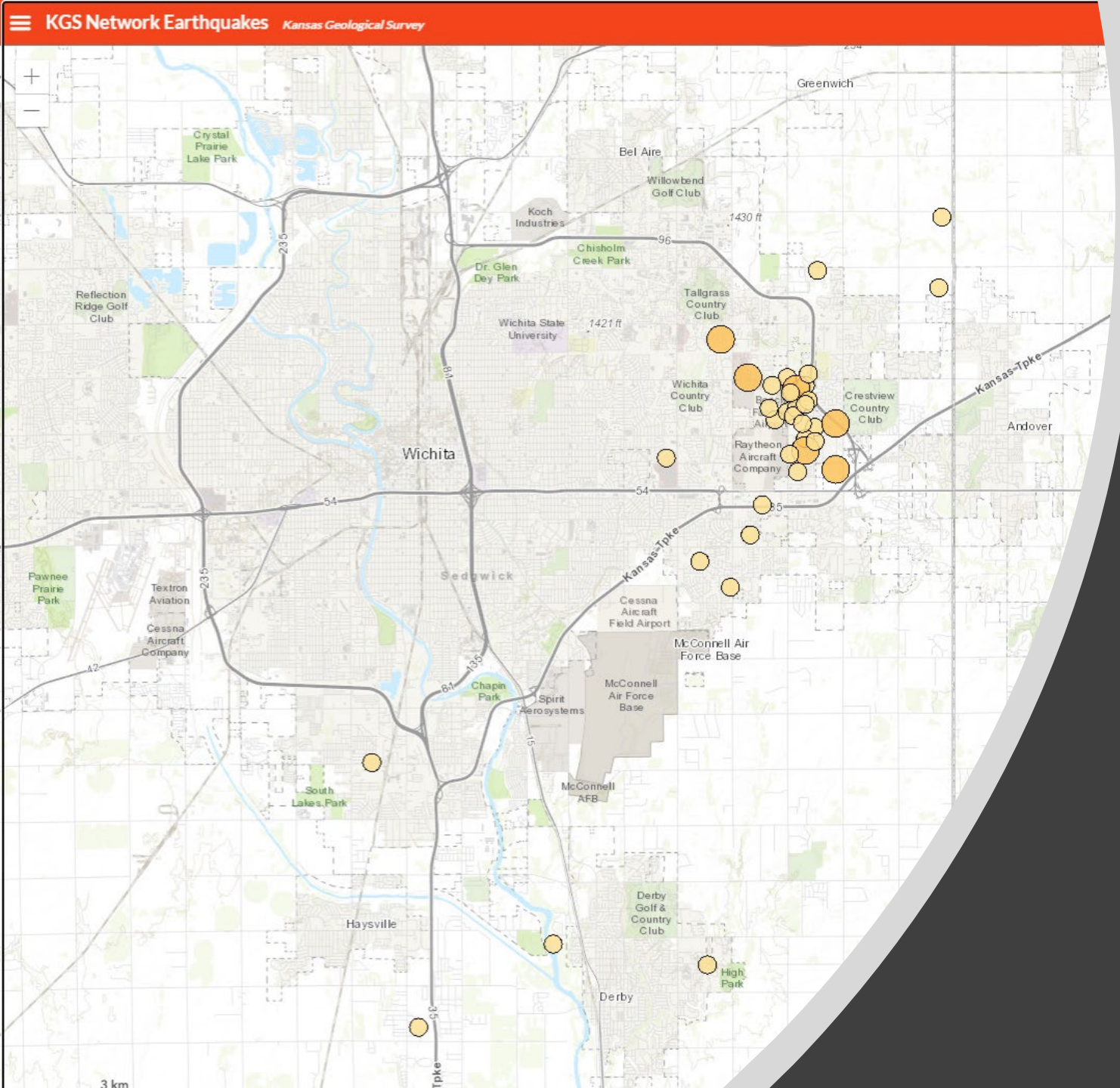


Earthquakes Recorded along the Wichita Trend 11/26/20 to 01/04/21

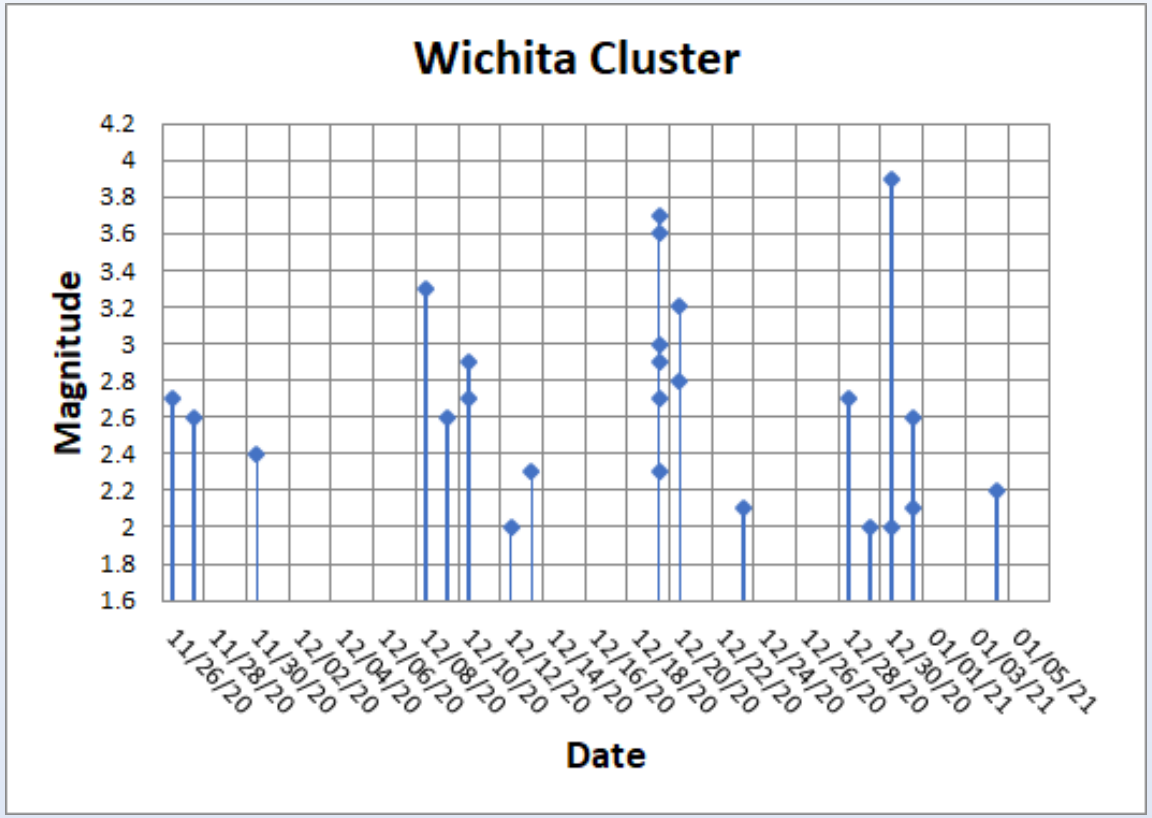
Kansas Geological Survey

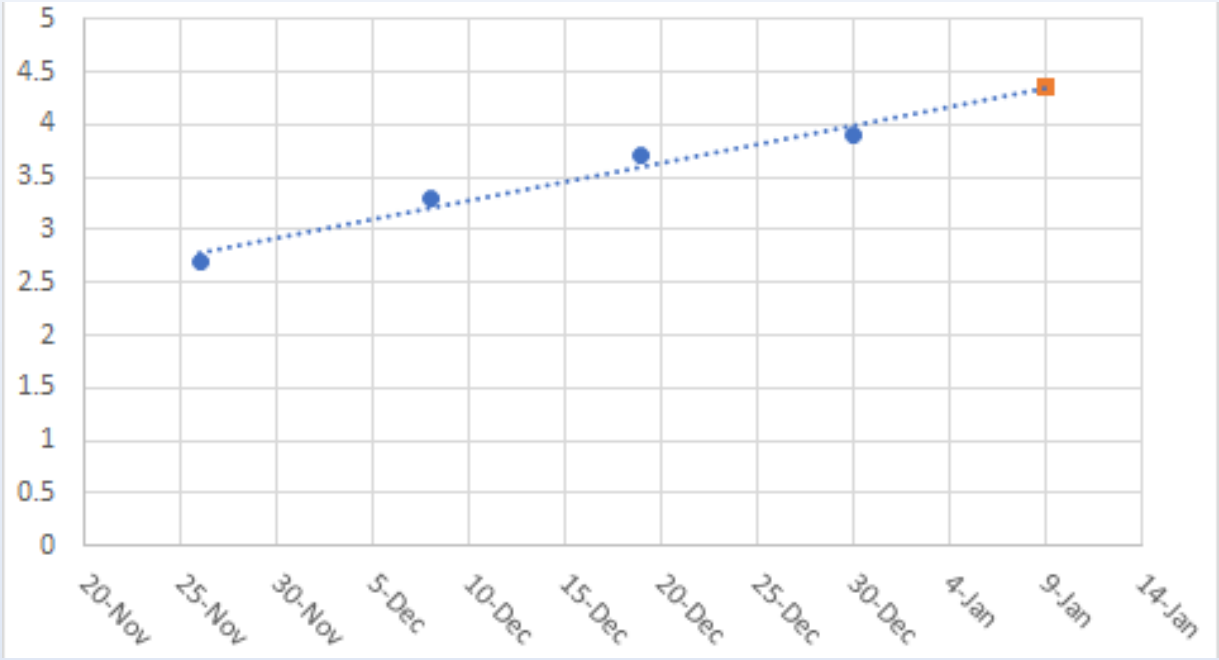
Miller, Peterie, Gonzales,. Buchanan

Magnitudes: Why is USGS different from KGS?

- **Richter Scale**—designed to provide a measure of magnitude for smaller earthquakes (<M5) possessing higher frequencies and recorded at close proximity stations. This magnitude scale is also known as the **M_L** or **Local Magnitude**.
- **Richter Magnitude or Local Magnitude (M_L)**—is most accurate for higher frequency earthquake energy and earthquakes in close proximity to several stations. Using California, where the Richter Scale was developed, as a model close proximity stations would be within about 200 km (125 miles).
- **Moment Magnitude(M_M)**—is a uniform extension of the Richter Magnitude and for very large earthquakes **M_M** gives the most reliable estimate of an earthquake's size. **M_M** is estimated from an earthquake's moment, which is the slip of the fault multiplied by the area of the fault surface that slips and is related to the total energy. The moment is converted to a number that can be correlated to magnitude. **M_M** provides a value measure of magnitude over a wide range of earthquake sizes.
- **KGS uses the Local Magnitude** because **M_L** most closely mimics the Richter Scale for smaller earthquakes and is consistently accurate for earthquakes, regardless of changes in local geologic conditions. Its accuracy is limited to earthquakes less than M5 or there abouts.
- **USGS uses Moment Magnitude** so they can use the same measurement method for all earthquakes globally, regardless of size or location of the nearest station. This provides an accurate method for large earthquakes, but the method is not as accurate as **M_L** for smaller earthquakes recorded at nearby stations.

