern fault line of the macroseismic field. Formed in sediments and rock and in the contact between them.
ESI intensity	VII
Geomorphologic setting	In the proximity to streams, in gullies, in channels, edges of dams, etc. It is a small valley.
Photographic documentation	
sources	Urbina and Camacho, 1913

Site number	025
Latitude	
Longitude	
Distance from epicenter	
Locality	Barranca Jecó
Type of effect	Lateral spreading
Description	Formed in sediments and rock and in the contact between them.
ESI intensity	VII
Geomorphologic setting	In the proximity to streams, in gullies, in channels, edges of dams, etc.
Photographic documentation	
sources	Urbina and Camacho, 1913

Site number	026
Latitude	2198470.18
Longitude	423778.24
Distance from epicenter	11.97 km
Locality	Barranca Timilpan
Type of effect	Lateral spreading
Description	Described as "slide cracks." Located on the southern fault line of the macroseismic field. Formed in sediments and rock and in the contact between them. Sandy clay.
ESI intensity	VII
Geomorphologic setting	In the proximity to streams, in gullies, in channels, edges of dams, etc. “Barranca” within the Timilpan Valley.
Photographic documentation	
sources	Urbina and Camacho, 1913

Site number	**027**
Latitude	2207066.27
Longitude	392564.84
Distance from epicenter	20.82 km
Locality	Temascalcingo – Hacienda Solís
Type of effect	Lateral spreading
Description	Described as "slide cracks." Located on the southern fault line of the macroseismic field. Formed in sediments and rock and in the contact between them. Sandy clay.
ESI intensity	VII
Geomorphologic setting	In the proximity to streams, in gullies, in channels, edges of dams, etc. In a section that is between two irrigation canals.
Photographic documentation	
sources	Urbina and Camacho, 1913

Site number	**028**
Latitude	2202045.89
Longitude	393280.13
Distance from epicenter	19.96 km
Locality	Solís Valley
Type of effect	Lateral spreading
Description	The right clay margin (2-3m) of the Lerma River was transported to the left bank with trees 4m high, without them falling.
ESI intensity	IX
Geomorphologic setting	In the proximity to the Lerma River.
Photographic documentation	 Fig. 34.—Derrumbe en la margen derecha del río Lerma, en el valle de Solís, después del puente de fierro, causado por el temblor. Los árboles que figuran en la fotografía, han sido transportados de la margen derecha a la margen izquierda, azolvando el canal.
sources	Urbina and Camacho, 1913

Site number	**029**
Latitude	2196005.24
Longitude	398230.85
Distance from epicenter	16.89 km
Locality	El Batán
Type of effect	Lateral spreading
Description	1.50 m slip. Stepped terraces on both sides by the river bank collapse, with jumps of 1, 2 m. Direction E-W parallel to the river and on the line fault.
ESI intensity	X
Geomorphologic setting	On the banks of the Lerma River and in the proximity and parallel to the cliffs of Cerro El Batán.
Photographic documentation	 Fig. 35.- Hundimiento de la margen derecha del río Lerma, antes de tomar la dirección E-W, entre la Hacienda de Toxi y el "Puente Grande."

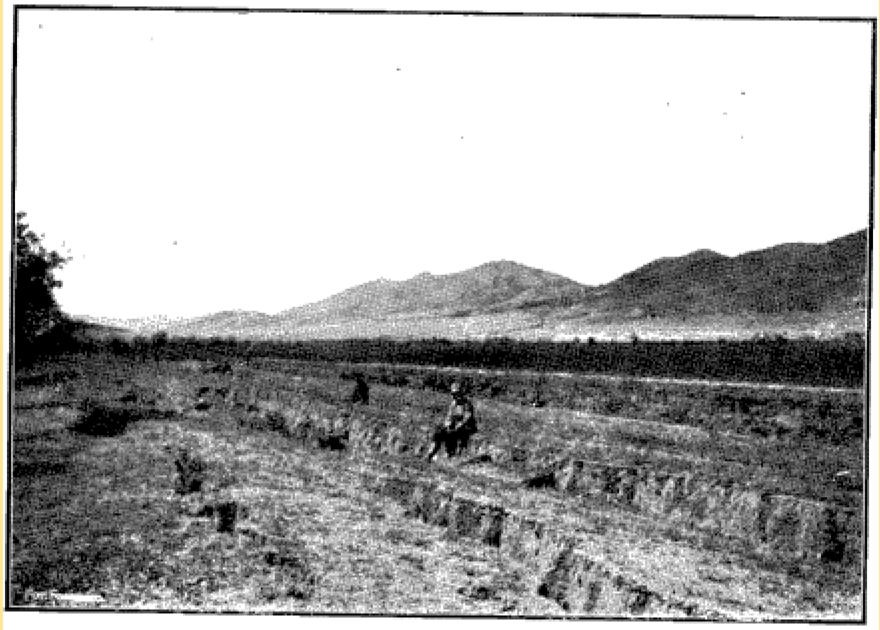


Fig. 40.—Terrazas escalonadas producidas paralelamente al curso del río, de E. a W. por el hundimiento de la margen derecha

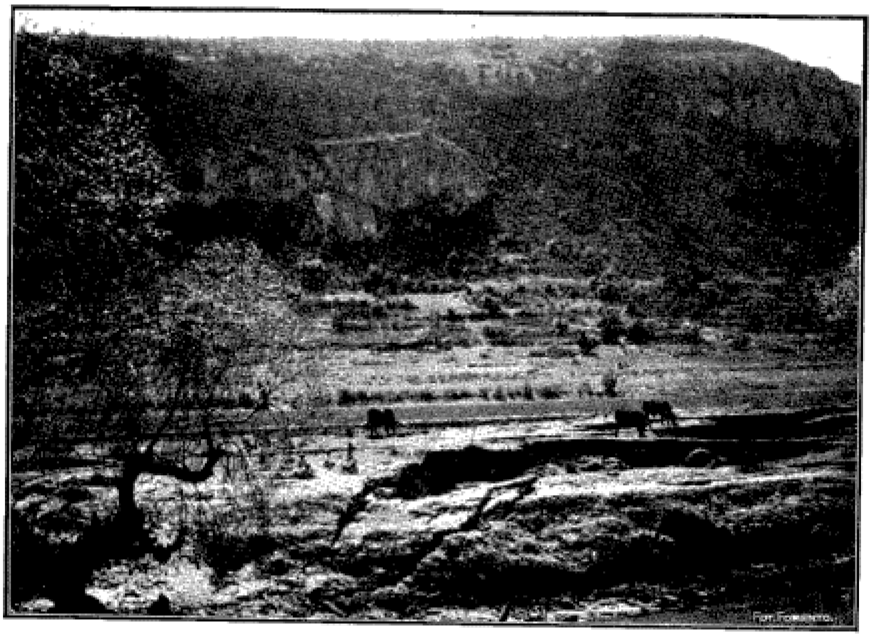
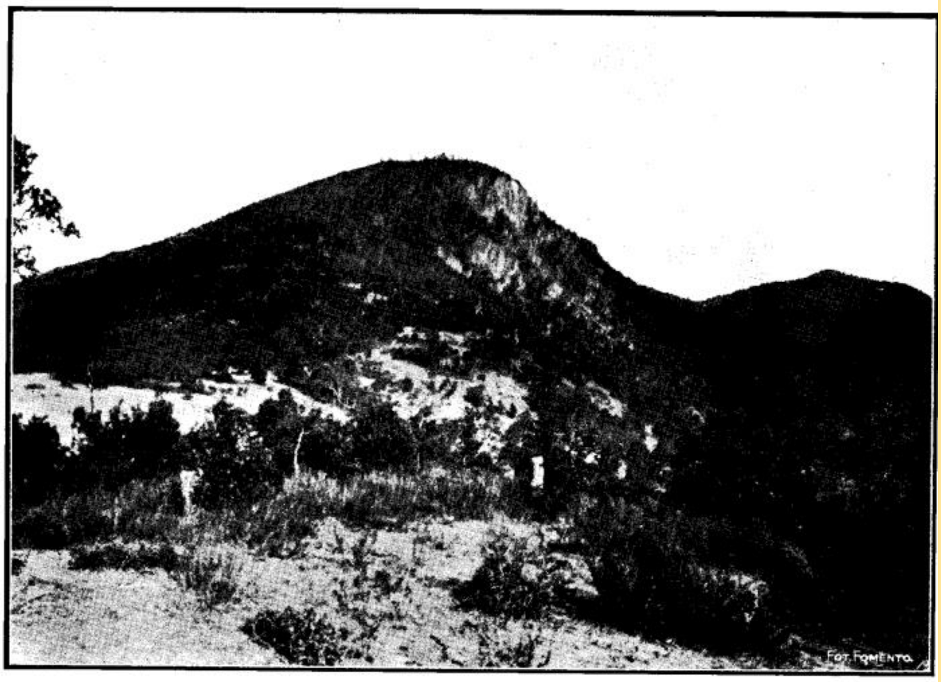
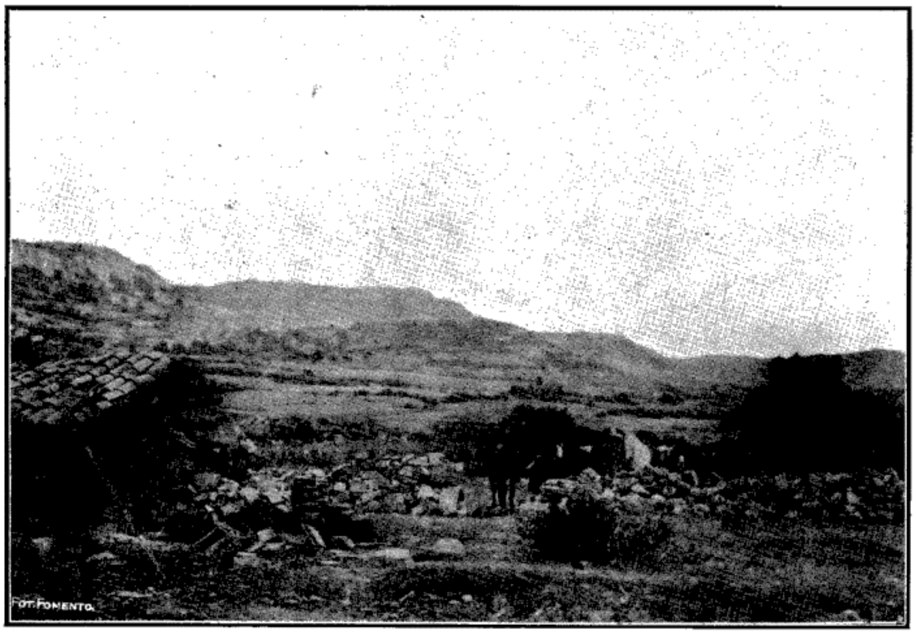


