KANSAS GEOLOGICAL SOCIETY

BULLETIN

Volume 86 Number 1 January—February 2011

Established 1925

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ON THE COVER:

During this cold time of the year, it's nice to look at photos from warmer times.

Featured on the front cover is a photo taken by Bob Bayer on his Grand Canyon trip a few years ago. Imagine the waterfall cooling you off on a hot summer day!

CALL FOR PAPERS

The Kansas Geological Society Bulletin, which is published bimonthly both in hard-copy and electronic format, seeks short papers dealing with any aspect of Kansas geology, including petroleum geology, studies of producing oil or gas fields, and outcrop or conceptual studies. Maximum printed length of papers is 5 pages as they appear in the Bulletin, including text, references, figures and/or tables, and figure/table captions. Inquiries regarding manuscripts should be sent to Technical Editor Dr. Sal Mazzullo at salvatore.mazzullo@wichita.edu, whose mailing address is Department of Geology, Wichita State University, Wichita, Kansas 67260. Specific guidelines for manuscript submission appear in each issue of the Bulletin, which can also be accessed on-line at the Kansas Geological Society web site at http://www.kgslibrary.com

SOCIETY Technical Meetings

Spring 2011 Schedule

Jan. 4— M.L. Korphage, "The Giants Beneath Our Feet—Oil & Gas Fields in Urban & Special Land Use Settings"

Jan. 18— Mark Houpe, Weatherford, "Logging Horizontal Tests"

Jan. 25— Robert Von Rhee, "Oil & Gas Property Evaluation"

Feb. 1—Dr. Tony Walton's KU Class

Feb. 15—Phil Knighton, "Talk on Uranium"

Feb. 22— Brian Cardott, "Hartsthorne Coal Rank Applied To Arkoma Basin Coalbed-Methane Activity, Oklahoma, USA"

Mar. 1—Ft. Hays State Students

Mar. 15—Dr. Lynn Watney— "Horizontal Wells in the Hunton Group—Unger Field"

Mar. 22—TBA

Apr. 5—Charles Smith— "unconventional Reservoirs Require Unconventional Solutions—Granite Was & Shale Reservoirs"

Apr. 19—Dr. James Puckette's Class from Oklahoma State

Apr. 26—Dr. Lynn Watney, etal - "Basement Tests in Wellington Field"

May 3—Alan DeGood

May 17—Kevin Evans, "Pre-Mississippian Tectonism on the Southern Margin of the Ozark Dome"

May 24—Larry Richardson's Wichita State Class

Location for Technical Meetings

*All KGS technical presentations are held at 12:30 p.m. at the **Wichita Bar Association**, located at **225 N. Market**, ground floor conference room, unless otherwise noted.*

Note: For those geologists who need 30 points to renew their licenses, there will be a sign-in sheet at each presentation and also a certificate of attendance.

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Kyle Day correctly identified last issue's Trilobite

Peachella iddingsi

Bulletin committee members and PhD's in Paleontology are prohibited from entering.

Friday, January 21, 2011

Kansas Geological Society Annual Banquet

We will be honoring our 50 year members

Robert D. Dougherty
Eldon J. Schierling
Richard M. Strong (deceased)
Bill G. Ree

Are there any others that we are missing? Please let us know if you know of anyone else that should be in this group.

President's Letter

Dear Members,

I would like to thank the membership electing me as president of the Society. I truly believe it is a privilege to serve on the board of this organization. I just hope that I honor all those who elected me and all those who have served before me.

The results of this year's election, has also brought to the board: Mr. Kent Scribner as VP-President-Elect; our new secretary is Mr. Rocky Milford who will replace Ms. Marjorie Noel, she will be the new Treasurer; the directors will include Mr. Ken Dean in his last year, Mr. Rick Saenger our out-going President, and our newest and youngest director at large is Mr. Ryan Dixon.

I believe that 2010 has been a turn-around year for the Society and the industry. The library over the last seven months has continued to have increased sales. Sales for November averaged $1,500 per day, and December sales are over $2,000 per day. Thus, it seems that 2011 sales will continue to improve.

The Robert F. Walters Digital Library had some financial setbacks over the last two years, but had continued growth in sales and the library membership has now grown to 181 members. This past year's program improvements by Mr. Kurt Look and his associates have made everyone extremely pleased with the product.

I hope that all the membership will join me in attending this year's Annual Banquet, January 21st. The new chairman, Mr. Bob Bayer, has been working very hard to make sure that we have an enjoyable evening. This year we will be honoring Mr. Bob Dougherty, Richard Strong (deceased), Bill Ree and Mr. Eldon Schierling has earned 50 year members.

This should be a very interesting and profitable year. As always, Mr. Bob Cowdery will have a great group of speakers, for our continued education and our entertainment.

I am looking forward to a prosperous and fun year for 2011. So continue to buy, buy, buy and …"drill baby drill".

Respectfully submitted,

Douglas V. Davis Jr.

ADVERTISER'S DIRECTORY

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From The Manager

Dear Members,

Another year is getting underway and it looks like a good start for the oil industry with prices staying steady to an upward motion. We certainly had a very busy end to 2010 here in the library. Several large orders have helped us to maintain a healthy net profit for the year.

The Walters Digital Library also had a very good year in 2010. We have fully implemented the new software and we keep gaining new members and those of you who have been long-time members seem to be using it more. This indicates to me that we have finally answered most peoples need for how the digital works. We love to hear your feedback, however, so let us know if you have other ideas that we might be able to address.

We have implemented a new feature for the Digital Library. You can now log in as a guest and see our database. Use "guest" as a username and "guest" as a password. This will take you to the Search Wells page and you can search our database. This will give you an opportunity to see how the Walters Digital Library works and also, help you when ordering paper copies from us.

The KGS new board members for 2011 are featured on page 31. Join me in welcoming them and thanking them for serving your organization. Our first event of the year is the KGS banquet, scheduled for Friday, January 21st. Come out for a fun evening and meet your new board of directors.

