KANSAS GEOLOGICAL SURVEY
The University of Kansas

TESTIMONY
House Standing Committee on Energy and Environment
Rex Buchanan, Interim Director
Kansas Geological Survey
20 January 2016

Mr. Chairman, Members of the Committee:

My name is Rex Buchanan. I am the interim director of the Kansas Geological Survey, a research and service division of the University of Kansas. I also chair the state's task force on induced seismicity. I am here today to provide a brief update on the issue of seismicity in Kansas and to answer questions.

As you know, induced seismicity is generally defined as earthquakes that are caused by human activity. The consensus within the scientific community is that the recent increase in seismicity in the midcontinent, including Kansas, is generally related to increases in the disposal of saltwater produced along with oil and gas. A handful of midcontinent earthquakes have been attributed directly to hydraulic fracturing, but to the best of our knowledge, no Kansas earthquakes have been directly caused by hydraulic fracturing. Instead, the issue appears to be one of disposal of large volumes of saltwater that has activated critically stressed faults in the deep subsurface.

Since we appeared before you last year, there have been a number of developments. Working with the Kansas Corporation Commission, the KGS has established a temporary seismic array for the monitoring of earthquakes in south-central Kansas. Dr. Richard Miller from our staff will brief you on the results of that monitoring. In March 2015 the KCC issued an order that, among other things, resulted in a staged reduction in the volume of saltwater being disposed of in five zones of seismic concern in Harper and Sumner counties. Ryan Hoffman, head of the KCC oil and gas division, will update you on that.

In the past year, we've seen a significant reduction in larger earthquakes (>2.7) with epicenters in Kansas, as shown on the attached graph of earthquakes reported by the U.S. Geological Survey's National Earthquake Information Center. There were about 60% fewer earthquakes of Magnitude 2.7 and larger in the last six months of 2015 compared to the last six months of 2014. We have discussed the possible reasons for this reduction, including the KCC order and the slow-down in exploration, production, and saltwater disposal that has resulted from low oil prices. At the same time, smaller earthquakes (<2.0) have not decreased, but appear to be increasing.

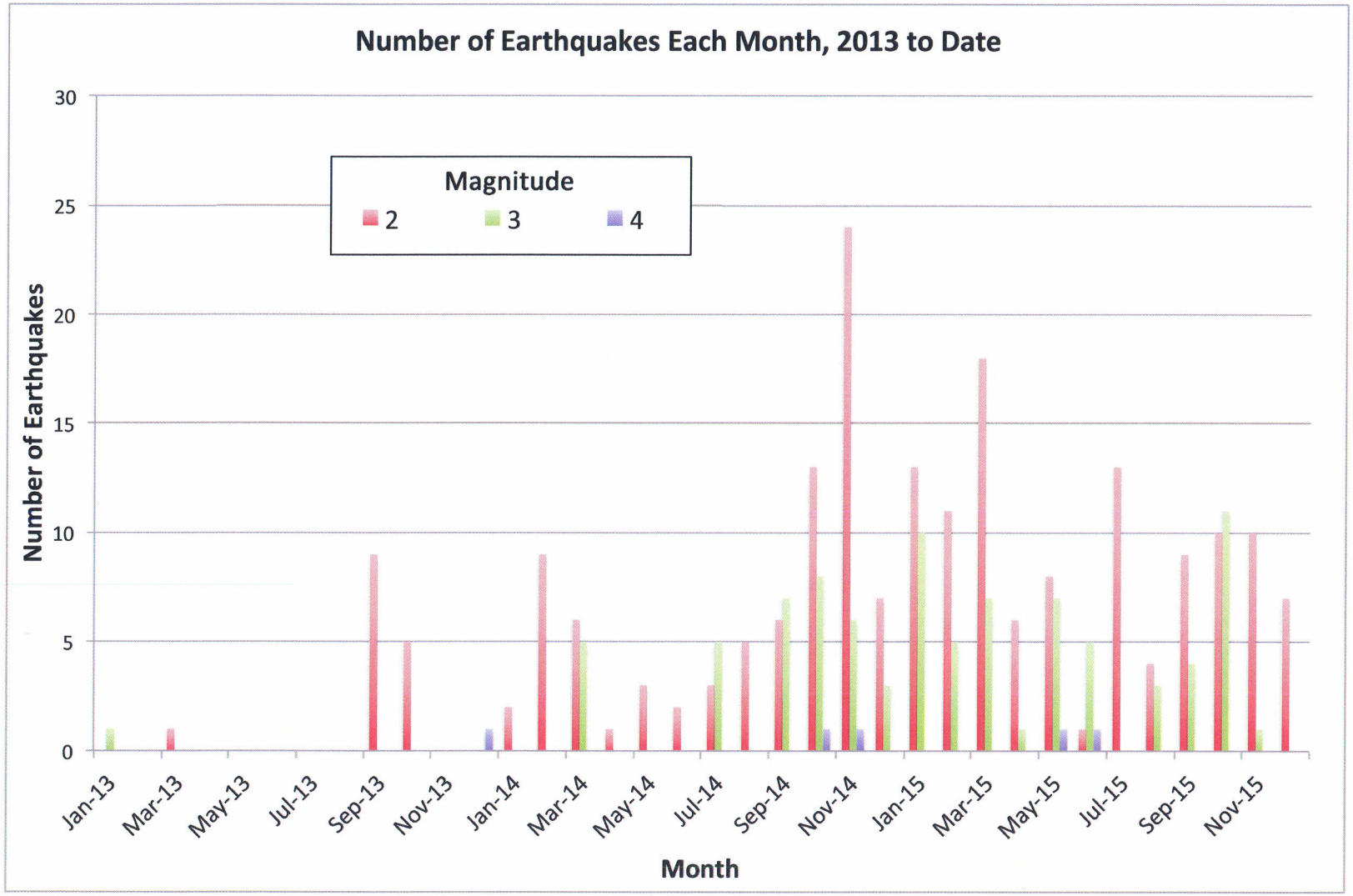
The KGS, the KCC, and Kansas Department of Health and Environment staff have been in regular, close contact throughout the past two years. This is a challenging issue, but I believe these organizations have worked it cooperatively and effectively. At the same

