

Oklahoma Geology Notes

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

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G. Randy Keller,
Oklahoma State Geologist

2012: AN INTERESTING AND EXCITING TIME FOR THE OKLAHOMA GEOLOGICAL SURVEY

The calendar year 2012 was an exciting and interesting time for the Oklahoma Geological Survey. Important improvements were made to the **Oklahoma Petroleum Information Center (OPIC)**, where new roofing greatly improved the quality of life for many occupants and collections housed there. The Survey also saw changes in office space in Sarkeys Energy Center.

Staff members have helped out with OU's Field Geology course conducted each Summer at the Bartell Field camp near Cañon City, Colorado; taught petroleum geology classes each spring semester; given interviews to the media on earthquakes, oil and gas issues, hydraulic fracturing and injector wells; provided speakers to civic and school groups; held workshops and published; addressed committees and citizens; and in general upheld the constitutional mandate to investigate and inform Oklahomans about their abundant natural resources.

Seismic Activity

Earthquake events were monitored and media interviews fell mostly to **Austin Holland**, OGS seismologist, who has become a sought-after source of information and well-known media personality because of Oklahoma's rash of earthquakes. Dr. Keller pitches in on many occasions, but Holland seems to be on everyone's speed dial when the ground starts shaking.

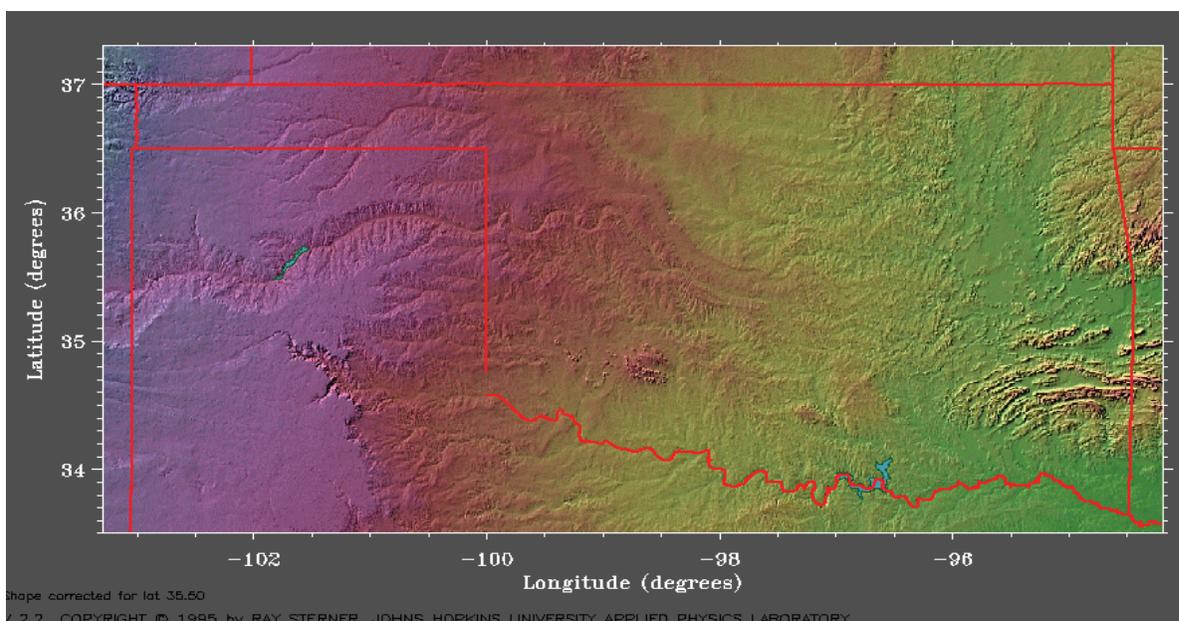
From January 1, 2012, to December 1, 2012, the OGS located **979** earthquakes in the state. As a result of the **EarthScope** project, Oklahoma is now home to five broadband state-of-the-art seismic stations and two backbone stations that are part of the Advanced National Seismic System. OGS researchers **Amie Gibson** and **Jacob Nance** keep the Leonard, Oklahoma observatory and seismometers up and running and aid in getting information out when quakes are felt.

