

Local Seismicity Near CSTS Member Wells

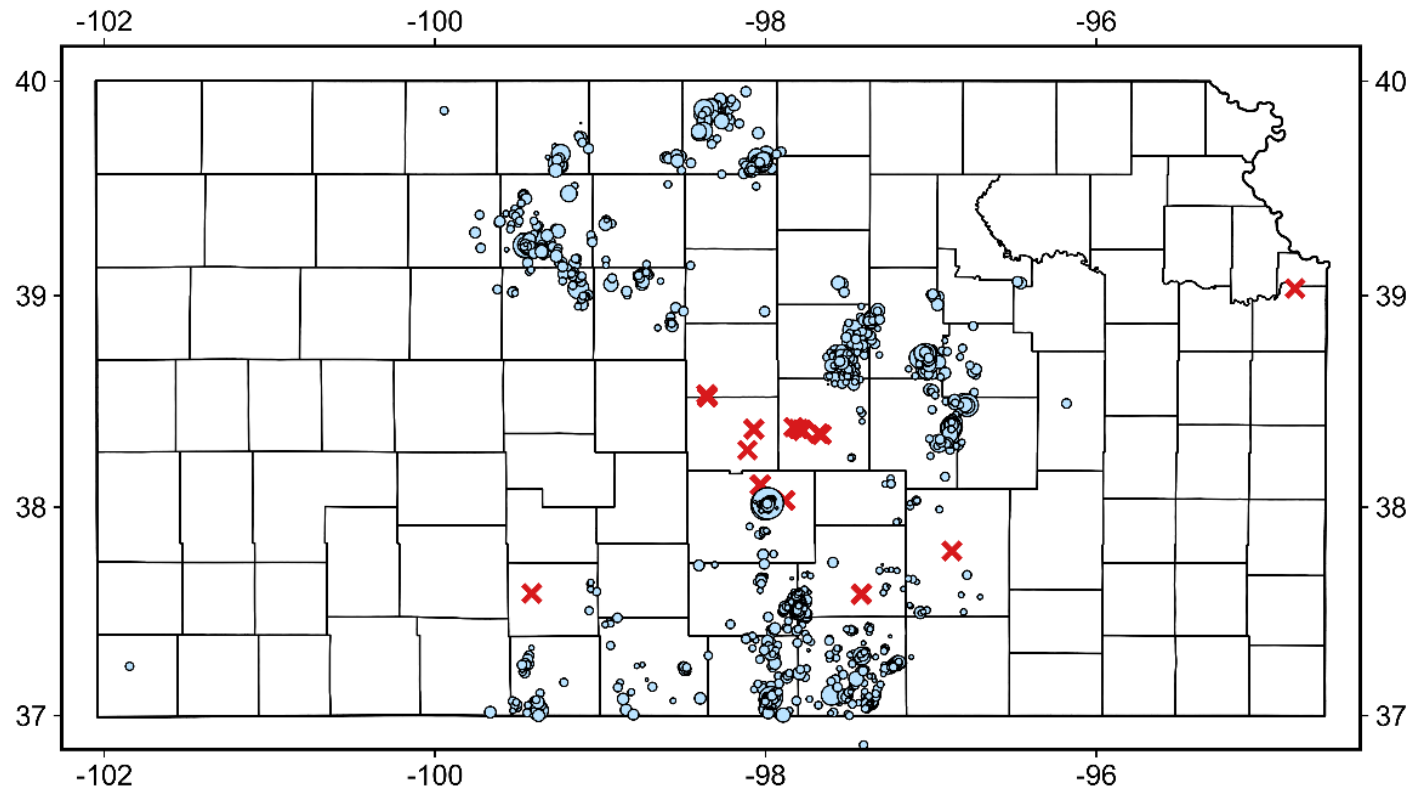
Shelby Peterie, Rick Miller, Juliana Gonzales, Carl Gonzales, Erik Knippel
Kansas Geological Survey

