

INTRODUCTION

The earthquake data shown on this map and listed in table 1 are a list of earthquakes that were originally used in preparing the Seismic Risk Studies in the United States (Algermissen, 1969) which have been recompiled and updated through 1979. These data have been reexamined which resulted in some revisions of epicenters and intensities as well as assignment of intensities to earthquakes that previously had none assigned. Only earthquakes located within the boundary of the State are listed in table 1 even though earthquakes in bordering states or countries may have been felt or caused damage in the state. Intensity values were updated from new and additional data sources that were not available at the time of original compilation. Some epicenters were relocated on the basis of new information. The data shown in table 1 are estimates of the most accurate epicenter, magnitude, and intensity of each earthquake, on the basis of historical and current information. Some of the aftershocks from large earthquakes are listed but are incomplete in many instances, especially for ones that occurred before seismic instruments were in universal usage.

The data in table 1 were used to compile the seismicity map. The latitude and longitude were rounded to the nearest tenth of a degree and sorted so that all identical locations were grouped together and counted. A triangle represents the epicenter plotted to a tenth of a degree. The number of earthquakes at each location is shown on the map by the number to the right of the triangle. A Roman numeral to the left of a triangle is the maximum Modified Mercalli intensity (Wood and Neumann, 1931) of all earthquakes located at that geographic position. The absence of an intensity value indicates that no intensities have been assigned to earthquakes at that location. A year shown below a triangle is the latest year for which the maximum intensity was recorded.

EXPLANATION OF THE TABLES

The data are listed chronologically in table 1 in the following categories: date, origin time, N. latitude, W. longitude, depth, hypocenter quality and referenced data sources, magnitude, and intensity (Modified) Mercalli) and intensity source references. Table 1 has some basic limitations in terms of the size (magnitude or intensity) of the earthquakes listed. Prior to 1965 all recorded felt earthquakes are listed, after 1965 only felt earthquakes or those with magnitudes above the 2.5-3.0 range are listed; the lower magnitude levels apply mostly to the Eastern United States. If no magnitude was computed and the earthquake was felt it was included in the earthquake list. The low magnitude events located in recent years with dense seismograph networks have not been included.

Listed below is an explanation of the symbols and codes used in the tables:

- 1. Leaders (..) indicate information not available. 2. Latitude and longitude are listed to a hundredth of a degree if they have been published with that degree of accuracy, or greater; however, most historical events have been published only to the nearest degree or tenth of a degree and are therefore listed at this accuracy in table 1. An asterisk (*) to the right of the longitude indicates that the latitude and longitude were not given in the source reference, but were assigned by the compilers of the data file. An (x) to the right of the longitude indicates that the event is an explosion, a suspected explosion, rockburst, or a nontectonic event; these have not been plotted on the map.
- 3. The letter code in the HYPOCENTER, QUAL column is defined below: a. Determination of instrumental hypocenters are estimated to be accurate within the ranges of latitude and longitude listed below; each range is letter coded as indicated:
 - B 0.1°-0.2° C 0.2°-0.5°
 - D 0.5°-1.0°
- E 1.0° or larger b. Determination of noninstrumental epicenters from felt data are estimated to be accurate within the ranges of latitude and longitude listed below; each range is letter coded as
 - G 0.5°-1.0° H 1.0°-2.0°

F 0.0°-0.5°

- I 2.0° or larger 4. The reference identification numbers in the HYPOCENTER, REF and INTENSITY, REF columns indicate the sources of the hypocenter and intensity. They are listed in numerical order in table 2.
- 5. The magnitudes listed under "USGS" are mb values (Gutenberg and Richter, 1956) published in the Preliminary Determination of Epicenters (PDE) by the National Earthquake Information Service, U. S. Geological Survey and predecessor organizations. Associated with the magnitude values listed under "OTHER" are the source code and type. Type is defined by 1 = ML (Richter, 1958), 2 = mbLg (Nuttli, 1973), 3 = MS (Bath, 1966 or Gutenberg, 1945), 4 = mb (Gutenberg and Richter, 1956), and 5 = mbLg modified. The source codes are listed below:
- KGS Kansas Geological Survey, Lawrence, Kans. 6. An asterisk (*) in the INTENSITY, MM column indicates that the intensity was assigned by the compiler on the basis of the available data at the time the catalog was compiled.

I. Not felt - or, except rarely under especially favorable circumstances. Under certain

100 KILOMETERS

conditions, at and outside the boundary of the area in which a great shock is felt: sometimes birds, animals, reported uneasy or disturbed; sometimes dizziness or nausea experienced; sometimes trees, structures, liquids, bodies of water, may sway--doors may swing, very slowly.