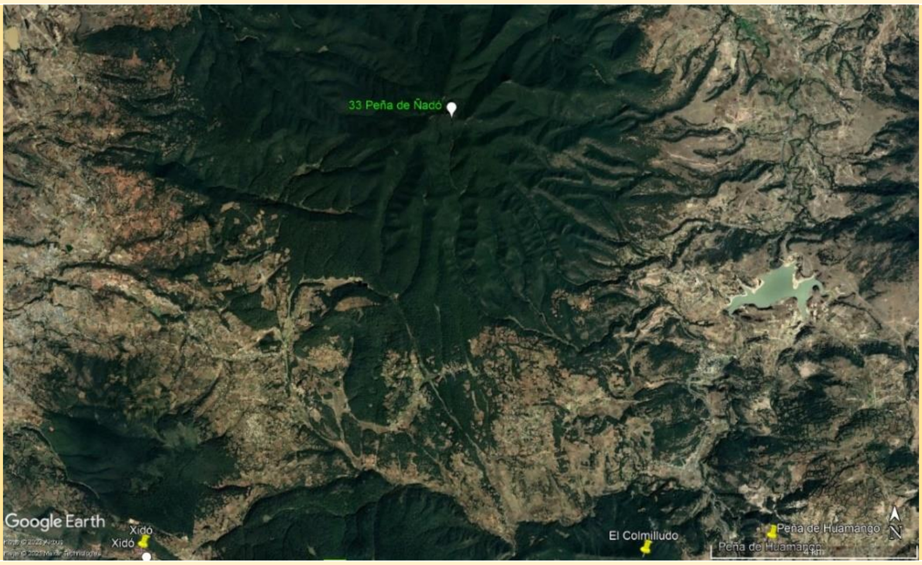
Fig. 41.—Agrietamientos y hundimientos en la margen izquierda del mismo río, al pie y paralelamente a los acantilados del cerro de "El Batán."

sources	Urbina and Camacho, 1913

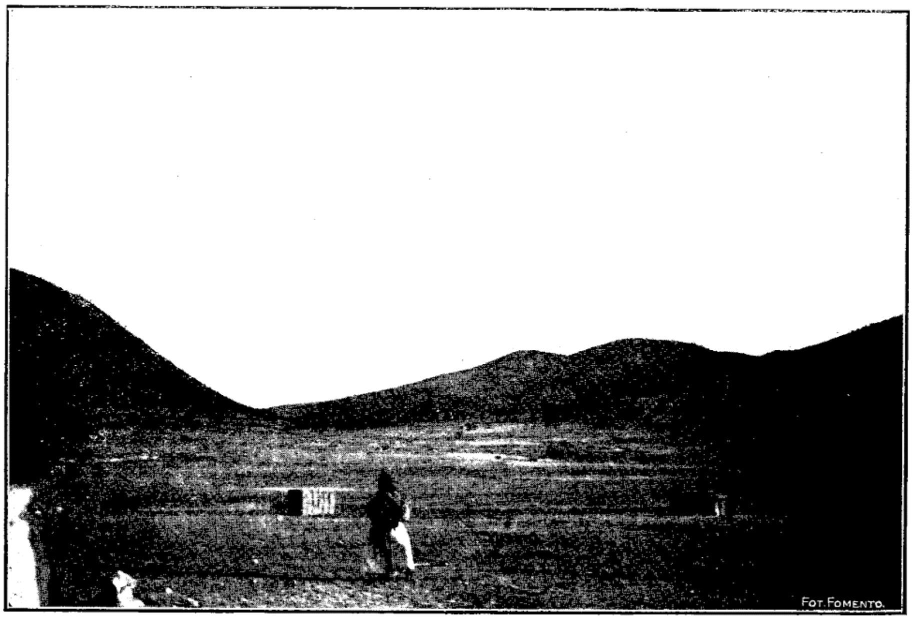
Site number	**030**
Latitude	2208867.55
Longitude	401672.73
Distance from epicenter	12.48 km
Locality	Santa María Tixmadejé
Type of effect	Rockfall
Description	Rockfall. An 8 m3 boulder. The boulder came off the top and bounced until it reached the town.
ESI intensity	VII
Geomorphologic setting	Cliff with steep slope.
Photographic documentation	  Actual picture taken by us, of the same place.  Fig. 43.—Aspecto del núcleo del pueblo de Santa María Tixmadeje, destruido por el temblor, y atrio de la iglesia donde se encuentra el bloque que cayó de los acantilados del mismo cerro.
sources	Urbina and Camacho, 1913

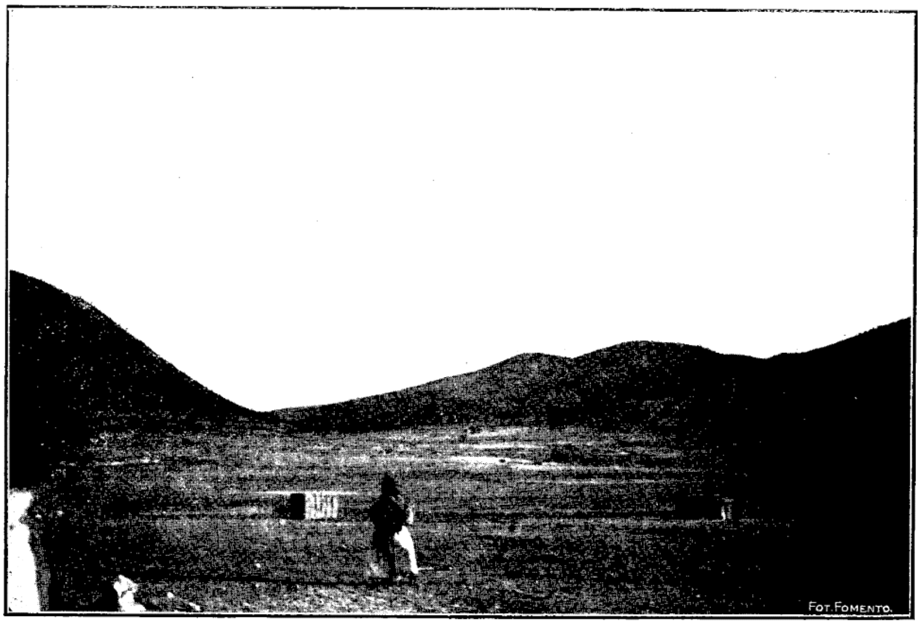
Site number	031
Latitude	2208999.25
Longitude	2208999.25
Distance from epicenter	5.08 km
Locality	Peña Larga
Type of effect	Landslide and Rockfall
Description	The face of the Peña Larga cliff (3150m), "a portion was divided in two due to movement, according to a fracture directed from east to west, and the boulder that remained to the north rotated approximately 30°, separating from the southern block. It is a hill, "its southern portion has almost disappeared". Estimated volume 100000 m^3.
ESI intensity	IX
Geomorphologic setting	Landslide and Rockfall 230 m to SE (Labradorite).
Photographic documentation	 Fig. 7.—"Peña Larga;" su porción meridional casi ha desaparecido  Actual picture taken by us, of the same place.
sources	Urbina and Camacho, 1913