Projects and Programs

The OGS continues its involvement in the **USGS National**

Contrary to popular belief, Oklahoma is not flat.

Underground, we have some huge mountains!





2012: AN INTERESTING AND EXCITING TIME..., *continued*

CO₂ Sequestration Assessment Program, which is being led by geologist **Rick Andrews**. Using structure contour maps depicting the tops of the Arbuckle Group and the Hunton Group in Oklahoma, the project is identifying very favorable areas for CO₂ storage in the state. The Arbuckle is an ideal sink for high-volume storage, while any formation within the Hunton may have good porosity development and lateral/vertical seals making it an excellent candidate for storage compartments. An isopach map of the Hunton and an extensive database having subsurface formation tops of the Arbuckle and basement rocks are proving to be important tools available to the Survey for this project. The database is dynamic and will be updated continually to reflect new data and provide quality checking of the Survey's existing data.

Also at the OGS **Dr. Ken Luza** continues to be involved the Tar Creek Superfund Site near Picher, Oklahoma. Luza has worked in the area since the 1980's, publishing, mapping and in general keeping contact with the residents and government agencies as this important and painful story played out for the town of Picher and the surrounding area. As an engineering geologist, he also contributes to projects in other areas of Oklahoma, including issues surrounding water quality in the Panhandle.

Dr. Stan Krukowski keeps track of Oklahoma's mineral resources and works with various professional groups and companies within the state. His research projects include: contributing to the Directory of Oklahoma Mines; industrial minerals utilization by native americans; rare earth elements concentrations in coal combustion products and igneous terranes; and conodont biostratigraphy of Mississippian through Permian carbonate rocks.

Brian Cardott continues to study coal and coalbed methane in general and the Woodford Shale in particular. Brian has one of the most visited and most updated sections on the OGS website. The increase in drilling for gas shales and shale oil in Oklahoma has made his studies a very valuable and sought after source of information for exploration and production efforts.

Dr. Neil Suneson continues his work in the Ouachita Mountains, Arbuckle Uplift, and Wichita Mountains areas, adding to the knowledge base of these complex and fascinating areas. Neil was hired in the 1980's at the beginning of STATEMAP and since has worked in virtually every area of Oklahoma. In addition to basic research, Suneson also helps teach class number 4233: Subsurface Methods, spends a great deal with students and their theses, and is

an instructor at OU's Field Camp.

Dr. Kyle Murray, who joined the Survey staff in November of 2011, brought with him a grant to investigate water resource geospatial infrastructure for oil shale development. He will be looking at the application of GIS to water resource studies, as well as investigating many other aspects of the important issue of groundwater in Oklahoma.

Dr. Keller and his team of Kevin Crain and Vikram Jayaram are studying the deep structure of Oklahoma and surrounding areas and building a 3-D geological models based on geological and geophysical constraints. Along with the OGS projects and programs, Dr. Keller is always busy with students, media interviews, administrative issues, speaking engagements, and all the other tasks that come along with his positions and titles as: Professor and Edward Lamb McCollough Chair in Geology and Geophysics, State Geologist, and Director of the Oklahoma Geological Survey.

In other areas, the Survey also is completing work on a grant from the *National Geological and Geophysical Data Preservation Program* administered by the USGS. This fourth year of the project was centered on completing work with the Survey's collection of mud logs. The Survey now has Header information for the more than **3,300** mud logs that are inventoried with the listings available for examination in the *Data Library at the Oklahoma Petroleum Information Center*. Users can view the information or download it as a Microsoft Excel file. Previous work for this effort involved metadata describing almost **9,000** individual rock core samples maintained at OPIC. The purpose of the project is to assist in archiving geological and geophysical data and sample collections held by the state surveys and making this information commonly available.

