Commemorating the 100-Year Anniversary of the June 29, 1925 Santa Barbara Earthquake

What We Learned After the Shaking Stopped

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Cover page: An entire outer wall of the Hotel Californian collapsed due to strong shaking. The hotel was located on lower State Street at the intersection of East Mason Street, one block away from the beach. Photo credit: Santa Barbara Historical Museum, Gledhill Library.

Preface

The 100-year anniversary of the 1925 earthquake is dedicated to the geoscientists that contributed to the knowledge base of the history of past earthquakes and the geologic structures that we understand today. Professors Arthur Sylvester and Edward Keller, and Thomas W. Dibblee, Jr. advanced the knowledge of the earthquake history, tectonic geomorphology, and geologic setting of the Santa Barbara area as we understand it today.

The 100^{th} anniversary of the 1925 earthquake is a reminder for the community that earthquakes are a part of living in Santa Barbara, a beautiful coastal area where the mountains meet the sea. For it is the faults that raise the land that created the Santa Ynez Mountains, the Mission Ridge (Riviera), and the Mesa hills and form such an inviting landscape. The faults accumulate convergent elastic strain produced by the colliding crustal blocks of the "Big Bend" of the San Andreas fault zone. It is the sudden release of this energy that produces earthquakes in the onshore and offshore areas. The stored energy radiates out as seismic waves that shake the quiet community by the sea.

This commemoration of the 29 June 1925 earthquake is to remind all who study geology and the residents of the Santa Barbara area that we live in a geologically dynamic environment that occasionally shakes with destructive force.

Cheers!

Larry D. Gurrola

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History of Santa Barbara

Spanish explorer Juan Rodríguez Cabrillo sailed into the Santa Barbara Channel in 1542 and made first contact with the Chumash people on the Channel Islands. Decades later in 1602, Sebastián Vizcáino sailed into the Santa Barbara channel who named it after the feast day of Saint Barbara (City of Santa Barbara, 2025). Subsequently, the Spanish government sent explorers to establish Presidios and Missions along the Alta California coastline. Leading the expedition, Gaspar de Portolá along with Padre Junipero Sierra entered the Santa Barbara area in summer of 1769 and founded the Presidio in 1782. The Spanish occupation began in 1782 with the first adobe houses constructed in the Presidio in 1784 and Mission Santa Barbara was founded in 1786. Coerced to build adobe dwellings near the Mission, the Chumash inhabitants established a Chumash village near the Mission and homes built to form a street and, the village expanded into the beginning of the 19th century.

Mexico became independent from Spain in 1822, so the Santa Barbara Presidio and Mission were under Mexican government rule by 1824. The Mexican secularization to the Alta California territory in 1824 divided large land holdings into ranchos and land grants to Presidio soldiers. The United States declared war with Mexico in 1846 and American forces captured the Presidio, which were subsequently captured by Mexican forces, and later that year, again recaptured the Presidio. Two years later, the Treaty of Guadalupe was signed with Mexico and California was established as an American territory and became the 31st state of the Union in 1850. The City of Santa Barbara was first surveyed by Captain Salisbury Haley and the streets were laid out. The Gazette, Santa Barbara's first weekly newspaper, was published in 1855.

Cattle dotted the hills of Santa Barbara in the 1850's but the boom declined a decade later (Gidney et. al, 1917). Several great ranches were subdivided into small tracts bought by eastern investors and immigrants, and the transition from stock raising to growing grain changed the inhabitants. The town of Santa Barbara slowly grew, with Stearn's Wharf built in 1872 and the Santa Barbara Electric Company founded in 1886. The first Southern Pacific train arrived in the following year and infrastructure such as City's first sewer system was installed in 1890, and water lines were shown along State Street on 1892 Sanborn Insurance Maps. Water infrastructure improved with the development of the Cold Spring Tunnel in 1897 and the completion of Sheffield Reservoir in 1918. The population of Santa Barbara in 1920 was counted at 19,441 residents.

Abridged Historic Earthquakes

Gidney et. al (1917) wrote about the history of the Santa Barbara County and noted that several strong earthquakes did severe damage to the adobe buildings at the Presidio and the Mission Santa Barbara in 1806. The earthquakes caused extensive damage to the Presidio Chapel and cracked three walls of the chapel at the Santa Barbara Mission (Willis, 1925). A minor earthquake occurred in late 1811 but no damage was noted in historical accounts.

Strong earthquakes on 21 and 22 December 1812 caused damage throughout the southern California area (Willis, 1925; Sylvester and Olsen, 1975). Severe shaking damaged Mission Santa

Barbara which required rebuilding rather than repair. Sylvester and Olsen (1975) established that the damage was more severe at the Presidio where none of the were left standing or usable. In fact, the residents moved from the Presidio to higher ground at the Mission Santa Barbara because the effects of the earthquake were less severe. Commander of the Presidio, Jose Arguello, reported that tremors continued through to 14 January 1813 and that the ground opened up at several places creating sulfur-spewing volcanoes. Although the locations of the volcanoes were not specified (Geiger, 1965).

The main 1812 shock, believed to be one of the strongest earthquakes in southern California's history, completely destroyed the "Mission Vieja" La Purísima Mission at Lompoc, approximately 60 km to the northwest of Santa Barbara (The Oakland Tribune, June 30, 1925).

An account of one of the residents of Santa Barbara in 1812 described a tsunami, "The sea was observed to recede from the shore during the continuance of the shocks, and left the latter dry for a considerable distance, when it returned in five or six heavy rollers, which overflowed the plain on which Santa Barbara is built" (J. B. Trask in The Oakland Tribune, June 30, 1962).

Geiger (1965) reported that extensive damage was caused to the Chumash adobe village by an earthquake and heavy rains in 1814 (Geiger, 1965). Another severe earthquake on 9 January 1856 was reported to be felt throughout the state (Geiger, 1965). A succession of shocks was recorded with the strongest shaking lasting between forty to sixty seconds which was described as violent (Writers Project, 1941). An earthquake reported to be one of the heavier shocks ever experienced in Santa Barbara was felt in southern California.

Shaking was felt from Santa Barbara to Ventura and northward to the Ojai Valley as the result of the April 12, 1917 earthquake. This is the first earthquake in the area that was related to a magnitude of shaking using the Rossi-Forel magnitude scale. A shaking intensity of VI was assigned to the shaking of this earthquake (Table 1) (Writers Project, 1941).

The "1925 Earthquake"

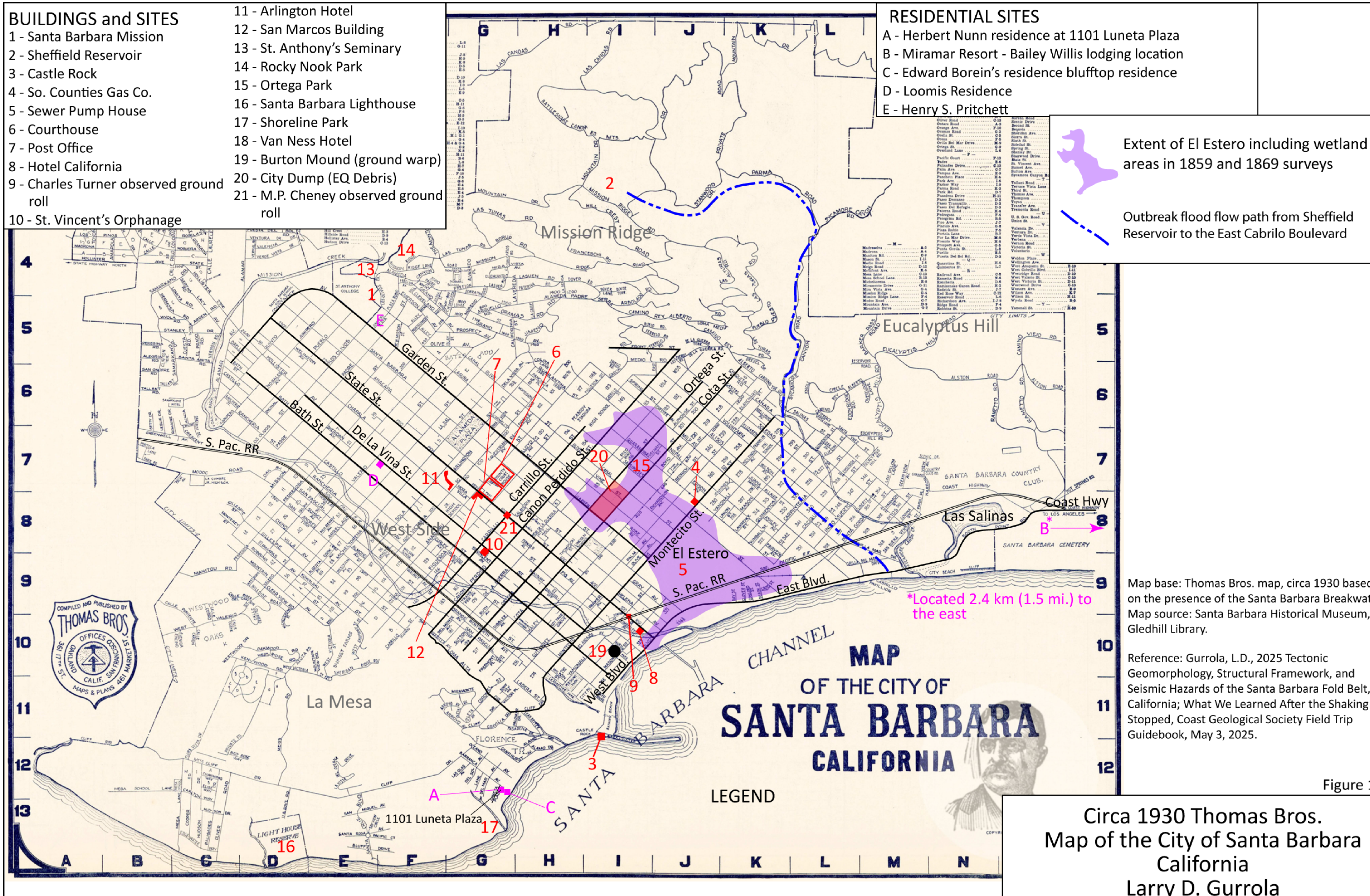
The following section includes accounts and summaries of historic newspapers and literature including detailed history written about the Santa Barbara Mission. One important contribution was the Bulletin of the Seismological Society (vol. 15, no. 4, 1925) which was dedicated solely to the earthquake. Detailed narratives offer individual experiences of the shaking (Ervin, Santa Barbara Historical Museum, 2025), news accounts of the damage, and the earliest interpretation of the faults that produced the shocks of the 29 June 1925 earthquake. This summary relates eyewitnesses' experiences and details provided in reports, and attempts to preserve the manner the information was conveyed.