Site number	032
Latitude	2208664.45
Longitude	408725.53
Distance from epicenter	6.46 km
Locality	Dongú
Type of effect	Landslide and Rockfall
Description	Rockfall (Labradorite)
ESI intensity	VIII
Geomorphologic setting	Boulders fell from the cliffs of Dongú into the Dongú Valley.
Photographic documentation	 Fig. 8.—Perfiles meridionales de las mesas de Dongú, vistos desde el pueblo de Detiñá  
sources	Urbina and Camacho, 1913

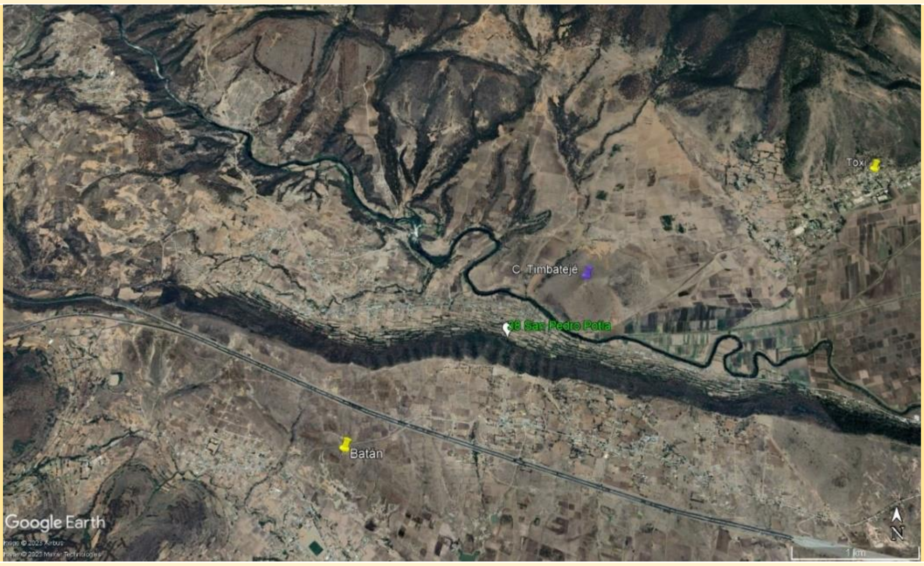
Site number	033
Latitude	2218767.26
Longitude	403209.51
Distance from epicenter	17.84 km
Locality	Peña de Ñadó
Type of effect	Landslide
Description	A landslide occurs in which large masses of land slide down from the top of the cliffs.
ESI intensity	VIII
Geomorphologic setting	Hills and steep cliffs.
Photographic documentation	
sources	Urbina and Camacho, 1913

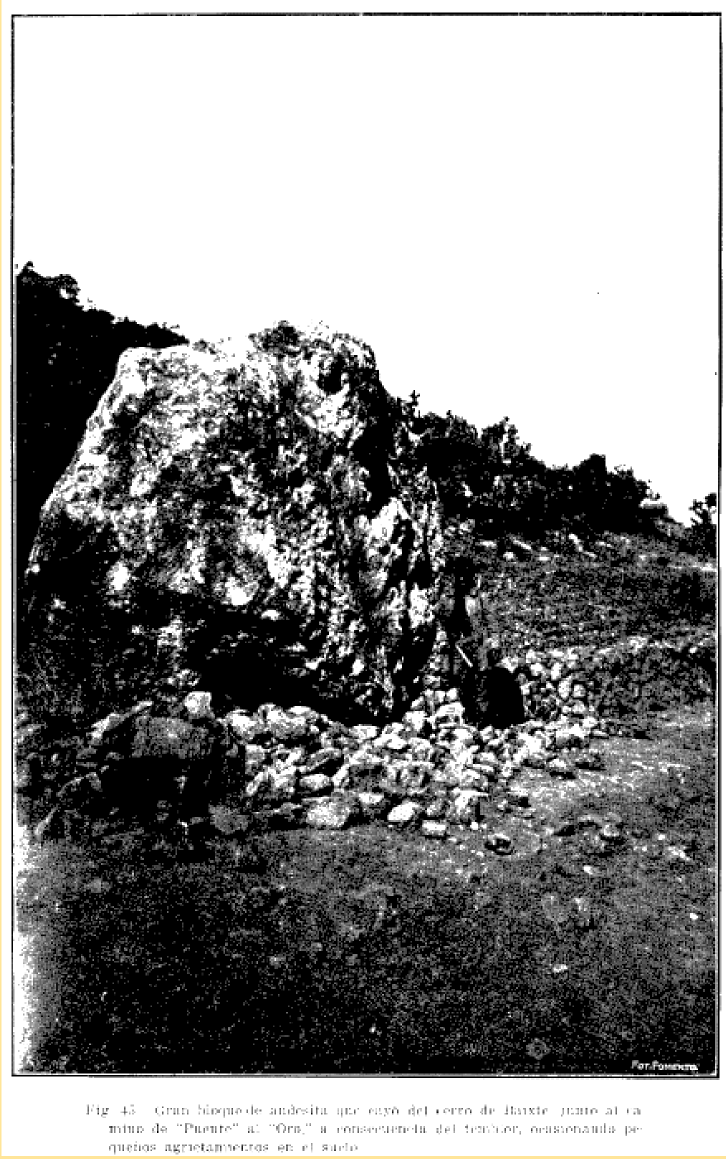
Site number	034
Latitude	2204450.99
Longitude	390410.17
Distance from epicenter	22.74
Locality	Cerros de Solís
Type of effect	Landslide
Description	A landslide occurs in which large masses of land slide down from the top of the cliffs.
ESI intensity	VIII
Geomorphologic setting	Hills and steep cliffs.
Photographic documentation	
sources	Urbina and Camacho, 1913

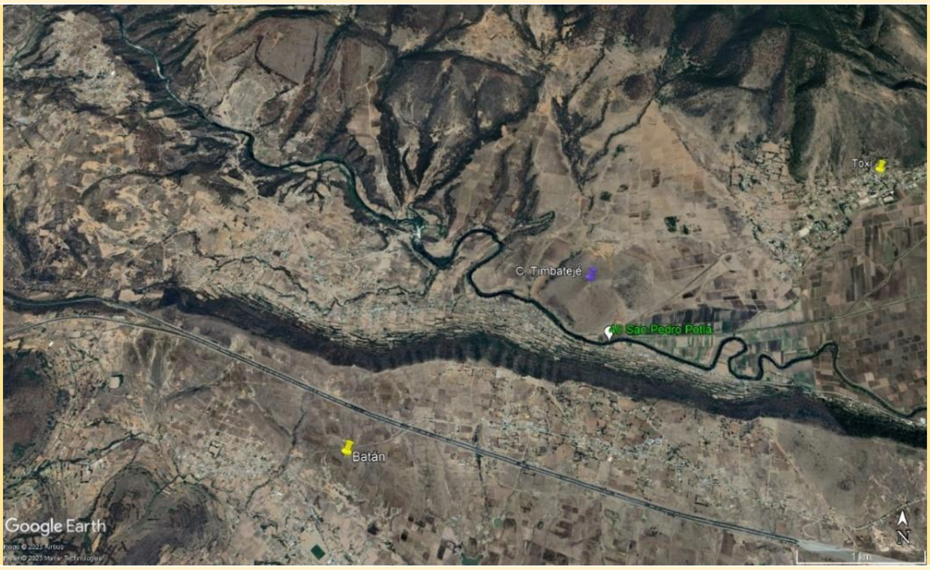
Site number	035
Latitude	2200703.48
Longitude	402853.30
Distance from epicenter	10.79 km
Locality	Cerro El Aguaje
Type of effect	Landslide
Description	A landslide occurs in which large masses of land slide down from the top of the cliffs.
ESI intensity	VIII
Geomorphologic setting	Hills and steep cliffs.
Photographic documentation	 Fig. 44.—Derrumbes en las cimas de las montañas producidos por el temblor. "Derrumbaderos" en las cimas de los cerros de "El Aguaje" y el "Yeso," vistos desde la estación de Manto. F. C. N. de M.
sources	Urbina and Camacho, 1913

