

History



Edgard Garrido/Reuters

Joutla, Morelos.

Virginia García Acosta*
Gerardo Suárez**

The Pre-instrumental Seismic History of Morelos¹

The state of Morelos, located in Central-Southern Mexico, only came into being in the second half of the nineteenth century. From the colonial period, the area had been known for its good climate, the production of sugar cane and top-quality rice, and its many rivers and lagoons. It had never been known as a seismic area, despite the fact that the Trans-Mexican Volcanic Belt crosses the northern part of the state, and the Popocatepetl Volcano is one of its highest points. However, the September 19, 2017 earthquake—the same day of the year that the emblematic 1985 earthquakes took

place—had its epicenter there, although with very particular characteristics that we will review here.

Its impact was noteworthy, particularly in Morelos, although also in Mexico City and the states of Mexico and Puebla. The National Seismological Service (SSN) reported its magnitude as 7.1, at 1:14 p.m., with an epicenter 12 kilometers southeast of Axochiapan, Morelos (latitude, 18.4°; longitude, 98.72°) and 57 kilometers deep.²

For those of us who were near the epicenter in Morelos, the experience was truly frightening. It reminded us of the title of one of graphic artist José Guadalupe Posada's works that we often use to illustrate our texts about earthquakes, *The End of the World*.³ That's what it felt like. As always with potentially destructive natural threats, its impact was very different from region to region. Once again we saw that both damage and the population's

* Anthropologist, historian, professor and researcher at the Center for Research and Study in Social Anthropology (CIESAS); vgarcia@ciesas.edu.mx.

** Researcher at the UNAM Institute of Geophysics Department of Seismology; gerardo@ollin.geofisica.unam.mx.

ability to recover correlate directly to the level of vulnerability and exposition of the communities affected.

The Morelos state government has stated that the earthquake affected the municipalities of Axochiapan, Cuautla, Cuernavaca, Miacatlán, Jojutla, Tecamac, Tlayacapan, Xochitepec, Yautepec, Yecapixtla, and Zacatepec, damaging approximately 20 000 homes, while 185 schools—mainly primary schools—suffered considerable damage. It contrasted sharply with what happened in Mexico City, where the destruction concentrated in buildings of several stories, whereas in Morelos, low-income family homes, many of which had been built by the owners themselves, suffered the greatest effects.

As researchers of historic disasters in Mexico, Latin America, and other latitudes, we took on the task of examining the seismic history of Morelos using the inter-

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disciplinary approach that is unavoidable for this kind of analysis. We encountered many surprises, since even though the area had not usually been identified as a land of earthquakes, reports of them exist from ancient times (see Table 1). Numerous social and geological studies and analyses have come out of this effort. One is the interactive Historic Earthquakes web site page (www.sismoshistoricos.org), published by the UNAM Geophysics Institute.

As we can see in Table 1, the first earthquake registered in Morelos was in 1540, apparently linked to an eruption of the Popocatepetl Volcano. The second, in 1585, was reported in Jojutla.⁴ The first detailed description of an earthquake in Morelos was one that happened on January 17, 1653. While the reports center on what happened in Mexico City, as usually happens with the oldest ones, damage was also recorded in the town of Amilpas, Morelos. Gregorio Marín de Guíjo, one of the authors of *Diarios de sucesos notables* (Journals of Noteworthy Events), a series of writings from the mid-seventeenth to the late eighteenth centuries, gives his version of the most important events in his two volumes for 1648-1664, originally published in 1853.⁵

As usual with this kind of record, as we approach the present, the reports become more frequent and detailed, not because there were more earthquakes, but because the country's population was growing and communications were expanding. The following are a few examples.

