



Update: Regulation of Disposal Wells In Seismically Active Areas of Texas

Paul Dubois, P.E. September 2023













Outline

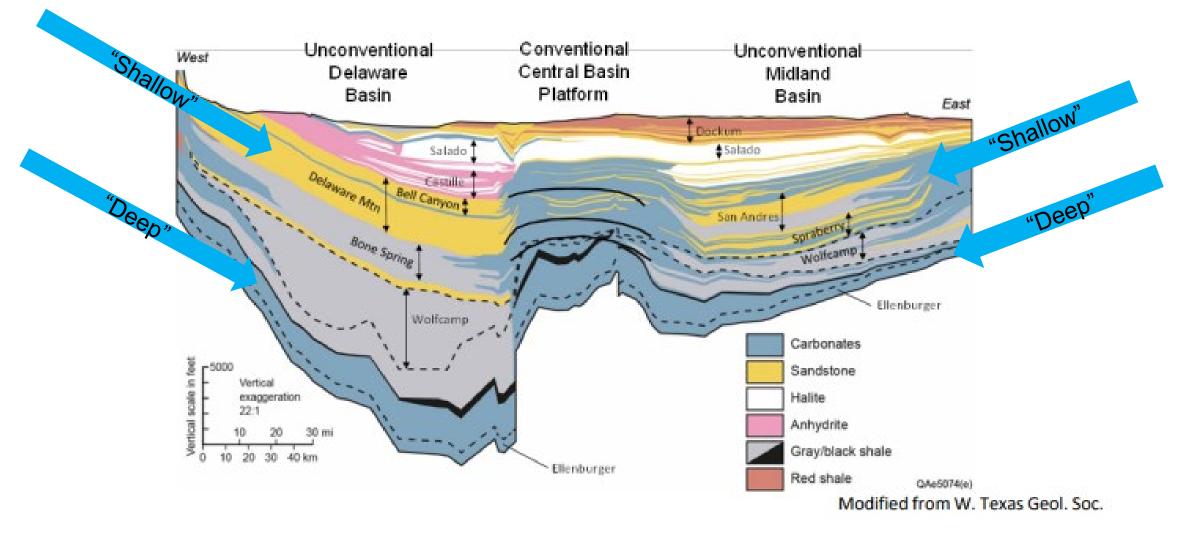


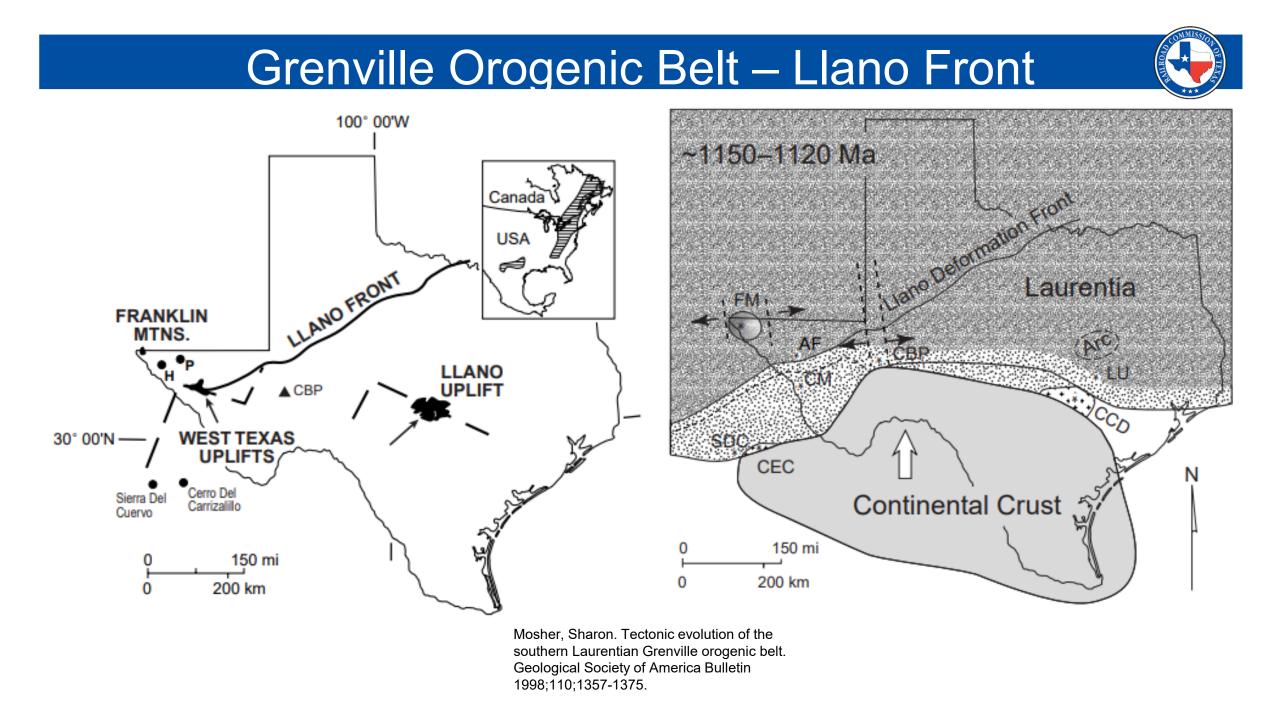
- Introduction to Permian Geology & Injection
- Seismic Response Areas Review and Status
 - Gardendale (Midland Basin)
 - Northern Culberson-Reeves (Delaware Basin)
- Going Forward

