

Oklahoma Geology Notes

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

Volume 72, No. 3 • 2012

HEAT PRODUCTION IN OKLAHOMA: OLD AND NEW DATA

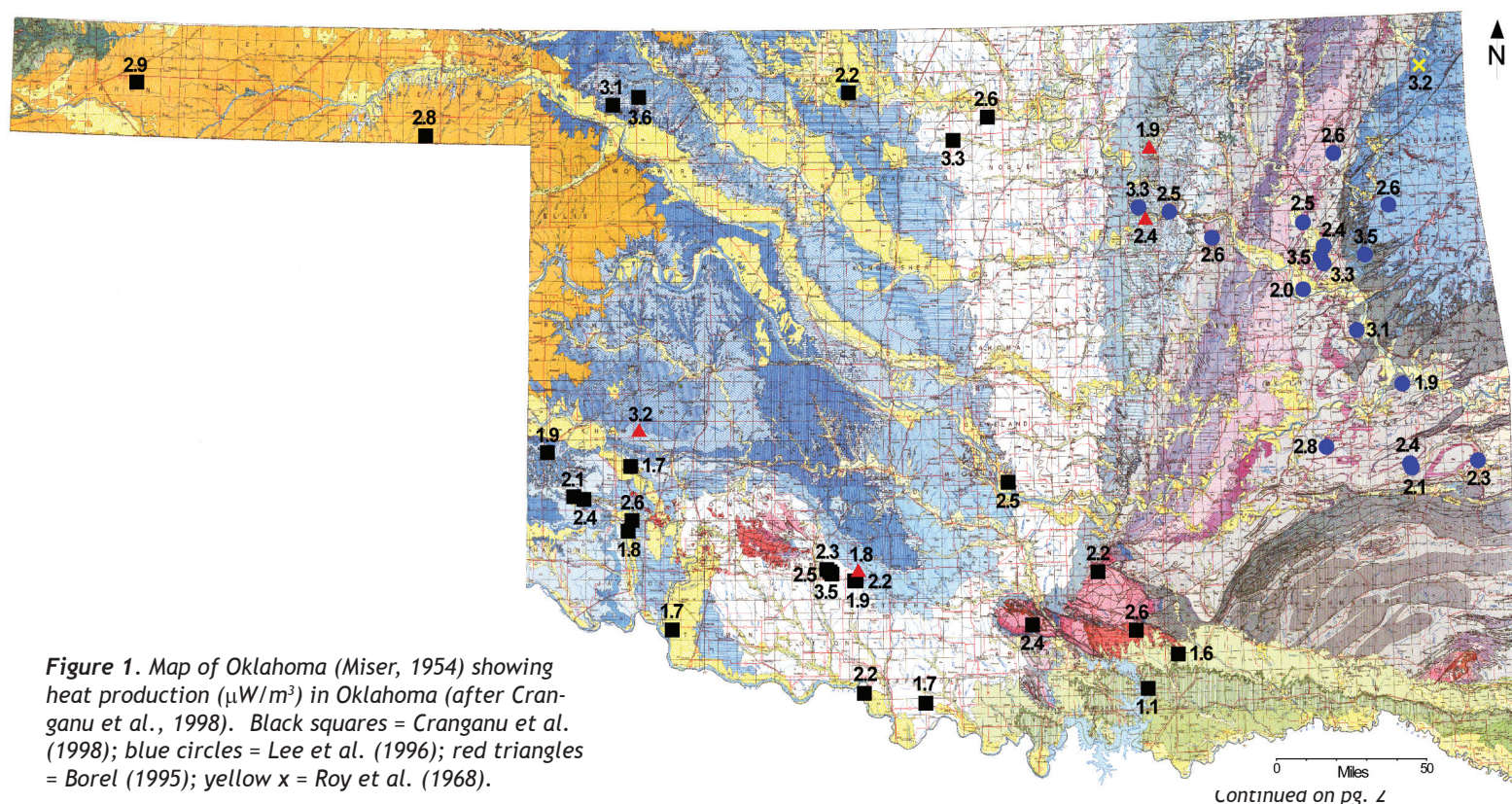
Julie M. Chang, OGS Geologist

INTRODUCTION

The Oklahoma Geological Survey obtained grant funding from the U.S. Department of Energy to compile and digitize geothermal data for the state of Oklahoma as well as to obtain a limited amount of new data. This funding is part of the **State Geothermal Data project** (<http://www.stategeothermaldata.org>), which is organized by the Association of American State Geologists and whose goal is to “bring data from all 50 states into the **National Geothermal Data System**.” In Oklahoma, one aspect of this geothermal project involves compiling old and obtaining new heat production data. Previous geothermal investigations in Oklahoma include Carter et al. (1998), Lee et al. (1994), Luza et al. (1984), and Harrison et al. (1983).

WHAT IS HEAT PRODUCTION?