The day before the earthquake was described by the City of Santa Barbara manager, Herbert Nunn, as unusually warm and sultry which carried into the night. He lived 200 feet from the top of the sea cliff bluff above Leadbetter Beach (Figure 1) and was awakened by a strong odor of crude oil at 3:30 a.m. (Nunn, 1925). The odor was so strong that he got up out of bed and investigated outside only to learn that there was no wind, so he concluded that the odor was not coming from the oil refinery at Summerland and went back to bed. Since Herbert was the city manager, he

Table 1. Comparison of Rossi-Forel Intensity Scale to Modified Mercalli Scale of 1931

Rossi-Forel	Modified Mercalli	
I	I	Not felt except by a very few under especially favorable circumstances.
I-II	II	Felt only by a few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing.
III	III	Shaking felt quite noticeably indoors, especially on upper floors of buildings, but many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibration like passing truck. Duration estimated.
IV-V	IV	During the day, shaking is felt indoors by many, outdoors by few. At night some awakened. Dishes, windows, and doors disturbed; walls make creaking sound. Sensation like heavy truck striking building. Standing motorcars rock noticeably.
V-VI	V	Felt by nearly everyone; many awakened. Some dishes, windows, etc., broken; a few instances of cracked plaster; unstable objects overturned. Disturbance of trees, poles, and other tall objects sometimes noticed.
VI-VII	VI	Felt by all; many frightened and run outdoors. Some heavy furniture moved; a few instances of fallen plaster or damaged chimneys. Damage slight.
-VIII	VII	Everybody runs outdoors. Damage is negligible in buildings of good design and construction slight to moderate in well-built ordinary structures; damage is considerable in poorly built or badly designed structures. Some chimneys are broken. Noticed by people driving motor cars.
VIII+ to -IX	VIII	Damage is slight in specially designed structures; considerable in ordinary substantial buildings, with partial collapse; great in poorly built structures. Panel walls thrown out of frame structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. Sand and mud ejected in small amounts. Changes in well water. People driving motor cars are disturbed.
IX+	IX	Damage is considerable in specially designed structures; well-designed frame structures thrown out of plumb; great in substantial buildings, with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken
X	X	Some well-built wooden structures are destroyed; most masonry and frame structures destroyed with foundations; ground badly cracked. Rails bent. Landslides are considerable from riverbanks and steep slopes. Shifted sand and mud. Water splashed over banks.
	XI	Few, if any (masonry), structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipelines completely out of service. Earth slumps and land slips in soft ground. Rails bent greatly.
	XII	Damage total. Waves seen on ground surfaces. Lines of sight and level distorted. Objects thrown upward into the air.

References: Wood and Neuman (1931); NOAA (2025). It is noted that criteria to define the highest Modified Mercalli intensities of X and above are related less to the level of shaking than to the presence of ground conditions susceptible to spectacular failures or to the ease seismic faulting can propagate to the ground surface (U.S.G.S., 2025). Criteria based on these phenomena are down weighted in assigning USGS intensities as presented in revised Modified Mercalli scale presented in Appendix A (Stover and Coffman, 1993).



Map base: Thomas Bros. map, circa 1930 based on the presence of the Santa Barbara Breakwater. Map source: Santa Barbara Historical Museum, Gledhill Library.

Reference: Gurrola, L.D., 2025 Tectonic Geomorphology, Structural Framework, and Seismic Hazards of the Santa Barbara Fold Belt, California; What We Learned After the Shaking Stopped, Coast Geological Society Field Trip Guidebook, May 3, 2025.

Figure 1.

Circa 1930 Thomas Bros.
Map of the City of Santa Barbara
California
Larry D. Gurrola

later became aware that small tremors had caused disturbances of the water pressure gauge beginning at 3:27 a.m. (Figure 2), and they repeated at intervals up until the main shock at 6:42 a.m. The swarm of several hundred tremors were small foreshocks that did not wake him or other residents in the city. These tremors were also evident on the thermometer gauge recording at the Southern Counties Gas Company which was located at the southwest corner of Montecito Street and Quarantina Street (Figures 1 and 3). These foreshocks were the first manifestation that something bigger would shake the community of Santa Barbara.

Herbert Nunn sat up on the edge of his bed prior to the earthquake, and faced in the northeast direction at 6:42 a.m. He suddenly experienced a sharp jolt which shoved him to the northeast, throwing him on his back. He timed the vibrations and counted about 6 to 7 vibrations per second and then exited the house. Being thrown violently to the ground by vertical vibrations, he rose to his feet but had difficulty keeping his balance. He then observed his wife and gardener exiting the home and being thrown on the ground as well after. They now watched the roof of their house vibrate vertically breaking tiles from their cement bonds, creeping down the roof two to three inches with each vibration. He concluded that there had been some lateral movement with the vertical vibrations as the sheeting of the roof buckled about the center of the house to form a "V". A subsequent news report noted that the Nunns could not stay at their home because it was severely damaged and that his neighbor located on the ocean front side, Edward Borein, was completely destroyed by the shaking.

Bailey Willis, a retired seismologist, was lodged at the Miramar Resort about 3¾ mi. (6 km) east of lower downtown Santa Barbara (Figure 1) He described the sound of a train approaching from the east, and felt rapid vibrations like a train nearby. This was followed by a sharp jolt from the west which threw him sideways in that direction. As his bed rotated in a counterclockwise sense, he counted fifteen seconds until the movement stopped. He then got dressed, taking nineteen minutes to get dressed, and counted an additional five tremors in that interval. He came to the conclusion that at the instant Herbert Nunn was thrown backward by the initial impulse, the fronts of the buildings facing the northeast on State Street were thrown onto the street or on the return swing in the southwest direction.

Bailey Willis surmised that the initial shock was from the southwest direction and was immediately followed by a shock from the northwest direction. He arrived at this conclusion as he later learned that a civil engineer was driving down State Street (in a southeast direction) and felt a shove push his car. He thought he was hit from behind and turned to look behind him and saw the San Marcos Building fall from the shaking.

Abridged Inventory of Damages

This section presents an abridged damage inventory of commercial structures along the business district and residential structures throughout the city based on findings from historical research of newspaper reports, the Gledhill Library at the Santa Barbara Historical Museum and other literature. The following descriptions of damaged structures reflect the accounts, and the experiences of observers as conveyed in their reports.

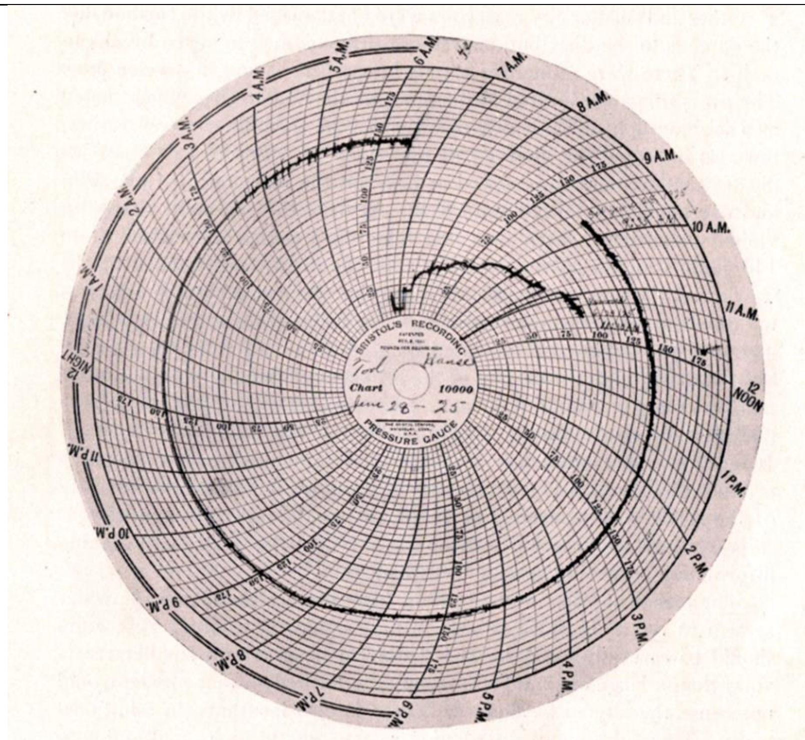


Figure 2. The needle that recorded the water pressure shows an abrupt displacement at 6:42 a.m. Prior to the main event, the graph shows that the needle was jostled at 3:27 a.m. by the initial foreshock (Nunn, 1925). Scientist later determined that a swarm of minor foreshocks followed the first foreshock, possibly up to several hundred small earthquakes (Olsen and Sylvester, 1975).

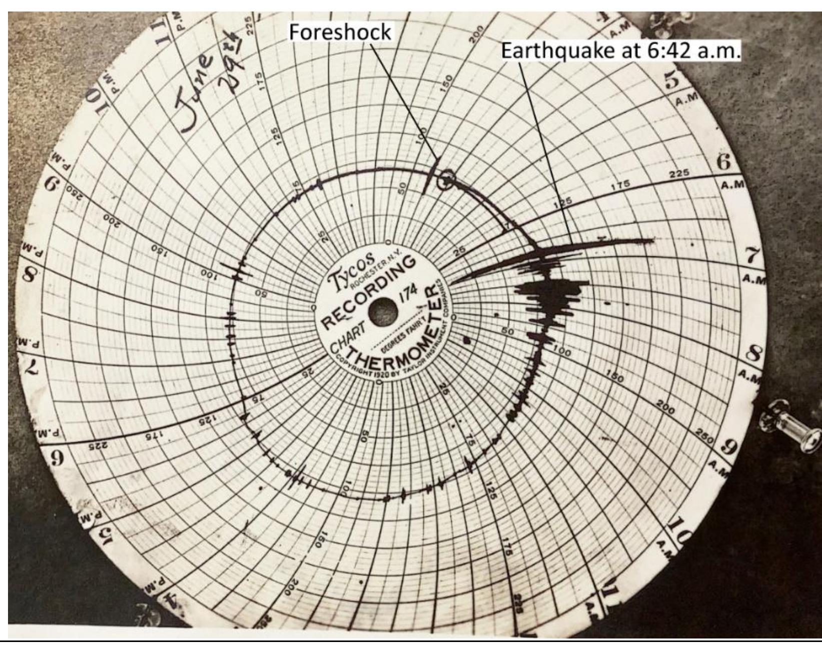


Figure 3. The temperature gauge recording of the Southern Counties Gas Company recorded the foreshock at 3:27 a.m. and the main shock at 6:42 a.m. Photo credit: Santa Barbara Historical Museum, Gledhill Library.