3rd Annual CSTS Meeting
August 12, 2020
virtual webinar

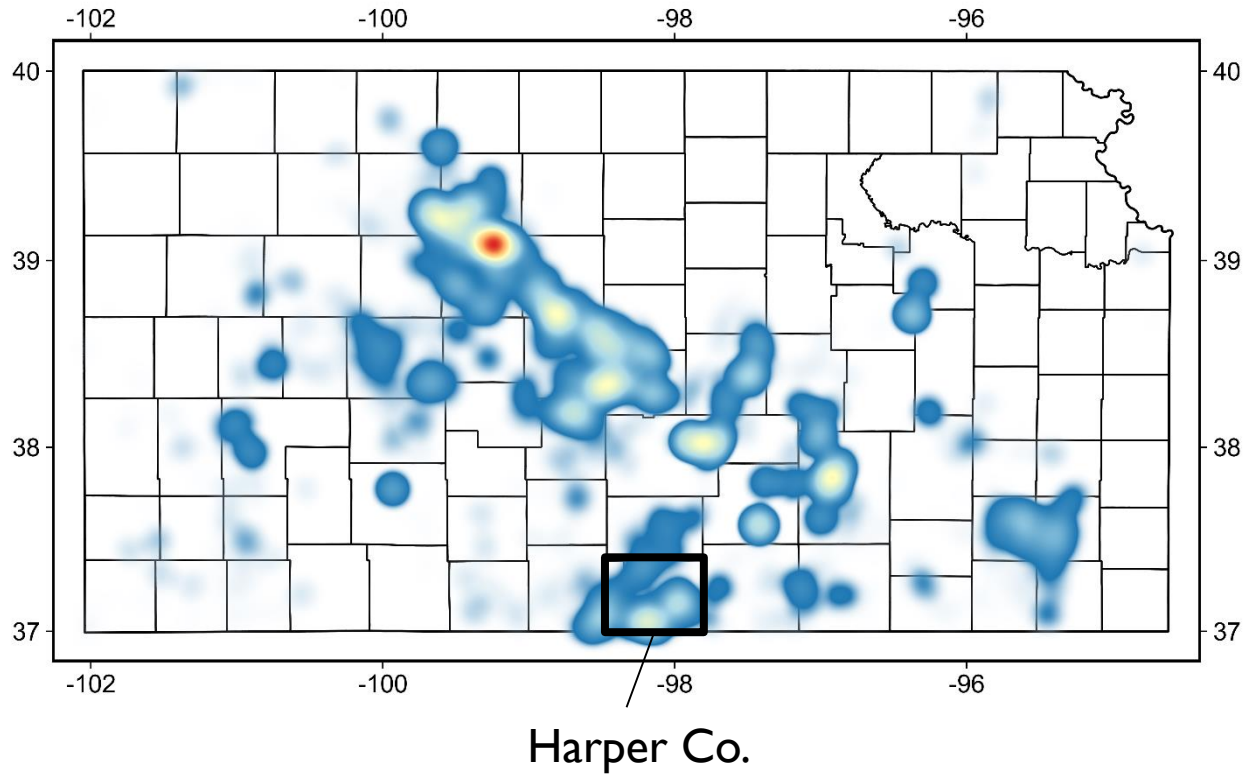


Statewide Overview

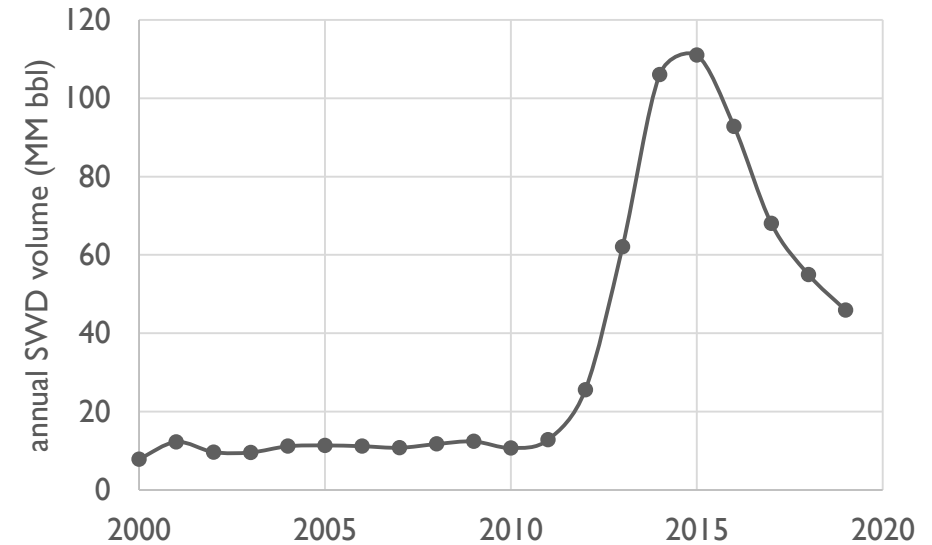
2019-2020 earthquakes



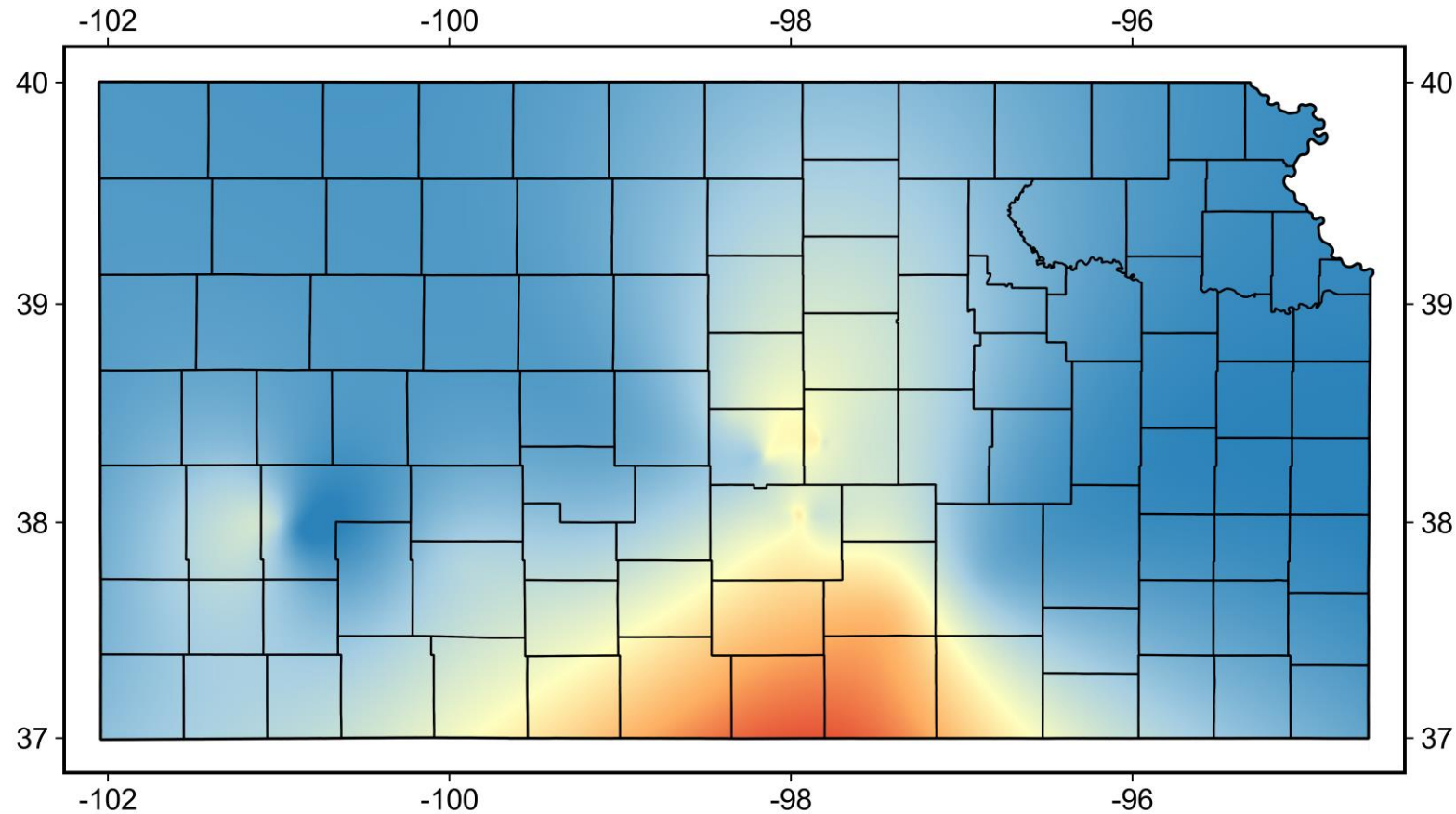
Disposal Volumes



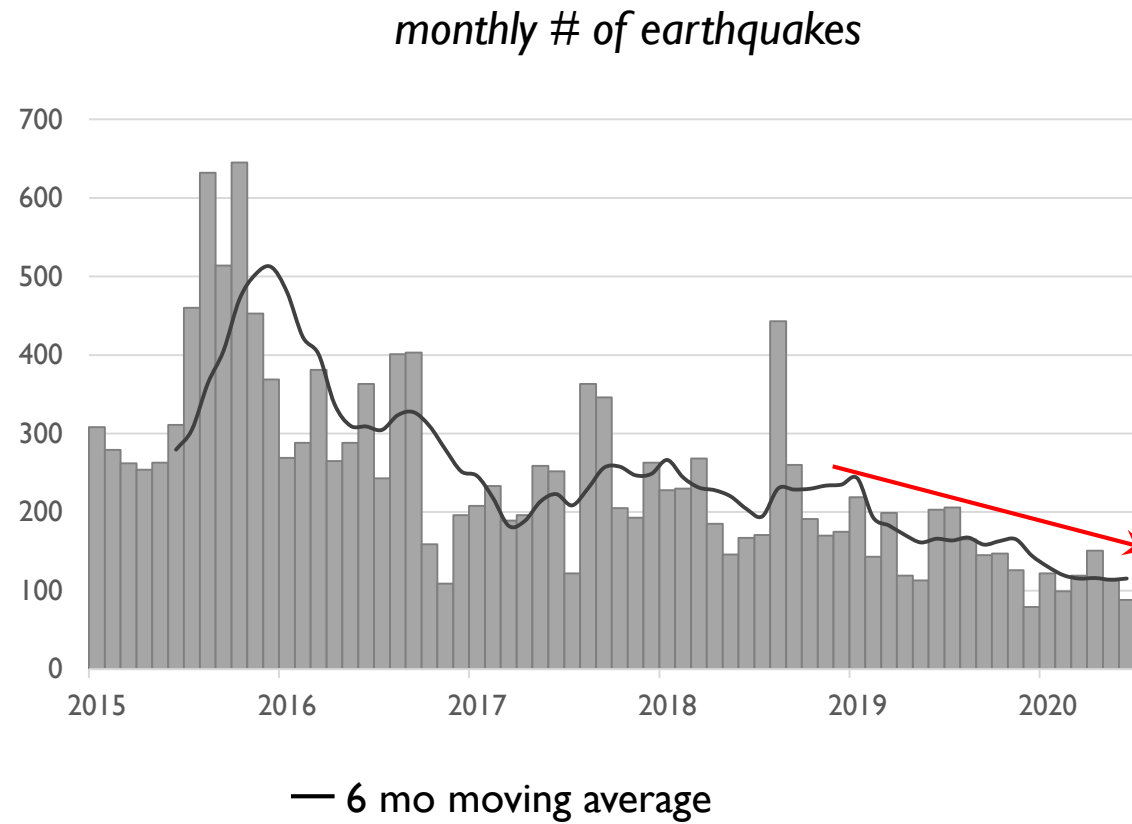
HP Annual SWD Volumes



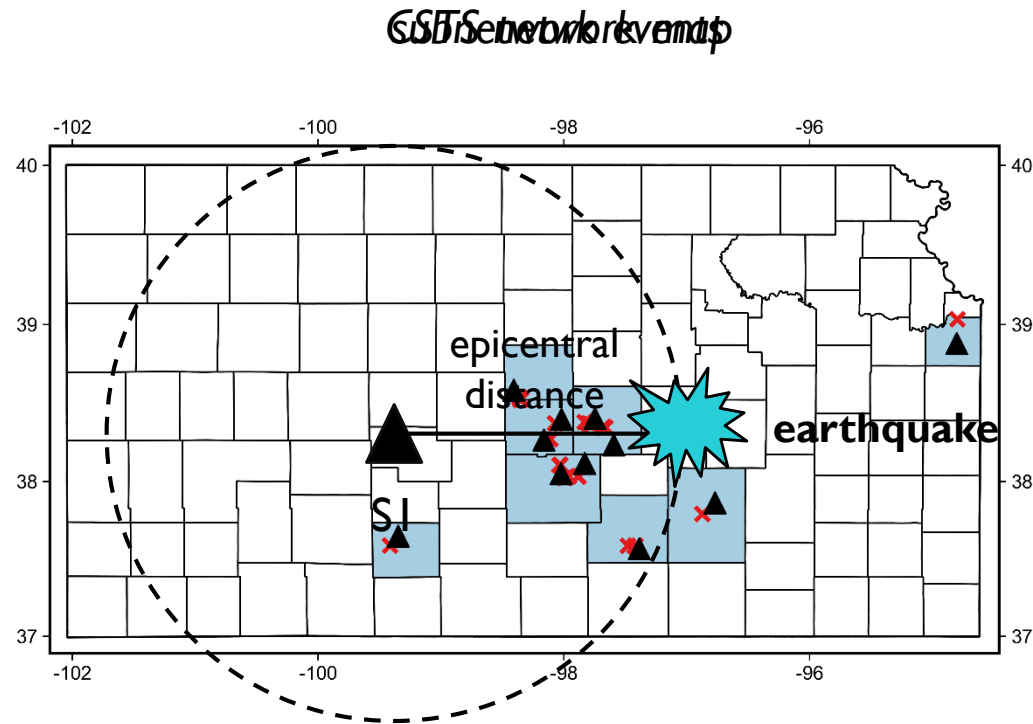
Formation Pressure



South-central Kansas

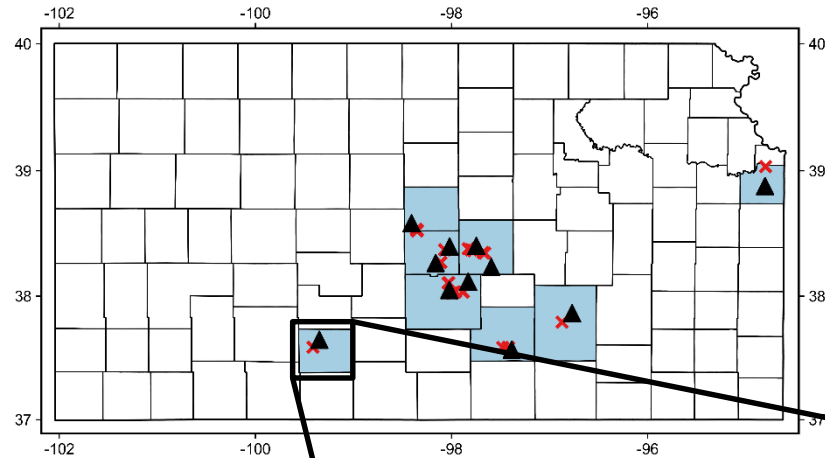


CSTS Network



- Station description
- Geologic setting
 - local structure
 - pressure
 - historic earthquakes
- Seismic activity within 20 mi
 - located earthquakes
 - subnetwork events
 - < 3 stations
 - epicentral distance
 - magnitude
 - small ($M < 1$)

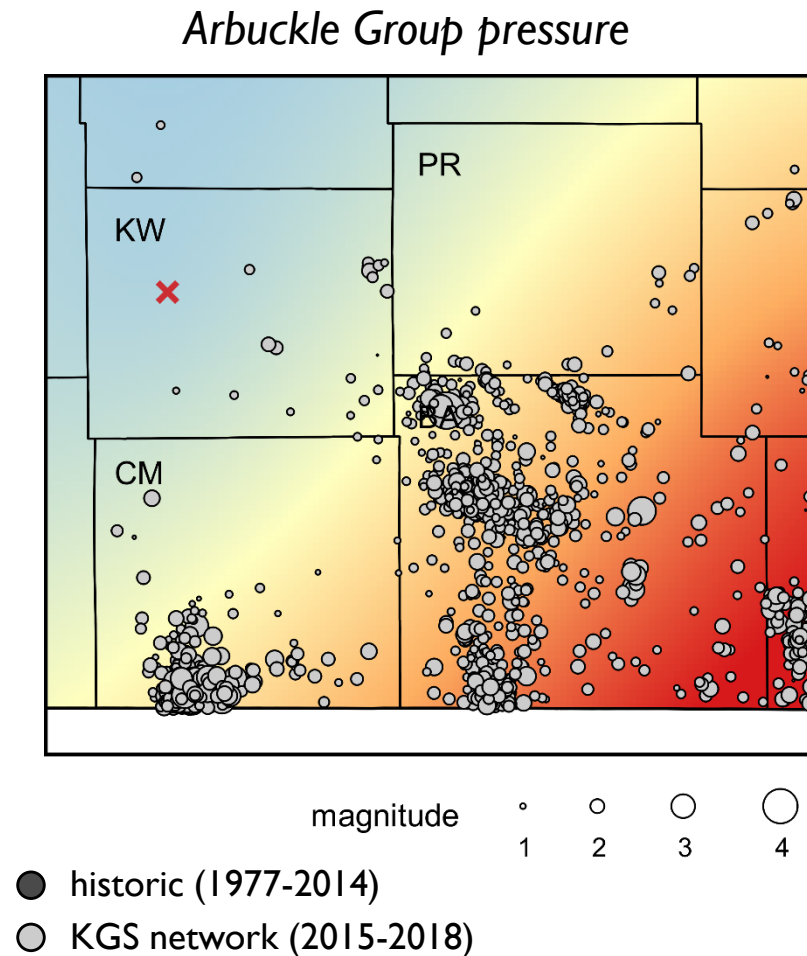
Kiowa County



- station moved due to flooding
- KW02
 - north central KW
 - pasture
 - Greensburg

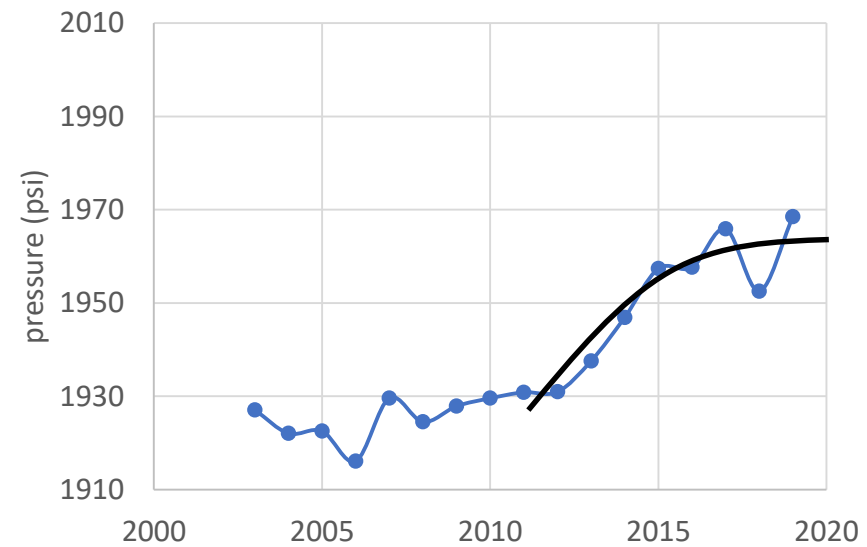
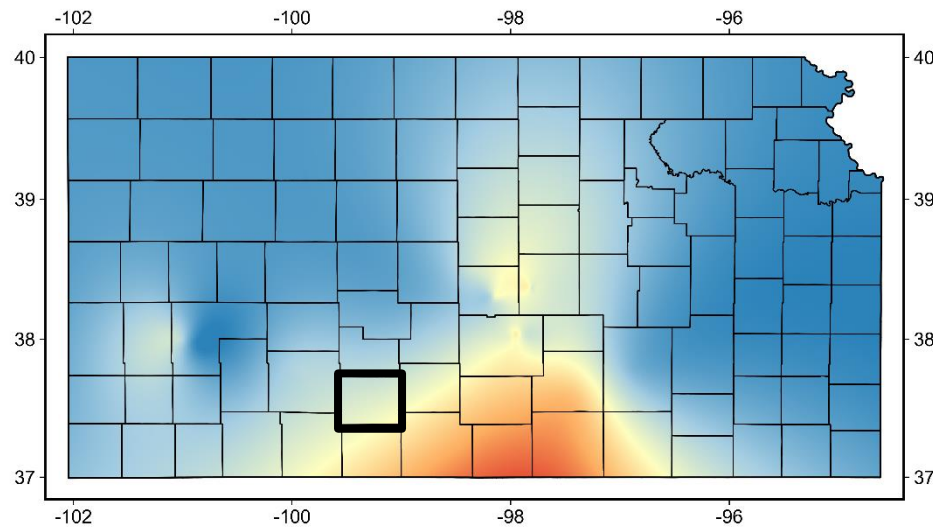


Kiowa County

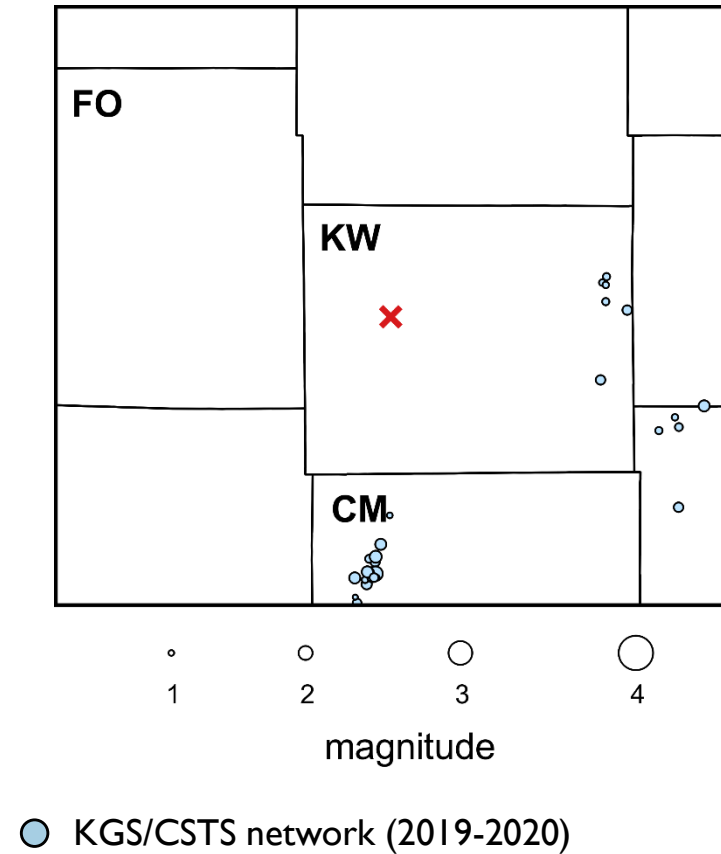


- Central Kansas Uplift
 - southwest margin
 - west of Pratt Anticline (southern extension)
- Mapped faults
 - None
- Historic earthquakes
 - None
 - Sparse recent seismicity
 - influenced by elevated pore pressure

Kiowa County

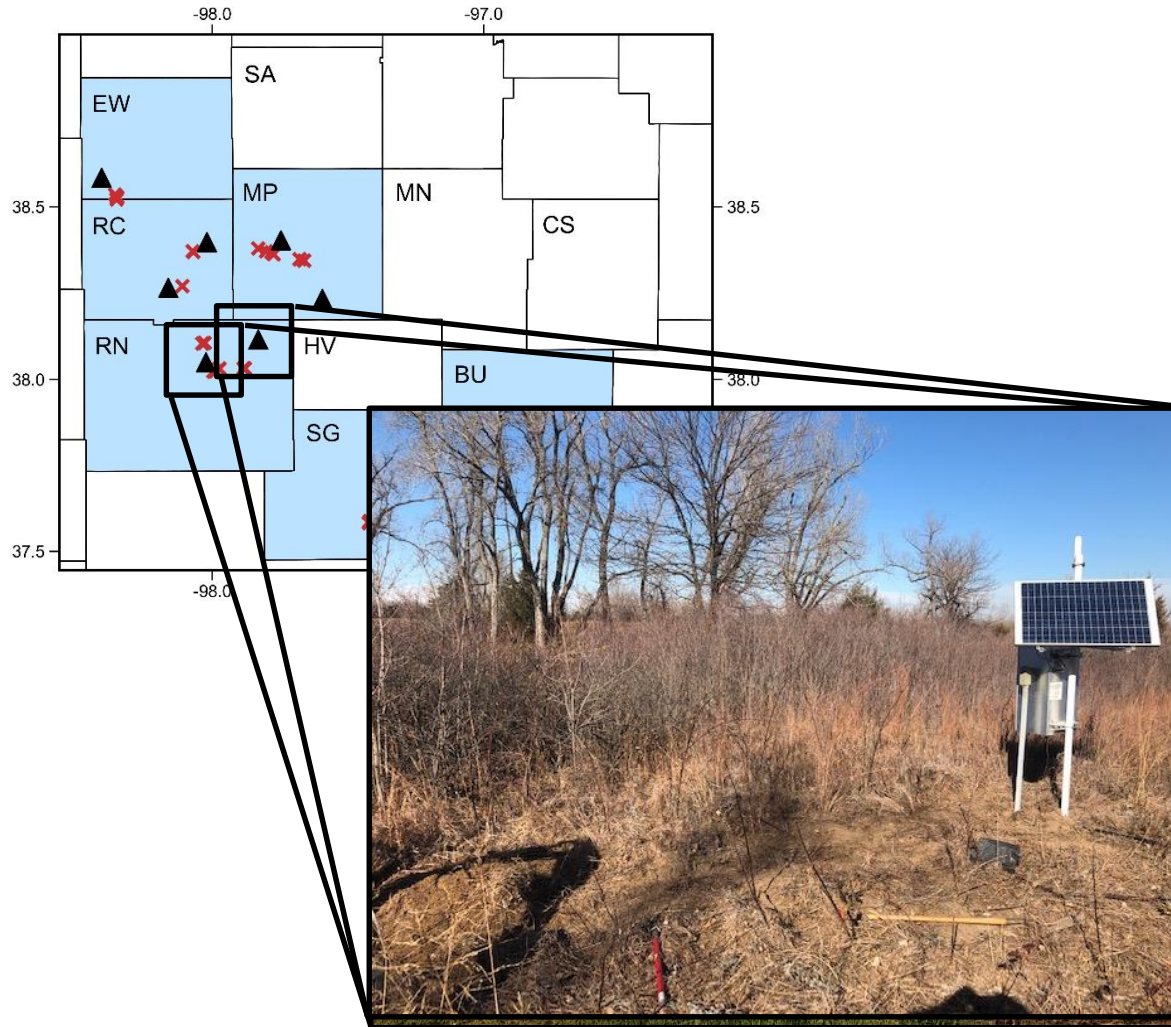


Kiowa County



- Local Earthquakes (>20 mi)
 - 6 events
 - M 1.3 to 1.7
 - same locations as previous
- Subnetwork events
 - None
- Consistent with previous year