Heat production in the earth is a measure of how much heat is released by the radioactive decay of elements such as uranium (U), thorium (Th), and potassium (K). In igneous rocks, heat production generally decreases from felsic to ultramafic rocks (Wollenberg and Smith, 1987). For example, heat production for felsic, intermediate, mafic, and ultramafic igneous rocks is ~4 micro-watts per cubic meter ($\mu\text{W}/\text{m}^3$); ~2 $\mu\text{W}/\text{m}^3$; ~1 $\mu\text{W}/\text{m}^3$; and 0.3 $\mu\text{W}/\text{m}^3$, respectively. Peralkaline (low aluminum; high sodium and potassium) intrusive igneous rocks may have heat production values up to 12-20 $\mu\text{W}/\text{m}^3$. Siliciclastic sedimentary rocks commonly have higher heat production values (2-4 $\mu\text{W}/\text{m}^3$) than do chemical sedimentary rocks (0.4-2 $\mu\text{W}/\text{m}^3$). Of the siliciclastic sedi-





HEAT PRODUCTION IN OKLAHOMA..., *continued*

mentary rocks, shales generally have the highest heat production because they have high clay and thus high K contents.

Knowledge of heat production in igneous rocks is important because they make up large volumes of the crust. However, large volumes of sedimentary rocks occurring in deep sedimentary basins (e.g., Anadarko and Arkoma Basins in Oklahoma) can also be a factor in evaluating overall heat production.

WHY DO WE MEASURE HEAT PRODUCTION?

Knowledge of heat production is important in order to evaluate the state's potential for economic sources of geothermal energy using new technologies called

enhanced geothermal systems that are currently being developed. Such technologies attempt to harness heat by methods such as circulating cold water into hot dry rock (HDR), rather than rely on traditional sources of geothermal energy such as hot springs.

OLD HEAT PRODUCTION DATA IN OKLAHOMA

Heat production measurements have been obtained and estimates made for Oklahoma by Roy et al. (1968), Borel (1995), Lee et al. (1996), and Cranganu (1997). Roy et al. (1968) report a single measurement from Spavinaw Granite in northeastern Oklahoma, calculated using U, Th, and K contents. Borel (1995) reports four measurements from granite and rhyolite core. Lee et al. (1996) and Cranganu (1997) report 17 and 27 heat production



From the Director...

G. Randy Keller, Oklahoma State Geologist

The 104th annual meeting of **Association of American State Geologists (AASG)** took place just outside of Austin, Texas in June. The theme for the meeting was "*Forging New Partnerships*". A big surprise at the meeting of the was that **Dr. Charles Mankin**, who served as for

40 years as the state geologist of Oklahoma, was **recognized 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. Those at the meeting who were very aware of Dr. Mankin's efforts in the late 1980's and 1990's expressed the opinion that no one did more toward the establishment of this program than Dr. Mankin.

The OGS receives almost \$200,000 to support the important but manpower-intensive job of geologic mapping of the state. Presently Tom Stanley, Julie Chang, and Russell Standridge work on this project, which is our biggest annual research grant.

The 20th anniversary of this landmark act was a major focus the annual AASG meeting. The concrete step taken to honor Dr. Mankin was that the best proposal submitted to this program each year will earn the **Charles Mankin Award**.



Betty and Charles Mankin

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OKLAHOMA GEOLOGY NOTES, ISSN 0030-1736, is published quarterly by the Oklahoma Geological Survey, 100 E. Boyd, Room N-131, Norman, OK 73019.

Director: G. Randy Keller; Editor: Sue Britton Crites
This publication, printed by Oklahoma Geological Survey Printing, Norman, Oklahoma, is issued by the Oklahoma Geological Survey as authorized by Title 70, Oklahoma Statutes 1981, Section 3310, and Title 74, Oklahoma Statutes 1981, Sections 231-238. 3,600 copies have been prepared for distribution at a cost of \$1,445 to the taxpayers of the State of Oklahoma. Copies have been deposited with the Publications Clearinghouse of the Oklahoma Department of Libraries.





estimates, respectively, calculated using gamma-ray data. Thus, 49 heat production measurements and estimates have been reported for the state of Oklahoma. These values span a wide geographic and petrographic range (Figure 1). The 49 values give an average heat production for basement rocks in Oklahoma of $2.48 \mu\text{W}/\text{m}^3$ (Cranganu et al., 1998).

NEW HEAT PRODUCTION DATA IN OKLAHOMA

Six samples were sent to Paul Morgan at the Colorado Geological Survey to obtain heat production measurements. Dr. Morgan's laboratory utilizes a fully shielded passive-gamma system to measure U, Th, and K using a doped 6-inch-diameter by 4-inch-thick sodium iodide (NaI) crystal, optically coupled to a photomultiplier tube with a 1024 pulse-height analyzer. The system is calibrated with U, Th, and K standards, diluted in olivine sand, at similar concentrations to the range typically found in rocks (non-ore bodies). Plexiglass sample containers, six inches in diameter by one inch thick, hold about two pounds of sample, crushed to 0.079-0.118 inch fragments (Paul Morgan, personal communication, 2012).