Oklahoma Petroleum Information Center (OPIC)

Great progress was achieved this year, resulting in a more comfortable and user-friendly place for patrons and staff to work. The core viewing area was enclosed, providing about 5,000 sq. ft. of heated, air conditioned (a life-saver in Oklahoma's 113-degree summer!), and well-lighted space in which to examine core. The area also has Wi-Fi, 450 ft of core layout tables and an extensive core-photography area.

Also added to the complex were a new Spectral Gamma Logger that scans core as it passes on a conveyor belt,

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and an upgraded imaging tube for the X-ray imaging lab. While the number of visitors has remained relatively constant, the core lay-out numbers, cores plugged, and cores slabbed counts are up significantly over previous years. To help with getting the information in an accessible form, **Richard Tarver** has joined OPIC as a research technician. An OU graduate, Richard is experienced in web-based databases and has five years of experience in database construction and management.

Mapping

STATEMAP, with OGS geologists **Dr. Tom Stanley** and **Dr. Julie Chang**, marks its 15th anniversary at the Survey in 2012. The project's goals are detailed mapping at 1:24,000 around urban areas and digital maps at 1:100,000 scale available to the public. These smaller-scale maps also are part of the ongoing effort to create a new 1:500,000-scale geologic map of the state.

To date, the OGS has completed more than 41 detailed 7.5' geologic maps at a scale of 1:24,000 and 16 reconnaissance maps at 1:100,000. These are available on the website and in hard copy and digital format upon request. This reconnaissance project is complete for the western half, and is moving northwest to southeast with plans to complete at least one 1° sheet annually.

Other News and Events

The year of 2012 turned out to be a time for additions, awards, and farewells. Geologist **Brittany Pritchett** joined the OGS on July 1st 2012. She will initially work with Rick Andrews on our ongoing data compilation efforts for petroleum, geothermal, and CO₂ sequestration studies. However, she will also be developing her own research program.

Dr. Kenneth S. Johnson, who served as OGS Associate Director for more than 20 years, received the **AASG Distinguished Service Award** at the annual meeting in 2012. Johnson's service to the geological community was based on a broad knowledge of geology, good humor, writing skills, and willingness to pitch in wherever he was needed. Although he has been retired from OGS for more than 10 years, he still maintains an office and is available for consultation and corporate knowledge when needed.

Two staff members of the Oklahoma Geological Survey recently retired – Jane Weber and James (Jim) Chaplin. Jane and Jim's contributions to the Survey are most appreciated and they both will be missed.

Jane Weber joined the Survey in 1982 as a chemist and computer programmer. Most recently Jane was involved with working in the library of OGS' OPIC facility.

Jim Chaplin joined the OGS in 1984 as regional stratigrapher after 20 years of teaching geology at Morehead State University in Kentucky. In recent years, Jim was

very active with Oklahoma science teachers, serving as a resource of information on geology, publishing teaching aids, and holding workshops for the teachers.

We are also sad to report that **Dr. Charles Mankin**, former Director of the Survey, passed away in November. Dr. Mankin's impact and influence in the nation's energy public policy, as well as on the local front, will not be forgotten. Dr. Mankin served as for 40 years as the state geologist of Oklahoma, was recognized in 2012 by the Association of American State Geologists (AASG) for his very important contributions to the establishment of the National Cooperative Geologic Mapping Act of 1992. This act provides several million dollars annually to fund state geological surveys (STATEMAP program), the U. S. Geological Survey (FEDMAP program), and students (EDMAP program) around the country to conduct the intensive fieldwork that is required to produce high quality geologic maps. The best proposal submitted to this program each year will earn the *Charles Mankin Award*.