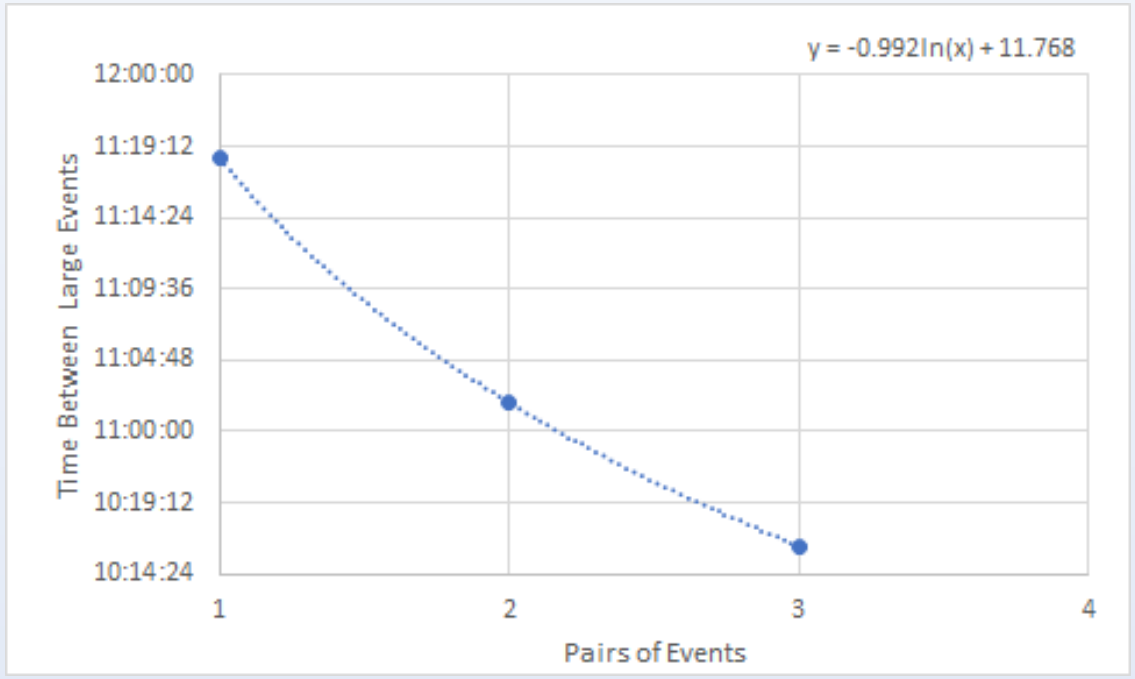
Sequence of Earthquakes >/= M2 Wichita Cluster Between Thanksgiving and Jan 4, 2021



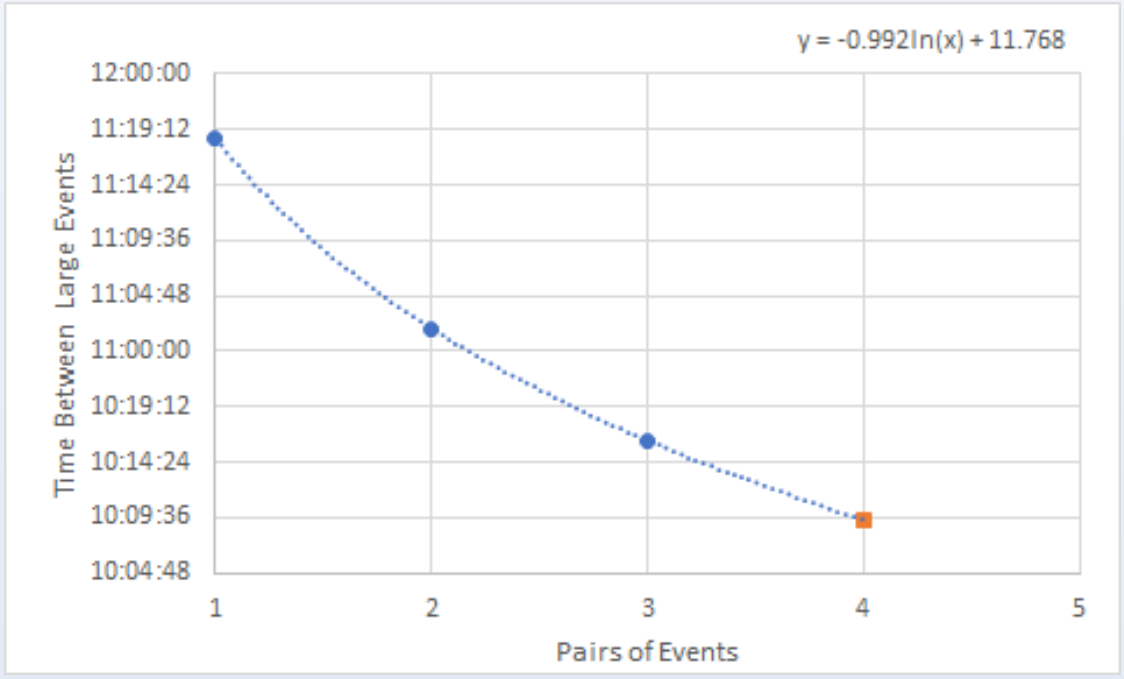


Time Series of Largest Earthquakes in Sequence on Wichita Cluster

Time series with difference between sequential events



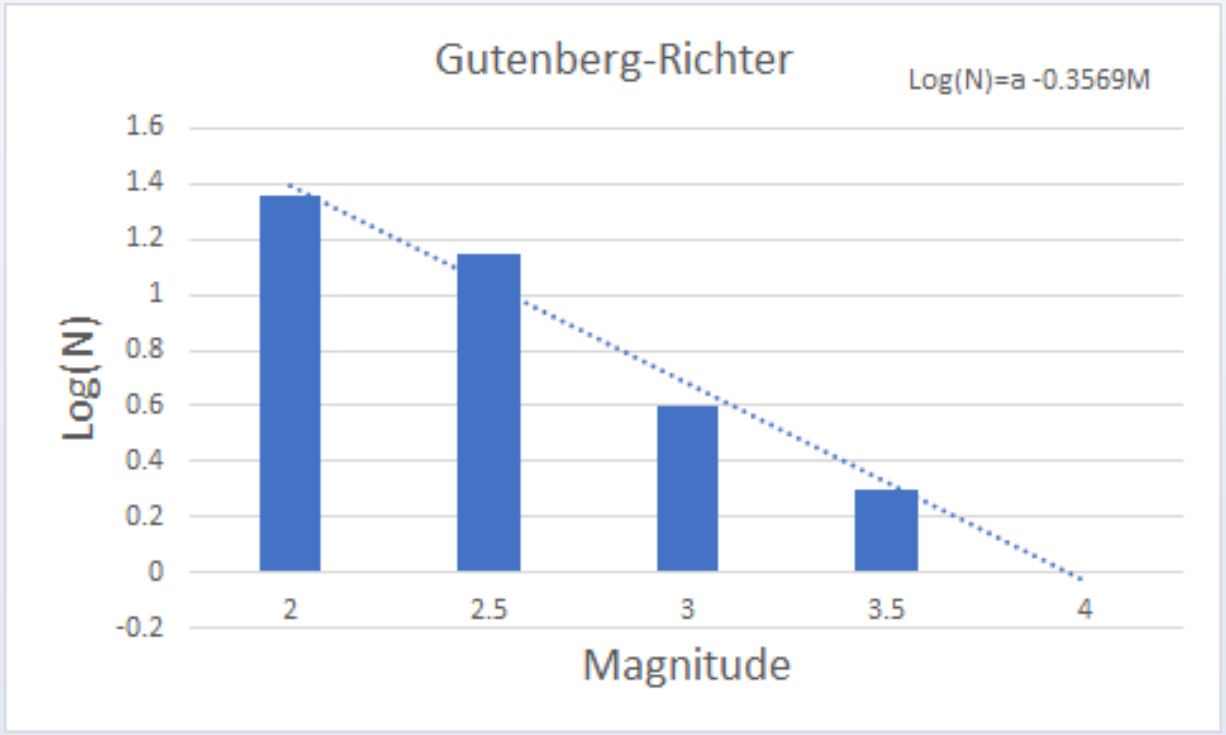
Time series with difference between sequential events and projection



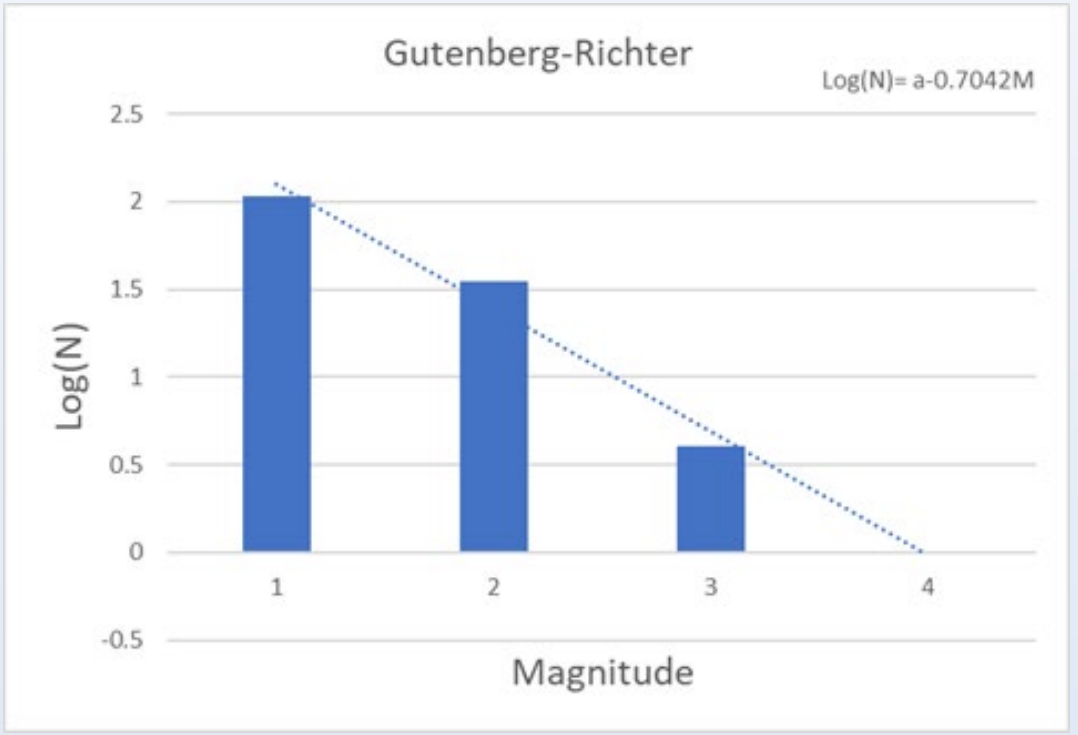
Event Pairs	Time Between Events (DD:HH:MM)
11/26/2020-12/8/2020	11:18:26
12/8/2020-12/19/2020	11:01:53
12/19/2020-12/30/2020	10:16:16
projected time next event	10:09:25

Gutenberg-Richter and Earthquake Expectations

Recursion relationship for Wichita cluster for 22 events from Thanksgiving to Jan 4, 2021



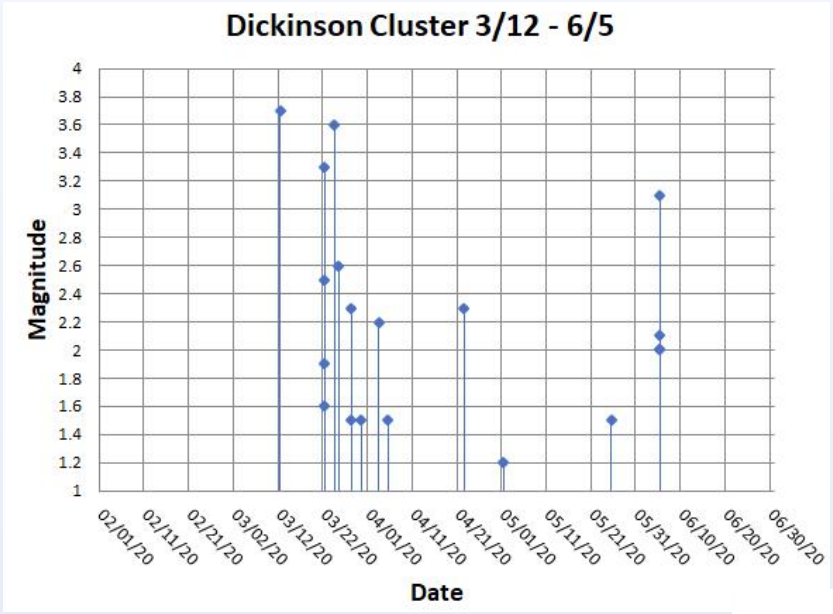
Recursion relationship for Wichita (10-mile radius CC) for 112 events beginning in 2016