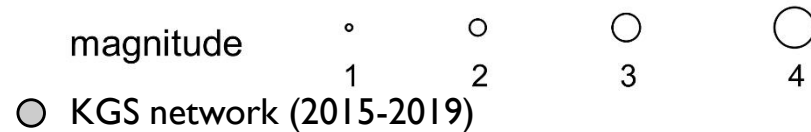
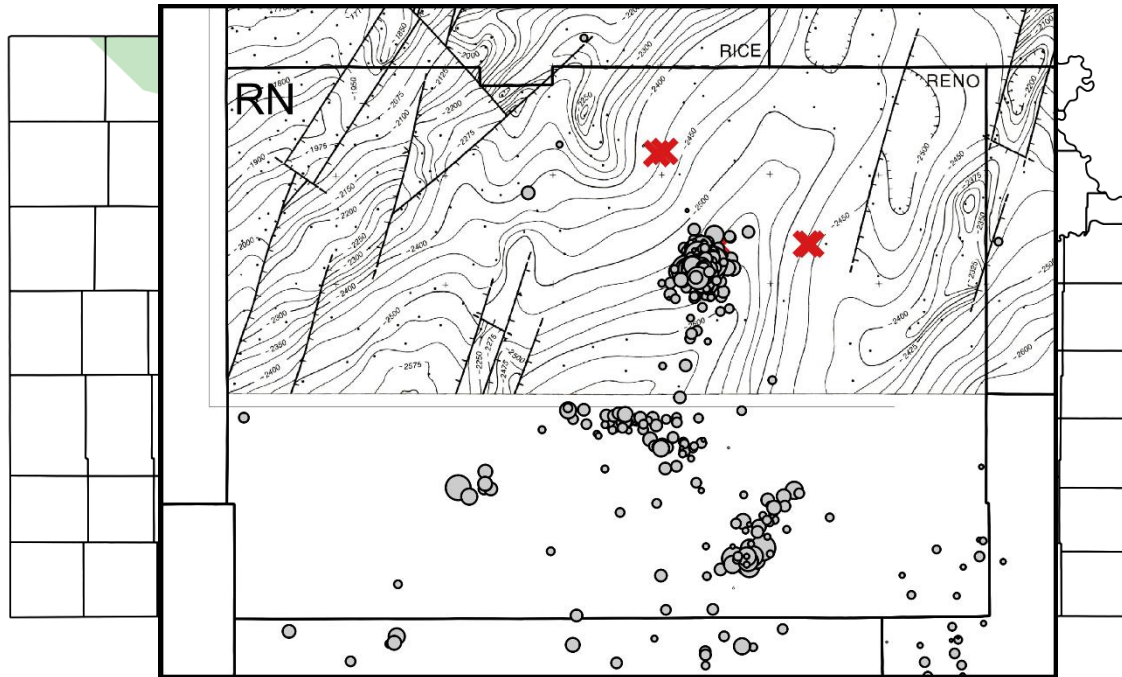
Reno County



- RN01
 - west of Hutchinson
 - cemetery
- RN02 moved due to flooding
- RN03
 - pasture
 - Sand Hills State Park
 - moved to higher ground

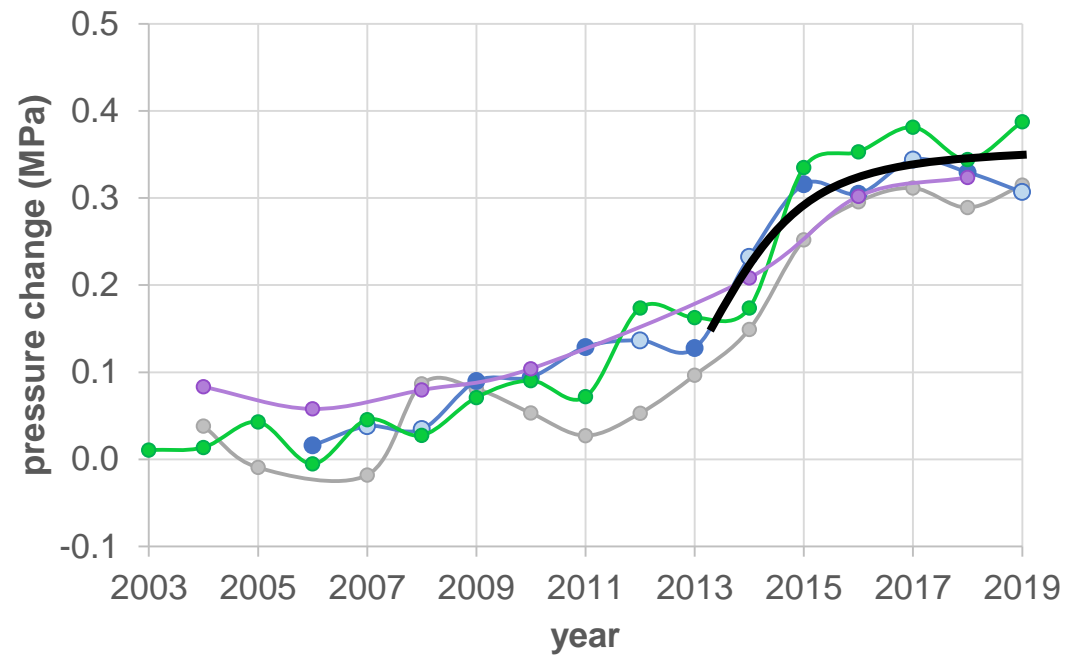
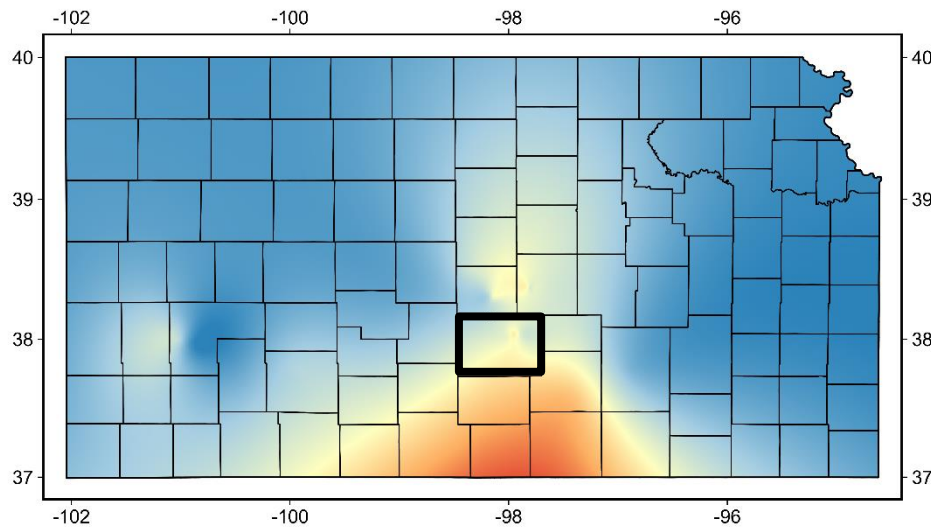
Reno County

Conway Syncline

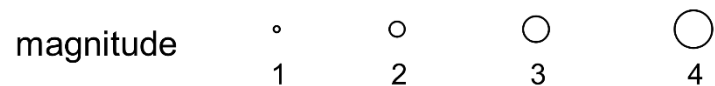
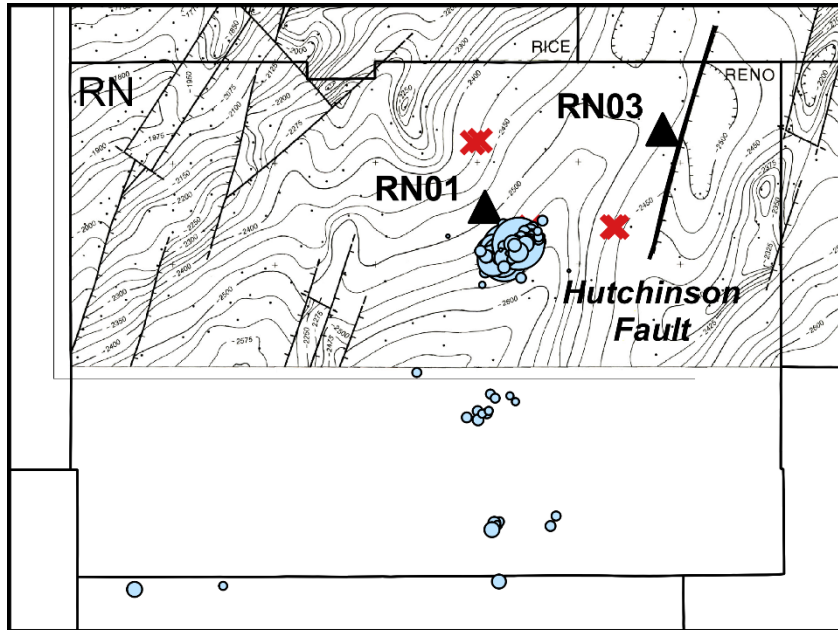


- Geologic Setting
 - CKU and MRS
 - structural low
 - Conway Syncline
 - faults bounding uplifted areas
- Historic earthquakes
 - None (M 3+)
 - Recent seismicity (2015-present)
 - progressed north
 - structural low

Reno County



Reno County

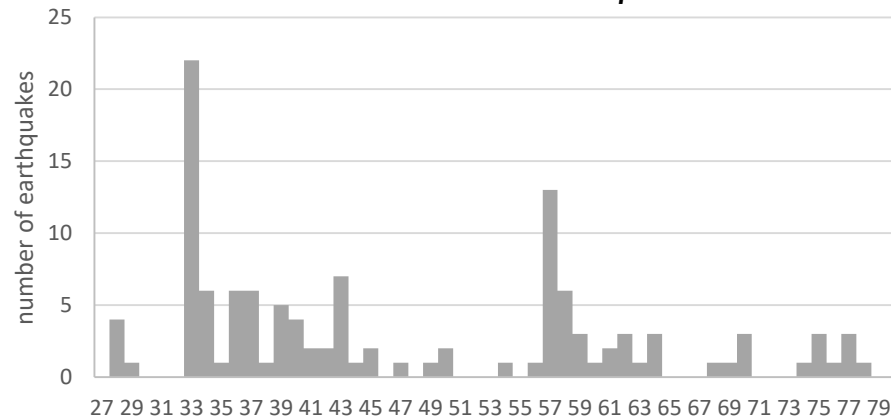


● KGS/CSTS network (2019-2020)

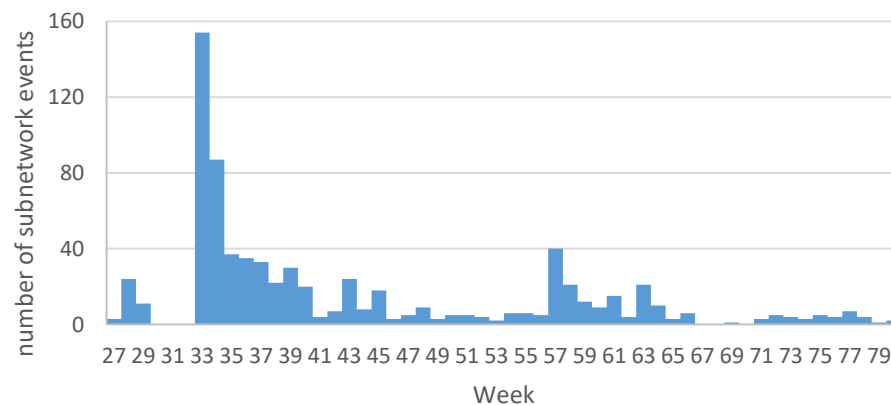
- Local earthquakes (w/in 20 mi)
 - About 140 events
 - Distinct clusters
 - Arlington (9, M 1.3 to 1.7)
 - Hutchinson (122, M 0.7 to 4.8)
- Pressure
 - continuing to stabilize
 - above triggering threshold
 - small fluctuations could trigger
- Subnetwork events
 - RN03
 - None
 - RN01
 - 700 (double)
 - M -1.5 to 0.6
 - corresponds to Hutchinson cluster