Permian Basin Stratigraphy

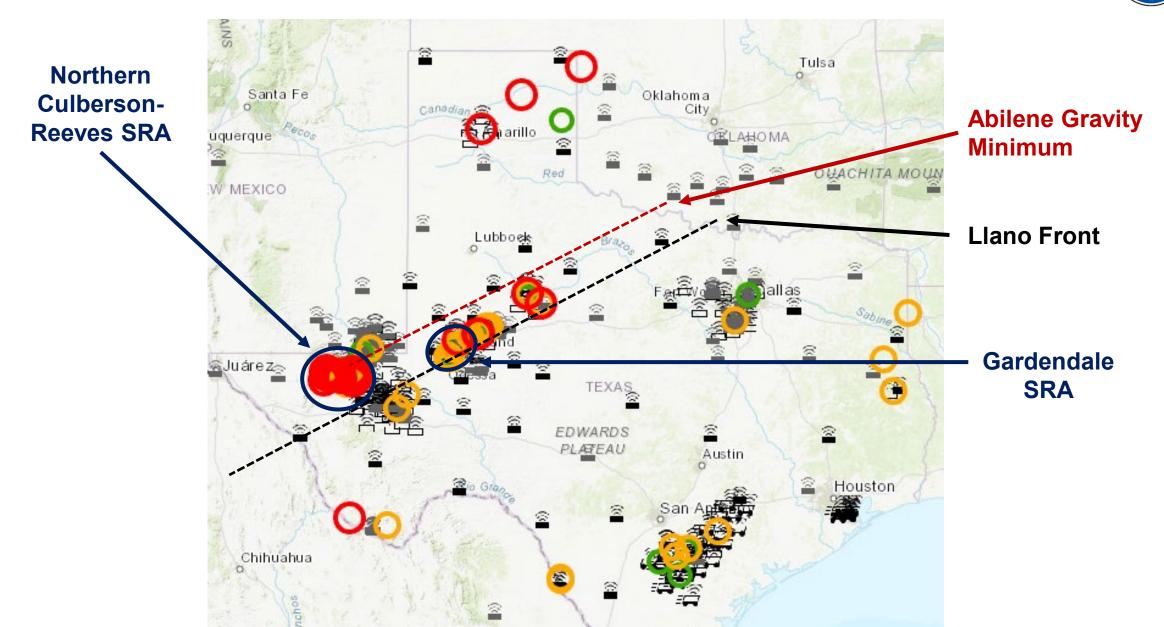


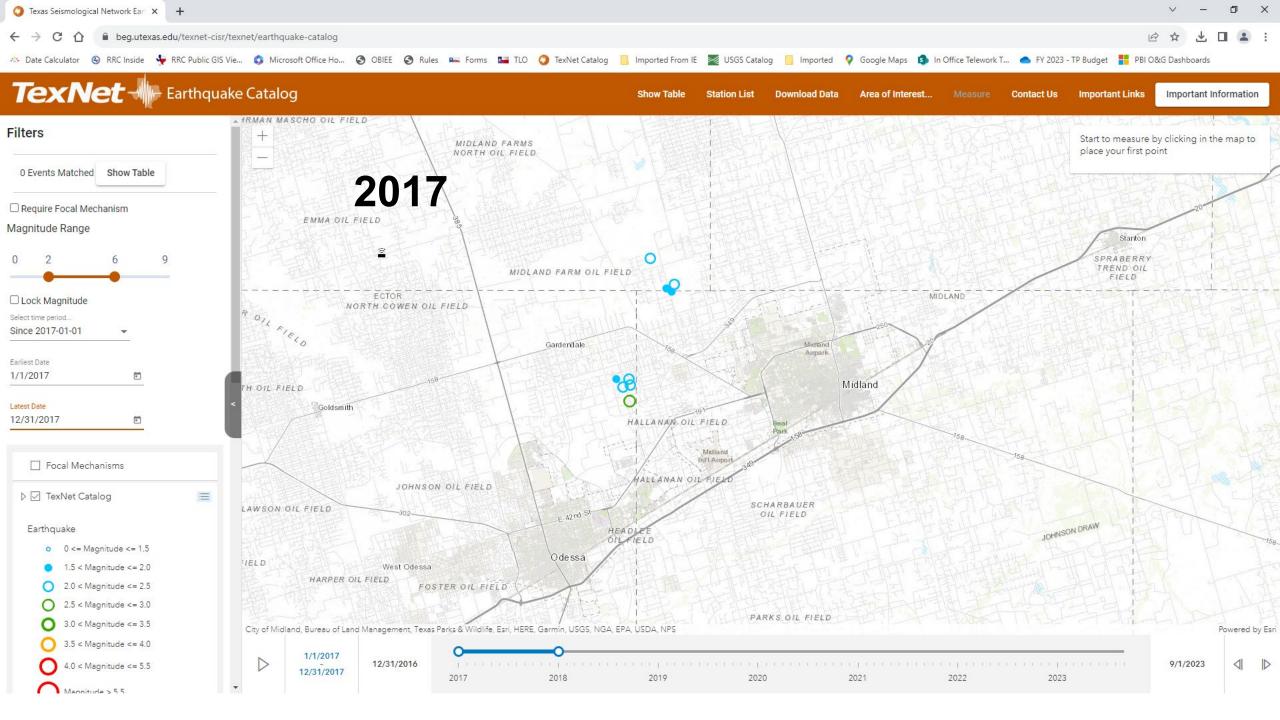
Cross Section of the Permian Basin

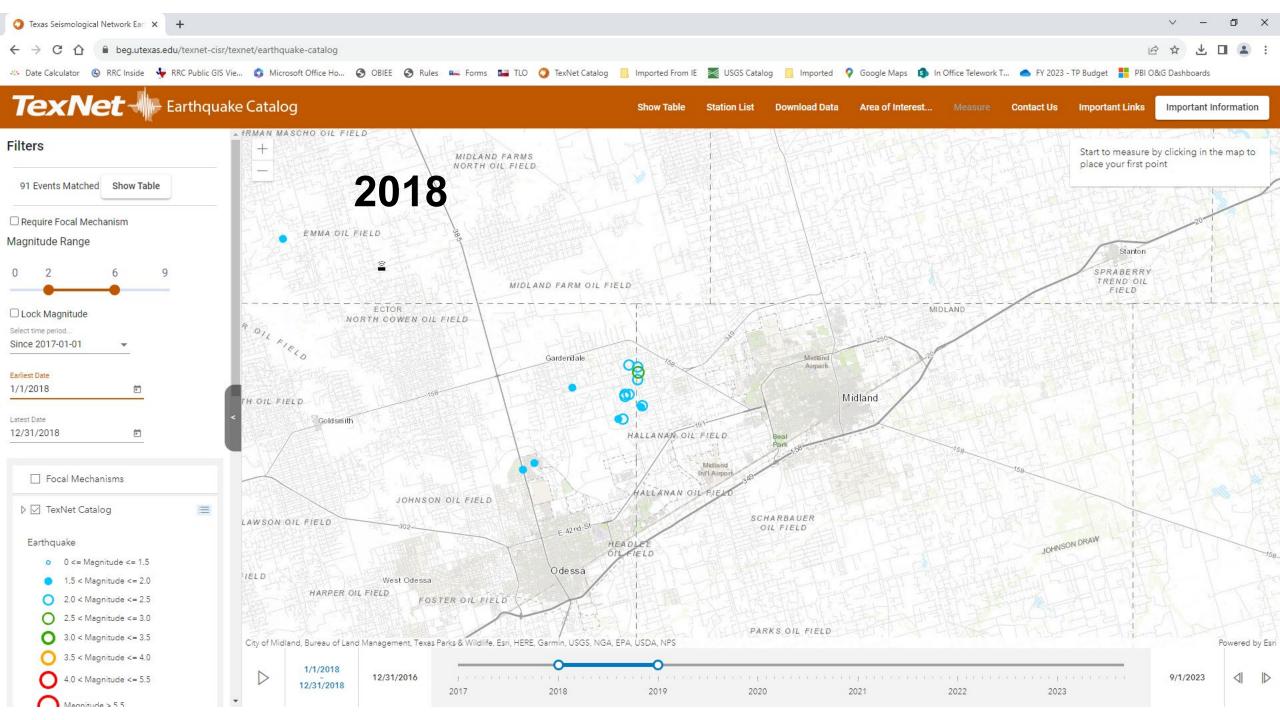


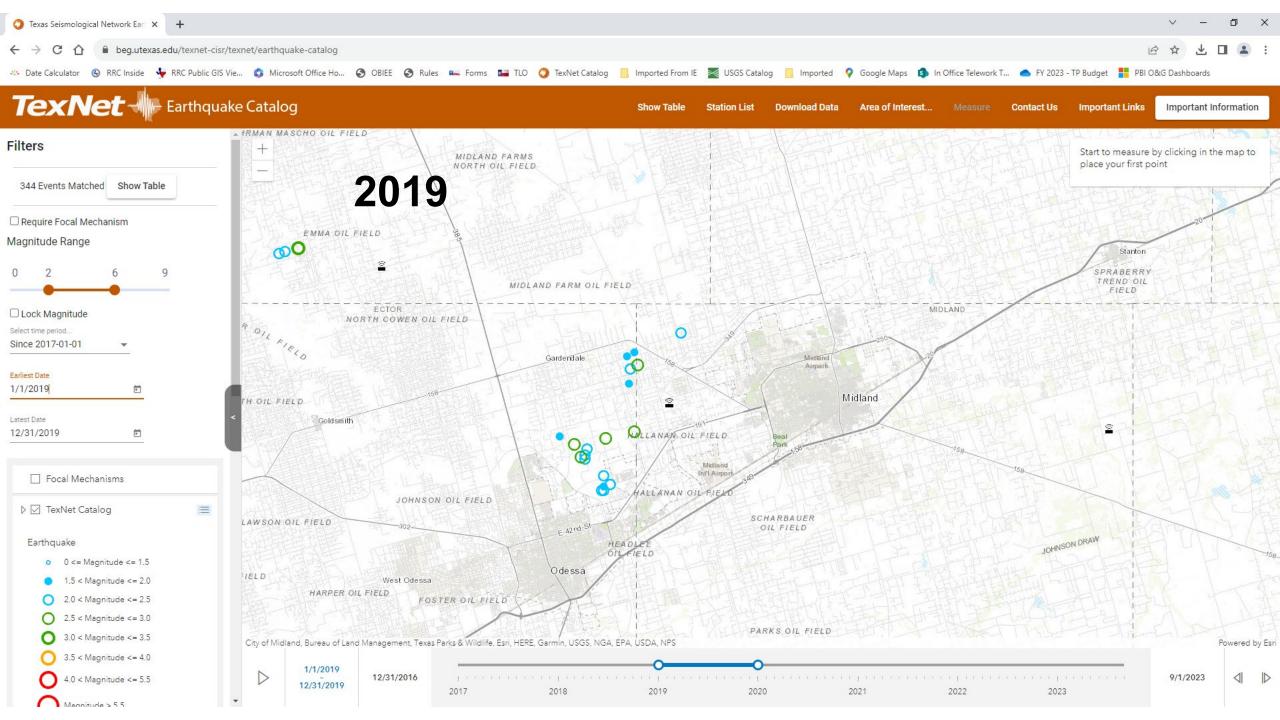


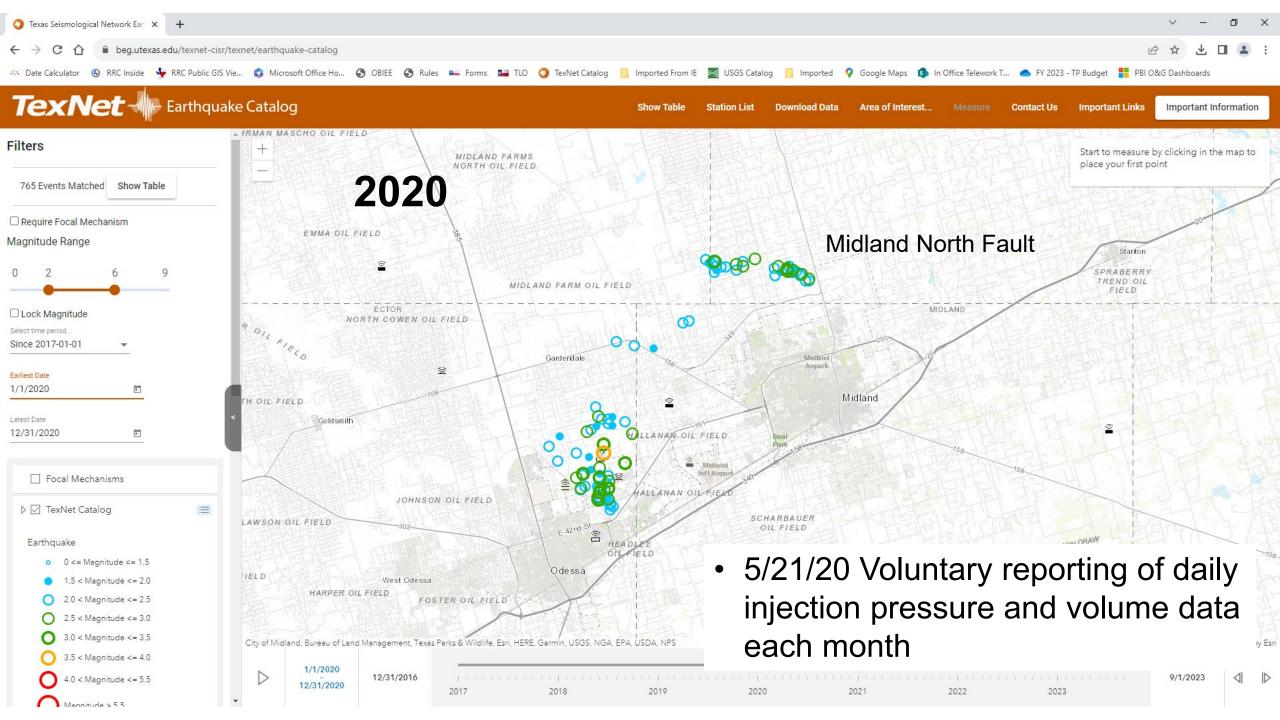
Deep Structure with Seismicity