Damages in the Business District

The Californian Hotel located at 35 State Street had opened for business less than two weeks prior to the earthquake and was the newest hotel in the city at the time (The Morning Press, June 30, 1925). The damage was described as a total loss (Figures 4, 5, 6, and 7). The first shock caused the walls to bulge out and three following shocks caused the wall to topple onto the sidewalk and street. The floors remained but the north and south walls had collapsed, and the hotel rooms were exposed. A woman fell out of the fourth-floor hotel and miraculously, she slid down to the ground falling on a man's shoulders. Neither of them was injured. A couple were thrown out of their second-floor room by the force of the shock and fell to the ground. Except for bruises and scratches, they were uninjured (The Morning Press, June 30, 1925).

Four employees of the Western Motors Transfer Company (Figure 8) worked in a building on State Street that collapsed with the first shock of the earthquake (The Morning Press, June 30, 1925). They didn't have time to clear out of the building and suffered minor to major injuries. A fifth employee was seriously injured and not expected to survive. The building was located 116-118 State Street in the lower downtown area.

Significant damage was done to other businesses on lower State Street including the Potter Theater at 233 State Street which was considered a total loss with the stage and the rear of the building collapsed (The Morning Press, July 1, 1925) (Figure 9). The three and one-third story brick and wood structure was one of the older buildings in the city. The foundation was built in a topographically low area that was filled and the ground elevated with artificial fill (Dewell and Willis, 1925). Most of the damage extended from the proscenium arch to the rear outer wall which collapsed completely. The building was constructed into two independent parts and the

Figure 4. View of the west side of the four-story Hotel Californian. The walls collapsed outward and constructed with exterior walls of concrete encased structural steel columns and beams that surround brick panels (Sylvester and Mendes, 2011). Photo credit: Santa Barbara Historical Museum, Gledhill Library.

Figure 5. View of the east side of the Hotel Californian and the adjacent garage structure shown on the lower left of the photograph. Photo credit: Santa Barbara Historical Museum, Gledhill Library.

Figure 6. Close-up view of the east side of the Hotel Californian with workers clearing debris from the structure. Photo credit: Santa Barbara Historical Museum, Gledhill Library.

Figure 7. Aerial view of the lower State Street business district. The view is looking up State Street from the waterfront. Photo credit: Santa Barbara Historical Museum, Gledhill Library.

Figure 8. The complete collapse of the Western Motors Transfer building which was located at 116-118 State Street.

Figure 9. View of the rear of the Potter Theater looking across Montecito Street. Photo credit: Edson Smith Collection, Santa Barbara Public Library.

rear portion was shoved outward by the heavy brick walls. The garage at the rear of the building completely pancaked flat.

A lodger at the El Camino Real Hotel (Figure 10), George Miller, was shaken out with his bed and fell on a wall which had already collapsed onto State Street and he only suffered cuts and bruises (The Morning Press, June 30, 1925). The hotel was located at 318 State Street.

The auto district was comprised of several auto showrooms that were severely damaged. Nearly the entire block of the auto district was considered a complete loss (Figure 11.) Auto row as it was called was located on the 300 block of State Street. The Hotel Barbara was located on State Street and Cota Street, and although all the brick had fallen off the first story walls, not a crack appeared on the walls of the three floors above (The Morning Press, June 30, 1925). The southwest corner of the building collapsed but the remainder of the building was left intact.

An attorney who was working in the Fithian building (Figure 12) when the earthquake occurred and he narrowly escaped when the earthquake struck (The Morning Press, July 1, 1925). He initially thought the building had been dynamited and jumped up to grab hold of the door frame to stop from falling. He didn't remember how he reached the street and recalled that building after building dropped to the ground. Next door to the Fithian building, the street-side wall of the Van Ness Hotel (Figure 12) toppled, and two bodies were reported buried in the debris (The Morning Press, June 30, 1995; July 1, 1925). The Van Ness Hotel was a three-story brick masonry constructed building. The Fithian building located at the southeast corner of

Figure 10. View of the El Camino Hotel located at 318 State Street on the northeast side of the street. Photo credit: Santa Barbara Historical Museum, Gledhill Library.

Figure 11. Auto row was destroyed by the earthquake as seen in the photograph where the partial collapse of second story lodging fell in the auto showrooms below. Photo credit: Santa Barbara Historical Museum, Gledhill Library.

Figure 12. The Van Ness Hotel with a collapsed wall and roof sits next to the Fithian Building. The brick masonry wall of the Fithian Building in the upper center of the photograph has collapsed. Photo credit: Santa Barbara Historical Museum, Gledhill Library.

State Street and Ortega Street fared better, but the upper part of the west wall was pushed out and fell (Byerly, 1925).

The San Marcos building was described as pancaked at the corner of State Street and Anapamu Street, and at least two fatalities occurred when the structure collapsed on them (Figures 13, 14, and 15; The Morning Press, July 1, 1925). The building had been built in sections at different times and a gap existed between the older structure on Anapamu Street and the new part on the corner (Figure 13; Dewell and Willis, 1925). The corner portion of the building was destroyed by the collapse of the columns and the fall of the heavy concrete wall and floors. The concrete was designed for a stress of 2,000 psi, however post-earthquake testing confirmed the concrete failed at 760 psi.

The shaking of the earthquake caused the collapse of the east wall and the second floor of the county jail (Figure 16) (The Morning Press, June 30, 1925). The prisoners were reportedly in shock and immediately removed from the building. Most of the prisoners held on minor charges were paroled.

The gardener of the Arlington Hotel (Figure 1) was working close to the hotel when the earthquake hit (The Morning Press, June 30, 1925). He looked up to see the wall crack and open up about halfway up the building. Suddenly a wall of water gushed out shoving him away from the building when the wall of the hotel collapsed (Figures 17, 18, and 19). A woman, Mrs. Charles E. Perkins and the son of G. Allen Hancock, Bertram Hancock, 21, were killed as the southeastern wall and part of the floor gave way. The hotel was constructed with brick and wood frame which was veneered with brick, reinforced concrete frame of beams and columns

Figure 13. Postcard photographs of before and after the earthquake of the four-story San Marcos Building. Sylvester and Mendes (2001) note that the building was constructed in several sections that were not structurally tied together, and they suggest that battering of the two wings occurred during the shaking. Two people were killed in the collapse of the building. Only one wing of the building was rebuilt and it is now a two-story building. The San Marcos building is located on the southeast corner of State Street and Anapamu Street. Photo credit: Santa Barbara Historical Museum, Gledhill Library.

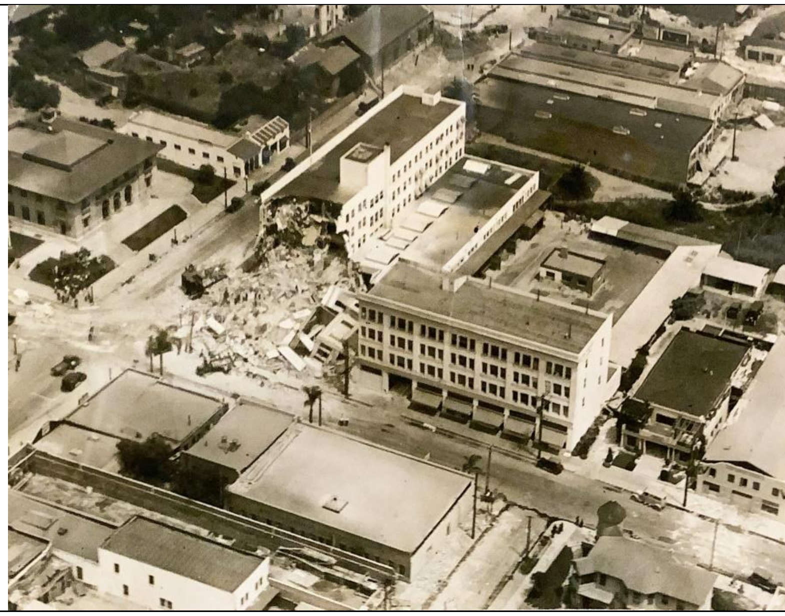


Figure 14. Aerial view of the severely damaged San Marcos Building. The street the runs from the left center to the top center of the photograph is State Street. The cross street is Anapamu Street. Photo credit: Santa Barbara Historical Museum, Gledhill Library.

Figure 15. View of the destruction of the east wing of the San Marcos Building. State Street is on the left side of the building. Photo credit: Santa Barbara Historical Museum, Gledhill Library.

Figure 16. The unreinforced stone masonry structure of the County jail was severely damaged. Standing in front was Supervisor Sam Stanwood (left) and Sheriff Jim Ross (right). Note the collapsed second story floor inside the structure. Photo credit: Santa Barbara Historical Museum, Gledhill Library.

Figure 17. Aerial view of the Arlington Hotel looking westward with State Street in the right bottom corner of the image. Photo credit: Santa Barbara Historical Museum, Gledhill Library.

Figure 18. View of the front of the Arlington Hotel. Photo credit: Santa Barbara Historical Museum, Gledhill Library.

Figure 19. A different perspective of the damage of the Arlington Hotel. Photo credit: Santa Barbara Historical Museum, Gledhill Library.

(Dewell and Willis, 1925). The appearance of the hotel was to render an impression of massiveness at a minimum cost. The central section of the hotel was severely damaged which collapsed completely. The failure of this structure, referred to as pretentious by the engineering committee, was attributed to the general plan of the building and torsional strains, and the placing of the water tower on the roof. The committee declared that the principles of safe construction were abandoned and the design disregarded the earthquake risk which characterized architectural and engineering practices at the time (Dewell and Willis, 1925).