Reno County

Hutchinson earthquakes

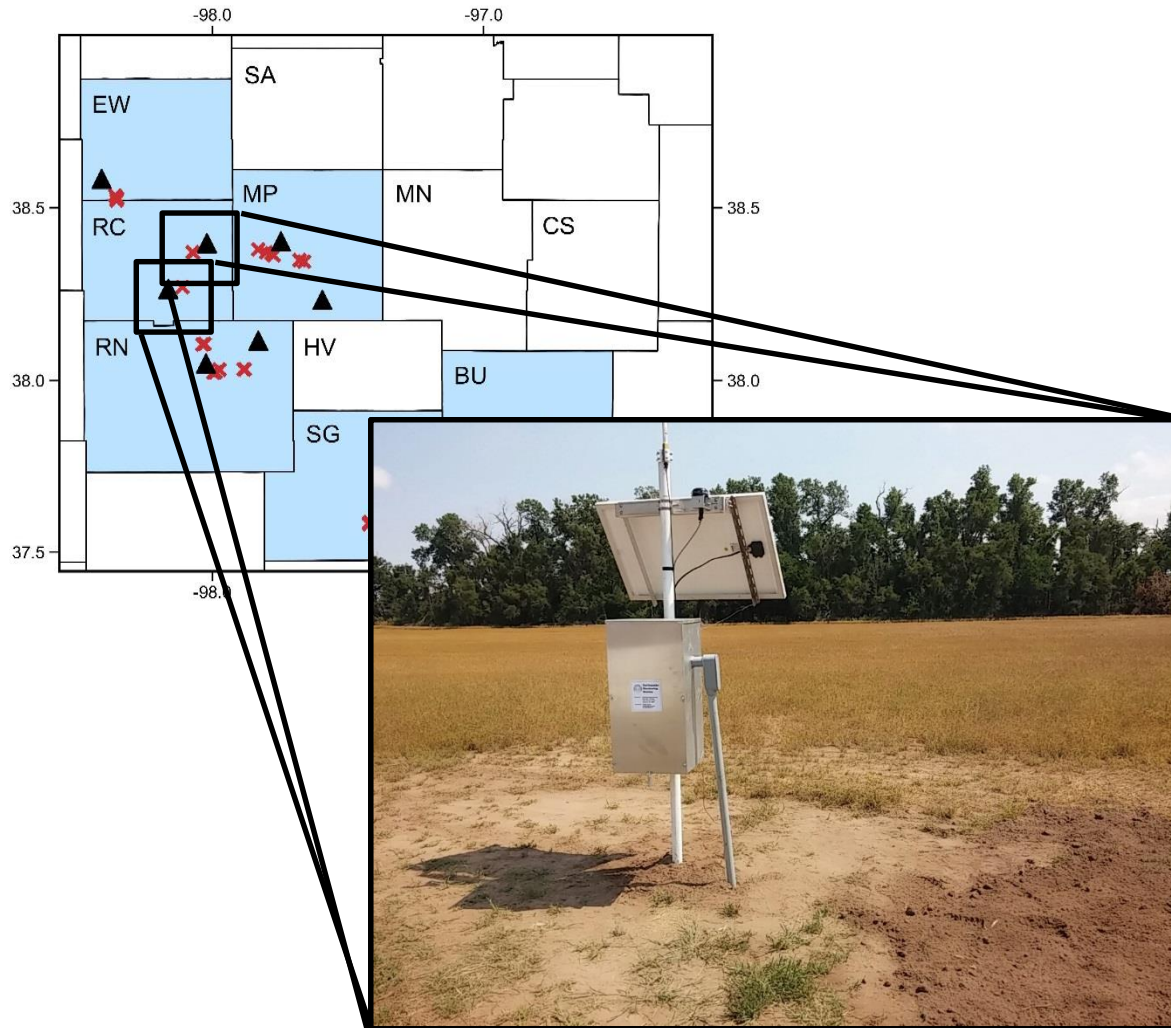


RN01 subnetwork events



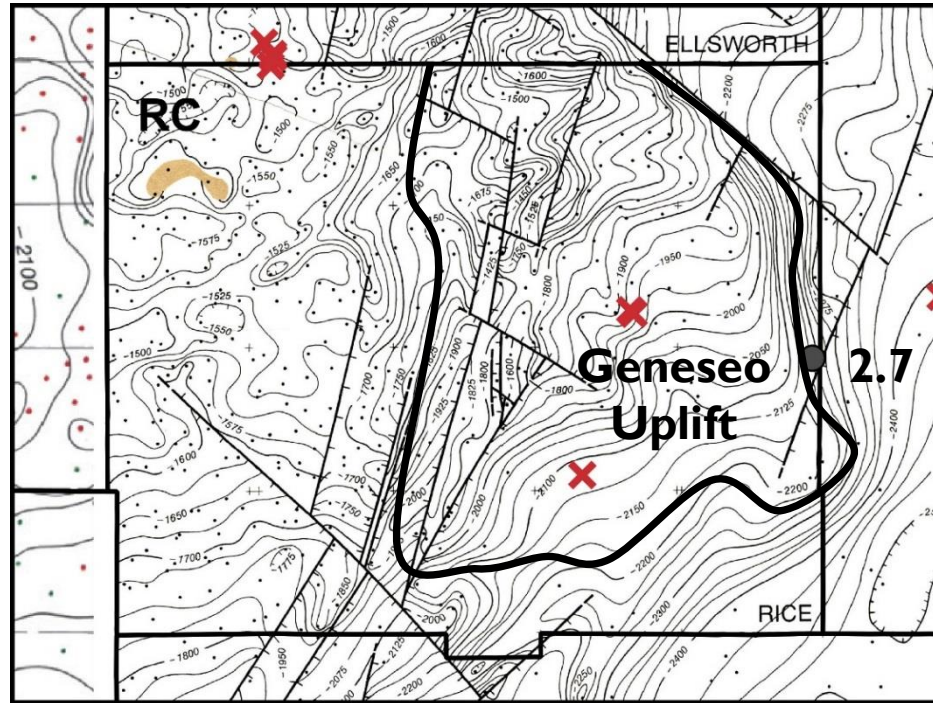
- Similar pattern
 - part of the earthquake sequences
 - affirms these subnetwork events are real earthquakes

Rice County



- RC02
 - northeast RC
 - pasture
 - Little River
- RC03
 - between Lyons and Sterling
 - pasture

Rice County

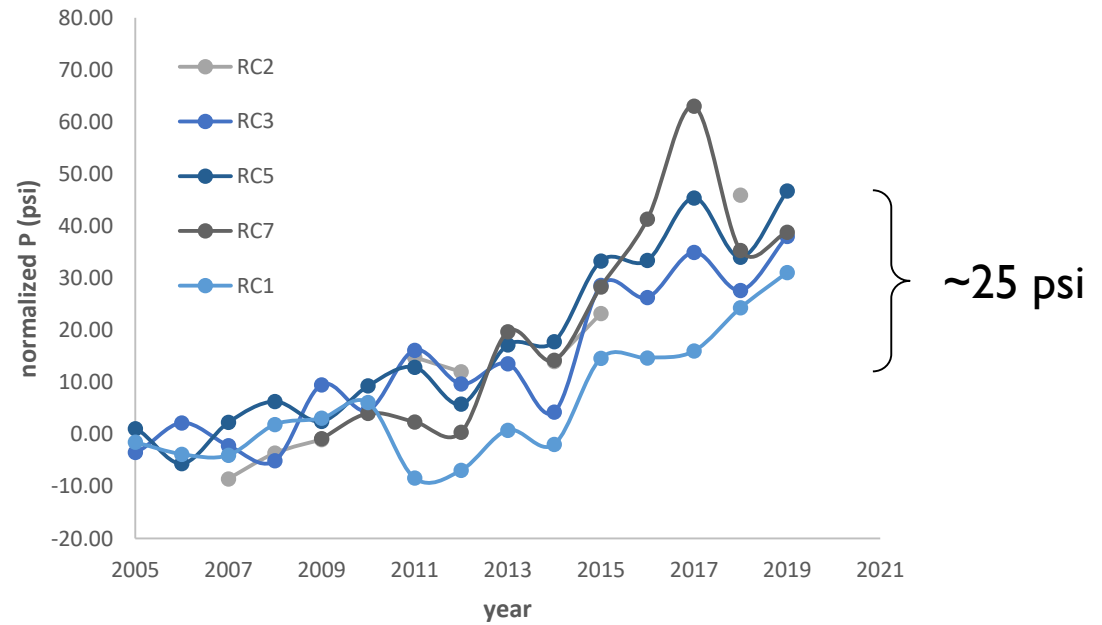
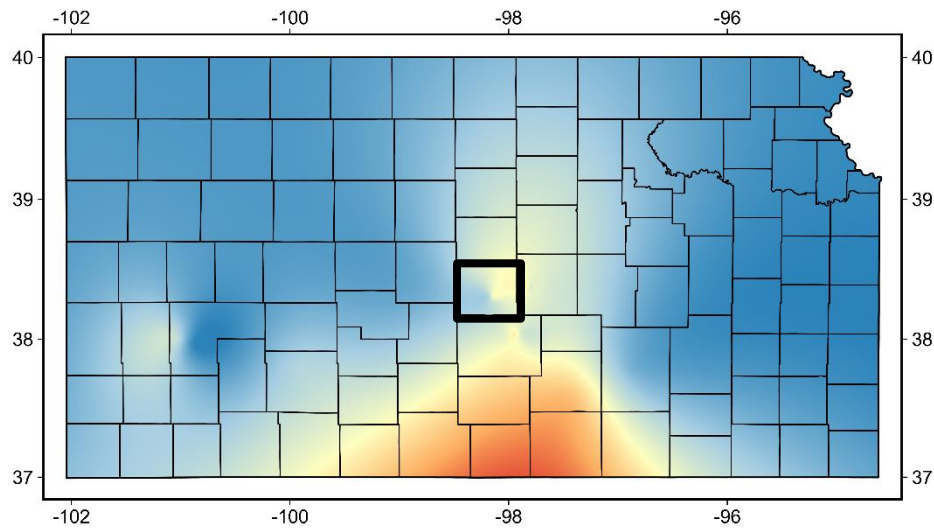


magnitude ○ ○ ○ ○
1 2 3 4

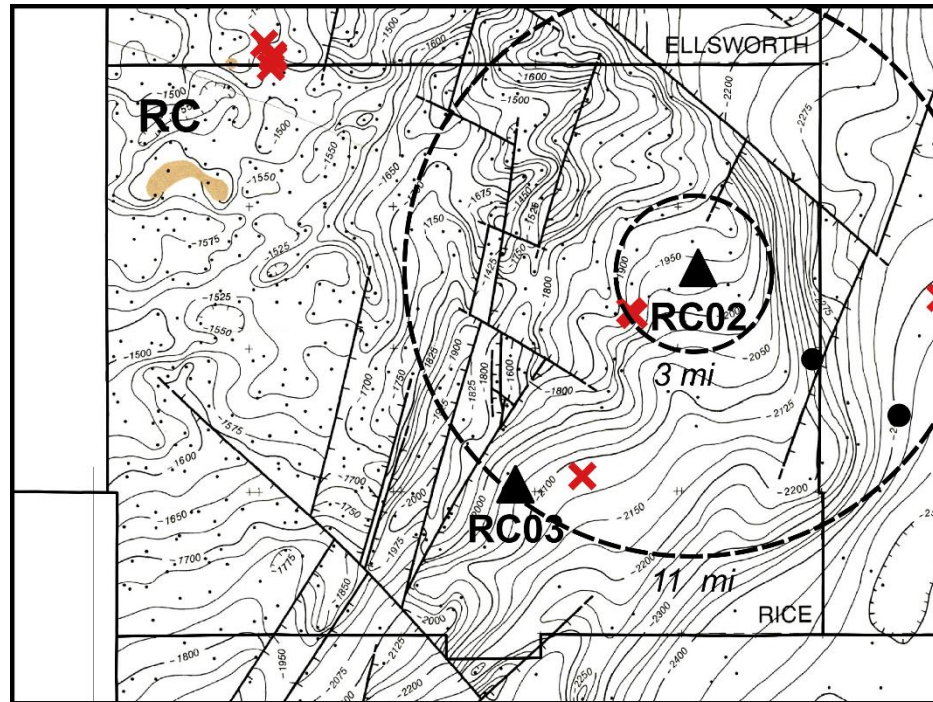
● Historic (1977-2014)

- Eastern margin of the CKU
- Mapped structures
 - Geneseo Uplift
 - bounded by faults
- Historic earthquakes
 - M 2.7 in 1981
 - Recently
 - M 1.2 in 2018
 - M 0.8 in 2019