Samples include (1) Troy Granite, collected from the Martin-Marietta quarry at Mill Creek in the eastern Arbuckle Mountains ($1,368 \pm 3$ Ma; Rohs, 2001); (2) basalt dike, collected from the Martin-Marietta quarry at Mill Creek in the eastern Arbuckle Mountains (likely Cambrian or Precambrian); (3) Colbert Rhyolite, collected at the Hanson-Davis quarry in the western Arbuckle Mountains (536 ± 5 Ma; 539 ± 5 Ma; Thomas et al., 2000); (4) basalt dike, collected from the Hanson-Davis quarry in the western Arbuckle Mountains (likely Cambrian); (5) Wichita Granite from the Wichita Mountains (530 ± 1 Ma; 533 ± 1 Ma; Wright et al., 1996); and (6) gabbro from the Glen Mountains Layered Complex in the Wichita Mountains (528 ± 29 Ma; Lambert et al., 1988).

New estimates of heat production will be done in two additional ways:

(1) Compile geochemistry for all Precambrian and Cambrian igneous and metamorphic rocks; for those samples that have U, Th, and K measurements, use equation from Turcotte and Schubert (2002, pp. 136-137) to estimate heat production.

(2) Use gamma-ray data obtained from the core scanner at OPIC (Oklahoma Geological Survey's Oklahoma Petroleum Information Center) to estimate heat production in the same manner as Lee et al. (1996) and Cranganu (1997), by using an equation reported by Bucker and Rybach (1996).

CONCLUSIONS

The new heat production values obtained by laboratory measurement can be compared to values estimated using gamma-ray data to assess the accuracy and validity of the Bucker and Rybach (1996) equation.

The new data will provide good heat production coverage of Oklahoma and will enhance our knowledge of Oklahoma's geothermal resource potential. These data will be submitted to the State Geothermal Data project.

ACKNOWLEDGEMENTS

Thanks to Neil Suneson for reviewing the article and providing useful feedback and to Russell Standridge for aid in drafting the figure.

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Continued on pg. 4





OGS Data Library Introduces Digital Imaging and Other Changes

Jane Weber and Richard Tarver, OGS Staff

For years the Data Library has offered shelf upon shelf and cabinet after cabinet of oil and gas records, aerial photos, and other archived geologic material for the public to browse and search. It still does. At the same time, these collections keep growing, as Library staff process new donations and continue to rescue and incorporate items uncovered from the mountains of paper documents stored throughout the cavernous rooms of the **Oklahoma Petroleum Information Center (OPIC)** building. **A major change has occurred in how we make data available to the public. We now can provide scanned images of some records if requested to do so (Figure 1).**

The Library received a narrow-bed continuous log scanner, which can be used for either electric logs or mud logs. Acquiring digital images of all our estimated 450,000 electric logs is not among our immediate plans. However, over 75% of our 3339 mud logs have already been scanned. This accomplishment is due in part to several companies who generously provided us with copies of logs they scanned with their equipment. Scanning old mud logs is not a straightforward process. Many logs consist of individual sheets that first have to be spliced to form one continuous log. Furthermore, many of our logs are too wide for our particular scanner to accommodate.

Another collection for which scanned images are becoming more and more important is **aerial photos**.

OGS has the widest aerial photo coverage of any library in the State. We have photos for every county but do not necessarily have complete coverage of each. While several pallets of photos have yet to be examined and identified, the organized set consists of 9" x 9" sheets at 1:40,000 scale. These photos are filed by County, then Township-Range, and finally by year of flight, which ranges from 1934 to 1982. Various federal agencies funded the flights. Nowadays, land use and environmental consultants are primary users of this collection. As with the mud logs, anyone bringing in equipment to make their own scans is requested to give us copies of the images. By leveraging resources of outside entities in this way, OGS can more quickly build its image files. A big boost came from the **Oklahoma Corporation Commission** when it scanned large numbers of our photos for one of their projects and gave us copies of the images.

Data Library staff also have been making progress in paring down the thousands of boxes of donated material stored in the OPIC facility. Changes made in this regard center on how to dispose of items that do not fit into one of our established collections. Our intent is to find a suitable home, where the item will be used. For donations such as text books or professional society journals, we introduced a Free Books Table. It is very popular with the public; books frequently disappear within a day or two. For large quantities of non-Oklahoma data, we arrange to transfer the material to other