time, we have learned as much as possible from other organizations and localities that are studying induced seismicity. In the past year, we hosted presentations and conversations with representatives from ExxonMobil, Pioneer Natural Resources, the U.S. Geological Survey, and other state geological surveys, all of which are studying induced seismicity in the midcontinent. We have talked with researchers at the Stanford University Center for Induced and Triggered Seismicity, an industry-funded consortium that has a long history of research into rock mechanics and induced seismicity. Both the KGS and the KCC were involved in a national effort by the Interstate Oil and Gas Compact Commission and the Groundwater Protection Council to develop information on induced seismicity for state regulators. Kansas efforts to mitigate seismicity have been informed by all these conversations.

We've also worked hard to provide regular updates and listen to concerns within the state. We've met regularly with the Governor and the Harper County Commission, and we've spoken to a number of state organizations, including engineering, insurance, and environmental groups, the Kansas Independent Oil and Gas Association, and the Kansas Geological Society. We have also begun conversations with the Kansas Water Office and others about possible reuse and recycling of saline water produced from oil and gas wells.

Our understanding of this issue is significantly better today than it was a year ago. I believe that we have made significant progress. Having said that, the issue has not gone away and there is no reason to expect that it will. We continue to have small magnitude earthquakes. The conventional wisdom in the scientific community is that it took years for this issue to develop, and it will take significant time to remediate it. And while oil prices are currently low, we know that they will recover, that new technologies will be brought to bear on exploration and production. We view this as a long-term issue that requires ongoing monitoring and response. I would hope that you all view it that way too.

Thank you for the opportunity to appear before you today.



