OF-WTWI-1984-14

HISTORIC SEISMICITY IN AND AROUND THE TEXAS PANHANDLE

by

Wayne D. Pennington

Scott D. Davis

Prepared for the
U. S. Department of Energy
Office of Nuclear Waste Isolation
under contract no. DE-AC-97-83WM46615

Bureau of Economic Geology
W. L. Fisher, Director
The University of Texas at Austin
University Station, P. O. Box X
Austin, Texas 78712

1984

332 FH LONG-TERM REGIONAL STABILITY

WITH RESPECT TO

TECTONIC AND GEOLOGIC PROCESSES (3.5)

Historic Seismicity in and around the Texas Panhandle

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At least twenty earthquakes have occurred in the Texas Panhandle north of 34°N since 1907. The largest earthquakes had magnitudes up to 4.8, and the intensities throughout the Panhandle have ranged from IV to VI (Modified Mercalli), corresponding to accelerations from 6.8 cm/s^2 to over 31.6 cm/s^2.

The record of seismicity in the Texas Panhandle dates from in 1907, when the first reported event occurred near Amarillo. Since that time, numerous events have been reported or instrumentally recorded from the Panhandle. In the most complete survey of seismicity in the Panhandle (north of 34° latitude) to be undertaken, 20 earthquakes were identified from 1907 through July 1982. Slightly more than half of the events have locations determined from felt reports, and the others from instrumental locations (fig. 1).

In the process of identifying earthquakes, contemporary newspaper accounts, weather bulletins, seismological reports, and other sources were reviewed. Several reported events were found to be in error. Specifically, the published locations of some events are erroneous by tens or hundreds of kilometers, one event was in fact a sonic boom, and one "event" near the Panhandle resulted from spurious data reported from seismological observatories nearby.

The largest earthquakes in the Texas Panhandle had magnitudes of 4.7 to 4.8 (determined by maximum intensity and felt areas); there were five such events between 1917 and 1951. Since instrumental recording became widespread in about 1962, only two events of magnitude greater than 4.0 have occurred (table 1). Although some of the earthquakes reported have been assigned magnitudes of 3.0 or less, the detection threshold is probably considerably higher. As evidence, it is noted that a magnitude 3.4 event in 1983 would have been undetected by conventional procedures, had there not been a specific interest in the modern seismicity. Since this interest did not exist until recently, it is probable that many earthquakes of magnitude up to 3.5 have gone unrecognized, and it is likely that some larger events have been missed as well.

All of the earthquakes in the Texas Panhandle appear at present to be natural, and not induced. A high level of activity near Snyder, Texas (33°N, 101°W) is clearly associated with

injection of fluids for secondary recovery of hydrocarbons; at least 22 events with magnitude greater than 3.0 have occurred there since 1977. Although there are some injection fields in the Texas Panhandle, none of them appear to be associated with the seismicity. Current research suggests that, under appropriate conditions, extraction of gas can result in the same seismicity as that observed in the Gulf Coast region of Texas. The primary requirement of active growth faulting is absent in the Panhandle, and gas production will probably not influence seismicity there. Thus, most if not all of the seismicity in the Panhandle is apparently "natural."

The depths of earthquake hypocenters are unknown in all but one case. The 1974 Oklahoma-Texas border event probably lies at 10 $\pm$ 3 km (Herrmann, 1979), placing it in the "basement" rock. Comparisons of felt areas of other events with the 1974 event, the 3-km-deep Snyder event of 1978, and other Central United States earthquakes for which depths are known, suggest that most Panhandle earthquakes are 3 to 15 km deep, and may be either in the basement or in sedimentary structures above it. Several basement structural features capable of producing seismic events are present in the Panhandle, particularly those associated with the Amarillo Uplift, but the features that may be responsible for the seismicity are unknown.

At least six earthquakes in neighboring regions with Modified Mercalli Intensities of up to V have been felt in the Texas Panhandle. Some Texas wells were damaged by the 1964 Alaskan earthquake. A final hazard assessment for any Panhandle waste repository site will have to include possible effects of regional earthquakes and of local seismic events.