The Santa Barbara lighthouse collapsed and was the oldest landmark of the Pacific Coast at the time (Figure 20; The Morning Press, July 1, 1925). The lighthouse was located on the blufftop on the Mesa just west of Santa Barbara Point (Figure 1). The keeper of the lighthouse, Mrs. H. A. Weeks, described the lighthouse as badly damaged in the first shock, and she remained inside with her children. However, they rushed out when the second shock occurred which caused the light tower to collapse and destroy the lighthouse (Figure 20).

St. Francis Hospital located on the lower Mission Ridge was described as ruined inside with large gaps where plaster fell to the ground (The Morning Press, June 30, 1925). The Sister Superior described the hospital was severely damaged inside and out with the steel framework and the foundation being the only parts left intact (The Morning Press, July 1, 1925). All the patients were safely evacuated. The neighboring nurse's home was also destroyed in the earthquake. The County General Hospital was severely damaged, and repairs were considered futile (The Morning Press, June 30, 1925). The patients and staff of the hospital escaped injury and the patients were kept outside and sufficiently far enough to avoid falling debris.

Mass was being held at the Mission Santa Barbara church (Figure 1) when the earthquake occurred. As it was the Feast of Saints Peter and Paul (Geiger, 1965), Father Augustine was in the choir loft with clerical students singing the music of the mass. The students went down to receive communion leaving Father Austine and the organist, Frater Cornelius with two elderly brothers, Odoric and Firmus. Then the earthquake struck. Father Augustine felt a violent jolt that seemed to come from the very depths and the church began to sway with a crunching sound. Several large statues were catapulted from their pedestals, one of the statues was thrown directly at Father Raphael, who was celebrating mass but then started running from the sanctuary. Brother Michael pulled Father Raphael aside, saving him from being hit by the wooden statue which landed on the floor.

Father Augustine instructed the remainder of the choir to remain where they were. The shaking intensified and more debris began to fall, and the noise became deafening. About fifteen people began running for the exit (Geiger, 1965). Father Augustine warned them that the towers were crumbling and halted the people attempting to leave (Figures 21, 22, and 23). They considered themselves fortunate to heed the father's warning. When the shaking had stopped, they exited the church and saw that large stones had fallen from the towers above and would have fallen on the parishioners. Both Frater Cornelius and Father Augustine went up to the loft to retrieve the elderly brothers and half carried them and half dragged them over the debris. After apparently finding safety, Father Augustine lost Brother Odoric in the dust and moved forward looking for him only to fall into the floor below. He realized that Brother Odoric had fallen through the they passed under the severely damaged bell tower, an aftershock occurred, and then the

Figure 20. View of the collapsed lighthouse tower that crushed the home of the light keeper. Photo credit: Santa Barbara Historical Museum, Gledhill Library.

Figure 21. View of the towers of the Santa Barbara Mission. Photo credit: Santa Barbara Historical Museum, Gledhill Library.

Figure 22. View of inside the Santa Barbara Mission. Photo credit: Santa Barbara Historical Museum, Gledhill Library.

Figure 23. View of the floor collapse where Father Augustine and Brother Odoric had fallen through the floor. Photo credit: Santa Barbara Historical Museum, Gledhill Library.

collapsed before him, but both were uninjured. Father Augustine carried him outside and as roof and floor collapsed (Figures 21, 22, and 23). The neighboring three-story St. Anthony's Seminary suffered moderate damage (Figure 24).

The 1925 earthquake resulted in 11 fatalities (Graffy, 2025) and 65 people injured, mostly from falling debris. A news report detailed that 411 larger Santa Barbara buildings were damaged. The damaged buildings included commercial buildings, semi-private structures, schools, and county buildings, but did not include damage to residential homes. Later, the Board of Fire Underwriters of the Pacific reported 618 buildings were destroyed or damaged in Santa Barbara (Easton, 2000).

The earthquake caused about $15,000,000 in damages in 1925 (Engineering Committee, 1925) which is equivalent to nearly $274 million in 2025 (Dollartimes.com, 2025). About 18% (74 buildings) were considered "total wrecks" by the Board of Structural Engineers that conducted an extensive survey of the city's buildings. The Board noted, "Our inspection of damaged buildings leads us to the conclusion that much of the damage might have been avoided if better material and workmanship had entered into the construction of the affected by the earthquake" (The Morning Press, July 25, 1925).

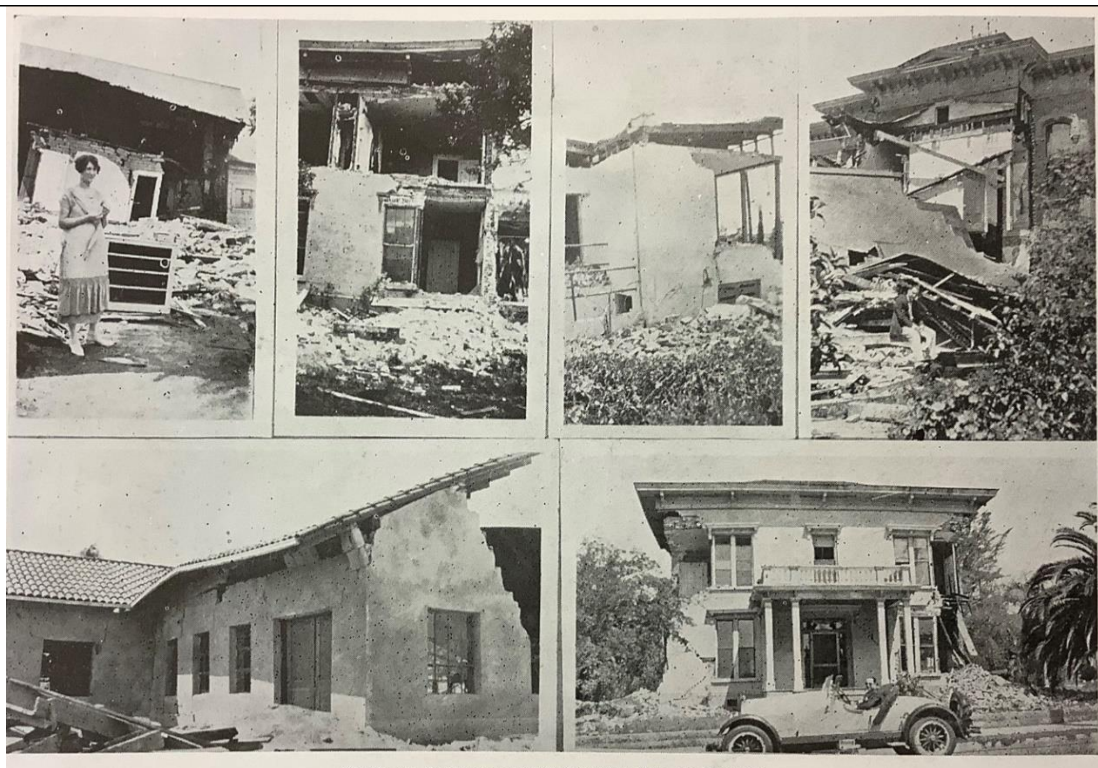
Damage to Residential Homes

Chimneys on nearly every house in the town were reported to have been destroyed (The Morning Press, July 1, 1925). Chimneys either fell over on to the ground or caved through the roofs of the houses. This report noted that (wood) frame houses, for the most part, fared better than brick or stone masonry structures. Several masonry homes suffered severe damage and had partially or completely collapsed, and these homes would require to be rebuilt from the ground up. Byerly (1925) concluded that all homes in Goleta had collapsed chimneys, and some homes were shaken off their foundations.

News accounts describe many homes and small cottages suffered damage on the lower west side of Santa Barbara (Figure 1) and these reports assign a higher degree of damage to the location along the Mesa fault. One news account related the severity of damage on Bath Street to the path of the crack over the Mesa fault (The Morning Press, June 30, 1925). No location was assigned to "the crack" so it is unclear if the article is just referring to the fault as a "crack". Regardless, accounts of damaged homes were concentrated in the west side neighborhood, however there were many accounts of damaged residences in the east side neighborhood (Figure 25).

Many homes were not tied down to their foundations and were shifted off their foundations, and some homes were completely shoved off and sitting on the ground. News accounts confirmed that more homes were damaged or shoved off their foundations than previously reported by other studies. A home on the northeast corner of Bath Street and De La Guerra Street was severely damaged. A home on the 700 block of Bath Street was sitting on the ground, not on its foundation, and another two-story home at 415 Bath Street was shoved off its foundation. An additional four homes located on Bath Street and below Cota Street were shoved off their foundation and damages to the structures (The Morning Press, July 1, 1925).

Figure 24. The sandstone masonry of St. Anthony's Seminary was damaged, and portions of the wall collapsed. Photo credit: Santa Barbara Historical Museum, Gledhill Library.



SOME OF THE 5000 HOMES DAMAGED IN QUAKE

Upper Row, Left to Right--Home at corner of W. Ortega and De la Vina. Home at corner of Victoria and Santa Barbara. Corner of cottage of Superintendent Black at Geperal Hospital. Senator Greenwell home at Montecito and Bath.

Lower Row, Left to Right—Home on East Boulevard. Dean House at Victoria and Santa Barbara.

Figure 25. A few of the damaged homes located on the west side and east side of town. Photo credit: Santa Barbara Historical Museum, Gledhill Library.

One such home was located at the intersection of Bath Street and Guitierrez Street was sitting on the ground and partially collapsed. A two-story brick building located at the corner of Bath Street and Montecito Street was described as wrecked and in pieces.

One partially collapsed home was located at 119 West Haley Street where a resident could not exit his house because the house was twisted off the foundation. (The Morning Press, June 30, 1925). A neighbor tore the wall down as the resident was trapped in his bedroom, and when the neighbor called out to him, another aftershock occurred and shifted his home further off the foundation. The Loomis House, located at 1625 De La Vina Street, was an adobe and wood frame structure that was severely damaged (Figure 26).

Figure 26. The destruction of the Loomis residence on De La Vina Street. Photo credit: Santa Barbara Historical Museum, Gledhill Library.

A transcript of Ester Jannsen Porter's experience of the earthquake described her and her father's difficulty in walking down the staircase during the shaking. They lived next to a home located on the southwest corner of Anapamu Street and Santa Barbara Street where the neighboring home was so severely displaced off the foundation that it ended up leaning against Ester's house (Transcript of Ester Jansen Porter, Gledhill Library, Santa Barbara Historical Museum). Later in 1931, a store was added on to the repaired home which was prominently known as Victor the Florist shop (Chris Ervin, pers. comm., 2025). Ester recalled hearing the prisoners screaming from across the street as the wall and the second floor of the County jail (Figure 16) were collapsing. Another home at the corner of Garden Street and Pedregosa Street was seriously damaged with the walls thrown down on the northeast side of the home (The Morning Press, June 30, 1925).

