



# Oklahoma Geology Notes

A NEWSLETTER OF THE OKLAHOMA GEOLOGICAL SURVEY  
*The University of Oklahoma* MEWBOURNE COLLEGE OF EARTH & ENERGY

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## The OGS' Role in Oklahoma's Seismic Activity Research Data Collection

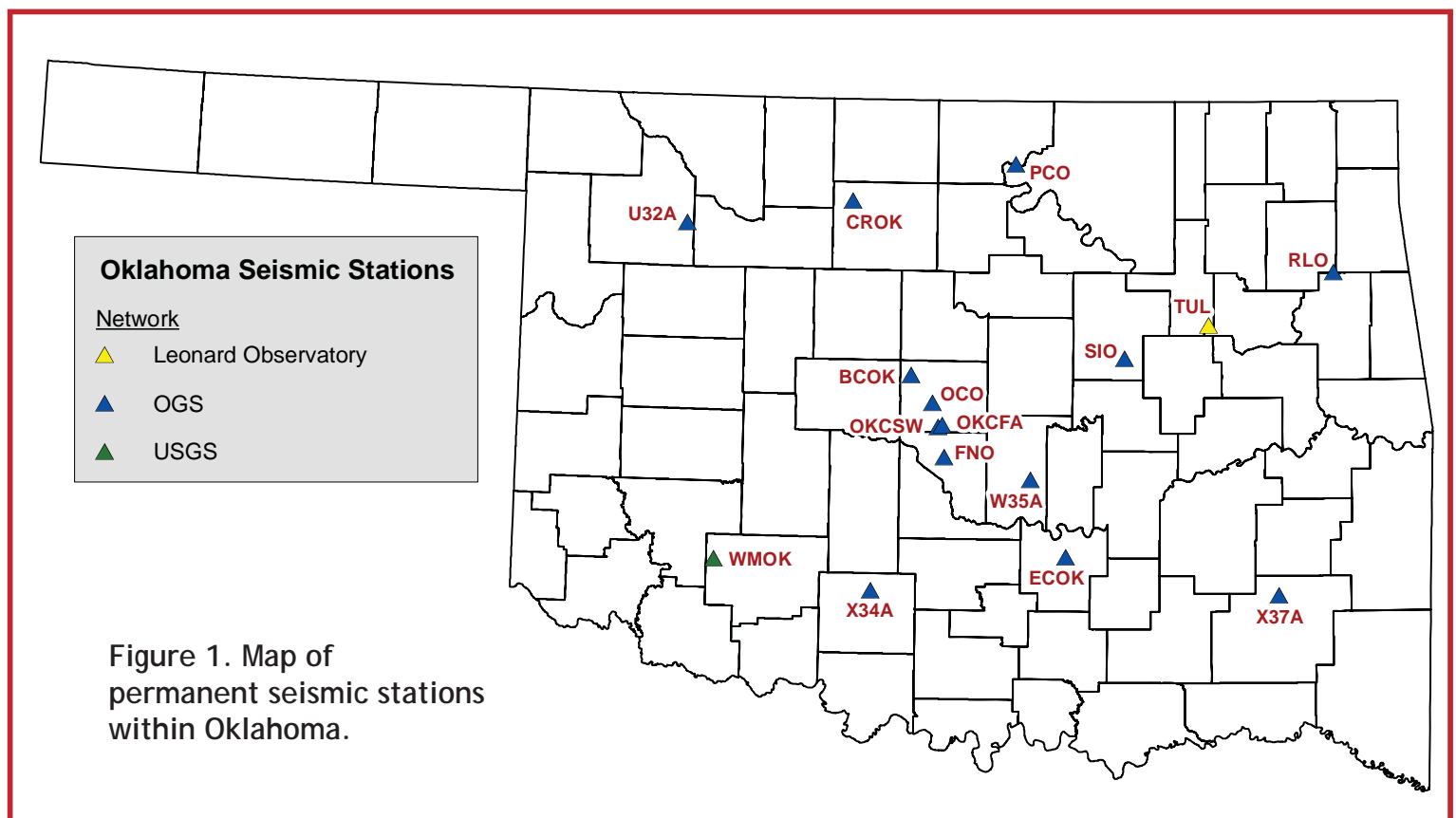
*Austin Holland, OGS Research Seismologist*

### Background: OGS Geophysical Observatory's Role in Seismic Data Collection

Located just southeast of Tulsa in Leonard, Oklahoma, the Oklahoma Geological Survey's Geophysical Observatory participates in the Survey's seismic data collection including receiving, recording, and transmitting data on seismic phenomenon. It also functions as an earthquake

public information center for Oklahomans. Many groups come to the Observatory for combined tours and mini-lectures on earthquakes and the magnetic field.