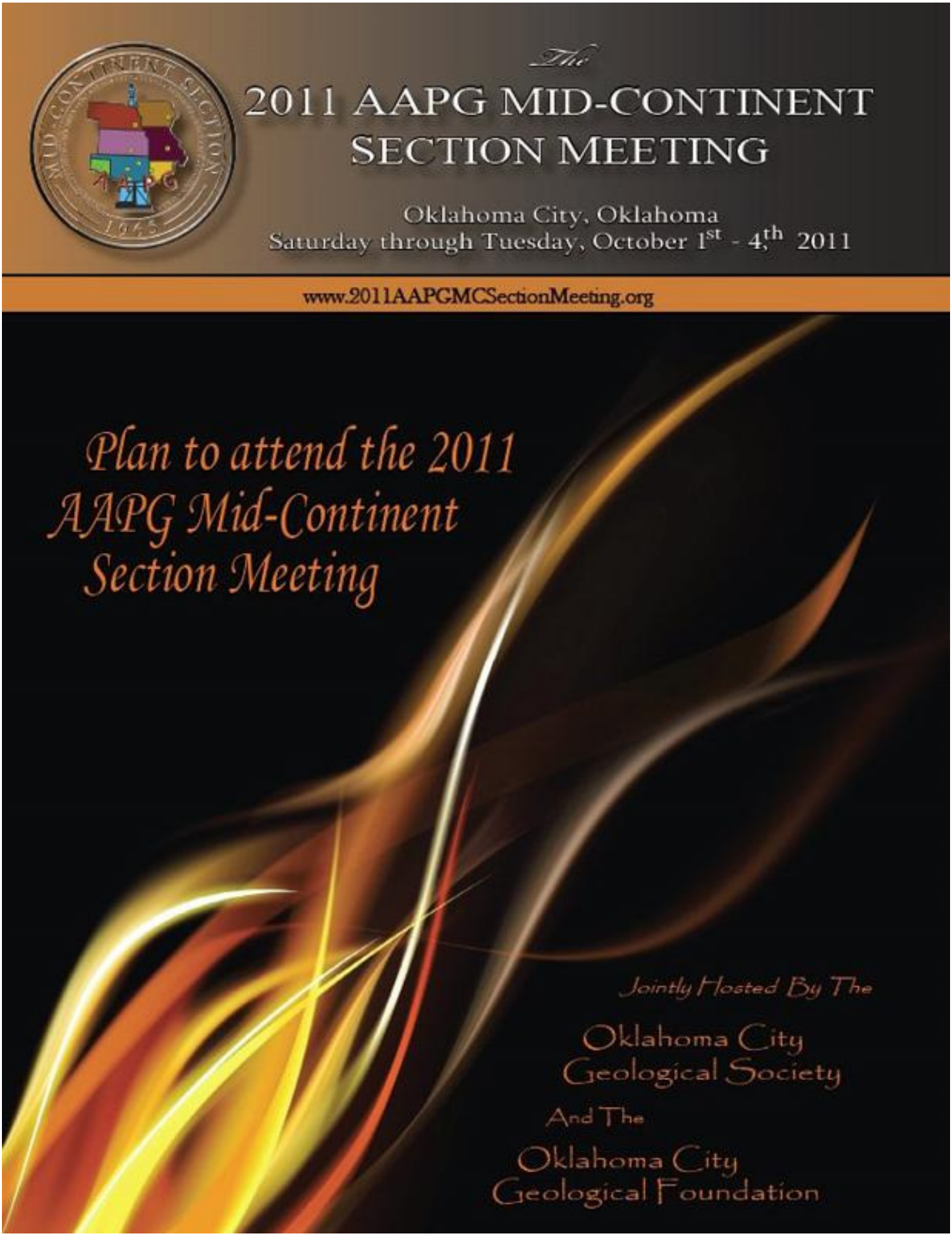
A bit of news from the **Kansas Geological Foundation**; they are helping to sponsor a KPTS NOVA special: ***The Deadliest Earthquake***, which will air on Channel 8 on January 11 at 8:00 PM CST. Also, if you do not belong to the Foundation, please consider joining. Your dues are tax deductible and will support very worthwhile projects that the Foundation continues to fund, such as scholarships for geology students, the integration project (bringing the donated data from the basement up to the library for usage), and supporting educators in Kansas who teach the earth sciences to our younger students.

Happy New Year to all of you far and near. Hope this is a good year for all!

Respectfully submitted,

Rebecca Radford

Manager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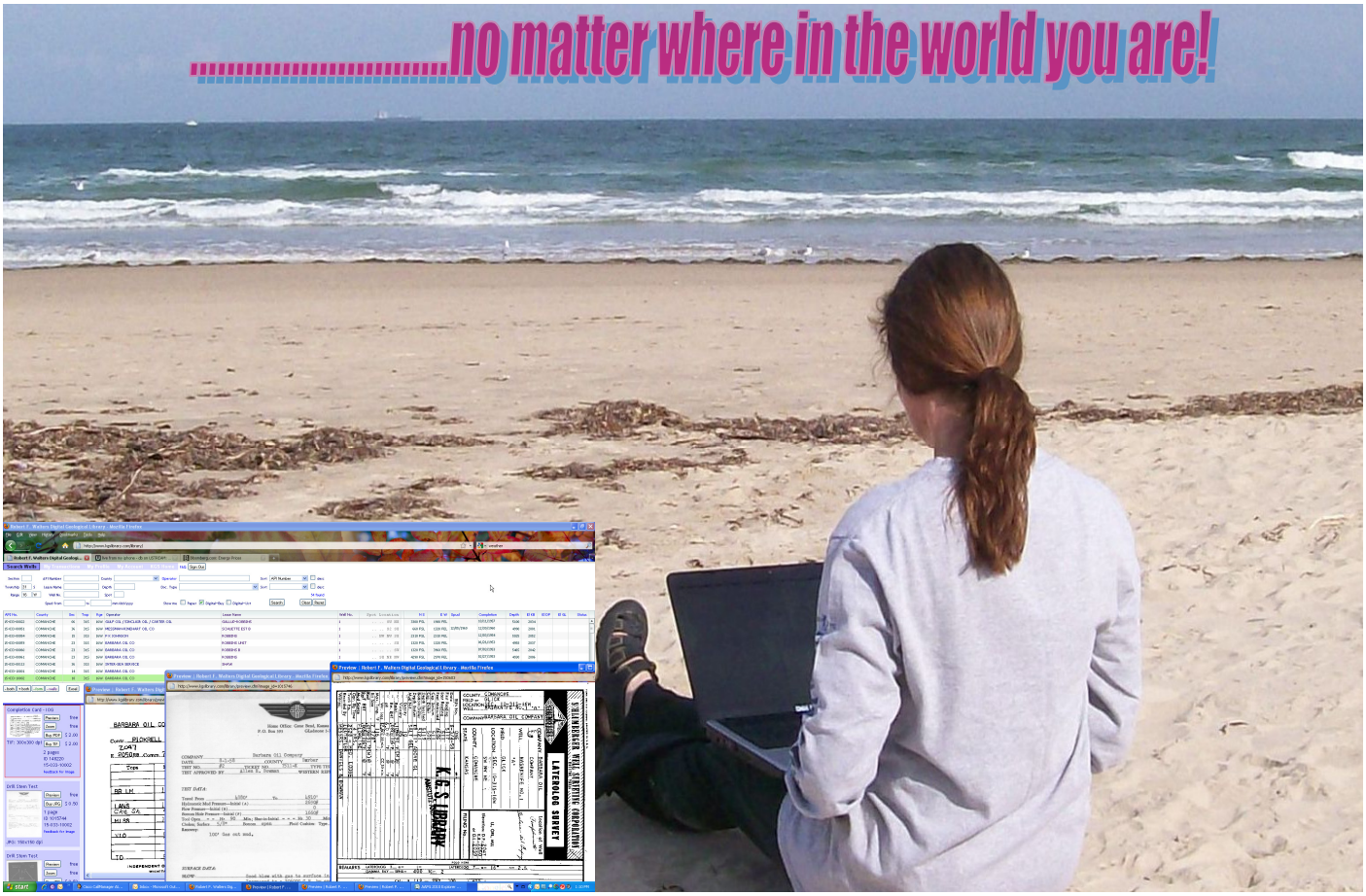