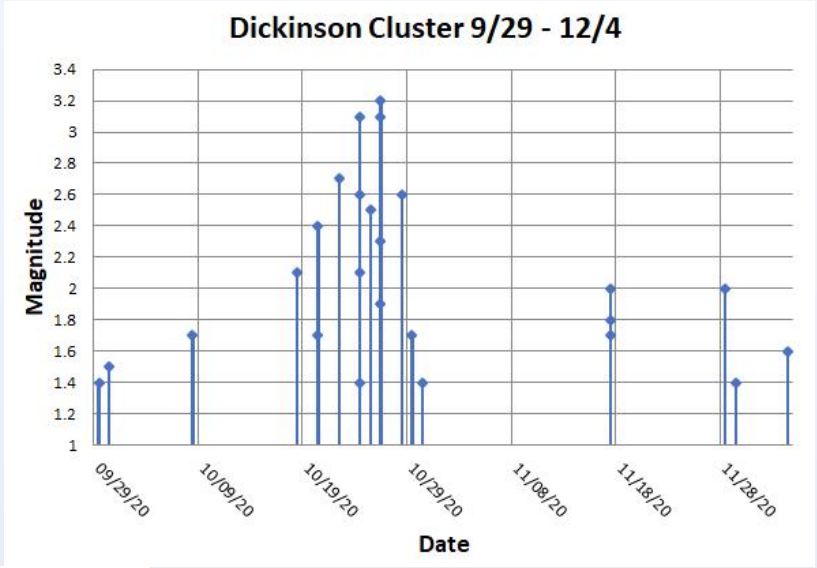


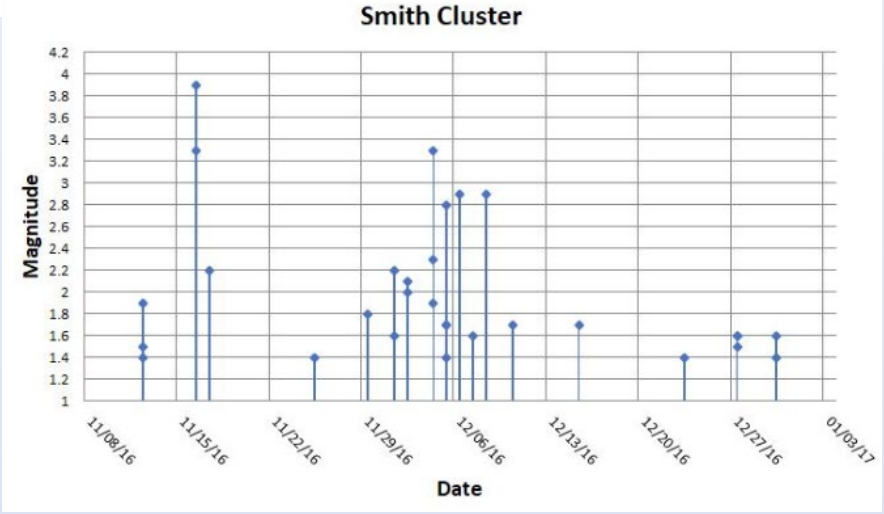
b index less than 0.5 not reasonable. Suggesting missing earthquakes. Within the Wichita cluster many more events below M2.5 are necessary raise the b index to within the normal range.

Based on available data, Wichita cluster should not be capable of producing an event larger than M4.5.

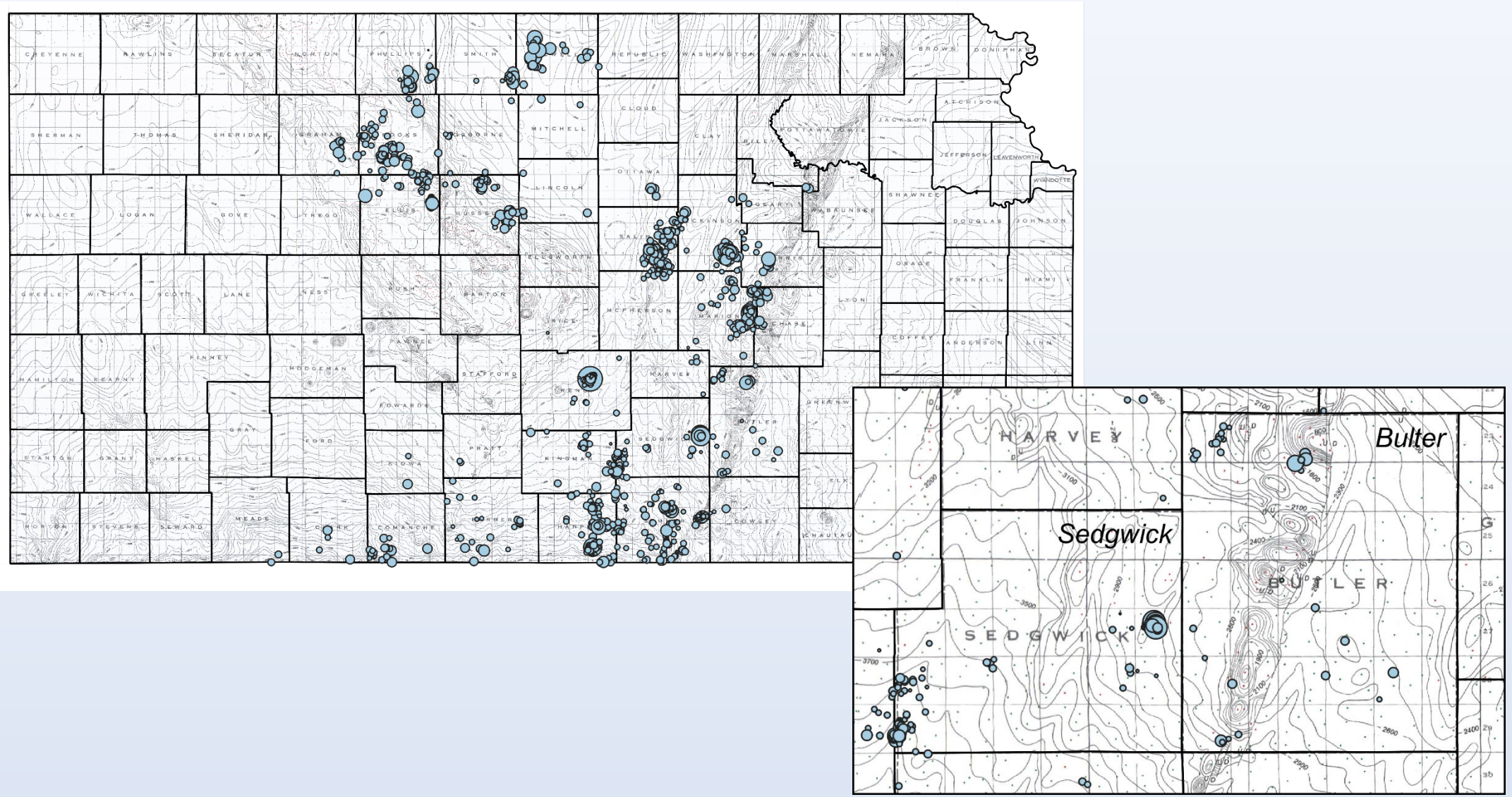
Examples of Typical Earthquake Sequences



