

SCITS AFFILIATES MEETING

January 11 & 25, 2021

February 1, 2021

Time: 8:00 – 10:00 AM PST (10:00 – 12:00 CST)

(2 hours, 20-minute presentations/10-minute discussions)

January 11, 2021 - Delaware Basin – Chair: Mark Zoback, Denise Baughman

Welcome and program status – Mark, Bill and Denise

On the depth of earthquakes in the Delaware Basin – A case study along the Reeves-Pecos County line (Ellsworth, Sheng, Pepin)

- Seismicity in the study area occurs at shallow depth on normal faults, principally in the Delaware Mountain Group.
- Are these earthquakes induced by wastewater disposal or other mechanisms?
- Are most earthquakes elsewhere in the southern part of the basin also at shallow depth?

Fault mapping in the Delaware Basin from Sentinel-1 InSAR (Pepin, Sheng and Ellsworth)

- Deformation in the case study area is consistent with shallow normal faulting at the same depth as the seismicity.
- Do other mechanisms, including water production from shallower horizons contribute to the deformation?

Pore pressure and stress constraints on induced seismicity in the Delaware Basin: Implications for maximum earthquake magnitudes (Dvory and Zoback)

- Why are induced earthquakes in the Delaware Basin principally concentrated in the southernmost part of the basin?
- What does this mean for future water disposal and hydraulic fracturing operations?

Preliminary analysis of the December 31, 2020 M 4 earthquake near Stanton, TX

- The M_w 3.8 earthquake occurred on a strike slip fault in the shallow basement.
- Little prior seismicity has been reported in the area by TexNet or the USGS.
- A number of new, deep saltwater disposal wells are located in the epicentral area.
- Are these earthquakes induced, and if so how?
- What are the prospects for additional earthquakes and what hazard do they pose to the nearby communities?

Report from SCITS Advisory Board – Shawn Maxwell, Chair

January 25, 2021 – Permian Basin, Hazards and Risk – Chair: Jack Baker

Slip potential and seismogenic association of basement-rooted and shallow faults in the Delaware Basin (Zoback, Dvory, Hennings, Horne)

- Utilization of FSP in collaboration with CISR has revealed several issues associated with FSP that need clarification.
- These will be discussed in the context of the Delaware Basin but have general applicability everywhere.

Short-term probabilistic hazard assessment in regions of induced seismicity (Teng, Baker)

- What types of events (in terms of magnitude and timing relative to injection) are most likely to lead to felt shaking near hydraulic fracturing operations?
- How widely felt are small-magnitude earthquakes associated with hydraulic fracturing?

Managing hydraulic fracturing induced earthquake nuisance and damage risks (Schultz, Beroza, Ellsworth)

- We develop a risk-informed approach to choosing red-light thresholds in traffic light protocols that manage HF induced seismicity and apply it to the Eagle Ford play.
- Impacts from earthquakes are found to be spatially heterogenous, with greater risk in the northeast of the play and relatively little in the southwest – with the heterogeneity being driven by concentrations of population density.
- Post-shut-in seismicity has the greatest impact on traffic light thresholds but is poorly constrained. How can we build better models for trailing seismicity?

The Midland – Odessa earthquakes: An integrated study characterizing a series of recent earthquakes in west Texas (Singh, Sheng, Ellsworth)

- Seismicity has significantly increased in the area, with 13 M3+ since February 2020.
- Moment tensor solutions are consistent with slip on near critically stressed planes.
- Why these earthquakes are occurring? Are they natural or induced?

February 1, 2021 - Machine Learning and Modeling – Chair, Greg Beroza

An initial look at the Mentone, Texas, earthquake using data from the Subscriber Array and public networks (Park, Singh, ...)

- Application of machine-learning methods to data from the TexNet and Nanometrics Subscriber Array enable a much richer earthquake catalog.
- That catalog offers new insight into the initial stages of the Mentone sequence.
- How can the community work together to create high-resolution earthquake catalogs from multiple sources?

High-resolution decadal earthquake catalog for Oklahoma (Park, Beroza, Ellsworth)

- A new catalog containing over 300,000 earthquakes in Oklahoma from 2011 to mid 2020 has been created using a new machine-learning assisted workflow.
- The improved catalog more clearly defines fault structures, particularly those active in the larger earthquake sequences.
- Going forward, how can the benefits of high-resolution catalogs support best practices?

Effect of porosity and permeability enhancement in injection-induced aseismic slip (Yang, Dunham)

- Constant rate fluid injection into a fault can produce aseismic slip whose front migrates outward at constant rate
- Pore pressure perturbations also migrate at constant rate, not diffusively, due to dilatancy that accompanies aseismic slip
- Aseismic slip migration rate is 50-1000 m/day for typical parameters, similar to microseismicity patterns seen in some injection operations

Are frac barriers also fault barriers? (Zoback et al.)

- We have documented significant variations of the magnitude of the least principal stress with depth from one lithofacies to another in a variety of sedimentary basins
- The cause of these stress variations appears to be viscoplastic creep in clay-rich formations
- In many cases, these stress variations can act as barriers to hydraulic fracture propagation
- Could these stress variations also act as barriers to propagation of induced earthquakes?
- If so, could this limit the magnitude of induced events

Wrap up discussion on future directions (All) Chair: Bill Ellsworth