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- **If you do not belong or qualify to belong to the KGS library, you can purchase a yearly membership to the WDL for $2000.00 /yr.**
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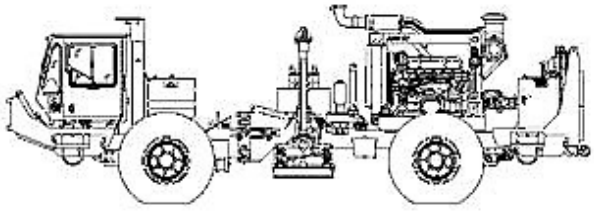

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Memorials — *Harold 'Hal' Brown*

With the passing of Hal Brown on October 26, 2010, the Society lost one of its most prominent and formerly active members

Hal was a native born Kansan and had been active geologist in Wichita from 1976 until his retirement., Hal Brown contributed considerable to the geologic effort and exploration success in this area.

He was born January 10, 1930 in Hays. Kansas where his father was a cable tool driller. Hal's mother was a homemaker although when they lived in Winfield, she was credit manager for Montgomery Ward. Hal was one of four sons. Two brothers still living are: Larry in Wichita and Sam in Almsville, Oregon.

Hal attended grade school, Jr. High School, and High School in Winfield where he graduated in 1948. He commenced college at Kansas State University, majoring in Soil Conservation, but was called into the Air Force in 1949.and was not discharged until 1953 at Forbes Field in Topeka. During his time in the Air Force, he was stationed for a period of time at Mildenhall, United Kingdom, which is near Cambridge. There he met Susan Williams, the mother of his three children: Sylvia Loving of Denton, Texas, Steven who lives in Midwest City, Oklahoma and Dr. Stephanie Forbes of Tulsa. These children survive as well as a brother, Larry D. Brown of Wichita.

After his discharge, Hal returned to Kansas State. There after taking a course in General Geology he realized he enjoyed geology so much that he changed his major to Geology. He also was influenced in part by his father's work in the "oil fields". In the summer of 1955, he worked for the USGS in Grand Junction, Colorado. The USGS was examining trees for radioactivity based on the theory that the tree's roots might extend into Uranium deposits. Hal graduated from K-State in January 1956

Following graduation, Hal went to work for Pan American Production in Abilene, Texas. In 1957, he worked for a period in Wichita. From 1958 until 1961, he worked in Liberal. In 1961, he was transferred to Oklahoma City where he remained until 1967 when the office was closed and he was transferred to Ft. Worth.. In 1970 Hal joined Helmerich and Payne in Tulsa and worked for that company until 1973 when he was employed by Texas Oil and Gas in Oklahoma City. Hal transferred to Wichita in 1976 where he served as District Geologist and later promoted to District Exploration Manager until his retirement from that company in 1985. As an Independent he maintained an office at American Energies until 1996. After his retirement, he engaged in volunteer activities, working as a driver for the Red Cross and also volunteering at the Zoo. He owned several different airplanes and accumulated well over 500 hours in the air.

Hal was a member of the American Association of Geologists, Kansas Geological Society and the Advisory Council to the Geology Department at Kansas State University He enjoyed his family, which includes not only the children, but grandchildren and three great-grandchildren and a rewarding and productive career of a Wichita geologist.

A service for Hal was Held at Good Shepherd Episcopal Church. The family indicated that a contribution to a charity of choice would be a suitable memorial. A memorial was also established with the Kansas Geological Foundation.

Memorial to Lawrence Gray

Lawrence Gray, 91, Petroleum Geologist passed away on November 9th, 2010. Services were held on November 15th at Resthaven Mortuary in Wichita, KS. The family has designated Wichita Audubon Society as a memorial. Lawrence "Larry" Gray was a former member of the Kansas Geological Society and a graduate of Wichita State University.

Memorial to Ed Lorenz

With the passing of Ed Lorenz on November 11th in Dodge City, the Kansas Geological Society lost one of its most interesting and skilled members.

Ed was born in Dayton Ohio on November 6, 1918. He was the son of a Presbyterian minister and his mother was a distinguished student at Vassar. His family included three Bishops and thirteen clergymen of several different denominations. He graduated from St Bernard High School in Ohio. Following graduation, h enrolled in Marysville College in Tennessee and attended there for a short time before enrolling at the University of Virginia where he graduated with a degree in Geology in 1941.

In 1942, Ed married Nancy Martin Johnson and they were married for better than 50 years until her death. To this union was born a daughter, Dorothy now residing in Chesapeake, Virginia and in 1956 Ed and Nancy adopted a son, Martin who currently resides in Windermere, Florida. Three grandchildren are also survivors.

Ed had decided to continue his education so in 1943 he once again enrolled at the University of Virginia and had completed all requirements for a Masters Degree with the exception of writing a thesis when he accepted position as a geologist with the Shell Oil Company. His first position was core-drill party chief and we worked in the state of Alabama. After this period he conducted surface investigations in Florida, Georgia, Mississippi, New Mexico, Louisiana, and Texas. From 1949 until 1956 he worked for Shell in East Central and Easter Kansas. In 1956 he joined the Shell office staff in Wichita as province sub-surface geologist.

He left Shell to join Charles Akers in forming a consulting firm. Later Ed said their timing was terrible because in 1960 the bottom dropped out of the "oil business". Ed was forced find other forms of employment including stock broker, insurance agent and controller for a small business. In 1970, Ed was treated for cancer of the larynx which left him unable to speak above a whisper. After many "ups and downs" he found a number of consulting jobs that kept him busy until 1985.

One very interesting statement from Ed was "As for my outstanding characteristic, I have never left any doubt in anyone's mind as to where I stood on any subject"

A memorial service will be held for Ed at a later date in upstate New York. Memorials may be made to the Dodge City Senior Center or the First Presbyterian Church of Dodge City.

KPTS, Channel 8, will be airing a NOVA series:

Deadliest Earthquake

January 11, 2011, 7:00 PM to 8:00 PM
and on the same night on KPTS Channel 8.2 at 10:00 PM to 11:00 PM.

Sponsored in part by the Kansas Geological Foundation

Kansas Geological Society Board Minutes

November 9, 2010 Mr. Rick Saenger called the meeting to order at 11:39 A.M.