HEAT PRODUCTION IN OKLAHOMA..., *continued*

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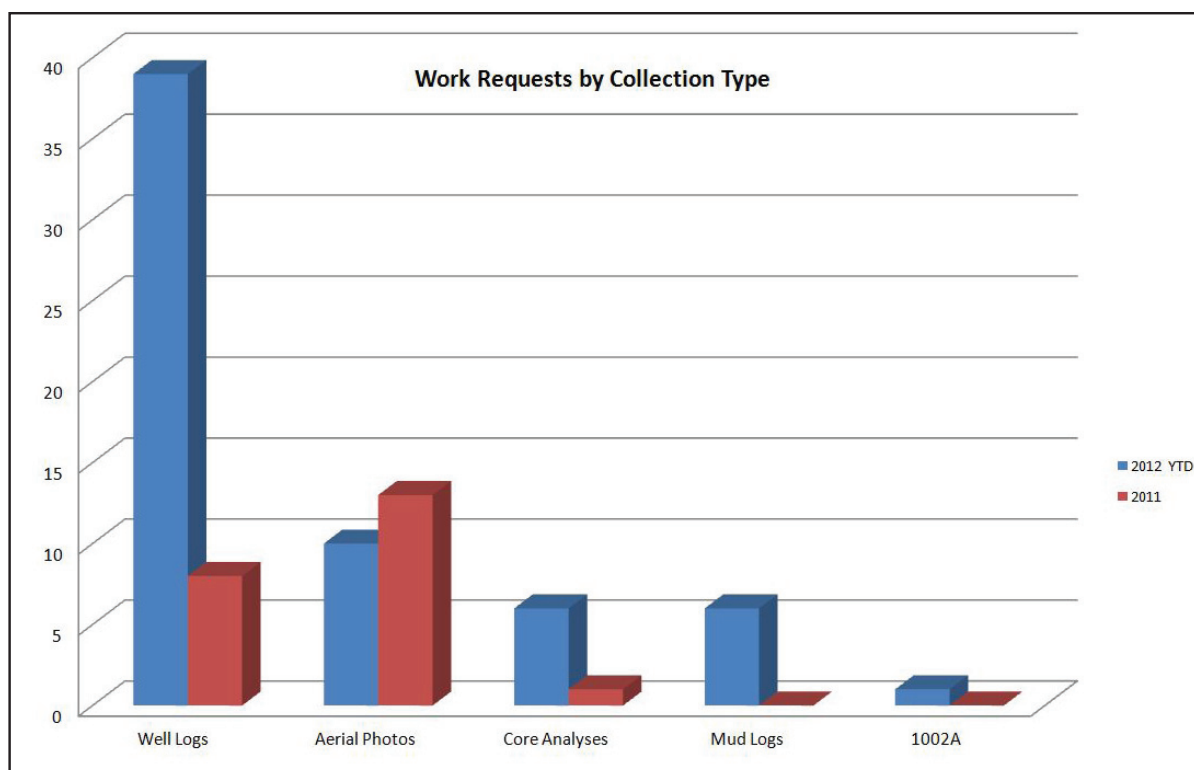


Figure 1. Work requests are tasks such as digitizing or photo-copying data records for patrons that require more than 15 minutes of staff time to complete.

government agencies. For example, the Kansas Geological Survey sent a 26-foot truck to retrieve a load of Kansas oil and gas data records. The Chickasaw Nation picked up 5 pallets of aerial photo mosaics from 12 states to digitize and georeference for their studies of their cultural and historical homelands.

Less noticeable changes concern two of our largest and most-used collections, **1002A Completion Report Forms** and **completion cards (Oil Reports)**. Because the Oklahoma Corporation Commission now scans 1002A Forms and makes the images available free-of-charge on their website, we no longer accept those forms to file. However, as time permits, we will continue to file those we have backlogged. We also have stopped receiving Petroleum Information/IHS Energy completion cards. We have several donated collections of such cards, including older ones issued by Ira Rinehart and D. B. Rhea, to merge with our main collection. **For both the 1002As and completion cards, our intent is to focus on adding older data (i.e., pre-1960) to the data sets. Our experience indicates it is that type of information which is the most difficult to find.**

Finally, **two small reference data sources have been added to the Library: lease maps and field studies.** We have assorted coverage of Herndon maps from 1956-2005 and Mid Continent maps from 1975-1986.

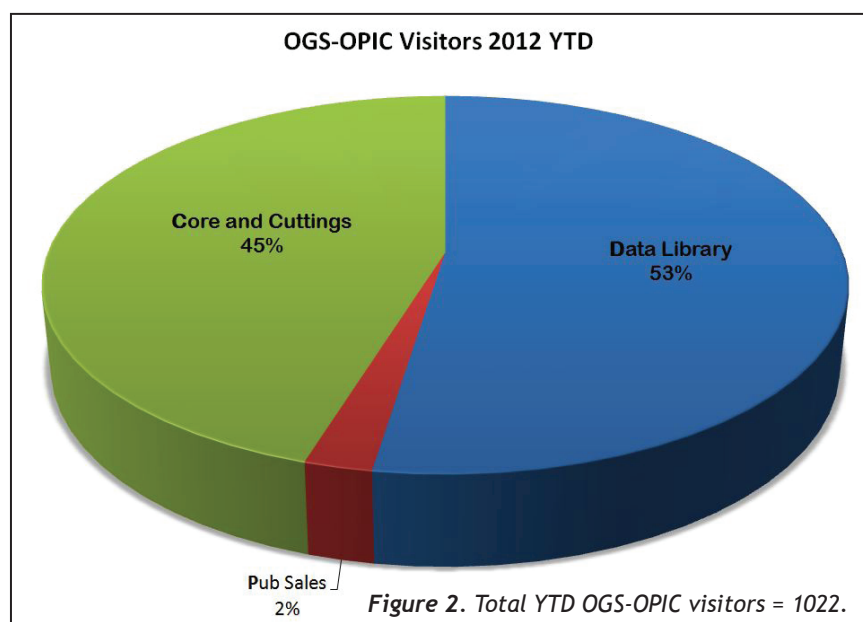


Figure 2. Total YTD OGS-OPIC visitors = 1022.

The 167 field study files may consist of only a structure or isopach map or they may include other information such as history, cross sections, and/or reservoir data.