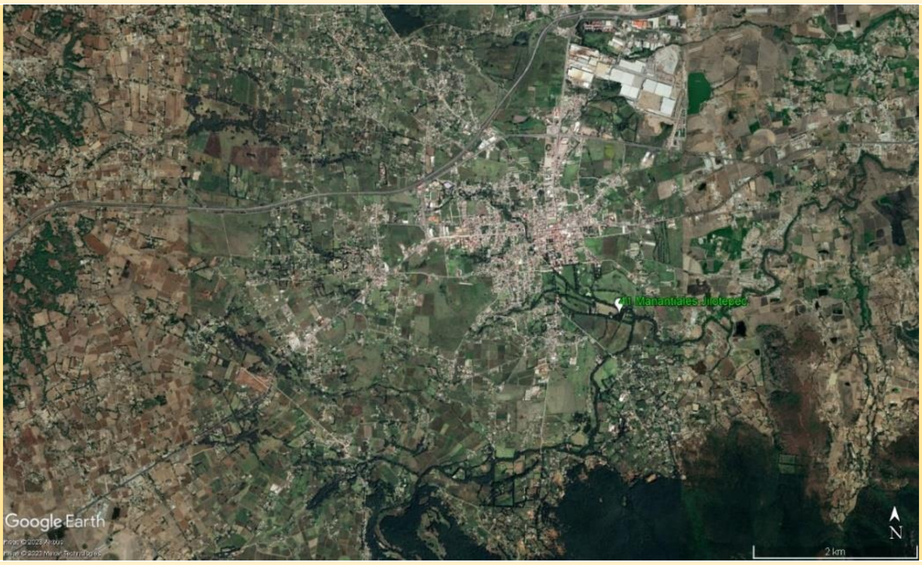
Site number	036
Latitude	2200300.59
Longitude	403330.89
Distance from epicenter	10.47 km
Locality	Cerro El Yeso
Type of effect	Landslide
Description	A landslide occurs in which large masses of land slide down from the top of the cliffs.
ESI intensity	VIII
Geomorphologic setting	Hills and steep cliffs.
Photographic documentation	 Fig. 44.—Derrumbes en las cimas de las montañas producidos por el temblor. "Derrumbaderos" en las cimas de los cerros de "El Aguaje" y el "Yeso," vistos desde la estación de Manto. F. C. N. de M.
sources	Urbina and Camacho, 1913

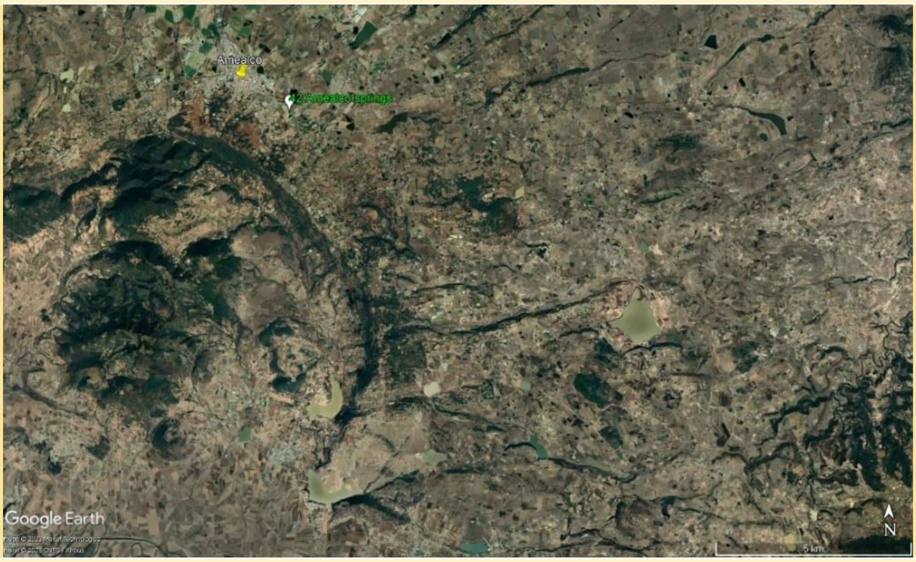
Site number	037
Latitude	2199702.08
Longitude	400178.15
Distance from epicenter	13.64
Locality	Cerro Cruz Colorada
Type of effect	Landslide
Description	A landslide occurs in which large masses of land slide down from the top of the cliffs.
ESI intensity	VIII
Geomorphologic setting	Hills and steep cliffs.
Photographic documentation	
sources	Urbina and Camacho, 1913

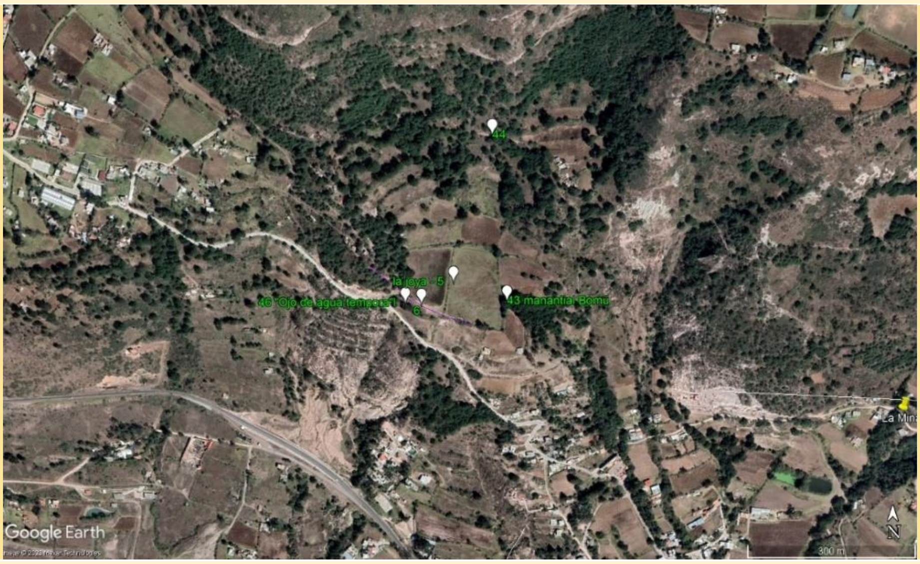
Site number	038
Latitude	2195538.24
Longitude	398353.47
Distance from epicenter	17.04 km
Locality	San Pedro Potla
Type of effect	Rockfall
Description	The boulders came off the hill. The blocks, when detached and rolled, marked their passage with destruction of fencing and vegetation.
ESI intensity	VII
Geomorphologic setting	Hills and steep cliffs.
Photographic documentation	
sources	Urbina and Camacho, 1913

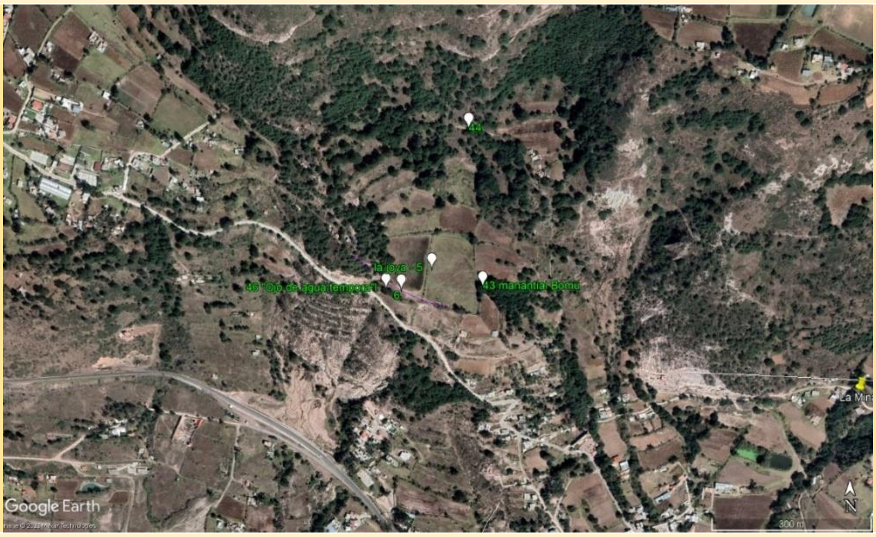
Site number	039
Latitude	2201494.00
Longitude	393424.10
Distance from epicenter	19.90
Locality	Cerro Temascalcingo (Baixté)
Type of effect	Rockfall
Description	Fall of 44 m3 andesite block. The boulder came off the Baixte hill with a trajectory towards the N 45° E, stopping at the edge of the road from "Puente" to "Oro", cracking part of the road. The boulders came off the hill. The blocks, when detached and rolled, marked their passage with destruction of fencing and vegetation.
ESI intensity	VIII
Geomorphologic setting	Hills and steep cliffs.
Photographic documentation	 Fig. 45- Large block of andesite that fell from Cerro Baixté, next to the road from "Puente" to "Oro," as a result of the earthquake, causing small cracks in the ground.
sources	Urbina and Camacho, 1913