It is interesting to note that the house next to Herbert Nunn's residence at 1101 Lunetta Plaza and was owned by a renowned artist from Oakland, Edward Borein, was reported as a total loss (Figure 1; Oakland Tribune, June 30, 1925) The adobe and stone masonry house was built in

Pueblo native American architectural style and referred to as the heaviest damaged house on the Mesa (The Morning Press, June, 1925). Mrs. Borein was injured by a falling wall which crushed her ankle, but her husband was able to pull her in time before the entire structure collapsed (Oakland Tribune, June 30, 1925; The Morning Press, July 1, 1925).

A stone residence owned by Mr. and Mrs. W. M. Silsby at Naples beach, was reported destroyed by the earthquake and in ruins (The Morning Press, July 1, 1925). A church constructed of sandstone block masonry was severely destroyed and was demolished prior to the inspection performed of the area by Byerly in Naples (1925). Perry Byerly, at the request by Bailey Willis, performed inspections of buildings and ground effects of the area four months after the earthquake. The furthest location of a destroyed residence was on the Santa Ynez River near San Marco Road. The ranch home of E. W. Alexander was reported destroyed by the earthquake and was the only seriously damaged home in the vicinity (The Morning Press, July 3, 1925). A news account by the Santa Cruz Evening News (June 29, 1925) reported that the earthquake was felt in Santa Cruz at 6:42 a.m. but no damage was reported.

Shaking Effects

News accounts described that the City's sewer pump house was badly damaged by the shaking (The Morning Press, June 30, 1925). Nunn (1925) noted that the sewer system performed well in areas where it was built on alluvium which was likely Older Alluvium, consolidated and dense material. He was aware that portions of the lower downtown area which were built on former El Estero marshlands and the waterfront was built on beach sands. He referred to the developed marshlands and former beach areas as unstable ground noting the damage to the sewer system was severe in these locations. A profile along the original grade line of the sewer outfall was conducted indicating a settlement of eight inches over the length of one hundred feet and the movement appeared to reflect sinuous waves. He noted that buried equipment and infrastructure only suffered minor damage, providing an example that the joints that connected 12-foot long segments of 44-inch diameter reinforced concrete pipe were damaged but the pipes were not broken. Everything above ground such as sewage disposal plant was completely destroyed. Much to his credit, Herbert Nunn concluded that there was much more violent shaking in beach sand and swamplands than in more consolidated alluvium.

At the time of the earthquake, the city was constructing the sewer's concrete outfall that emptied into the ocean, but the construction was suspended for the day. The pump house was reported to be located on the (Mesa) fault that had ruptured, and it was noted that settlement of the ground had occurred along the eastern and western sides of Cabrillo Boulevard. The news account stated there was speculation that the settlement of the ground was the result of its proximity to the fault, however it appears that the settlement of up to two feet was the result of shaking of unconsolidated, saturated soils. The sewer line was damaged and leakage from the line had occurred and had flowed back into the depressions formed on the boulevard. Ocean water subsequently flowed from the beach and into the subsided areas along the boulevard. A portion of East Boulevard a quarter of a mile long was lowered two to three feet with huge crosswise fissures in the asphalt (The Morning Press, June 30, 1925). Lengthwise fissures were formed that split the pavement wide open for a length of a mile or more.

The rails of the Santa Barbara Traction Company for electric street cars were twisted and sheared along the West (Cabrillo) Boulevard (Figures 1, 27, and 28; The Morning Press, June 30, 1925; Ventura County Star, June 30, 1925; Pasadena Star-News, June 30, 1925) and along the State Street (Sylvester and Mendes, 2011). Buckled and offset concrete and asphalt pavement were noted on the street on the West and East (Cabrillo) Boulevards, and outside of Santa Barbara (Figures 29 and 30), with the severest noted at the foot of Chapala Street (The Morning Press, June 30, 1925). The Promenade along the beach boulevard, and on State Street were damaged and cracked with areas sunken and the road displaced one to two feet and raised in other locations (Figures 29, 30, and 31; Nunn, 1925; Pasadena Star-News, June 30, 1925). Olsen and Sylvester (1975) tallied 120 breaks in the pavement, curbs, and gutters, and 150 breaks in the sidewalks. They noted the cracks varied in length from 10 inches (25 cm) to nearly 200 feet (60 m).

A news account reported asphalt pavement sank six to 12 inches, in places, east of State Street. Although the area was not specified, upper areas of El Estero which had been reclaimed for development, was and presently is susceptible to subsidence and liquefaction during earthquake shaking (Figure 1). Ortega Park is an area developed in El Estero and subsurface exploration confirms poorly consolidated, Holocene estuarine deposits and shallow groundwater conditions (Figure 1). The City of Santa Barbara established a free refuse dump for property owners who had cleared debris from damaged buildings and properties. The dumping of debris was provided for of charge by the City who encouraged residents to dump their debris on the two-block detailed site.

Ground fissures were noted on the grounds at St. Vincent's Orphanage and School located at 925 De La Vina Street. Although the building was only slightly damaged with some dislodged tiles on the roof, the ground fissures were described as huge (The Morning Press, June 30, 1925). Ground fissures were described by Captain Skelly who was fortunate to have checked out of the Hotel Californian before the earthquake occurred (The Oakland Tribune, June 30, 1925). He was parked below the building and although the sides of the building walls had fallen, the wall in front of the building did not collapse on his automobile with his family inside. Hearing that a dam had burst, he quickly left Santa Barbara driving south on the Coast Highway and described that the road pavement had sunken two to three feet in many places. Encountering a deep fissure that crossed the road, he was able to drive over it and leave the area. He had observed many fallen chimneys on ranch houses on the way to Ventura.

A fissure that measured 150 feet long and nine inches wide was discovered on the County Farm on July 16, 1925 (The Morning Press, July 17, 1925). The account described an undeterminable depth and was considered to be a hazard to livestock. The County Farm was located next to the County Hospital on North San Antonio Road located west of the city. A superintendent inspected the fissure and ordered dynamite to loosen the earth and fill the fissure. Another fissure reported as smaller in size, was discovered across Las Positas Road in Veronica Canyon.

Figure 27. Broken pavement and trolley tracks on West Cabrillo Boulevard. Minor buckling of the gutter along the southeastern side of the road can be seen in the upper right of the photograph. Photo credit: Courtesy of the Edson Smith Photo Collection, Santa Barbara Public Library.


Figure 28. Workers clear pavement and debris from the area of the sheared trolley tracks on the West Boulevard. Photo credit: Santa Barbara Historical Museum, Gledhill Library.

Figure 29. Uplifted and buckled road surface near the Santa Barbara waterfront. Photo credit: Santa Barbara Historical Museum, Gledhill Library.

Figure 30. Displaced road on the Boulevard along the beach as the result of subsidence. The road is offset one to two feet. Photo credit: Santa Barbara Historical Museum, Gledhill Library.

Figure 31. Displaced and tilted road surface produced by subsidence in Santa Barbara, however the specific location is unknown. Photo credit: Santa Barbara Historical Museum, Gledhill Library.

Numerous reports of people knocked or thrown to the ground including several workers in the Daily News Building (Santa Cruz Evening News, June 30, 1925). Harry Afford, janitor at the Daily News, stated, "The first shock shook the Daily News building like a little ship in a big storm. It knocked several of us down. There was nothing to do, it was a question of getting up and holding on." Juliet Morgan, a well-known architect, arrived about 6:00 a.m. at the Southern Pacific depot (Easton, 1990). She was waiting for the streetcar to pick her up on West Boulevard and State Street when the earthquake hit. She looked up and saw clouds of dust spurting from building fronts, and the next thing she remembered, she was on the ground. She crawled on hands and knees to the front of an auto sales room. She described concrete posts of buildings move to an angle of at least 20 degrees. When it was safe, she retrieved her belongings blocks away and recalled watching "materials working" as the earthquake occurred (Easton, 1990). A Goleta woman was thrown to the ground in her home in Goleta by the force of the shaking (The Morning Press, July 1, 1925). Byerly (1925) confirmed that the ground was cracked near a refreshment store in Goleta and a new spring emitted from one of the cracks. The location of the store was not noted in his report.

Castle Rock was a popular destination from the 1880's until 1930 and consisted of two rock pillars (Santa Maria Times, April 3, 2020, updated January 15, 2021). The rock formation was formed of Monterey Formation shale and was accessible at low tide. Tom Dibblee often recalled this landmark with fond memories as it was near his home on the bluff top where Santa Barbara City College is now located. The rock pillars were damaged in the 1925 earthquake and the end result was referred to as a demon face (Figure 32). Castle Rock was dynamited for the construction of the Santa Barbara Breakwater in 1930 (Figure 1).

North of Santa Barbara (actually west), Los Angeles Times employee K. W. Gale described buckled and cracked concrete pavement along a 12 mile stretch of the state highway (Los Angeles Times, June 30, 1925). The highway in 1925 was designated Route 2 (Gribblenation, 2021) and reports described it was seriously damaged in places by landslides, boulders, and rock debris. Landslides occurred where cuts had been made to make room for the road and where fill had been placed. The landslides ranged from about a cubic yard to many cubic yards of material. It appeared that the pavement had swayed laterally from the shaking and formed fissures two to ten inches deep which bordered the displaced pavement. Most of the damaged roadways occurred in rolling terrain and where culvert crossed the road, the culvert was lifted 6 to 8 inches. Mr. Gale had been staying at a beach near Surf when the earthquake occurred and observed beach sand that behaved like quicksand during the shaking.

The dam at Sheffield Reservoir (Figures 1, 33, and 34) failed during the shaking of the earthquake (The Morning Press, June 30, 1925; Easton, 2000). Initial reports noted that the suspected fault which caused the earthquake underlies the reservoir and dam, however no ground displacement occurred (The Morning Press, June 30, 1925). Seepage had been observed near the toe of the downstream side and in the area beyond the toe of the dam before the earthquake occurred (Seed et. al, 1990).