Rice County

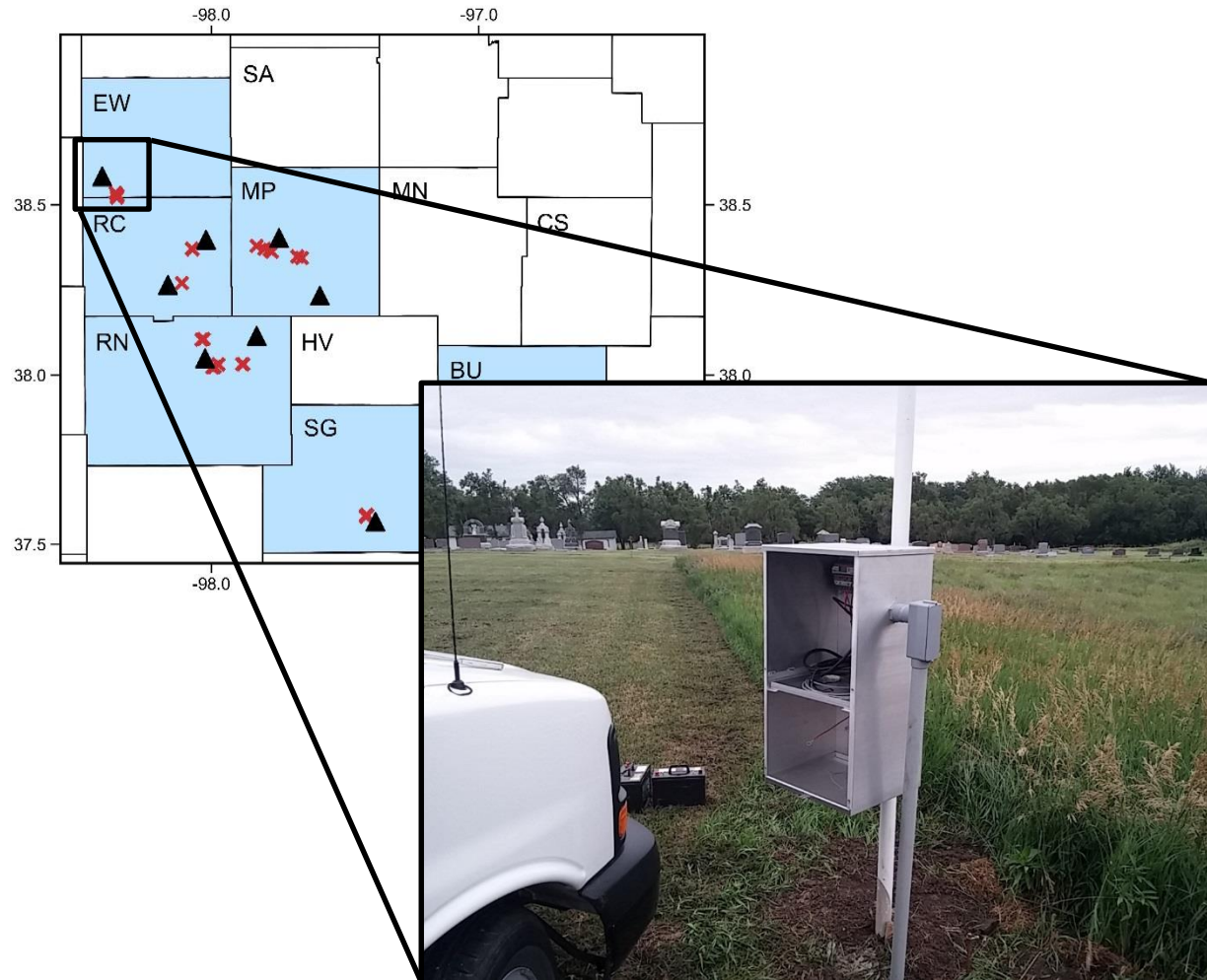


Rice County



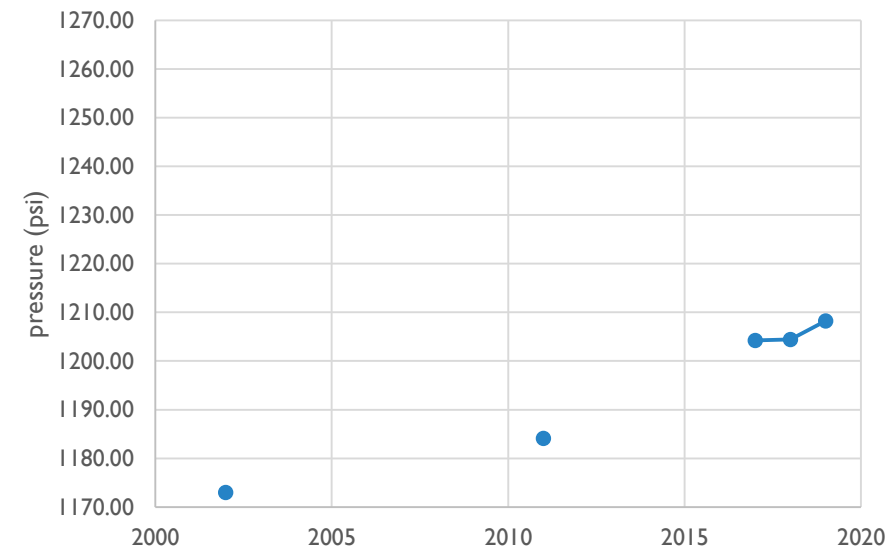
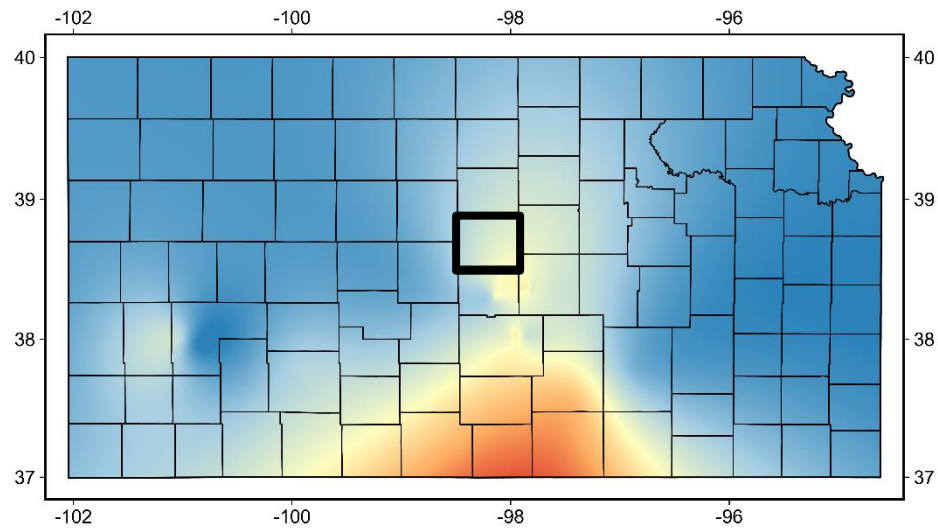
- Local earthquakes (< 20mi)
 - None
- Subnetwork events
 - RC02: 11
 - M -1.5 to 0.3
 - distance: 3-11 mi
 - Geneseo Uplift
 - RC03: more than 500
 - 8 mi, regular timing (8 hours)
 - spectral characteristics: likely underground mining blasts
- Consistent with last year

Ellsworth County

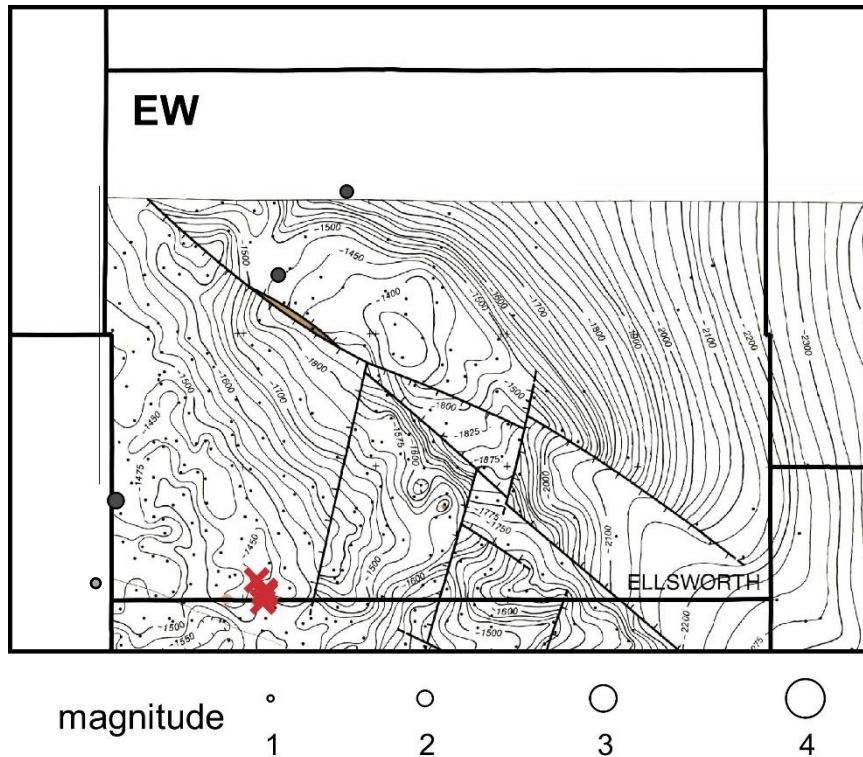


- EW01
 - southwest EW
 - Holyrood
 - pasture, cemetery

Ellsworth County



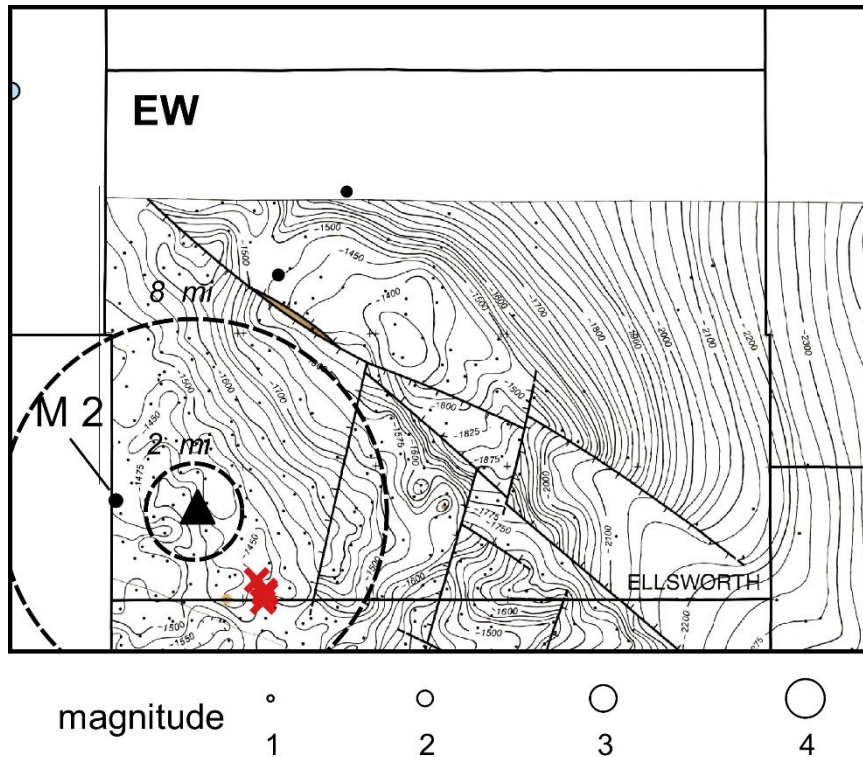
Ellsworth County



- Historic (1977-2014)
- KGS network (2015-2019)

- Eastern margin of the CKU
- Mapped structures
 - faults
 - anticlines
- Historic earthquakes
 - M 1.7 to 2.0 in 1980s
 - M 1.4 in 2018 (Barton)

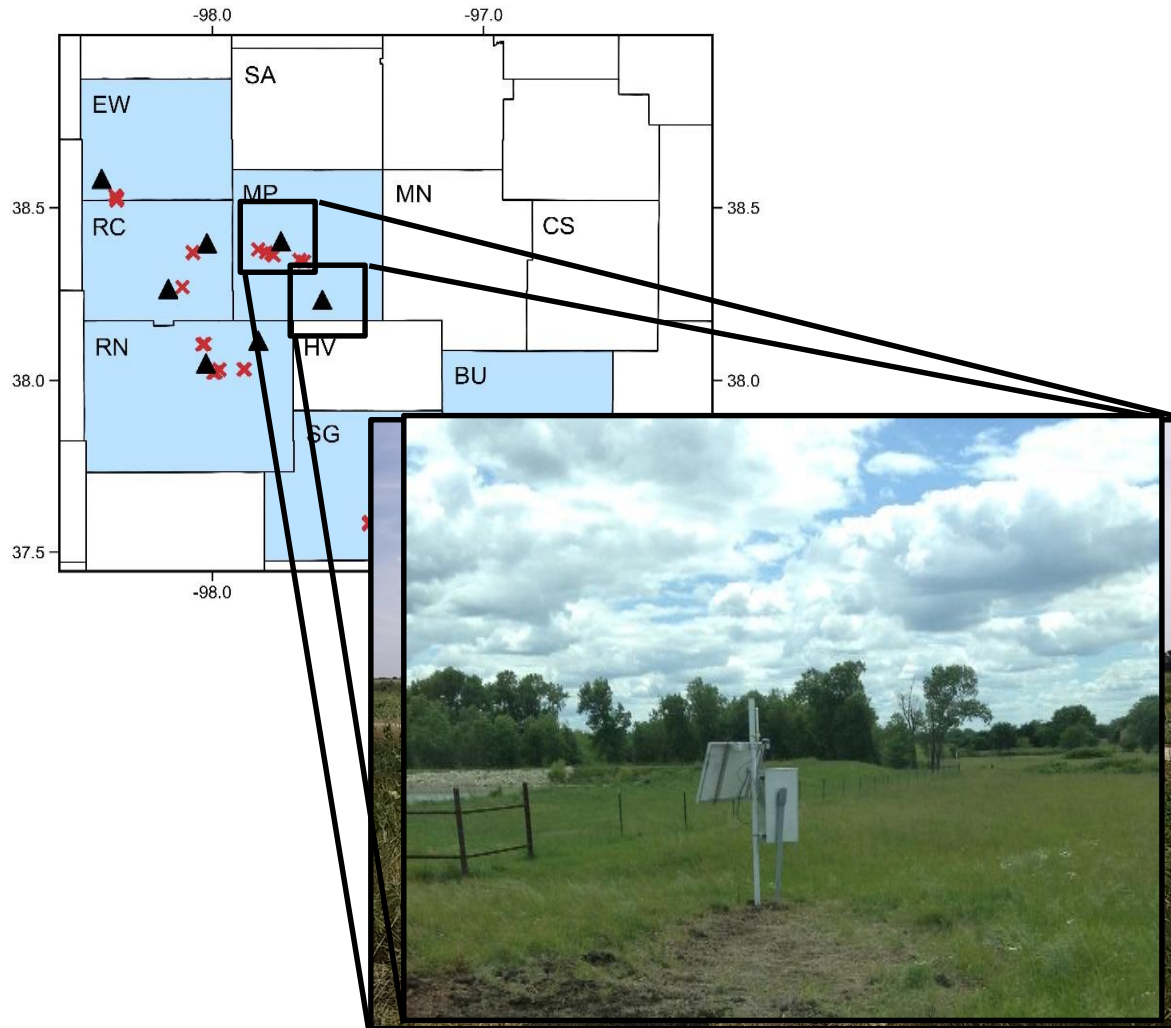
Ellsworth County



- Historic (1977-2014)
- KGS/CSTS network (2019-2020)

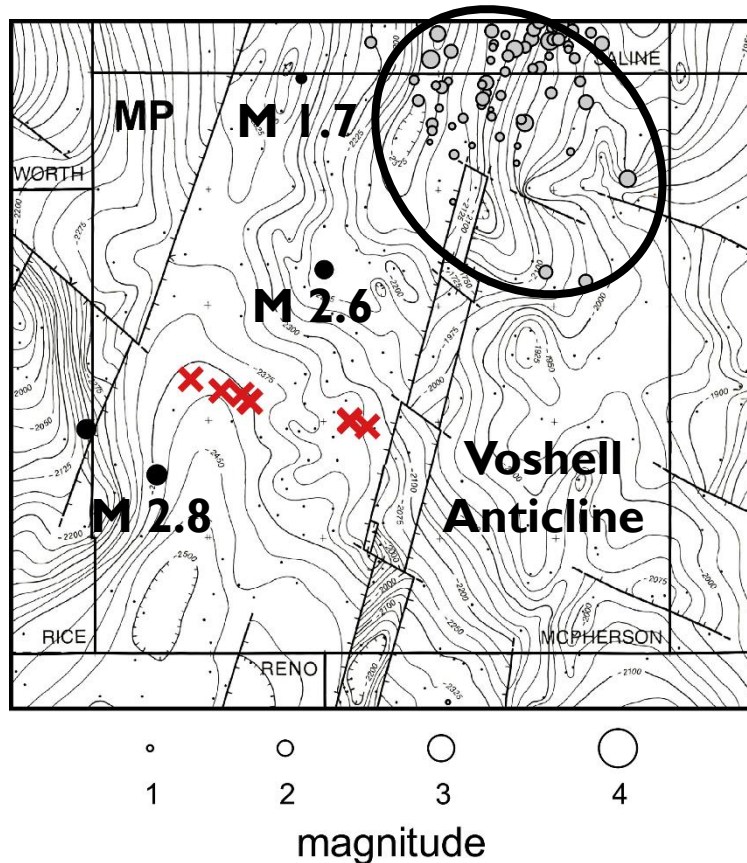
- Local earthquakes (< 20 mi)
 - None
- Subnetwork events
 - 4 events during past quarter
 - $M < 1$
 - 2-8 mi from station
 - may represent movement of faults that produced historic events

McPherson County



- MP01
 - northeast of Conway
 - pasture
 - McPherson Valley Wetlands
- MP02
 - south of McPherson
 - pasture
 - local church

