

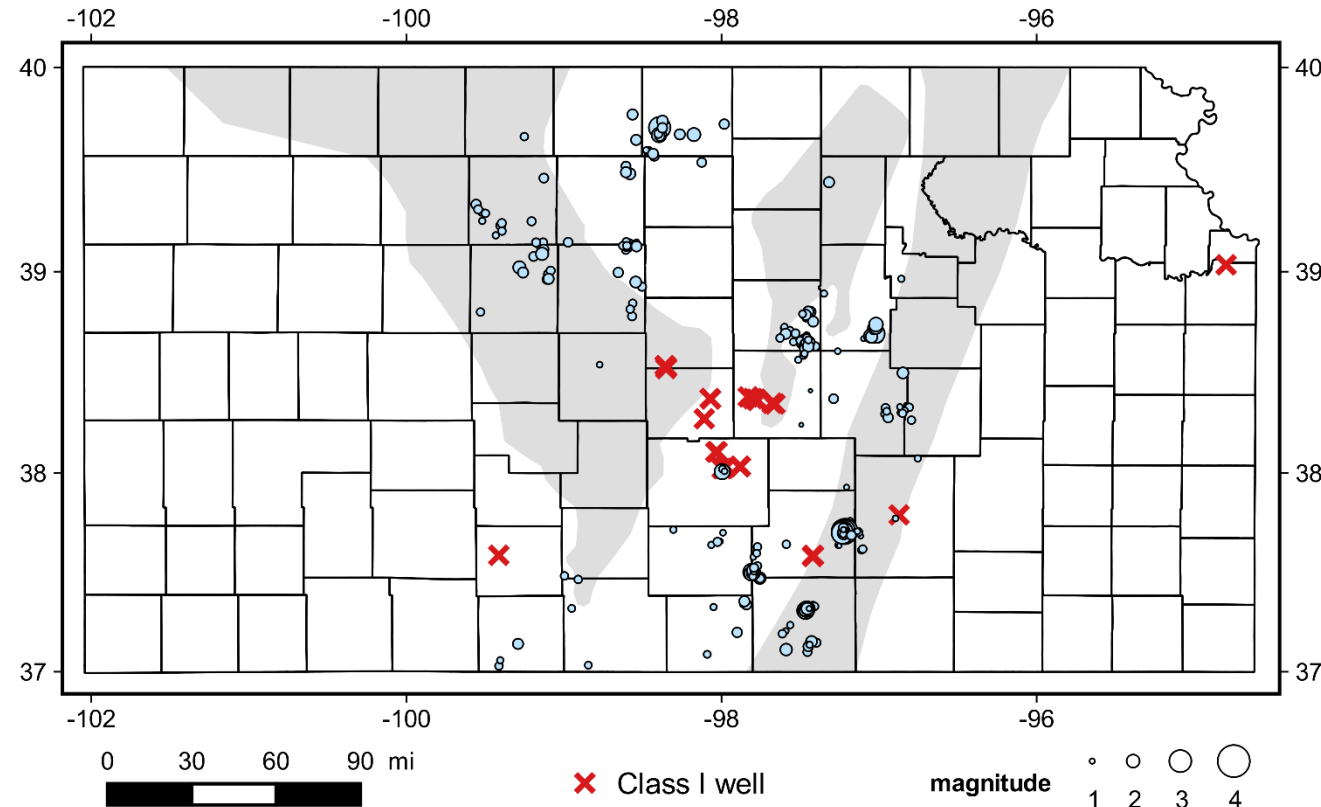
# Consortium to Study Trends in Seismicity

