Injection Capacity Challenges and Opportunities: Midland Basin

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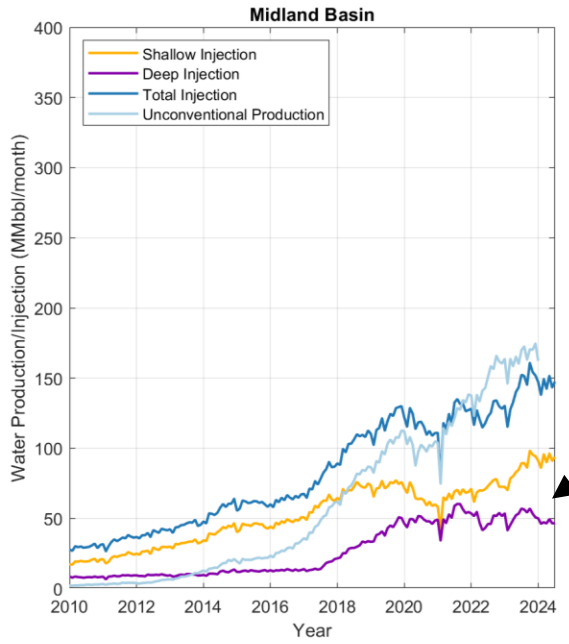
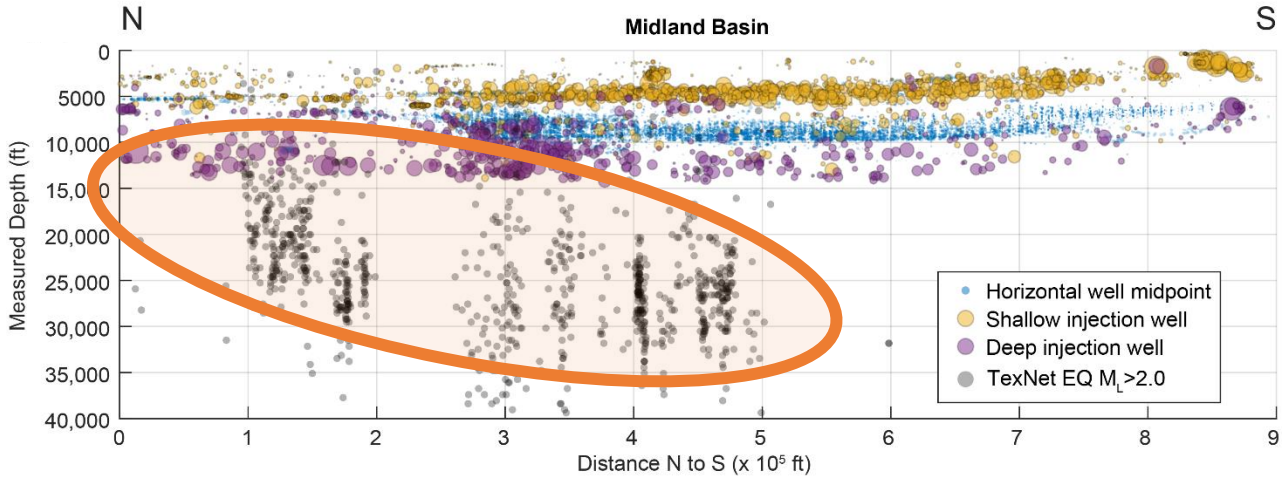
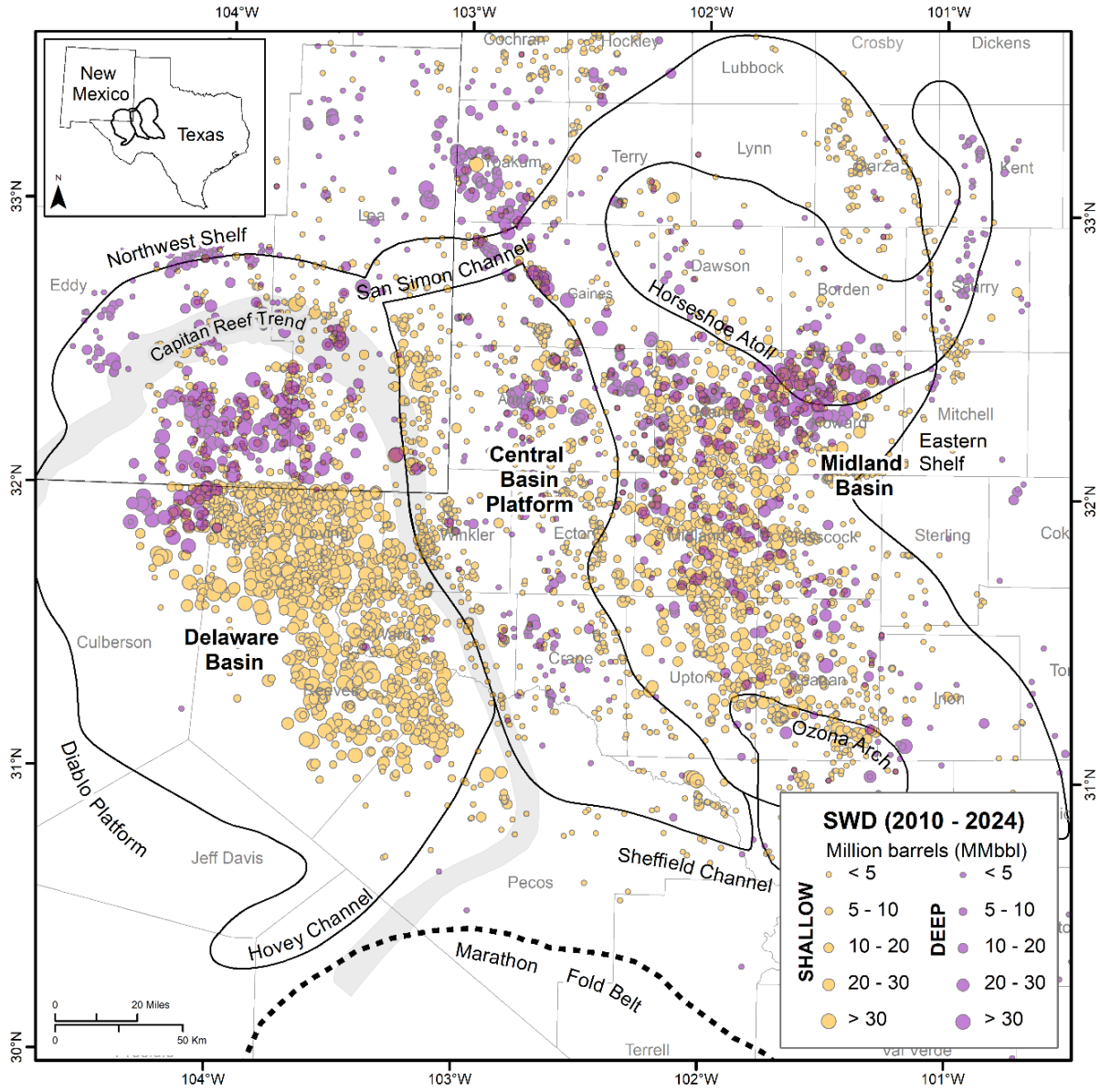
Midland Basin Injection Trends

