

on the Mississippi River overwhelmed many boats and washed others high on the shore. High banks caved and collapsed into the river; sand bars and points of islands gave way; whole islands disappeared. Surface rupturing did not occur, however. The region most seriously affected was characterized by raised or sunken lands, fissures, sinks, sand blows, and large landslides that covered an area of 78,000 - 129,000 square kilometers, extending from Cairo, Illinois, to Memphis, Tennessee, and from Crowleys Ridge to Chickasaw Bluffs, Tennessee.

Although the motion during the first shock was violent at New Madrid, Missouri, it was not as heavy and destructive as that caused by two aftershocks about 6 hours later. Only one life was lost in falling buildings at New Madrid, but chimneys were toppled and log cabins were thrown down as far distant as Cincinnati, Ohio; St. Louis, Missouri; and in many places in Kentucky, Missouri, and Tennessee.

The Lake County uplift, about 50 kilometers long and 23 kilometers wide, upwarps the Mississippi River valley as much as 10 meters in parts of southwest Kentucky, southeast Missouri, and northwest Tennessee. The uplift apparently resulted from vertical movement along several, ancient, subsurface structures; most of this uplift has occurred during earthquakes. The Lake County uplift can be subdivided into several topographic bulges, including Tiptonville dome, Ridgely Ridge, and the south end of Sikeston Ridge. A strong correlation exists between modern seismicity and the uplift, indicating that stresses that produced the uplift still exist today.

Tiptonville dome, which is 14 kilometers in width and about 11 kilometers in length, shows the largest upwarping and the highest topographic relief on the uplift. It is bounded on the east by Reelfoot scarp, which has a zone of normal faults (displacement about 3 meters) at its base. Although most of Tiptonville dome formed between 200 and 2,000 years ago, additional uplifting deformed the northwest and southeast parts of the dome during the earthquakes of 1811-1812.

A notable area of subsidence is Reelfoot Lake in Tennessee, just east of Tiptonville dome. Subsidence there ranged from 1.5 to 6 meters, although larger amounts were reported. It may be that the lake was enlarged by compaction, upwarping, and subsidence occurring simultaneously during the New Madrid earthquakes.

Other areas subsided by as much as 5 meters, although 1.5 to 2.5 meters was more common. Lake St. Francis, in eastern Arkansas, which was formed by subsidence, is 64 kilometers long by 1 kilometer wide. Coal and sand were ejected from fissures in the swamp land adjacent to the St. Francis River, and the water level is reported to have risen there by 8 to 9 meters.

Large waves were generated on the Mississippi River by fissures opening and closing below the surface. Local uplifts of the ground and water waves moving upstream gave the illusion that the river was flowing upstream. Ponds of water also were agitated noticeably. *Source: <http://earthquake.usgs.gov/regional/states/events/1811-1812.php>*

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badly broken. In the business district, which was built on ground made by filling in the cove of Yerba Buena, pavements were buckled, arched, and fissured; brick and frame houses of ordinary construction were damaged extensively or destroyed; sewers and water mains were broken; and streetcar tracks were bent into wavelike forms.

On or near the San Andreas fault, buildings were destroyed (one was torn apart), and trees were knocked to the ground. The surface of the ground was torn and heaved into furrow-like ridges. Roads crossing the faultline were impassable, and pipelines were broken. One pipeline that carried water from San Andreas Lake to San Francisco was broken, shutting off the water supply to the city. The fires that ignited soon after the onset of the earthquake quickly raged through the city because of the lack of water to control them. They destroyed a large part of San Francisco and intensified the loss at Fort Bragg and Santa Rosa.

This earthquake caused the most lengthy rupture of a fault that has been observed in the contiguous United States. The displacement of the San Andreas Fault was observed over a distance of 300 kilometers from San Juan Bautista to Point Arena, where it passes out to sea. Additional displacement was observed farther north at Shelter Cove in Humboldt County, and, assuming the rupture was continuous, the total length of rupture would extend 430 kilometers. The largest horizontal displacement - 6.4 meters - occurred near Point Reyes Station in Marin County.