Public Service, Outreach and Education

The OGS provides speakers for many events in the state and nationally: Civic, school and scout groups, legislative groups, professional organizations and many other gatherings call on OGS staff to present information. The OGS also leads many field trips for professional and educational groups during the year. As always, the Survey responds to numerous calls, e-mails and office visits from citizens who need information about everything from a rock or fossil they found, suspected gold on their property or mineral rights they have inherited. It is a task that everyone takes seriously and a service the OGS does its best to provide.

The OGS issued its fifth Newspapers in Education program titled: **OKLAHOMA ROCKS! Groundwater 2012**. The 16-page booklet, compiled by **Dr. Kyle Murray**, was provided to enrolled schools free of charge, 25 copies per classroom, along with 6 lessons in the *Daily Oklahoman* newspaper, an online teacher's guide, and classroom activities incorporated with the material. The project, sponsored by the *Daily Oklahoman*, has been extremely successful, and reaches more than 350 classrooms throughout all areas of the state. More than a thousand extra copies are available to the OGS for scout and educational groups, and civic and professional organizations where they are distributed throughout the year. The Oklahoma Geological Foundation and Oklahoma Aggregates Association helped to sponsor this 5th issue of **OKLAHOMA ROCKS!**

In recent months, seismologist **Austin Holland** and **Dr. Keller** have spent a good deal of our time in media interviews and as speakers dealing with earthquakes in general and the topics of fracturing in drilling along with the topic of injection wells and seismic events. Although time consuming, they both make a great effort to dispel much of the misinformation that surrounds these subjects.



2012: AN INTERESTING AND EXCITING TIME..., *continued*

As the needs of the state and the nation have changed since 1908, the OGS has modified its programs to meet the demands for information while keeping its mission of basic research intact. But always foremost is the Constitutional mission to gather and dispense scientific information that will lead Oklahoma to the wise use and conservation of its natural resources. Uppermost in the mind of all OGS directors has been this charge to provide accurate and impartial scientific findings to the public.

Meetings Workshops

The OGS staff routinely attends various national, state and professional meetings during the year as guests, speakers and panelists. The Survey also conducts technical workshops that have an extensive following, and in this time period were held for capacity crowds at each session, with long waiting lists of potential attendees. The workshops are a major activity at the Survey, and have a loyal following in industry and academia.

Among the scheduled events last fiscal year were:

Oklahoma Aggregates Association Annual Meeting and Field Trip, January 24-25, Oklahoma City.

Water Day at the Capitol, Feb. 13

2012 Society for Mining, Metallurgy & Exploration Annual Meeting & Exhibit (SME), Feb. 19-22

Science in Action, Feb. 26

Oklahoma Aggregates Association "Aggregates Day at the Capitol", Feb. 28

Held by the OGS and Oklahoma City Geological Society: Oklahoma -- A Structural and Stratigraphic Oil & Gas Workshop, March 7

GIS Day at the State Capitol, March 14

AAPG/SEG Spring Student Expo, March 15-16

American Association of Petroleum Geologists Annual Meeting, April 22-25

ScienceFest Oklahoma, April 19

Seismological Society of America Annual Mtg., April 13-15

OGS Mid-Continent Mississippian Play Workshop, May 18

Held by the OGS and Oklahoma City Geological Society: 2012 Real Deal Mid-Continent Prospect Expo, Sept. 20