One report about Tetela del Volcán and associated, as the name

TABLE 1. EARTHQUAKES IN MORELOS IN THE PRE-INSTRUMENTAL PERIOD (1540-1912)

1540	1880, October 27	1904, January 3
1585	1882, April 23	1904, April 12
1653, January 17	1882, April 24	1906, January 29
1784, January 16	1882, April 28	1906, March 7
1837, November 22	1882, June 5	1906, March 16
1842, October 18	1882, June 6	1907, April 14
1845, April 7	1882, July 17	1907, September 24
1845, April 8	1882, July 19	1909, July 30
1845, April 10	1884, May 10	1909, July 31
1852, December 4	1887, June 3	1909, September 5
1854, May 5	1888, September 6	1909, October 31
1857, August 19	1889, September 1	1910, May 31
1872, March 27	1889, September 6	1911, February 3
1873, February 8	1889, September 7	1911, March 10
1873, October 7	1890, December 2	1911, May 25
1874, March 16	1892, August 4	1911, June 7
1874, August	1892, August 29	1911, August 27
1874, October 7	1894, December 30	1911, Noviembre 18
1874, November 13	1896, March 20	1911, December 16
1880, March 19	1899, March 24	1912, November 19
1880, October 10	1902, April 18	
1880, October 11	1902, September 23	

Source: Virginia García Acosta and Gerardo Suárez Reynoso, *Los sismos en la historia de México* (Mexico City: Fondo de Cultura Económica/UNAM/CIESAS, 1996).

indicates, with the volcano, was published in the newspaper *El siglo diez y nueve* (Nineteenth Century) on November 6, 1842, regarding an earthquake on October 18 of that year:

On the 18th, at 12:30 precisely, there was an earthquake here [in Tetela del Volcán] that was so strong as to alarm me. . . . It increased in strength so much that I had no alternative but to crouch in the doorway of the parlor, whose walls were more than a yard and a half thick, and it was necessary to stop the doors that were closed so they didn't bang. The strange noise that could be heard in this building caused me grave concern, and I merely began to recite the prayers of the litany and the Magnificat, which lasted throughout the earthquake. The volcano, which constitutes the barometer of this place, continues to belch red beauties [sic] so thick that, once dispersed, they made the rest of the day dark and melancholy. The atmosphere and the days have continued thus, despite having vented on the 20th at nine at night, with a storm of wind, lightening, torrents of water, and thunder that also intimidated me, and I had to light the candle of the Blessed Sacrament.⁶

In its August 24 and 28, 1857 editions, the same newspaper covered an earthquake felt in Yautepec on August 19 at 11:20 a.m., writing, "A shaking was felt first and then repeated a short time later, ending with a strong vibration that caused the dome of the church to collapse. . . . The rest of the building, the priory, and the schools are at risk of being ruins. . . . It was also felt in Cuernavaca and other towns to the south."⁷

Two important sources of Mexico's seismic history, Mariano Bárcena and Manuel Martínez Gracida,⁸ explain what happened in Xochitepec during the October 7, 1873 earthquake in their texts published in 1875 and 1890, respectively:

Underground noises [could be heard], and several fountains of crystalline water with a strong, sulfurous smell appeared in the plaza. They continued to bubble on the 8th, 9th, 10th, and 11th, augmenting the amount of water in the old stream that existed on one of the town's streets, through a new mouth very near the main flow. These shaking movements ceased completely without leaving any sign at all that could indicate a volcanic eruption.⁹

In the specific case of Morelos, throughout the nineteenth century and up until 1913, the last year we will examine in this text, the period of what has been dubbed the pre-instrumental stage of Mexican seismology, we have identified 57 reported earthquakes. Abundant information exists about the ones in April 1845 and July 1882, even detailing consequences, the population's response, and measures taken by the authorities.

It is estimated that the April 7, 1845, 8.1-magnitude earthquake, which took place at 3:47 p.m., was similar in magnitude to the great earthquake of September 19, 1985. The first centered on the coast of the state of Guerrero and was one of those about which the most information was given at the time, beginning on the following day. This is a treasure-trove of information for understanding its characteristics, but also

the responses from different quarters: government, private, and religious. The national and even the international press undoubtedly offered data and references with details that are extremely valuable for its study.