Post-failure studies by the U.S. Army Corps of Engineers (1949) and Seed et. al, (1969; 1990) determined the earthen dam failed as the result of catastrophic landslide failure due to liquefaction of the sand that formed the base of the embankment (Figures 1, 22, and 23). The dam was constructed in 1917 with soil from the reservoir excavation and was 720 feet (220 m) long with a maximum height of 25 feet (7.6 m). The upstream side was faced with a 4-foot (1.2 m) clay blanket that extended 10 feet (3 m) into the foundation to serve as a cut-off wall and then overlain with 5-inch (13 cm) concrete facing. One contributing aspect to the failure was that surficial soil layers were not removed prior to the construction of the dam embankment (Seed et. al, 1969). Perry Byerly (1925) inspected the area four months after the earthquake and assigned a Rossi-Forell intensity of VIII to IX to the Sheffield Reservoir site (Table 1; Seed et. al, 1990)

The catastrophic release of 45 million gallons of water produced an outbreak flood that tore through the mostly uninhabited Sycamore Canyon (The Morning Press, June 30, 1925). A. Cozzalio, a dairyman working in the canyon, attempted to escape the outbreak flood. When he reached the Alisos Creek bridge, he had to scamper up the slope to safety but the raging torrent as he described, carried his auto out to sea by a wall of water twenty feet (6 m) high (American Autochrome Co., 1925). The flood uprooted trees, mud, boulders, and masses of kindling, and after exiting the mouth of Sycamore Canyon, the flood rushed down a natural gully between Voluntario Street and Aliso Street (Figure 1; Easton, 2000). The outbreak flood then carried off three houses and dumped them on the banks at Cacique Street and damaged several others.

Figure 32. A rare photograph showing the resulting fractures produced by the earthquake. Photo credit: Courtesy of the Edson Smith Photo Collection, Santa Barbara Public Library.

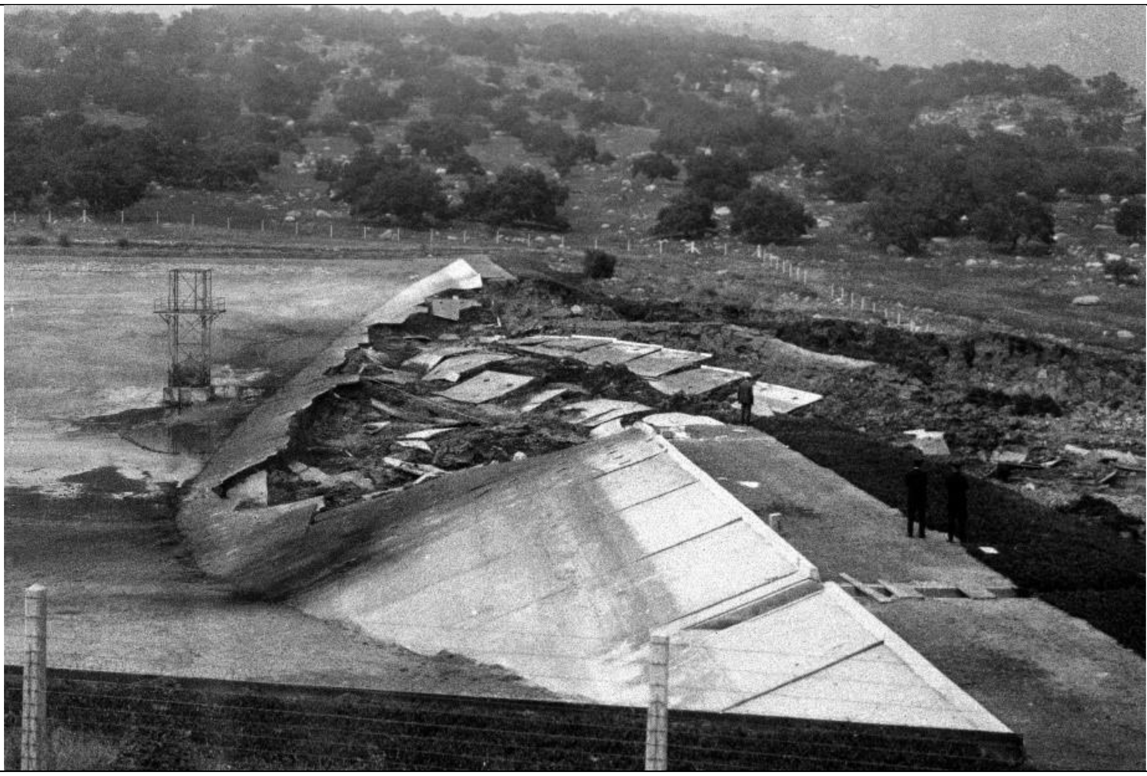


Figure 33. Close up view of the dam after the landslide failure of the earthen dam. Photo credit: California Department of Dam Safety Archives in Association of State Dam Safety Officials.

Figure 34. Wide angle perspective looking at the drained reservoir (left of dam) and the landslide formed on the earthen dam. Photo credit: California Department of Dam Safety Archives in Association of State Dam Safety Officials.

Seventeen milk cows were carried out to sea and flood waters inundated the East Boulevard and lower Milpas Street area forming a lake two feet that slowly drained into the ocean.

Ground Roll

Several accounts of ground roll were reported, although the term “ground roll” was not used to describe this phenomenon of “ocean waves” moving across the ground surface. The most detailed account was recounted by former president of M.I.T. and president of the Carnegie Foundation, Dr. Henry S. Pritchett. He lived on Junipero Plaza (Figure 1) who described ground waves ripple through his garden. He was familiar with earthquakes and pointedly noted the ominous roar which occurred two to three seconds prior to the intense shaking. He and his family clothed hurriedly dressed themselves and escaped to the backyard when the next earthquake struck five minutes later. He described the terrifying impression the of the plainly visible motion of wave formed by ground surface that were 25 feet long gave him a sense of helplessness (Pritchett, circa 1925). The waves crossed the lawn and travelled down a hedge, and trees bent over as the wave passed under and returned to an upright position after the wave passed.

A businessman was playing golf at La Cumbre Country Club when the earthquake occurred and provided a graphic description of the shaking (The Morning Press, June 30, 1925). He described the sound of the earthquake as, “The roar which seemed to precede the actual shock by two or three seconds seemed to be coming from a long distance away and came with the rapidity of a bullet”. He described the shaking as, “…and was then picked up and shaken as if some monster had me by the shoulders with the sole intent of shaking my head from my shoulders. It was all that I could do to stay on my feet. The hills seemed to rise and then fall…the rolling of the landscape being plainly visible to me. It was not the little jerks once in a while felt in many parts of the state, but a long-drawn-out roll." The news report noted that several other people who were in the outer sections of the city, provided a similar description of the earthquake. The forementioned report suggests that surface waves produced ground roll along the Mission Ridge-More Ranch fault system.

One of the most stunning observations of surface waves producing the surface effect of ground roll was an account that described a similar heaving of the ground and that the heaving created an ocean wave in the northern part of City (The Morning Press, June 30, 1925). A loud blast was heard by residents from the Mission Ridge area and preceded the heaving of the ground surface like an ocean wave movement. The ground roll was followed by sharp jerks that shook side to side. Concrete pavement was described as badly buckled and broken on the top of Mission Ridge (The Morning Press, July 1, 1925). The news report speculated that the damage was the result of the proximity to the (Mission Ridge) fault.

A third account of ground roll was reported by Ole Hanson, former mayor of Seattle, he was lodging on the ocean front and witnessed a rather large wave wash up on the beach (The Arizona Daily Star, June 30, 1925; Humboldt Times, June 30, 1925). Then, the first shock caused the ground to heave up with an intense crunching sound, the floor hit him when he attempted to run outside onto State Street. He stated, "The ground rolled like a slight wave hitting a canoe".

Additional accounts of the ground roll are more compelling as one eyewitness watched as the ground moved like a huge (ocean) wave that could be seen to advance up State Street leaving destruction in its wake (The Morning Press, July 5, 1925). Charles Turner, gatekeeper for the Southern Pacific Railroad at the State Street crossing saw the waves begin at the water's edge and roll up State Street. He watched the waves hit the Hotel Californian and then was thrown flat on the ground. He saw the waves continue up State Street which caused building to topple, and walls collapse. He lost sight of the waves at Carrillo Street.

M.P. Cheney was standing at the State Street and Carrillo Street and described the ocean wave undulations similarly to Charles Turner account (The Morning Press, July 5, 1925). He saw the San Marcos building telescope on itself and the water tank on top of the Arlington Hotel collapse.

Tsunami

Pearl Chase reported that the earthquake caused a "tidal wave" about ten feet high which washed over West Beach sea wall and flow up State and Chapala Streets nearly up to the railroad tracks (Easton, 1990; Palmer, 2000). Historian David Myrick recalled hearing of water coming over the sea wall which was bordered by a narrow beach in 1925. A longtime resident, I. A. (Ike) Bonilla noted that during high tide or during storms, water reached inland a block or two, and he had seen beach sand left on the floor of the Southern California depot (Easton, 1990). So, it wasn’t uncommon for the sea to spill over the wall and inundate State Street and Chapala Street a block or two inland.

Professor Emeritus Arthur Sylvester acknowledged the wave might have been more in the form of a rising tide than a cascading wave. “Many tsunamis take the form of rapidly rising sea level…especially if caused by quakes of less than magnitude 7.2 to 7.5 intensity needed to rupture the sea floor sufficiently to create a wave” he said (Easton, 2000). He also cited two men in a small boat offshore that witnessed the surface of the water divided and poured downward, “…as if over a waterfall” at the time of the earthquake (Easton, 1990).

A notable fissure formed on the sea floor which was described by Patrolman Bartholomew (The Morning Press, 1925). He described a black streak that was three city blocks long and continued into the ocean. Upon closer inspection, he observed an immense cavity opened by the earthquake with sea water rushing into the immense cavity. It took more than five minutes for the cavity to fill with water. Having observed a large fissure on the ocean floor suggests that the sea floor may have been exposed for a temporary period due to a tsunami. A news account of a swimmer taking an early morning swim near Castle (Castillo) Rock described the sudden receding of water (The Oakland Tribune, June 30, 1925). The swimmer described, “Where I had been in the ocean up to the waistline a second before I now found myself on dry sand.” The swimmer observed a nearby “great” rock disintegrate by the shaking and the description fits in the fact that Castle Rock was damaged by the earthquake. Other oddities of the coastline were reported to have occurred.

A steamer named the Barbara C reported to the federal telegraph station in Los Angeles that the earthquake was felt while fifteen miles offshore of Santa Barbara (Santa Cruz Evening News, June 29, 1925). Unusual heavy undulations on an otherwise calm sea which were reported to have lurched the ship.