## Quarterly Report January 1 to March 31, 2021

Rex Buchanan, Shelby Peterie, Rick Miller, *Kansas Geological Survey*



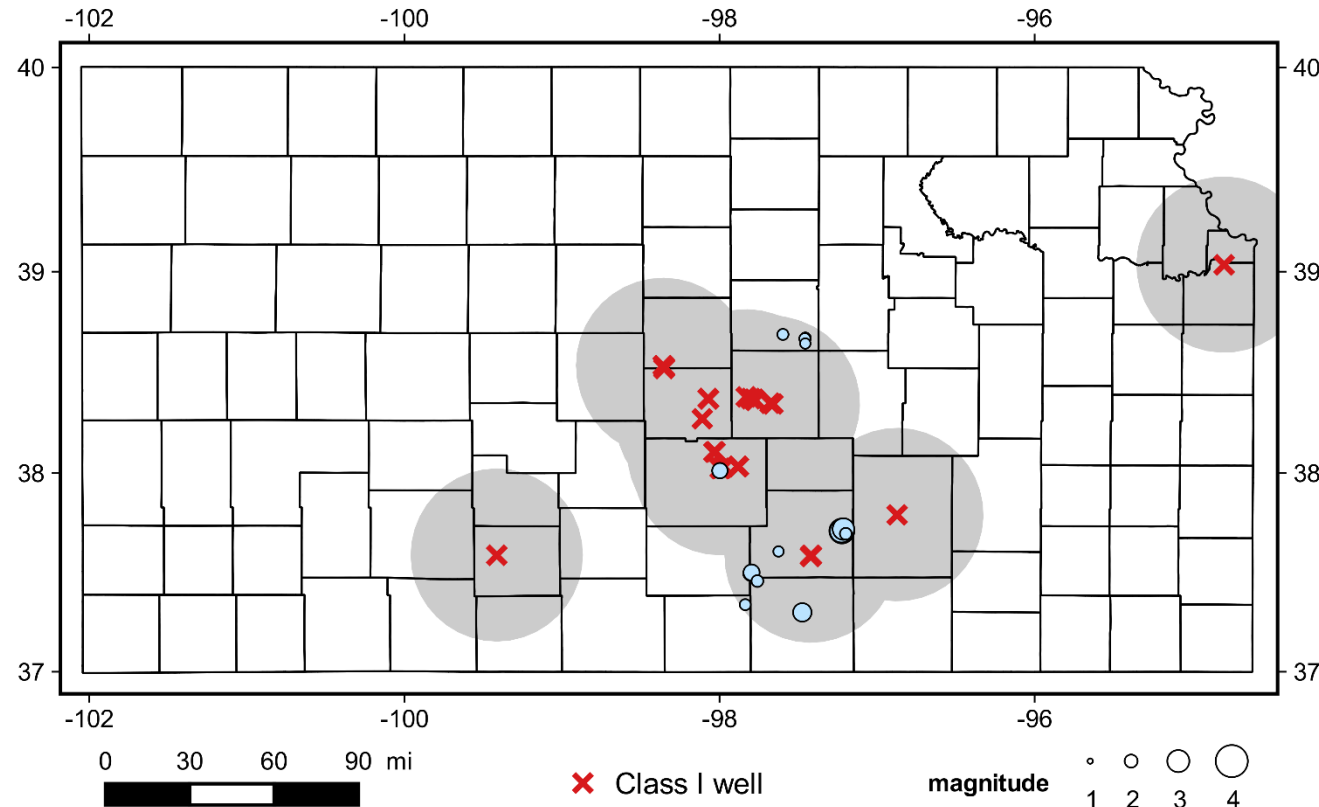
# Statewide Earthquakes



- Statewide earthquakes
  - This quarter: 290
  - Last quarter: 307
- Largest: M 3.9 near Wichita

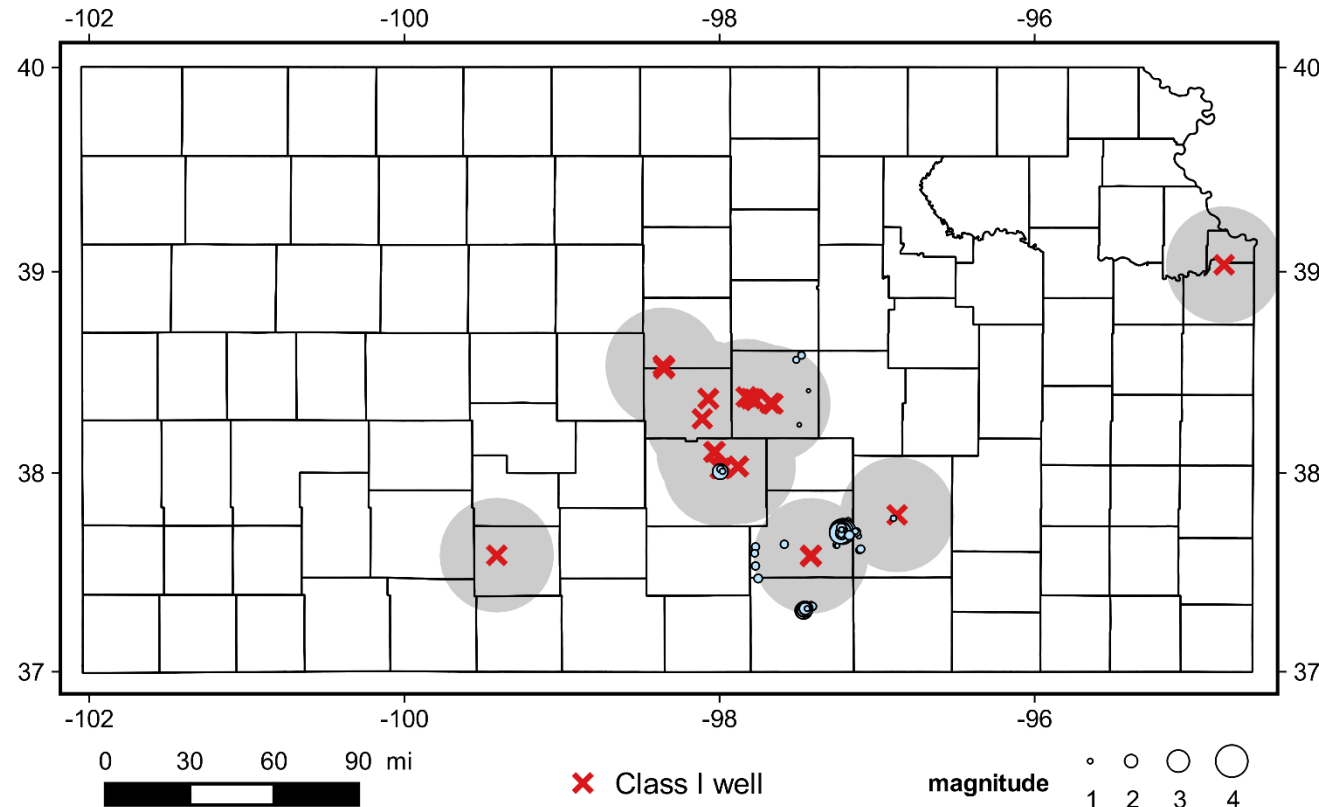
# CSTS Alerts

- Criteria
  - $M \geq 2$
  - 30 mi of tier I wells
- Alerts
  - This quarter: 25
  - Last quarter: 40

