

ILLINOIS EARTHQUAKE OF JUNE 10, 1987

ILLINOIS QUAKE FELT IN SIXTEEN STATES AND CANADA

June 10, 1987

This summary consists of two brief reports, the first prepared by K. B. Taylor and R. B. Herrmann, Department of Earth and Atmospheric Sciences, St. Louis University, and the second prepared by EERI members W. J. Hall, S. Schiff, and S. Lu, Department of Civil Engineering, University of Illinois at Urbana-Champaign. We wish to acknowledge the valuable assistance provided by Erie Jones and his staff, Central United States Earthquake Consortium (CUSEC), in helping gather information from the region affected.

Seismological Aspects

Introduction. On 10 June 1987, at 23:48:54.0 UTC (18:48 CDT), a magnitude 5.0 m_b earthquake shook the Midwest. Centered in the Wabash Valley Seismic Zone, it was the largest event to occur in that zone since a 5.5 mb quake on 9 November 1968. The Wabash Valley Seismic Zone delineated by Dr. Otto Nuttli is capable of producing an mb = 6.8 earthquake with a 1000-year recurrence time.

The main shock was recorded digitally by the 45-station Central Mississippi Valley Seismic Network operated by St. Louis University. Within seven hours of the main shock, a team from SLU had the first of five MEQ-800 microearthquake recorders deployed within 15 km of the epicenter. Reaction teams from Tennessee Earthquake Information Center (TEIC), Purdue

University, Indiana University, University of Kentucky, and the USGS arrived the following day. This preliminary note summarizes the seismological aspects of this event.

Historical Seismicity. Fourteen earthquakes since 1899 with Modified Mercally (MM) intensities V or greater have occurred within 100 km of the epicenter. (Table 1.)

Source Parameters. Table 2 lists the location, depth and origin time calculated for the main shock by SLU. The magnitude of the main shock was calculated by NEIS from teleseismic signals. Twenty-two aftershocks were recorded in the first five days of monitoring. Preliminary hypocentral parameters for the aftershocks are also listed in Table 2. All events are also plotted

in Figure 1. The NNW trend of the aftershock pattern is an artifact of station location and should not be interpreted as outlining the fault plane. The error in location is on the order of the size of the plotted epicenter.

Fifty P-wave first motions were used to construct a focal mechanism for the main shock. The mechanism is strike-slip with a small amount of dip-slip. The nodal planes are N36E with a dip of 86 degrees SE, and N54W with a dip of 60 degrees SW. The pressure axis has a trend of 281 degrees and a plunge of 21 degrees. The tension axis has a trend of 79 degrees and a plunge of 22 degrees. The mechanism is shown in Figure 2. It is a lower hemisphere equal area projection with compressional motion as circles and dilata-

HISTORICAL SEISMICITY

Location	Date	Lat. (N)	Long. (W)	Felt Area * 10 ³	Intensity (MM)
S. Indiana	4 30 1899	38.5	87.0	100	VI-VII
Ill. Basin	5 21 1906	38.7	88.4	---	V
Wabash Valley	9 27 1909	39.5	87.4	250	VII
S.E. Illinois	10 23 1909	39.0	87.8	35	V
S. Indiana	5 25 1919	38.4	87.5	65	V
S. Illinois	11 27 1922	37.8	88.5	130	VI-VII
Ind./Ky.	4 27 1925	38.3	87.6	250	VI-VII
Kentucky	9 2 1925	37.8	87.5	200	VI
S. Indiana	1 6 1931	39.0	87.0	1	V
Ill./Ind.	11 8 1958	38.4	88.0	85	VI
Ill. Basin	6 27 1962	37.9	88.6	45	V
S. Illinois	11 9 1968	37.9	88.4	1600	VII
Wabash Valley	4 3 1974	38.5	88.1	632	VI
S. Illinois	12 5 1978	38.6	88.4	12	V

TABLE 1 -- Historical Seismicity within 100 km of epicenter MM Intensity V or greater since 1899.

tional motion as triangles. We note that this focal mechanism is very similar to the mbLg = 4.7 event of 3 April 1974 located 15 km south-southwest. The focal mechanism is also similar to the 9 November 1968 earthquake in that the P-axis trends east. However, the 1968 event had a thrust mechanism while the recent event had a large component of strike-slip.