In areas where dislocation of fences and roads indicated the amount of ground movement, motions of 3 to 4.5 meters were common. Near Point Arena, in Mendocino County, a fence and a row of trees were displaced almost 5 meters. At Wright's Station, in Santa Clara County, a lateral displacement of 1.4 meters was observed. Vertical displacement of as much as 0.9 meters was observed near Fort Ross in Sonoma County. Vertical displacement was not detected toward the south end of the fault. *Source:*

http://earthquake.usgs.gov/regional/states/events/1906_04_18.php

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J.C. Penny Company building was damaged beyond repair; the Four Seasons apartment building, a new six-story structure, collapsed; and many other multistory buildings were damaged heavily. The schools in Anchorage were almost devastated. The Government Hill Grade School, sitting astride a huge landslide, was almost a total loss. Anchorage High School and Denali Grade School were damaged severely. Duration of the shock was estimated at 3 minutes.

Landslides in Anchorage caused heavy damage. Huge slides occurred in the downtown business section, at Government Hill, and at Turnagain Heights. The largest and most devastating landslide occurred at Turnagain Heights. An area of about 130 acres was devastated by displacements that broke the ground into many deranged blocks that were collapsed and tilted at all angles. This slide destroyed about 75 private houses. Water mains and gas, sewer, telephone, and electrical systems were disrupted throughout the area.

The earthquake was accompanied by vertical displacement over an area of about 520,000 square kilometers. The major area of uplift trended northeast from southern Kodiak Island to Price William Sound and trended east-west to the east of the sound. Vertical displacements ranged from about 11.5 meters of uplift to 2.3 meters of subsidence relative to sea level. Off the southwest end of Montague Island, there was absolute vertical displacement of about 13 - 15 meters. Uplift also occurred along the extreme southeast coast of Kodiak Island, Sitkalidak Island, and over part or all of Sitkinak Island. This zone of subsidence covered about 285,000 square kilometers, including the north and west parts of Prince William Sound, the west part of the Chugach Mountains, most of Kenai Peninsula, and almost all the Kodiak Island group.

This shock generated a tsunami that devastated many towns along the Gulf of Alaska, and left serious damage at Alberni and Port Alberni, Canada, along the West Coast of the United States (15 killed), and in Hawaii. The maximum wave height recorded was 67 meters at Valdez Inlet. Seiche action in rivers, lakes, bayous, and protected harbors and waterways along the Gulf Coast of Louisiana and Texas caused minor damage. It was also recorded on tide gages in Cuba and Puerto Rico. *Source:*
http://earthquake.usgs.gov/regional/states/events/1964_03_28.php

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continued on the Denali Fault, where largely horizontal "right-lateral" movement (in which the opposite side moves to the right, when you look across the fault) propagated eastward at more than 7,000 miles per hour. As the rupture propagated, it offset streams, glacial ice, frozen soil, and rock, opening some cracks so wide that they could engulf a bus. The rupture crossed beneath the Trans-Alaska Oil Pipeline and terminated on the Totschunda Fault, 184 miles east of the epicenter, about 90 seconds after the quake began. The maximum horizontal movement (fault offset) of about 29 feet occurred in the eastern part of the rupture, near subevent 3.

The Denali Fault earthquake ruptured the Earth's surface for 209 miles, crossing beneath the vital Trans-Alaska Oil Pipeline, which carries 17% of the U.S. domestic oil supply. Although slightly damaged by movement on the fault and by intense shaking, the pipeline did not break in the quake, averting a major economic and environmental disaster. This success is a major achievement in U.S. efforts to reduce earthquake losses.