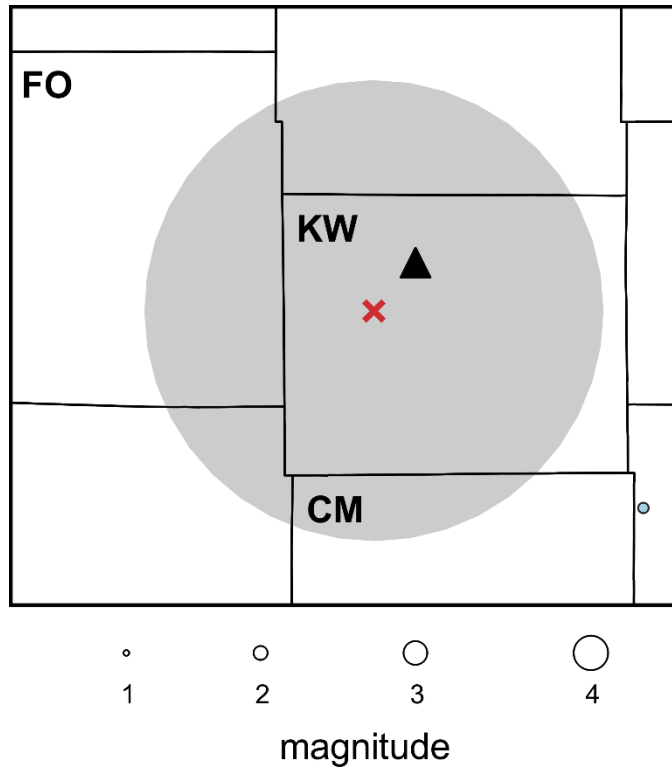


# Earthquakes Within 20 miles

- Earthquakes w/in 20 mi
  - This quarter: 107
  - Last quarter: 78
- Fewer large events
- More small events
  - More than half in Wichita
  - 23 near Wellington

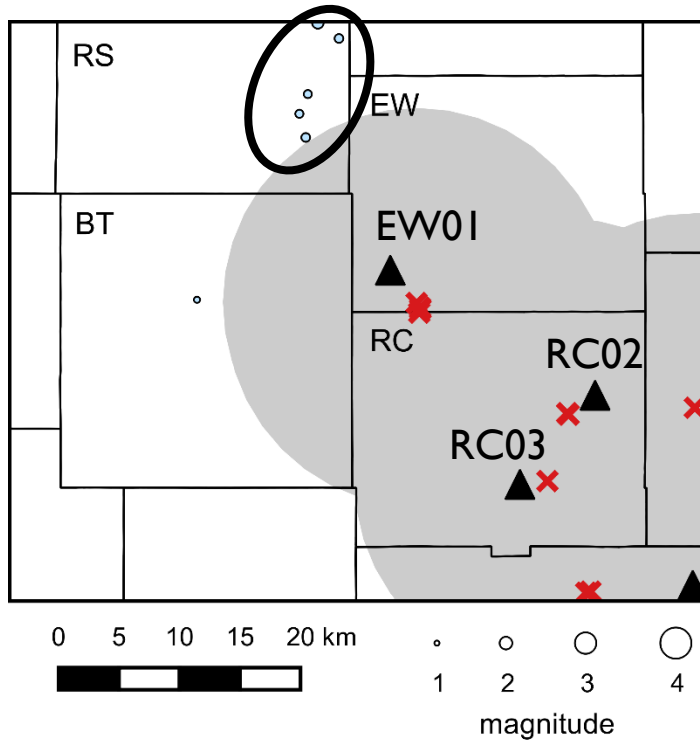


# Kiowa County



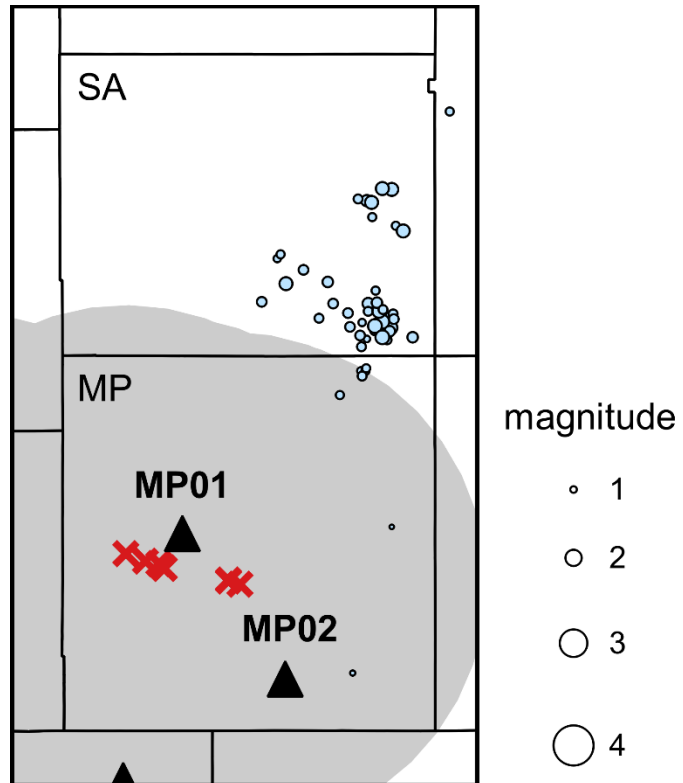
- Located earthquakes
  - none
- Subnetwork events
  - none
- Consistent with past observations