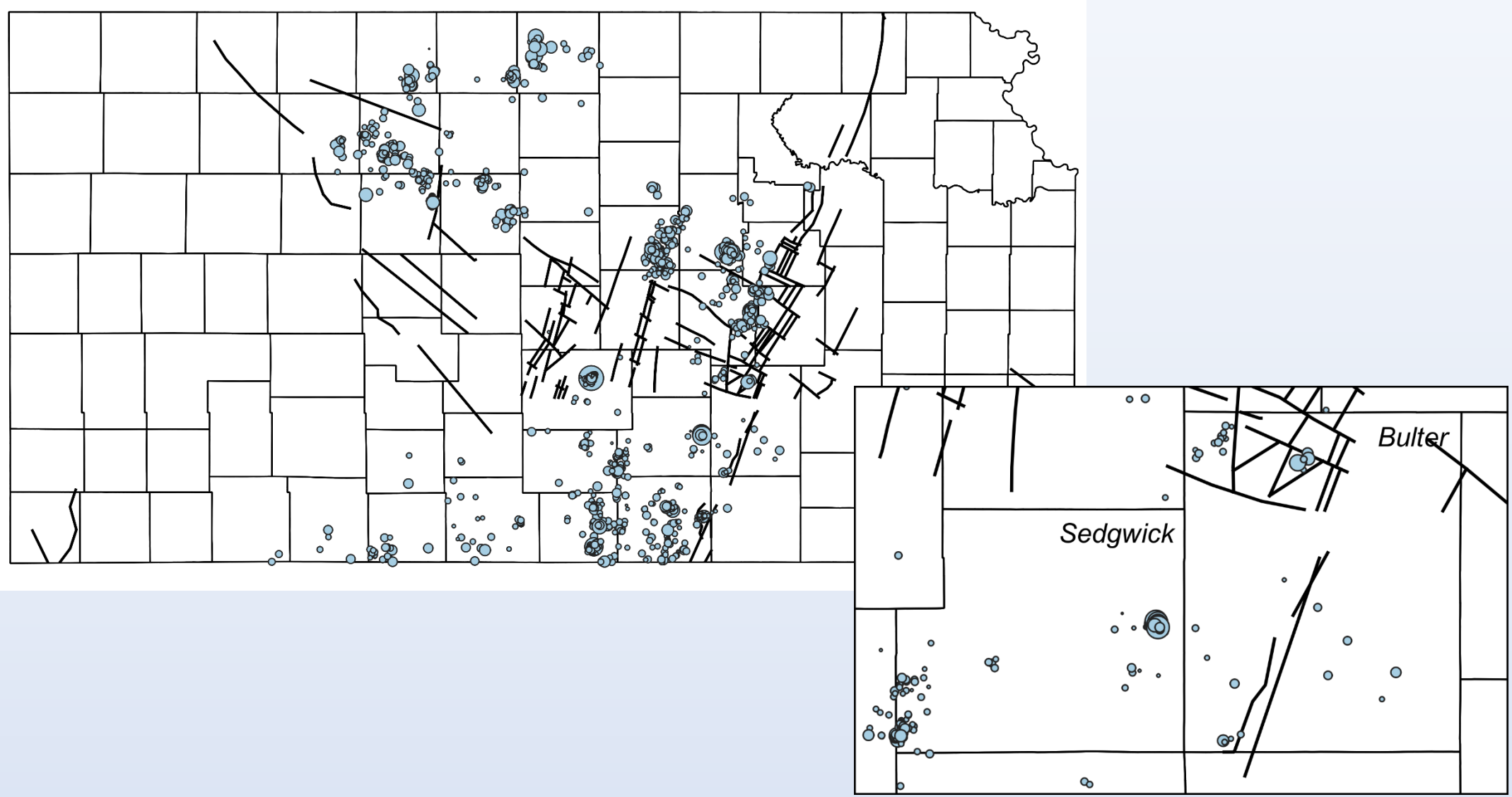




2020 Earthquakes with Basement Faults

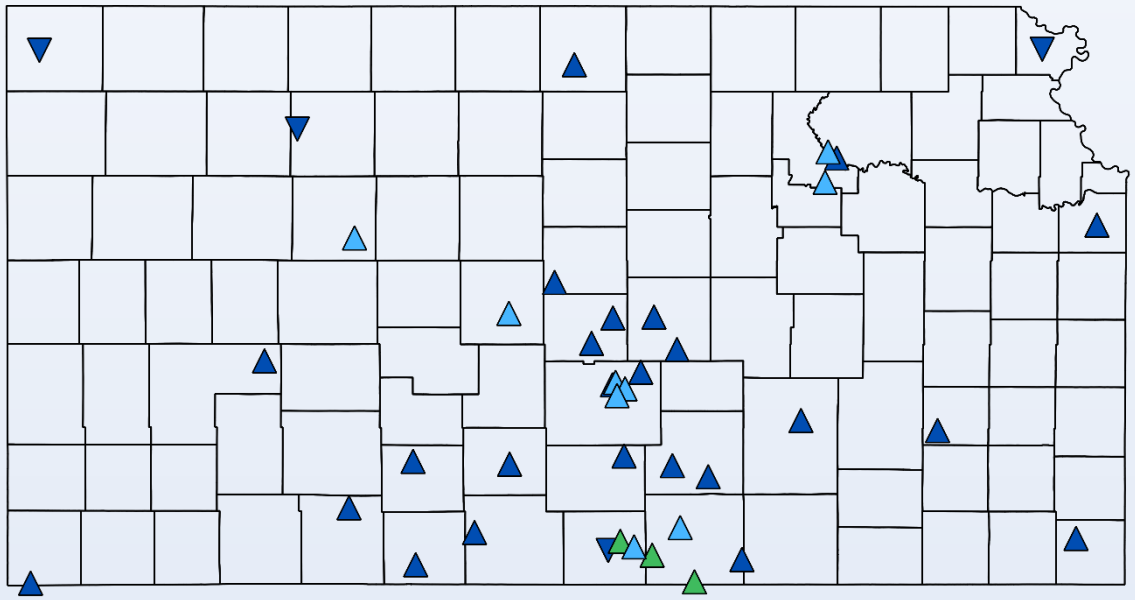


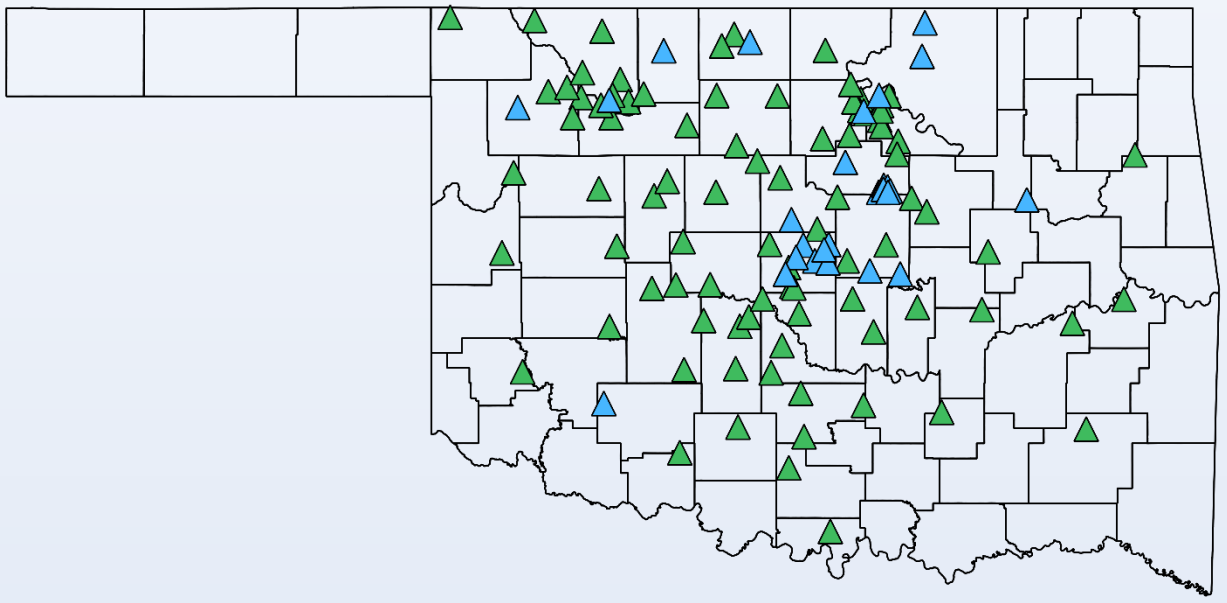
2020 Earthquakes with Basement Faults



Station Coverage

KGS USGS OGS



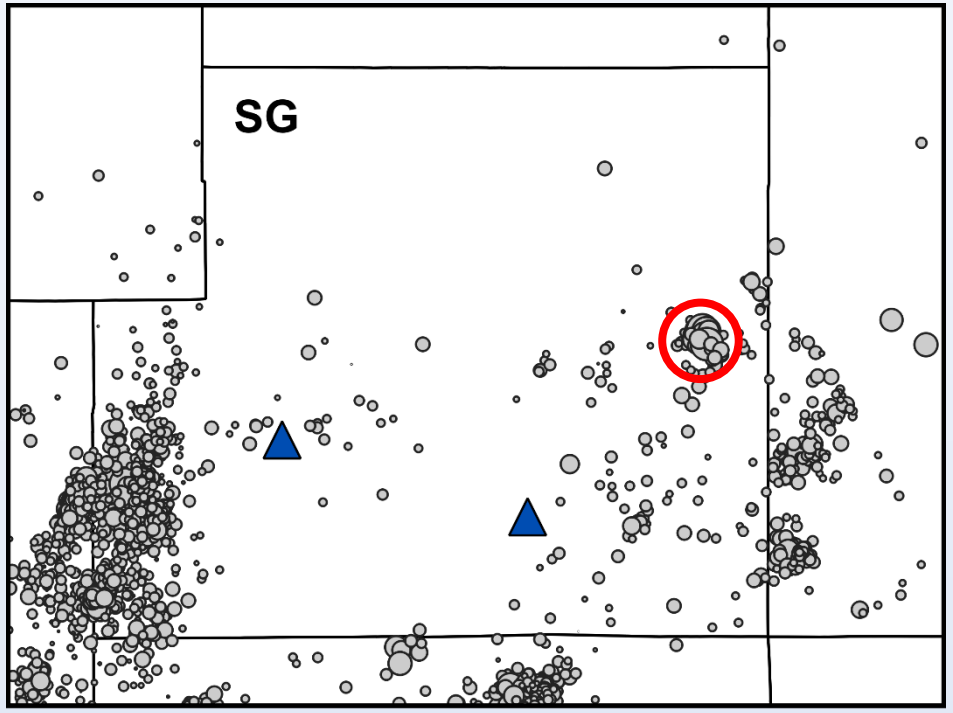


KGS stations = 30
USGS stations = 9 (3-4 permanent)
OGS stations = 3

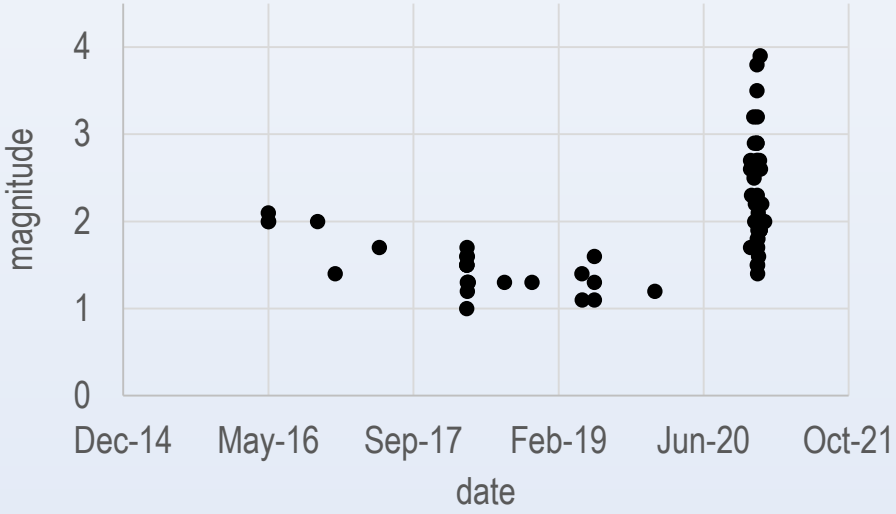
USGS stations = 30
OGS stations = 89

Wichita Earthquakes and Local Stations: KGS

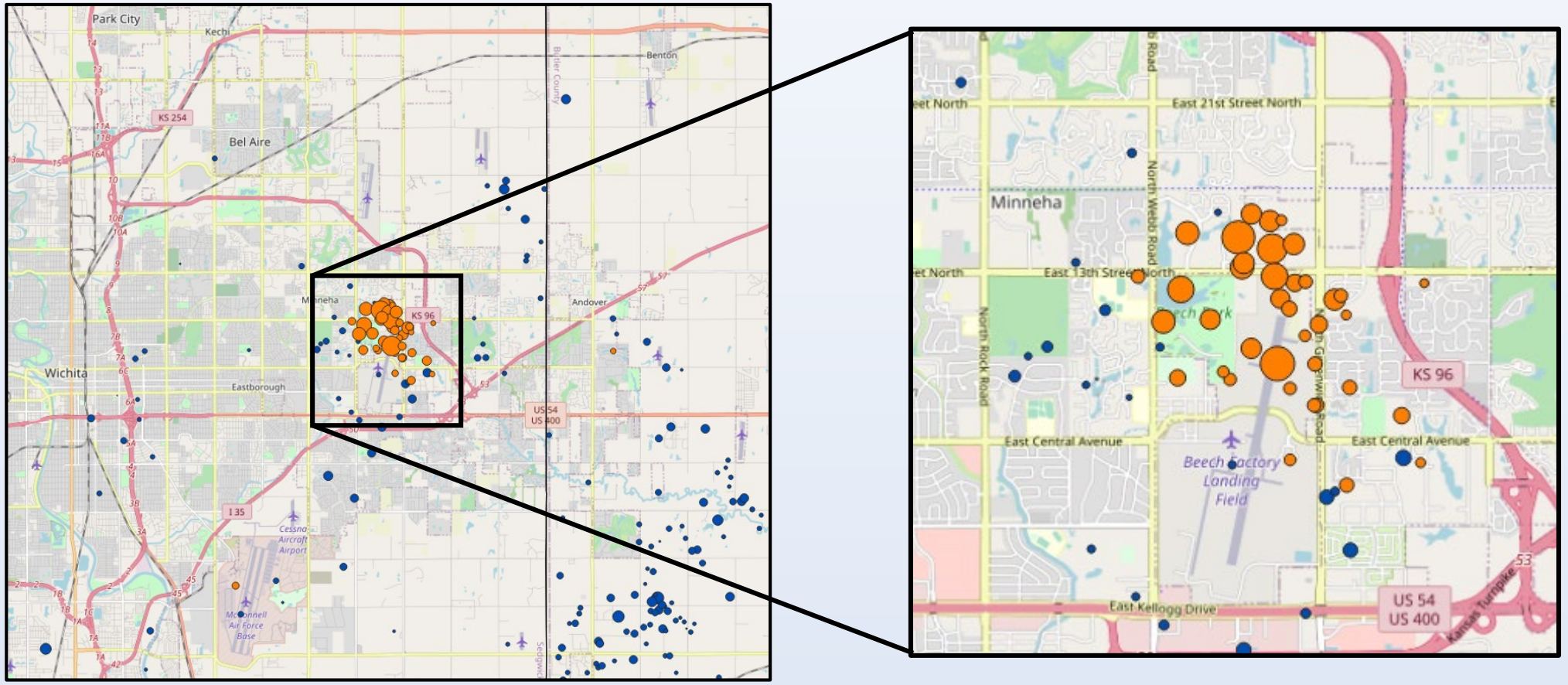
64 Wichita earthquakes (2 mi radius)



