TexNet and CISR: An Update on Monitoring and Understanding Seismicity in Texas

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UIC Conference
February 23, 2017
Texas Shale Basins, Injection, Seismicity

- ~50,000 injection wells permitted since 1930’s
- ~34,000 active injection wells for enhanced oil production
- ~8,000 permitted UIC Class II disposal wells
Seismic Activity in Texas

Earthquakes in Texas as from USGS/ANSS Catalog of M≥3

Savvaidis, BEG

Existing seismic station
• Earthquake event (1973-Feb. 2016)
Activity (>M2.0) in DFW Area (since 1/2013)

Data source: IRIS
Fluid Injection Volumes – Ft. Worth Basin

Lemons and Hennings, unpublished
Texas is Geologically Diverse

12+ distinct tectonic areas
- Anadarko Basin
- Amarillo Uplift
- Palo Duro Arch
- Midland Basin
- Delaware Basin
- Marathon
- Far West
- Val Verde
- Gulf Coast
- East Texas Basin
- Sabine Uplift
- Ft Worth Basin
- Llano/Bend Arch
- Talco/Mexia/Balcones

Many known subsurface fault systems that are poorly documented publically

BEG after Ewing

Ewing, in press
Known Unknowns

- Knowledge of subsurface fault architecture – 3D seismic data, crucial to understanding subsurface conditions, often maintained in house with operators and services companies and are not public

- High resolution data on injection volumes and rates – currently monthly averaged injection volumes are made available once per year, daily values needed

- Downhole pressures – pressure responses radiate from injection wells. Monitoring wells or monitored injection wells would better define subsurface conditions

- Sufficient understanding of rock and fault properties (for modeling) – including porosity, permeability, offsets, stress states, fault planes, etc.
Public/Media Response to Texas Seismicity

STATEIMPACT
How Oil and Gas Disposal Wells Can Cause Earthquakes

INTERNATIONAL BUSINESS TIMES
Energy’s New Legal Threat: Earthquake Suits

The New York Times
Metro
Exxon subsidiary: Quakes not caused by injection wells

THE WALL STREET JOURNAL
Metro
Study Ties Fracking to Quakes in England

The Dallas Morning News

U.S. Maps Pinpoint Earthquakes Linked to Quest for Oil and Gas

Fracking The Reason For Texas’ Earthquakes?
Report Rules Out ‘Natural’ Causes For More Tremors

State orders well tests for links to Venus-Midlothian quakes

Editorials
Editorial: Texas regulators, get your head out of the shale

Biz Beat Blog
Railroad Commission rules “no conclusive evidence” Venus quake linked to oil and gas

New Studies Link Earthquakes With Oil, Gas Drilling
SECTION 16. THE UNIVERSITY OF TEXAS AT AUSTIN: BUREAU FOR ECONOMIC GEOLOGY. (a) In addition to amounts previously appropriated for the state fiscal biennium ending August 31, 2015, $4,471,800 is appropriated out of the general revenue fund to The University of Texas at Austin for the two-year period beginning on the effective date of this Act for the purchase and deployment of seismic equipment, maintenance of seismic networks, modeling of reservoir behavior for systems of wells in the vicinity of faults, and establishment of a technical advisory committee.
TexNet Goals

- To monitor, locate, and catalog seismicity across Texas, capable of detecting and locating earthquakes with magnitudes ≥M2.0 (aka—Backbone)
- To improve investigations of ongoing sequences by deploying temporary seismic monitoring stations and conducting site-specific assessments, especially for
  - Events >M3.0 in or near urban areas, or
  - Events co-located where ongoing human activities may be related to earthquake activity
TexNet – Integrated Monitoring Network

- Add 22 additional broadband stations, providing 40 station backbone
- Include auxiliary sites
- Deploy up to 36 additional, short-period, temporary stations
Permian Basin
2016-2017
- 6 stations near Pecos
- 9 at Cogdell Field
2018
- 9 near Pecos and elsewhere

Ft Worth Basin
2016-2018
- 12 stations to be adjusted depending on seismicity trends and availability of other sensors

Northeast Texas
2016-2017
- 0 stations
2018
- 3 stations

Eagle Ford
2016-2017
- 3 near Fashing
2018
- 6 near Fashing and elsewhere

UT-BEG rapid deployment reserve
2016-2017
- 3 stations
2018
- 3 stations (other deployed portable stations can be repositioned to augment rapid deployment reserve)
Hardware Setup of Permanent Station

Pole mount hardware
Installation:
- 6 Channel Datalogger
- Wireless Modem
- 200Ah Battery
- 150W Solar Panel, and
- 120sec – 3 Component Post-Hole Seismometer
TexNet-CISR Goals and Stakeholders

**TexNet** - Monitor, locate, and catalog seismicity across Texas, minimizing uncertainties, with magnitudes ≥M2.0 using the new *backbone* network and improve investigations of ongoing sequences by deploying temporary seismic monitoring stations and conducting site-specific assessments.

**Center for Integrated Seismicity Research** - CISR will conduct fundamental and applied research to better understand naturally occurring and potentially induced seismicity and the associated risks, and to discern strategies for communicating with stakeholders and responding to public concerns regarding seismicity.
Research Project Integration

TexNet and Seismology
permanent and portable seismic networks → velocity models → EQ locations, calibrated magnitudes, catalog, maps → EQ focal mechanisms → advanced source characterization

Geologic & Hydrologic Description
stress magnitude characterization (SCITS) → fault system characterization → disposal zone geomodels → site to basin fluid budgets

Geomechanics and Reservoir Modeling
static fault sensitivity analysis → basin-scale reservoir models for Pp estimation → site-specific poroelastic scenario models → site-specific reservoir flow models → coupled fault rupture and permeability models

Seismic Hazard and Risk Assessment
Vs30 database and TX Vs map → ground motion models → seismic vulnerability estimates

Seismic Risk Social Science
data on risk perceptions of EQs → characterization of stakeholder beliefs, values, and reactions to seismic risk → communication strategy effectiveness and tools

Petroleum Operator Data and Collaboration
Longer-Term Science and Application Timing

**State-Wide and General Topics**
1. network procurement and installation
2. network management and data stream
3. R&D products to improve network performance
4. EQ compilations and characterizations
5. fault mapping and disposal zone characterizations
6. seismic risk communication and outreach

**Ft Worth Basin Integrated Study**
1. local seismic networks and EQ studies
2. basin-scale fluid budgets and pore pressure
3. stress characterization (Stanford)
4. fault characterization
5. 3D basin geo and hydrologic and modeling
6. fault reactivation analysis and mapping
7. reservoir modeling of seismicity mechanics
8. assessment of basin seismogenic potential

**Greater West Texas Basin Integrated Study**
1. local seismicity base-line studies and analyses
2. *integrated geological characterization
3. assessment of basin seismogenic potential

**Eagle Ford Operating Area Integrated Study**
1. local seismicity base-line studies and analyses
2. *integrated geological characterization
3. assessment of basin seismogenic potential

**Panhandle Seismicity Study**
1. seismicity analysis (existing and TA stations)
2. *integrated geological characterization
3. assessment of basin seismogenic potential

*integrated geological characterization
Event:
Near Pecos, TX
17Feb2017; 12:52CST
Mag 2.3
Thank You!!