Kansas Geological Survey

Data from U.S. Geological Survey

Jan. 7, 2016

Kansas Earthquake Activity in 2015

Kansas Geological Survey

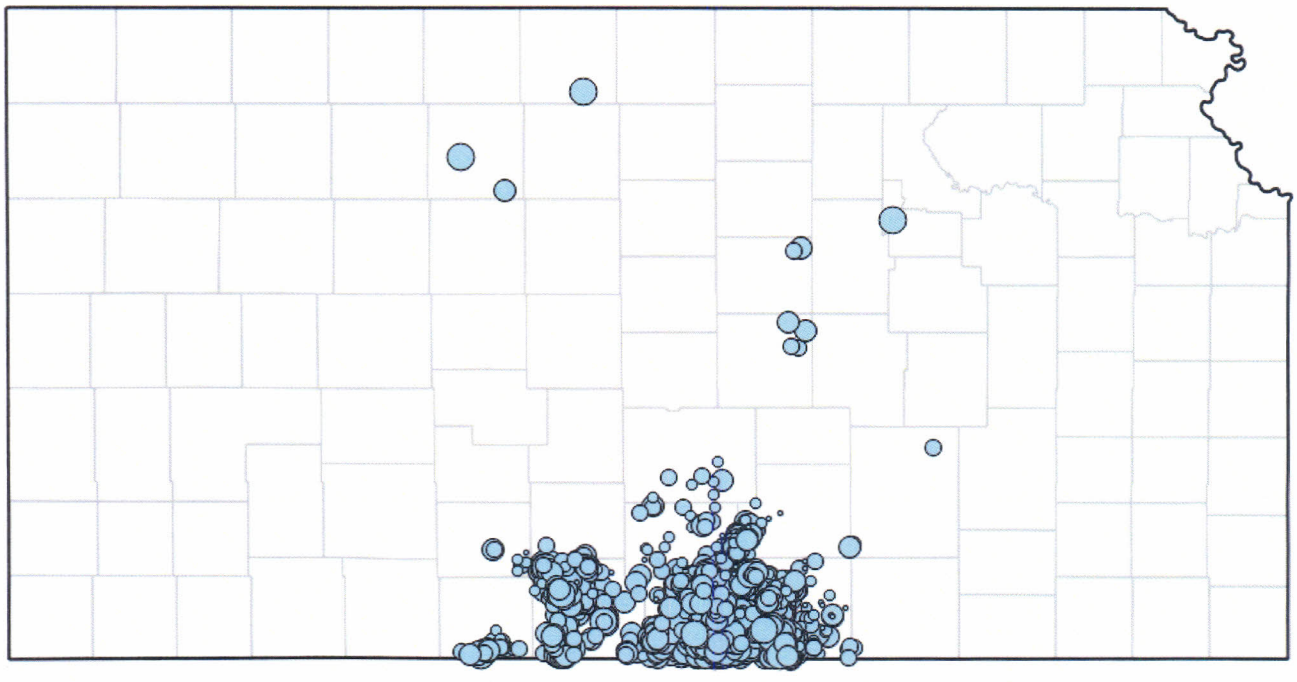


Figure 1. 4785 earthquakes ranging from magnitude 0.0 to 3.7 were located by the KCC/KGS network in Kansas in 2015. Eighty-five percent of the earthquakes occurred in Harper and Sumner counties.

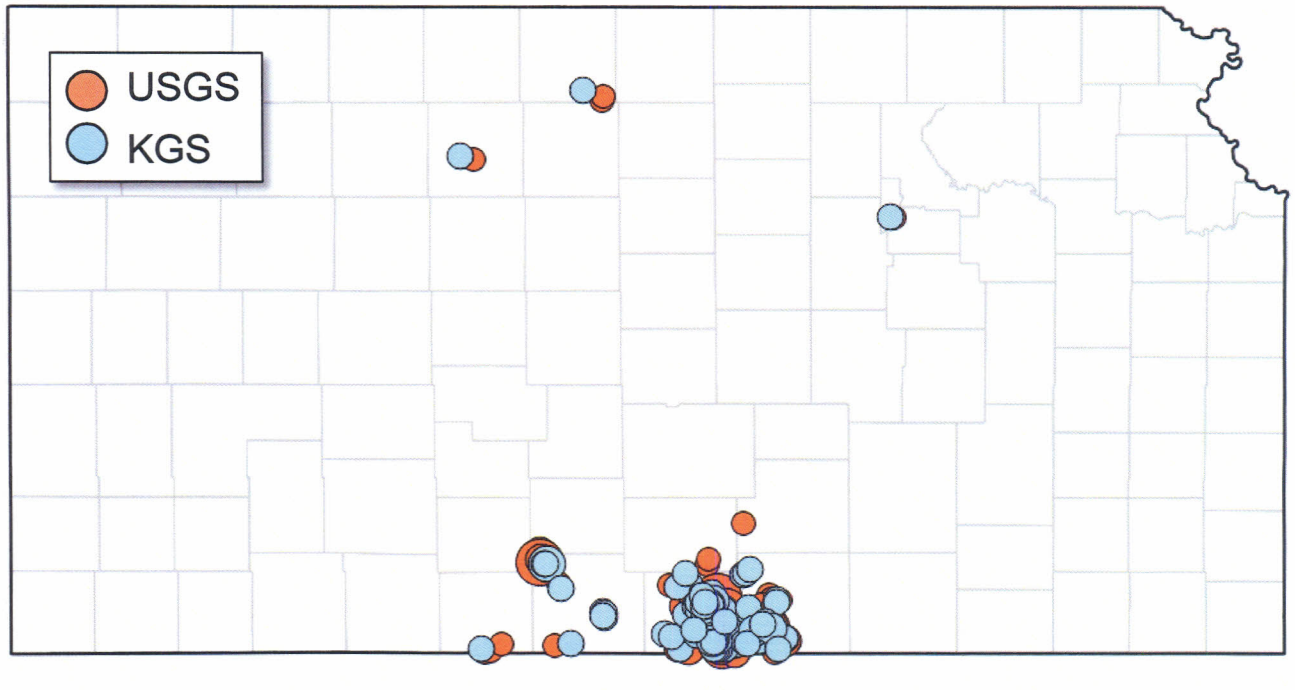


Figure 2. Earthquakes reported by the USGS (orange, 172) and KGS (blue, 148) with magnitude 2.5 or greater. Locations of earthquakes of this size reported by both agencies are generally consistent.