We invite you to visit us at 2020 Industrial Boulevard in Norman — there's plenty of free parking — to personally search for information you need (**Figure 2**). **For help or questions about our holdings, contact either Richard Tarver at 405-325-1119, rdtarver@ou.edu or Jane Weber at 405-325-5830, jlweber@ou.edu.** You can also check out or download our database listings at <http://ogs.ou.edu>. On the OGS home page, choose the "OPIC Petroleum Info" button and then select Databases.

Come by or give us a call!



Earthquake Report 2nd Quarter 2012

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

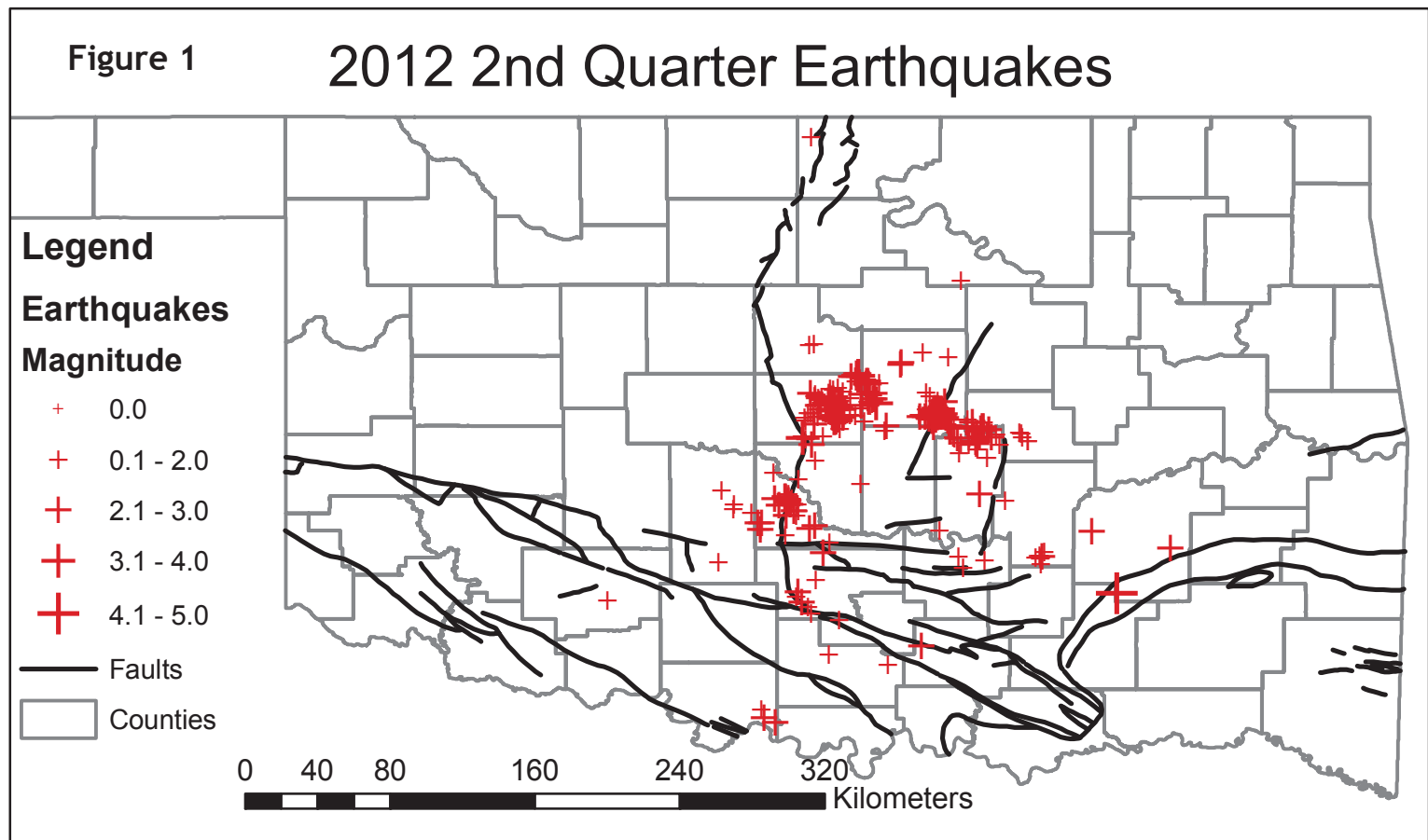
The Oklahoma Geological Survey (OGS) located 309 earthquakes within Oklahoma from April 1 to June 30, 2012. There were 18 felt earthquakes in the second quarter of 2012 shown in **Table 1**. 85 earthquakes occurred in Lincoln County with the majority of those associated with aftershocks of the Nov. 2011 M5.6 Prague Earthquake sequence. 105 earthquakes were located in Oklahoma County with most of those consistent with the ongoing Jones earthquake swarm. There were 26 earthquakes located in McClain County, 21 in Okfuskee County, and 17 earthquakes located in Seminole County. All earthquakes located in Oklahoma for the second quarter of 2012 can be seen in **Figure 1**. Current seismic activity continues to be con-

centrated within central Oklahoma. The largest earthquake to occur during this quarter was on April 3 in Pittsburg County, which had a magnitude of 4.4. Detailed information on this event is available online at, http://wichita.ogs.ou.edu/evreports/20120403_07/index.html. Other significant earthquakes in **Table 1** can be found in the “evreports” online archive.