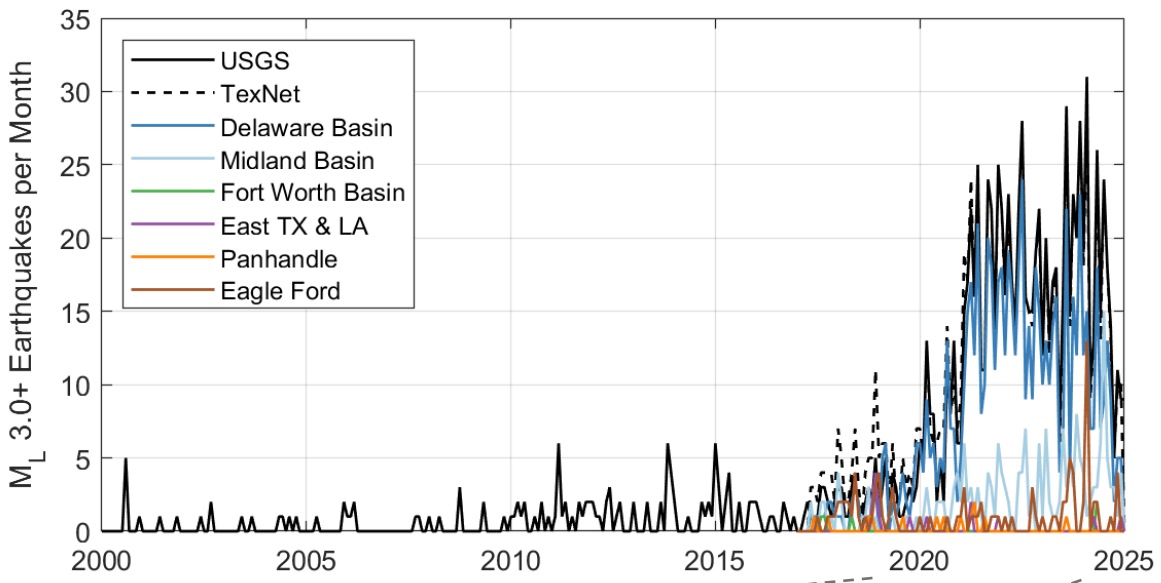


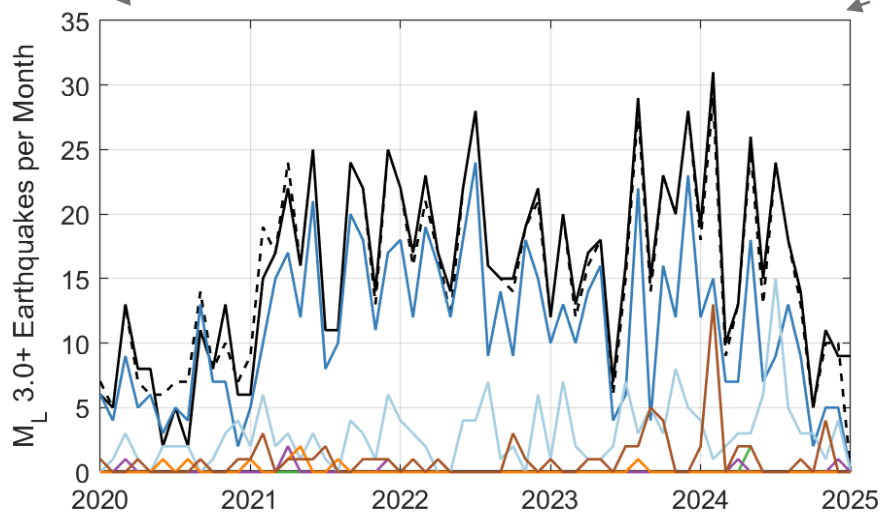
since ~2021, shallow injection increasing while deep injection remaining steady