FINANCIAL REPORT/MANAGERS REPORT

A. **Treasurer's Report-** Mr. Clothier presented us with the Treasurer's report for October 2010. The CD that expired in October was transferred to a new account at Kanza Bank with a rate of 1.40% for 14 months. The next CD to expire is at First Choice CU and it expires on 12/8/10. At this time, Mr. Clothier is looking into options, including looking at longer-term maturity rates (2-3 years). *Mr. Davis moved to accept the Treasurer's report as presented. Mr. Watney seconded the motion and the motion passed unanimously.*

B. **Manager's Report-** Mrs. Radford presented the Manager's Report as of October 31, 2010. October was a better month for the paper library than September. Monthly income was $44,724.10 and expenses were $44,938.07, making the paper library end up at $-213.97. When the library net income is combined with the WDL net income of $-2,710.67, the net income for the month came to a loss of $2,924.64. It should be noted that the WDL made its $20,114.50 payment for programming, which caused the WDL to be in the red. The Society has 722 members, the Library has 262 members and WDL has 177 members.

Mrs. Radford also reported that 89,773 new images from the KCC for wells drilled 2005-2007 were added to WDL. Currently 2008 images are being scanned in followed by 2009 and 2010 images.

OLD BUSINESS

A. **Employee Reviews-** Mr. Callen, Mr. Davis and Mrs. Radford met to discuss the employee review process. It was decided that Mrs. Radford is in charge of reviewing the employees and the KGS Board will review Mrs. Radford's performance.

B. **2011 Budget-** The 2011 Budget includes an annual WDL maintenance fee of $45,000 (Kurt suggests $50,000 but is negotiable). This fee includes maintenance and programming. Overall, equipment costs would be the only major concern with the budget as the Library is looking into replacing the scanners in 2011. *Mr. Clothier moved to accept the 2011 proposed budget as adjusted with raises. Mr. Watney seconded the motion and the motion passed unanimously.*

C. **Geophysical Symposium-** Mr. Saenger reported that the Geophysical Symposium was well attended and the Society will profit with about $1200 from this conference.

D. **Future Plans Committee-** Due to scheduling conflicts, no meeting was held.

NEW BUSINESS

A. **AAPG Delegates-** Currently we will have 3 delegates based on the number of AAPG members Kansas currently has.

B. **Foundation-** The Foundation is planning to reproduce Mr. Cowdery's book on all the profiles he has done. The money will go back to the Foundation to give you as scholarships to students. A free book will be provided to the state universities.

C. **Field Studies Book-** A new edition is currently being worked on.

D. **Type Log Committee-** Mr. Watney informed the Board that the committee is currently scanning in logs.

E. **Annual Banquet-** The awards committee has informed the Board that there will not be an honorary member this year.

ADJOURNMENT- *Mrs. Noel moved to adjourn the meeting at 1:29 p.m. Mr. Dean seconded the motion and the motion passed unanimously.*

December 14, 2010 Mr. Rick Saenger called the meeting to order at 11:45 A.M.

FINANCIAL REPORT/MANAGERS REPORT

A. **Treasurer's Report-** Mr. Clothier presented us with the Treasurer's report for November 2010. As of December 8, the CD at First Choice Credit Union had matured. Mr. Clothier is currently looking at options for this CD and may possibly look at the 2 year interest rates. It was recommended that the Money Market Account with Securities America be combined with the Kanza Bank CD which matures June 23, 2011. **Mrs. Noel moved to accept the Treasurer's report as presented. Mr. Davis seconded the motion and the motion passed unanimously.**

B. **Manager's Report-** Mrs. Radford presented the Manager's Report as of November 30, 2010. Monthly income was $46,110.85 and expenses were $39,590.37, making the paper library profit $6,520.48 for the month. When the library net income is combined with the WDL net income of $19,313.43, the net income for the month was $25,833.91. The Society has 727 members, the Library has 277 members and WDL has 181 members. Mrs. Radford noted that the month of December started with an average of $1800/day for the paper library, a very strong showing for the month. The Board approved to open up a guest account for the WDL to see what data was available online in hopes of adding new memberships.

OLD BUSINESS

A. **NO OLD BUSINESS**

NEW BUSINESS

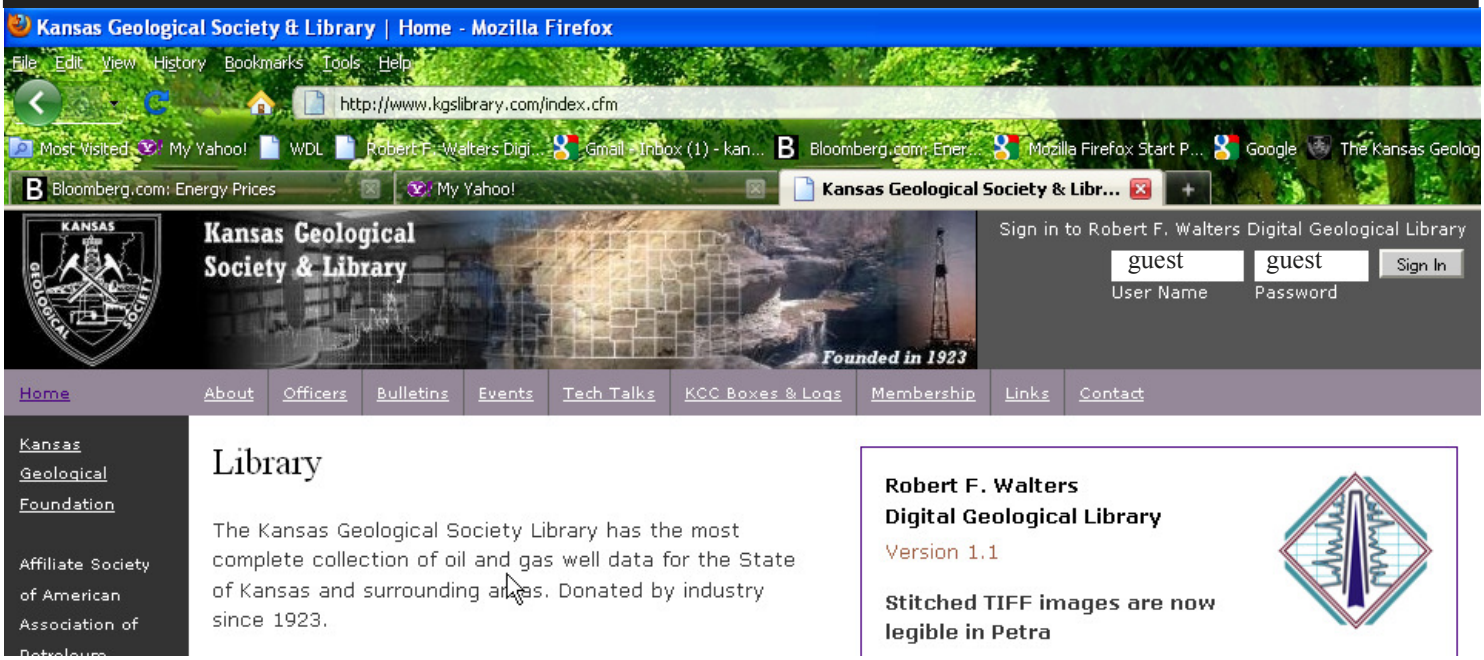
A. **Welcome New Board Members-** The 2010 Board welcomed new members to the 2011 Board. New members include President-Elect Kent Scribner, Secretary Rocky Milford, Director Ryan Dixon and Advisors Don Beauchamp and Alan DeGood.