American Institute of Professional Geologists (AIPG) Annual Meeting, Sept. 22-25

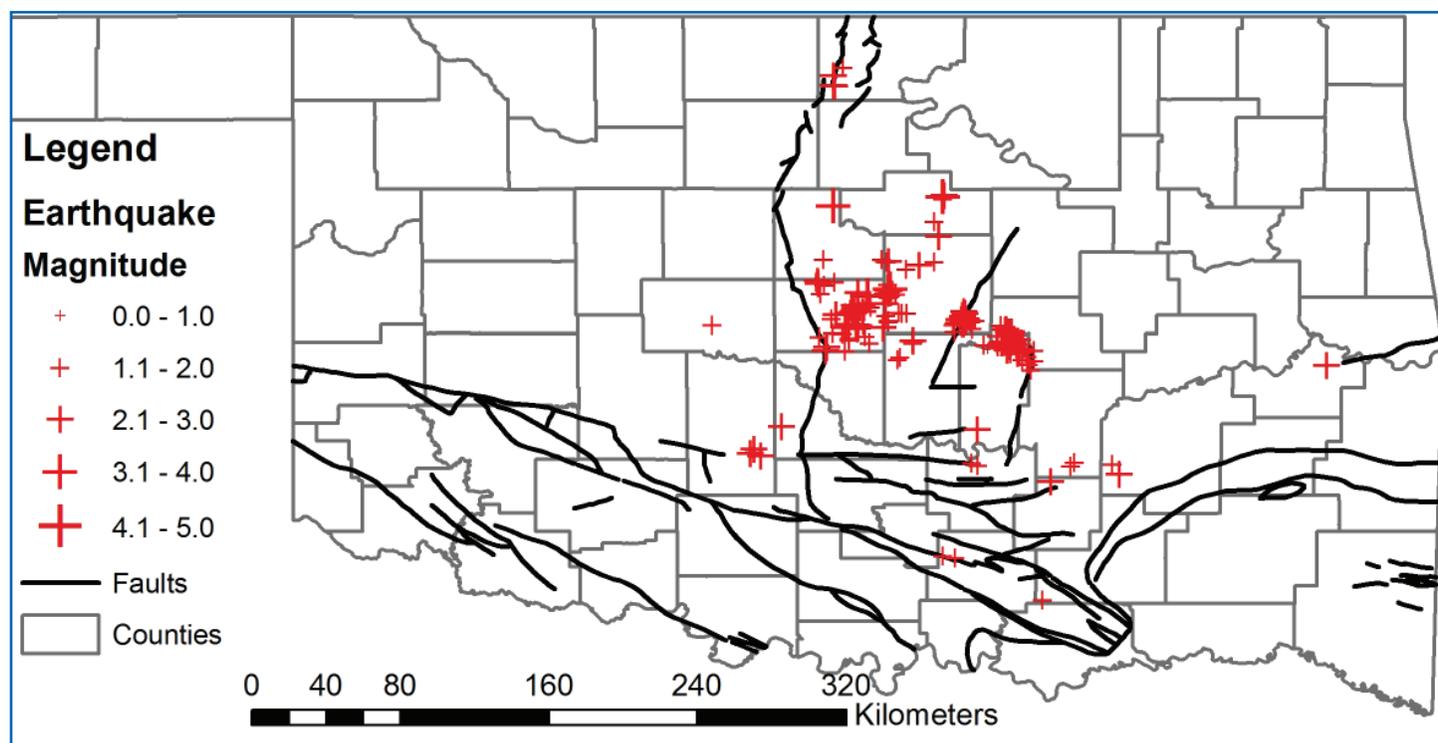
OGS Mississippian Play Workshop, Oct. 31

11th Annual Osage Minerals Council Oil & Gas Summit & Lease Sale, Nov. 7-8

Governor's Water Conference 2012, Nov. 13-14

American Geophysical Union (AGU), Dec. 3-7

2012 4th Quarter Earthquakes



Earthquake Report 4th Quarter 2012

Austin Holland, OGS Research Seismologist; Amie Gibson, OGS Research Scientist II

