

Recent Seismic Activity in Kansas: Events and Responses

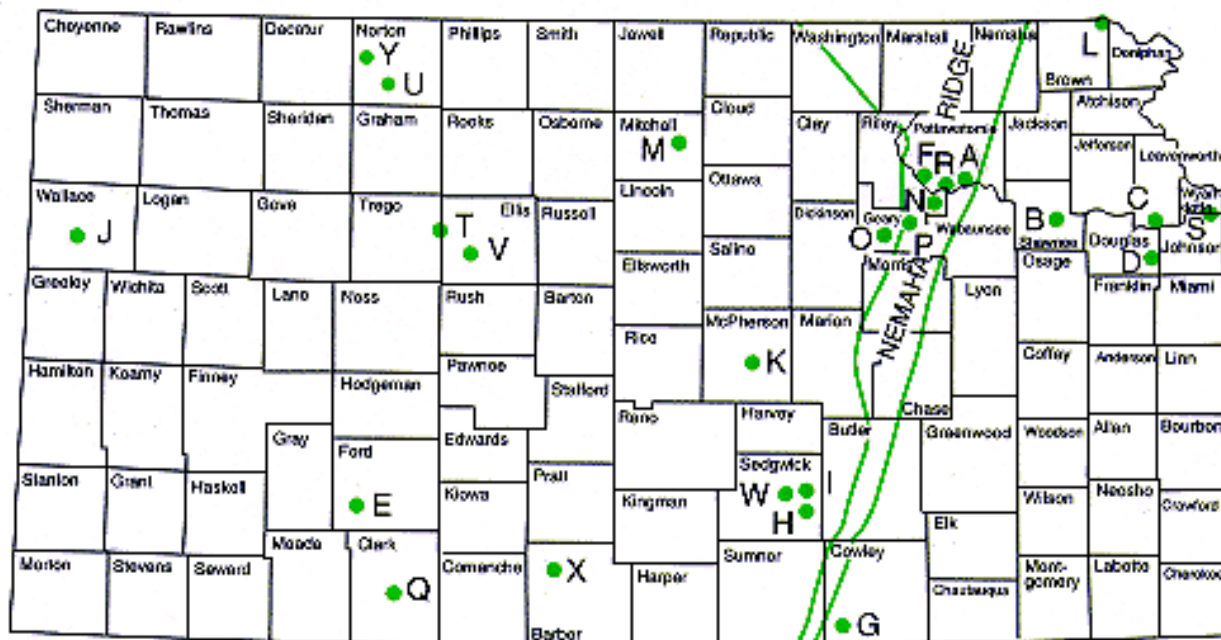
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Independent Petroleum Association of America
Colorado Springs, CO
18 June 2014

Induced or Triggered Seismicity

- Defined: Earthquake activity related to human activity; associated with deep wastewater injection, geothermal energy, large reservoirs
- Potential examples in midcontinent include Arkansas, Colorado, Ohio, Oklahoma, Texas