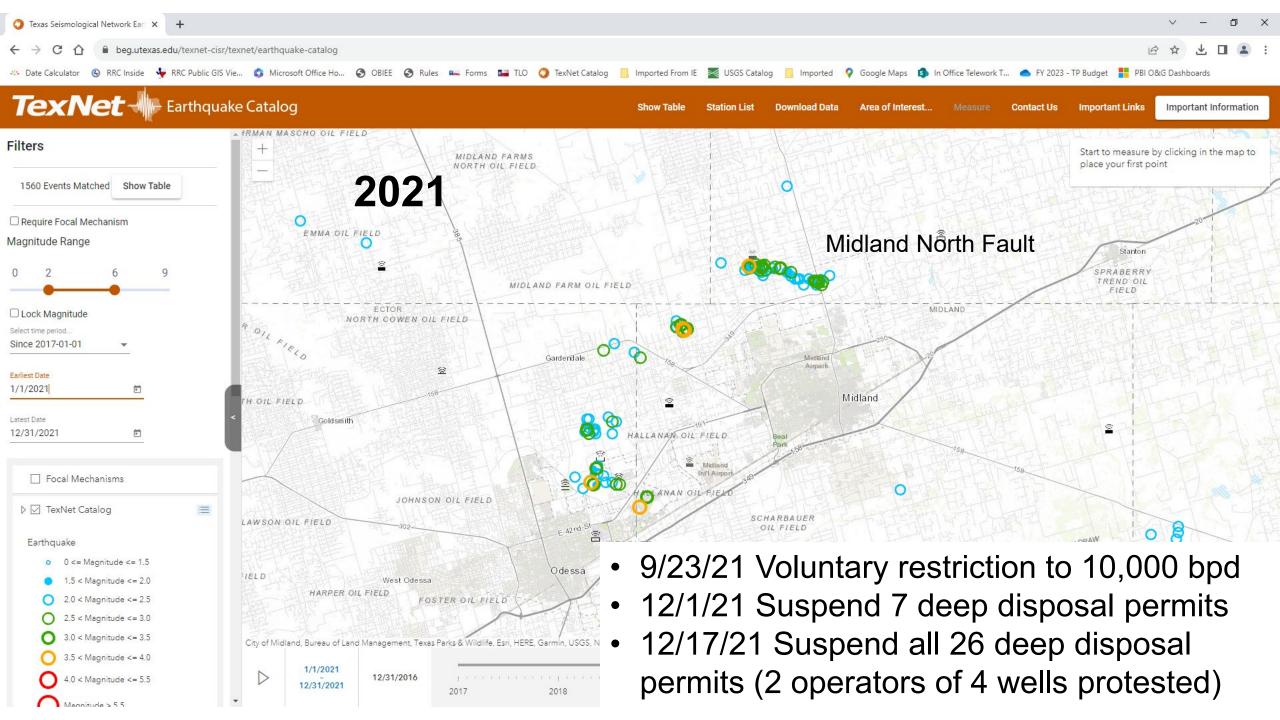


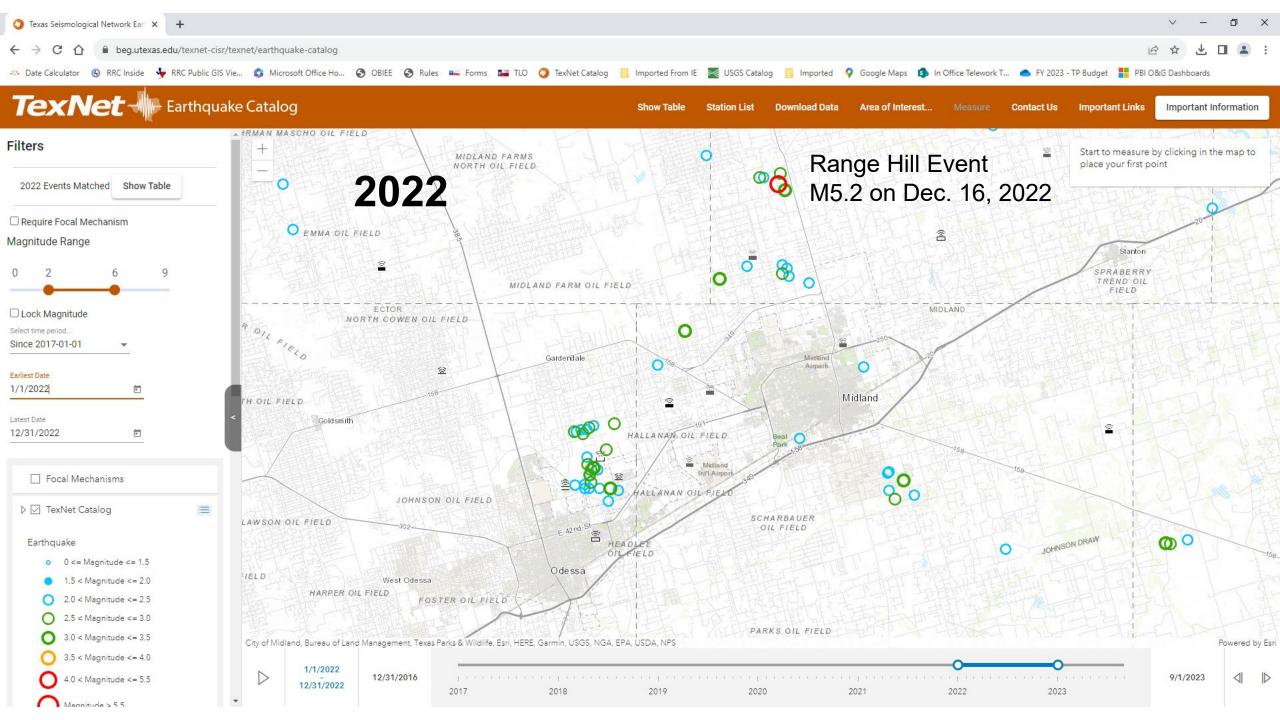


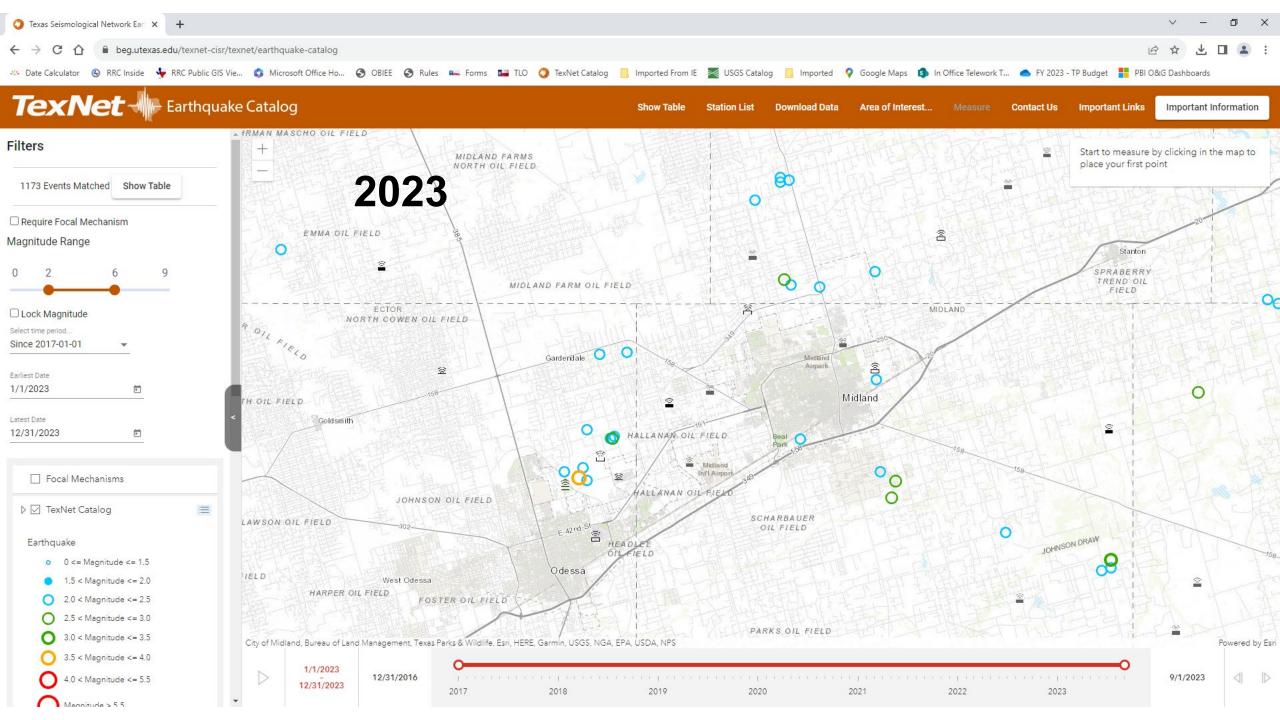


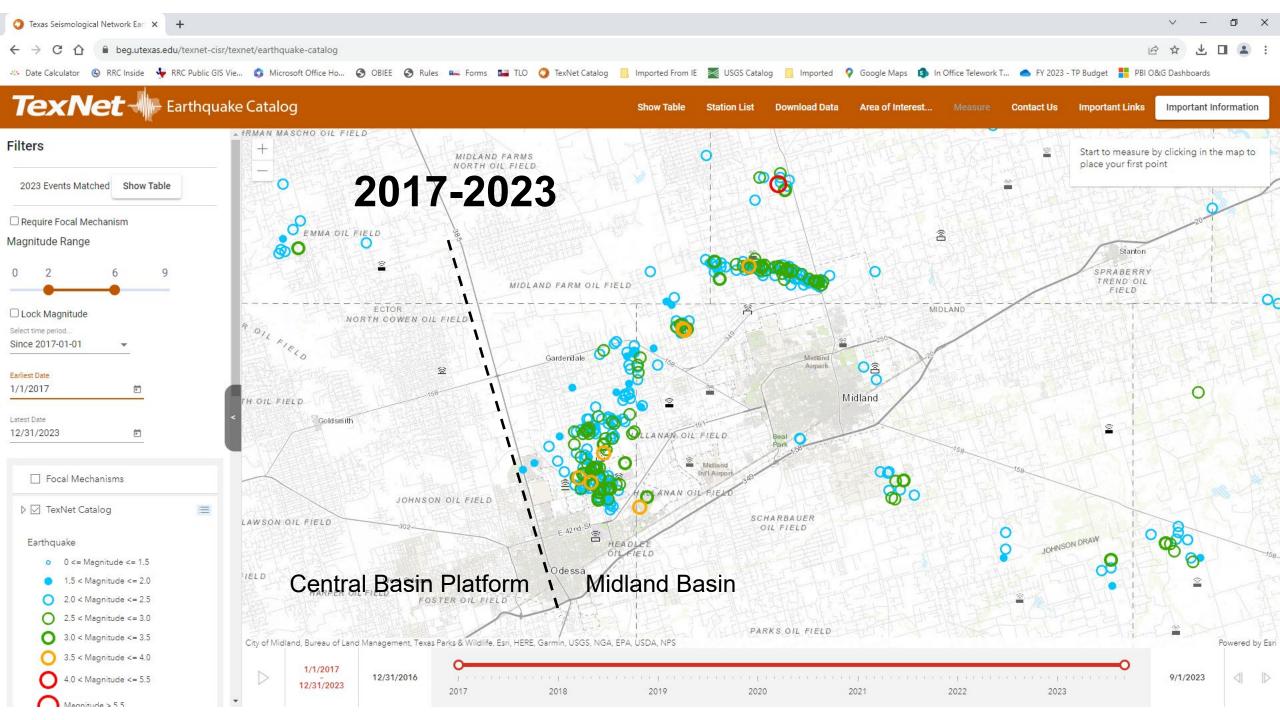






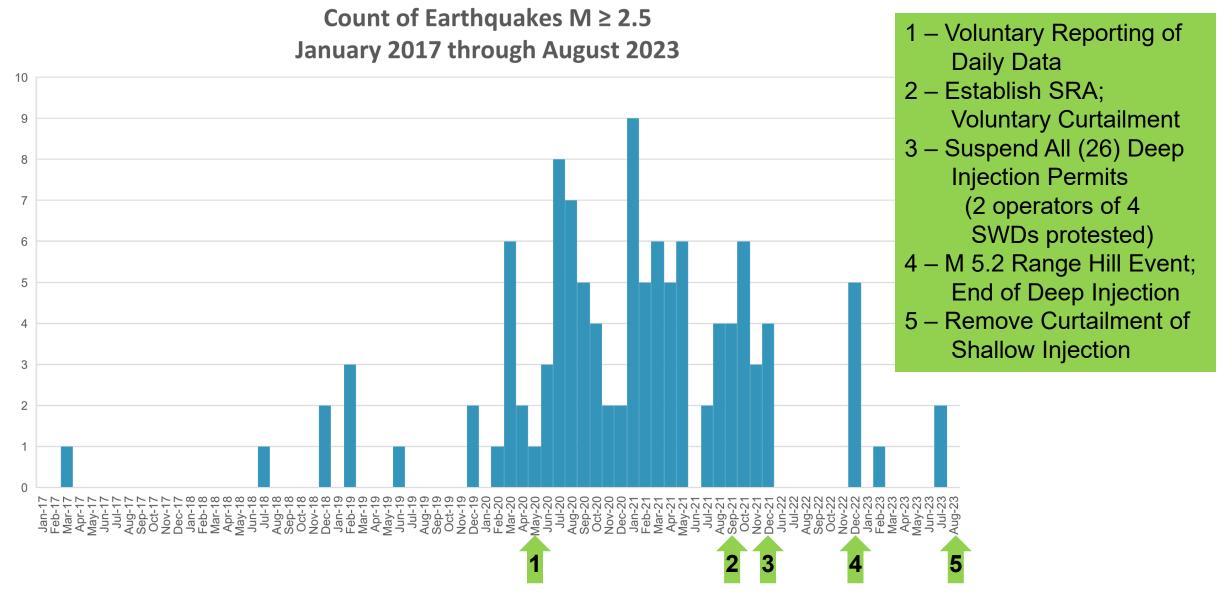








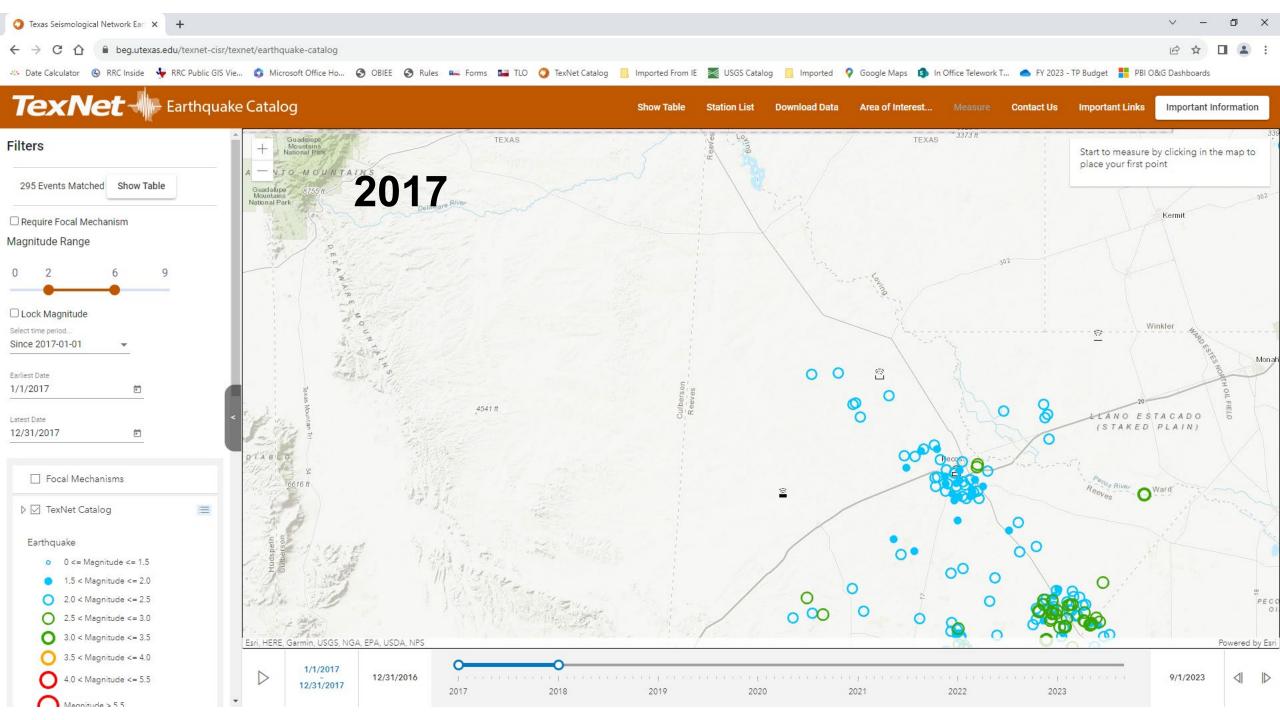
