

PROJECT UPDATES — August through October 2017

Summary — Project personnel at the Bureau, along with our UT-Austin, SMU, and TAMU research partners, continue to make progress on this highly successful program. This project update covers the period of August through October, the next will be for November through December, and in 2018 the updates will be issued quarterly.

Network Installation and Operations

- On October 17th, following extensive testing and feature enhancement, and consultation with the TexNet Technical Advisory Committee, the CISR Science Advisory Committee, and many additional relevant experts, the TexNet Earthquake Catalog became available to the public at <http://www.beg.utexas.edu/texnet/catalog>.
- With the earthquake catalog, users can view the location of TexNet seismic stations and seismic events in Texas that are manually verified as earthquakes, and search specific regions, dates and magnitudes. The earthquake catalog can be downloaded for further analysis and research. Important additional information on TexNet and links on earthquakes in general can be found in the supplemental information in the website header.
- The TexNet Seismological Network grew through 2017 as 22 permanent stations and 3 auxiliary stations were added to the 17 preexisting seismic stations bringing the “backbone” seismic network to 42 stations.
- 30 out of 40 portable stations were deployed to regions of special emphasis, leaving 7 portable stations left to deploy (3 will be kept in house for rapid response).

Synopsis of 2017 Seismicity in Texas:

- From January through October, 2017 TexNet recorded 1,045 earthquakes of $M_L 0.0$ to $M_L 3.1$. This includes 8 events of $M_L \geq 3.0$, 109 events of $3.0 > M_L \geq 2.0$, and 928 events of $M_L < 2.0$.
- Earthquakes occurred in the Dallas-Ft Worth area, Cogdell Field north of Snyder, Delaware Basin near Pecos, south of San Antonio in an arc from I-10 to I-35, and in the Texas panhandle.
- Preliminary calculations of the magnitude of completeness of the TexNet network is less than $M_L 1.4$ meaning that TexNet is recording all earthquakes greater than $M_L 1.4$ state-wide. This is very strong network performance considering the limited date range for which TexNet data are available. The magnitude of completeness of specific regions such as the DFW area and Delaware Basin will be provided in the coming months.
- Please refer to the TexNet Earthquake Catalog for more specific earthquake information.

Research:

- *Bureau Seismology* team provided a 1D crustal velocity model for the Delaware Basin from earthquake tomography in order to minimize the uncertainties in earthquake location of the area.
- *Bureau Seismology* team is working on a 3D crustal velocity model for West Texas and panhandle using current and previous seismicity studies.
- *Bureau Seismology* team is working on double difference relocation of earthquake events in the Delaware Basin to identify seismicity clusters in the area.
- *Bureau Faults and Geomodels* team continues to refine the 3D fault model of the Ft. Worth Basin to quantitatively characterize the confidence assigned to the included faults.
- *Bureau Faults and Geomodels* team has worked with the Stanford Center for Induced and Triggered Seismicity to integrate a new tectonic stress model of the Ft. Worth Basin with the 3D fault model to produce a preliminary “faults of concern” map which is being evaluated for completeness and accuracy.
- *Bureau Faults and Geomodels* team has finished characterizing outcropping faults along the southwest flank of the Ft. Worth Basin with the collection of field data, drone mapping, and 3D rendering which enables quantitative characterization.

- *Bureau Faults and Geomodels* team began work with subcontractor Golder Associates to build discrete fault models of the faults that outcrop on the NE flank of the Llano uplift for deriving anisotropic permeability modifiers for implementation in the Ft. Worth Basin hydrogeologic model.
- *Bureau Faults and Geomodels* team began work with subcontractor Southwest Research Institute to build a 3D geological model of the Eagle Ford operating area which will be used for integrated seismicity assessment of that region.
- *Bureau Geomechanics of Fault Reactivation* team incorporated detailed injection well data into the 3D fully coupled poroelastic model of the Azle, TX area to examine individual contributions of fluid injection and production to pore pressure change, stress change, and fault reactivation.
- *Bureau Hydrogeology* team continued developing the fluid flow model of the Ft. Worth Basin. The team focused on the conversion of measured surface injection pressures to estimated bottomhole pressures, which will be used for history matching.
- *UT Petroleum and Geosystems Engineering* team worked with the USGS on the fault rupture model to test the dependence of modeling results on model element size, and is assembling a dataset for case study. The basin flow model's predicted pressures were cross-checked with updated RRC surface pressure reported.
- *TAMU Fluid Flow, Geomechanics* team is developing and testing the rapid coupled fluid flow and geomechanics simulation using the Fast Marching Method, solving Eikonal equations for 'phase' functions representing travel times of propagating pressure and stress fronts. This will be applied in the Azle seismicity study.
- *TAMU Fluid Flow, Geomechanics* team completed an interim research report summarizing its evaluation of Azle-area seismicity using coupled fluid flow and geomechanical modeling.
- *UT Seismic Hazard and Risk Assessment* team performed V_s measurements at 20+ sites in Pecos, Snyder, and the Texas Panhandle. Initial numerical models of building facades were developed to evaluate structure vulnerabilities.

Recruitment:

- *Bureau Seismology* team hired a new Research Associate, Dr. Dino Huang. Team member Dr. Chastity Aiken moved to IFREMER in France.
- *Bureau Geomechanics of Fault Reactivation* team hired a new postdoc Dr. Mahdi Haddad from UT-Austin Petroleum and Geosystems Engineering. Team member Dr. Zhiqiang Fan moved to the Desert Research Institute, Reno, NV, and maintains a research affiliation with the BEG.

Outreach:

- *Bureau Seismology* team presented TexNet into the Water Sourcing & Produced Water Management Permian Basin 2017 meeting (10/26/2017), and San Antonio Geophysical Society (10/24/2017).
- *Bureau CISR/TexNet, PI's* presented TexNet into the Texas Oil and Gas Association on 10/25/2017.
- *UT Social Science* team has completed a white paper of the 2016 survey data on public perception of earthquakes and distributed it to CISR Industrial Associates and also for publication.
- *UT Seismic Hazard and Risk Assessment* team published a V_s30 paper (Zalachoris et al. 2017) in the Journal of Earthquake Spectra. The team's map was the used as the journal's cover image.
- *Bureau Faults and Geomodels* team visited the offices of the Headwaters Groundwater Conservation District in Kerrville to share information on faults and architecture of the Kerr Basin.
- *Bureau* personnel were given the go-ahead by the U.S. Department of Energy, through the Groundwater Protection Council, to organize a multi-state research collaborative related to induced seismicity, known as Regional Induced Seismicity Collaborative (or RISC). This collaborative will include Texas, Oklahoma, Kansas and New Mexico. The goals are to inform the partners of research approaches in this technical area, and reduce overlaps and gaps wherever possible. We anticipate that RISC will officially start up in 2018.