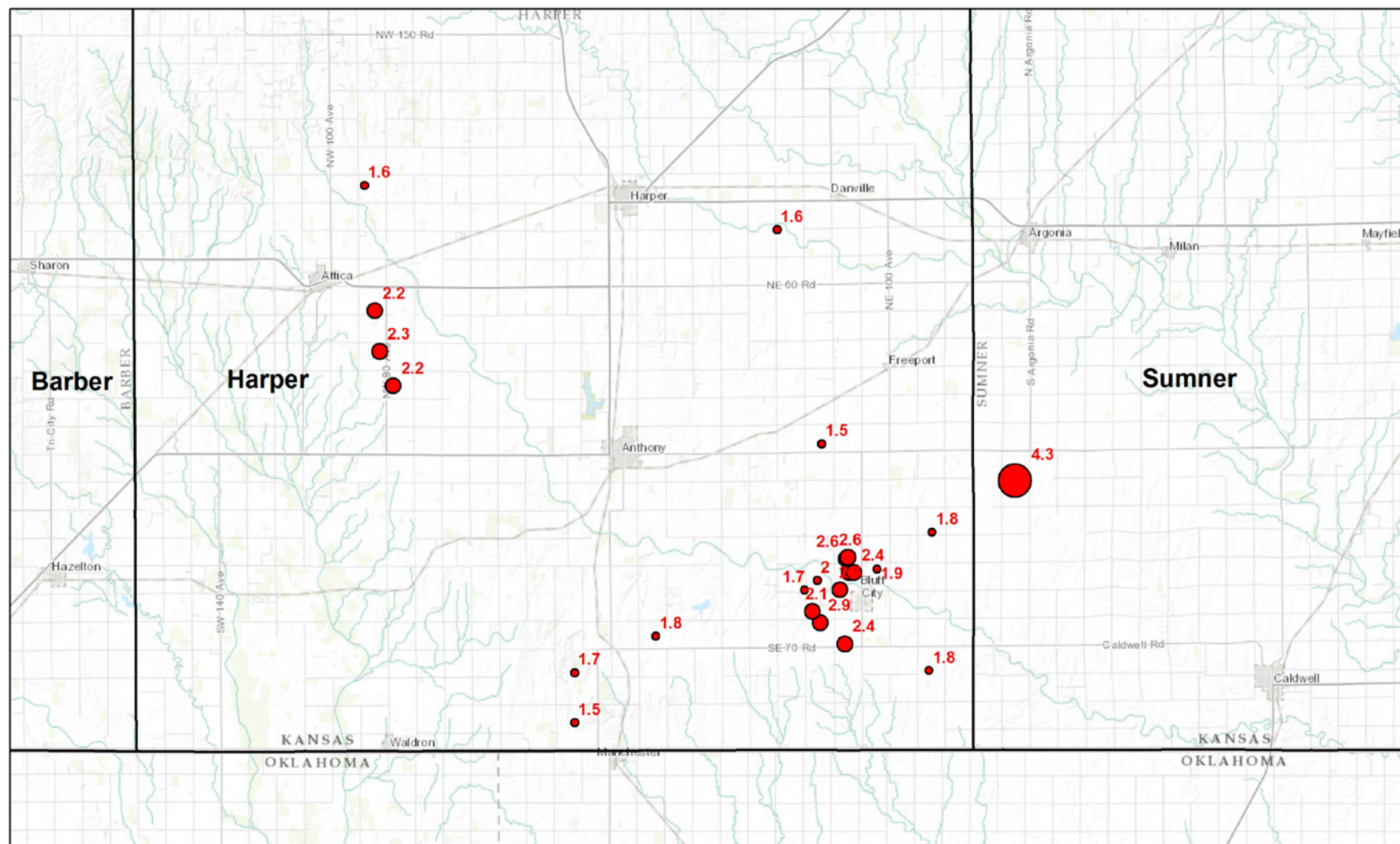
Historic Kansas Earthquakes



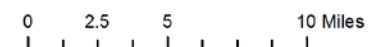
A. 1867 VII	F. 1908 VII	K. 1927 V	P. 1929 V	U. 1933 V
B. 1875 V	G. 1907 IV	L. 1927 VI	Q. 1929 V	V. 1942 IV
C. 1881 III	H. 1919 IV	M. 1928 IV	R. 1929 V	W. 1948 IV
D. 1902 II	I. 1919 IV	N. 1929 V	S. 1931 VI	X. 1956 VI
E. 1904 IV	J. 1926 ?	O. 1929 V	T. 1932 V	Y. 1961 V