ADJOURNMENT- *Mr. Davis moved to adjourn the meeting at 1:00 p.m., motion passed unanimously.*

Respectfully submitted,

Marjorie Noel
Secretary

You Can Now Log Into the Walters Digital Library without belonging
Use guest / guest for username & password
This will allow you to see what's in our database
You won't be able to download of course but you can see if we have what you are looking for.
You might find this helpful when placing an order with the KGS Paper Library.
www.kgslibrary.com



FYI
Are you aware??????

We keep a list of all the new data coming from the KCC to our Paper Library in an Excel Spreadsheet.
On the Home Page of www.kgslibrary.com
You will find a link "KCC Boxes & Logs"
If you click on this link, you will be able to download the list of new well data received.
If you do not find it in the file cabinets, please ask staff and they will assist you in locating the new data in our boxes.
Some of this data has not been entered yet, and we must keep track of it so ……

PLEASE — ALWAYS ASK STAFF TO HELP YOU.

Petrographic Comparison and Contrast of Fluvial and Deltaic Sandstones, Upper-Pennsylvanian Oread Cyclothem, NE Oklahoma

Jonathan Obrist Farner
Department of Geology, Wichita State University, Wichita, Kansas

Wan Yang
Department of Geological Sciences & Engineering, Missouri University of Science and Technology, Rolla, Missouri

Introduction

Upper Pennsylvanian sandstones have been the target in petroleum exploration and production in Kansas and Oklahoma. However, the petrographic characteristics of these sandstones have been rarely reported. A good understanding of the characteristics and depositional environments of those sandstones will help explore the correlative subsurface petroleum reservoirs efficiently.

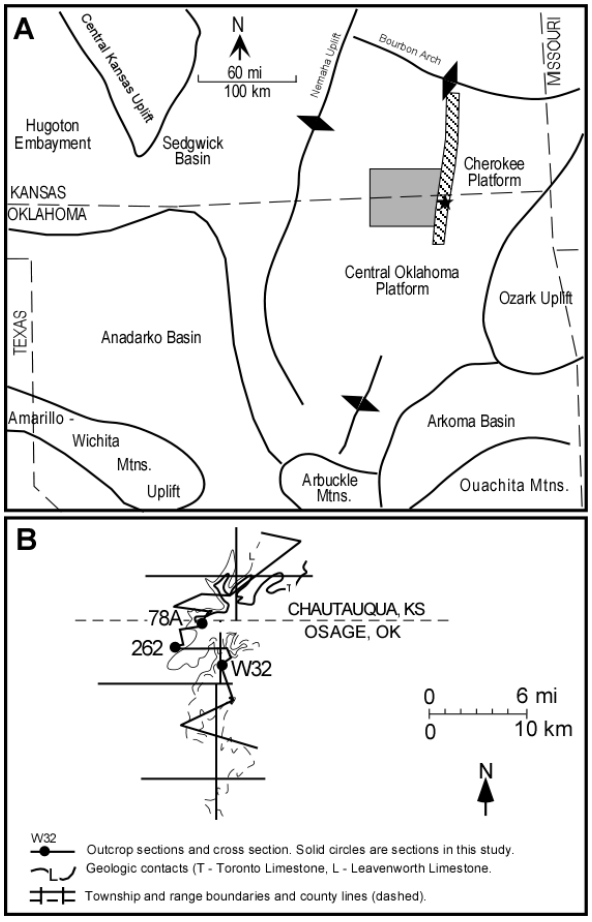
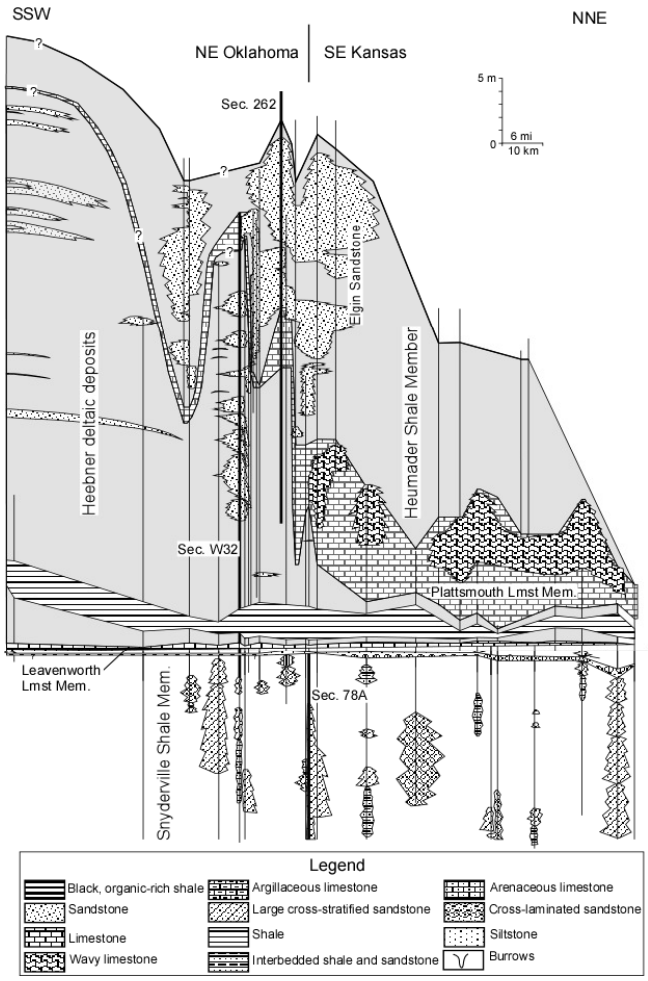


Figure 1. A) Regional tectonic elements in the vicinity of the study area in Kansas and Oklahoma. The hachured and gray areas are the outcrop and subsurface Oread cyclothem, respectively, studied by Bruemmer (2003) and Yang et al. (2003a, b). Star is the approximate location of this study. B) The location of three outcrop sections where sandstones of this study are sampled and the location of outcrop stratigraphic sections in C). C) Outcrop stratigraphic cross-section in the vicinity of the transition zone between the shelf and fluvial-deltaic provinces. The three outcrop sections in this study are labeled. Simplified from Yang et al. (2003a).