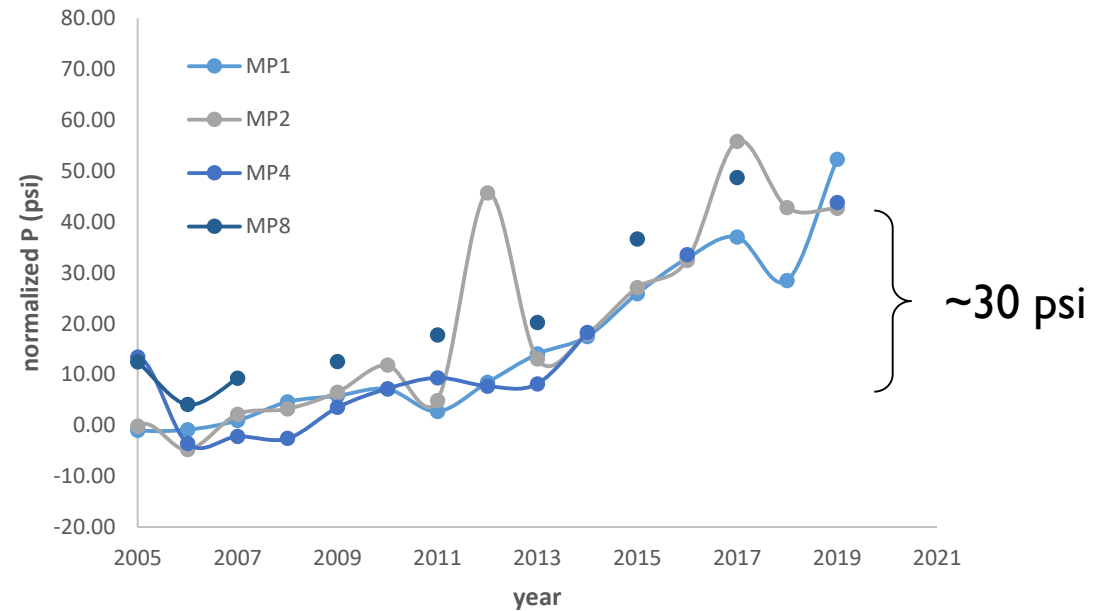
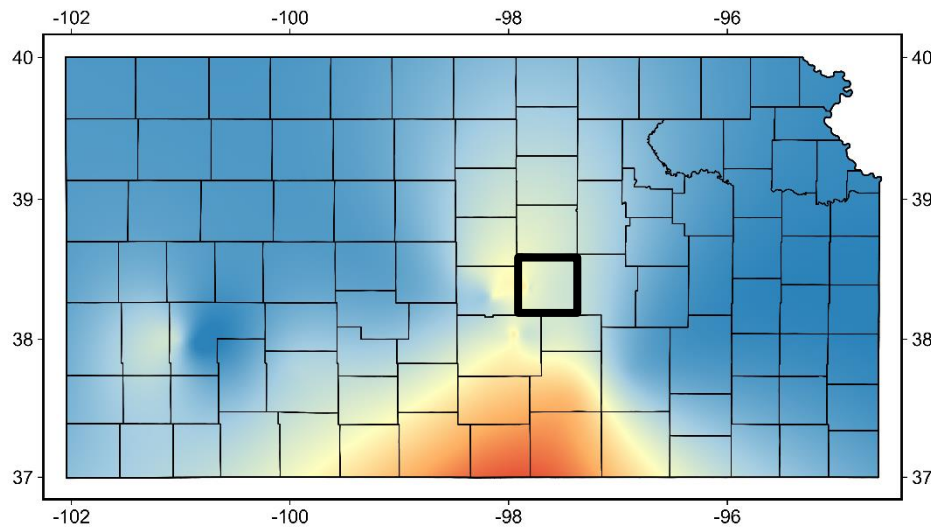
McPherson County



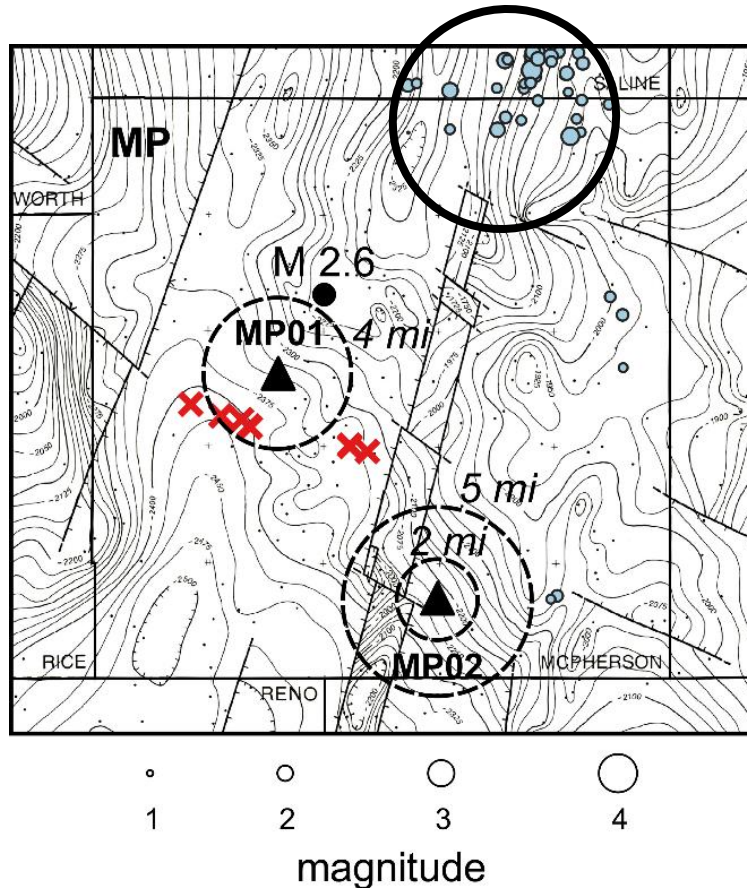
- Historic (1977-2014)
- KGS network (2015-2019)

- Midcontinent Rift System
- Mapped structures
 - Voshell Anticline
 - bounded by faults
- Previous earthquakes
 - M 2.8 in 1981
 - M 1.7 in 1983
 - M 2.6 in 2014
 - Recent seismicity near MP–SA county line

McPherson County



McPherson County

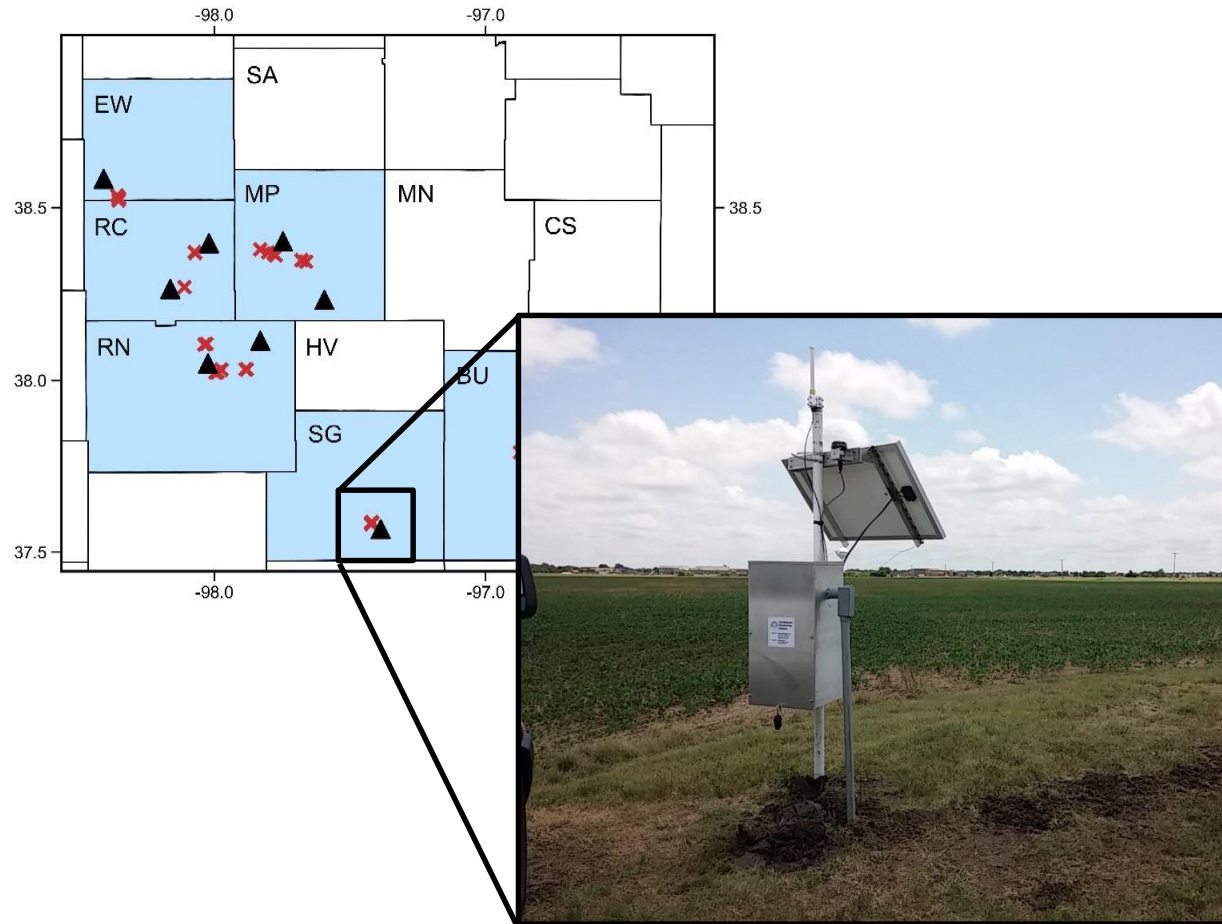


● Historic (1977-2014)

○ KGS/CSTS network (2019-2020)

- Local earthquakes
 - 11 earthquakes, M 0.4 to M 2.2
 - likely an extension of seismicity in SA along the MGA
- Subnetwork events
 - MP01: 10 events
 - M -0.6 to 0.4
 - 4 mi away
 - corresponds to 2014 earthquake
 - MP02: 27 events
 - M -1.5 to 0
 - 2-5 mi away
 - likely occurred on fault associated with Voshell anticline
- Consistent with last year

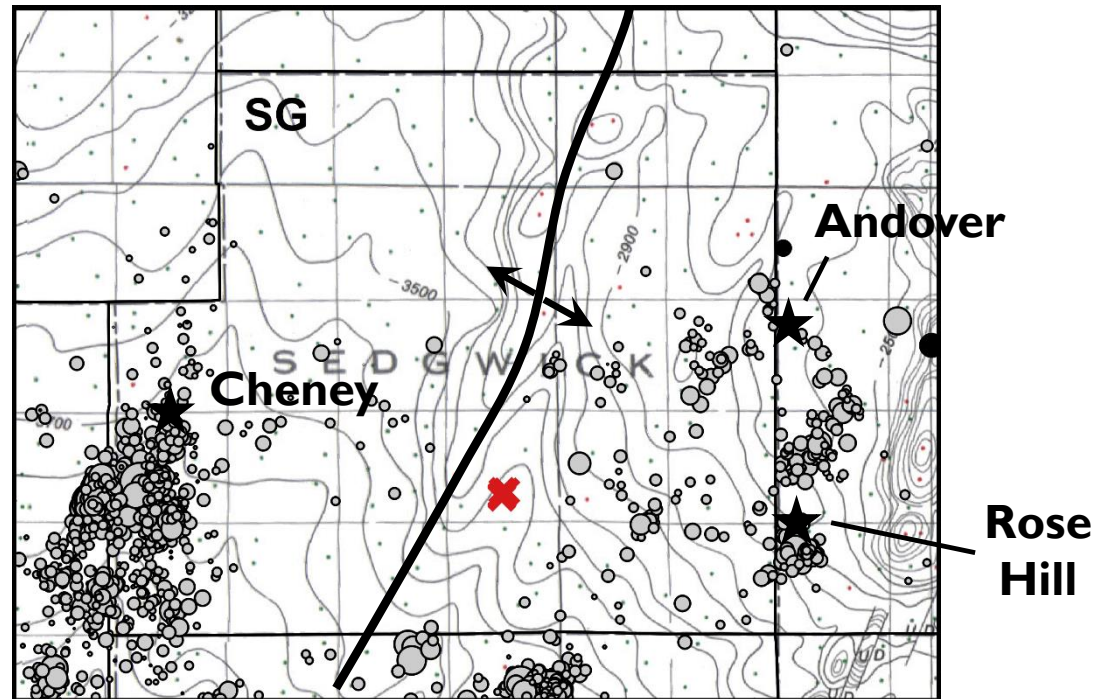
Sedgwick County



- SG02
 - south of Wichita
 - pasture
 - local church

Sedgwick County

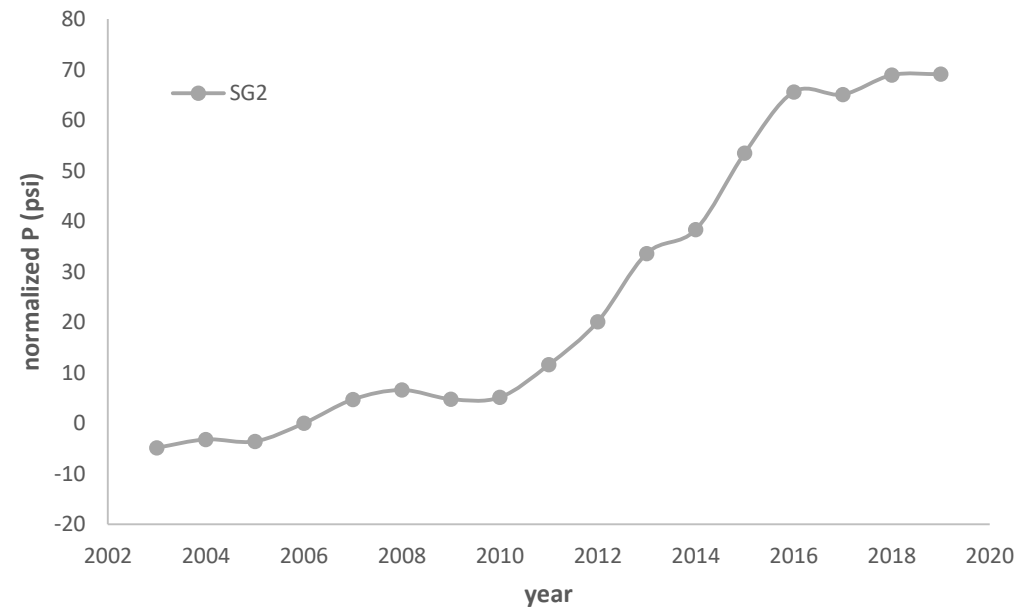
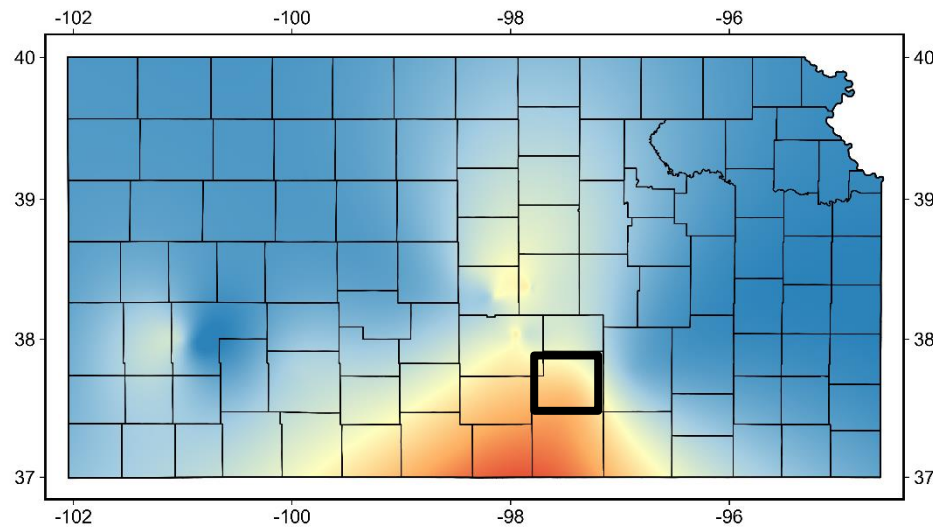
Valley Center Anticline