Earthquake Activity - 2013

PRELIMINARY

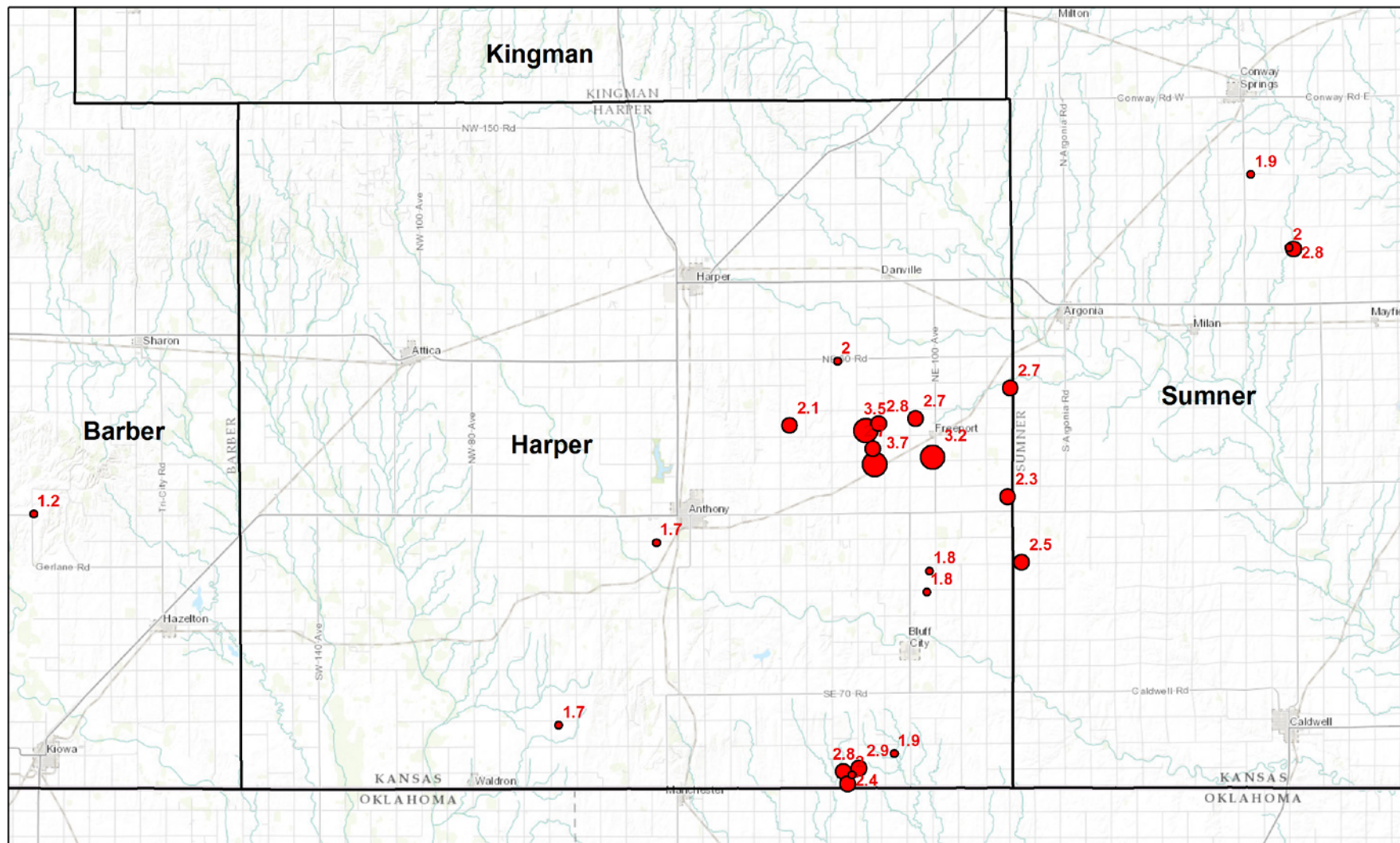


Kansas Geological Survey
Data from Oklahoma Geological Survey, USGS
18 March 2014