A preliminary map has been prepared (fig. 2), showing the maximum intensities (Modified Mercalli) felt throughout the Texas Panhandle since 1907. In constructing this map, isoseismal lines were drawn for all felt earthquakes in and near the Panhandle, interpolating between points when necessary. In addition, some anomalously high reports were discarded when they appeared isolated within a region of consistently lower intensity reports for the same event.

A site-specific hazard assessment requires further work, but a simple evaluation of the maximum accelerations experienced throughout the Panhandle during the last 76 years can be performed, utilizing a simple intensity-acceleration function (Richter, 1958; p. 140):

$$\log a = \frac{I}{3} - \frac{1}{2}$$

The accelerations corresponding to specific intensities observed in the Panhandle range from 6.8 cm/s^2 to over 31.6 cm/s^2. More detailed estimates of expected accelerations should be performed, using specific attenuation laws appropriate for the High Plains and for specific active features, once they can be identified.

References

Herrmann, R. B., 1979, Surface wave focal mechanisms for eastern North American earthquakes with tectonic implications: Journal of Geophysical Research, v. 84, p. 3543-3552.

Richter, C. F., 1958, Elementary seismology: San Francisco, W. H. Freeman, 768 p.

Figure 1. Epicentral locations from Table 1); 1907 to July 1983.