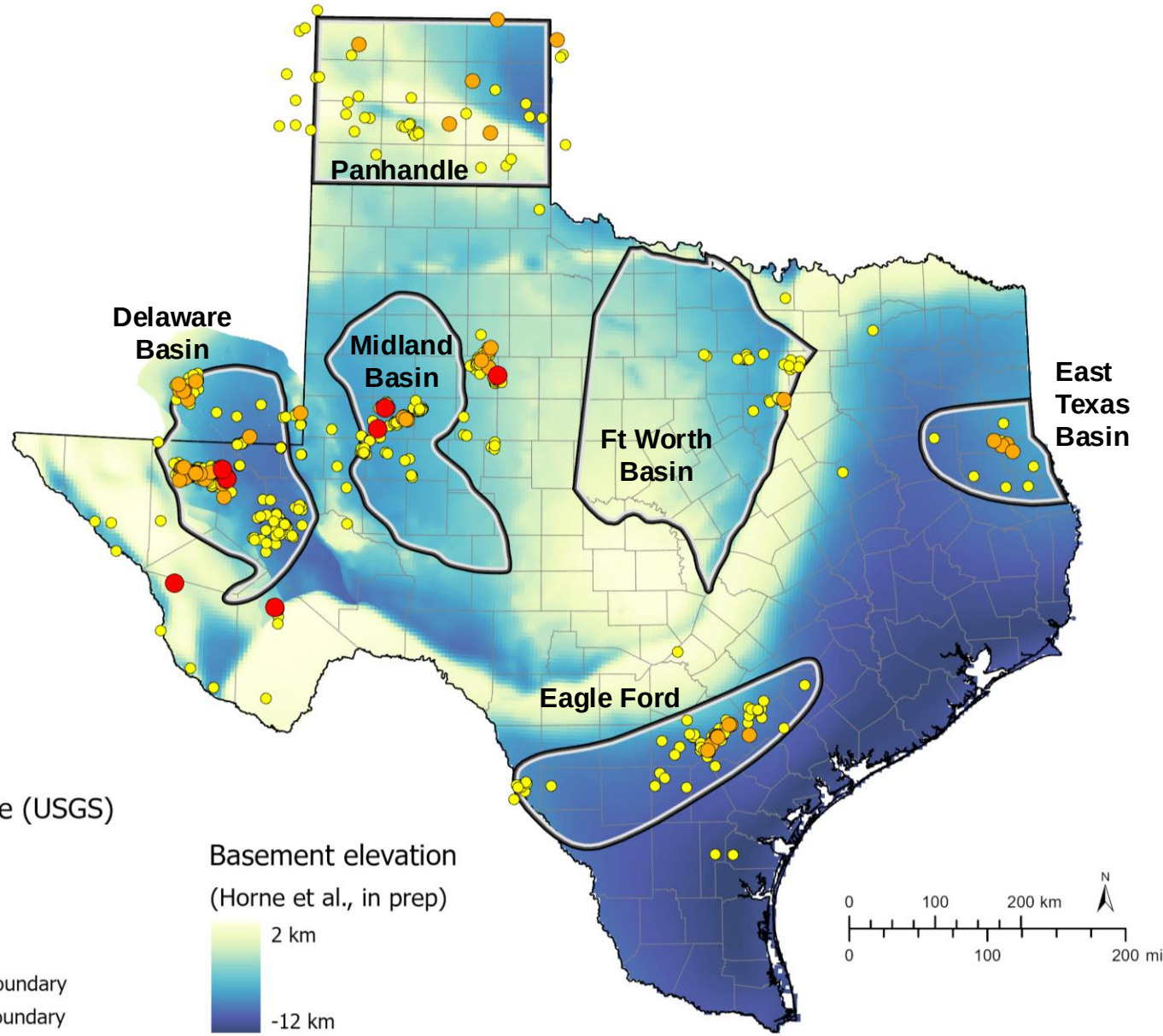




Midland Basin Earthquake Rates in Context







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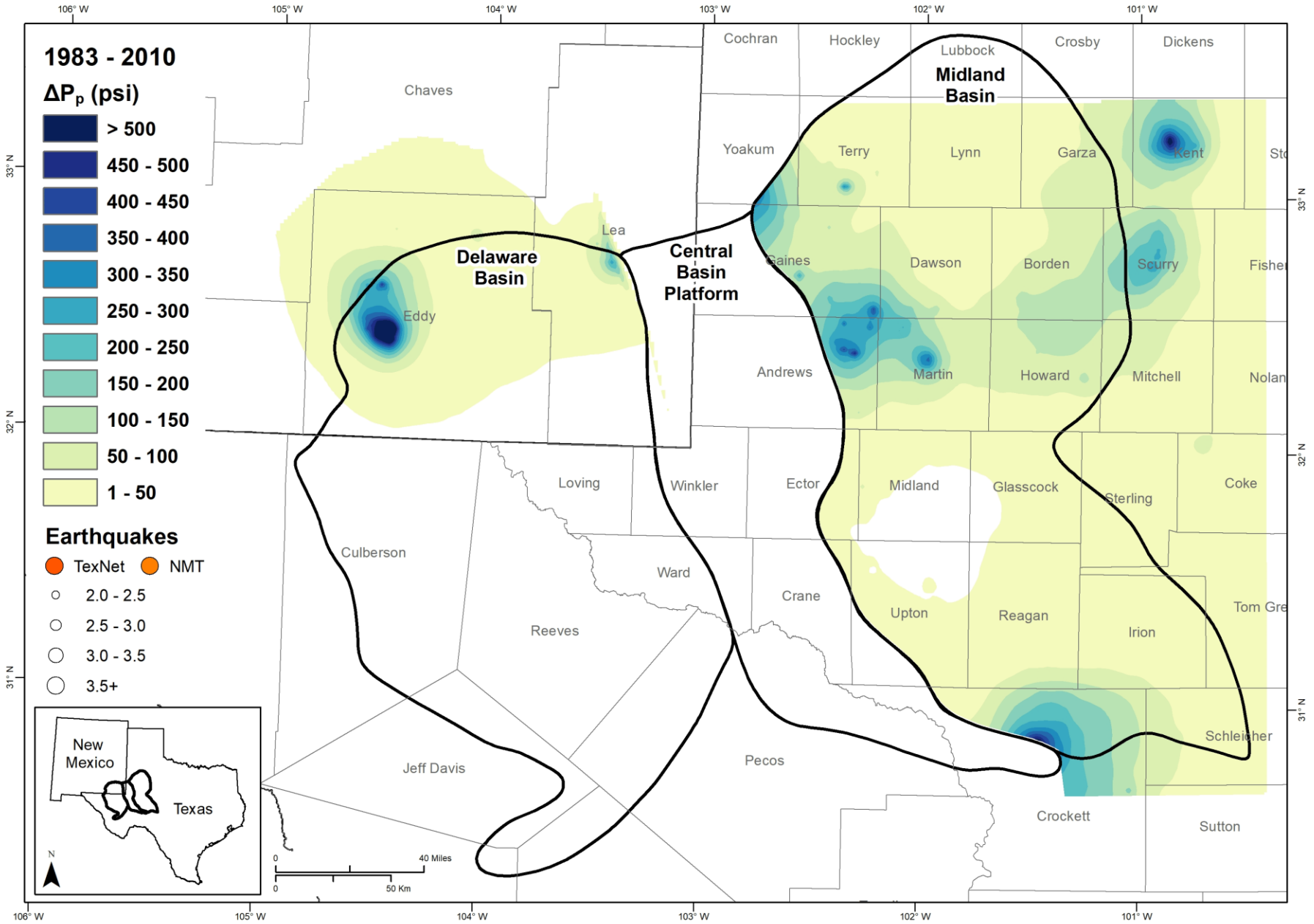
Deep Pore Pressure Change and Earthquakes (2015-2023)



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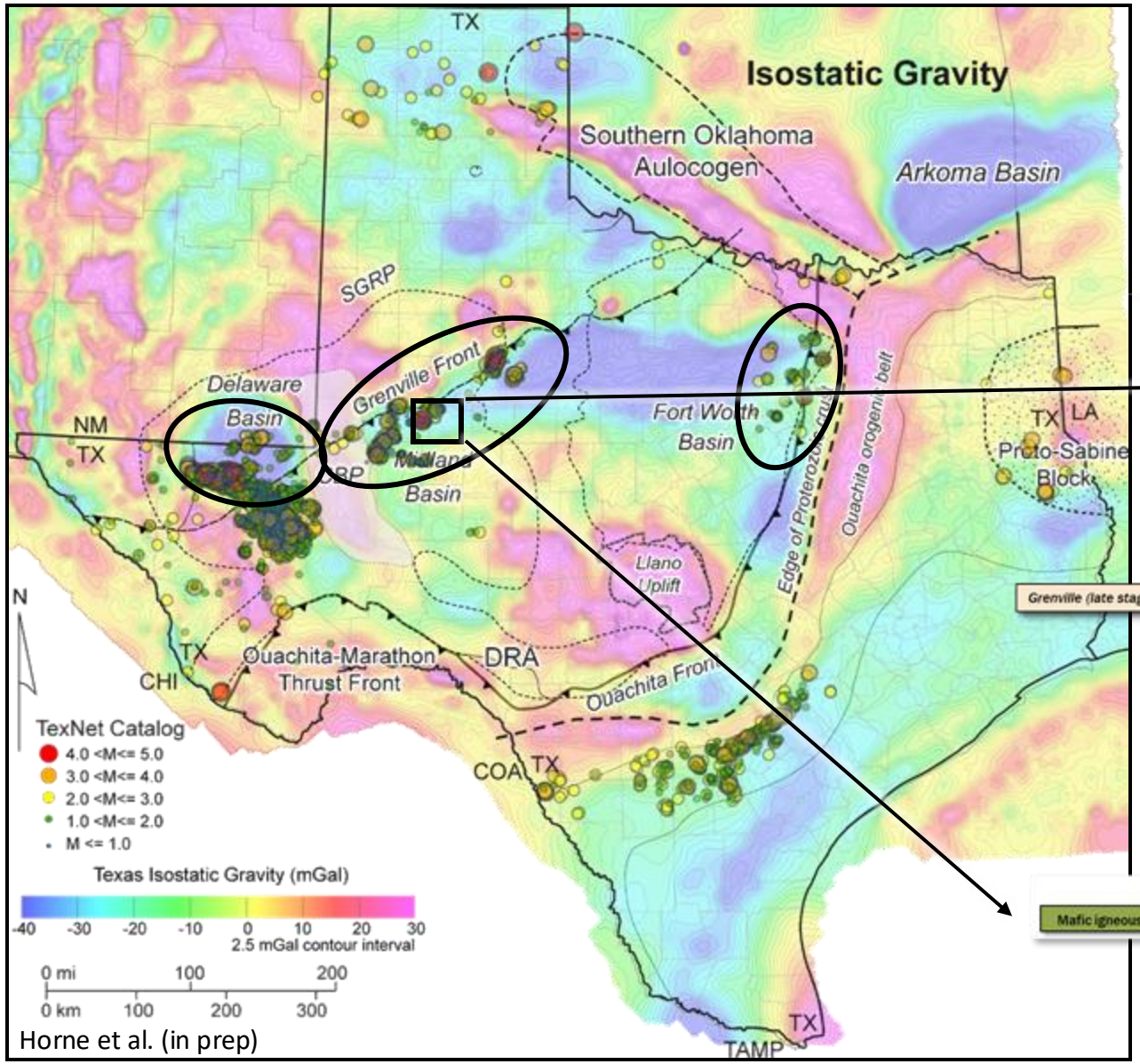
Basement Structural Control on Seismicity