# Rice and Ellsworth Counties



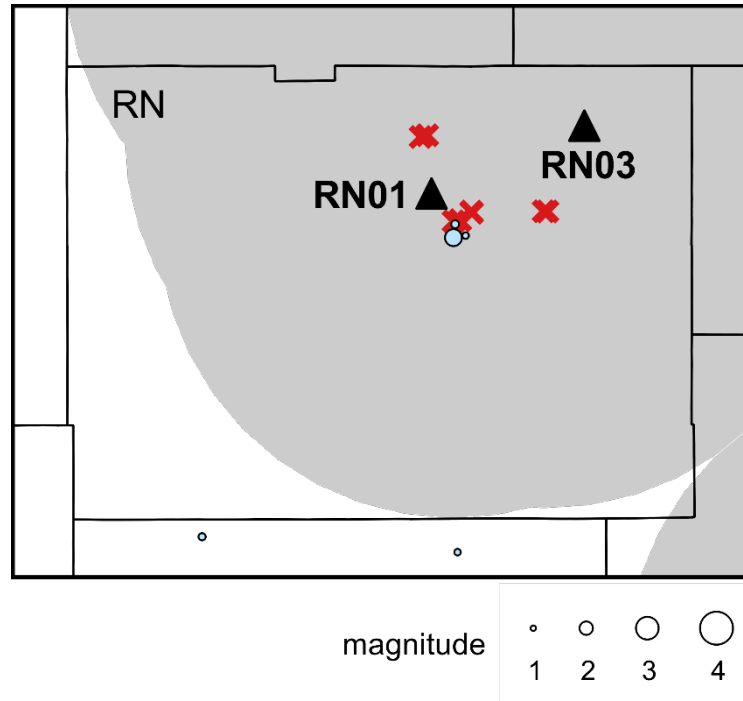
- Located earthquakes
  - none w/in 20 mi
  - continued seismicity in RS
  - M 1.3 in BT
- Subnetwork events
  - EW01: 10
    - largest M 0.4
    - January, 5 mi away
  - RC02: 6, largest M 0.5
  - RC03: 161 (blasts)
- Mostly consistent with past observations

# McPherson County



- Located earthquakes
  - 5, M 1.0 to 1.5)
  - >15 miles from wells
  - consistent with MGA
- Subnetwork events
  - MP01: 11
  - MP02: 9
  - subzero
- Mostly consistent with past observations

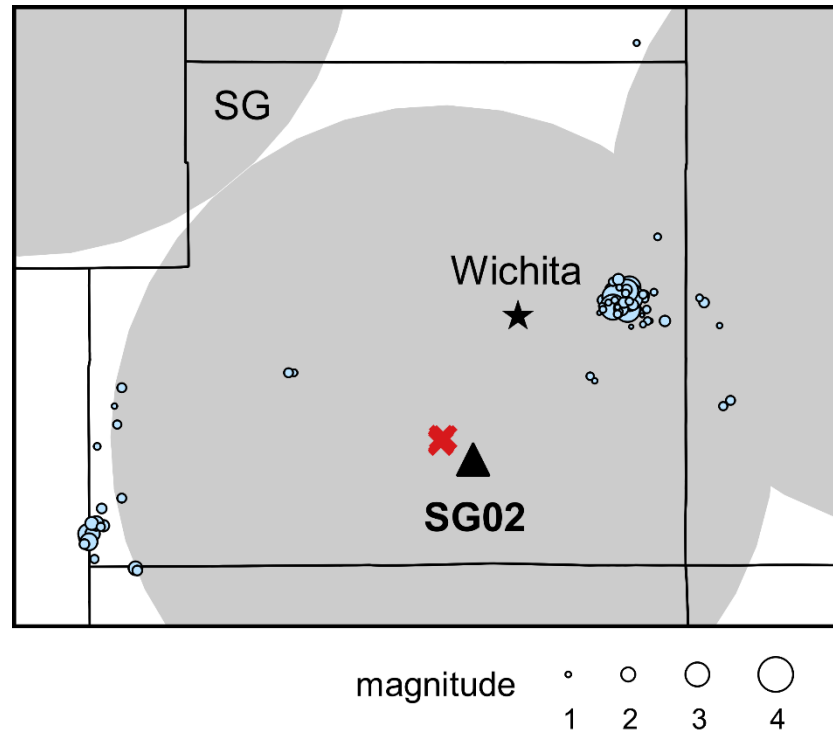
# Reno County



- Located earthquakes
  - 4 earthquakes
  - largest = M 2.7
- Subnetwork events
  - RN01: 44
    - consistent with the Hutchinson cluster
    - similar to previous quarter
  - RN03
    - 2 M < 0