Geological Background

Sandstones are common in upper Paleozoic cyclothems in the midcontinent U.S. The cyclothems formed by cyclic sedimentation on epi-cratonic shelves during repetitive shoreline transgression and regression caused by large sea-level changes (Wanless and Shepard, 1936; Heckel, 1994; Yang, 2007). Sandstones in the Upper Pennsylvanian (Virgilian) Oread cyclothem of the Shawnee Group in Osage County, northeastern Oklahoma, are the focus of this study (Figs. 1 and 2). The cyclothem was deposited during a renewed episode of Ouachita thrusting at the beginning of the Oread time (Heckel, 1994). The tectonic event had probably accelerated the subsidence of the Arkoma Basin and Central Oklahoma Platform and promoted siliciclastic sediment production in the Ouachita source area (Yang et al., 2003a, b). Regional outcrop and

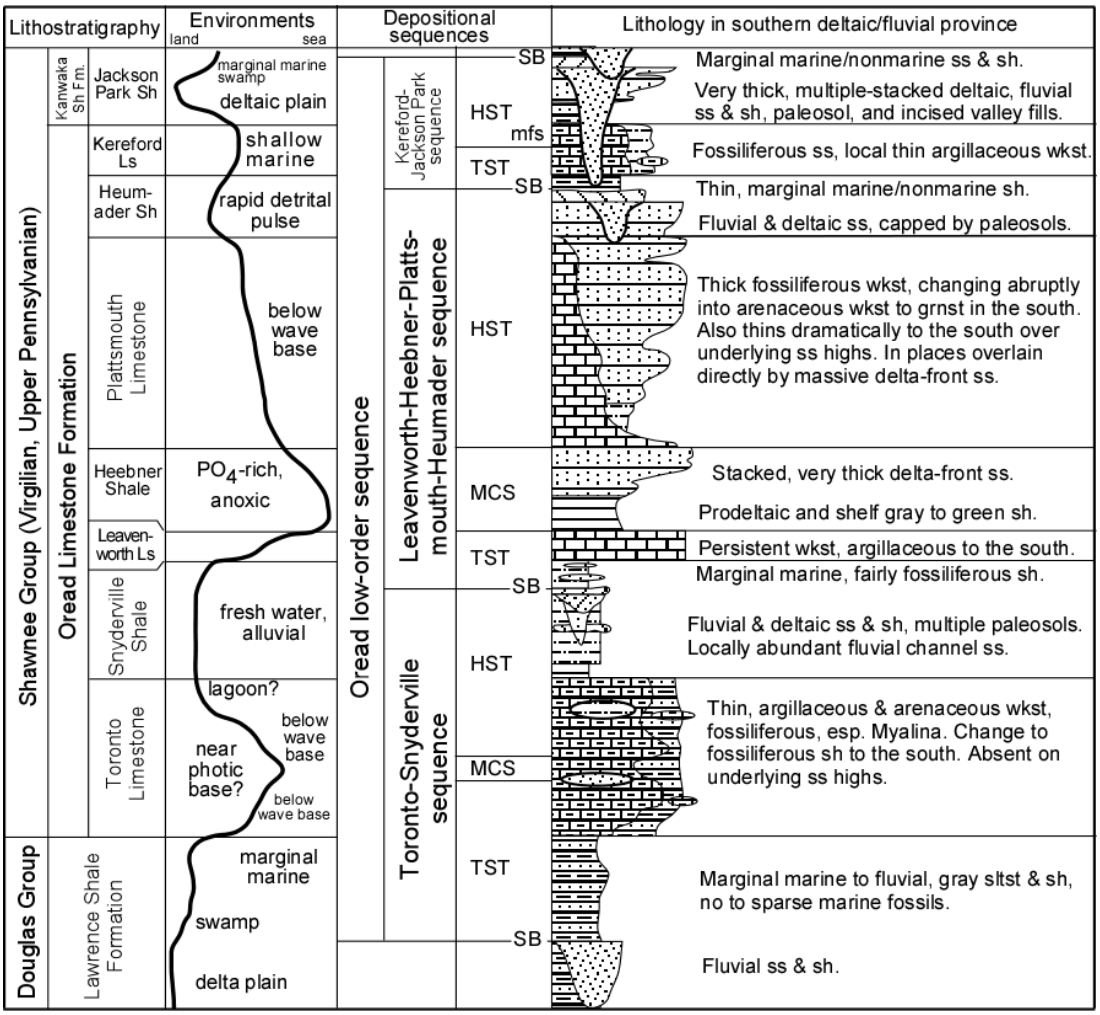


Figure 2. Stratigraphy of the Oread cyclothem in the northern shelf and southern deltaic-fluvial provinces, NE Oklahoma. Elgin Sandstone is an informal outcrop and subsurface stratigraphic name, referring to the sandstone-rich intervals approximately correlative to the Heumader Shale Member in NE Oklahoma and SE Kansas. No vertical scale intended. Shelf stratigraphy is modified from Heckel (1979, 1994) and Yang et al. (2003a) with reference to Moore et al. (1951); deltaic-fluvial stratigraphy is after Yang et al. (2003a, b) and Yang (2007).

subsurface correlation in SE Kansas and NE Oklahoma (Bruemmer, 2003; Yang et al., 2003a; Yang, 2007) indicates that the Oread cyclothem was deposited in two depositional provinces: the northern shelf province composed dominantly of marine and marginal marine shale and limestone and the southern deltaic province of deltaic and fluvial siliciclastics. The two provinces are separated by a narrow transition zone ~2 km wide (Fig. 1C).

Petrography of six sandstones is the focus of this study. The sandstones are from three measured sections at the southern edge of the transition zone (Fig. 1B, C). Two sandstones are from the point-bar sheets in the upper Snyderville Shale regressive interval at Section 78A (Figs. 1C, 2, and 3). Multiple fining-upward point-bar sandstone successions fill a channel form cutting into underlying floodplain calcareous paleosols, forming the Snyderville meandering stream system (Yang, 2007). Two sandstones are from the delta-front deposits in the maximum-transgressive Heebner Shale interval, that is, the Heebner delta, at Section W32, which changes to anoxic phosphatic shale in the shelf province to the north (Figs. 1C, 2, and 4). The delta consists of nine upward-coarsening shale-sandstone successions, indicating a northward progradation (Yang et al., 2003a, b). The last two sandstones are from the delta-front deposits of the Elgin Sandstone within the regressive Heumader Shale interval at Section 262 (Figs. 1C, 2, and 5). The Elgin deltaic system consists of three coarsening-upward shale-sandstone successions which are laterally persistent for several kilometers in the study area. This study compares and contrasts the petrographic characteristics of the six fluvial and deltaic sandstones at different stratigraphic positions of a single depositional system and from different transgressive and regressive intervals within the Oread cyclothem, in the context of previously interpreted depositional environments and cyclostratigraphy of Yang et al. (2003a, b).