KGS earthquakes 2015-present



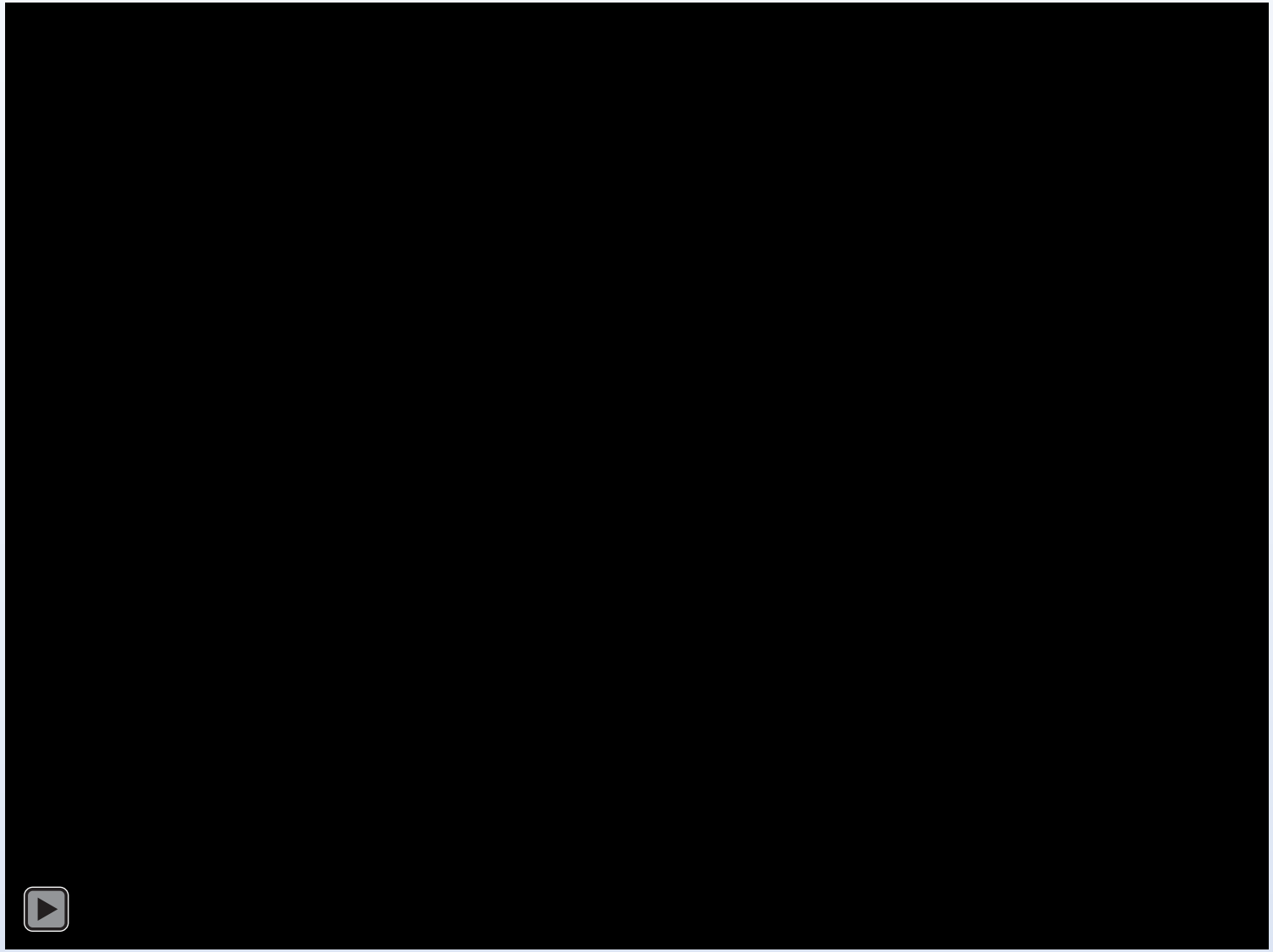
Close-up of Wichita Earthquakes



● 2015 to October 2020

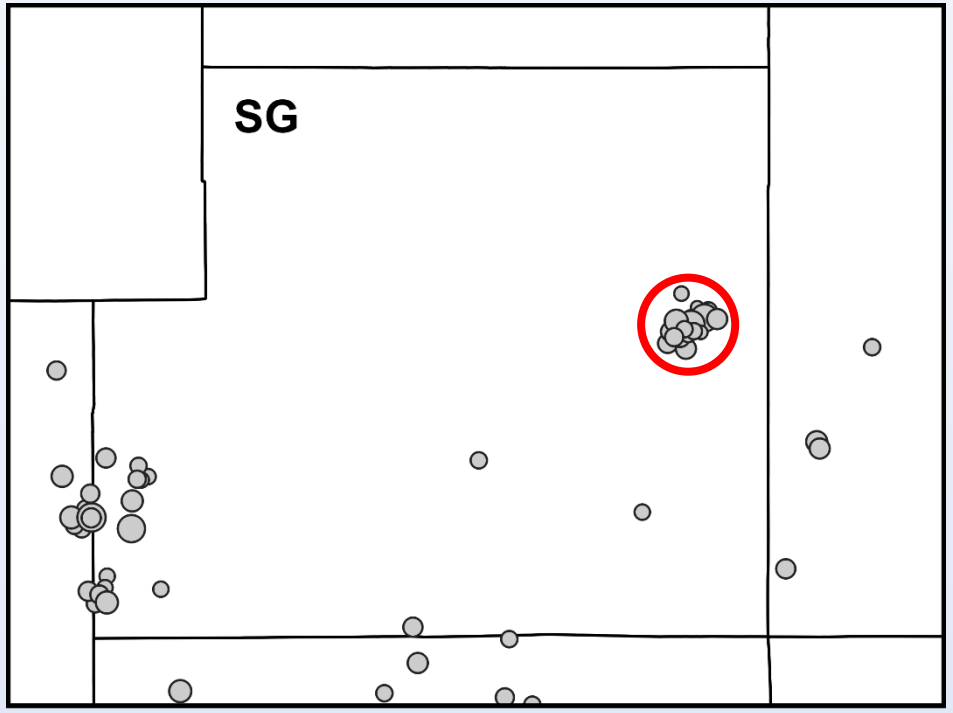
● November 2020 to January 2021

Sequence of Earthquakes from Thanksgiving till Jan 4, 2021



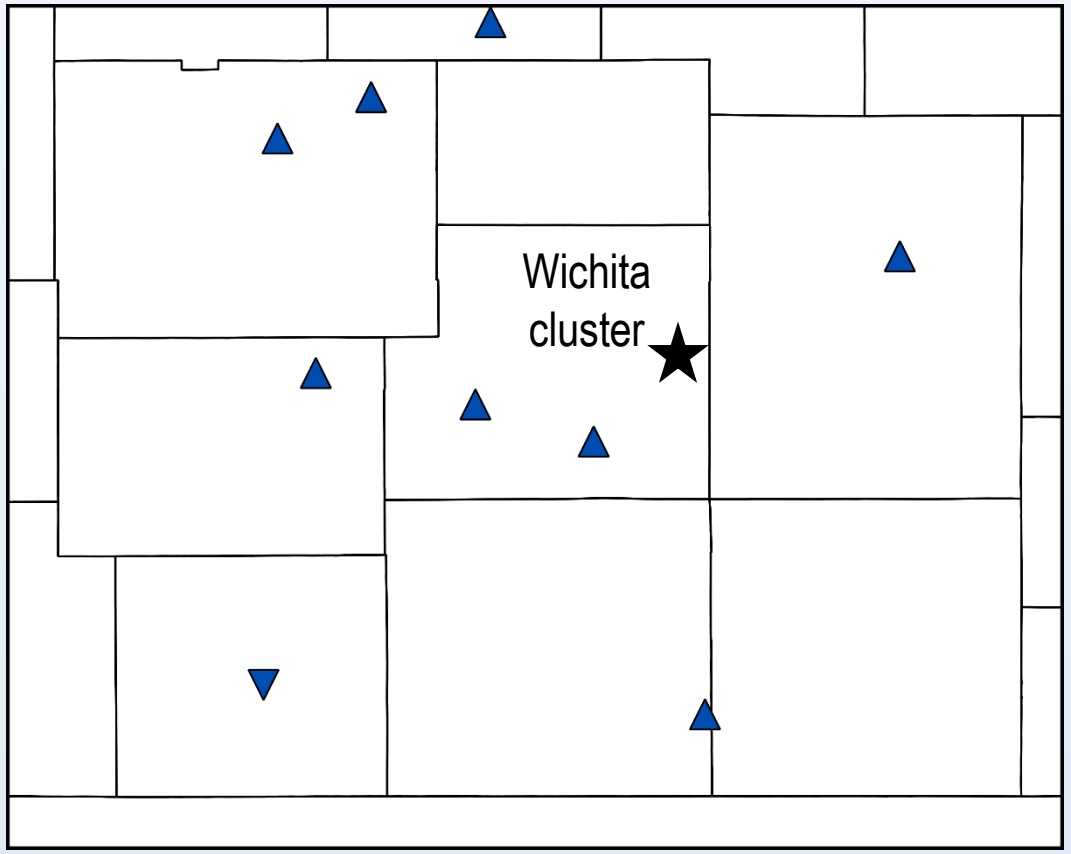
Wichita Earthquakes and Local Stations: USGS