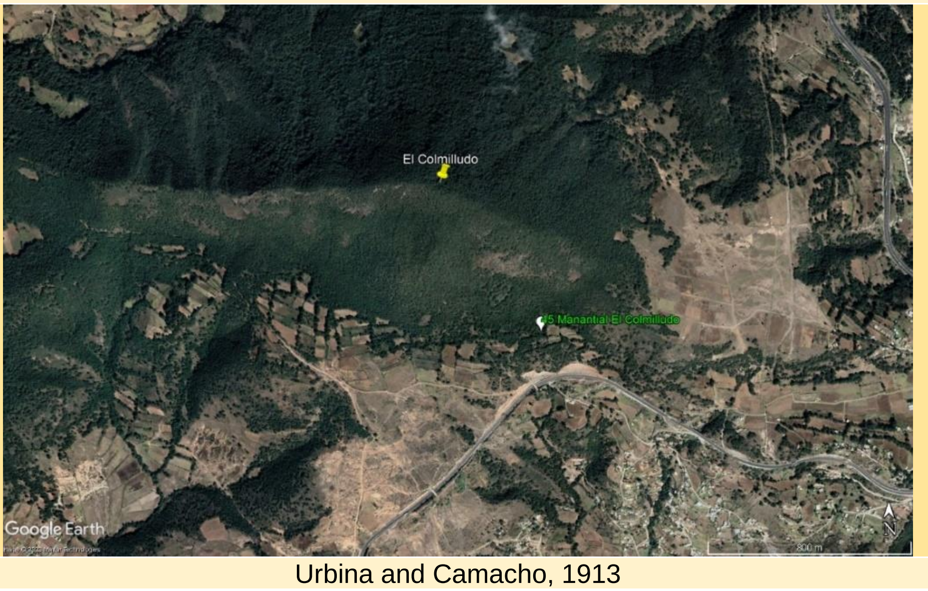
Site number	040
Latitude	2195549.90
Longitude	399215.70
Distance from epicenter	16.26 km
Locality	San Pedro Potla
Type of effect	Hydrogeological anomaly
Description	Temporal decreased water flow.
ESI intensity	VIII
Geomorphologic setting	In the Lerma River, just where the fracturing of the ground was observed, in the stretch before San Pedro Potla.
Photographic documentation	
sources	Urbina and Camacho, 1913

Site number	041
Latitude	2205349.81
Longitude	445102.32
Distance from epicenter	32 km
Locality	Jilotepec
Type of effect	Hydrogeological anomaly
Description	36 km from Acambay, the water of the Jilotepec springs, previously clear, turned cloudy after the earthquake.
ESI intensity	VI
Geomorphologic setting	Plain belonging to the Sierra de Querétaro.
Photographic documentation	
sources	Urbina and Camacho, 1913

Site number	042
Latitude	2231684.34
Longitude	381596.91
Distance from epicenter	42.1 km
Locality	Amealco
Type of effect	Hydrogeological anomaly
Description	The spring presented cloudy water after the earthquake, even 80 days after the event the water was still cloudy. The amount of water from the spring increased, the water level in the ditches rose.
ESI intensity	VI
Geomorphologic setting	On the slopes of Cerro or Amealco caldera.
Photographic documentation	
sources	Urbina and Camacho, 1913

Site number	043
Latitude	2208282.34
Longitude	410936.62
Distance from epicenter	4.87 km
Locality	Bomú - Acambay
Type of effect	Hydrogeological anomaly
Description	In the Acambay valley, the spring that supplies water to the population temporarily disappeared.
ESI intensity	VIII
Geomorphologic setting	Inside the Acambay Valley.
Photographic documentation	
sources	Urbina and Camacho, 1913

Site number	044
Latitude	2208549.93
Longitude	410910.08
Distance from epicenter	5.12 km
Locality	La Jolla (Mesa) Acambay
Type of effect	Hydrogeological anomaly
Description	In the Acambay valley, a small spring on "la mesa de La Jolla" disappeared.
ESI intensity	VIII
Geomorphologic setting	Top of the small Cerro de la Jolla.
Photographic documentation	
sources	Urbina and Camacho, 1913

Site number	**045**
Latitude	2210022.86
Longitude	407163.18
Distance from epicenter	8.53 km
Locality	Cerro El Colmilludo
Type of effect	Hydrogeological anomaly
Description	Emergence of spring.
ESI intensity	VIII
Geomorphologic setting	In the foothills of Cerro El Colmilludo.
Photographic documentation	
sources	Urbina and Camacho, 1913

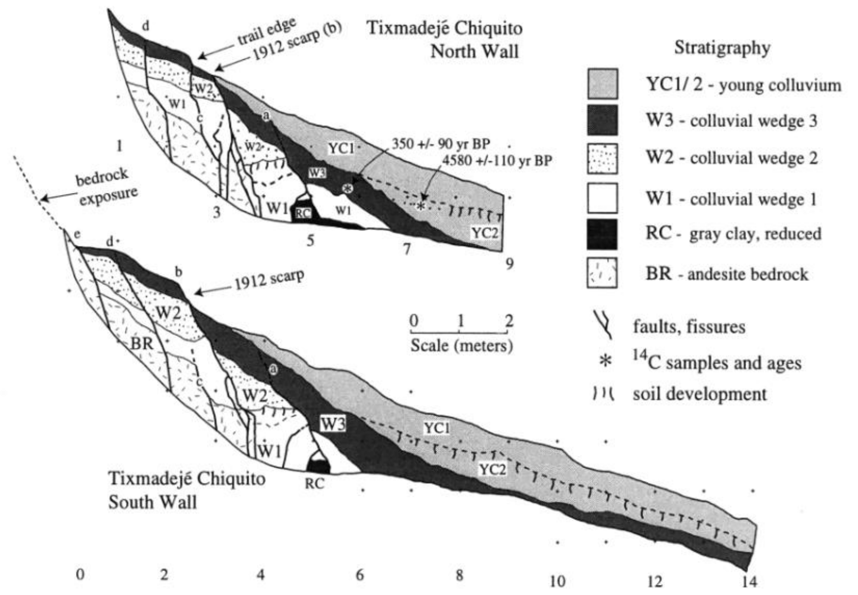
Site number	046
Latitude	2208279.53
Longitude	410763.96
Distance from epicenter	4.94 km
Locality	Into the megaseismic zone (ex. “La Jolla”)
Type of effect	Hydrogeological anomaly
Description	Temporary emergence of spring. Appearance and disappearance of springs. Change in circulation flows water. "Within the megaseismic zone, while some springs disappeared, others sprouted."
ESI intensity	VIII
Geomorphologic setting	Valleys, foothills, tops of hills and hills.
Photographic documentation	
sources	Urbina and Camacho, 1913

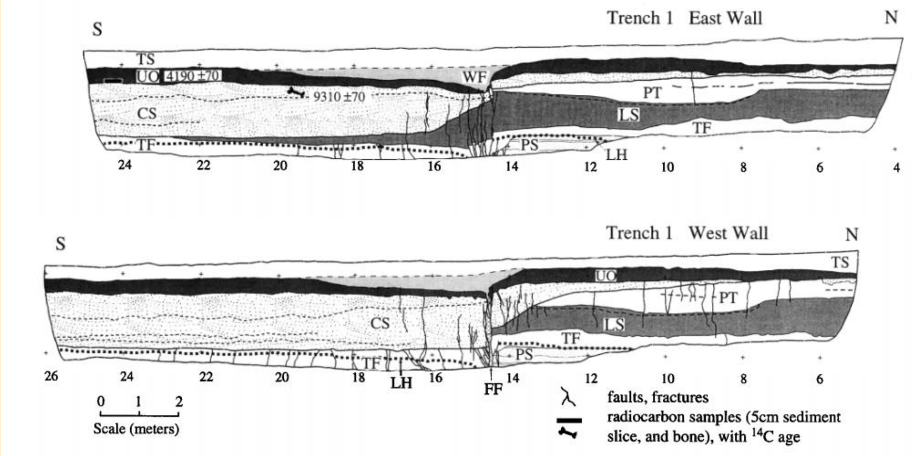
Site number	047
Latitude	2201088.72
Longitude	399936.51
Distance from epicenter	13.68 km
Locality	San Pedro El Alto Valley
Type of effect	Liquefaction processes
Description	Water and mud ejections from the cracks. The "thrown" material is silt, formed from volcanic glass, deposited in a 50 cm crack open with the water towards the dam.
ESI intensity	IX
Geomorphologic setting	Valley bottom plain.
Photographic documentation	
sources	Urbina and Camacho, 1913