Violent, prolonged shaking from the quake triggered thousands of landslides, especially on the steep slopes of the Alaska Range. Mountainsides gave way, burying the valleys and glaciers below in deposits of rock and ice as much as 15 feet thick. The majority of landslides clustered in a narrow band extending about 8 to 12 miles on either side of the rupture.

One facility that was badly damaged by the earthquake was the runway at Northway Airport, 40 miles from the eastern part of the November 3, 2002, fault rupture. The runway was rendered unusable by lateral spreading, accompanied by sand boils. These effects were the result of a phenomenon called "liquefaction," in which strong, prolonged earthquake shaking transforms loose, water-saturated sediments into a liquid slurry. Areas that experienced liquefaction during the earthquake include much of the Tanana River Valley north and east of the rupture and other locations near smaller rivers.

Like some other large earthquakes, the Denali Fault quake triggered small shocks as far as 2,000 miles away, mainly in volcanic areas. Yellowstone National Park had the most energetic swarm of triggered earthquakes. Following the Denali Fault earthquake, Lake Union in Seattle experienced an earthquake-induced seiche, or water sloshing, which knocked many houseboats off their moorings and caused minor damage. Seiches were seen as far away as Lake Pontchartrain in Louisiana. *Source: <http://pubs.usgs.gov/fs/2003/fs014-03/>*

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injured. In the worst-hit area, Bengkulu, hundreds of buildings were brought down, the airport closed and electricity and water supplies cut. Telephone lines have been knocked out and several roads into the province damaged, hampering rescue efforts. The quake was recorded at 7.9 on the Richter scale by the United States Geological Survey (USGS). The Indonesian Meteorological and Geophysical Service measured it at 7.3.

The tremor lasted several minutes and shook a wide area. It was followed by more than 30 aftershocks.

It was centred in the Indian Ocean off Sumatra's west coast - and was considered likely to cause a tsunami, commonly referred to as a tidal wave. Several buildings collapsed in Bengkulu - a city of about 150,000 people, some 100km (60 miles) east of the quake's epicentre. Widespread panic was reported as people dug through the rubble in search of bodies and trapped survivors. The death toll is expected to rise further as volunteers and emergency workers search through ruined buildings. Several buildings were damaged at Bengkulu airport.

Witnesses said local hospitals were overwhelmed with injured people and were struggling to cope as few staff members had arrived at work. Doctors in Bengkulu treated injured people outside, fearing that aftershocks might bring down the state hospital, the official Antara news agency reported. The first tremor struck at 2328 local time (1628 GMT), followed 11 minutes later by an aftershock measured at 6.7 on the Richter scale. The epicentre was 33km (21 miles) below the Earth's surface - "shallow in earthquake terms," USGS spokeswoman Carolyn Bell said. She said it set up a "very probable situation for a tsunami in the Indian Ocean". But police said there had been no reports so far of a tidal wave along the west Sumatran coast. Shockwaves continued for several minutes and were felt 540km (335 miles) away in Jakarta, and in Singapore, more than 640km (400miles) distant.

The quake was one of the strongest recorded in Indonesia in recent years. The Indonesian archipelago sits on major fault lines and is prone to frequent seismic upheavals. A 6.5-rated earthquake in central Indonesia a month ago killed at least 16 people and caused a tsunami. In December 1992, a magnitude 7 earthquake caused a tsunami that killed about 2,500 people on Flores island in eastern Indonesia. An earthquake of the strength reported on Monday is capable of causing widespread and heavy damage in urban areas. Some of those affected by the huge quake have been e-mailing BBC News Online telling of their ordeals. Tony Milne said: "I was surprised to hear splashing in the swimming pool behind our house. There were waves between one and two feet high in the pool, but no sense of movement in the house." Florence from Singapore added: "The first tremor was the strongest and we could not really stand properly. "We live in the tallest floor and are the worst affected. Downstairs, people dressed in their pajamas were out on the streets, helpless and full of anxiety." Source: <http://news.bbc.co.uk/1/hi/world/asia-pacific/777257.stm>

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