Damage and Effects

Personal Observations

W. J. Hall and his wife were sitting on their sofa at their one-story wood frame, brick veneer, heavy vaulted ceiling home when the earthquake occurred. The earthquake motion consisted of a short intense burst of energy that shook the home vigorously for two to

three seconds followed by a quiet period of three to four seconds and another short intense shaking for a second or two. The house was severely strained with no apparent damage; the house audibly "settled back" over a period of two or three days.

S. Schiff and his wife were on the upper level of a two-story four unit wood frame townhouse. The first pulse was felt clearly alerting them to the earthquake; the second pulse was strong and created considerable strain and noise within the structure. His neighbors quickly gathered in the courtyard to discuss the event.

S. Lu and his wife were in their second story apartment (six-story brick apartment building with heavy equipment

load on roof). His wife felt the first shock, called to her husband not knowing what was occurring. As the second shock occurred, he observed three violent cyclic shakes of the building which lasted for a total of about four to five seconds. Most residents of the building went outside.

Observations on Damage and Effects

The map shows the epicenter, located to the west of Lawrenceville, Illinois, a community of 5000 people, as well as major cities in the midwestern region where the shaking was clearly felt and reported in newspapers. The early reports indicated the earthquake to have a local Richter magnitude in the range of 5.0 to 5.5.

On the basis of published reports it is our belief that the Modified Mercalli intensity of shaking in the Lawrenceville area was VI, and in the Champaign-Urbana area about IV. In general terms the damage arising from the earthquake was light.

The last earthquake of this magnitude with somewhat more damage reported was on November 9, 1968 and was centered near Carmi, Illinois, not far from Lawrenceville; in the interim there have been a large number of smaller earthquakes in the central U.S. For the most part, the summary of effects presented below is extracted from a thorough study of newspapers in the central U.S., and some damage reports by individuals as submitted to CUSEC.

In Lawrenceville there was one reported injury in a mobile home to a young girl requiring several stitches when the bunk bed her parents were assembling fell on her during the earthquake. There were reports of merchandise falling from the shelves, minor damage to breakable items in grocery stores, and other light miscellaneous damage. Slight damage occurred to a cell block ceiling in the