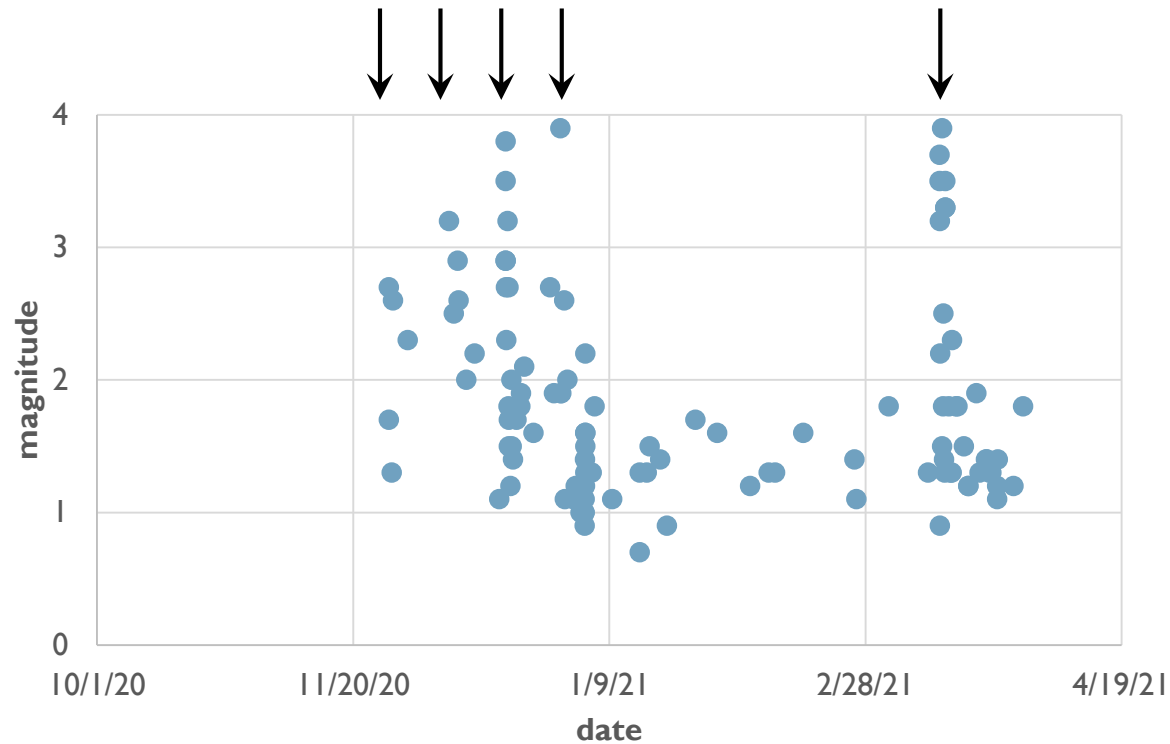


# Sedgwick County



- Located earthquakes
  - 67 events, similar to previous
  - $M < 1$  to  $M 3.9$
  - 11  $M2+$ 
    - 2 dozen previous quarter
- 17 Subnetwork events
  - majority occurred in February
  - largest  $M 0.3$
  - 2 mi to 12 mi (Wichita)

# What are the Odds?



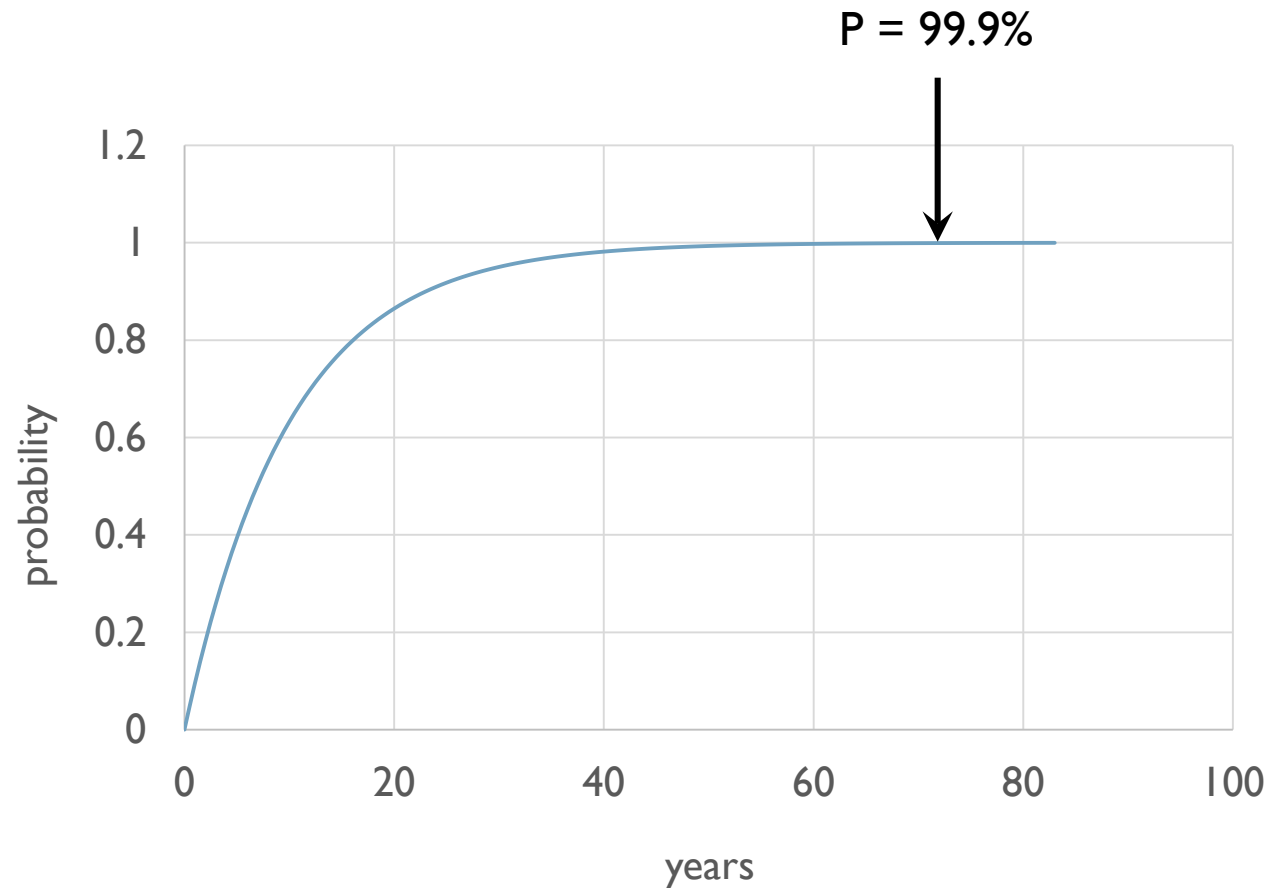
- 5 main shocks
  - random, Poisson distribution