Author Robert Easton (Easton, 1990) postulated that the tsunami wasn’t noticed at a time of more dramatic events (Easton, 1990). He added that 40 million gallons of water from Sheffield Reservoir had just inundated the East Beach area, and the tide was dropping from a high tide of 3.2 feet at about 3:00 a.m. So, the wave may have gone unnoticed by most residents whose attention was focused on the earthquake damage.

A report of tremendous waves accompanying the earthquake were reported by the Los Angeles Evening Express (June 29, 1925). The waves rushed in from the bay and flooded the lowlands. No specific area was mentioned of the locale of the inundation. Although it is not definitively recorded, given Pearl Chase’s testimonial of witnessing the tsunami and Professor Sylvester’s reference of two men witnessing disturbances of the ocean surface, it is probable that a tsunami was generated by the earthquake but went unnoticed for the most part.

Oil Seeps

Herbert Nunn observed the ocean right after the shaking stopped and noted it was glassy without disturbance and that crude oil came up from the beach sands within 200 yards (183 m) of this home and elaborated this phenomenon occurred on the beach at several points to the south (Nunn, 1925). He also mentioned that several barrels of oil flowed out of beach sand about 1 mile south of his residence, which coincidentally is near the trace of the Mesa fault. R. F. Pinkham, president of the Channel Oil well located on La Mesa, stated that gas production in the well increased following the main shock and a series of aftershocks on July 3 (The Morning Press, July 4, 1925).

W.H. Schuyler was on Santa Cruz Island when the earthquake hit, and he described the ground began to roll and rocks tumbled from the cliffs into the ocean (Santa Barbara Daily News, 1925). Upon returning, he said "…and ran into oil spread like a heavy film on the surface of the sea for miles, and oil bubbling from the sea's bottom." He also stated that he had never seen such a spread of oil over the sea on his way back to Santa Barbara.

Springs

A large number of springs were formed above the Gibraltar Dam which caused the water level to rise in the reservoir according to Ranger Frank E. Dunne (The Morning Press, June 30, 1925). He visited the reservoir immediately following the earthquake to ensure that the dam remained standing. Nunn (1925) noted an eyewitness described severe shaking during the earthquake but the dam did not exhibit cracks or any damage. Doulton tunnel which conveys water from the dam to the south slopes of the Santa Ynez Mountains was not damaged but increased flow was observed from the mountain into the tunnel (Nunn, 1925). Comparison off the gauge record at the dam and another at the outfall portal indicated that the flow increased from 1,114,000 gallons to 1,874,000 gallons.

Water well production increased in Carpinteria Valley as a number of ranchers noted a rise of the water levels in their wells (The Morning Press, July 4, 1925). In fact, some dry water wells began producing water after the earthquake. A rancher with a water well in Goleta found that his water well that was dry before the earthquake was producing at such a high flow after the earthquake, that it created a lake (The Lompoc Record, July 3, 1925).

Earthquake Magnitude and Shaking Intensity

Past studies have assigned site intensities using the Rossi-Forel scale and Willis (1925) assigned an intensity of X (Figure 35) to the Santa Barbara area (Table 1) whereas Olsen and Sylvester (1975) assigned a maximum Modified Mercalli intensity of IX for some areas of Santa Barbara (Table 1, Appendix A). They noted that shaking intensities were greatest in the southeastern portion of the city and along the base of Mesa in the lower west side of the city. A regional isoseismal map was produced by Toppozada and Parke (1975) and they assign Modified Mercalli intensities of VIII-IX for the Santa Barbara area (Figure 36). Hough and Martin (2018) produced a detailed analysis of shaking intensities for the city of Santa Barbara with most intensities ranging from VII-IX and another of the Santa Barbara and Goleta areas (Figure 37). The higher intensities may be associated with seismic amplification in unconsolidated alluvium and estuarine deposits.

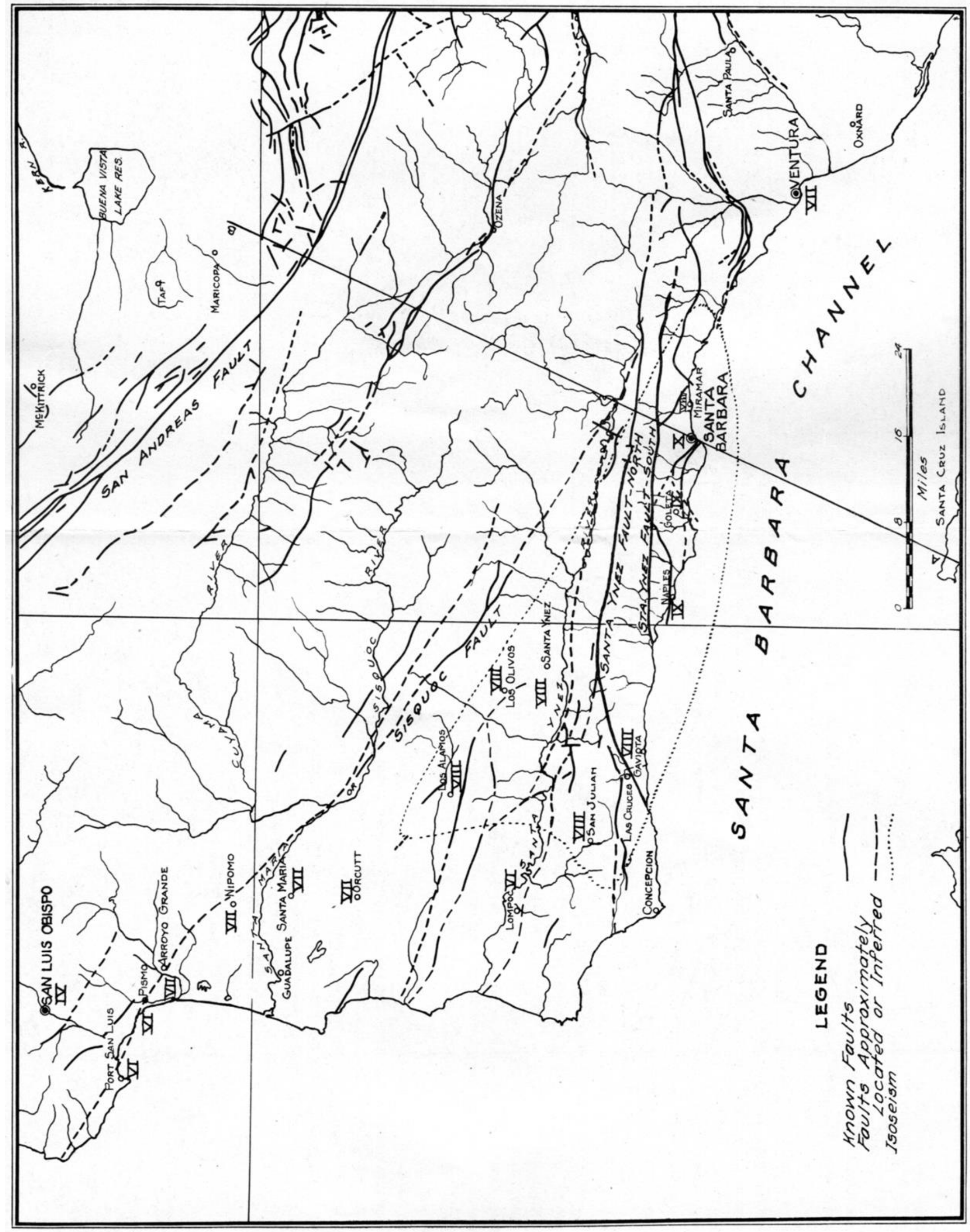


Figure 35. Rossi-Forel scale map of the Santa Barbara region by Willis (1925).

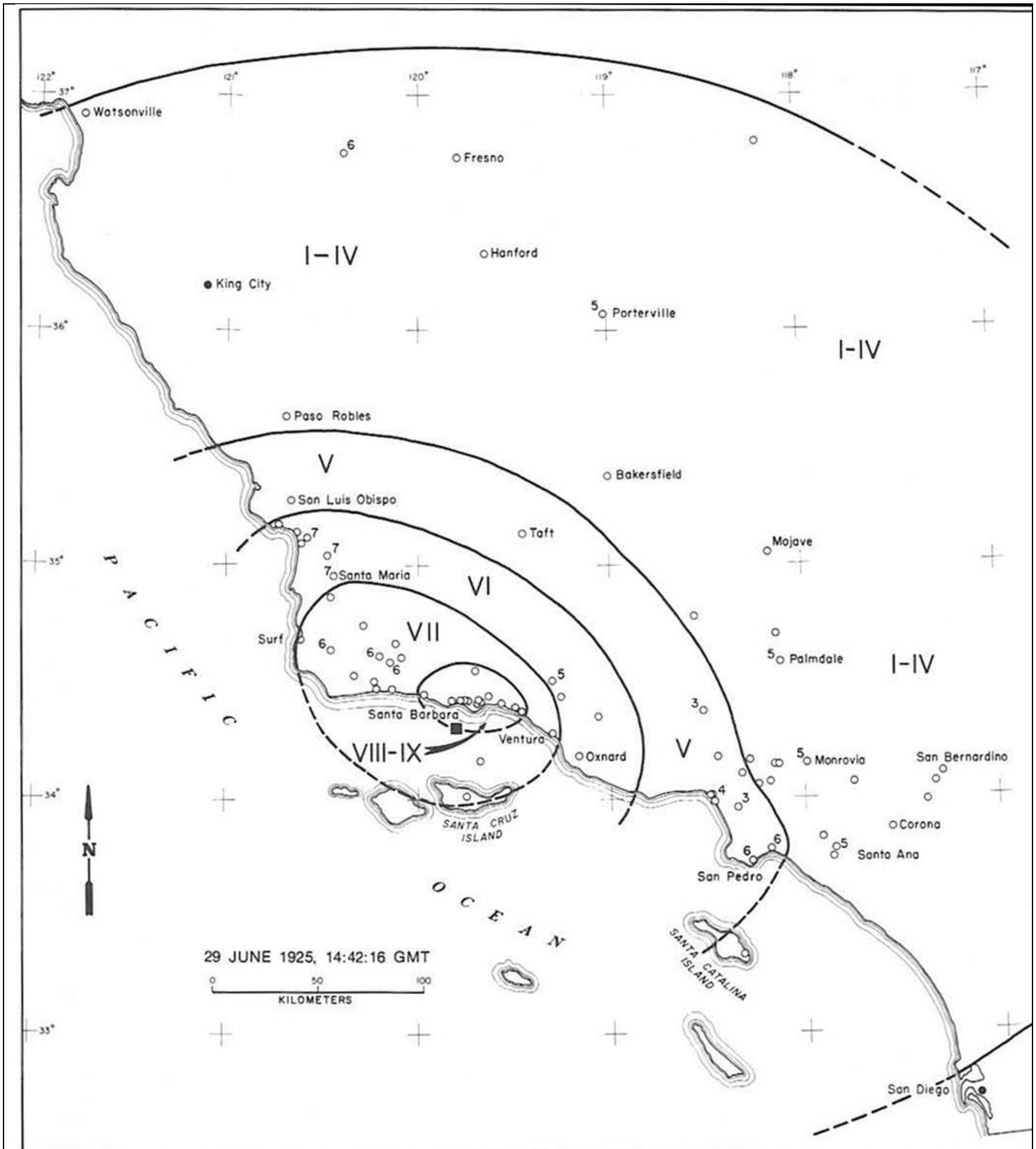


Figure 36. Isoseismal map of the June 29, 1925 earthquake by Toppozada and Parke (1975). Used with permission from the California Geological Survey, California Geology.