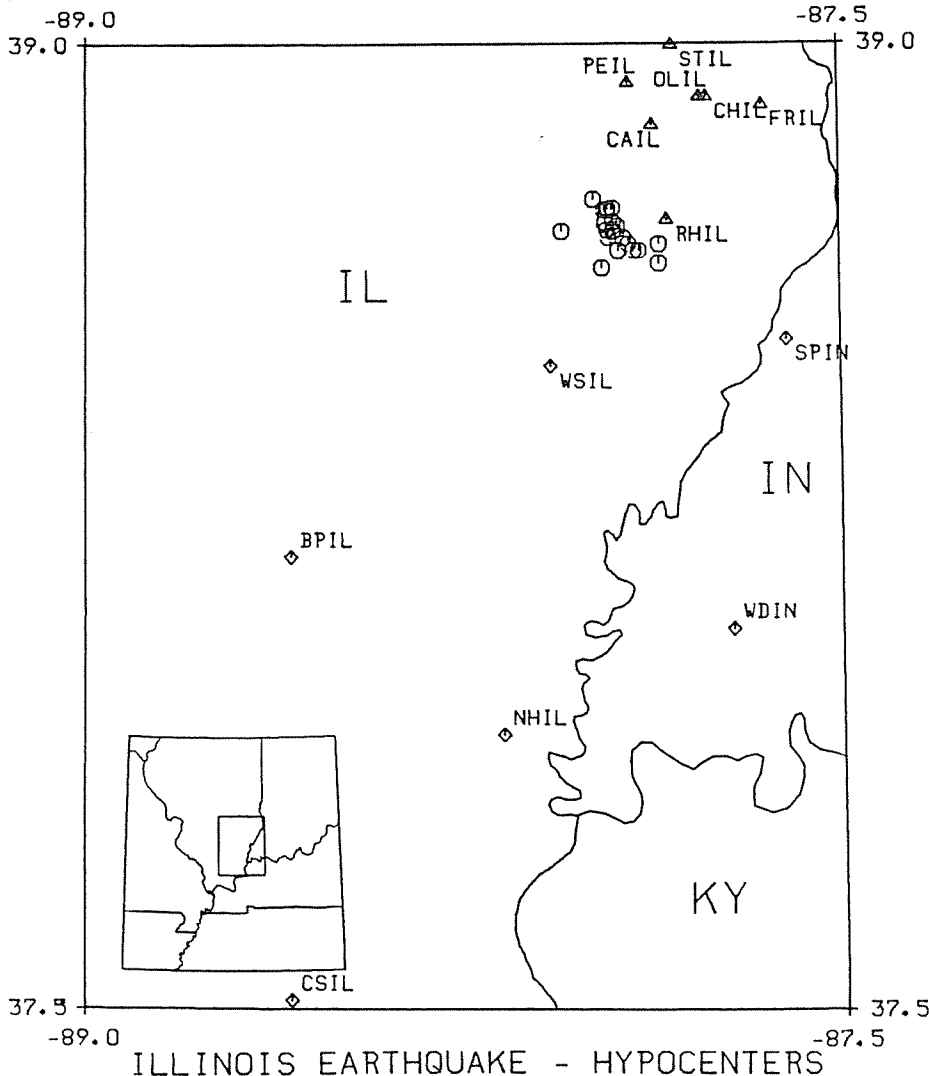


Fig. 1 Main shock and aftershocks of 10 June 1987 event. Triangles are seismograph stations.

Lawrence County Jail. In Bridgeport, a mile away, electrical service was disrupted, and a masonry belfry sustained cracks.

In nearby Olney (a community twenty miles west of Lawrenceville) a large piece of stone fell from the top of the chimney at the Zirkle Funeral Home causing damage to both the ceiling and roof; the funeral home was built in 1919. Most of the other reported local damage was limited to cracking of masonry walls and slabs, and occasional falling bricks. There have been no reports of damage to modern engineered buildings.

At Vincennes, Indiana, directly to the east of Lawrenceville, the quake was reported to be felt for fifteen to twenty seconds. It was reported in the Indianapolis Star that Paul Willis, graphics editor for the Sun-Commercial, said, "I was in my back yard and I could see my broccoli swaying." As humorous as this may seem, anyone who has raised broccoli realizes that these plants are exceptionally fine inverted pendulums (or reed gauges).

In the Greene County Court House in Bloomfield, Indiana (56 miles east of the epicenter) it was reported that 50 to 100 bricks fell when an iron lintel over a window collapsed, and cracks developed in the masonry. In the Madison County Government Center in Anderson, Indiana (150 miles to the east of the epicenter) a glass facade cracked. In Indiana it was reported that some limited damage to highway overpasses occurred.

In New Albany, Indiana, across the Ohio River from Louisville, it was reported that a two-story school administration building (used as a hospital during the Civil War and now listed on the National Register of Historic Places) suffered damage when two hidden chimneys in the building collapsed. The following morning two feet of brick and plaster from the

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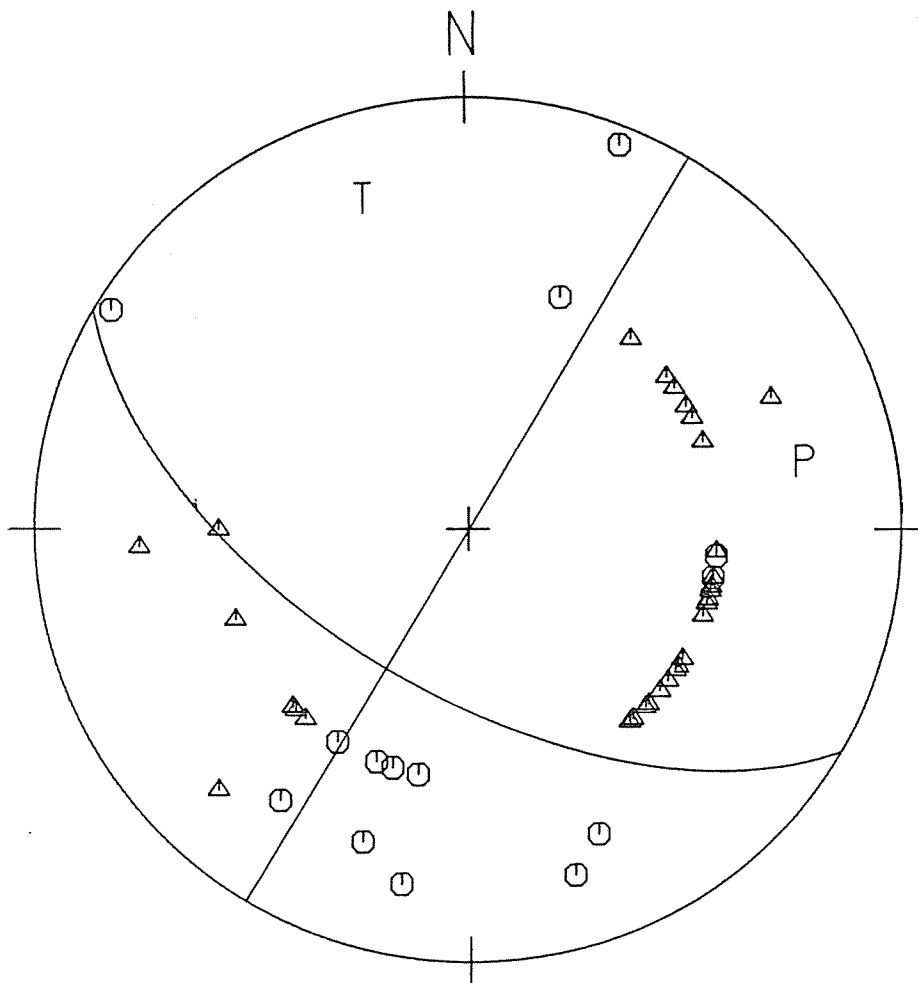