The Observatory is steeped in a varied history that began with its construction by the Jersey Production Research Company as the Leonard Earth Sciences Observatory in 1960. This location was selected because it was seismically and



## The OGS' Role in Oklahoma's Seismic Activity Research...



remote seismographs, which was up and running by the close of 1977. With this network as the basis, OGS has operated a seismic network from 1977 to present day.

In 1978, the Observatory became part of the Oklahoma Geological Survey, and was named the "Oklahoma Geophysical Observatory". It was soon renamed the "Oklahoma Geological Survey Observatory". During 1978, the last photo paper seismogram drum recorders were converted to heat writing (and some to ink writing).

magnetically quiet (i.e., no heavy industrial and traffic vibrations) and was within driving distance from their Tulsa headquarters.

In 1965 Jersey gave the Observatory to the University of Oklahoma and functioned as a small department in the College of Arts and Sciences. Through the generosity of the Sarkeys Foundation, the quarter section (160 acres, 64.8 hectares) of leased land at the site was purchased for the State of Oklahoma.

The Oklahoma Geological Survey Observatory has collected a wide variety of geophysical data over the history of the observatory and has archived these records. These observations include 26 years of telluric currents, 19 years of Earth-tide gravimeter, 30 years of riometer, 6 years of solar radiation, and about 40 years of various weather data. In addition it was used as a mobile Very Long Baseline Interferometry (VLBI) observation point.

In 1976, a Nuclear Regulatory Commission (NRC) grant through the Oklahoma Geological Survey provided for a statewide network of



On June 1, 1990, Bush and Gorbachev signed a protocol that called for building a Soviet Nuclear Monitoring site near the Observatory Building. The Russians were allowed to have a seismograph station there to record seismic waves from American, and an occasional British, underground nuclear blast in Nevada. Seven years later, after Russian-UK-US Nuclear testing ended, Russia released the site, and the United States turned the dollar-per-year leased land back to Oklahoma.

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The Oklahoma Geological Survey has continued to maintain the seismic monitoring capability in the state of Oklahoma, even after the NRC grant had expired. The seismic network moved to digital archival of data in the mid-1990's. Prior to 2010 the OGS seismic monitoring program was primarily based out of the Observatory. The seismic monitoring network has seen many changes throughout its 37 years, but has been continuously supported and operated by the Oklahoma Geological Survey over that time period. The Observatory also has four research boreholes, three of which have had operating borehole seismometers operating in them. The OGS has 675 square feet of archived paper helicorder recordings for seismic stations within the region dating back to 1961.

### **Current Capabilities of the Oklahoma Seismic Network**

The OGS currently operates 14 continuous-recording seismic stations within the state of Oklahoma, in addition to supporting the operation of the new backbone station TULI located at the Leonard Observatory Russian Vault (Figure 1). The Earthscope USArray Transportable Array (TA) data was incorporated into the regional monitoring efforts in early 2010 as the TA moved into Oklahoma. The Oklahoma seismic network has seen a great number of improvements since the beginning of 2010. The OGS adopted two TA complete stations, U32A and X37A. In addition, two TA vaults were adopted, X34A and W35A. X34A is a broadband site with a response from 120s to 100 Hz and W35A is high gain 1 Hz three-component short-period system.

There have also been two more permanent stations added to the system. One is located near Oklahoma City and was installed to monitor ongoing earthquakes swarms and potential seismicity from disposal wells in close proximity to the Nemaha fault zone. The other station, CROK, is located in north-central Oklahoma, and both are broadband stations. In total the OGS operates 7 broadband seismic stations, three three-component short period stations with the four



*Pictures above show vault installation at station CROK and the final completed installation.*

additional stations being vertical only, short-period stations. Additionally, the OGS is operating 7 temporary seismic stations within Oklahoma. Four of these are on loan from the Conoco-Phillips School of Geology and Geophysics at the University of Oklahoma and the others are OGS short-period instrumentation. Moreover, the OGS has supported a number of USGS stations within the state since early 2010 and is very appreciative of the additional data coverage from these stations.

The OGS currently sends data from all three-component stations to the **Incorporated Research Institutions for Seismology Data Management Center (IRIS DMC)** for archival. These same data also are provided directly to the **USGS National Earthquake Information Center (NEIC)**. The OGS routinely locates and reports earthquakes throughout Oklahoma and locates earthquakes within surrounding states that often go unreported to the ANSS system, simply because we currently only report seismicity within Oklahoma. The OGS incorporates surrounding **Advanced National Seismic System (ANSS)** backbone and regional monitoring stations into its event detection and location efforts. Data is collected, processed, and exchanged using the Earthworm software.