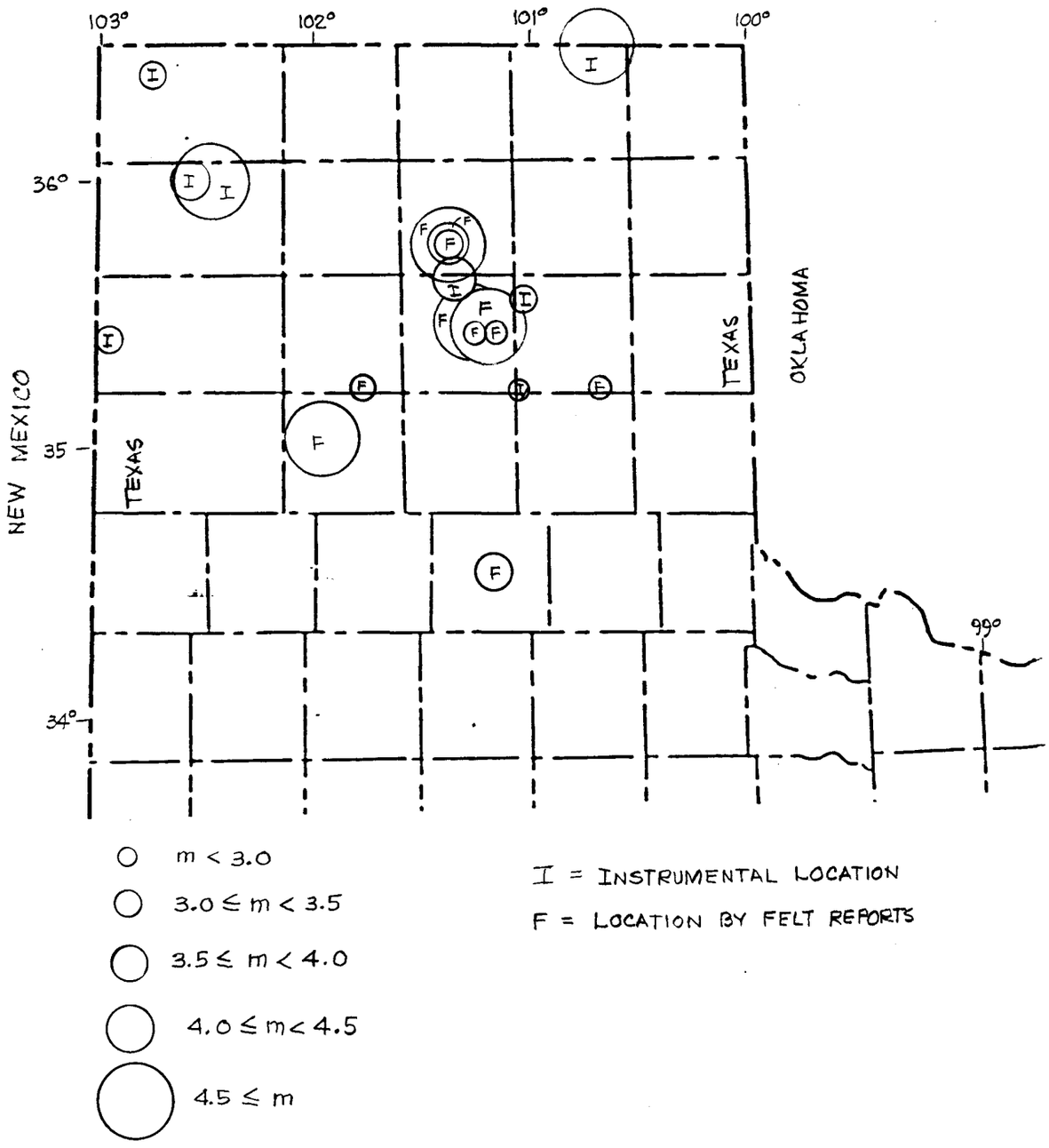
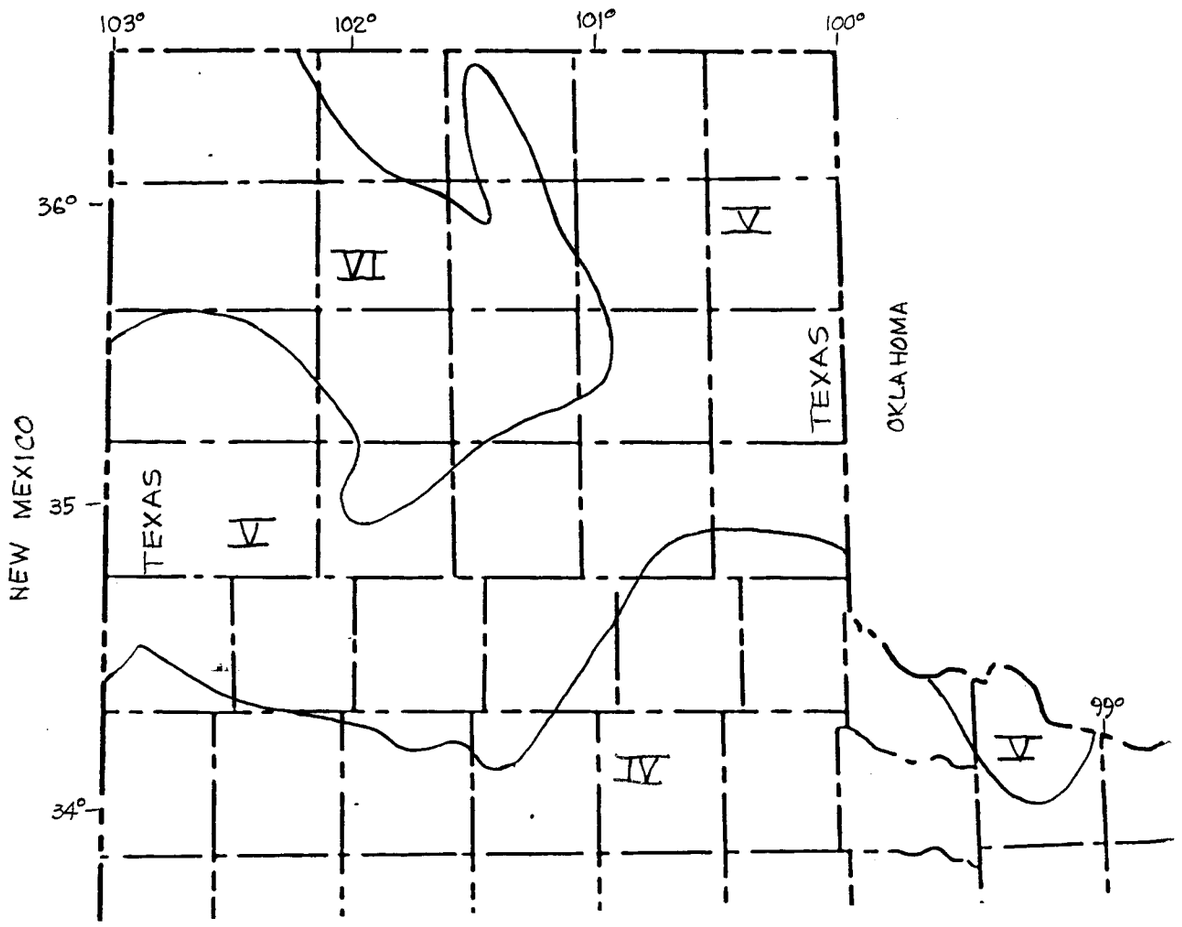