The Oklahoma Geological Survey (OGS) located **203** earthquakes within Oklahoma from October 1 to December 31, 2012. There were 19 felt earthquakes in the fourth quarter of 2012 shown in **Table 1**. **69** earthquakes occurred in Lincoln County with the majority of those associated with aftershocks of the Nov. 2011 **M5.6 Prague Earthquake sequence**. **48** earthquakes were located in Oklahoma County with most of those consistent with the ongoing Jones earthquake swarm. Other counties that had significant numbers of earthquakes include Seminole (**24**) and Okfuskee (**27**) counties. The activity that has been occurring in this sequence is part of a continuing earthquake swarm in the area east-southeast of the Prague earthquake sequence located south of Paden. All earthquakes located in Oklahoma for the fourth quarter of 2012 can be seen in **Figure 1**. Current seismic activity continues to be concentrated within central Oklahoma. The largest earthquakes to occur during this quarter were a

magnitude 3.4 on October 21st located in Oklahoma county, and a magnitude 3.3 on October 9th located in Logan county. There was also a magnitude 3.3 earthquake on October 28 in Seminole county, which is part of the ongoing activity south of Paden.

Download 2012 4th quarter earthquake file and complete list of felt earthquakes (CSV):

<http://www.okgeosurvey1.gov/media/quarterlies/2012qt4.csv>

http://www.okgeosurvey1.gov/media/quarterlies/2012qt4_felt.csv

Table 1 - Felt earthquakes for October 1 to December 31, 2012

(MMI is the maximum reported Modified Mercalli Intensity)

Origin Time (UTC)	Longitude	Latitude	Depth (km)	Magnitude	Type	MMI	County
10/8/12 17:11	-96.801	35.472	5.0	2	ML	III	LINCOLN
10/9/12 8:49	-97.386	36.083	8.9	3.3	ML	III	LOGAN
10/10/12 12:41	-97.375	35.553	5.6	2.9	ML	III	OKLAHOMA
10/17/12 4:42	-97.112	35.679	6.5	3.2	ML	IV	LINCOLN
10/21/12 10:44	-97.221	35.649	4.1	3.4	ML	III	OKLAHOMA
10/28/12 4:00	-96.537	35.422	3.3	3.3	ML	V	SEMINOLE
10/29/12 15:45	-97.271	35.487	0.5	2.2	ML	III	OKLAHOMA
10/30/12 17:55	-97.269	35.495	5.7	2.7	ML	III	OKLAHOMA
11/1/12 0:40	-96.878	35.932	5.0	2.5	ML	III	LINCOLN
11/17/12 4:24	-97.388	36.711	5.0	2.7	ML	III	KAY
11/20/12 18:53	-97.460	35.705	6.3	2.7	ML	IV	OKLAHOMA
11/21/12 7:54	-97.463	35.716	4.8	2.5	ML	III	OKLAHOMA
11/28/12 9:34	-97.432	35.697	5.5	2	ML	II	OKLAHOMA
11/29/12 6:21	-96.800	35.514	5.0	1.8	ML	II	LINCOLN
11/30/12 10:42	-97.454	35.450	4.3	1.8	ML	I	OKLAHOMA
12/3/12 16:26	-97.331	35.492	2.0	2.4	ML	IV	OKLAHOMA
12/8/12 9:05	-96.492	35.386	5.0	2.6	ML	III	SEMINOLE
12/12/12 3:30	-96.759	35.532	5.0	3.1	ML	III	LINCOLN
12/16/12 16:46	-96.855	36.128	5.0	3.1	ML	IV	PAYNE



A Karst by Any Other Name: Abstracts from the 13th Multidisciplinary Conference on Sinkholes and the Engineering and Environmental Impacts of Karst

Retired OGS Associate Director Dr. Kenneth Johnson recently attended the 13th Multidisciplinary Conference on Sinkholes and the Engineering and Environmental Impacts of Karst in Carlsbad, New Mexico. Dr. Johnson gave a lecture on sinkholes resulting from solution mining, or oil-well drilling, in/through salt, and laying out the geologic conditions and potential problems of an abandoned brine-well operation in the south part of Carlsbad. In addition, he also authored /co-authored five published evaporite-karst papers as part of this conference. We have provided abstracts for three of these papers:

GYPSUM KARST AND POTENTIAL RISK IN SITING WIND TURBINES IN BLAINE COUNTY, OKLAHOMA

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Abstract

Gypsum, a highly soluble rock, is readily dissolved to form karst features identical to those associated with limestones and dolomites. Investigations in Blaine County, in north-western Oklahoma, evaluated potential problems that subsidence due to gypsum karst may pose for the proposed Watonga Wind-Power Project, a wind-turbine project just east of Watonga. Catastrophic collapse of a wind turbine is clearly unacceptable, and minor settlement could also be a risk. Differential settlement by even 3 cm across a 15-m-wide turbine foundation could lead to the turbine tilting out of tolerance, requiring remedial repairs.

Gypsum beds of the Permian Blaine Formation underlie all parts of the Project Area, at depths ranging from 10 to 45 m below ground level. The Blaine Formation here is about 29 m thick: it consists of four gypsum beds, each 0.6 to 4 m thick, interbedded mainly with red-brown shales. The Blaine is overlain by the Permian Dog Creek Shale and by unconsolidated Quaternary sands, clays, and gravels that may obscure karst features. Field studies, aerial-photo analysis, and literature review show that there is no evidence of gypsum karst in the Project Area.

Although lacking direct evidence of karst in or near the Project Area, we recognize there is some potential for subsidence due to dissolution of shallow gypsum. Additional mitigation of this risk can be achieved by placing wind

turbines at sites where the gypsum beds are deepest: we believe that where gypsum is 25 m below ground level, or deeper, the risk related to gypsum karst is low. Placing turbines at sites where gypsum beds are less than 25 m deep would pose a medium or high risk. To minimize this risk, a map was prepared showing areas of low, medium, and high risk, related to potential gypsum karst.

SALT KARST AND COLLAPSE STRUCTURES IN THE ANADARKO BASIN OF OKLAHOMA AND TEXAS

Kenneth S. Johnson

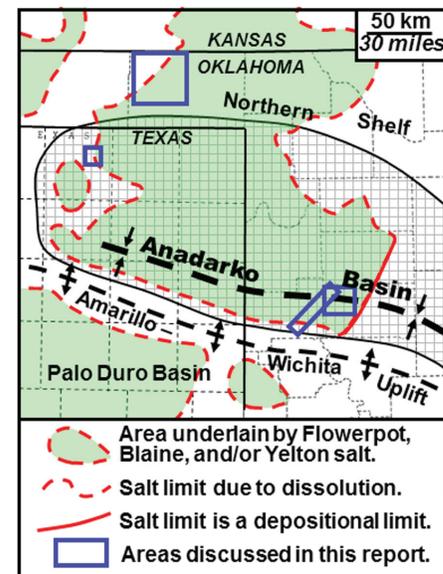
Oklahoma Geological Survey, 1321 Greenbriar Dr., Norman, OK 73072, USA, ksjohnson@ou.edu

Abstract

Permian bedded salt is widespread in the Anadarko Basin of western Oklahoma and the Texas Panhandle, where partial or total dissolution of the shallowest salt in some areas has resulted in subsidence and/or collapse of overlying strata. Groundwater has locally dissolved these salts at depths of 10-250 m. The distribution (presence or absence) of salt-bearing units, typically 80-150 m thick, is confirmed by interpretation of geophysical logs of many petroleum tests and a few scattered cores. Salt dissolution by ground water is referred to as "salt karst."

Chaotic structures, collapse features, breccia pipes, and other evidence of disturbed bedding are present in Permian, Cretaceous, and Tertiary strata that overlie

areas of salt karst. The dip of Permian and post-Permian strata in the region normally is less than one degree, mainly towards the axis of the Anadarko Basin. Where strata locally dip in various directions at angles of 5-25 degrees or more, and underlying salt units show clear evidence of dissolution, these chaotic dips must result (mostly, if not totally) from subsidence and collapse into underlying salt-dissolution cavities. Gypsum karst and



[Figure 1 from this paper.] Map of Anadarko Basin in western Oklahoma and Texas Panhandle, and dissolution limit of areas underlain by the Flowerpot, Blaine, and/or Yelton salts.





resultant collapse of overlying strata have been proposed in many parts of the Anadarko Basin. However, the gypsum beds typically are only 1-6 m thick and more than 100 m deep, and cannot contribute to disruption of outcropping strata—except where they are within 10-20 m of the surface.