Methodology

Petrographic study was carried out through thin-section microscopy. 50 points were counted along a line at equal increments in each thin section to document the composition, size, roundness, grain contact, and surface texture of framework grains, porosity, type of cements, and type and amount of matrix. Next, the size distribution in percentage of abundance was established from the raw point-count data for each sample. The distribution was then used to construct a cumulative curve of abundance for the sample. Last, the graphical mean grain size, degree of sorting, and skewness of framework grains were calculated using the cumulative curve according to Folk's (1957) formulae. The histograms of grain mineralogy and roundness were also constructed. These statistical data, combined with other textural features of frame

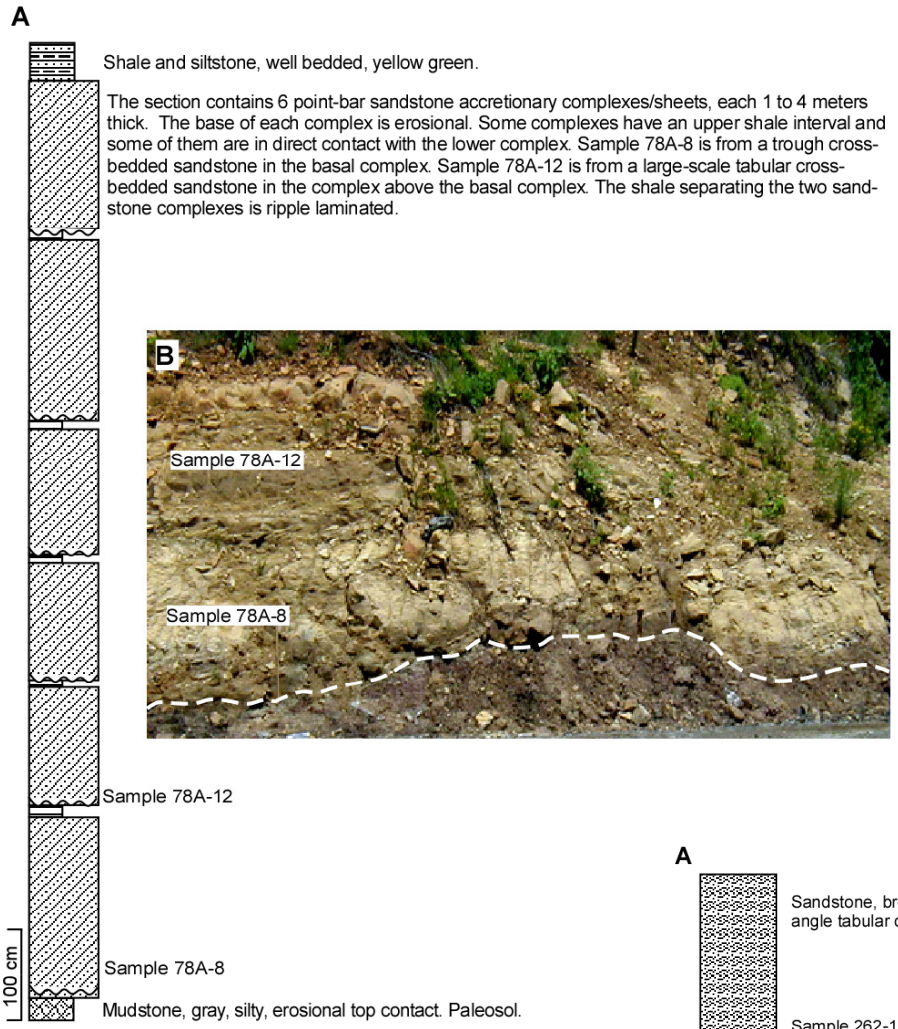


Figure 3. A) Measured section of the Snyderville fluvial sandstones at Section 78A (Fig. 1B, C). B) Field photo of the basal point-bar sandstone sheet cutting into underlying red-purple paleosol (Yang, 2007) with approximate location of samples 78A-8 and 78A-12. Dashed white line is the channel base. Ruler is 1 m long. See Figure 1C for lithologic patterns.

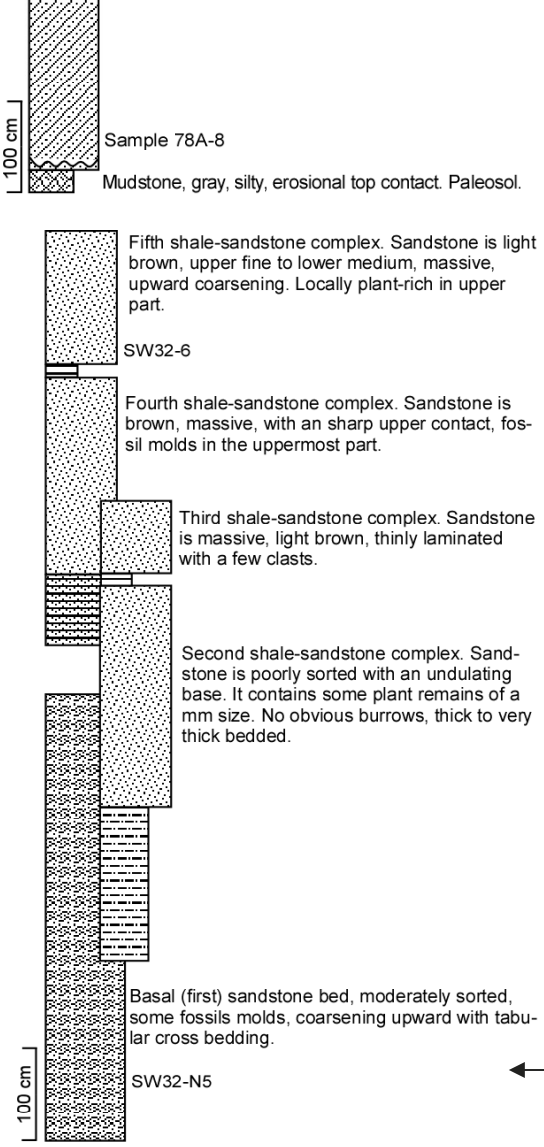
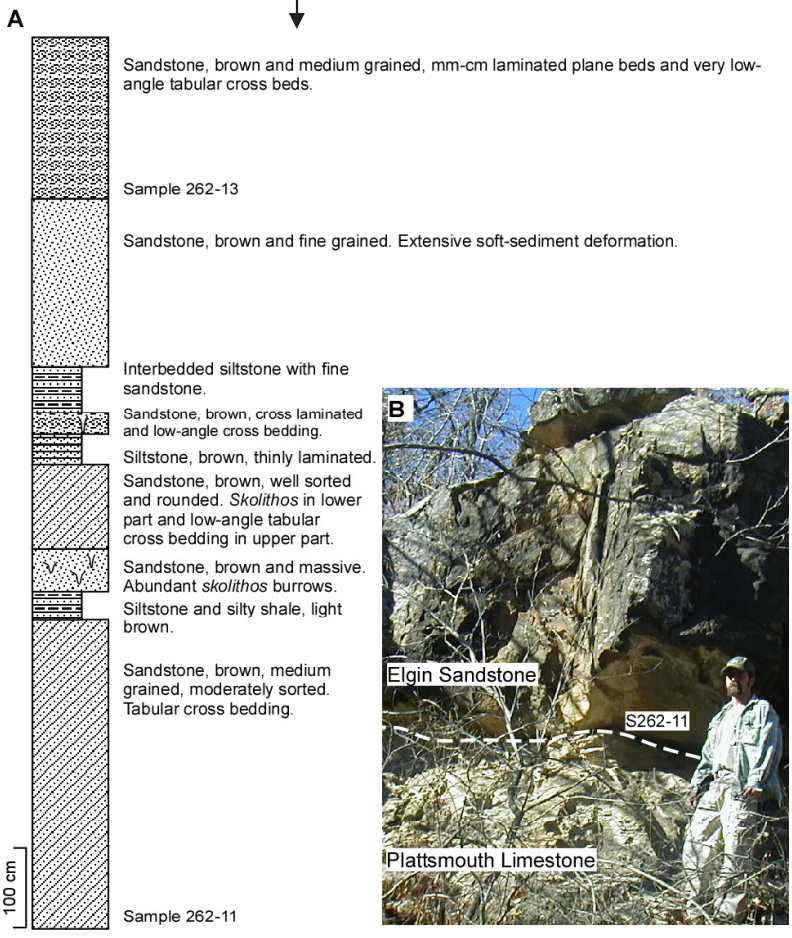