$$P(t) = \frac{(rt)^k e^{-rt}}{k!}$$

- where  $r$  = rate

- Historic events
  - May 1919
  - July 1919
  - April 1948
- Probability of an earthquake each year since 1948

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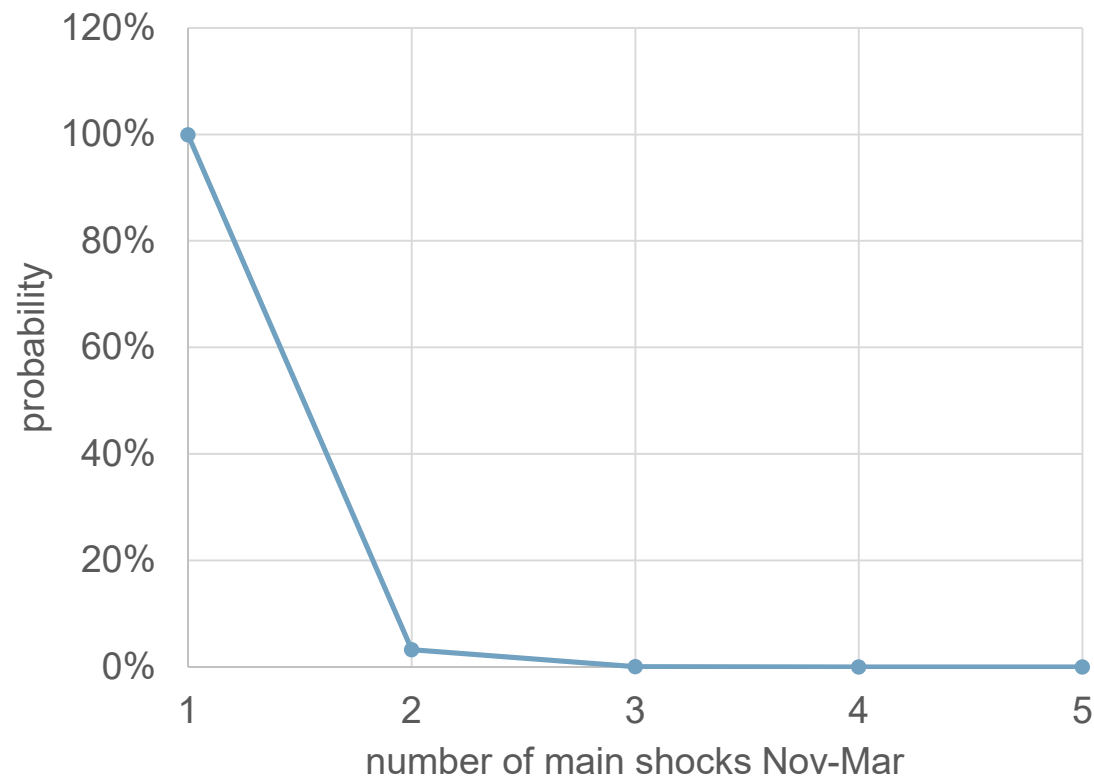
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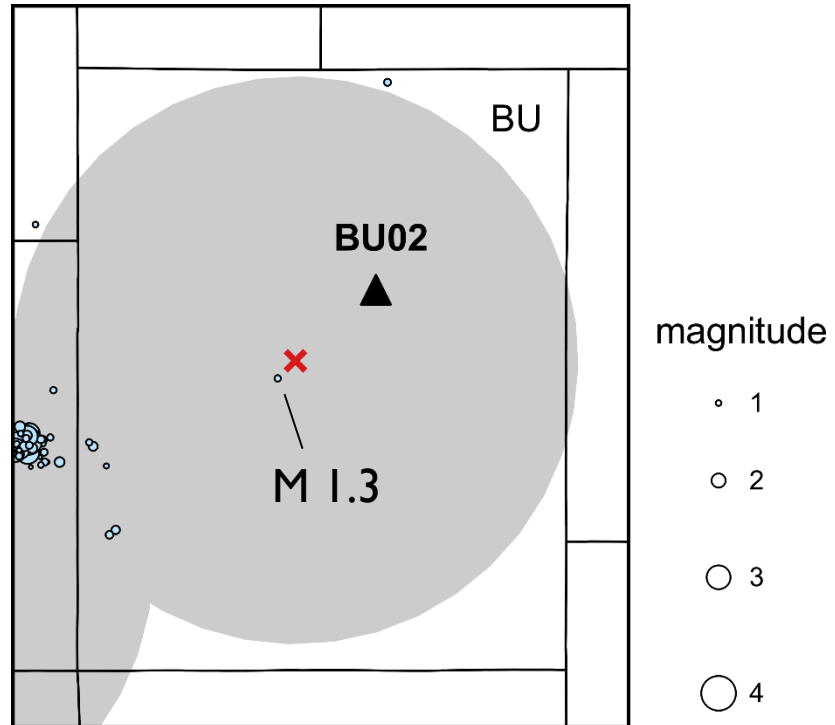
# Probability of Subsequent Main Shocks