Typical areas of disturbed bedding comprise several hectares, or more, with outcrops of moderately dipping strata—as though large blocks of rock have foundered and subsided into large underground cavities. Other examples of disturbed bedding are small-diameter breccia pipes, or chimneys, that extend vertically up from salt-karst cavities, through several hundred meters of overlying strata. The best evidence of these chimneys are collapsed blocks of Cretaceous strata, chaotically dropped some 50 m, or more, that are now juxtaposed against various Permian formations on the north flank of the Anadarko Basin. Any study of surface or shallow-subsurface geology in the Anadarko Basin must consider the influence of subsurface salt karst on the structure and distribution of overlying rocks.

EVALUATING KARST RISK AT PROPOSED WINDPOWER PROJECTS

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Abstract

Karst can cause a litany of problems for a windpower project, and it is good practice to evaluate karst risk before proceeding with a proposed project. Windpower projects involve widely-spaced structures with small footprints that can cost \$2 million to \$5 million each. Financial viability can prove difficult, so it is important to find useful, inexpensive procedures for evaluating karst risk. The karst-risk-review process we have used can be split into the two categories outlined below.

Desktop studies:

- Search for relevant literature
- Review aerial-photo and map, and analyze lineament
- Search for existing well and boring logs
- Survey local experts—landowners, U.S. Geological Survey, state geological survey, cavers, etc.

Field studies:

- Perform site reconnaissance

- Conduct pit tests if bedrock is shallow
- Drill—A normal geotechnical investigation includes one boring per turbine, while karst investigations may include multiple borings per turbine
- Use a downhole camera—May be useful in evaluating extent of voids and convincing clients of risk.
- Conduct geophysical studies

Effectively communicating with developers is critical. They want to know the location of the problem sites and may ask, If there is a cave, what is the chance that a turbine will fail? The geo-professional needs to do the following effectively:

- Explain the short-term (collapse) and long-term (settlement) risks, and mitigation options
- Explain the uncertainty
- Negotiate liability
- Costs of investigation and mitigation
- Get developers to determine how much to spend while understanding how much incremental-risk reduction they will receive

The discussion of karst risk should be ongoing and investigations may proceed on a step-by-step basis as new information is gathered. It's important to determine whether to investigate all sites underlain by a potentially karstic unit or try to rank the sites based on risk before focusing the investigation on those with potentially higher risk. Per-turbine karst investigation costs can easily reach \$20,000 and more, so investigating each site in a 100-turbine development can be a significant commitment. When possible, start karst evaluation early, manage available cash with a stepwise approach, and communicate.

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.

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





Oklahoma Geological Survey
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OGS Calendar

- July 14-15** **Tulsa Rock & Mineral Society “Treasures of the Earth”
Rock & Mineral Show**
Exchange Center 1 – Expo Square
Tulsa, Oklahoma
Website: <http://www.ttownrockhound.org>

- June TBA** **2013 Energy Advocates Mid-Year Meeting**
Tulsa, Oklahoma
Website: <http://www.energyadvocates.org>

- August 14-16** **Summer North American Prospect Expo (NAPE)**
George R. Brown Convention Center
Houston, Texas
Website: <http://www.napeexpo.com>

- August 16-17** **Tahlequah 2013 Rock & Mineral Show & Sale**
Tahlequah Community Building
Tahlequah, Oklahoma
Contact: 918/284-5770

- Sept 4** **The Society for Organic Petrology (TSOP)**
Sosnowiec, Poland
Website: <http://www.tsop.org>