Horne et al. (in prep)

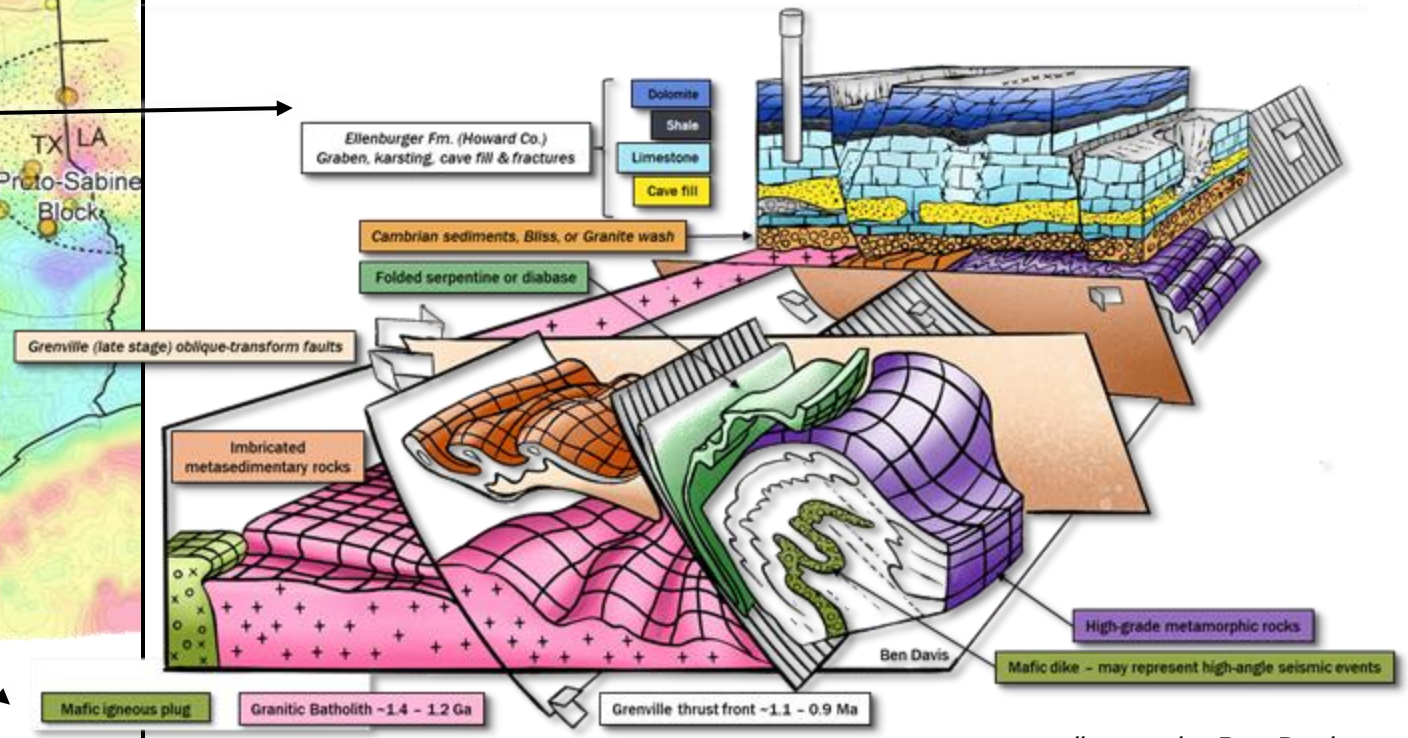


diagram by Ben Davis

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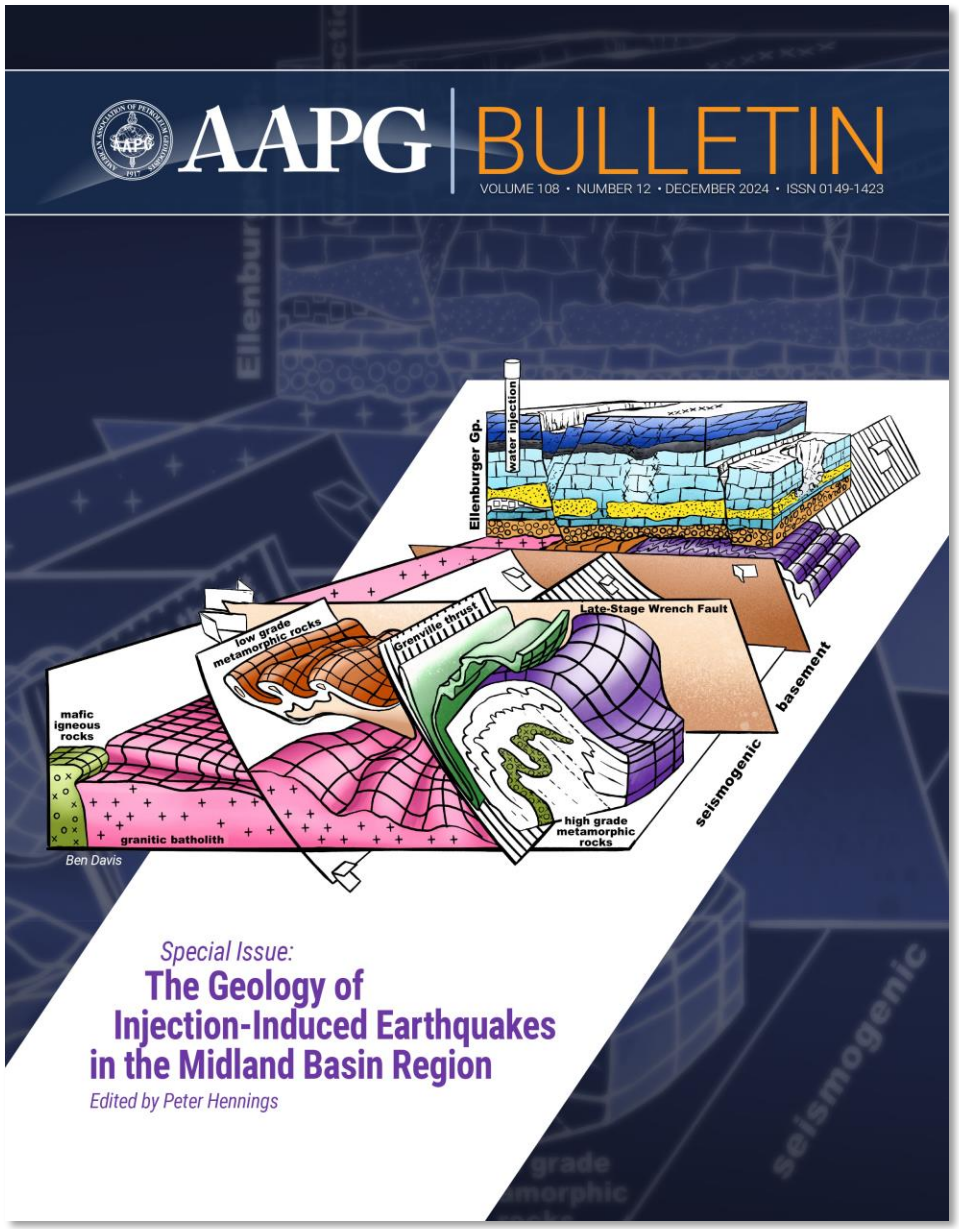
Geology of Injection-Induced Earthquakes in the Midland Basin