There were three tours of the Leonard Observatory in the second quarter of 2012. There were a number of presentations at the **Seismological Society of America (SSA)** meeting in April about the recent Oklahoma earthquakes, including one by an OGS undergraduate student employee, Christo-

Table 1 – Felt earthquakes for April 1 through June 30, 2012, MMI is the maximum reported Modified Mercalli Intensity

Origin Time (UTC)	Longitude	Latitude	Depth		Magnitude			County
			km		Type	MMI		
4/3/12 7:34	-95.8748	34.635	5	4.4	ML	V		Pittsburg
4/6/12 16:20	-97.1594	35.7171	5	3.1	ML	III		Oklahoma
4/9/12 3:58	-97.1106	35.6873	5	2.6	ML	IV		Lincoln
4/12/12 12:10	-96.775	35.518	2.3	3.1	mbLg	IV		Lincoln
4/12/12 12:15	-96.7627	35.5179	5	3	ML	II		Lincoln
4/14/12 7:35	-96.001	34.9436	5	3	ML	IV		Pittsburg
4/16/12 8:12	-96.768	35.53	3.5	3.7	MW	V		Lincoln
4/21/12 12:45	-97.0699	35.5796	5	3.2	ML	III		Lincoln
4/28/12 2:14	-96.766	35.536	3.9	3.1	ML	III		Lincoln
4/30/12 17:14	-96.771	35.531	4.6	3.2	ML	IV		Lincoln
5/10/12 21:14	-96.789	35.517	1.7	3.8	MW	IV		Lincoln
5/11/12 4:37	-96.791	35.512	1	3.2	ML	III		Lincoln
5/11/12 7:52	-97.6383	34.9829	5	2.8	ML	III		McClain
5/13/12 19:10	-97.3028	35.5386	3.3	2.9	ML	IV		Oklahoma
6/13/12 6:21	-97.2773	35.5049	5	3.6	ML	III		Oklahoma
6/13/12 6:36	-97.27	35.5092	5	3.3	ML	III		Oklahoma
6/13/12 22:44	-96.702	35.458	4.2	3.1	ML	IV		Pottawatomie
6/14/12 20:24	-97.4343	35.4068	1.9	3.1	ML	III		Oklahoma



pher Toth, bibliography below.

Download 2012 2nd quarter earthquake file and complete list of felt earthquakes (CSV):

http://www.okgeosurvey1.gov/media/quarterlies/2012_qt2.csv

http://www.okgeosurvey1.gov/media/quarterlies/2012_qt2felt.csv

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From the Director...continued

The OGS is creating a nice plaque to which each year's winner's name will be added.

This is a brief history of this act from the U. S. Geological Survey website (<http://ncgmp.usgs.gov/about/history.html>)

The National Cooperative Geologic Mapping Program was created by the National Geologic Mapping Act (NGMA) of 1992. (PL 102-285).

The original goal of the Program was to produce surficial and bedrock geologic map coverage for the entire United States. These maps were to be produced in a reasonable time frame and at a scale that would meet national and regional needs for (1) resource development, (2) environmental protection, and (3) identification and mitigation of natural hazards. After passage of the NGMA of 1992, Congress reauthorized the Act in 1997 and 1999 (Public Laws 105-36 and 106-148). The latest reauthorization (PL 111-11) in 2009 authorizes the program for 10 years. In response to the Act, the following events have occurred:

- The matching-funds program component with State geological surveys (STATEMAP) was fully implemented in FY 1996, although a limited amount of funding was distributed earlier
- The EDMAP matching-funds cooperative with universities was implemented in FY 1996
- The NCGMP Federal Advisory Committee first met in 1996
- The National Geologic Map Database was implemented as a digital database in 1996
- The Digital Geologic Mapping Committee, which represents all of the State geological surveys and works with the NCGMP to establish digital geologic map standards for the National Geologic Map Database, had its first annual Digital Mapping Techniques workshop in 1997
- The first NCGMP five-year strategic plan was released in 2000, and the second five-year plan was released in 2007.

Another big event was **Ken Johnson** being presented the **Distinguished Service Award** for his long record of service to the **American Association of State Geologists (AASG)**. This is a big and well deserved honor.

CITATION FOR AASG DISTINGUISHED SERVICE AWARD FOR KENNETH S. JOHNSON:

G. Randy Keller, State Geologist of Oklahoma:

My own interest in the large structures in southern Oklahoma began when I was a graduate student, and my introduction to Ken Johnson fortunately occurred early in my career. After attending Oklahoma Geological Survey workshops and several GSA meetings of one sort or another in and around Oklahoma, I came to think of him as "Mr. Oklahoma Geology" because he seemed to be able to answer any geological question I had in a friendly and straightforward way. I still ask him questions about geology regularly and receive the same kinds of answers.

Ken spent his entire geologic career with the Oklahoma Geological Survey, but he also played an active role in numerous AASG activities and in a variety of State, National, and International programs.