Data collection occurs at both the Leonard Observatory and at the main OGS offices at University of Oklahoma in Norman, Oklahoma. Seismic data is collected, processed and archived on three Linux-servers at the two different OGS facilities. Phase arrivals and magnitudes are currently measured using **SEISAN** (earthquake analysis software) by OGS seismic monitoring staff. Continuous waveforms and event-triggered waveforms are archived on 16TB of RAID storage.

Seismic monitoring staff at the OGS has more than 35 years of combined experience in seismic network management and earthquake monitoring. This includes research seismologist Austin Holland, research scientist Amie Gibson (shown above right), and technical support staff. In addition the OGS has geology, technical, edito-

rial, general support, business, cartography, and public information and outreach staff to assist in associated network operations and activities. The OGS generally has several University of Oklahoma graduate or undergraduate students working on specific research projects and gaining relevant research and field experience. In addition, the OGS has hired another seismologist for the seismic monitoring program, and the new staff-member is scheduled to start in January of 2014.



### **Funded and Planned Improvements to the Seismic Network and Observatory**

The OGS has received a commitment of funds totaling \$210,000 to upgrade and expand monitoring within Oklahoma. The Mewbourne College of Earth and Energy has committed \$70,000 for the upgrade of existing seismic stations. This upgrade will create a consistent architecture for the existing network. All existing stations will be three-component stations with a combination of broadband, mid-band (30s to 100Hz), and short-period three component systems depending on noise characteristics at the existing seismic stations.

In addition, the Oklahoma Secretary of Energy and the Oklahoma Corporation Commission are contributing another \$140,000 to add another eight seismic stations to the Oklahoma seismic



network. These stations will be situated such to optimize and provide for more even coverage of seismicity throughout Oklahoma with the exception of the panhandle. These systems will be the mid-band (30s to 100 Hz) seismic stations and transmitted to central recording facilities through cellular modems. Additional supporting hardware, such as a new server with 18 TB of RAID storage, is also being added as part of these upgrades. These upgrades will take place over the next year and should be completed by the end of 2014. Finally, monitoring hardware in

good condition from the existing network will be repurposed as additional temporary monitoring systems that can be rapidly deployed or redeployed to augment the regional network.

A number of unique opportunities for research exist at the Observatory. These include the large relatively culturally quiet 168 acre facility, and the four research boreholes and the long history of weather and geophysical measurements. In addition the quiet location and accessible vaults offer other opportunities.

## **Workshops, Meetings, Conferences, and Field Trips**

### **January 28-29 13<sup>th</sup> Annual Oklahoma Aggregates Association Field Trip and Meeting**

Magnuson Hotel & Meridian Convention Center; Oklahoma City, Oklahoma  
Meeting: Jim Rodriguez, 405/524-7680; e-mail: [jrodriguez@okaa.org](mailto:jrodriguez@okaa.org)  
Field Trip: Stan Krukowski, 405/325-8033; e-mail: [skrukowski@ou.edu](mailto:skrukowski@ou.edu)  
Website: <http://www.okaa.org>

### **Feb. 23-26 2014 Society for Mining, Metallurgy & Exploration Annual Meeting & Exhibit (SME)**

Salt Palace Convention Center; Salt Lake City, Utah  
Contact: 303/948-4200 or 800/763-3132; website: <http://www.smenet.org>

### **March 13-14 AAPG/SEG Spring Student Expo**

University of Oklahoma ConocoPhillips School of Geology & Geophysics  
Norman, Oklahoma  
Contact: Devon Harr, 405/325-0360; e-mail: [devonharr@ou.edu](mailto:devonharr@ou.edu)  
Website: <http://www.geology.ou.edu>

### **March 18 Aggregates Industry Day at Oklahoma State Capitol**

Oklahoma State Capitol Rotunda; Oklahoma City, Oklahoma  
Contact: 405-524-7680; website: [www.okaa.org](http://www.okaa.org)

### **March 19 Water Appreciation Day at the Capitol**

Oklahoma State Capitol Rotunda; Oklahoma City, Oklahoma  
Contact: 405/530-8800; website: <http://www.owrb.state.ok.us>

### **March 27 GIS Day at the Capitol**

Oklahoma State Capitol Rotunda; Oklahoma City, Oklahoma  
Contact: Shellie Willoughby, 405/521-4828; e-mail: [shelliew@okcc.state.ok.us](mailto:shelliew@okcc.state.ok.us)  
Website: <http://www.okmaps.onenet.net>



# ***THE REAL DEAL*** **MID-CONTINENT PROSPECT EXPO**

The 6<sup>th</sup> annual OCGS/OGS Expo, held on August 28, 2013, was a great success!