The Geology of Injection-Induced Earthquakes in the Midland Basin Region
edited by Peter Hennings

The Geology of Injection-Induced Earthquakes in the Midland Basin Region: Introduction
Peter Hennings

Knowns, Questions, and Implications of Induced Seismicity in the Permian Basin
Peter Hennings and Katie Smye

Challenges Associated with Water Production and Injection in the Permian Basin Region
Katie Smye, K. Yut, R. Reedy, B. Scanlon, J.P. Nicot, P. Hennings

Lithofacies and Porosity Heterogeneity of Ordovician-Pennsylvanian Successions of the Midland Basin: Implications for Wastewater Disposal Reservoir Potential
Amanda Z. Calle, K. Smye, E. Horne, R. Eastwood, R. Reedy, and P. Hennings

Modeling the Evolution of Pore Pressure from Deep Wastewater Injection in the Midland Basin, West Texas, USA
Jun Ge, J.-P. Nicot, K.M. Smye, A. Calle, P. Hennings, E. Horne, and J. Leng

Characterization and Slip Hazard Assessment of Faults in the Midland Basin, West Texas, USA
Elizabeth Horne, P. Hennings, K. Smye, A. Calle, A. Morris, and G. Huang

Pore Pressure Thresholds Associated with Seismogenic Fault Slip in the Midland Basin, West Texas, USA
Peter Hennings, J. Ge, E. Horne, K. Smye, J.-P. Nicot

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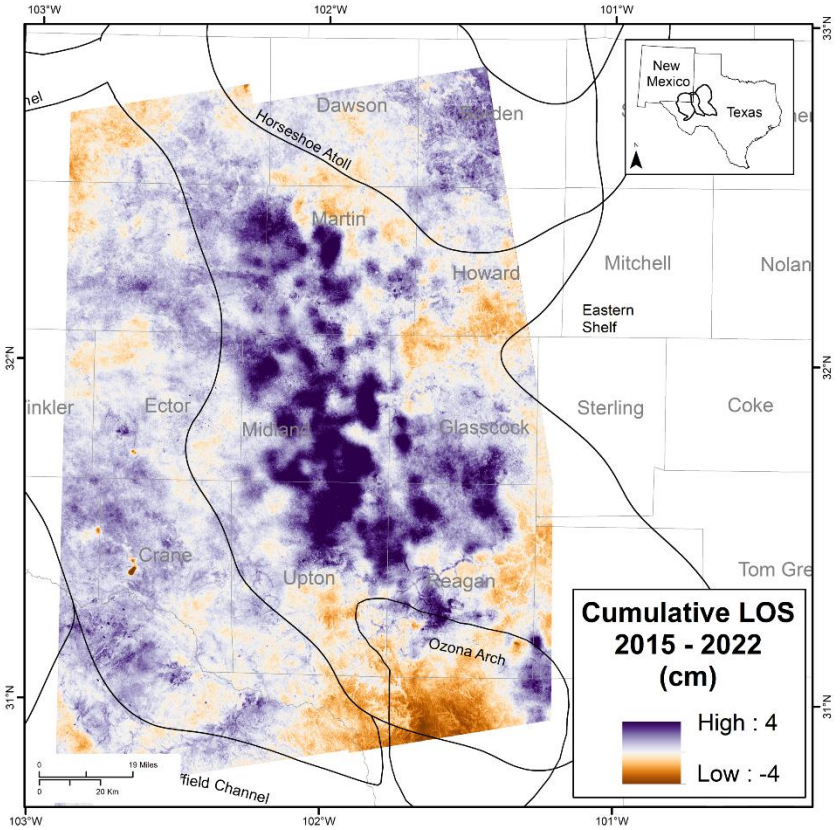
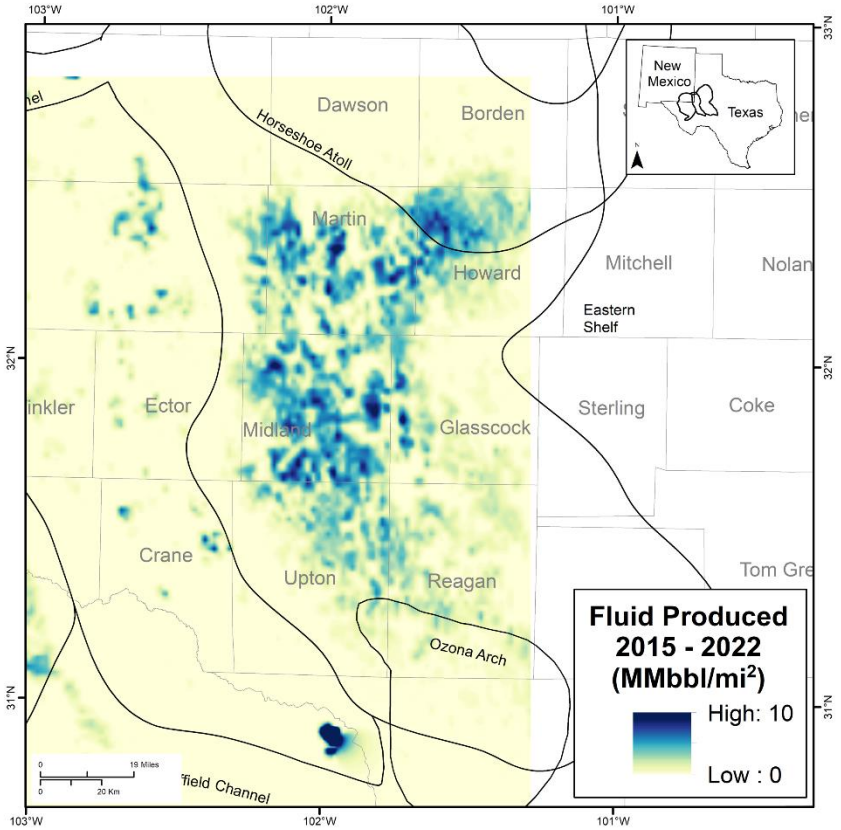
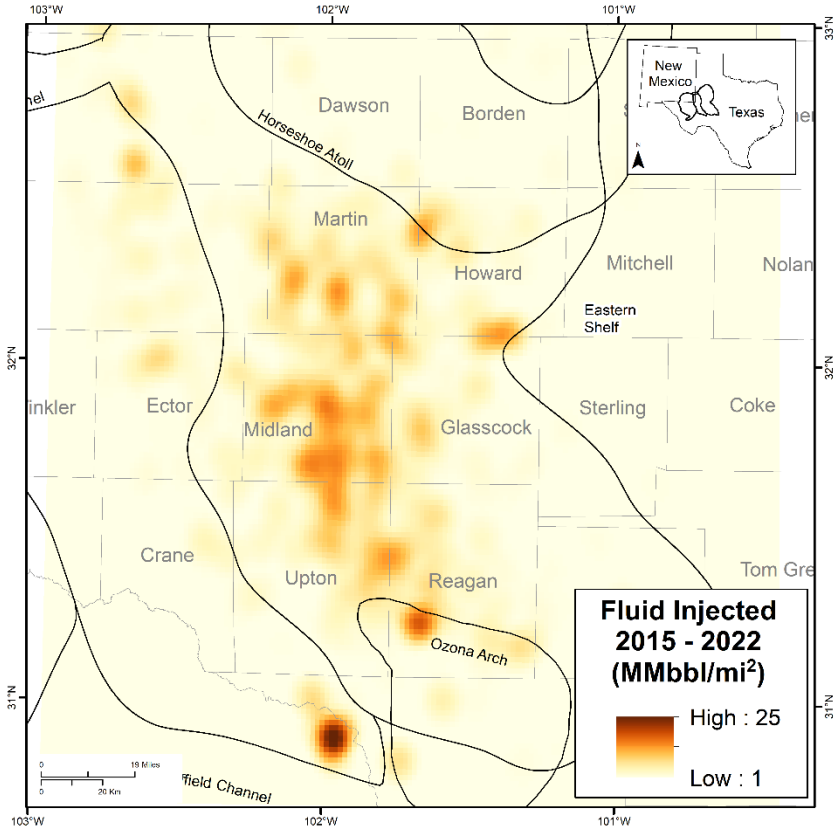
Midland Basin Shallow Injection System