MODIFIED MERCALLI INTENSITY SCALE OF 1931

- II. Felt indoors by few, especially on upper floors, or by esensitive, or nervous persons. Also, as in grade I, but often more noticeably: sometimes hanging objects may swing, especially when delicately suspended; sometimes trees, structures, liquids, bodies of water, may sway, doors may swing, very slowly; sometimes birds, animals, reported uneasy or disturbed; sometimes dizziness or nausea experienced.
- III. Felt indoors by several, motion usually rapid vibration. Sometimes not recognized to be an earthquake at first. Duration estimated in some cases. Vibration like that due to passing of light, or lightly loaded trucks, or heavy trucks some distance away. Hanging objects may swing slightly. Movements may be appreciable on upper levels of tall structures. Rocked standing motor cars slightly.
- IV. Felt indoors by many, outdoors by few. Awakened few, especially light sleepers. Frightened no one, unless apprehensive from previous experience. Vibration like that due to passing of heavy or heavily loaded trucks. Sensation like heavy body striking building or falling of heavy objects inside. Rattling of dishes, windows, doors; glassware and crockery clink and clash. Creaking of walls, frame, especially in the upper range of this grade. Hanging objects swung, in numerous instances. Disturbed liquids in open vessels slightly. Rocked standing motor cars noticeably.
- V. Felt indoors by practically all, outdoors by many or most: outdoors direction estimated. Awakened many, or most. Frightened few--slight excitement, a few ran Buildings trembled throughout. Broke dishes, glassware, to some outdoors. extent. Cracked windows--in some cases, but not generally. Overturned vases, small or unstable objects, in many instances, with occasional fall. Hanging objects, doors, swing generally or considerably. Knocked pictures against walls, or swung them out of place. Opened, or closed, doors, shutters, abruptly. Pendulum clocks stopped, started or ran fast, or slow. Moved small objects, furnishings, the latter to slight extent. Spilled liquids in small amounts from well-filled open containers. Trees, bushes, shaken slightly.
- VI. Felt by all, indoors and outdoors. Frightened many, excitement general, some alarm, many ran outdoors. Awakened all. Persons made to move unsteadily. Trees. bushes. shaken slightly to moderately. Liquid set in strong motion. Small bells rang-church, chapel, school, etc. Damage slight in poorly built buildings. Fall of plaster in small amount. Cracked plaster somewhat, especially fine cracks chimneys in some instances. Broke dishes, glassware, in considerable quantity, also some windows. Fall of knick-knacks, books, pictures. Overturned furniture in many instances. Moved furnishings of moderately heavy kind.
- VII. Frightened all--general alarm, all ran outdoors. Some, or many, found it difficult to stand. Noticed by persons driving motor cars. Trees and bushes shaken moderately to strongly. Waves on ponds, lakes, and running water. Water turbid from mud stirred up. Incaving to some extent of sand or gravel stream banks. Rang large church bells, etc. Suspended objects made to quiver. Damage negligible in buildings of good design and construction, slight to moderate in well-built ordinary buildings, considerable in poorly built or badly designed buildings, adobe houses, old walls (especially where laid up without mortar), spires, etc. Cracked chimneys to considerable extent, walls to some extent. Fall of plaster in considerable to large amount, also some stucco. Broke numerous windows, furniture to some extent. Shook down loosened brickwork and tiles. Broke weak chimneys at the roof-line (sometimes damaging roofs). Fall of cornices from towers and high buildings. Dislodged bricks and stones. Overturned heavy furniture, with from breaking. Damage considerable to concrete irrigation ditches.
- VIII. Fright general--alarm approaches panic. Disturbed persons driving motor cars. Trees shaken strongly--branches, trunks, broken off, especially palm trees. Ejected sand and mud in small amounts. Changes: temporary, permanent; in flow of springs and wells; dry wells renewed flow; in temperature of spring and well waters. Damage slight in structures (brick) built especially to withstand earthquakes. Considerable in ordinary substantial buildings, partial collapse: racked, tumbled down, wooden houses in some cases; threw out panel walls in frame structures, broke off decayed piling. Fall of walls. Cracked, broke, solid stone walls seriously. Wet ground to some extent, also ground on steep slopes. Twisting, fall, of chimneys, columns, monuments, also factory stacks, towers. Moved conspicuously, overturned, very heavy furniture.