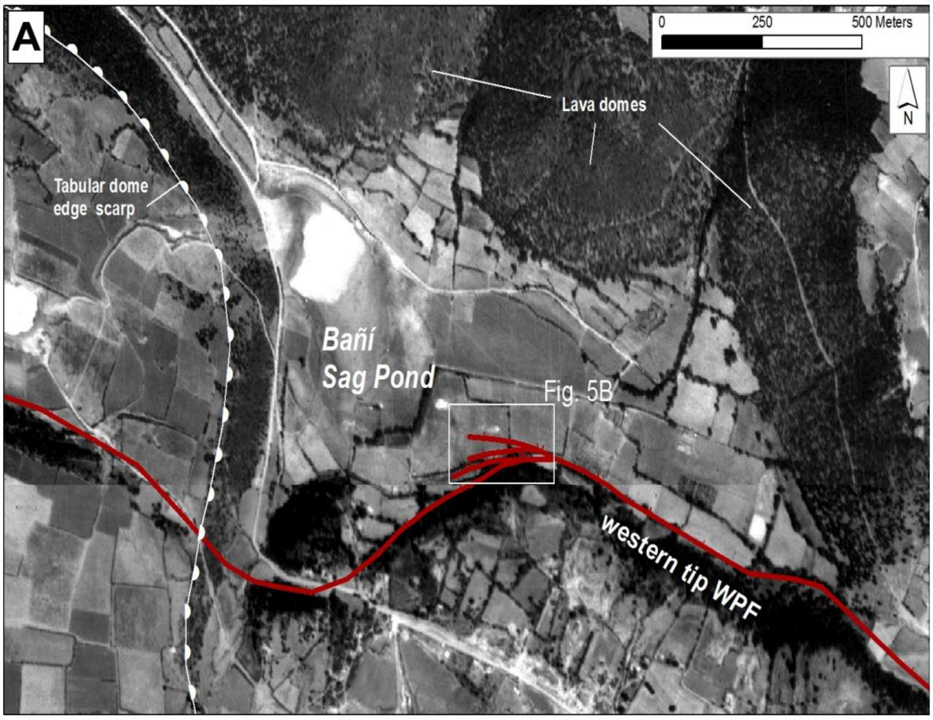
Site number	048
Latitude	2206124.95
Longitude	391158.44
Distance from epicenter	22.09 km
Locality	San Vicente, Solís
Type of effect	Liquefaction processes
Description	Water and mud ejections from the cracks. Liquefaction line with almost N-S direction, which presented ejecta of white sandy material.
ESI intensity	VIII
Geomorphologic setting	Valley bottom. Field sown with wheat.
Photographic documentation	
sources	Urbina and Camacho, 1913

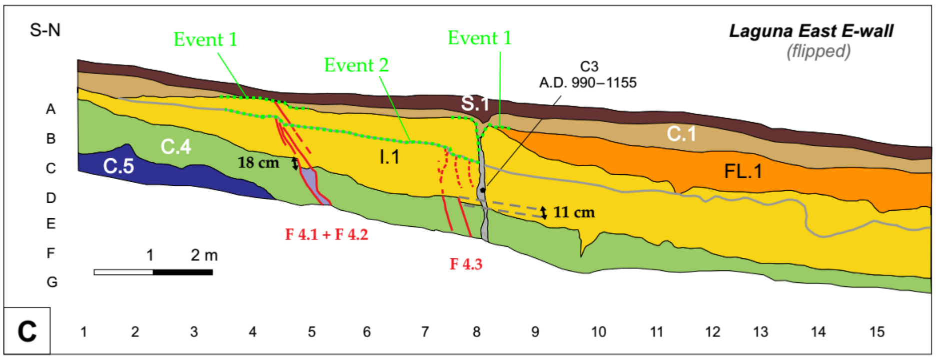
Site number	049
Latitude	2200516
Longitude	399598
Distance from epicenter	13.99 km
Locality	San Pedro El Alto (Trench)
Type of effect	Surface faulting
Description	A small escarpment is visible in the landscape. The scarp has increased to more than one meter, possibly due to sediment compaction and water extraction.
ESI intensity	IX
Geomorphologic setting	This place is located near the old dam. It corresponds to a volcanic-lacustrine sequence.
Photographic documentation	  Escarpment on the Temascalcingo fault, southern edge of the San Pedro El Alto dam. a) Effect caused by the Acambay earthquake of 1912 (Urbina and Camacho, 1913). b) Current escarpment (2015) in the same place described by Urbina and Camacho (1913)
sources	Velázquez-Bucio M.M. 2018

Site number	050
Latitude	2200207
Longitude	400032
Distance from epicenter	13.64 km
Locality	San Pedro El Alto (Trench 2)
Type of effect	Surface faulting
Description	15 cm vertical displacement. Trench opened in the flat part of the bottom of the valley of San Pedro El Alto, at the site reported by Urbina and Camacho (1913) as a flat place where a 50 cm wide crack was opened towards the valley of the dam.
ESI intensity	IX
Geomorphologic setting	This place is located in the San Pedro Valley, near the old dam. It corresponds to a volcanic-lacustrine sequence.
Photographic documentation	 
sources	Velázquez-Bucio M.M. 2018

Site number	051
Latitude	2209871.33
Longitude	406372.72
Distance from epicenter	9.03 km
Locality	Tixmadejé Chiquito
Type of effect	Surface faulting
Description	Landgridge et al. (2000) propose that this segment is part of the main structure that broke in the 1912 earthquake. The trenching analysis indicates that the observed scarp is associated with a subvertical fault, cutting through trench deposits and displacing bedrock at the trench bottom. The displacement measures are 46 cm on the north wall of the trench and 58 cm on the south wall.
ESI intensity	X
Geomorphologic setting	Close to the slope break, the trench was dug into a steep escarpment-shaped area, altered by a pathway along its base. This hand-excavated trench at Tixmadejé Chiquito is positioned within a topographic transition, signifying the change from weathered andesitic bedrock to colluvium.
Photographic documentation	 **Figure 5.** Trench logs from the Tixmadejé Chiquito paleoseismic site. The South Wall is inverted for comparison. Major faults are labeled a through e. The trench is excavated through a series of coarse colluvial deposits shed off the bedrock of the rangefront, which rises steeply above the trench. The 1912 earthquake is seen by the geomorphic step and faults between meter 2 and 3 on fault b. The scarp has been modified by a walking trail. Paleoevents and vertical separation have been determined by back-slipping the faults. Units above the bedrock are believed to be Holocene in age based on the age of YC2 and soil development.
sources	Langridge et al., 2000

Site number	**052**
Latitude	2203050
Longitude	424653
Distance from epicenter	11.55 km
Locality	Las Lomas, Huapango Plain
Type of effect	Surface faulting
Description	Urbina and Camacho (1913) measured a maximum vertical ground rupture of 20 cm on the Huapango Plain. Despite reporting vertical separation, the absence of a well-defined escarpment suggests a significant lateral component of slip on this fault segment. Photographs of right-stepping cracks on the plain strongly indicate a sinistral component of slip (Suter et al., 2000).
ESI intensity	IX
Geomorphologic setting	Flat Huapango Plain. In the Huapango Plain, stream are cut, slopes gently southwest, normal to the fault trace.
Photographic documentation	 **Figure 10.** Complete views of East and West Walls of Trench 1 at Las Lomas site. East Wall is inverted for comparative purposes. Symbols and units as described in Figure 9. The difference in the geometry of the CS channel edge and facies mismatches between the East and West Walls are suggestive of lateral separation, which led us to excavate Trenches A to G at Las Lomas.
sources	Langridge et al., 2000

Site number	053
Latitude	2198314
Longitude	388695
Distance from epicenter	24 km
Locality	Laguna Bañi
Type of effect	Hydrogeological anomaly
Description	After the earthquake, a natural spring adjacent to the lake ceased to supply water.
ESI intensity	VIII
Geomorphologic setting	The site is located in an area of sag pond created by the fault, where the Bañi Lagoon could have formed.
Photographic documentation	
sources	Ortuño et al., 2015

Site number	054
Latitude	2198183
Longitude	388882
Distance from epicenter	24 km
Locality	Laguna Bañi
Type of effect	Ground crack
Description	Fracture parallel to the fault, 26 cm wide, identified in one of the walls of an excavated trench. The fracture is possibly younger than the sediments that fill it.
ESI intensity	VIII
Geomorphologic setting	The site is located in an area of sag pond created by the fault, where the Bañi Lagoon could have formed.
Photographic documentation	 "Event 1" in the trench log represents the fracture that most likely was generated during the 1912 Acambay earthquake  Filled fracture
sources	Ortuño et al., 2015

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Velázquez-Bucio, M.M.2018 Estatrigrafía cosísmica en secuencias lacustres del Holoceno en el graben de Acambay, Estado de México y evaluación del peligro sísmico, PhD Thesis, Centro de Investigaciones en Geografía Ambiental, Universidad Nacional Autónoma de México.

Plate I - Synoptic Table of ESI 2007 Intensity Degrees - The accuracy of the assessment improves in the higher degrees of the scale, in particular in the range of occurrence of primary effects, typically starting from intensity VIII, and with growing resolution for intensity IX, X, XI and XII. Hence, in the yellow group of intensity degrees (VIII-X) the effects on natural environment are an essential component of seismic intensity that cannot be disregarded. In the orange group of intensity degrees (XI-XII) they become the most effective tool for intensity assessment.

- Quadro sinottico dei Gradi di Intensità della scala ESI 2007 - L'accuratezza della valutazione aumenta verso i gradi più alti della scala, in particolare nell'intervallo di occorrenza degli effetti primari che tipicamente iniziano a manifestarsi dall'VIII grado con risoluzione crescente fino al XII grado. Pertanto, per i gradi di intensità in giallo (VIII-X) gli effetti sull'ambiente naturale sono una componente essenziale dell'intensità che non può essere ignorata. Per i gradi di intensità in arancio (XI e XII), essi sono lo strumento più affidabile per la valutazione dell'intensità.