Gardendale SRA Earthquake Frequency

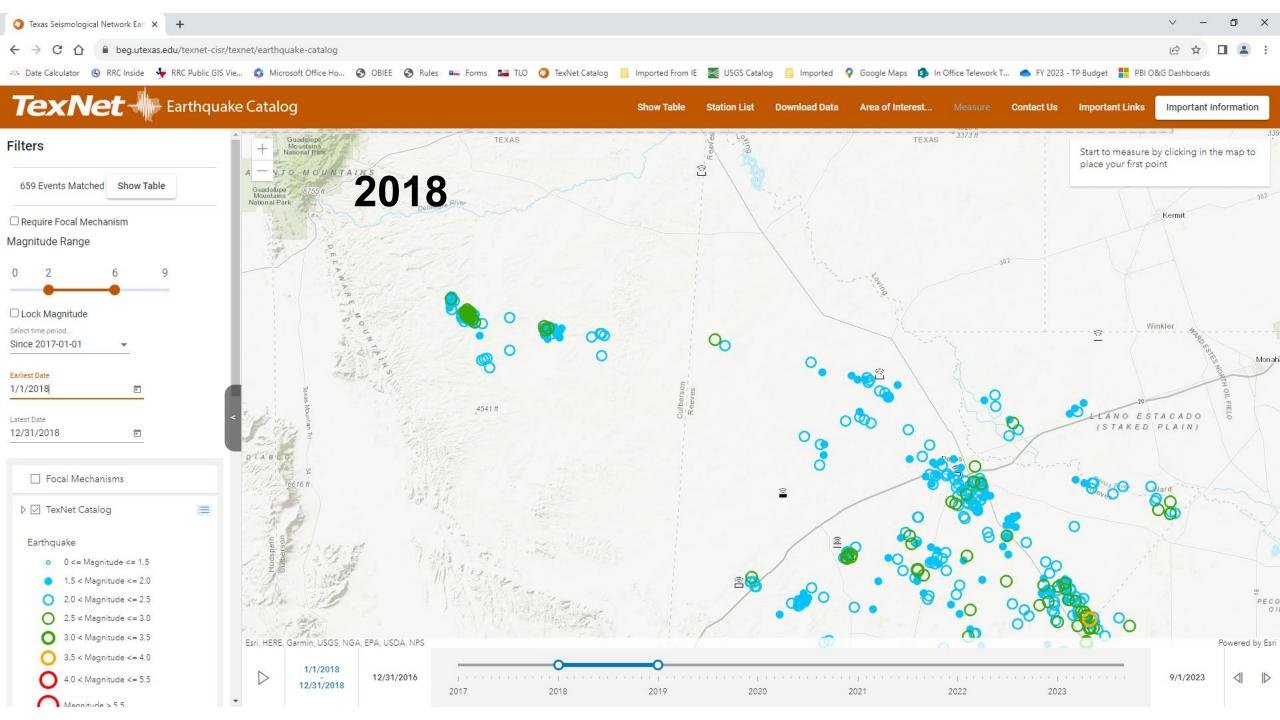


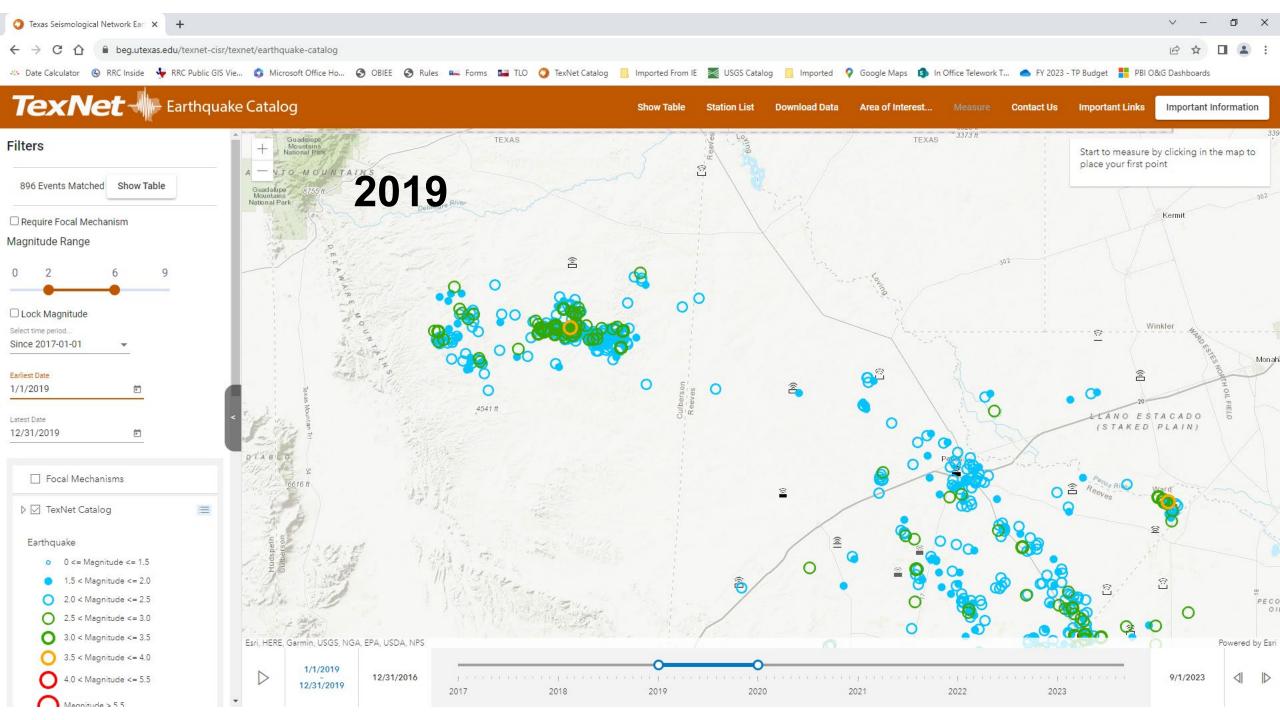
Gardendale Current Status

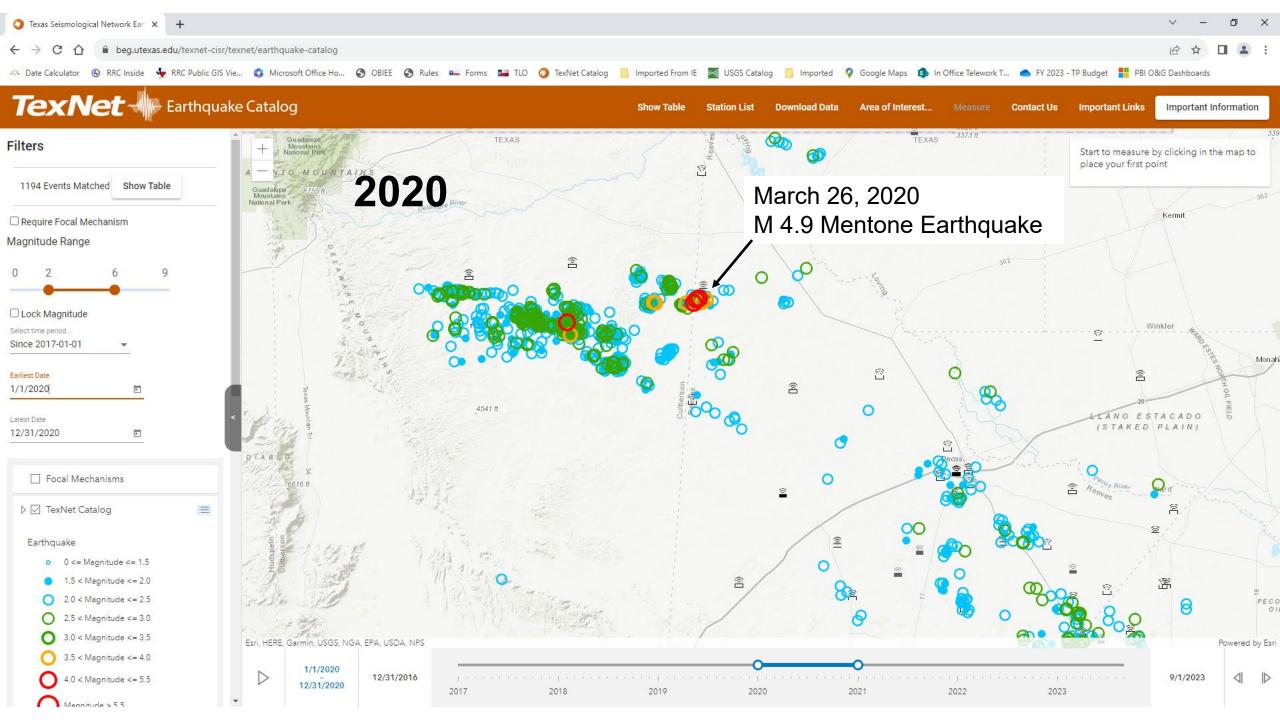


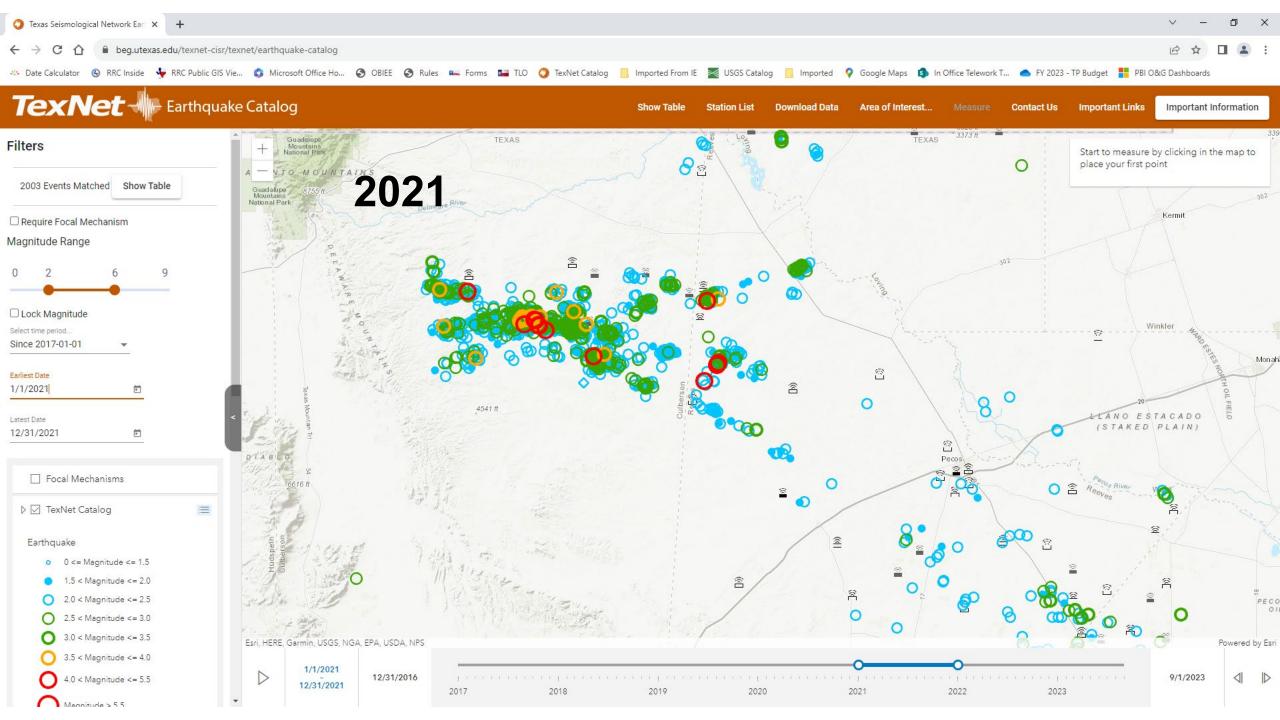
- Deep disposal injection is the primary causal factor.
 - Two SWD wells with very proximal deep injection into a deep fault or near basement; good injection activity and seismicity correlation.
 - Other areas are harder to identify individual contributing SWDs
- Marked decrease in seismicity since deep SWD permits suspended in December 2021.
- M 5.2 Range Hill event was very proximal to a deep disposal well that recently increased injection activity.
- No deep disposal in SRA since December 17, 2022.
- Operator group formed after the M 5.2 Range Hill event.
- Shallow curtailment ended in August 2023.
- New shallow SWD permits may be issued per guidelines.