Earthquake Activity - 2014

PRELIMINARY

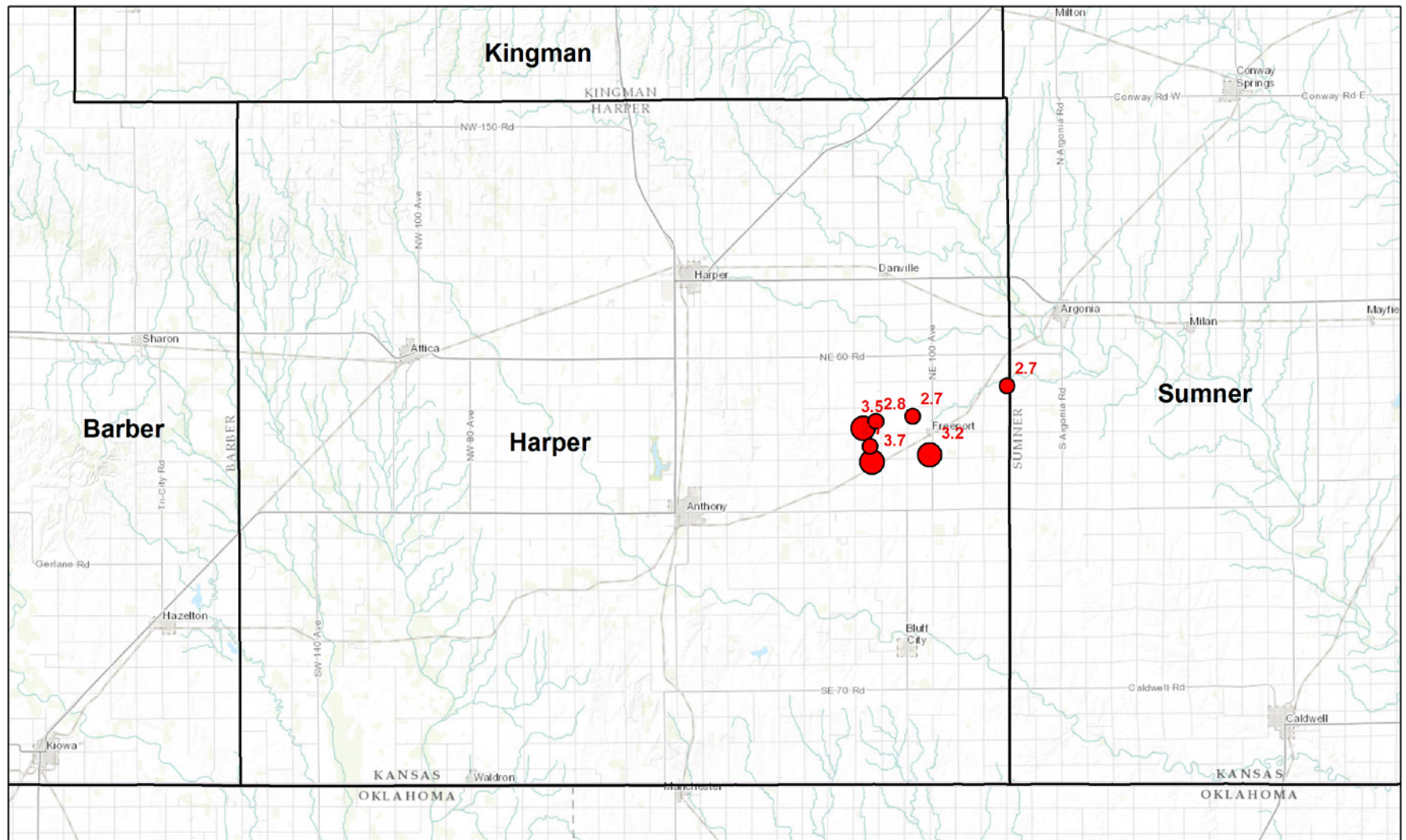


Kansas Geological Survey
Data from Oklahoma Geological Survey, USGS
18 March 2014