Ken was born and grew up in New York City (Queens). He attended Haverford College for 2 years, but with no major and no specific goal, he left and returned to NYC. Working at a series of short-term, non-fulfilling jobs in Manhattan for 2 years, he also took a Geology course at Columbia University night school, and to his amazement, he discovered that one could go to college and really enjoy a field of study.

With a goal of studying geology at a university in either Kansas, Oklahoma, or Texas, Ken hitchhiked from NYC, and the last ride he got (in Ohio) was to Oklahoma City. Thus, he ended up at the University of Oklahoma in 1956.

Ken received a BS and MS in Geology, and a BS in Geological Engineering, from OU. While studying at OU, he worked 3 summers for the Shell Oil Company, doing office work in Amarillo, Texas and field-work in the Arkoma Basin in Arkansas and Oklahoma.

He started working for the Oklahoma Geological Survey in 1962 and did mapping of evaporites and redbeds in western Oklahoma. He then went to the University of Illinois (1965-67) for his Ph.D. in Geology. He returned to the OGS in the summer of 1967 and worked there continuously till he retired on the last day of 1999. He also served as a Visiting



Professor, Geology & Geological Engineering and the University of Oklahoma from 1972 to 1999.

Oklahoma Geological Survey:

Ken's work with OGS included the following:

- Served as Associate Director from 1978 to 1999
- Served as the OGS Industrial Minerals Geologist
- Mapped Permian rocks in western Oklahoma
- Conducted research on the Permian geology of the Southwestern U.S.
- Developed a series of guidebooks for field trips in Oklahoma
- Organized 20 major symposia and workshops on geology, resources, and environmental problems in the Southern Midcontinent
- Organized and directed the OGS STATEMAP program
- Served as OGS liaison for various local, State, and Federal agencies
- Published more than 250 books, articles, and abstracts

AASG activities:

He participated in virtually all annual and mid-year meetings of AASG from 1975 to 2000 and helped staff the AASG booth at annual GSA meetings.

From 1990–1999, Ken was active in organizing the Associates of the various State Surveys in support of AASG programs. He served on a number of committees and in programs carried out by the Associates on behalf of AASG, and supported establishing the category of "AASG Associates."

Ken helped Charlie Mankin, former OGS Director, implement and carry out the AASG–USGS STATEMAP program, and he organized and directed the Oklahoma program from its inception until 1995.

When AASG held its annual meeting in Oklahoma in 1989, he was active in planning the meeting and in leading field trips around Oklahoma.

Later, Ken also organized and led several special geologic field trips, primarily for staff members of all the State Geological Surveys. These trips included a geologic field trip to Iceland and three geologic rafting trips on the Colorado River through the Grand Canyon.



Ken and Dorthea Johnson (left and right ends, respectively) shown at the awards reception.

State, National, and International activities:

He is a Registered Professional Geologist in Texas and Arkansas, and a member of AIPG, and he remains active as a consultant.

For 20 years, Ken was active on National and International committees dealing with hazardous-waste disposal, karst hydrology, and karst in evaporite rocks.

For 15 years, he was active in national programs seeking suitable repositories for disposal of high-level and low-level radioactive wastes. This work, carried out for Oak Ridge National Labs, Battelle Memorial Institute, and the USGS, involved characterizing various rock types and various geologic provinces.

Ken chaired Oklahoma's Hazardous-Waste Management Council for 12 years.

For 10 years he served on the Editorial Board of the journal *Environmental Geology*.

Ken was a Member of the Environmental Advisory Board for the Chief Engineer of the US Army Corps of Engineers in Washington, DC, for 4 years.

While working for the OGS, he also taught graduate courses in economic geology and environmental geology at the University of Oklahoma for 5 years, and directed or served on about 25 Ph.D. and M.S. committees at OU and Oklahoma State University.

Ken has been honored as a Senior Fellow of GSA, as an Honorary Member of the Oklahoma City Geological Society, and in 2011 became an Honorary Associate of AASG.

Our sincere congratulations and thanks to Charles Mankin and Ken Johnson on their distinguished service and well-deserved awards!

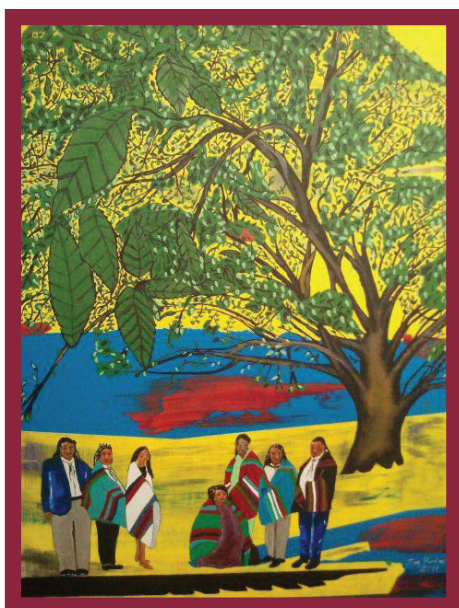
November 7 & 8, 2012

**11th Annual
OSAGE MINERALS COUNCIL**



**OSAGE OIL &
GAS SUMMIT
And LEASE SALE**

“Technology: Our Bridge to the Future”