Fig. 2 Focal mechanism of main shock. This is a lower hemisphere equal area projection. Compressional motion is shown as circles, dilatational motion as triangles.

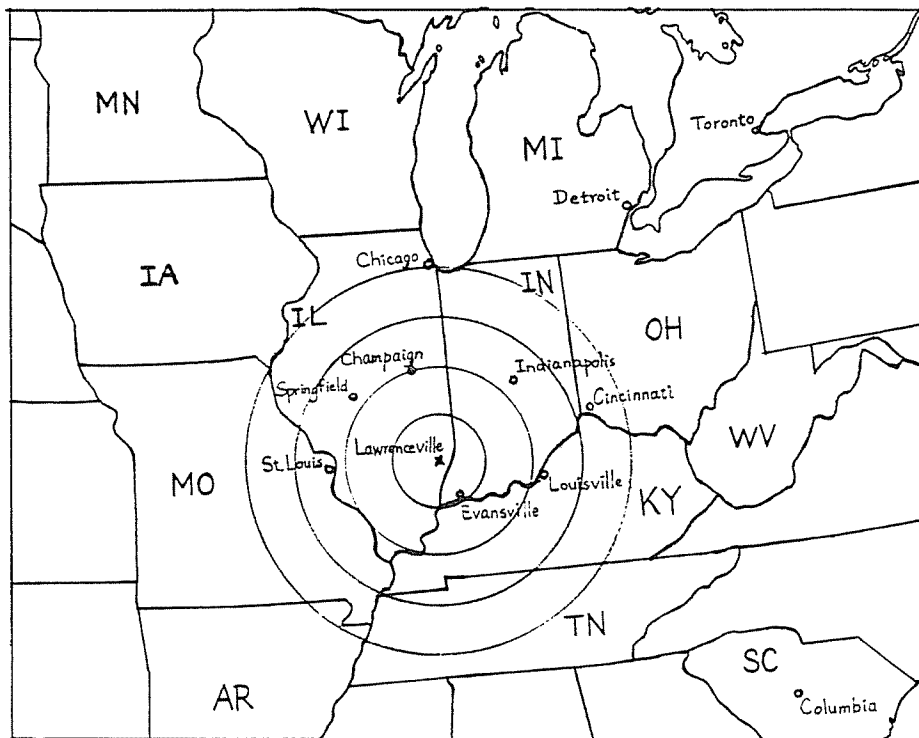


Fig. 3 Epicentral location map.

ceiling was discovered on the floor of an office in the building having crushed the furniture. Fortunately no one was in the area at the time of collapse.

The eighty-foot control tower located at the Capital Airport in Springfield, Illinois (140 miles northwest of the epicenter) underwent significant motion to the extent that the personnel became alarmed. The plate glass windows in the control tower rattled from the ground motions.

Tall buildings in Chicago, Springfield and Indianapolis swayed during the earthquake; however, many occupants of the buildings attributed the motion to wind. In Columbia, South Carolina (520 miles southeast of the epicenter) residents of a twelve-story apartment building were evacuated due to the swaying of the building.

"Unusual Events" were reported in at least six nuclear power plants in the midwest.