N earthquakes	Probability
1	99.9%
2	3.2%
3	0.1%
4	0.0006%
5	0.000005%

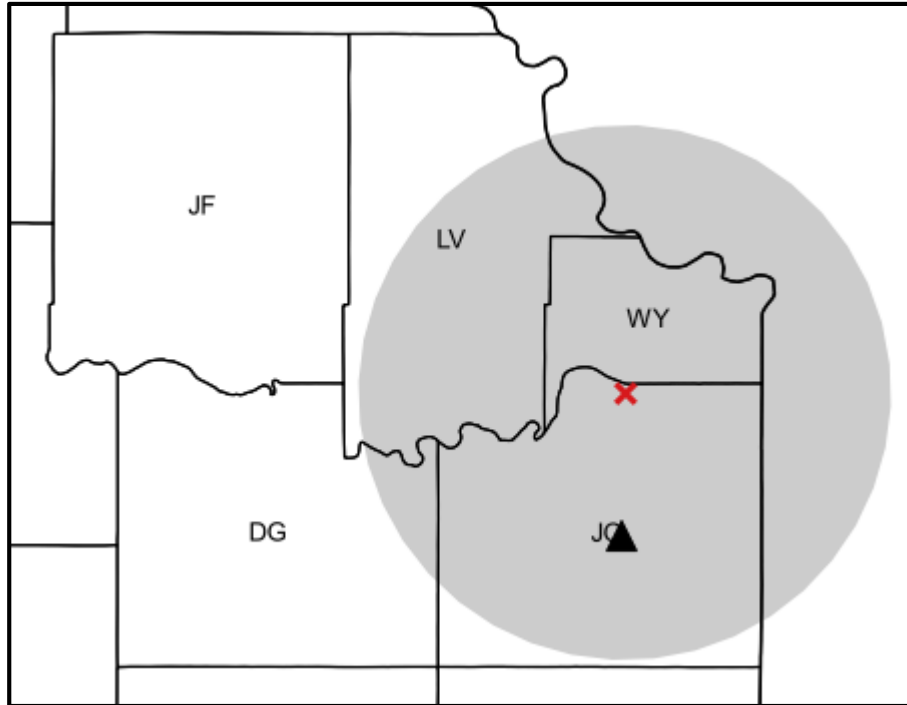
*extremely low probability  
based on natural rate*

# Butler County



- Located earthquakes
  - one in central BU
  - M 1.3
  - consistent with low-energy
- Subnetwork events
  - BU02: 3
  - 4-11 mi
  - consistent with previous