- ◆ 213 Attendees
- ◆ 23 Prospect Booths
- ◆ 14 Vendor/Mineral Acquisitions Booths

Attendees were awarded continuing education credits: 8 CEUs / PDHs.

The four technical papers presented were well-received by Expo attendees:

- ◆ **Paul Philp, University of Oklahoma**  
*"The Added Value of Integrating Petroleum Geochemistry into the Characterization of the Woodford Shale"*
- ◆ **Steve Grimes, EMPIRICA**  
*"Onsite Mass Spectrometry of Mud Gasses: Geofluid Chemistry and Formation Evaluation"*

- ◆ **Gary Gore, Gore Nitrogen**  
*"Economical Solutions: Foam Stimulation"*
- ◆ **Jim Puckette, Oklahoma State University**  
*"Woodford Shale: Correlating Rock Properties in Outcrop and Core with Wireline Log Characteristics"*

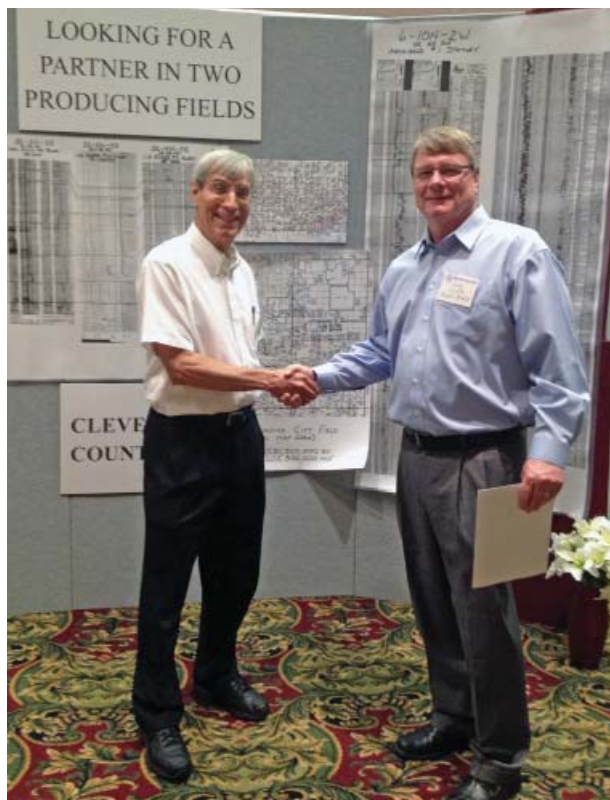
Scholarships: \$500 scholarships were awarded to Drew Davis, Oklahoma State University, and Aria Linares, University of Oklahoma.

A special thank you to the following coffee break/lunch sponsors:

- ◆ Brett Exploration LLC
- ◆ North Texas Sample Log Service
- ◆ Raydon Exploration, Inc.







*Stay tuned for details on the  
2014 Real Deal Mid-Continent  
Prospect Expo...*

Created by the Oklahoma Territorial Legislature in 1890, the University of Oklahoma is a doctoral degree-granting research university serving the educational, cultural, economic and health-care needs of the state, region and nation. The Norman campus serves as home to all of the university's academic programs except health-related fields. The OU Health Sciences Center, which is located in Oklahoma City, is one of only four comprehensive academic health centers in the nation with seven professional colleges. Both the Norman and Health Sciences Center colleges offer programs at the Schusterman Center, the site of OU-Tulsa. OU enrolls more than 30,000 students, has more than 2,400 full-time faculty members, and has 20 colleges offering 163 majors at the baccalaureate level, 166 majors at the master's level, 81 majors at the doctoral level, 27 majors at the doctoral professional level, and 26 graduate certificates. The university's annual operating budget is \$1.5 billion. The University of Oklahoma is an equal opportunity institution. [www.ou.edu/eoo](http://www.ou.edu/eoo)

#### Oklahoma Geological Survey Mission Statement:

*The Oklahoma Geological Survey is a state agency for research and public service located on the Norman Campus of the University of Oklahoma and affiliated with the University of Oklahoma Mewbourne College of Earth and Energy. The Survey is chartered in the Oklahoma Constitution and is charged with investigating the state's land, water, mineral, and energy resources and disseminating the results of those investigations to promote the wise use of Oklahoma's natural resources consistent with sound environmental practices.*



*Oklahoma Geological Survey*  
THE UNIVERSITY OF OKLAHOMA  
MEWBOURNE COLLEGE OF EARTH & ENERGY  
100 E. Boyd, Room N-131  
Norman, Oklahoma 73019-1001

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*Stream-rock drill equipment used to build roads in eastern Oklahoma, ca. 1899. Holmes Collection, Western History Collections, University of Oklahoma.*