- Historic (1977-2014)
- KGS network (2015-2019)

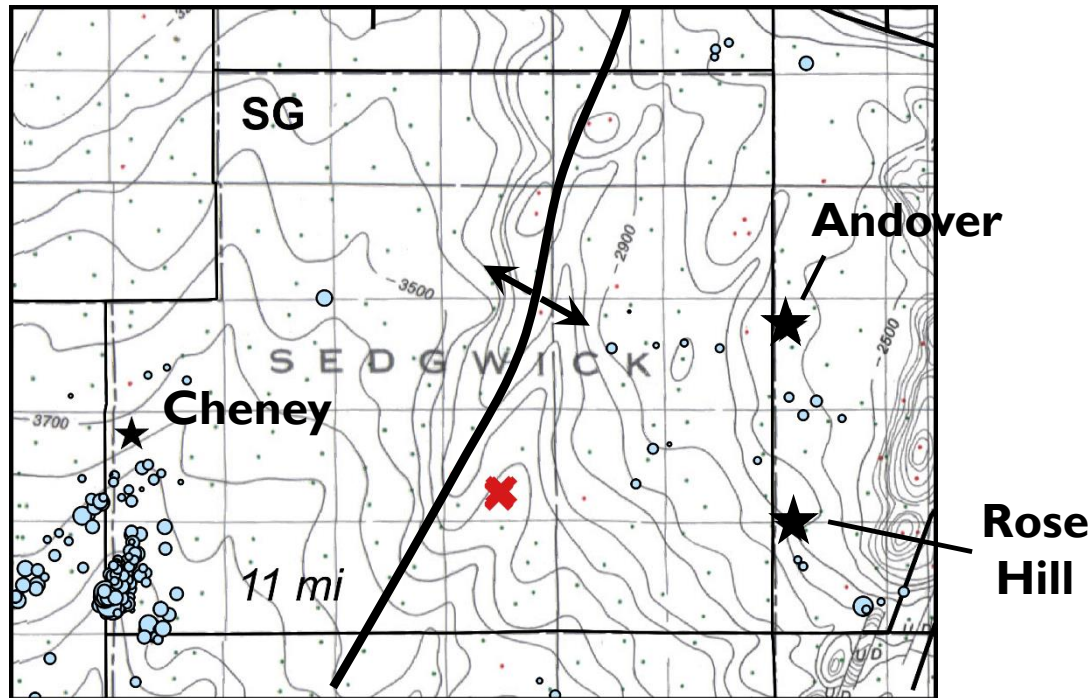
- Nemaha Ridge
- Mapped structures
 - Valley Center Anticline
 - likely associated faults
- Previous earthquakes
 - Historic
 - none recorded
 - felt events in early 1900s
 - Recent seismicity recorded by KGS network
 - predominantly NE trends
 - migrated from KS-OK
 - likely induced

Sedgwick County



Sedgwick County

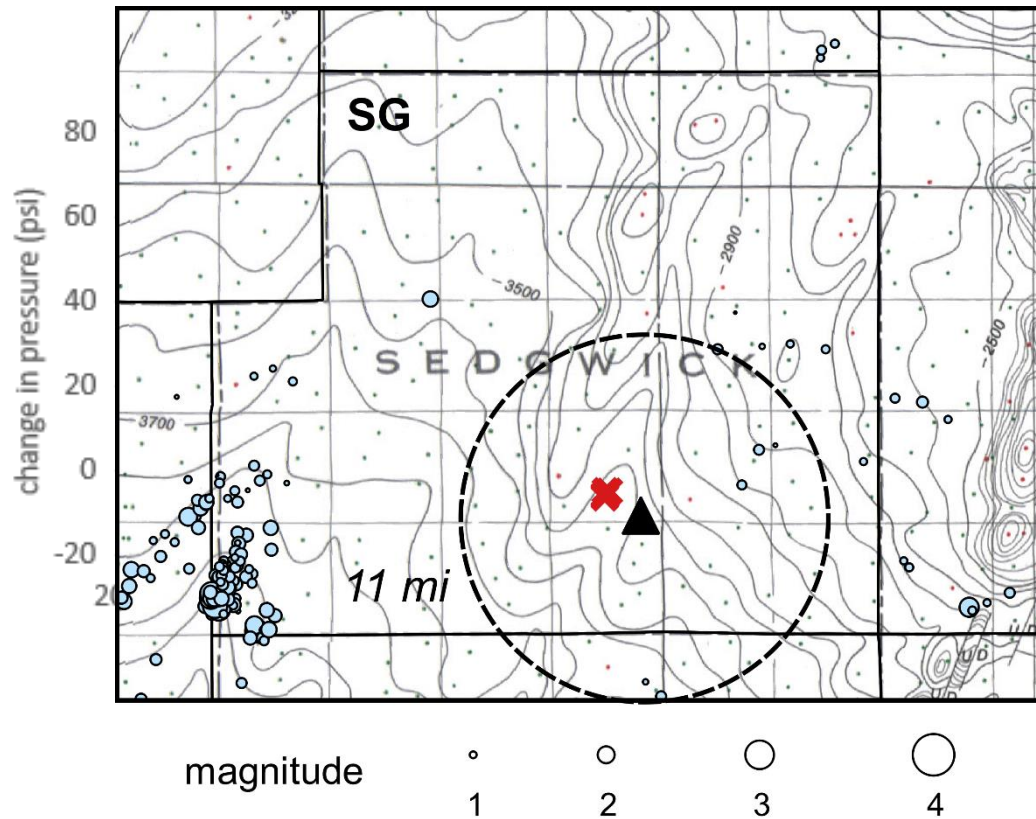
Valley Center Anticline



- Local earthquakes
 - more than 100
 - M 0.5 to 3.1
 - majority in 2019
 - clusters identified previously
- Cheney
 - ~110, largest was M 1.9
- Northern Sumner
 - 10, largest was M 2.0
- Andover and Rose Hill
 - 10, largest M 1.5

● KGS/CSTS network (2019-2020)

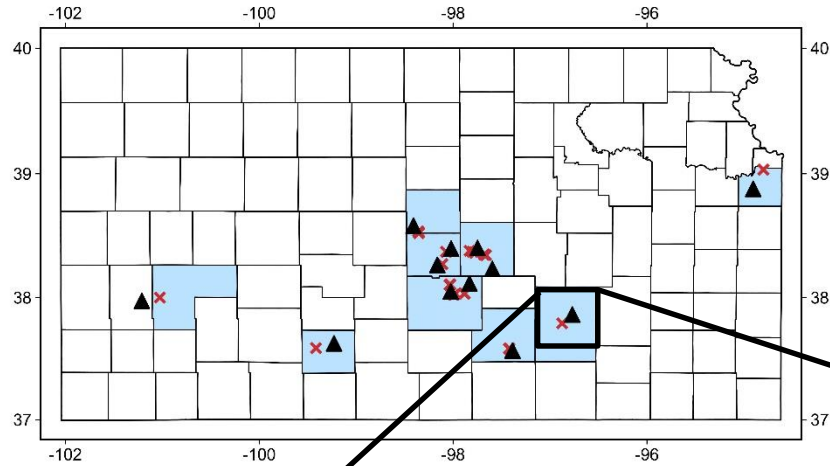
Sedgwick County



- Subnetwork events
 - 34 events
 - M -1.5 to 0.6
- Distance: 3-11 mi
 - known clusters
 - Valley Center anticline

● KGS/CSTS network (2019-2020)

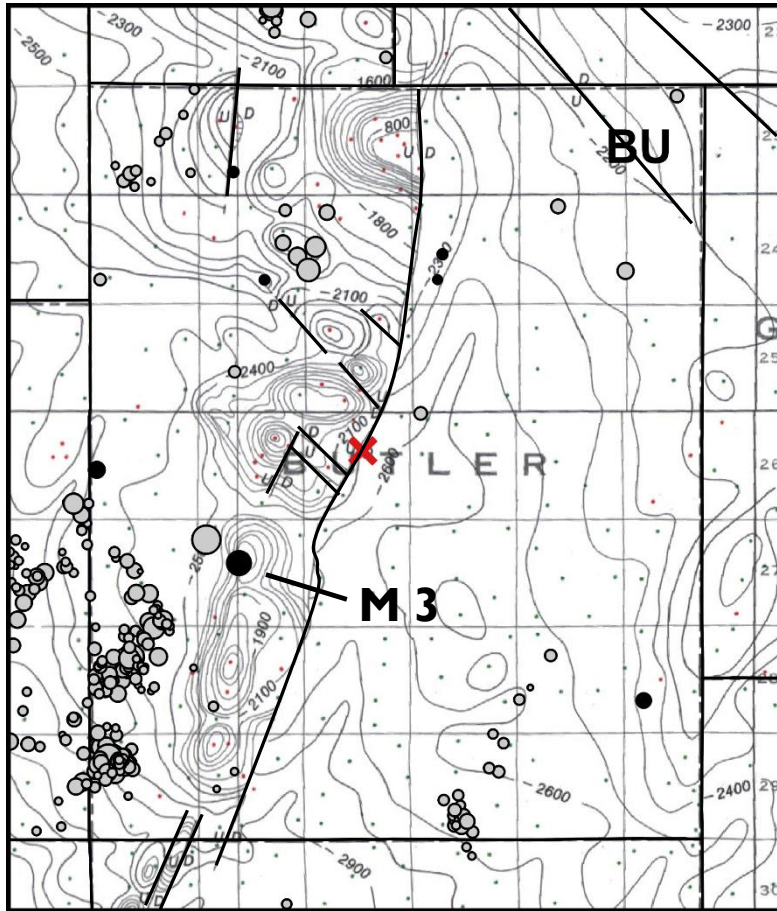
Butler County



- BU02
 - northeast of El Dorado
 - pasture
 - El Dorado State Park



Butler County



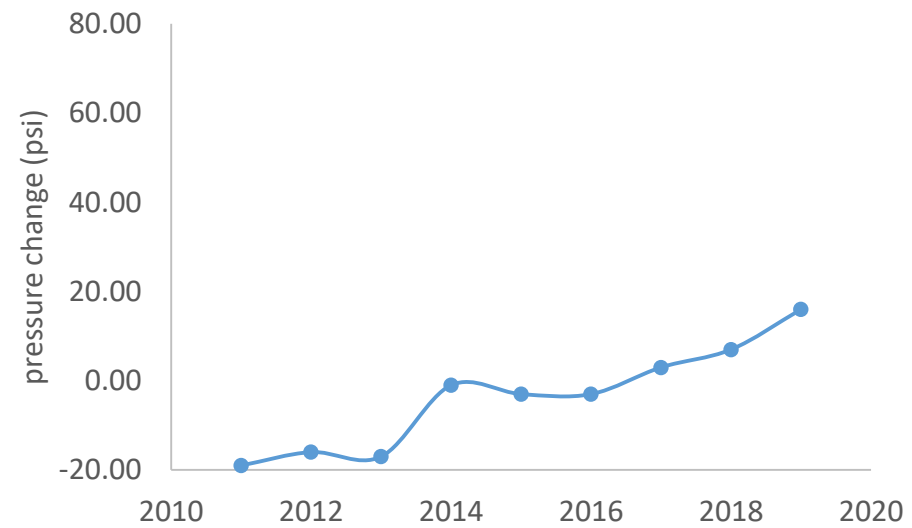
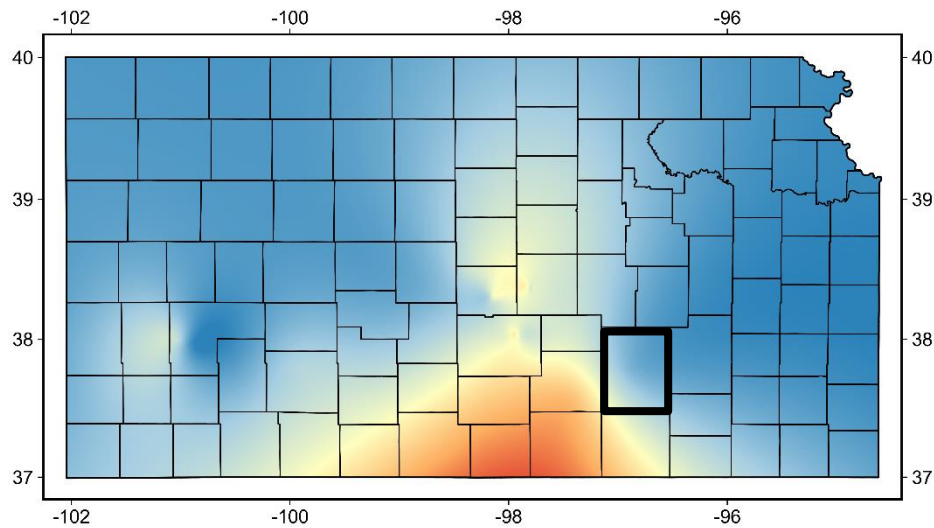
- Historic (1977-2014)
- KGS network (2015-2019)

magnitude

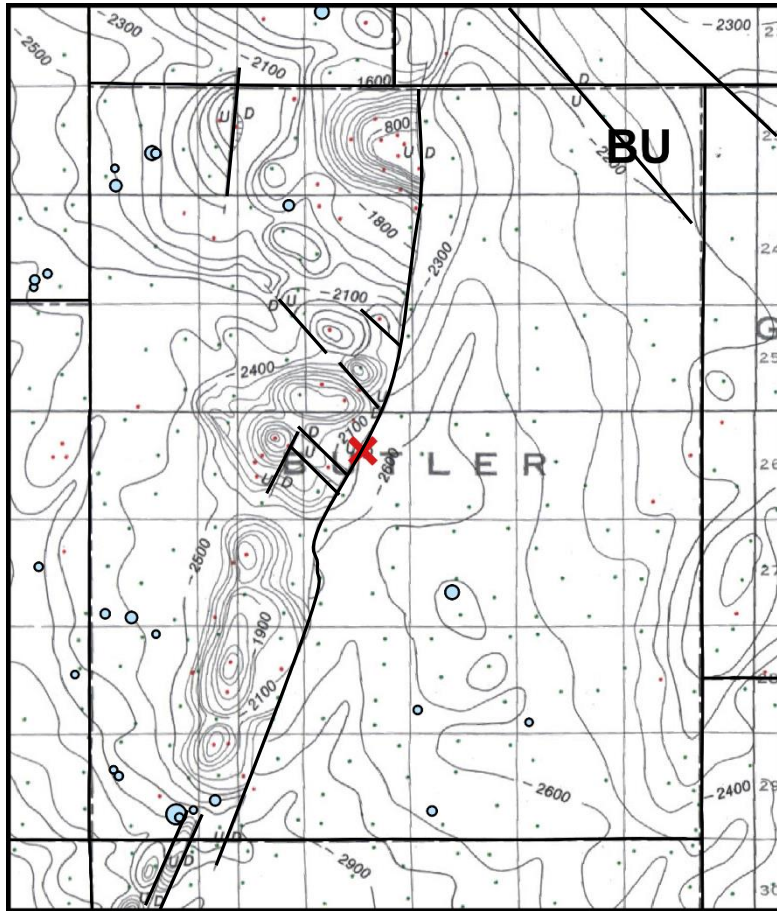
- 1
- 2
- 3
- 4

- Nemaha Ridge
- Mapped structures
 - Nemaha Ridge/Humboldt FZ
 - anticlines/synclines
 - mapped faults
- Previous earthquakes
 - 7 historic events (M 3 in 2001)
 - Recent seismicity recorded by KGS network
 - M 2.9 near historic event
 - clusters in northern BU