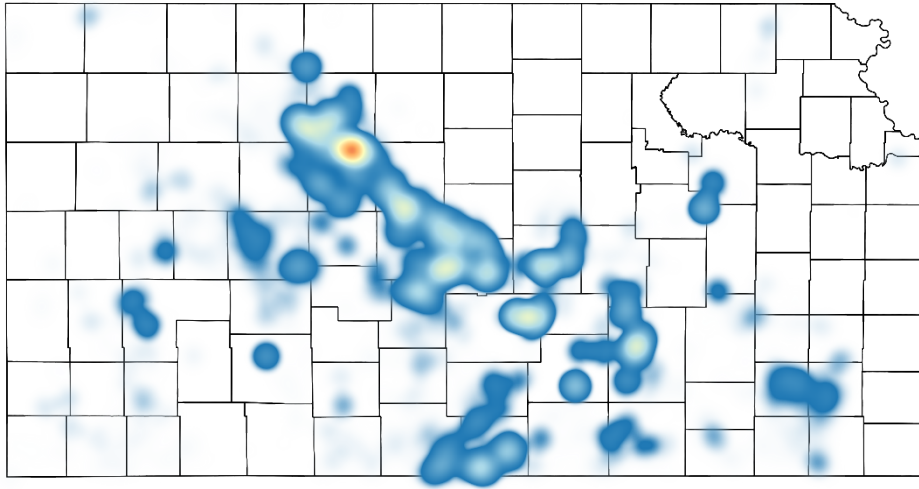
# Johnson County



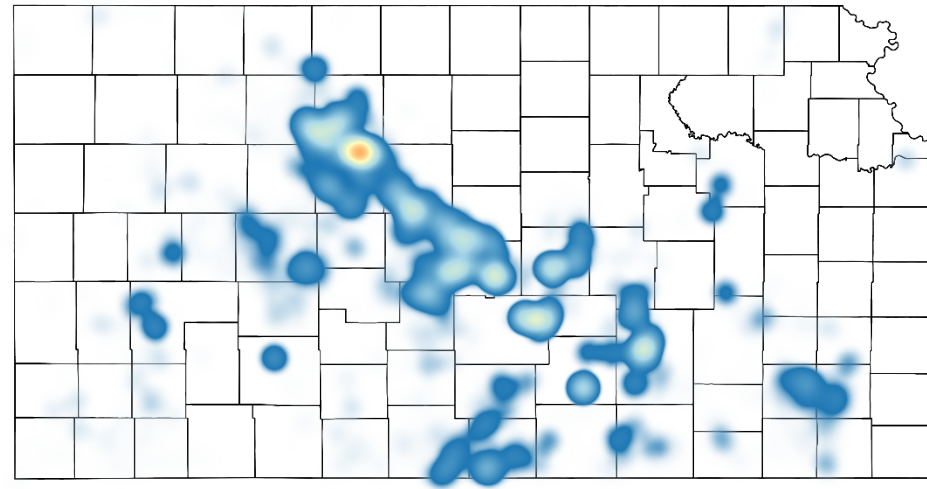
- Located earthquakes
  - none
- Subnetwork events
  - $M < 0$
  - 4 mi

# Disposal Volumes

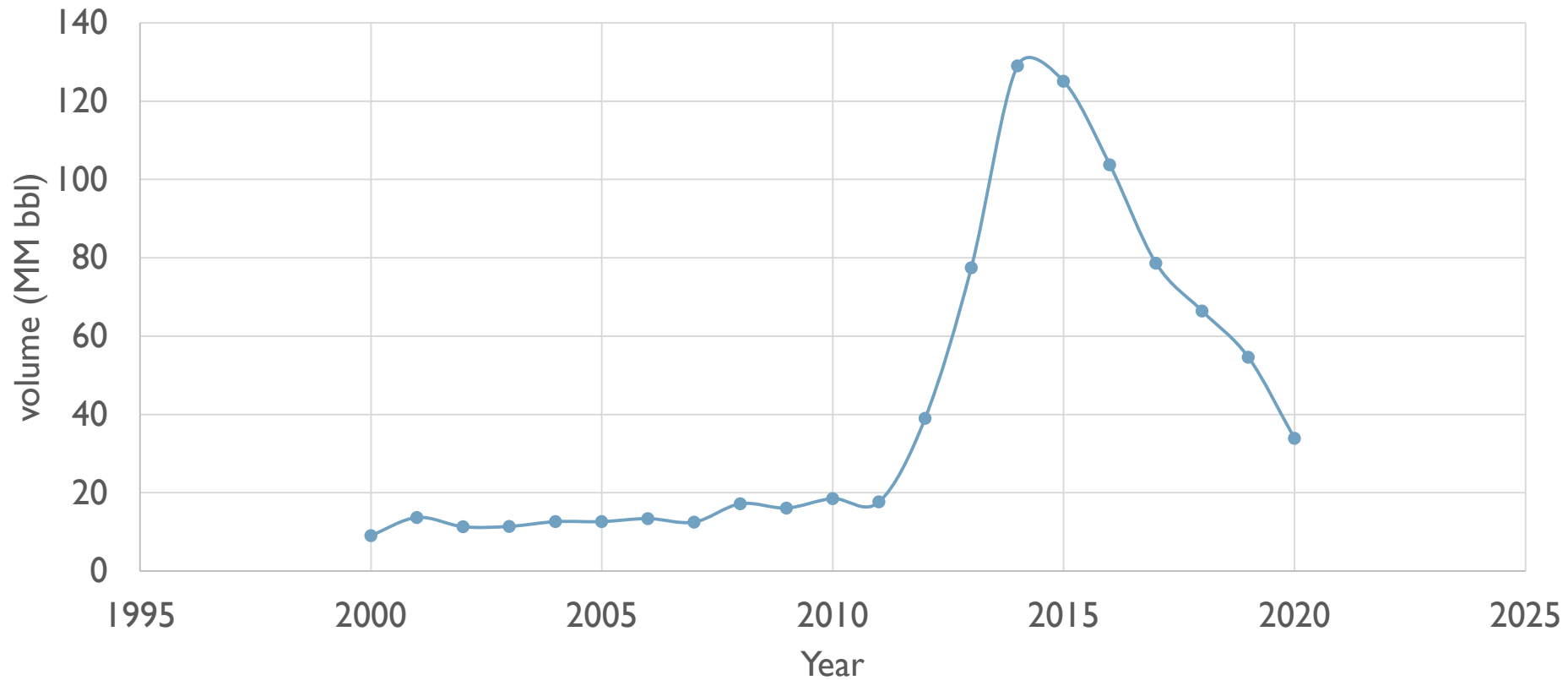
2019



2020



# Harper & Sumner Volumes





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