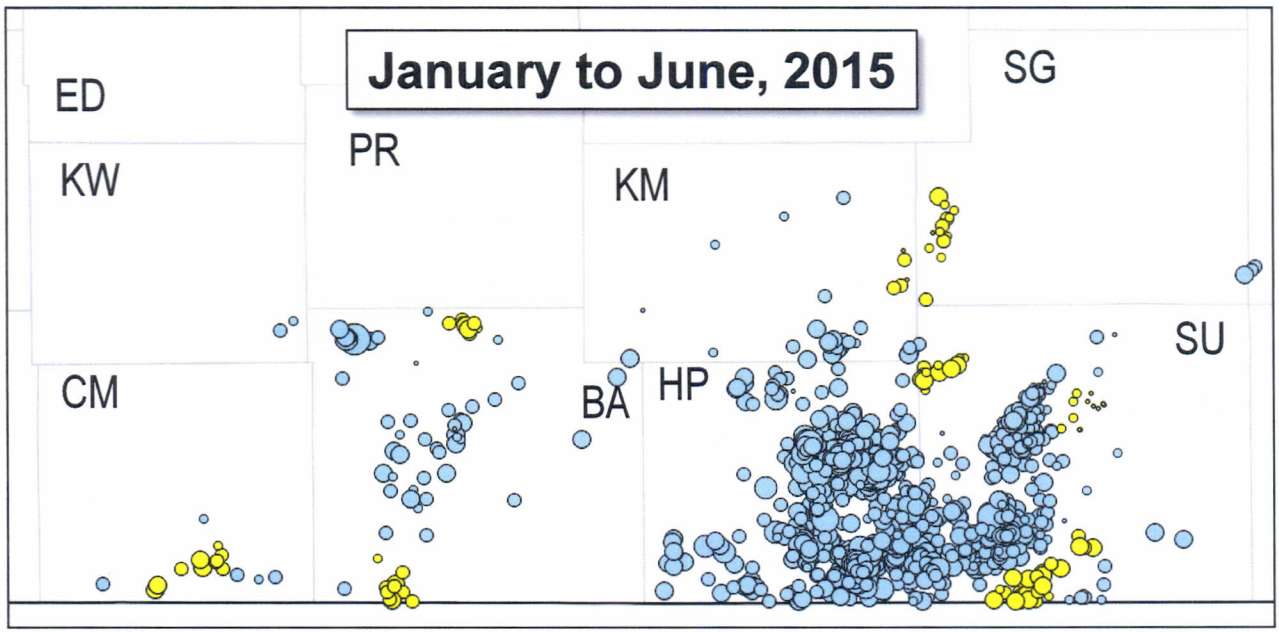


Figure 3. 1690 earthquakes were located by the KCC/KGS network in south-central Kansas from January to June, 2015. Yellow indicates areas with very little activity during the first half of the year that increased significantly during the second half of the year.

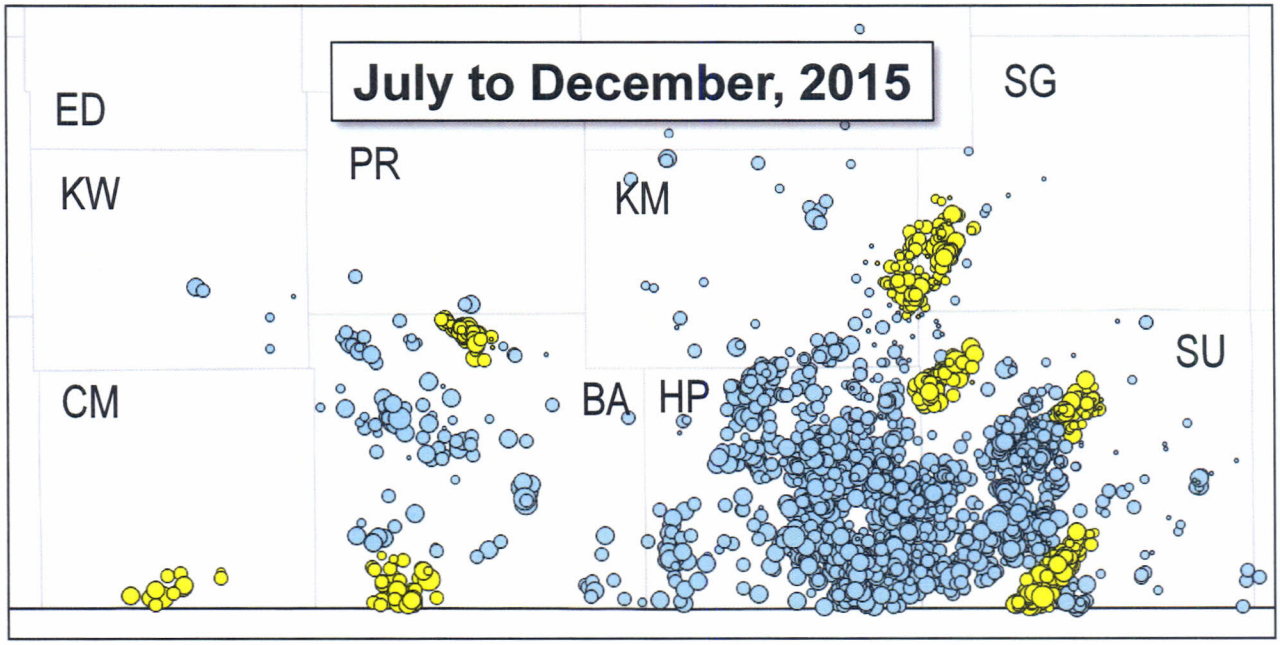


Figure 4. 3085 earthquakes were located by the KCC/KGS network in south-central Kansas from July to December, 2015. Yellow indicates cluster areas with very little activity during the first half of the year that increased significantly during the second half of the year.