The movement and its effects were particularly severe in Mexico City. It is known as the Saint Teresa earthquake, not because it was Saint Teresa's day, following the tradition of baptizing an earthquake in honor of some Marian advocacy or a saint, but because the most

TABLE 2. MORELOS LOCATIONS REPORTING EARTHQUAKES BETWEEN 1540 AND 1912

• Alpuyeca	• Jojutla	• Tepetlapa
• Amilpas	• Jonacatepec	• Tepoxtla(n)/Tepoztlán
• Astillero	• Mazatepec	• Tetecala
• Coahuixtla	• Miacatlán	• Tetela del Volcán
• Coatlán del Río	• Nepantla	• Tlalquitenango
• Cuautla	• Oacalco	• Tlatenchi
• Cuernavaca	• Panchimalco	• Xochitepec
• Ixtla	• Puente de Ixtla	• Yautepec
• Jiutepec	• San Gabriel	

Source: Virginia García Acosta and Gerardo Suárez Reynoso, *op. cit.*, p. 93 (using information from Gregorio Martín de Guijo, *Diario 1648-1664*, 2 vols. (Mexico City: Porrúa, 1953), "Escritores mexicanos" Collection, nos. 64 and 65).

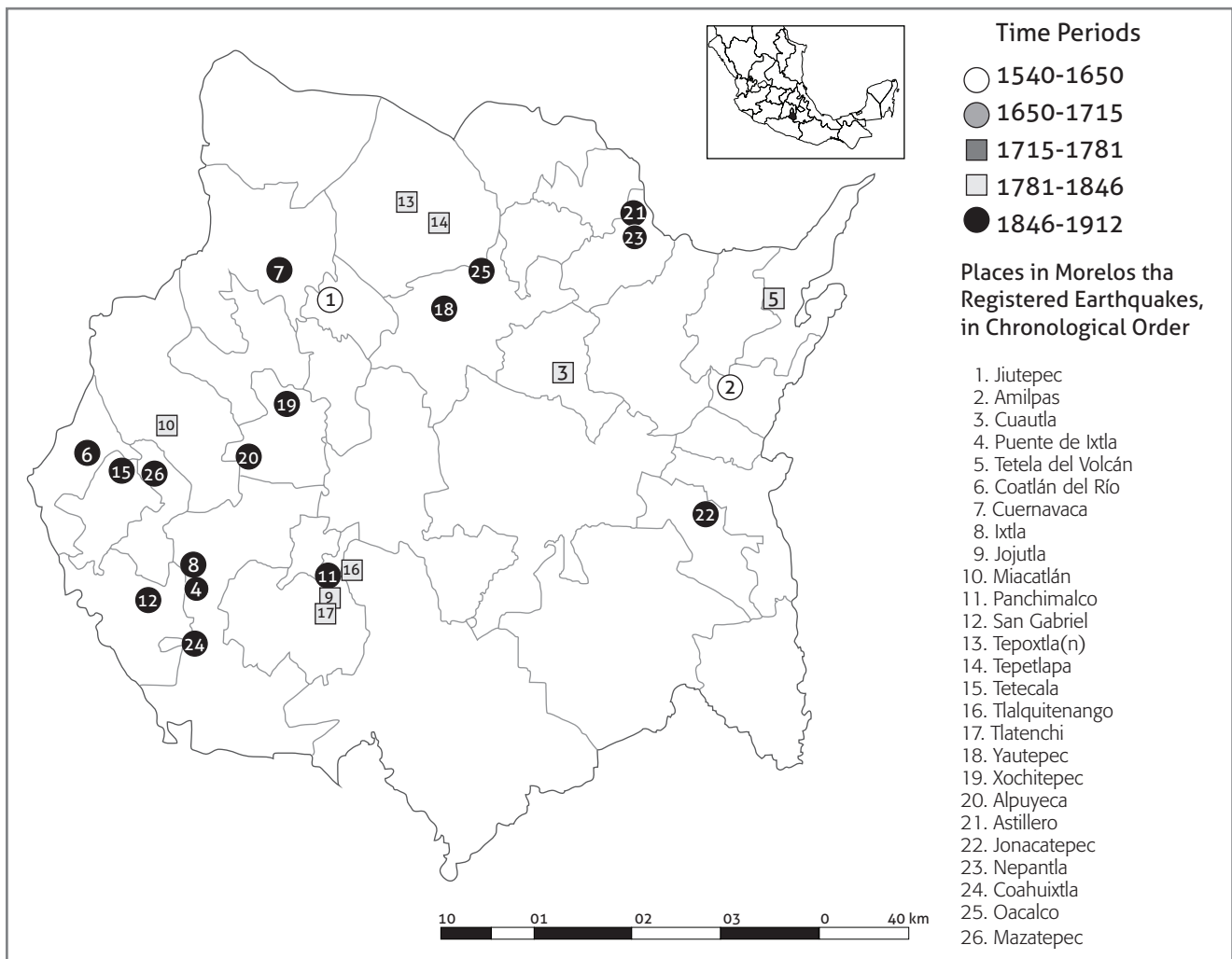
lamented damage was the collapse of the dome of Mexico City’s Old Saint Teresa Parish Church. Damage of differing degrees was also recorded in the states of Aguascalientes, Colima, Mexico, Guanajuato, Guerrero, Hidalgo, Jalisco, Michoacán, Oaxaca, Puebla, Querétaro, San Luis Potosí, Tlaxcala, and Veracruz. In the specific case of Morelos, the earthquake was reported as particularly strong in Cuautla, Tetecala, Puente de Ixtla, and Jojutla. Reports from Cuernavaca said that an earthquake that strong had never been felt before, and that the walls of several houses cracked open.