In the central region (Illinois, Indiana, and Kentucky) there were major problems with communication. Police, television, and radio stations were inundated with telephone calls by concerned and curious citizens. Local radio and television stations broadcast appeals to citizens to refrain from calling and await news reports. This communication congestion was serious enough that it will most assuredly receive attention from authorities in the months ahead.

It appears to us that there is a need to gather data on the excitation that takes place in the central states from events of this nature, which are occurring rather regularly. To this end there needs to be installed and maintained a number of instruments at selected locations throughout the central states which can provide engineers and scientists with information about the ground motions. The required instru-

MAIN SHOCK and AFTERSHOCKS

ORIGIN TIME	LAT N	LONG W	DEPTH KM	MAG	RMS ERROR TIME	STD ERROR DIST	STD ERROR DEPTH	
10 JUN								
23 48 54.0	38.71	87.95	4.6	5.0	0.2	0.7	0.6	
23 56 37.6	38.72	87.96	8.0*	2.2	0.4	2.0	2.8	
11 JUN								
00 05 50.0	38.67	87.95	5.0*	2.6	0.4	1.9	1.9	
01 03 34.2	38.68	87.94	11.2	2.3	0.2	2.1	1.7	
01 28 21.4	38.74	87.95	7.0	2.1	0.1	1.6	1.3	
03 01 27.3	38.71	87.96	5.6	1.5+	0.1	1.0	1.1	
03 06 13.5	38.72	87.95	9.1	1.5+	0.2	0.9	1.5	
08 51 13.8	38.76	87.99	9.8	1.5+	0.3	2.5	3.8	
09 13 47.2	38.74	87.96	8.0*	1.8	0.2	0.8	5.3	
14 08 36.7	38.74	87.96	8.0*	2.4	0.3	0.8	2.1	
16 32 10.7	38.74	87.96	4.2	2.3	0.3	1.0	4.0	
22 30 33.9	38.89	88.05	5.0*	1.5+	3.2	62.5	99.9	
23 01 39.1	38.71	87.94	8.0*	1.8	0.6	3.1	5.3	
12 JUN								
04 21 16.2	38.71	87.95	5.0*	1.5+	0.3	1.4	2.5	
13 10 19.6	38.70	87.93	5.6	1.5+	0.4	1.7	2.2	
13 JUN								
06 16 12.5	38.70	87.95	8.0*	1.5+	0.2	3.9	4.2	
08 40 32.0	38.69	87.92	5.0*	1.5+	0.5	5.5	5.0	
08 48 04.0	38.71	87.94	4.5	2.2	0.4	1.1	2.5	
14 20 12.2	38.68	87.91	1.9	1.5+	0.4	2.8	5.5	
19 59 42.4	38.66	87.86	5.0*	1.5+	0.6	16.6	5.9	
14 JUN								
04 18 44.7	38.68	87.90	5.0*	1.5+	0.7	15.0	9.4	
05 08 53.1	38.70	87.94	2.0*	1.7	0.4	1.3	1.7	
13 48 49.0	38.69	87.86	5.0*	1.5+	0.6	8.7	4.0	

* -- Depth fixed at this value
 + -- Estimated magnitude from MEQ-800 records
 RMS ERROR in sec, STD ERROR in km

TABLE 2 -- Hypocentral parameters for the main shock and aftershocks

ments range from seismographs through strong-motion accelerographs, and should include instruments that record long-period ground motion. The potential for loss of life, injury, and great damage to property has reached the point where such an investment is justified.

Sources

Sources: **The Cincinnati Enquirer**, Cincinnati, Ohio (6/11/87); **The Courier-Journal**, Louisville, Kentucky (6/11/87); **The Daily Illini**, Champaign-

Urbana, Illinois (6/11/87); **Daily Record**, Lawrenceville, Illinois, (6/11/87); **The Evansville Courier**, Evansville, Indiana (6/11/87); **The Evansville Press**, Evansville, Indiana (6/11/87); **The Indianapolis Star**, Indianapolis, Indiana (6/11/87); **The News-Gazette**, Champaign, Illinois (6/11/87); **Post-Dispatch**, St Louis, Missouri (6/11/87); **State Journal Register**, Springfield, Illinois (6/11/87); **Southern Illinoisan**, Carbondale, Illinois (6/11/87); **Sun Times**, Chicago, Illinois (6/11/87).