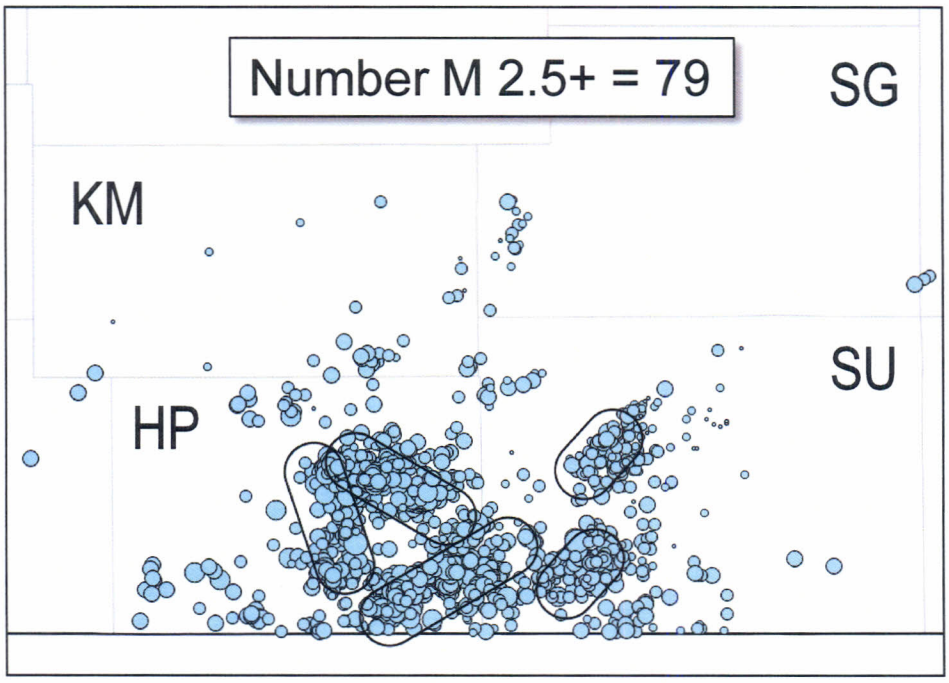


Figure 5. Of the 1690 earthquakes that occurred in Kansas from January to June 2015, 1206 were located within the areas of seismic concern where the KCC ordered a reduction in saltwater disposal volumes.

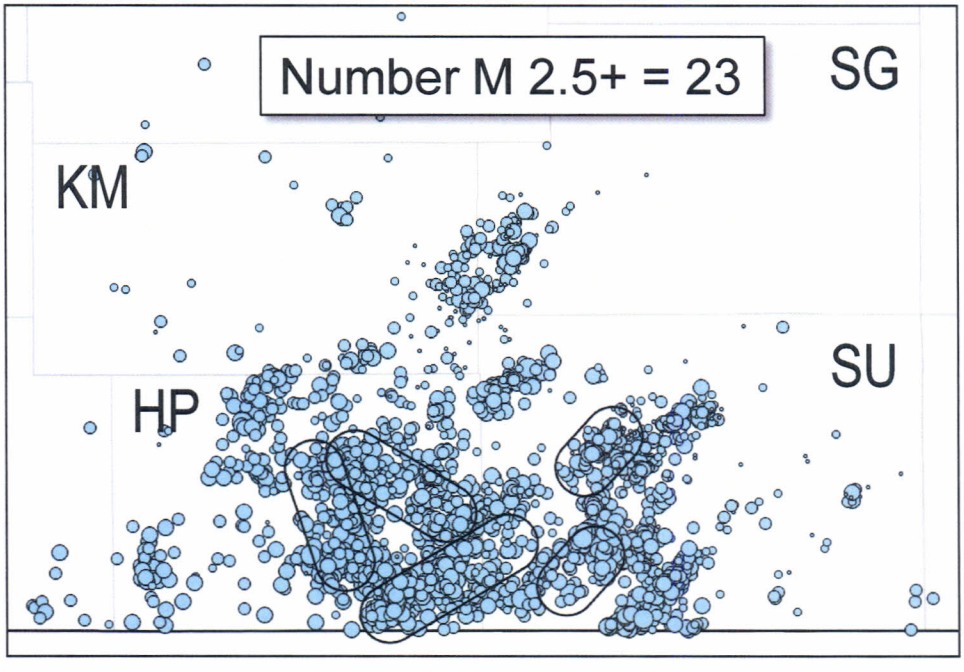


Figure 6. Of the 3085 earthquakes recorded in Kansas from July to December 2015, 1174 were located within the areas of seismic concern.