0 2.5 5 10 Miles

Earthquake Activity - March 12 to 18, 2014

PRELIMINARY



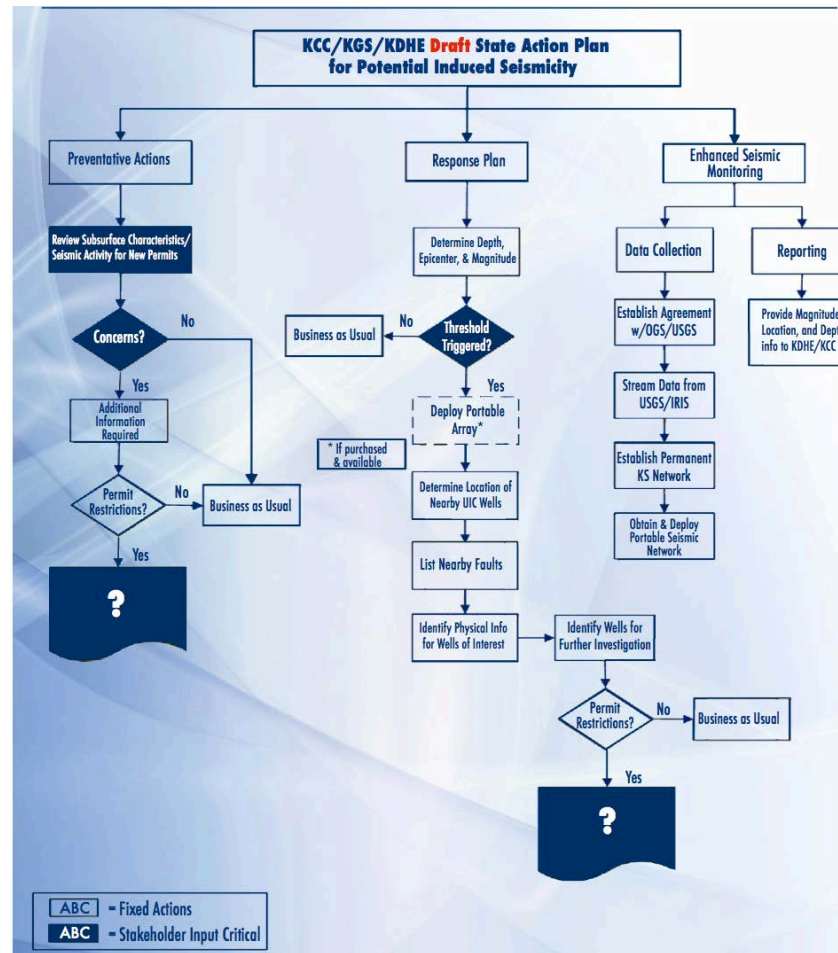
Kansas Geological Survey
Data from Oklahoma Geological Survey, USGS
18 March 2014

0 2.5 5 10 Miles

Kansas Responses

- Governor's Task Force on Induced Seismicity
KGS, KCC, KDHE
- USGS, OGS
- Proposed permanent network
- Public information, legislative interaction
- Interstate Oil and Gas Compact
Commission/Groundwater Protection Council

Kansas Response Plan (Draft)



Induced Seismicity: The Potential for Triggered Earthquakes in Kansas

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Introduction

Earthquake activity in the Earth's crust is known as seismicity. When linked to human activities, it is commonly referred to as "induced seismicity." Industries that have been associated with induced seismicity include oil and gas production, mining, geothermal energy production, construction, underground nuclear testing, and impoundment of large reservoirs (National Research Council, 2012). Nearly all instances of induced seismicity are not felt on the surface and do not cause damage.