- IX. Panic general. Cracked ground conspicuously. Damage considerable in (masonry) structures built especially to withstand earthquakes: Threw out of plumb some wood-frame houses built especially to withstand earthquakes; great in substantial (masonry) buildings, some collapse in large part; or wholly shifted frame buildings off foundations, racked frames; serious to reservoirs; underground pipes sometimes broken.
- X. Cracked ground, especially when loose and wet, up to widths of several inches; fissures up to a yard in width ran parallel to canal and stream banks. Landslides considerable from river banks and steep coasts. Shifted sand and mud horizontally on beaches and flat land. Changed level of water in wells. Threw water on banks of canals, lakes, rivers, etc. Damage serious to dams, dikes, embankments. Severe to well-built wooden structures and bridges, some destroyed. Developed dangerous cracks in excellent brick walls. Destroyed most masonry and frame structures, also their foundations. Bent railroad rails slightly. Tore apart, or crushed endwise, pipe lines buried in earth. Open cracks and broad wavy folds in cement pavements and asphalt road surfaces.
- XI. Disturbances in ground many and widespread, varying with ground material. Broad fissures, earth slumps, and land slips in soft, wet ground. Ejected water in large amounts charged with sand and mud. Caused sea-waves ("tidal" waves) of significant magnitude. Damage severe to wood-frame structures, especially near shock centers. Great to dams, dikes, embankments often for long distances. Few, if any (masonry) structures remained standing. Destroyed large well-built bridges by the wrecking of supporting piers, or pillars. Affected yielding wooden bridges less. Bent railroad rails greatly, and thrust them endwise. Put pipe lines buried in earth completely out of service.
- XII. Damage total--practically all works of construction damaged greatly or destroyed. Disturbances in ground great and varied, numerous shearing cracks. Landslides, falls of rock of significant character, slumping of river banks, etc., numerous and extensive. Wrenched loose, tore off, large rock masses. Fault slips in firm rock, with notable horizontal and vertical offset displacements. Water channels, surface and underground, disturbed and modified greatly. Dammed lakes, produced waterfalls, deflected rivers, etc. Waves seen on ground surfaces (actually seen, probably, in some cases). Distorted lines of sight and level. Threw objects upward into the air.

Algermissen, S. T., 1969, Seismic risk studies in the United States: Fourth World Conference on Earthquake Engineering, Santiago, Chile, January 13-18, 1969, Proceedings, v. 1, p.14-27. Bath, Markus, 1966, Earthquake energy and magnitude, in v. 7 of Physics and chemistry of the Earth: Oxford and New York, Pergamon Press, p. 115-165. Gutenberg, B., 1945, Amplitudes of surface waves and magnitudes of shallow earthquakes: Seismological Society of America Bulletin, v. 35, no. 1, p. 3-12. Gutenberg, B. and Richter, C. F., 1956, Magnitude and energy of earthquakes: Annali di Geofisica, v. 9, no. 1, p. 1-15. Nuttli, O. W., 1973, Seismic wave attenuation and magnitude relations for eastern North America:

REFERENCES

Wood, H. O., and Neumann, F., 1931, Modified Mercalli Intensity Scale of 1931: Seismological Society of America Bulletin, v. 21, no. 4, p. 277-283.

Richter, C. F., 1958, Elementary Seismology: San Francisco, Calif., W. H. Freeman and Co., Inc.,

Journal of Geophysical Research, v. 78, no. 5, p. 876-885.