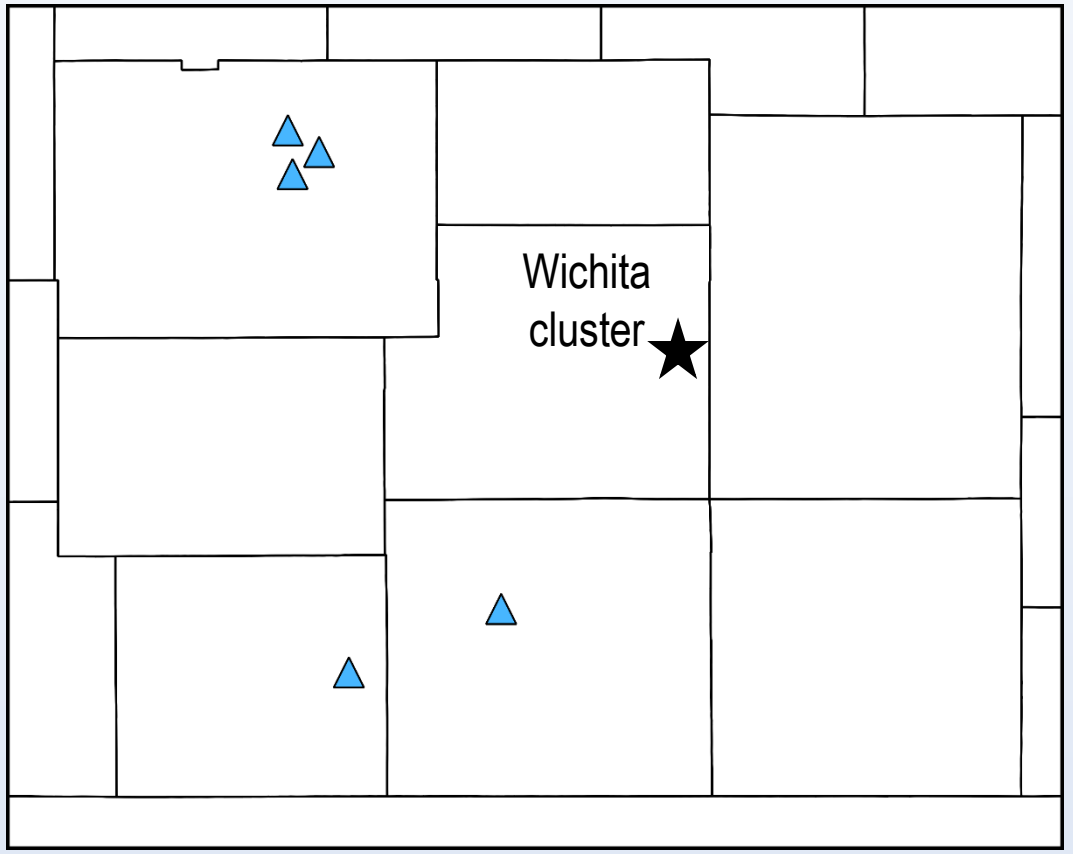
28 Wichita earthquakes



USGS earthquakes 2015-present

Local Earthquake Stations

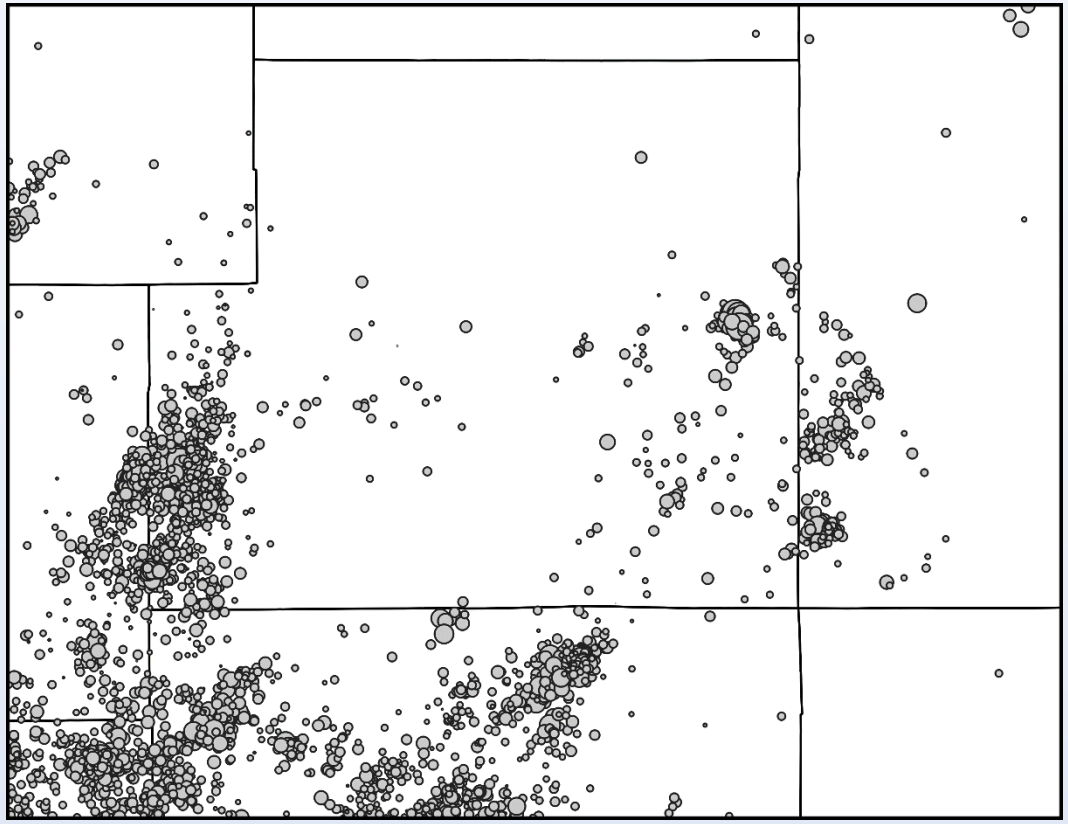




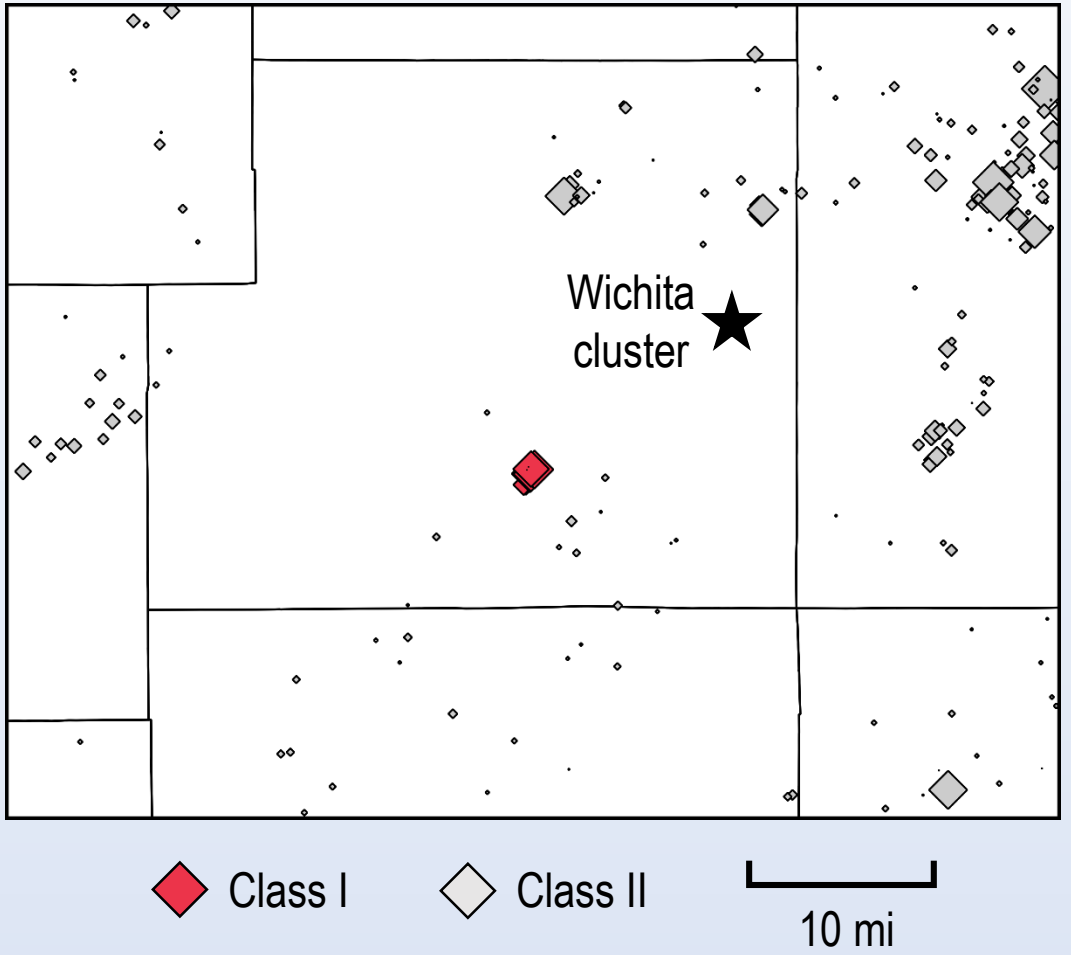
Note: these USGS stations are not part of the backbone permanent network

Wichita Area Disposal Wells

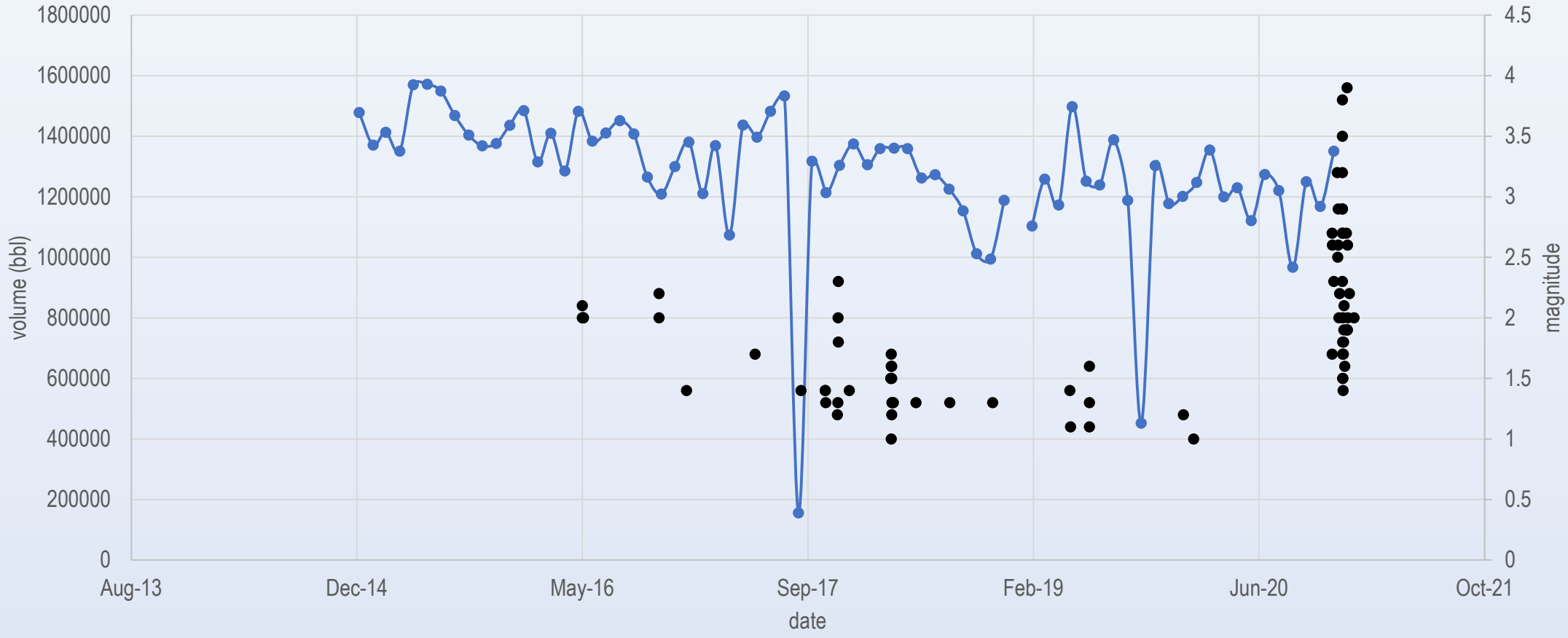
earthquakes 2015-2021



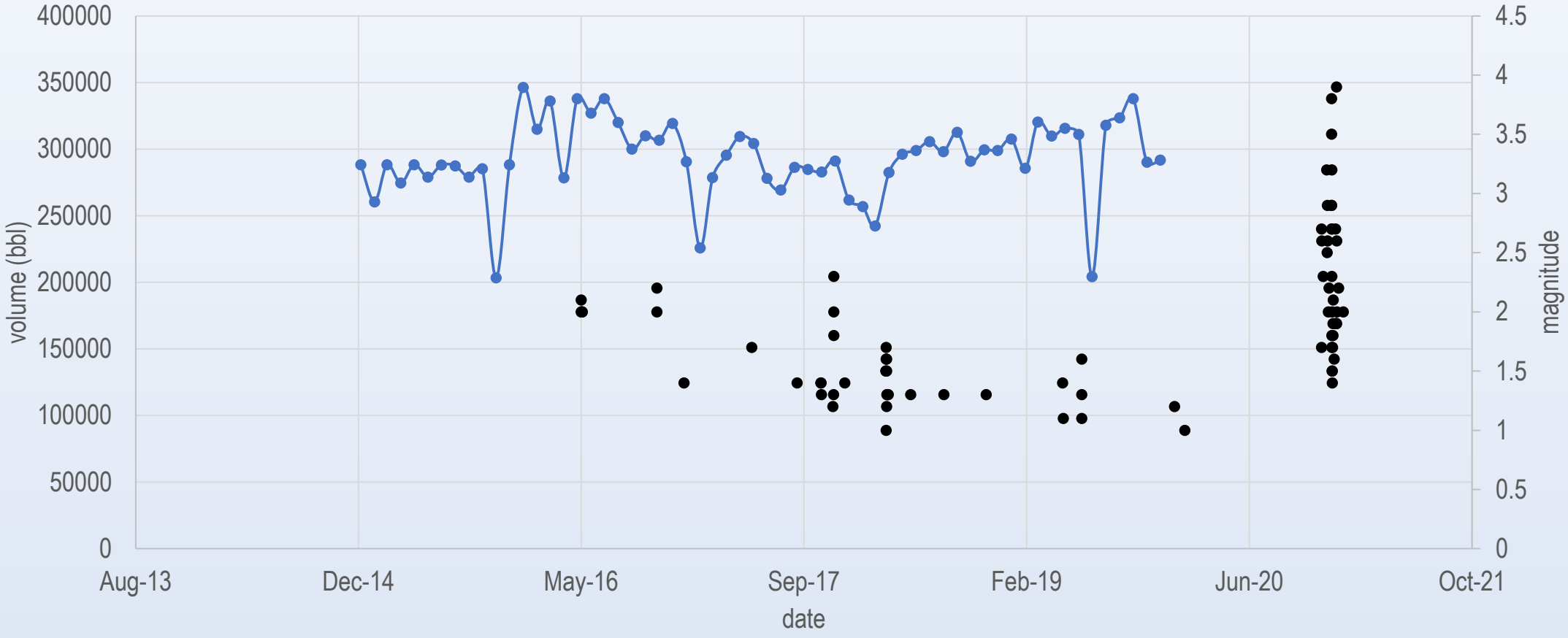
disposal wells (2019)