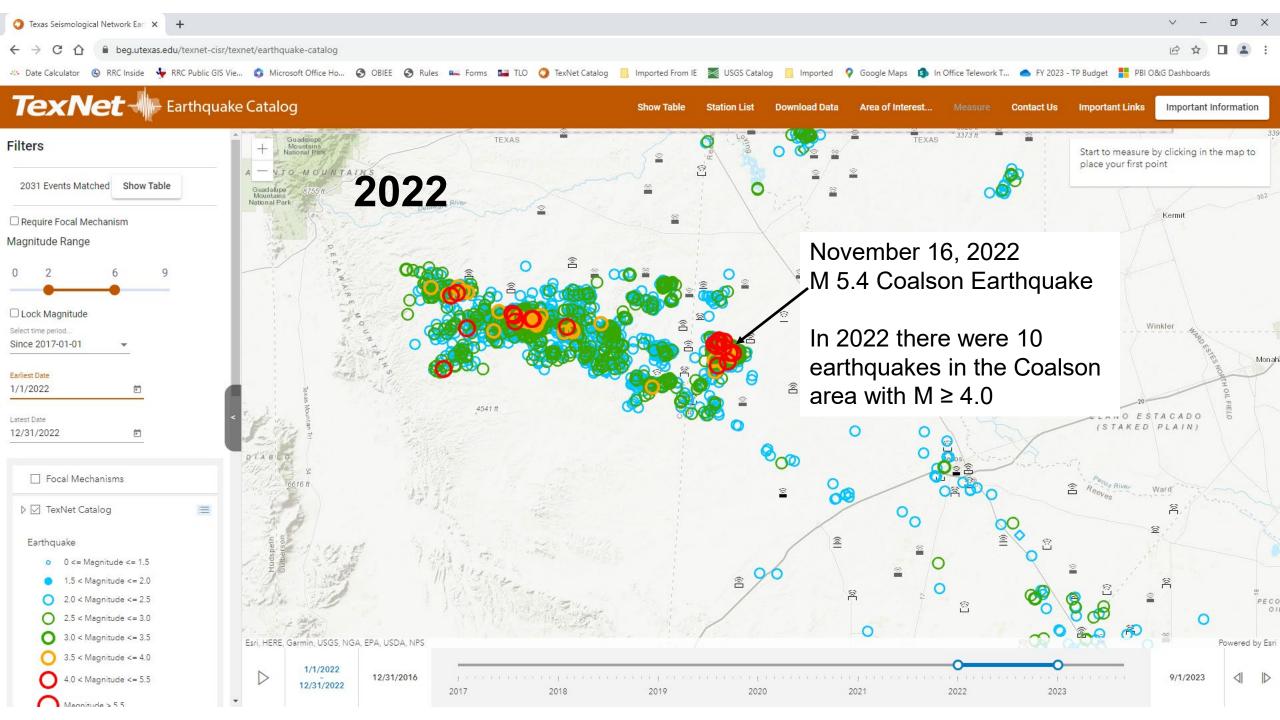


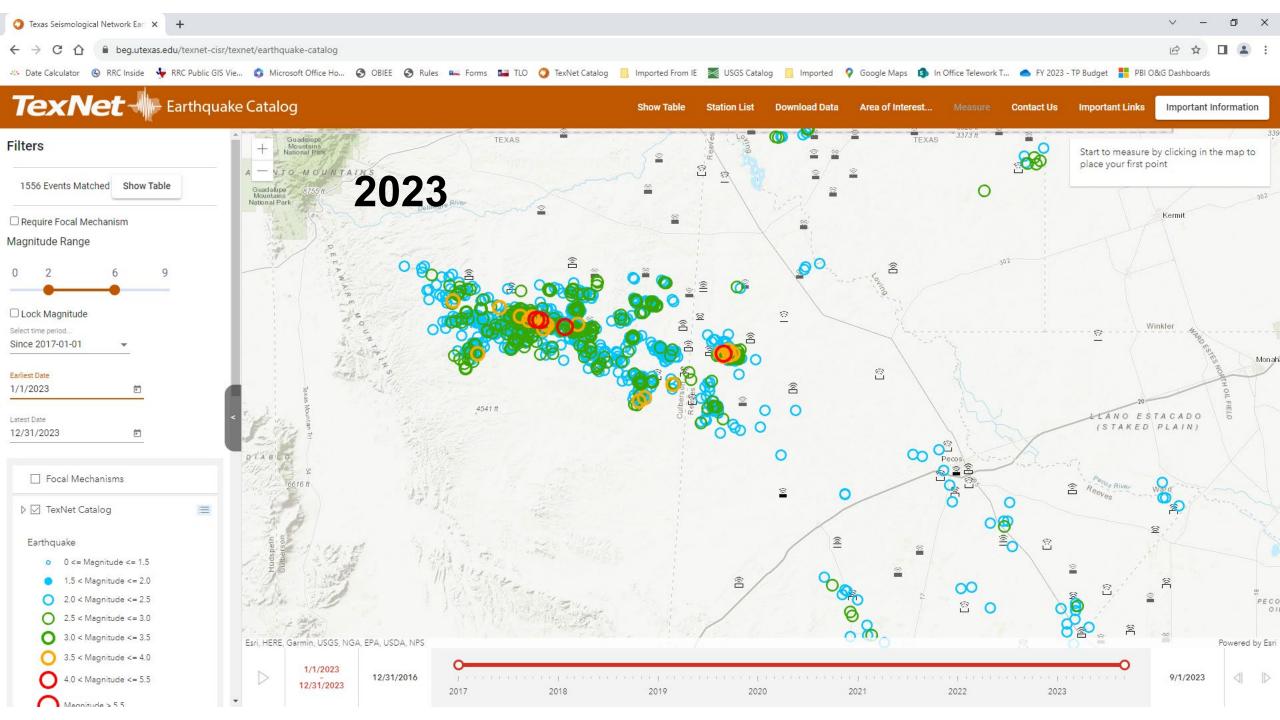


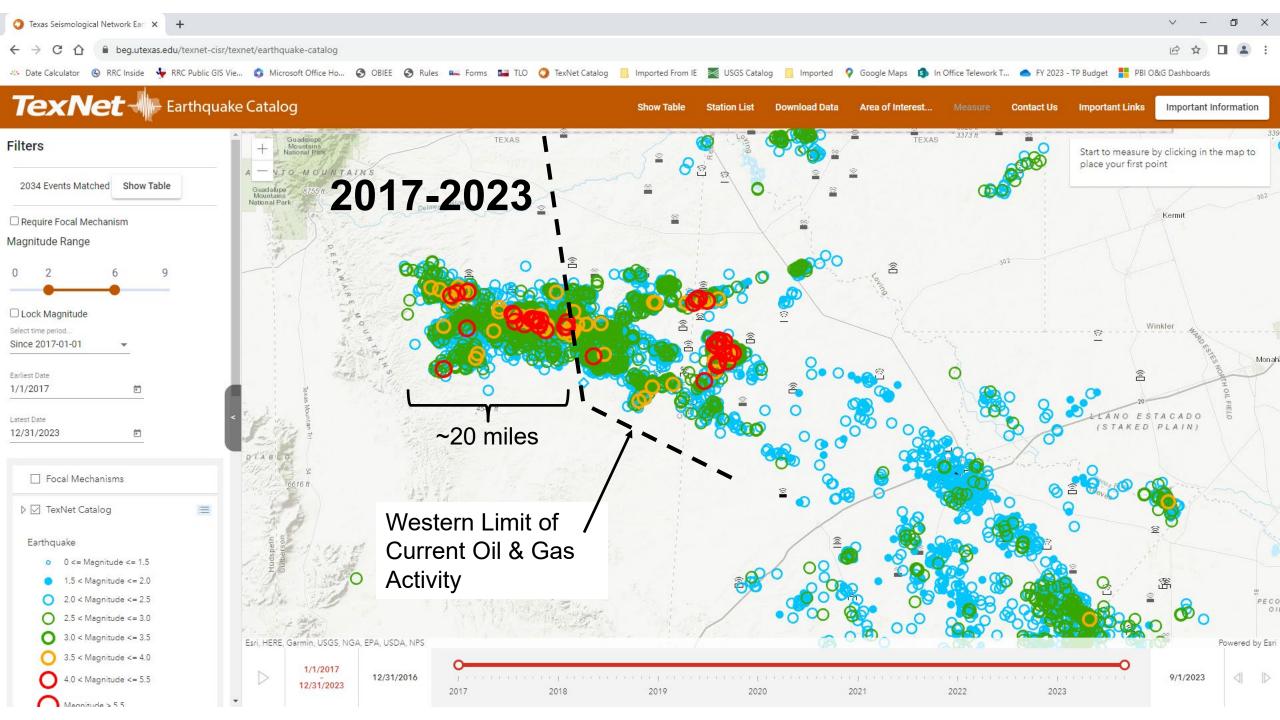














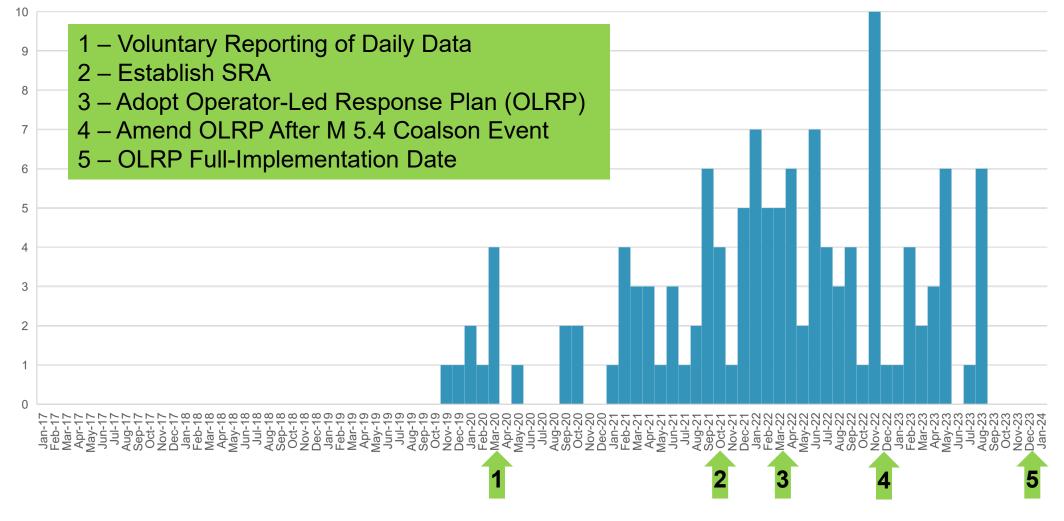
Operator-Led Response Plan

- RRC Goal: No M ≥ 3.5 earthquakes 18 months after implementation
- Industry OLRP Goal: Decreasing rate of M ≥ 3.5 earthquakes 18 months after implementation
- Shallow SWDs: Rate curtailment based on distance from seismicity
- Deep SWDs: Significant rate curtailment; two largest operators moving away from deep injection altogether.