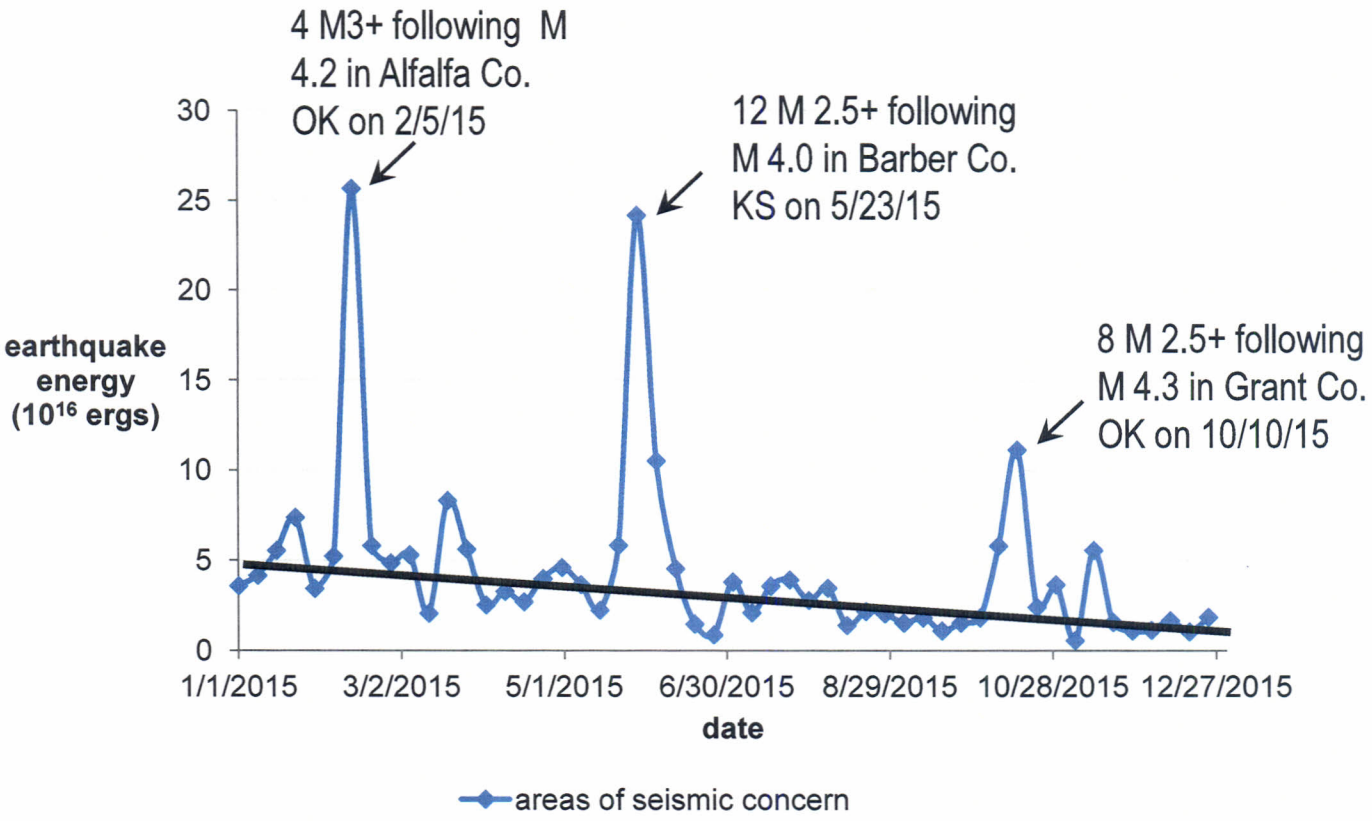


Figure 7. Total earthquake energy per week in the areas of seismic concern in 2015. Weeks with a large amount of energy typically followed a large event in neighboring Kansas and Oklahoma counties in the preceding days. Earthquake energy from July to December energy is approximately half that observed from January to June.