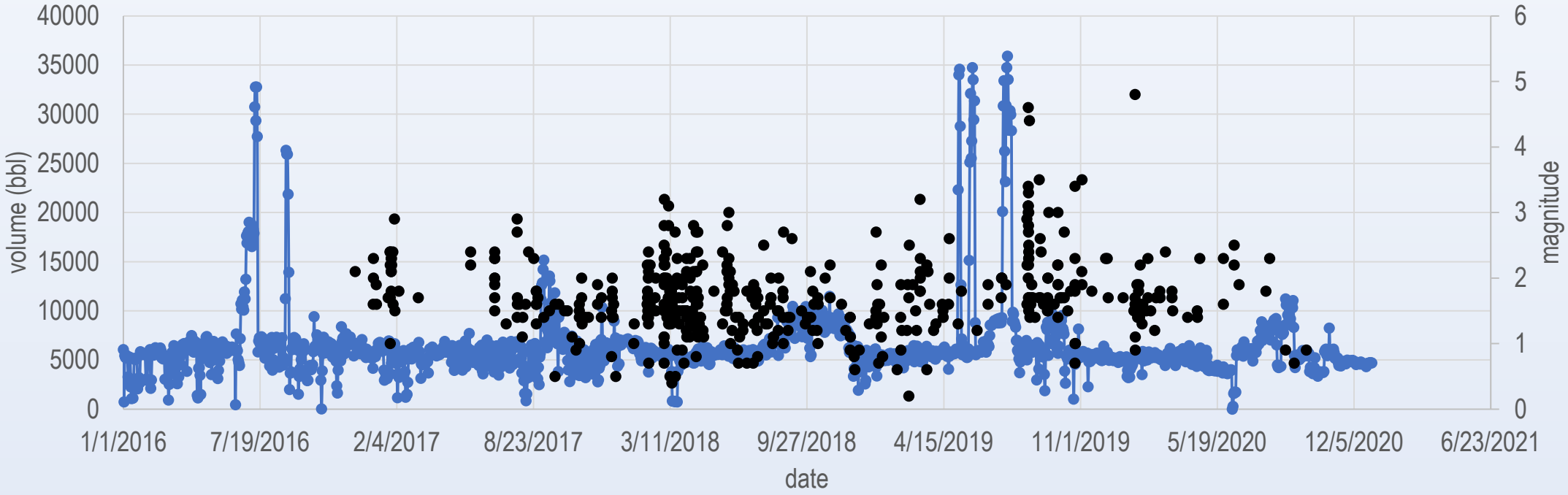
Class I Disposal volumes (within 15 mi)



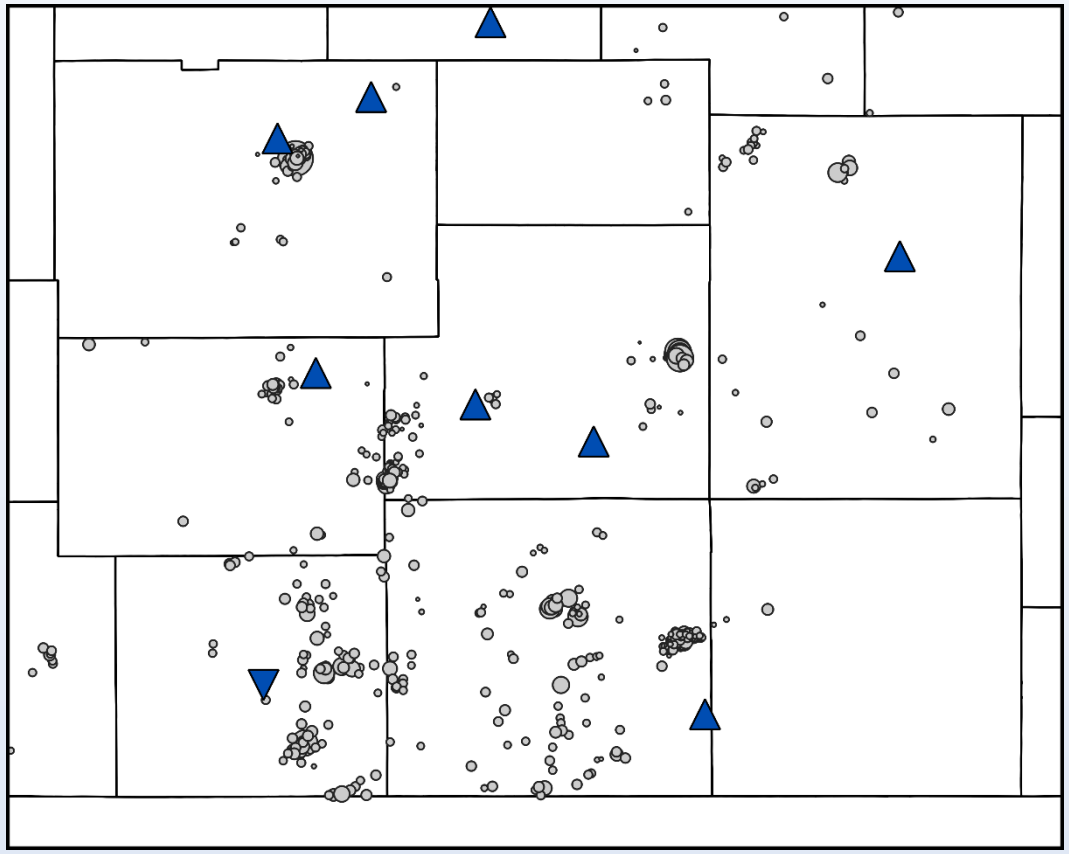
Class II Disposal volumes (within 10 mi)

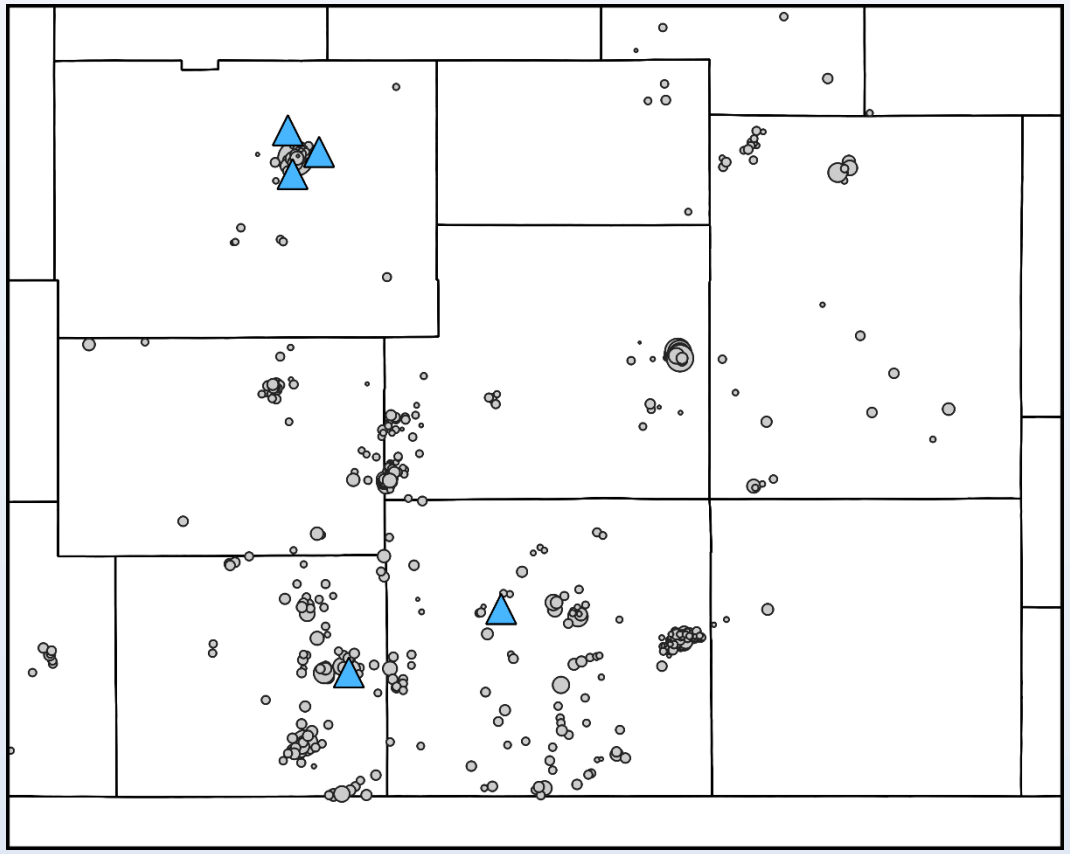


Earthquakes and Injection: Hutchinson
Update on Seismicity vs Local Injection



2020 Earthquakes and Local Stations

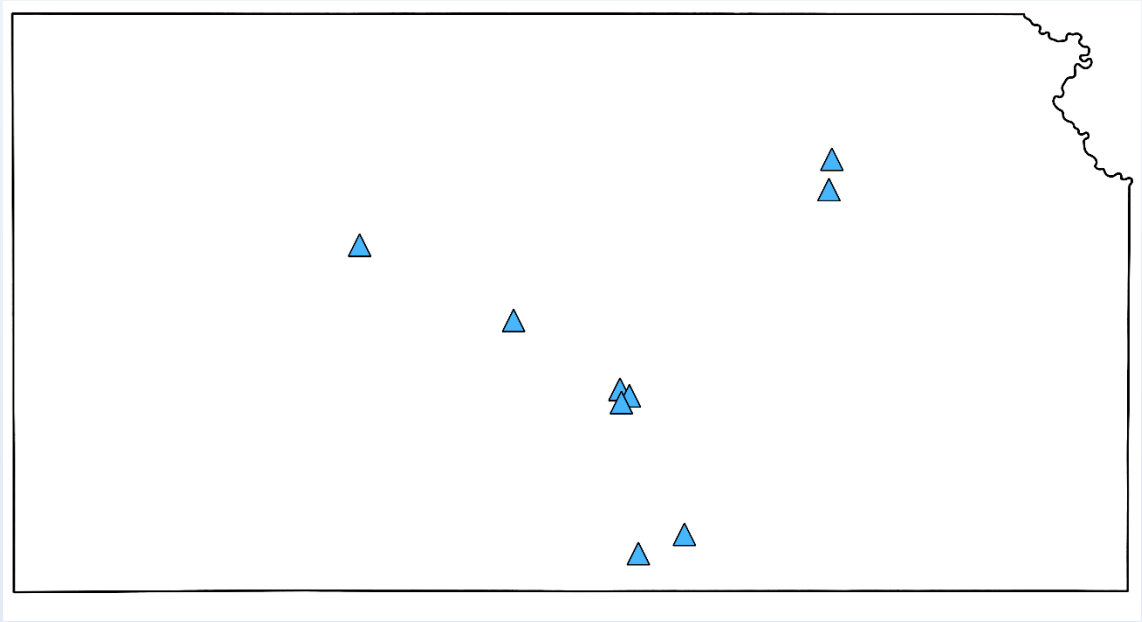




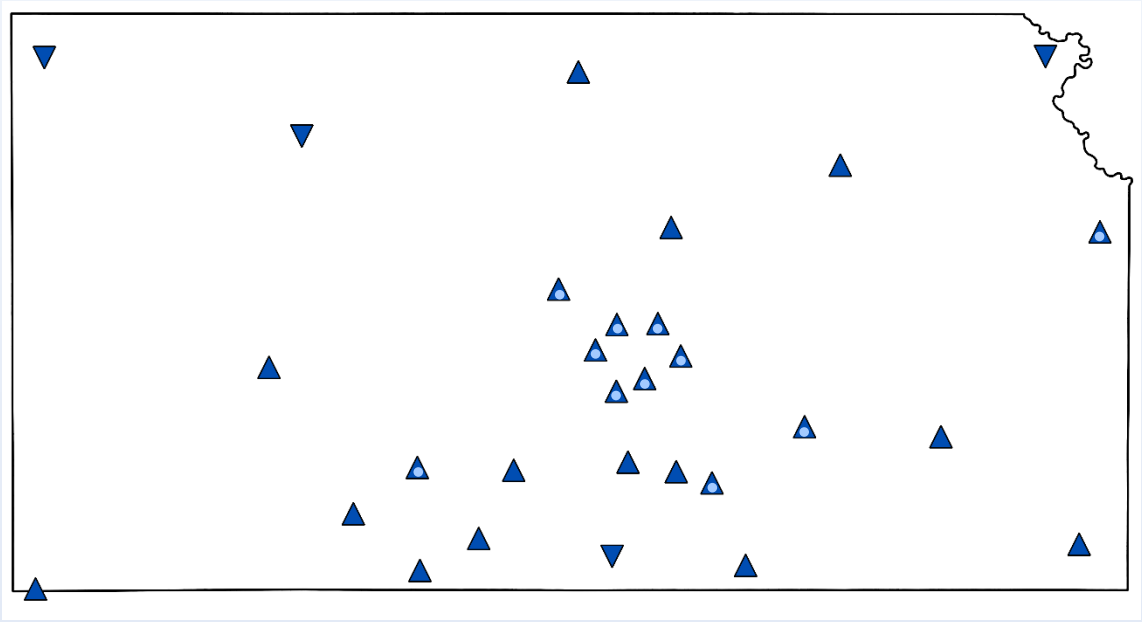
Note: these USGS stations are not part of the backbone permanent network