Butler County



Butler County



○ KGS/CSTS network (2019-2020)

magnitude

○ 1

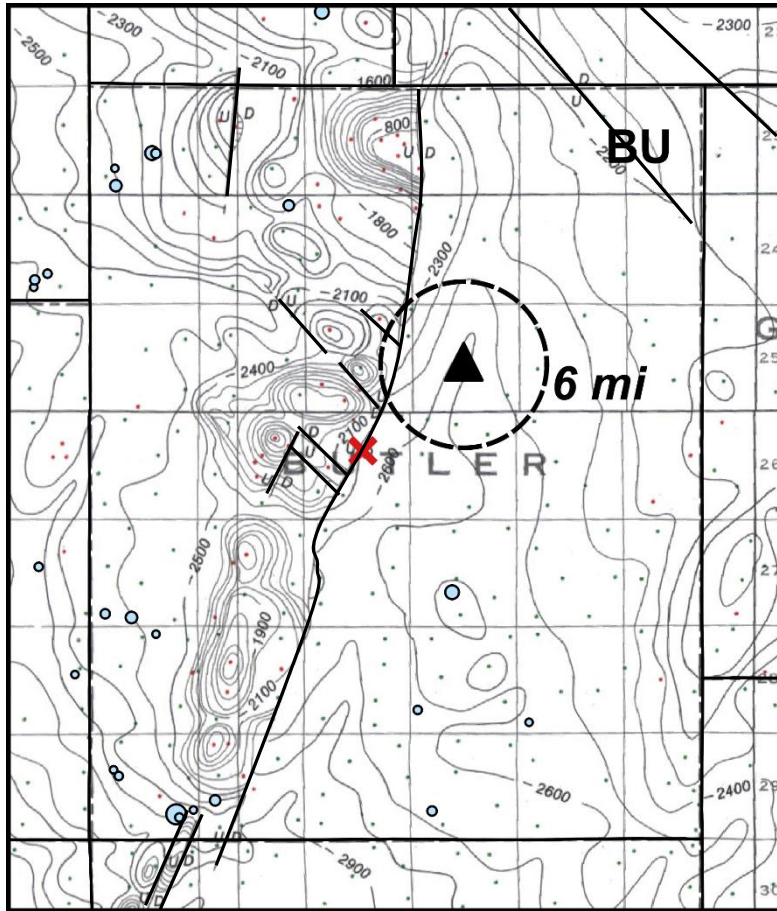
○ 2

○ 3

○ 4

- Local earthquakes
 - 18 earthquakes
 - M 1.2 to 2.3
 - clusters identified previously
 - near historic
 - not along induced trends
- Subnetwork events
 - Two M < 1
 - ~6 mi
 - Consistent with mapped faults
 - likely natural
- Consistent with last year

Butler County



○ KGS/CSTS network (2019-2020)

magnitude

○ 1

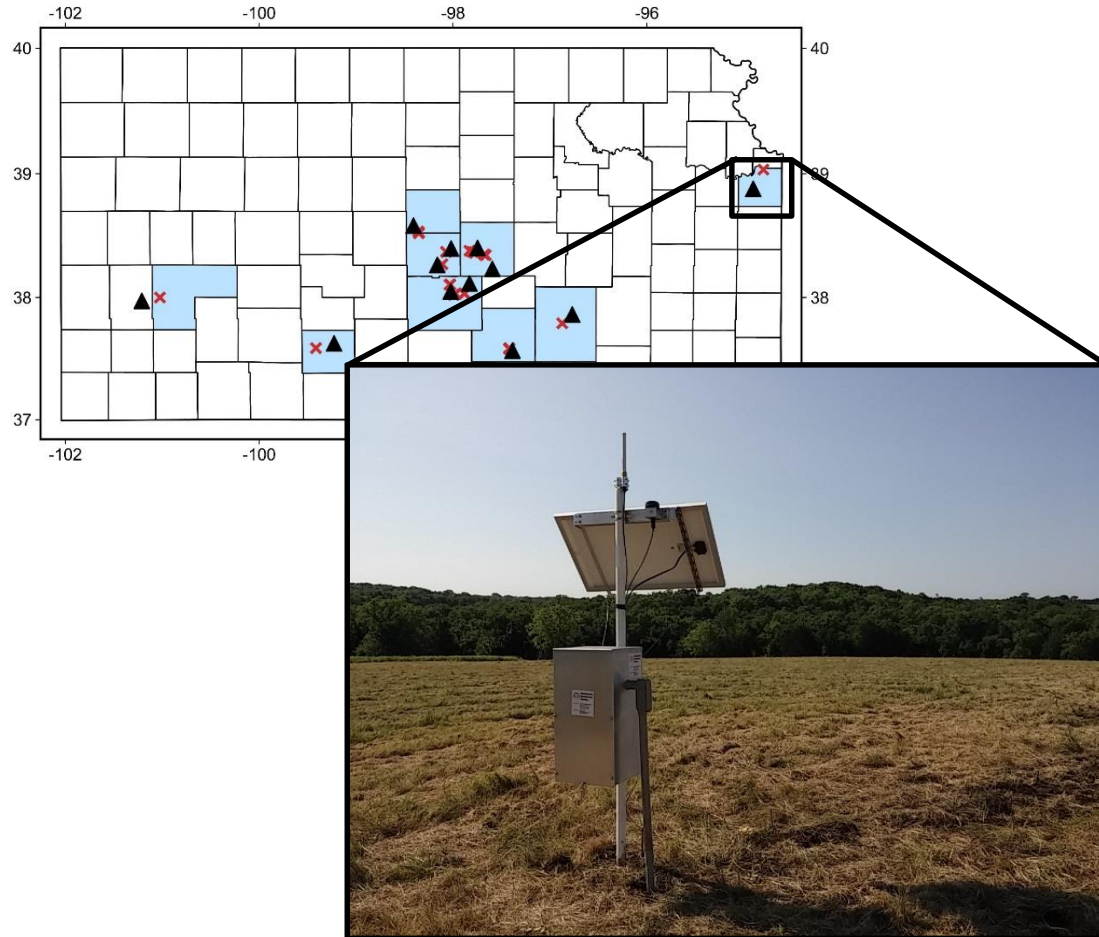
○ 2

○ 3

○ 4

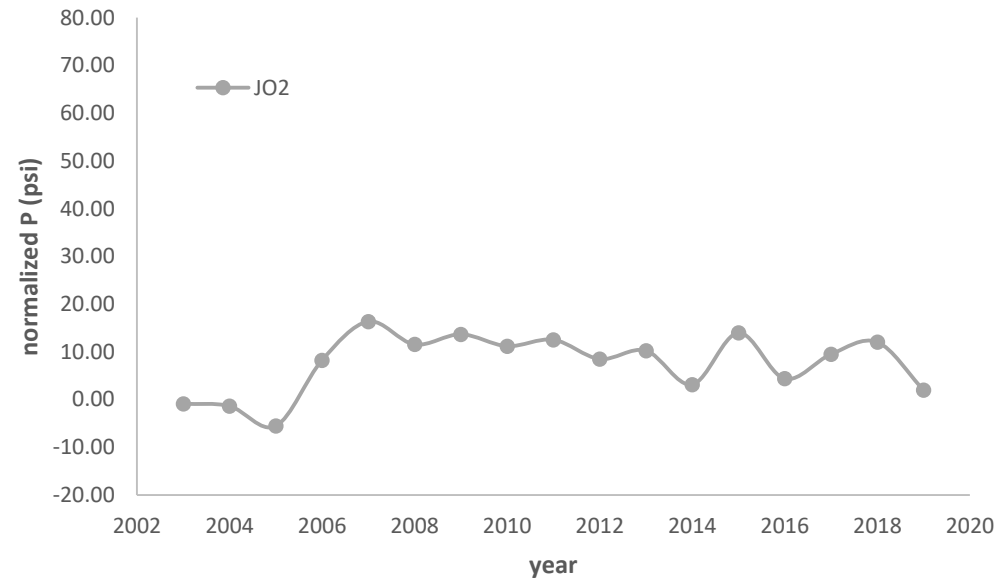
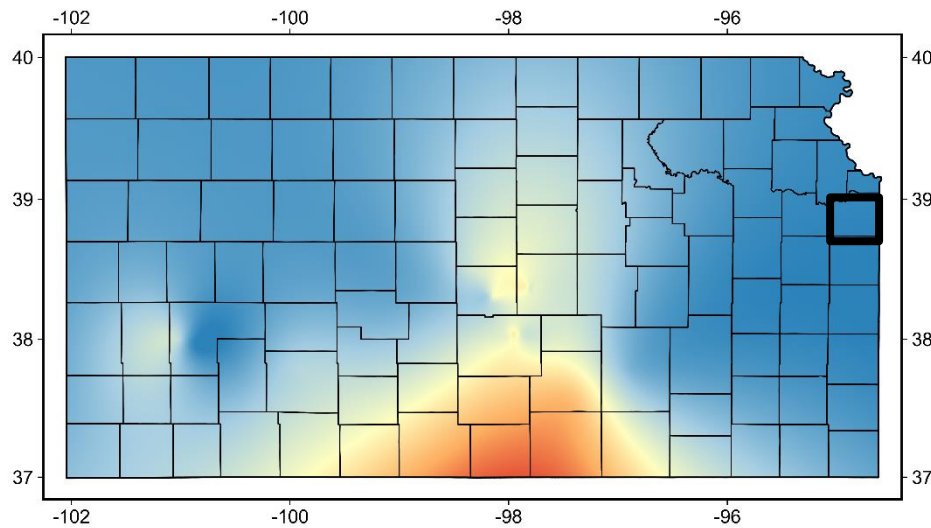
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Johnson County

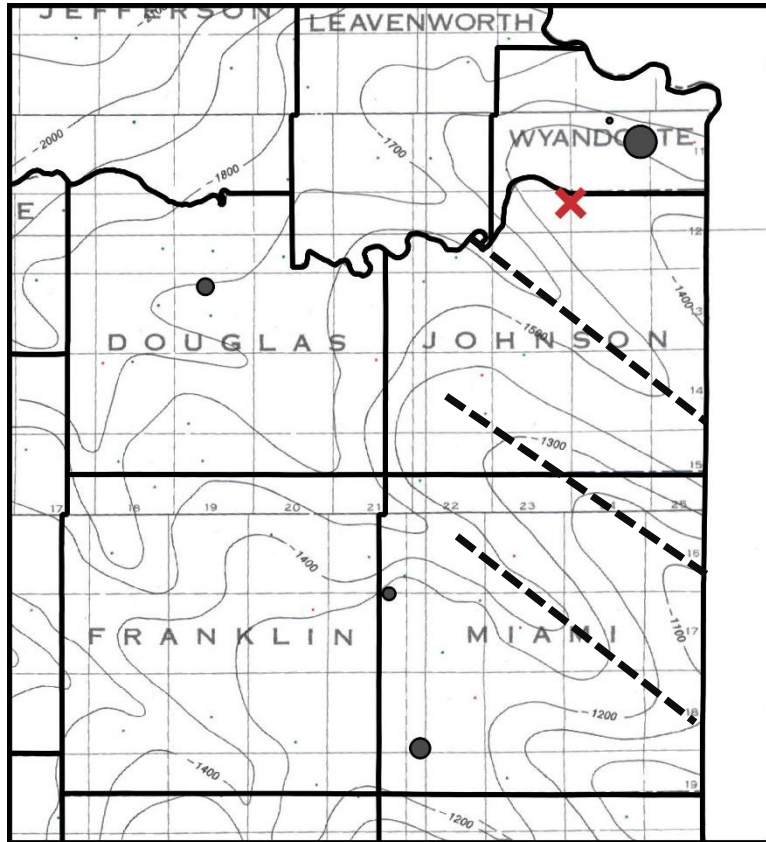


- JO01
 - western JO
 - pasture
 - Olathe Prairie Center
- 2 quarries within 5 mi
 - characteristic waveforms
 - confidently identified
 - not cataloged

Johnson County



Johnson County



● historic (1977-2014)

magnitude

- 1
- 2
- 3
- 4

- Forest City Basin
 - Nemaha Ridge
 - Bourbon Arch
- Mapped structures
 - no mapped faults
 - NW structural trends
- Seismicity
 - Historic
 - M 0.8 to M 2.1 in 1980s
 - M 3 in 1999
 - Local: none
 - Subnetwork: none
 - Consistent with last year

Summary

- Largely consistent with previous reporting year
 - affirm background trends
 - some exceptions (e.g. RN)
 - decreased seismicity
 - consistent with formation pressure trends
- Formation pressure is stabilizing
 - continued low-rate seismicity
 - because it remains elevated, small changes could trigger
 - Hutchinson possible example
- Plans for the coming year:
 - Move KE01

Thank You