- No evidence of regions of strong surface uplift associated with shallow injection overcoming subsidence signal from production as observed in Delaware Basin







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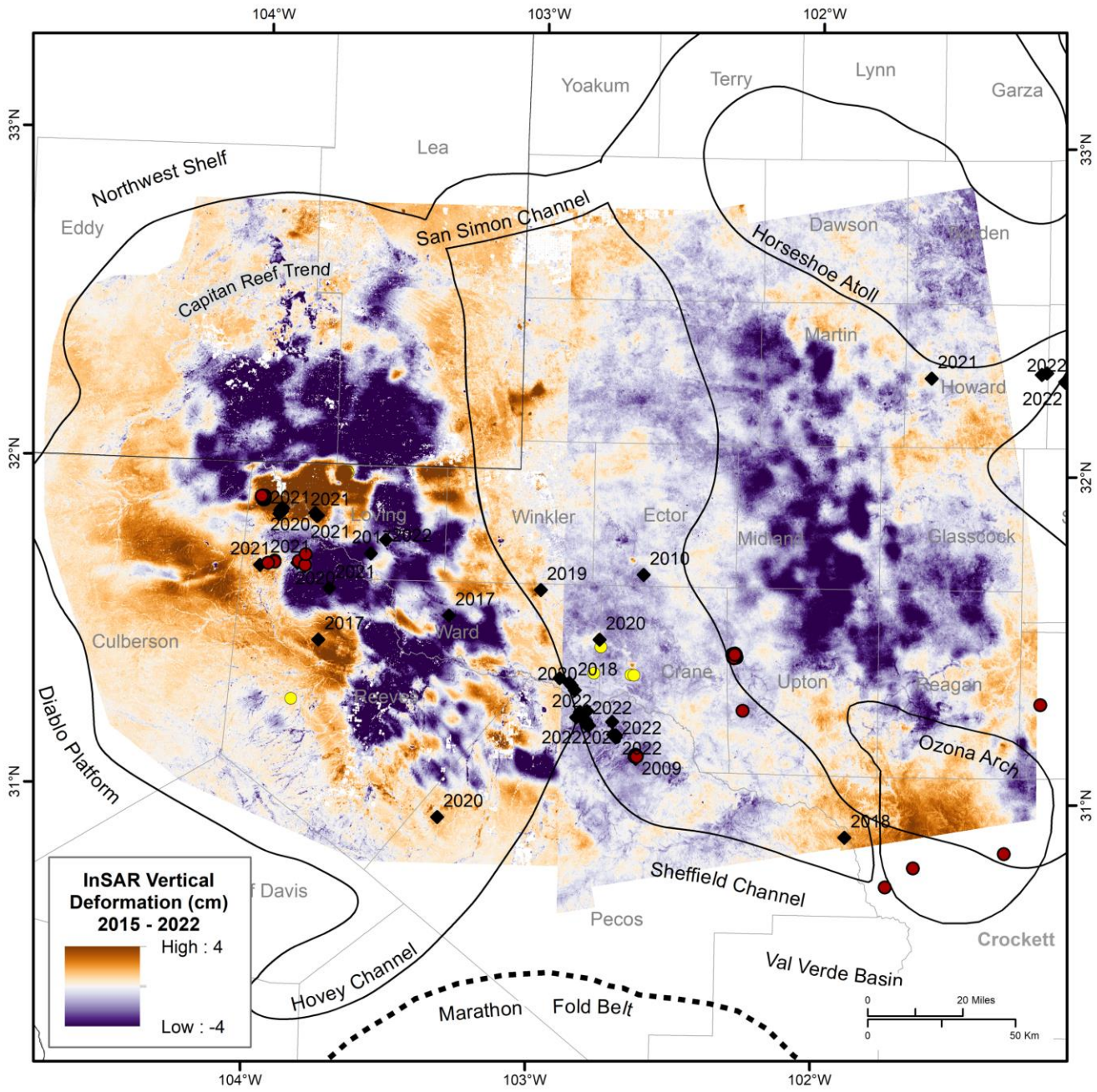
Midland Basin Shallow Injection Status

- No evidence of regions of strong surface uplift associated with shallow injection overcoming subsidence signal from production as observed in Delaware Basin
  - → Local surface uplifts highlighting potential areas of concern
  - → Suggest use of InSAR as proactive reservoir management tool
- Mud weights increasing with increasing shallow injection rates
- Many older vertical wellbores in the basin
- Well TDs for older vertical wellbores coincident with shallow injection strata