In the early 2000s, concern began to grow over an increase in the number of earthquakes in the vicinity of a few oil and gas exploration and production operations, particularly in Oklahoma, Arkansas, Ohio, Colorado, and Texas. **Horizontal drilling** in conjunction with **hydraulic fracturing** has often been singled out for blame in the public discourse. Hydraulic fracturing, popularly called "fracking," does cause extremely low-level seismicity, too small to be felt, as do explosions associated with quarrying, mining, dam building, and other industrial activities. Although the actual process of hydraulic fracturing has been suspected of inducing larger earthquakes a few times worldwide, the U.S. Geological Survey has found no evidence to suggest that it has contributed much to increases in the rate of earthquakes (Hayes, 2012).

Felt earthquakes associated with any oil and gas production activities are rare. In the United States, only a small fraction of the hundreds of thousands

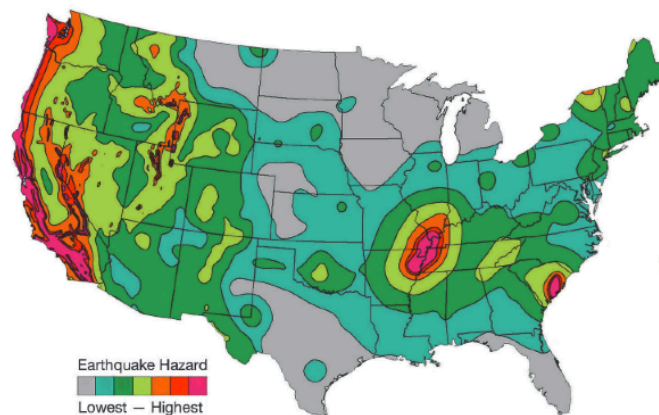


Figure 1—Earthquake hazard maps show the probability that ground shaking, or motion, will exceed a certain level, over a 50-year period. The low-hazard areas on this map have a 2% chance of exceeding a low level of shaking and the high-hazard areas have a 2% chance of topping a much greater level of shaking (modified from USGS, 2008).

of wells currently in operation have been suspected of inducing earthquakes large enough to be felt or cause damage (National Research Council, 2012). Most often, detected seismic activity associated with oil and gas operations is thought to be triggered when wastewater is injected into a disposal well. In the disposal process, waste products—such as saltwater produced with oil and gas and recovered hydraulic fracturing fluids—are injected into deep and confined porous rock.

Identifying a link between earthquakes and human activities is difficult. Complex subsurface geology and limited data about that geology make it hard to pinpoint the cause of many seismic events in the midcontinent, particularly in regions historically prone to naturally occurring low-level seismic activity. In south-central Kansas, for example, several small earthquakes have been

recorded near disposal wells starting in September 2013, about three years after horizontal drilling activities in the **Mississippian limestone play**—and associated water disposal—had crossed over the state line into Kansas from Oklahoma. However, the region also experienced several small historical earthquakes long before the increased oil activity, making it difficult to determine the cause of the recent seismic events. Although some areas of Kansas are at greater risk of seismicity than others, whether natural or induced, none of the state is in a high-hazard earthquake zone (fig. 1).

Scientists continue to monitor and evaluate possible instances of induced seismicity. In states with significant increases in seismic activity, including Oklahoma, monitoring has increased in localized areas where unusually high rates of seismicity have occurred near oil and gas production activities. To

Terms in **bold** are defined in the glossary.

The background of the entire cover is a grayscale topographic map of the United States. Overlaid on this map are numerous small, semi-transparent circles representing seismic activity. A dense cluster of orange and yellow circles is located in the central United States, primarily in the Great Plains region. Scattered across the rest of the country, particularly in the western and southern regions, are many smaller, light blue circles.

Induced Seismicity Potential in **ENERGY TECHNOLOGIES**



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Summary

- Felt earthquakes related to hydraulic fracturing are extremely rare.
- Some earthquakes may be due to deep fluid injection, including wastewater disposal.
- Need for better reporting of injection data (volumes, pressures), improved seismic monitoring, fault mapping, and public communication.
- A state issue.

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