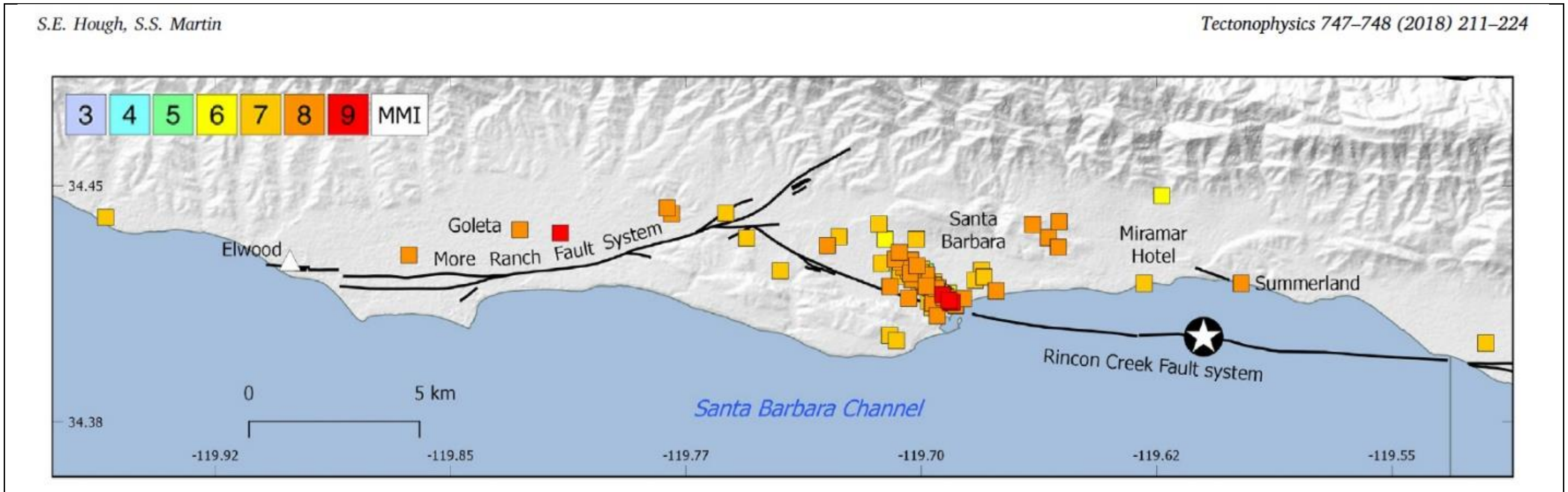


Figure 37. Modified Mercalli intensity map of the Santa Barbara and Goleta areas. Refer to Appendix A for an explanation of the Modified Mercalli scale. From Hough and Martin (2018).

The epicenter has not been located with any degree of confidence, but an analysis of aftershocks inferred from data recorded on portable instruments by Hough and Martin (2018), make the argument that the rupture occurred offshore on the Mesa-Rincon Creek fault system and the More Ranch fault system. Olsen and Sylvester (1975) suggested that the Mesa fault is the probable fault that ruptured but qualify that the apparent high degree of shaking intensity and ground fracturing along the Mesa fault may be due to local geology, but the evidence cast suspicion upon the Mesa fault. A possible rupture scenario postulated by this study speculates in addition to the rupture of the Mesa fault, the Mission Ridge fault may have also ruptured.

Estimated magnitudes for the earthquake range from a Richter magnitude, M_L = 6.3 to a moment magnitude, Mw = 6.8 (Hanks et al., 1975; Toppozada and Parke, 1982; Felzer, 2013). Hough and Martin (2018) recently estimated a moment Magnitude Mw = 6.5. Given all the ancillary evidence of eyewitness accounts and shaking intensity levels, it is suggested that that the 1925 Santa Barbara earthquake produced a moment magnitude of Mw = 6.5 (Hough and Martin, 2018) to Mw = 6.8 (see Appendix B for a brief discussion of the different types of magnitude scales). This earthquake in addition to earthquake studies by Keller and Gurrola (2000) that the Santa Barbara area may experience a Northridge-type earthquake as the result of a rupture on the Mission Ridge fault system, and if the entire Mission Ridge fault system ruptured, a Mw = 7.0 or slightly greater is possible.

Summary Statement

The fortunate set of events beginning with the lodging of Bailey Willis at the Miramar Hotel, Herbert Nunn's early awakening in the morning of June 29, 1925 by the strong odor of oil, and the eyewitness accounts of ground roll on State Street advances our understanding of the 1925 earthquake. The aspects of the earthquake that standout include (1) a series of foreshocks that occurred prior to the earthquake; (2) a deafening noise described as a loud roar, explosive blast, or grinding sounds accompanied the shaking, in some cases, was heard before the shaking began; (3) the expulsion of oil from the sea floor and beaches, and increase in groundwater production from wells and seepage into Mission Tunnel; and (4) sulfur spewing mud volcanoes. Some of the noted higher flows of oil were mentioned by Herbert Nunn to be on the beach a mile south of his residence which generally coincided with the location of the Mesa fault. A higher concentration of damage has been noted along the Mesa fault which have resulted from slip at depth. Both Bailey Willis and recent studies further support the hypothesis that the Mesa fault was responsible for the initial rupture. However, all past studies agree that the epicenter cannot be determined with confidence.

We are fortunate to have had two quick-thinking and courageous heroes turn off the electrical power and shut-off. Their quick actions prevented fire from raging the earthquake damaged buildings allowing structural engineers to perform surveys of damages and produce reports to better design and construct commercial and residential buildings which ultimately improved the

City's resilience to earthquakes and shaking hazards. Without the detailed accounts of Herbert Nunn, Bailey Willis, geologists, seismologists, engineers, and historians, there would be gaps in our understanding of the shaking, direction of wave propagation, extent of shaking, extend of damages, and the shaking effects of various geologic conditions. Our understanding would be lacking, and our interpretations of the seismic event might be flawed.

The contributions of the study of the historical analysis of the earthquake by Professor Arthur Sylvester, the study of tectonic geomorphology by Professor Edward Keller, and the geologic mapping and understanding of the geologic history established by Thomas Dibblee, Jr. have certainly improved our understanding of the seismic hazards. These scientists have laid the foundation of knowledge for us to expand upon their work and research.

Much of what is presented in this historical research of the 1925 Santa Barbara earthquake confirms our understanding that the lower downtown and west side of town are susceptible to greater shaking and ground settlement. Most importantly, the Santa Barbara area is subject to large earthquakes and secondary shaking effects. Although not discussed in this report, landslides were abundant and reported occurring on the sea cliff bluffs and surrounding slopes, even as far away as Gaviota and Ventura. What we have learned from the 1925 earthquake is that the faults we are aware of, some that have yet to be discovered, and accumulated elastic strain, will one day be released in a large earthquake that poses a significant hazard to the community of Santa Barbara and surrounding area. It is with this understanding and our desire to increase our understanding of the hazards, that this report was prepared. We know a little but have much more to learn.

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Appendix A

Modified Mercalli Intensity Scale

Intensity	Shaking	Description/Damage
I	Not felt	Not felt except by a very few under especially favorable conditions.
II	Weak	Felt only by a few persons at rest,especially on upper floors of buildings.
III	Weak	Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibrations similar to the passing of a truck. Duration estimated.
IV	Light	Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.
V	Moderate	Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.
VI	Strong	Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.
VII	Very strong	Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.
VIII	Severe	Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.
IX	Violent	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.
X	Extreme	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.

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Appendix B

Moment magnitude, Richter scale - what are the different magnitude scales, and why are there so many?

Earthquake size, as measured by the Richter Scale is a well-known, but not well understood, concept. The idea of a logarithmic earthquake magnitude scale was first developed by Charles Richter in the 1930's for measuring the size of earthquakes occurring in southern California using relatively high-frequency data from nearby seismograph stations. This magnitude scale was referred to as ML, with the L standing for local. This is what was to eventually become known as the Richter magnitude.

As more seismograph stations were installed around the world, it became apparent that the method developed by Richter was strictly valid only for certain frequency and distance ranges. In order to take advantage of the growing number of globally distributed seismograph stations, new magnitude scales that are an extension of Richter's original idea were developed. These include body wave magnitude (Mb) and surface wave magnitude (Ms). Each is valid for a particular frequency range and type of seismic signal. In its range of validity, each is equivalent to the Richter magnitude.

Because of the limitations of all three magnitude scales (ML, Mb, and Ms), a new, more uniformly applicable extension of the magnitude scale, known as moment magnitude, or Mw, was developed. In particular, for very large earthquakes, moment magnitude gives the most reliable estimate of earthquake size.

Moment is a physical quantity proportional to the slip on the fault multiplied by the area of the fault surface that slips; it is related to the total energy released in the earthquake. The moment can be estimated from seismograms (and also from geodetic measurements). The moment is then converted into a number similar to other earthquake magnitudes by a standard formula. The result is called the moment magnitude. The moment magnitude provides an estimate of earthquake size that is valid over the complete range of magnitudes, a characteristic that was lacking in other magnitude scales.

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