Station Coverage: Kansas

USGS = 9

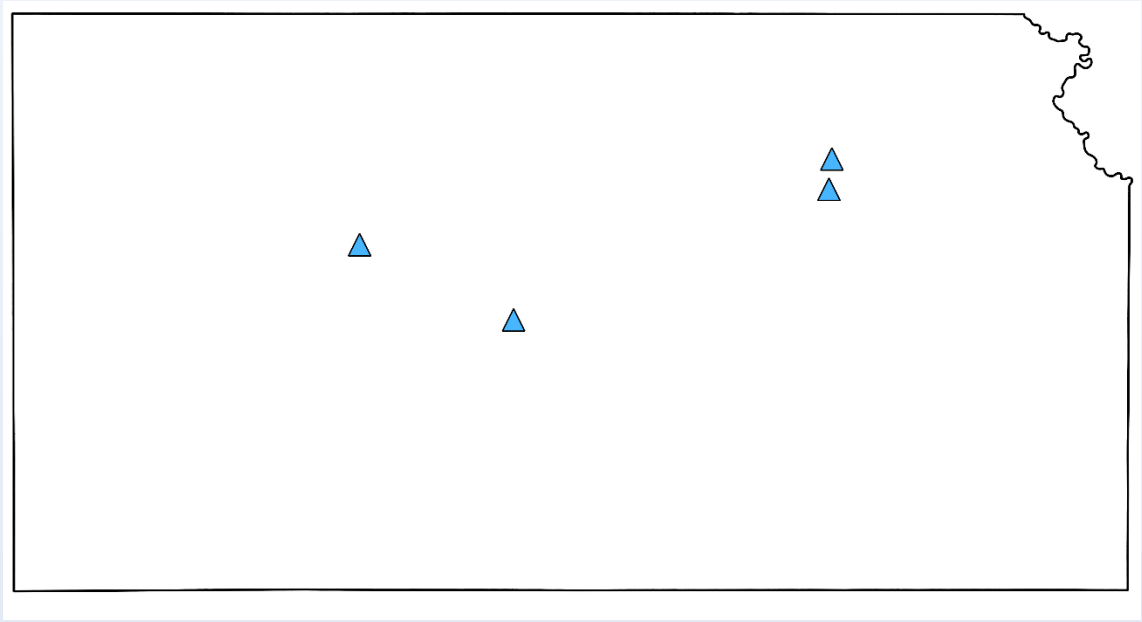


KGS & industry sponsored = 30

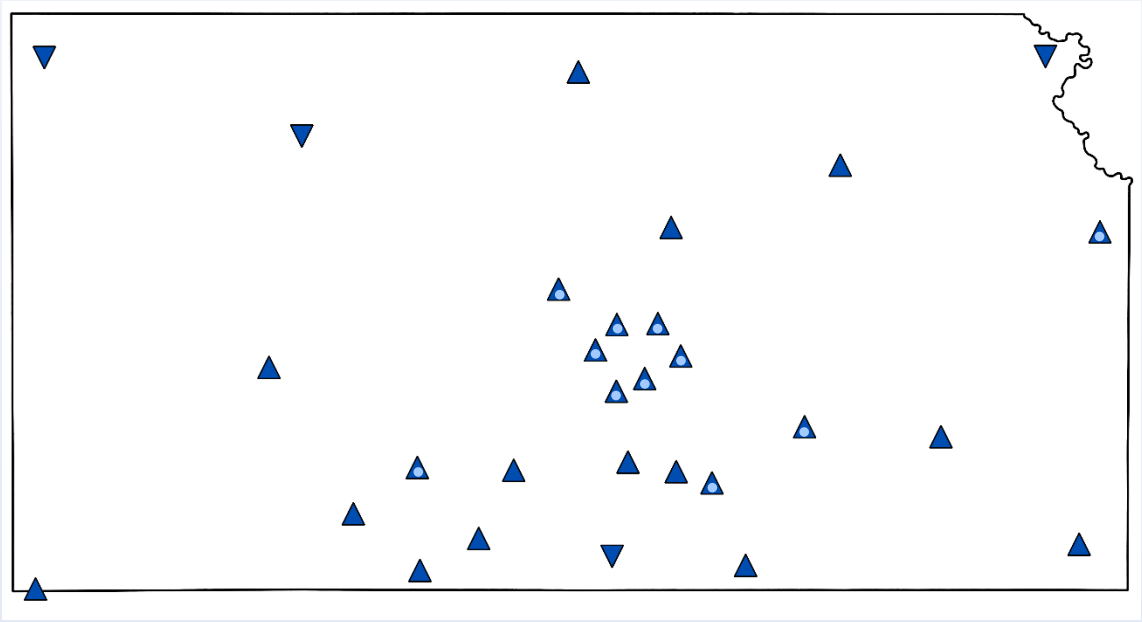


Station Coverage: Kansas

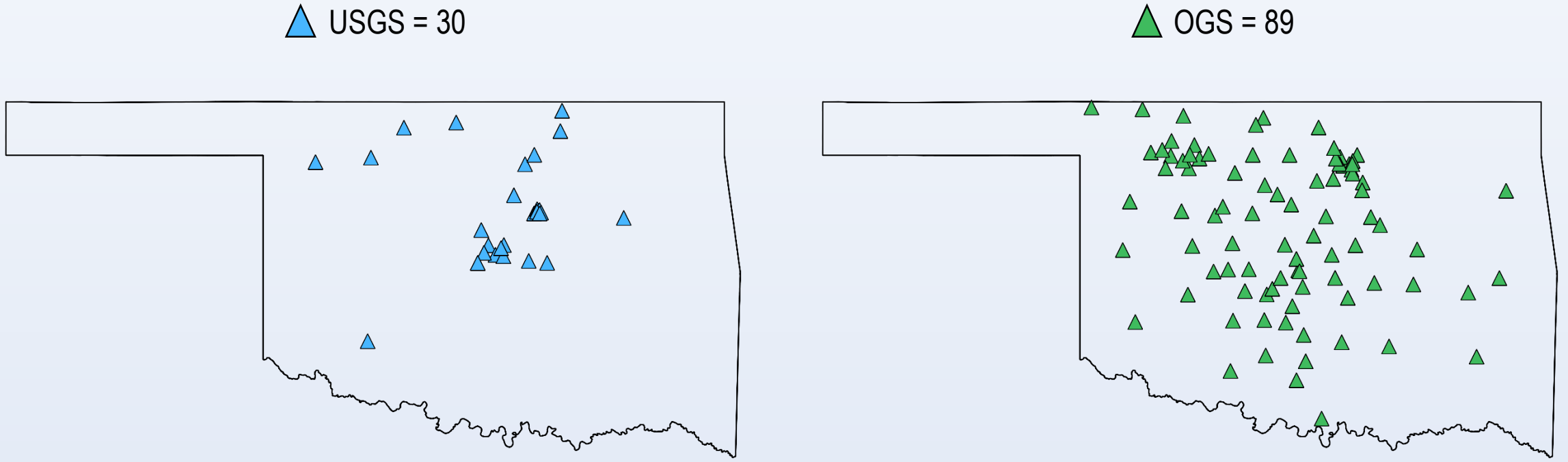
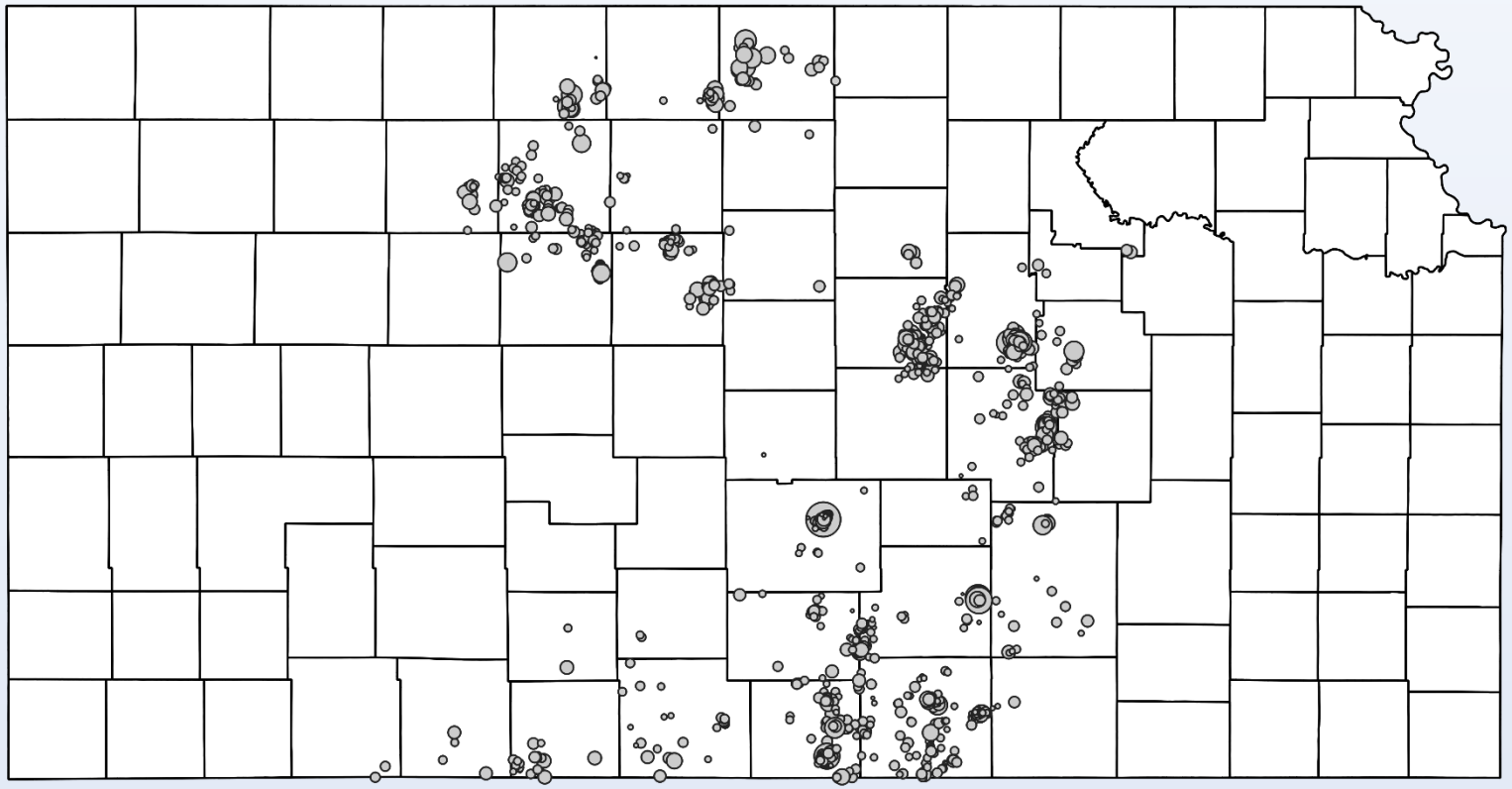
USGS = 4 permanent



KGS & industry sponsored = 30



Station Coverage: Oklahoma



2020 Earthquakes