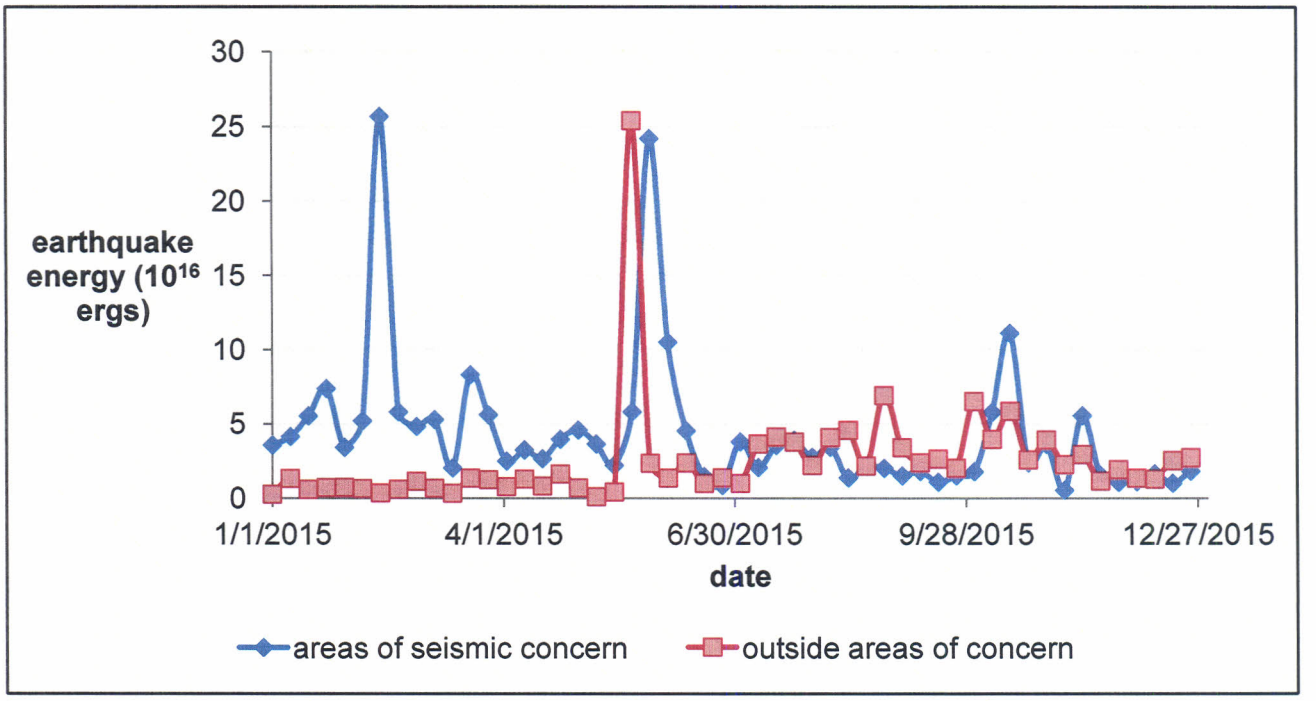


Figure 8. Total earthquake energy per week in the areas of seismic concern (blue) and in the rest of the state of Kansas (red).