It is noteworthy that of all the earthquakes registered in the pre-instrumental period, Axochiapan does not appear, despite the fact that the name has existed since

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pre-Hispanic times, while the epicenter of the September 19, 2017 quake was only 12 kilometers from there. This is a matter still to be investigated. The scientific explanations we have found since the nineteenth century refer to Morelos’s geological conditions. In the case of the 1873 Xochitepec quake, the naturalist, geologist, and biologist Mariano Bárcena reported that his exploration found that the town was built on a limestone formation riddled with

MAP 1. MORELOS LOCATIONS THAT REGISTERED EARTHQUAKES BETWEEN 1540 AND 1912



Source: Map developed by Jorge Luis Galdamez Brindis and Diego Armando Vargas Zacarías.

Note: The locations appear in the order the earthquakes were registered in the pre-instrumental period.

different caverns and excavations of different sizes; no signs of recent volcanic eruption were found since the basaltic rock near the town are from the Tertiary Period, and the seismological phenomena experienced there began on October 7 of the previous year [1873] and concluded on the 11th of the same month.¹⁰

The 1882 earthquake was very similar to those of September 19, 1985 and 2017: it was a relatively deep movement located in northern Guerrero on the border with Morelos. While the epicenter was not as close to Morelos as in the 2017 quake, a larger number of Morelos sites were reported affected.¹¹ With this information, scientists of the time resurrected Baron Alexander von Humboldt's theory about the existence and orientation of "the underground galleries that the volcanic forces run through," which led him to take on board the unavoidable —although generally wrong— association between earthquakes and eruptions:

What is the seismic focus of the earthquake? Given the strength with which the phenomenon has occurred in the capital, that focus could well be placed at the base of the Popocatepetl Volcano. Until today, we do not know what relationships may exist between the volcanic region of the West and that of the East, but someone has told us that the activity of the Colima Volcano has ceased completely for a long time. Do the forces that no longer find their release retreat through the respective galleries until they invade our area? Cannot the lava, the watery vapors, and the gases travel such a considerable distance?¹²

By the beginning of the twentieth century, experts were noting the damage and effects they observed, calculating the intensity in different locations. For example, the great quake on the coast on June 7, 1911 was explained thus:

The oval that forms the limit of the seismic wave on the map of the earthquake can be divided into zones according to their greater or lesser intensity: first, the epicenter, whose maximum intensity was felt in the region where the towns of Tuxpana (Jalisco), Ciudad Guzmán (also in Jalisco), Tecatitlán, four leagues to the south of the second, and San Sebastián, even though the first suffered little. Secondly, the area of very strong intensity that ranges over part of the states of Guanajuato, Querétaro, Hidalgo, Mexico, and the Federal District, where the quake was felt with tremendous force. Third, the

zone of medium intensity in the rest of the state of Guanajuato and part of Veracruz, Puebla, and Morelos; and the fourth area, of weak or almost imperceptible intensity, in the states around the others: in the extreme east, Veracruz; to the west, Manzanillo (in Colima); to the north, Jerez (in the state of Zacatecas), and to the south, Chilpancingo (in Guerrero).¹³

Today the damage caused by the earthquakes is used as semi-quantitative data to locate the epicenter and the characteristics of the event. What is well known —and Mexico City is the best and most dramatic example of this— is that the quality of the soil is one of the factors that determine the damage suffered. Low-quality, soft soil, like that in our capital city, which was the murky bottom of a lake, produces more damage than rocky soil. In Morelos, whether the damage suffered in certain towns was accentuated by the quality of the soil is still to be studied. What is clear is that the state is and has been a land of earthquakes, and its inhabitants must be prepared and build appropriately for this kind of event. **NMM**

Notes

- 1 The authors wish to thank Diego Armando Vargas Zacarías for his support in writing this article.
- 2 Servicio Sismológico Nacional, http://www.ssn.unam.mx/sismicidad/reportes-especiales/2017/SSNMX_rep_esp_20170919_Puebla-Morelos_M71.pdf.
- 3 *Monografía: las obras de José Guadalupe Posada. Grabador mexicano* (Mexico City/Aguascalientes: INBA/Ediciones Toledo/Instituto Culturas de Aguascalientes [ICA], 1993), p. 89.
- 4 Virginia García Acosta and Gerardo Suárez Reynoso, *Los sismos en la historia de México* (Mexico City: FCE/UNAM/CIESAS, 1996) pp. 74 y 83.
- 5 Gregorio Martín de Guijo, *Diario 1648-1664*, 2 vols. (Mexico City: Porrúa, 1953), *Escritores mexicanos Collection*, nos. 64 and 65.
- 6 *El siglo diez y nueve*, November 6, 1842, p. 3.
- 7 *El siglo diez y nueve*, August 24, 1857, p. 3, and August 28, 1857, p. 3.
- 8 Mariano Bárcena, "Los terremotos de Jalisco," *Boletín de la Sociedad Mexicana de Geografía y Estadística*, 3^a época, vol. II, pp. 240-248. Bárcena was the founder of the National Astronomical Observatory of Mexico; Manuel Martínez Gracida, "Catálogo de terremotos desde 1507 hasta 1885," *Cuadro sinóptico, geográfico y estadístico de Oaxaca*, unpublished manuscript, 1890. This magnificent work, consulted in the 1990s in the "Oaxacan Matters" section of the Oaxaca Public Library, constituted until then one of the most complete catalogues of Mexico's historic earthquakes, as well as those in other parts of the world. Juan Orozco y Berra based himself on it to write his chronology, *Efemérides sísmicas mexicanas*, published in 1887 by the Mexican government.
- 9 Virginia García Acosta and Gerardo Suárez Reynoso, op. cit., pp. 351-352.
- 10 *Ibid.*, p. 352.
- 11 Alpuyecá, Astillero, Cuautla, Cuernavaca, Jonacatepec, Nepantla, Puente de Ixtla, Tetecala, and Yautepec.
- 12 Virginia García Acosta and Gerardo Suárez Reynoso, op. cit., p. 407.
- 13 *Ibid.*, p. 633.