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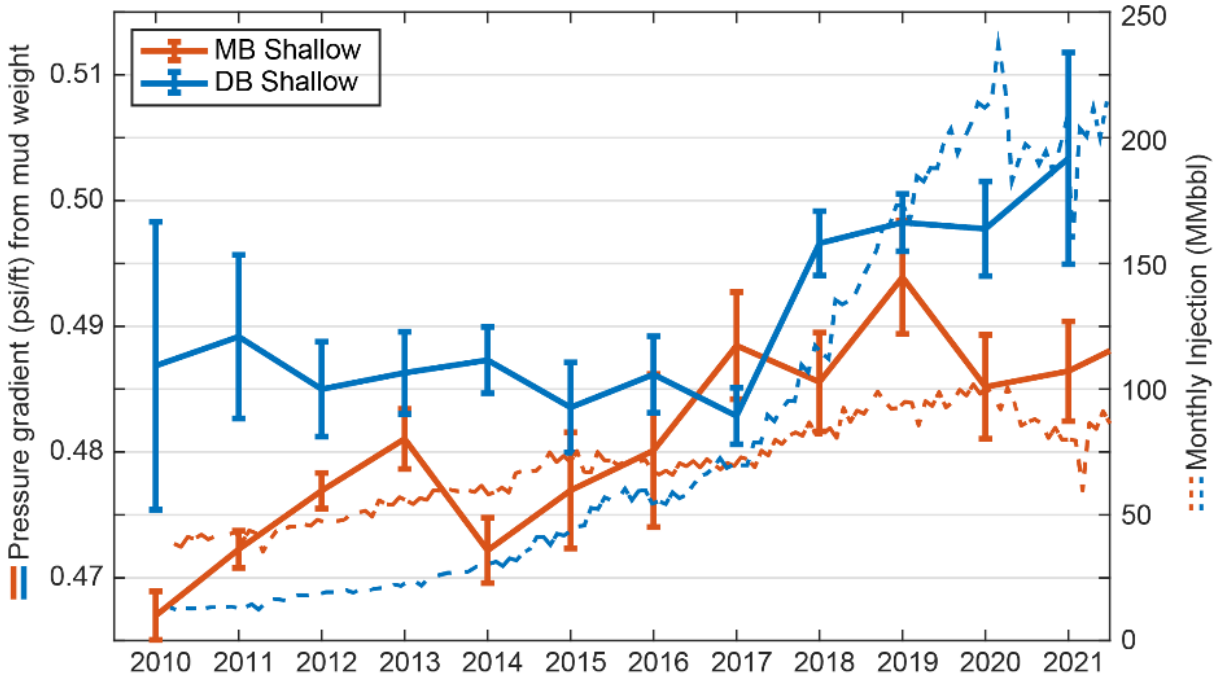

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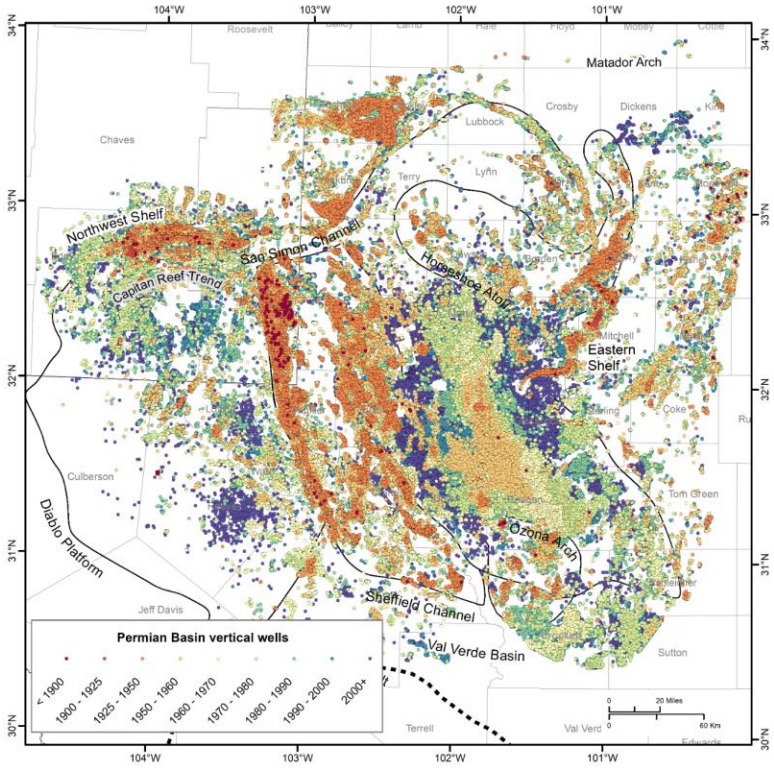

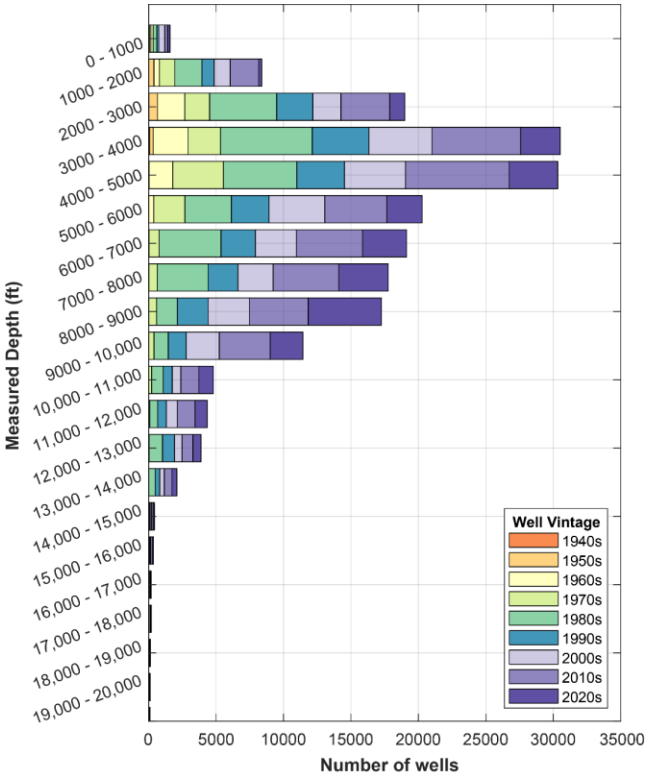

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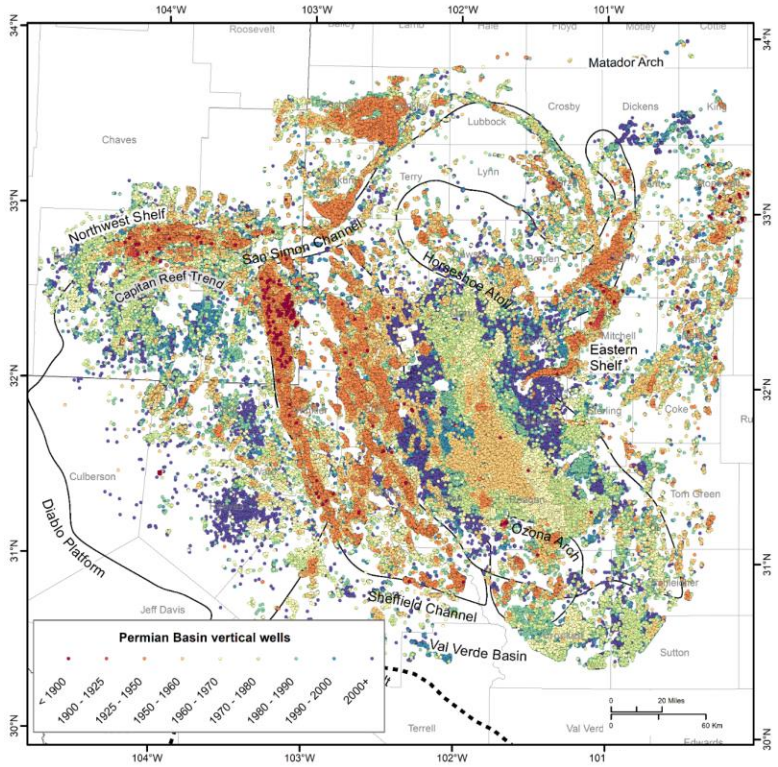
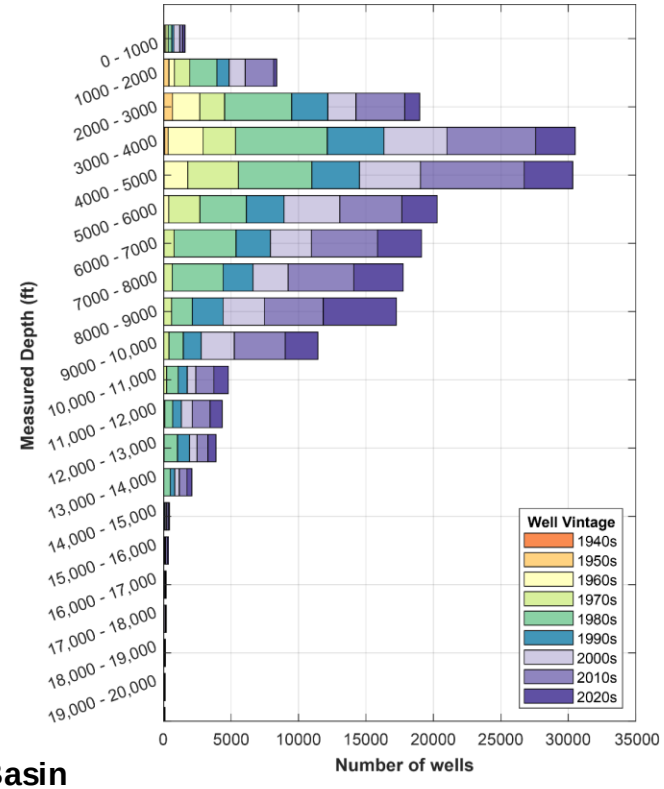