Table 1.--Chronological listing of earthquakes for the State of Kansas

	ATE				TIME (U'		LONG.		HYPOCENTER			NITUDE	INTENS ITY		
YEAR	MONTH	DAY	Н	M	S	(N.)	(W.)	(KM)	QUAL	REF	USGS	OTHER	М	M	REF
1867	APR	24	20	22		39.2	96.3		G	234			V	II	38
1875	NOV	08	10	40		39.3	95.5		G	63				V	63
1879	MAR	• •				39.6	99.1		Н	105				IV*	105
1881	MAY	19	15	00		39.0	95.2		H	105			I	II	105
1904	OCT	28	04	06		37.5	100.2	• •	G	105				V	6.
1904	OCT	28	04	09		37.5	100.2 *		G	234				IV*	23
1906	JAN	08	00	15		39.3	96.6		G	63			V	II	10
1906	JAN	08	00	38		39.3	96.6 *		G	105				• •	
1906	JAN	08	04	30		39.3	96.6 *		G	105					
1906	JAN	08	07	00		39.3	96.6		G	105				II*	10
1906	JAN	08	09	00		39.3	96.6		G	105			I	II*	10
1906	JAN	14	15	00		39.3	96.6		G	105				IV	84
1906	JAN	16	02	40		39.3	96.6	• •	G	105				II	8
1906	JAN	20	05	30		39.3	96.6		G	105				II	10
1906	JAN	23	13	40		39.3	96.6		G	63				II	8
1906	JAN	23	14	25		39.3	96.6		G	105	••			II	8
1907	JAN	02	07	45		37.1	97.0		Н	105				IV	8
1919	MAY	27	03	06		37.7	97.3		G	84				IV	6
1919	JUL	26	11	00		37.7	97.3		G	63			1	II*	63
1919	JUL	26	12	55		37.7	97.3		G	63				IV	23
1927	JAN	07	09			38.4	97.7		G	105				IV	10
1927	MAR	18	17	25		39.9	95.3		G	105				V	3
1928	NOV	08	14			39.5	98.1		G	1				IV	10
1929	SEP	23		00		39.0	96.6		G	2				IV*	
1929	SEP	23	11			39.0	96.6		G	2	• • •			V	. 38
1929	OCT	21		25		39.2	96.5		G	2				v	3
1929	OCT	23				39.0	96.8	• • • • • • • • • • • • • • • • • • • •	G	2	• • •		т	II	109
1929	NOV.	27	04	20		37.2	99.7	• • • • • • • • • • • • • • • • • • • •	G	2				IV	10
1929	DEC	07		02	• • •	39.2	96.5	•••	G	2	• •			v	6:
1931	AUG	09		18		39.1	94.7	• • •	F	105				VI	234
1931	AUG	09	07			39.1	94.7 *		F	105	• •	• • • •		IV*	6.
1931	AUG	09	07		• • • • • • • • • • • • • • • • • • • •	39.1	94.7 *		F	105		•• ••		IV*	6:
1932	JAN	29			• • •	39.0	99.6	• • • • • • • • • • • • • • • • • • • •	G ·	105	• •	•• ••		V	105
1933	FEB	20	17	00	• • • • • • • • • • • • • • • • • • • •	39.8	99.8		G	63	• •	••••		v	6.
1942	SEP	10	10	00	• • •	38.9	99.3	• •	G	105	• •	•• ••		IV	10
1948	APR	03	03	••		37.7	97.3	• •	G	105	••	•• ••		IV	10
1956	JAN	06	11	57	59	37.3	98.8	• •	G	105	••	•• ••		VI	2
1961	APR	13			57.2	39.9	100.0	025	C	34	• •	• • • •		V	3
1975	DEC	04			59.9	38.24	94.62x			90	• •	• • • • •			
1979	JUN	30			41.3	39.94		005	A B	262	• •	2 1VCC		· ·	22
. 119	JUN	30	20	40	41.3	39.94	97.27	003	ь	202	• •	3.1KGS	2	VI	232

Table 2.--List of data sources

1. Heck, N. H. and Bodle, R. R., 1930, United States Earthquakes 1928: U. S. Coast and Geodetic Survey, Serial No. 483, p. 1-28. O 2. Heck, N. H. and Bodle, R. R., 1931, United States Earthquakes 1929: U. S. Coast and Geodetic Survey, Serial No. 511, p. 1-55. 29. Brazee, R. J. and Cloud, W. K., 1958, United States Earthquakes 1956: U. S. Coast and Geodetic Survey, p. 1-78.

- 34. Lander, J. F. and Cloud, W. K., 1963, United States Earthquakes 1961: U. S. Coast and Geodetic Survey, p. 1-106. 38. Coffman, J. L. and von Hake, C. A., 1973, Earthquake History of the United States: U. S. National Oceanic and Atmospheric Administration, No. 41-1(through 1970), p.
- 63. Merriam, D. G., 1956, History of earthquakes in Kansas: Seismological Society of America Bulletin, v. 46, no. 2, p. 87-96. 84. Woollard, G. P., 1968, A catalogue of earthquakes in the United States prior to 1925 based on unpublished data compiled by Harry Fielding Reid and unpublished sources
- 105. Docekal, J., 1970, Earthquakes of the stable interior, with emphasis on the midcontinent, v. 2, A dissertation presented the faculty of the graduate college in Doctor of Philosophy: Ann Arbor, Michigan, University Microfilms Ltd., p. 1-332.

prior to 1930: Hawaii Institute of Geophysics, University of Hawaii, Data Report

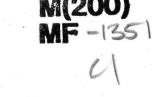
- 109. Heinrich, R. R., 1941, A contribution to the seismic history of Missouri: Seismological Society of America Bulletin, v. 31, no. 3, p. 187-224.
- 232. Stover, C. W., Hubiak, P., Minsch, J. H., and Person, W. J., 1980, Earthquakes in the United States, April-June 1979: U. S. Geological Survey Circular 836-B, 34 p. 234. DuBois, S. M. and Wilson, F. W., 1978, A revised and augmented list of earthquake
- intensities for Kansas, 1867-1977: Kansas Geological Survey, Environmental Geology 262. Stover, C. W. and von Hake, C. A., 1981, United States Earthquakes 1979: U. S. Geological Survey and U. S. National Oceanic and Atmospheric Administration,

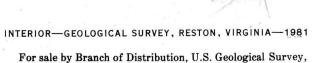
(unpublished data).

SEISMICITY MAP OF THE STATE OF KANSAS

C.W. Stover, B.G. Reagor, and S.T. Algermissen 1981







Box 25286, Federal Center, Denver, CO 80225