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

WEDNESDAY, NOVEMBER 7

- 8:00am- Continental Breakfast;
9:00am Exhibitor Hall, Promenade C/D
- 9:00am- Opening Ceremonies
10:00am Promenade A/B
- Osage Drum & Singers, Vann BIGHORSE
American Legion Post #198
Lord's Prayer sung by Talee REDCORN
Lord's Prayer in Sign Language by Osage Princesses
- Welcome and Introductions:
Summit Chairman Joyce WHITEWING
Principal Chief John RED EAGLE
Tulsa Mayor Dewey BARTLETT
Minerals Council Chairman Galen CRUM
Osage Speaker Drew PIERCE
- 10:00am BREAK; Exhibitor Hall, Promenade C/D
- 10:30am- Osage Oil & Gas Lease Sale;
Noon Conducted by the Bureau of Indian Affairs; Promenade A/B
- Noon- Lunch;
1:00pm Tulsa Ballroom
- 1:00pm- 1 Mississippi, 2 Mississippi,
2:00pm 3 Mississippi, Drill! SubSurface Procedures for Drilling in Osage Co.; Bureau of Indian Affairs; Promenade A/B
- 2:00pm- Osage Digital Database; Darin WEST;
2:30pm Osage Nation; Promenade A/B
- 2:30pm BREAK; Exhibitor Hall, Promenade C/D
- 3:00pm- Mississippi Horizontal Well Designs;
5:00pm Key Osage Producers; Promenade A/B
- 5:00pm- Cocktail Hour; Tulsa Ballroom Foyer
6:00pm
- 6:00pm- Banquet; Tulsa Ballroom A
9:00pm

THURSDAY, NOVEMBER 8

- 8:00am- Full Breakfast; Tulsa Ballroom
9:00am
- 9:00am- Northeast Oklahoma Shelf Coalbed
9:30am Methane Activity and Issues, 1994 - 2012; Brian J. CARDOTT; Oklahoma Geological Survey; Promenade A/B



8:00am Hybrid Nature of the Cowley & Reeds
Spring Reservoirs in Northern Oklahoma;
10:00am ; 1a Witchita State University,
2Woolsey Operating Co., LLC;
Promenade A/B

10:00am Exhibitor Hall, Promenade C/D

10:00am Geological Characterization of the
11:00am Mississippian in Osage County;
; Spyglass Energy Group, LLC; *Promenade A/B*

11:00am The Unconventional Black Swan;
; SM Energy Co.;
Promenade A/B

Lunch: Keynote Speaker – ;

1:00pm ; IHS: The Tight Oil Renaissance – Delivering on the Promise; *Tulsa Ballroom*

1:00pm Dewatering & Horizontal Drilling in
the Osage; ; Sullivan Oil & Gas Co.; *Promenade A/B*

8:00am Reservoir Characterization Studies
of the Bartlesville Sandstone:
Insights from Application of New
Ideas; ; University of
Tulsa; *Promenade A/B*

8:00am Exhibitor Hall, Promenade C/D

8:00am Burbank Field: An Example of Using
Vintage Data to Improve the Geologic
Model and Enhance Modern
Success; ;
Oklahoma State University; *Promenade A/B*

8:00am The Arbuckle Group, an Integral
Part of the Mississippian Play or a
Lost Opportunity?; ;
Consultant; *Promenade A/B*

8:00am Federal Standards for Hydraulic
Fracturing & Well Construction on
Indian Lands; ;
Bureau of Land Mgmt; *Promenade A/B*

8:00am Closing of Osage Oil & Gas Summit
and Lease Sale; ;
; *Promenade A/B*

PREREGISTRATION FORM—Please make checks payable to ***“Osage Oil & Gas Summit”***

Please print out form, detach, and return with check to: **Osage Oil & Gas Summit** PO Box 1000000, Tulsa, OK 74110

NAME: (Last) _____ (First) _____ (Initial) _____

AFFILIATION: _____

MAILING ADDRESS: _____ PHONE: _____

CITY: _____ STATE: _____ ZIP: _____ FAX: _____

E-MAIL: _____

Check must accompany this form. Use separate form for each registrant. ☐ credit, check here. ☐ PO credit, check here. ☐

☐ If you have a special disability, medical, or dietary needs, please check here.

____ \$100 Attendee Pre-Registration

____ \$150 Attendee On-Site Registration

____ \$0 Complimentary Student Registration

**Sorry, we are unable to accept credit cards.*

Please check below *all* food functions that you will be attending:

____ Continental Breakfast on Wednesday, November 7

____ Full Breakfast on Thursday, November 8

____ Luncheon on Wednesday, November 7

____ Lunch on Thursday, November 8

____ Banquet on Wednesday, November 7

____ \$300 10'x10' Exhibit/Vendor Booth (you may also show prospects by purchasing a vendor booth)

Name of other complimentary exhibit/vendor booth representative: _____

TOTAL \$_____ Please make checks payable to ***“Osage Oil & Gas Summit”***





Capping a well six miles east of Henryetta, Oklahoma. Courtesy of the Western History Collections, University of Oklahoma.

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