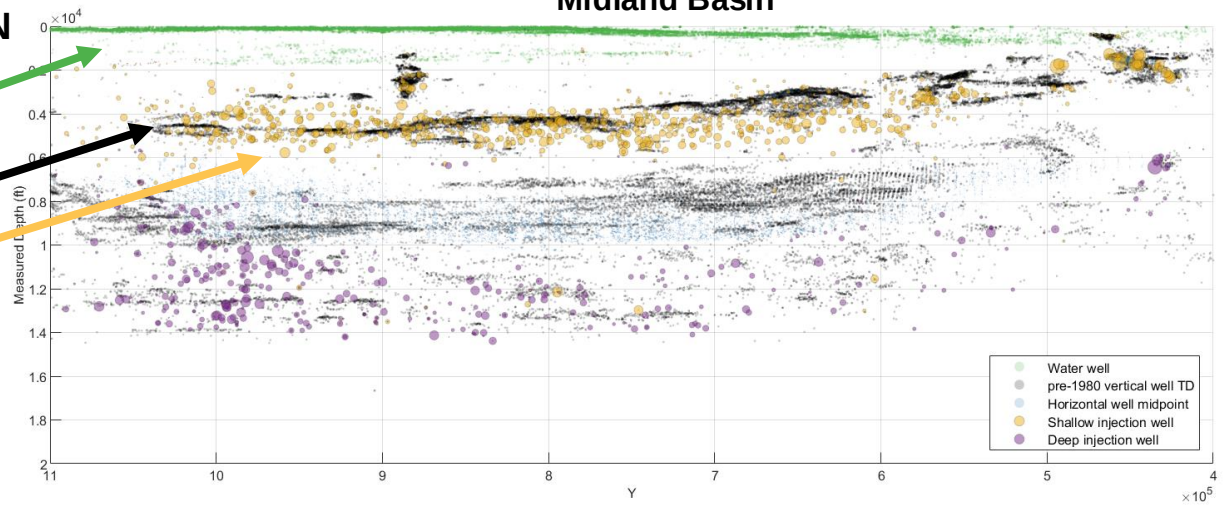
Midland Basin

N **S**

water well

vertical well TD

shallow injection well



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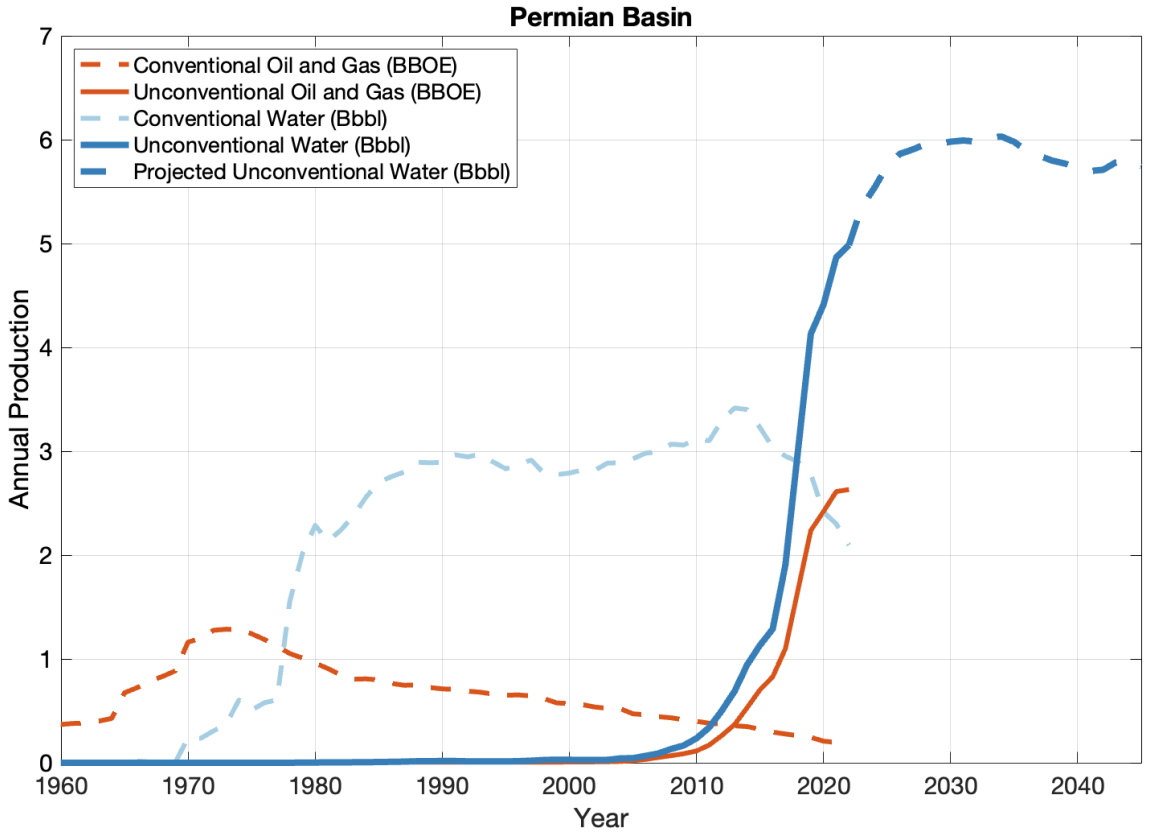
Future Opportunities and Challenges

- Subsurface pressure increases related to wastewater injection result in challenges in both deep and shallow systems in the Permian Basin region
- Seismicity *can* been mitigated in the most problematic areas of the Midland Basin, and pore and pressure space for disposal is ample in some systems
- A potential near-future challenge: increases in shallow injection resulting in pressure increases combined with the complex operational history of the basin and the presence thousands of older vertical wellbores



- Although tens of billions of barrels of prior injection for permanent disposal in the Permian Basin have been managed, several hundred billion barrels likely as production is maintained in the basin
- An **opportunity**: a coherent and collaborative water management strategy in the basin informed by geology and cognizant of the hazard of exceeded injection capacity