Figure 2. Maximum seismic intensities (Modified Mercalli) experienced in the past within the Texas Panhandle, from earthquakes in the Panhandle and nearby regions. Maximum accelerations are indicated, making use of the relationship $\log a = \frac{1}{3} - \frac{1}{2}$ (Richter, 1959; p.140).



INTENSITY ACCELERATION

VI $a = 31.6$ cm/s²

V $a = 14.7$ cm/s²

IV $a = 6.8$ cm/s²

Table 1. Historical seismicity of the Texas Panhandle in area bounded by 100°W-103°W, 34°N-36.5°N; 1907 to July 1983.

Year	Month	Day	Origin (UTC)	Latitude °N	Longitude °W	F/I	Magnitude	Felt Area (km^2)	MMI	General Location
1907	04		00	35.2	101.8	F	3.0		V	Amarillo
1917	03	28	19:56	35.4	101.3	F	4.7	5,000	VI	Panhandle
1917	03	28	23:38	35.4	101.3	F	3.0		II-III	Panhandle
1925	07	29	11:30	34.5	101.2	F	3.8		IV	Silverton
1925	07	30	08	35.4	101.3	F	3.5		III-IV	Panhandle
1925	07	30	12:17	35.4	101.3	F	4.8	500,000	VI	Panhandle
1925	07	31	18	35.4	101.2	F	3.0		III	White Deer
1936	06	19	21	35.2	100.7	F	3.0	>600	II-III	NE of Clarendon
1936	06	20	03:13:37	35.7	101.4	F	3.0	>200	II-III	Borger
1936	06	20	03:18:27	35.7	101.4	F	3.5	30,000	IV	Borger
1936	06	20	03:24:06	35.7	101.4	F	4.7	110,000	VI	Borger
1948	03	12	04:29:00	36.0	102.5	I	4.7	300,000	VI	Dalhart
1951	06	20	18:37:10	35.0	102.0	F	4.7	65,000	VI	Amarillo
1966	04	21	14:14:12	35.4	103.0	I	3.4			TX-NM border
1966	07	20	09:04:58.4	35.6	101.4	I	4.3	30,000	V	Borger
1974	02	15	13:33:49.2	36.5	100.7	I	4.6	37,000	V	OK-TX border*
1980	02	21	20:42:02	35.2	101.08	I	2.9			Pampa
1980	06	09	22:37:10.0	35.5	101.05	I	3.3			Pampa
1982	10	14	12:52:45.4	36.0	102.6	I	3.8	10,000	III	Dalhart
1983	04	03	04:55:25	36.4	102.8	I	3.4			Dalhart area**

*Depth 10 km
**Preliminary location

F/I: F = Location determined by felt reports
I = Location determined instrumentally
MMI = Maximum Modified Mercalli intensity
UTC = Coordinated Universal Time