		PRIMARY EFFECTS	SECONDARY EFFECTS								
		Surface faulting and deformations	Hydrological anomalies	Anomalous waves/tsunamis	Ground cracks	Slope movements	Tree shaking	Liquefactions	Dust clouds	Jumping stones	TOTAL AREA
	From I to III	There are no environmental effects that can be used as diagnostic									
IV	**LARGELY OBSERVED** First unequivocal effects in the environment	Absent	Rare small variations of the water level in wells and/or of the flow-rate of springs are locally recorded, as well as extremely rare small variations of chemical-physical properties of water and turbidity in springs and wells, especially within large karstic spring systems, which appear to be most prone to this phenomenon.	In closed basins (lakes, even seas) seiches with height not exceeding a few centimeters may develop, commonly observed only by tidal gauges, exceptionally even by naked eye, typically in the far field of strong earthquakes. Anomalous waves are perceived by all people on small boats, few people on larger boats, most people on the coast. Water in swimming pools swings and may sometimes overflows.	Hair-thin cracks (millimeter-wide) might be occasionally seen where lithology (e.g., loose alluvial deposits, saturated soils) and/or morphology (slopes or ridge crests) are most prone to this phenomenon.	Exceptionally, rocks may fall and small landslide may be (re)activated, along slopes where the equilibrium is already near the limit state, e.g. steep slopes and cuts, with loose and generally saturated soil.	Tree limbs shake feebly.	Absent	Absent	Absent	------
V	**STRONG** Marginal effects in the environment	Absent	Rare variations of the water level in wells and/or of the flow-rate of springs are locally recorded, as well as small variations of chemical-physical properties of water and turbidity in lakes, springs and wells.	In closed basins (lakes, even seas) seiches with height of decimeters may develop, sometimes noted also by naked eye, typically in the far field of strong earthquakes. Anomalous waves up to several tens of cm high are perceived by all people on boats and on the coast. Water in swimming pools overflows.	Thin cracks (millimeter-wide and several cms up to one meter long) are locally seen where lithology (e.g., loose alluvial deposits, saturated soils) and/or morphology (slopes or ridge crests) are most prone to this phenomenon.	Rare small rockfalls, rotational landslides and slump earth flows may take place, along often but not necessarily steep slopes where equilibrium is near the limit state, mainly loose deposits and saturated soil. Underwater landslides may be triggered, which can induce small anomalous waves in coastal areas of sea and lakes.	Tree limbs and bushes shake slightly, very rare cases of fallen dead limbs and ripe fruit.	Extremely rare cases are reported of liquefaction (sand boil), small in size and in areas most prone to this phenomenon (highly susceptible, recent, alluvial and coastal deposits, near-surface water table).	Absent	Absent	------
VI	**SLIGHTLY DAMAGING** Modest effects in the environment	Absent	Significant variations of the water level in wells and/or of the flow-rate of springs are locally recorded, as well as small variations of chemical-physical properties of water and turbidity in lakes, springs and wells.	Anomalous waves up to many tens of cm high flood very limited areas nearshore. Water in swimming pools and small ponds and basins overflows.	Occasionally, millimeter-centimeter wide and up to several meters long fractures are observed in loose alluvial deposits and/or saturated soils; along steep slopes or riverbanks they can be 1-2 cm wide. A few minor cracks develop in paved (either asphalt or stone) roads.	Rockfalls and landslides with volume reaching ca. 10^3 m^3 can take place, especially where equilibrium is near the limit state, e.g. steep slopes and cuts, with loose saturated soil, or highly weathered / fractured rocks. Underwater landslides can be triggered, occasionally provoking small anomalous waves in coastal areas of sea and lakes, commonly seen by intrumental records.	Trees and bushes shake moderately to strongly; a very few tree tops and unstable-dead limbs may break and fall, also depending on species, fruit load and state of health.	Rare cases are reported of liquefaction (sand boil), small in size and in areas most prone to this phenomenon (highly susceptible, recent, alluvial and coastal deposits, near surface water table).	Absent	Absent	------
VII	**DAMAGING** Appreciable effects in the environment	Observed very rarely, and almost exclusively in volcanic areas. Limited surface fault ruptures, tens to hundreds of meters long and with centimetric offset, may occur, essentially associated to very shallow earthquakes.	Significant temporary variations of the water level in wells and/or of the flow-rate of springs are locally recorded. Seldom, small springs may temporarily run dry or appear. Weak variations of chemical-physical properties of water and turbidity in lakes, springs and wells are locally observed.	Anomalous waves even higher than a meter may flood limited nearshore areas and damage or wash away objects of variable size. Water overflows from small basins and watercourses.	Fractures up to 5-10 cm wide and up to hundred metres long are observed, commonly in loose alluvial deposits and/or saturated soils; rarely, in dry sand, sand-clay, and clay soil fractures are also seen, up to 1 cm wide. Centimeter-wide cracks are common in paved (asphalt or stone) roads.	Scattered landslides occur in prone areas, where equilibrium is unstable (steep slopes of loose / saturated soils), while modest rock falls are common on steep gorges, cliffs). Their size is sometimes significant (10^3 - 10^5 m^3); in dry sand, sand-clay, and clay soil, the volumes are usually up to 100 m^3. Ruptures, slides and falls may affect riverbanks and artificial embankments and excavations (e.g., road cuts, quarries) in loose sediment or weathered / fractured rock. Significant underwater landslides can be triggered, provoking anomalous waves in coastal areas of sea and lakes, directly felt by people on boats and ports.	Trees and bushes shake vigorously; especially in densely forested areas, many limbs and tops break and fall.	Rare cases are reported of liquefaction, with sand boils up to 50 cm in diameter, in areas most prone to this phenomenon (highly susceptible, recent, alluvial and coastal deposits, near surface water table).	Absent	Absent	The total affected area is in the order of **10 km^2**.
VIII	**HEAVILY DAMAGING** Extensive effects in the environment	Observed rarely. Ground ruptures (surface faulting) may develop, up to several hundred meters long, with offsets not exceeding a few cm, particularly for very shallow focus earthquakes such as those common in volcanic areas. Tectonic subsidence or uplift of the ground surface with maximum values on the order of a few centimeters may occur.	Springs may change, generally temporarily, their flow-rate and/or elevation of outcrop. Some small springs may even run dry. Variations in water level are observed in wells. Weak variations of chemical-physical properties of water, most commonly temperature, may be observed in springs and/or wells. Water turbidity may appear in closed basins, rivers, wells and springs. Gas emissions, often sulphureous, are locally observed.	Anomalous waves up to 1-2 meters high flood nearshore areas and may damage or wash away objects of variable size. Erosion and dumping of waste is observed along the beaches, where some bushes and even small weak-rooted trees can be eradicated and drifted away. Water violently overflows from small basins and watercourses.	Fractures up to 50 cm wide and up to hundreds metres long, are commonly observed in loose alluvial deposits and/or saturated soils; in rare cases fractures up to 1 cm can be observed in competent dry rocks. Decimetric cracks are common in paved (asphalt or stone) roads, as well as small pressure undulations.	Small to moderate (10^3 - 10^5 m^3) landslides are widespread in prone areas; rarely they can occur also on gentle slopes; where equilibrium is unstable (steep slopes of loose / saturated soils; rock falls on steep gorges, coastal cliffs) their size is sometimes large (10^5 - 10^6 m^3). Landslides can occasionally dam narrow valleys causing temporary or even permanent lakes. Ruptures, slides and falls affect riverbanks and artificial embankments and excavations (e.g., road cuts, quarries) in loose sediment or weathered / fractured rock. Frequent is the occurrence of landslides under the sea level in coastal areas.	Trees shake vigorously; branches may break and fall, trees may be uprooted, especially along steep slopes.	Liquefaction may be frequent in the epicentral area, depending on local conditions; the most typical effects are: sand boils up to ca. 1 m in diameter; apparent water fountains in still waters; localised lateral spreading and settlements (subsidence up to ca. 30 cm), with fissuring parallel to waterfront areas (river banks, lakes, canals, seashores).	In dry areas, dust clouds may rise from the ground in the epicentral area.	Stone sand even small boulders and tree trunks may be thrown in the air, leaving typical imprints in soft soil.	The total affected area is in the order of **100 km^2**.