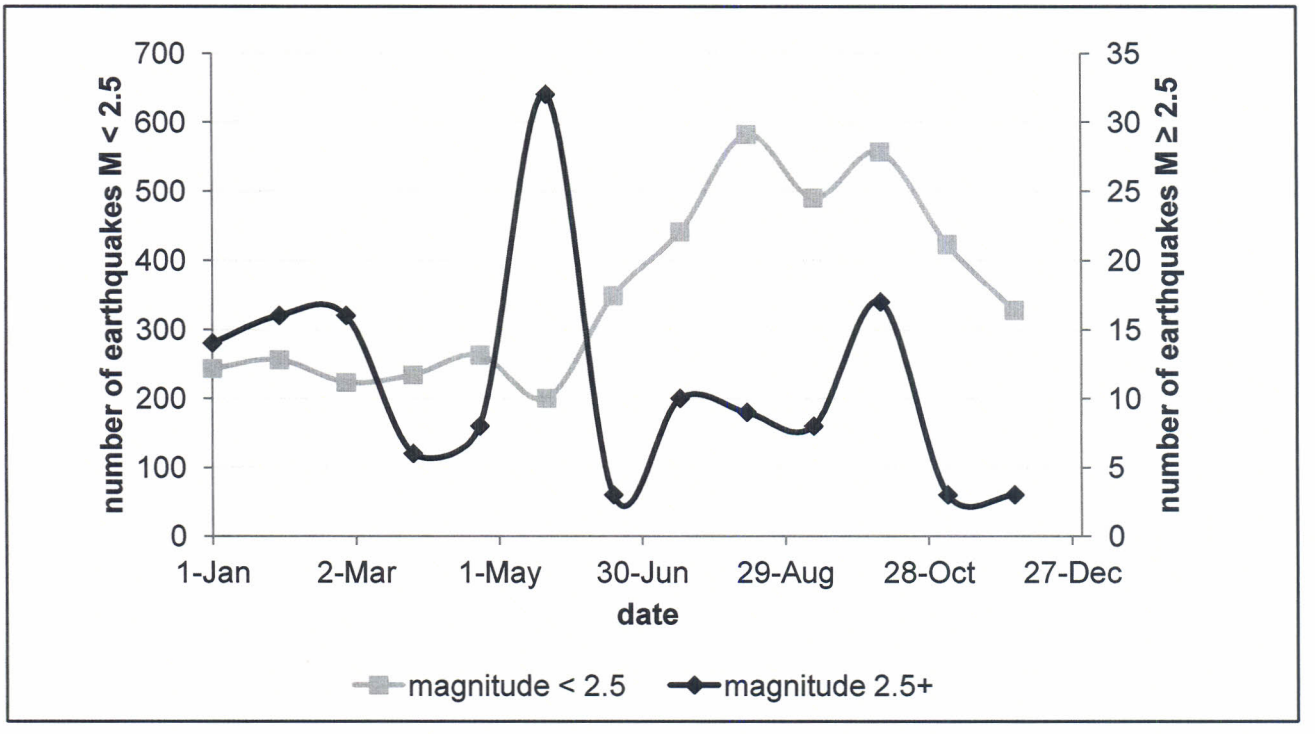


Figure 9. Number of earthquakes in Kansas with magnitude less than 2.5 (gray) and magnitude 2.5 or greater (black) per week.

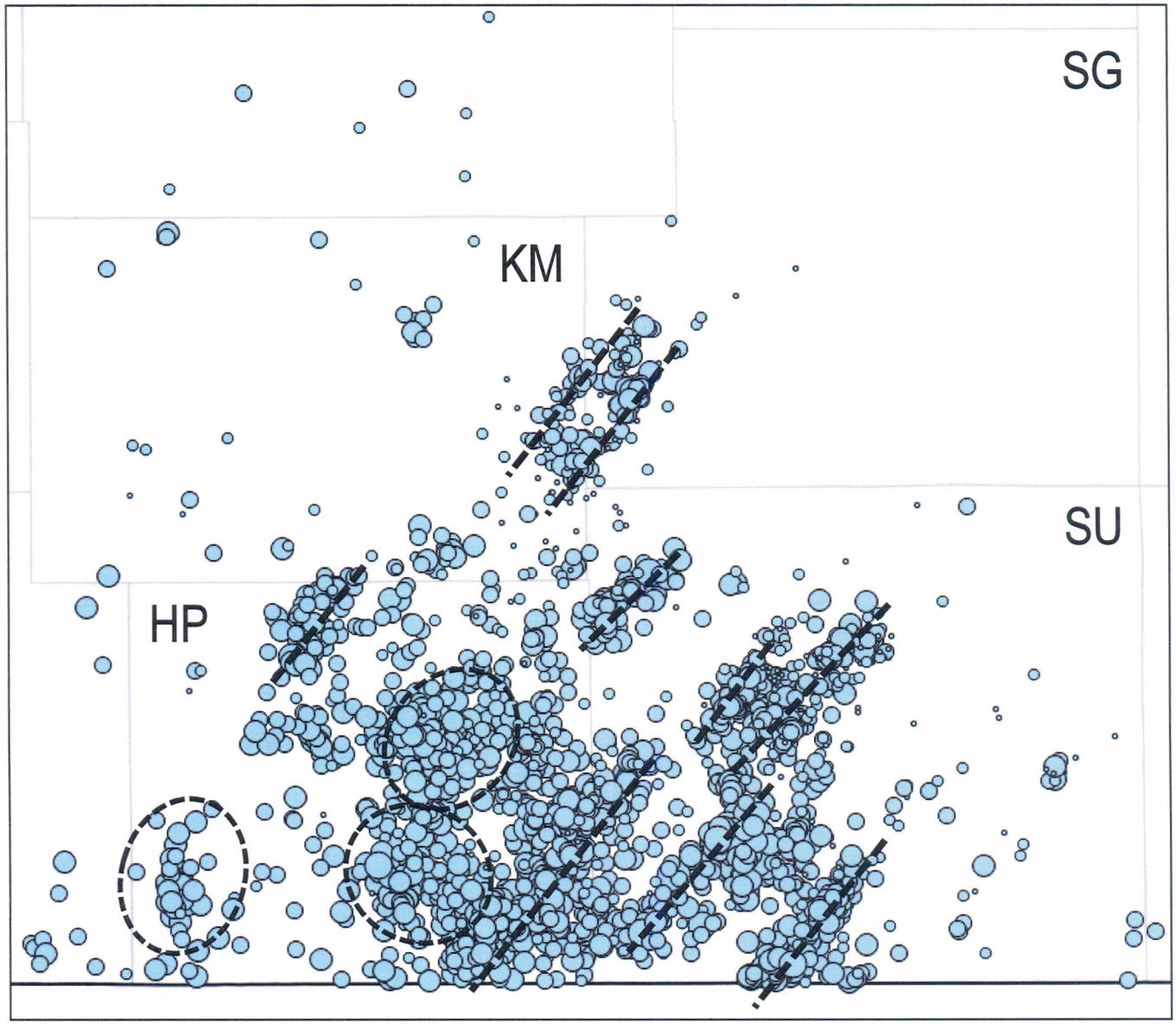


Figure 10. Earthquakes recorded south-central Kansas from July to December 2015. Patterns of earthquake epicenters are generally a combination of cloud-like (dashed circles) and linear (dashed lines), typically but not always with a northeast-southwest trend.