Northern Culberson-Reeves SRA Earthquake Frequency



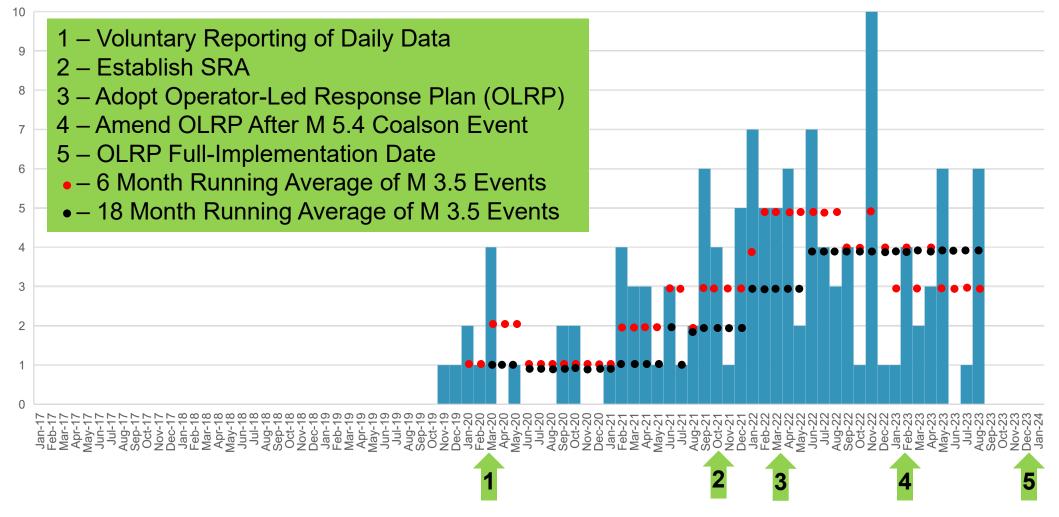
Count of Earthquakes M ≥ 3.5 January 2017 through August 2023



Northern Culberson-Reeves SRA Earthquake Frequency



Count of Earthquakes M ≥ 3.5 January 2017 through August 2023



Northern Culberson-Reeves Current Status



- Deep injection is the primary causal factor.
- Cannot rule out shallow injection as a local causal factor.
- Significant reductions in deep injection volume.
- Very large area with several significant clusters, and possibly different causal factors.
- Far-field affects from deep injection into the northern Delaware Basin.
- Need regional structure and hydrogeological information.
- Shallow disposal formations are pressure constrained.
- Concern for shallow disposal formation containment.

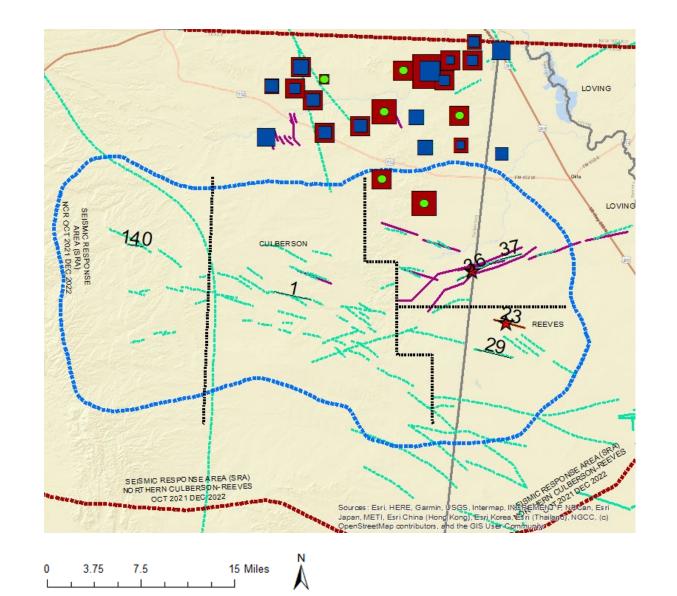
The Whole Delaware Basin



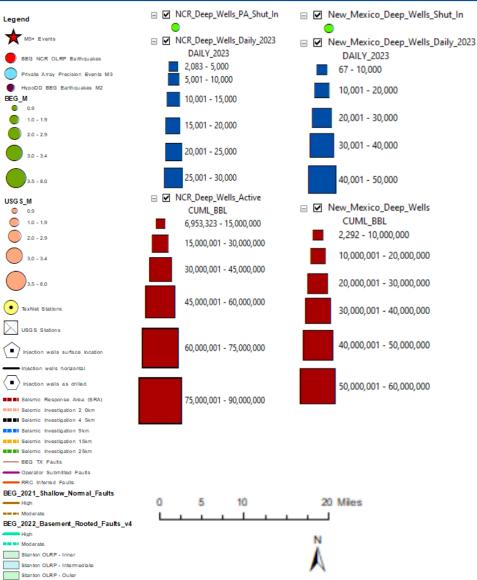
- Meet regularly with New Mexico Oil Conservation Division staff to discuss shared interests and concerns.
- Obtained New Mexico data on SWD well and injection data.
 - Historically, New Mexico has a regulatory bias in favor of deep injection over shallow injection to protect the correlative rights of shallow oil and gas producers.
 - Growth in Delaware Basin activity spurred Texas operators to seek deep disposal, but no longer due to recent seismicity.
- Conducting preliminary work with Fault Slip Potential (FSP) modeling to history-match deep injection and seismicity activity, but there are significant limitations.

NCR SRA Deep Disposal Wells

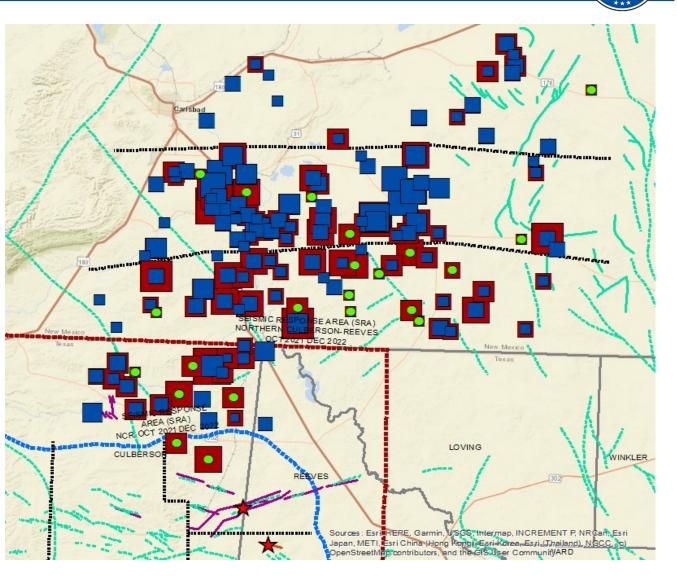




Map: 140 Deep Injection Wells

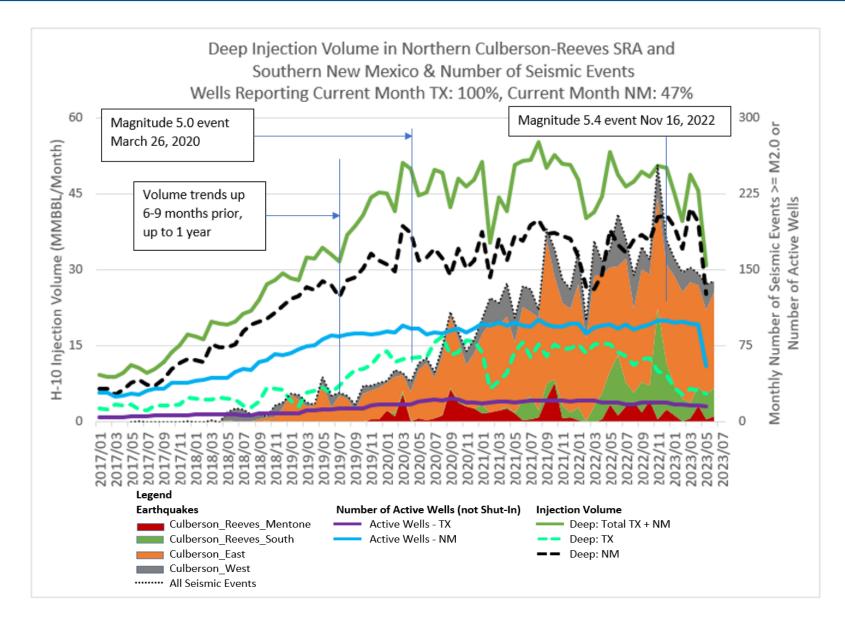


County Boundaries City Limits



Deep Injection & Seismicity Analysis: NCR and Southern New Mexico





Going Forward – The Big Picture



- **Proposition:** The seismicity problem is a produced water problem.
 - Water production demands disposition
 - Alternatives to disposal by injection are needed, especially for deep disposal
- **Posture:** Adjusting from reactive to proactive
 - Establish a Seismicity Team in UIC
 - February 2023 Notice to Operators regarding permitting, monitoring, and reporting
 - Provide data to support research at the University of Texas Bureau of Economic Geology and the Center for Injection and Seismicity Research (CISR)
 - Protective measures to ensure integrity of shallow disposal and related pressure issues
 - Add a seismologist to support Dr. Aaron Velasco, State Seismologist
- Potential:
 - Policy, rule, and practice frameworks to support a proactive posture
 - RRC is considering pilot projects to new produced water recycling options.

Going Forward – SWD Permitting



- Update Guidelines for Permitting Saltwater Disposal Wells in Seismically Active Areas of the Permian Basin
 - Can we decouple deep and shallow permitting review?
 - Do we have a valid basis for distinguishing deep from shallow earthquakes?
 - Can we time-limit cataloged events, instead of the full historical catalog?
 - Do we have high-quality, location-specific knowledge of faulting?
- Require Pressure Data
 - Initial bottomhole
 - Periodic bottomhole





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