IX	**DESTRUCTIVE** Effects in the environment are a widespread source of considerable hazard and become important for intensity assessment	Observed commonly. Ground ruptures (surface faulting) develop, up to a few km long, with offsets generally in the order of several cm. Tectonic subsidence or uplift of the ground surface with maximum values in the order of a few decimeters may occur.	Springs can change, generally temporarily, their flow-rate and/or location to a considerable extent. Some modest springs may even run dry. Temporary variations of water level are commonly observed in wells. Variations of chemical-physical properties of water, most commonly temperature, are observed in springs and/or wells. Water turbidity is common in closed basins, rivers, wells and springs. Gas emissions, often sulphureous, are observed, and bushes and grass near emission zones may burn.	Meters high waves develop in still and running waters. In flood plains water streams may even change their course, also because of land subsidence. Small basins may appear or be emptied. Depending on shape of sea bottom and coastline, dangerous tsunamis may reach the shores with runups of up to several meters flooding wide areas. Widespread erosion and dumping of waste is observed along the beaches, where bushes and trees can be eradicated and drifted away.	Fractures up to 100 cm wide and up to hundreds metres long are commonly observed in loose alluvial deposits and/or saturated soils; in competent rocks they can reach up to 10 cm. Significant cracks are common in paved (asphalt or stone) roads, as well as small pressure undulations.	Landsliding is widespread in prone areas, also on gentle slopes; where equilibrium is unstable (steep slopes of loose / saturated soils; rock falls on steep gorges, coastal cliffs) their size is frequently large (10^5 m^3), sometimes very large (10^6 m^3). Landslides can dam narrow valleys causing temporary or even permanent lakes. Riverbanks, artificial embankments and excavations (e.g., road cuts, quarries) frequently collapse. Frequent are large landslides under the sea level in coastal areas.	Trees shake vigorously; branches and thin tree trunks frequently break and fall. Some trees might be uprooted and fall, especially along steep slopes.	Liquefaction and water upsurge are frequent; sand boils up to 3 m in diameter; the most typical effects are:apparent water fountains in still waters; frequent lateral spreading and settlements (subsidence of more than ca. 30 cm), with fissuring parallel to waterfront areas (river banks, lakes, canals, seashores).	In dry areas, dust clouds may rise from the ground.	Small boulders and tree trunks may be thrown in the air and move away from their site for meters, also depending on slope angle and roundness, leaving typical imprints in soft soil.	The total affected area is in the order of **1,000 km^2**.
X	**VERY DESTRUCTIVE** Effects in the environment become a leading source of hazards and are critical for intensity assessment	Become leading. Surface faulting can extend for few tens of km, with offsets from tens of cm up to a few meters. Gravity grabens and elongated depressions develop; for very shallow focus earthquakes in volcanic areas rupture lengths might be much lower. Tectonic subsidence or uplift of the ground surface with maximum values in the order of few meters may occur.	Many springs significantly change their flow-rate and/or elevation of outcrop. Some springs may run temporarily or even permanently dry. Temporary variations of water level are commonly observed in wells. Even strong variations of chemical-physical properties of water, most commonly temperature, are observed in springs and/or wells. Often water becomes very muddy in even large basins, rivers, wells and springs. Gas emissions, often sulphureous, are observed, and bushes and grass near emission zones may burn.	Meters high waves develop in even big lakes and rivers, which overflow from their beds. In flood plains rivers may change their course, temporary or even permanently, also because of widespread land subsidence. Basins may appear or be emptied. Depending on shape of sea bottom and coastline, tsunamis may reach the shores with runups exceeding 5 m flooding flat areas for thousands of meters inland. Small boulders can be dragged for many meters. Widespread deep erosion is observed along the shores, with noteworthy changes of the coastline profile. Trees nearshore are eradicated and drifted away.	Open ground cracks up to more than 1 m wide and up to hundred metres long are frequent, mainly in loose alluvial deposits and/or saturated soils; in competent rocks opening reaches several decimeters. Wide cracks develop in paved (asphalt or stone) roads, as well as pressure undulations.	Large landslides and rock-falls (> 10^5 - 10^6 m^3) are frequent, practically regardless of equilibrium state of the slopes, causing temporary or permanent barrier lakes. River banks, artificial embankments, and sides of excavations typically collapse. Levees and earth dams may also incur serious damage. Frequent are large landslides under the sea level in coastal areas.	Trees shake vigorously; many branches and tree trunks break and fall. Some trees might be uprooted and fall.	Liquefaction, with water upsurge and soil compaction, may change the aspect of wide zones; sand volcanoes may even be more than 6 m in diameter; vertical subsidence even > 1m; large and long fissures due to lateral spreading are common.	In dry areas, dust clouds commonly rise from the ground.	Boulders (diameter in excess of 2-3 meters) can be thrown in the air and move away from their site for hundreds of meters down even gentle slopes, leaving typical imprints in soil.	The total affected area is in the order of **5,000 km^2**.
XI	**DEVASTATING** Effects in the environment become decisive for intensity assessment, due to saturation of structural damage	Are dominant. Surface faulting extends from several tens of km up to more than one hundred km, accompanied by slips reaching several meters. Gravity graben, elongated depressions and pressure ridges develop. Drainage lines can be seriously offset. Tectonic subsidence or uplift of the ground surface with maximum values in the order of numerous meters may occur.	Many springs significantly change their flow-rate and/or elevation of outcrop. Many springs may run temporarily or even permanently dry. Temporary or permanent variations of water level are generally observed in wells. Even strong variations of chemical-physical properties of water, most commonly temperature, are observed in springs and/or wells. Often water becomes very muddy in even large basins, rivers, wells and springs. Gas emissions, often sulphureous, are observed, and bushes and grass near emission zones may burn.	Large waves develop in big lakes and rivers, which overflow from their beds. In flood plains rivers can change their course, temporary or even permanently, also because of widespread land subsidence and landsliding. Basins may appear or be emptied. Depending on shape of sea bottom and coastline, tsunamis may reach the shores with runups reaching 15 meters and more devastating flat areas for kilometers inland. Even meter-sized boulders can be dragged for long distances. Widespread deep erosion is observed along the shores, with noteworthy changes of the coastal morphology. Trees nearshore are eradicated and drifted away. along the shores, with noteworthy changes of the coastline profile. Trees nearshore are eradicated and drifted away.	Open ground cracks up to several meters wide are very frequent, mainly in loose alluvial deposits and/or saturated soils. In competent rocks they can reach 1 m. Very wide cracks develop in paved (asphalt or stone) roads, as well as large pressure undulations.	Large landslides and rock-falls (> 10^5 - 10^6 m^3) are frequent, practically regardless of equilibrium state of slopes, causing many temporary or permanent barrier lakes. River banks, artificial embankments, and sides of excavations typically collapse. Levees and earth dams incur serious damage. Significant landslides can occur even at 200 – 300 km distance from the epicenter. Frequent are large landslides under the sea level in coastal areas.	Trees shake vigorously; many branches and tree trunks break and fall. Many trees are uprooted and fall.	Liquefaction changes the aspect of extensive zones of lowland, determining vertical subsidence possibly exceeding several meters; numerous large sand volcanoes, and severe lateral spreading can be observed.	In dry areas dust clouds arise from the ground.	Big boulders (diameter of several meters) can be thrown in the air and move away from their site for long distances down even gentle slopes, leaving typical imprints in soil.	The total affected area is in the order of **10,000 km^2**.
XII	**COMPLETELY DEVASTATING** Effects in the environment are the only tool for intensity assessment	Are dominant. Surface faulting is at least few hundreds of km long, accompanied by offsets reaching several tens of meters. Gravity graben, elongated depressions and pressure ridges develop. Drainage lines can be seriously offset. Landscape and geomorphological changes induced by primary effects can attain extraordinary extent and size (typical examples are the uplift or subsidence of coastlines by several meters, appearance or disappearance from sight of significant landscape elements, rivers changing course, origination of waterfalls, formation or disappearance of lakes).	Many springs significantly change their flow-rate and/or elevation of outcrop. Temporary or permanent variations of water level are generally observed in wells. Many springs and wells may run temporarily or even permanently dry. Strong variations of chemical-physical properties of water, most commonly temperature, are observed in springs and/or wells. Water becomes very muddy in even large basins, rivers, wells and springs. Gas emissions, often sulphureous, are observed, and bushes and grass near emission zones may burn.	Giant waves develop in lakes and rivers, which overflow from their beds. In flood plains rivers change their course and even their flow direction, temporary or even permanently, also because of widespread land subsidence and landsliding. Large basins may appear or be emptied. Depending on shape of sea bottom and coastline, tsunamis may reach the shores with runups of several tens of meters devastating flat areas for many kilometers inland. Big boulders can be dragged for long distances. Widespread deep erosion is observed along the shores, with outstanding changes of the coastal morphology. Many trees are eradicated and drifted away. All boats are tore from their moorings and swept away or carried onshore even for long distances. All people outdoor are swept away.	Ground open cracks are very frequent, up to one meter or more wide in the bedrock, up to more than 10 m wide in loose alluvial deposits and/or saturated soils. These may extend up to several kilometers in length.	Large landslides and rock-falls (> 105^5 - 106^6 m^3) are frequent, practically regardless to equilibrium state of the slopes, causing many temporary or permanent barrier lakes. River banks, artificial embankments, and sides of excavations typically collapse. Levees and earth dams incur serious damage. Significant landslides can occur at more than 200 – 300 km distance from the epicenter. Frequent are very large landslides under the sea level in coastal areas.	Trees shake vigorously; many branches and tree trunks break and fall. Many trees are uprooted and fall.	Liquefaction occurs over large areas and changes the morphology of extensive flat zones, determining vertical subsidence exceeding several meters, widespread large sand volcanoes, and extensive severe lateral spreading can be observed.	In dry areas dust clouds arise from the ground.	Also very big boulders can be thrown in the air and move for long distances even down very gentle slopes, leaving typical imprints in soil.	The total affected area is in the order of **50,000 km^2** and more