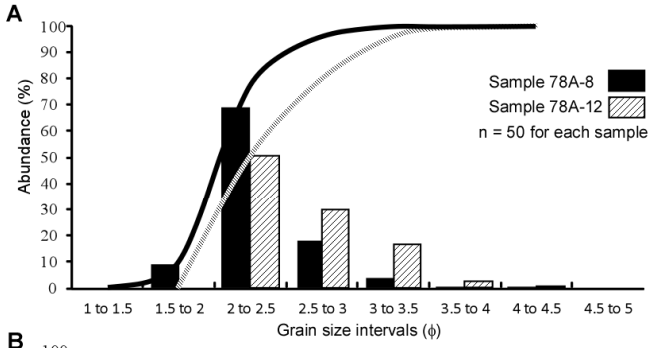
Figure 4. Measured section of the lower part of Heebner deltaic sandstones at Section W32, showing several shale-sandstone successions (Fig. 1B, C). See Figure 1C for lithologic patterns.

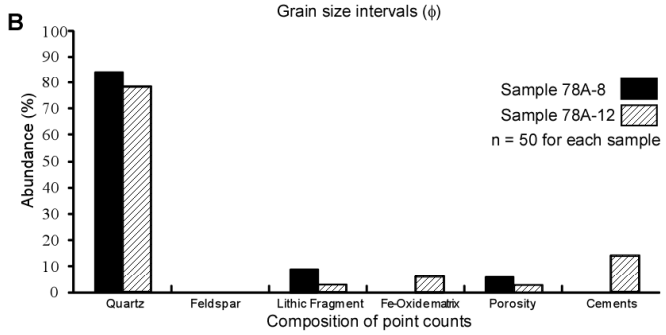
Figure 5. A) Simplified measured section of the Elgin Sandstone deltaic deposits at Section 262 (Fig. 1B, C). B) Field photo of the lower part of the measured section and approximate location of Sample 262-11. Dashed line is the knife-sharp contact between the Plattsmouth Limestone and Elgin Sandstone. Person is 1.7 m tall. See Figure 1C for lithologic patterns.



work grains, provide a comprehensive characterization of the petrographic features of each sample. It should be noted that Folk's (1957) formulae are based on cumulative weight percentage of a sample, not the cumulative abundance percentage obtained through point counting. Our calculations using Folk's formulae assume that all grains are equi-dimensional and spherical, and have equal densities. Hence, the grain abundance percentage is only an approximation of weight percentage.

The petrographic characteristics of each sample were compared between the two Snyderville fluvial, two Heebner deltaic, and two Elgin deltaic sandstones, and among the Heebner and Elgin deltaic sandstones, and the fluvial and deltaic sandstones. Finally, all six samples were combined to summarize the overall petrographic characteristics of Oread sandstones. Field and petrographic observations and interpretations were combined to decipher the differences between fluvial and deltaic processes of the Oread cyclothem.





C

Statistics	78A-8 (n = 46)		78A-12 (n = 42)	
	Data	Description	Data	Description
Mean Grain Size (ϕ)	2.07	Upper fine sand	2.33	Middle fine sand
Standard Deviation (ϕ)	0.28	Very well sorted	0.43	Well sorted
Skewness	0.23	Fine skewed	0.31	Strongly fine skewed

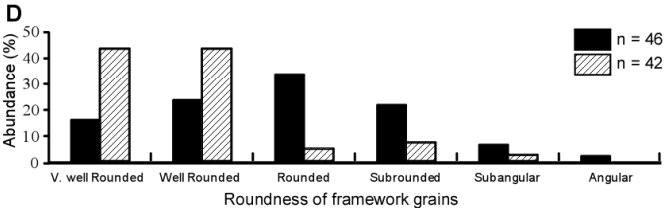


Figure 6. Petrographic characteristics of samples 78A-8 and 78A-12 of Snyderville fluvial sandstones. A) Histograms and cumulative curves of grain-size abundance distribution. B) Abundance (%) of mineral types of framework grains and matrix, porosity, and cement. C) Statistical data and description of mean grain size, standard deviation (degree of sorting), and skewness. D) Abundance (%) of degrees of roundness of framework grains.

Petrographic Results

Snyderville fluvial sandstone samples

Observations - Two sandstone samples, 78A-8 and 78A-12, are from a single laterally accreting point-bar complex. 78A-8 is from the trough cross-bedded basal sheet (Fig. 3B); 78A-12 from the overlying tabular cross-bedded sheet. Both samples contain more than 91% quartz and 0% feldspar framework grains and a trace amount of matrix. The lithic grains are shale clasts and most quartz grains are monocrystalline. The Quartz-Feldspar-Lithic (QFL) ratio of framework grains is $Q_{91}F_0L_9$ for 78A-8 and $Q_{97}F_0L_3$ for 78A-12 (Fig. 6B). The sandstones are classified as quartz arenite (Dott, 1964). 78A-8 has a coarser mean grain size (upper fine sand) and is better sorted (very well sorted) than 78A-12 (middle fine sand and well sorted); Fig. 6A, C). Both samples are fine skewed, although 78A-8 is less (i.e. containing less fine grains) than 78A-12 (Fig. 6C). In addition, 78A-8 is dominantly well to sub-rounded, whereas 78A-12 is dominantly very well to well rounded (Fig. 6D). Quartz grains are mainly in point to line contacts and commonly fractured in two or three directions. Finally, both sandstones are calcite cemented, resulting in a small porosity (5% for 78A-8 and 0% for 78A-12).

Discussions – The petrographic characteristics of samples 78A-8 and 78A-12 reflect the general upward-fining trend of a point-bar complex, although they are from different accretionary sheets. 78A-8 contains less quartz and more shale clasts than 78A-12, because the former is closer to coarse and lithologically-diverse channel-lag deposits. For the same reasons, 78A-8 is slightly coarser, better sorted, less rounded, and less fine-skewed than 78A-12. In general, however, both arenites are compositionally and texturally supermature (Folk, 1951). The fine quartz grains are likely of a recycled origin. The common healed fractures in the quartz grains suggest brittle deformation possibly caused by compressional or shear stresses. All the above evidence suggests that the quartz grains were probably derived from preexisting sandstones in exposed thrust belts of the Ouachita Mountains to the south (Yang et al., 2003a).

Heebner deltaic sandstone samples

Observations - Two sandstone samples, W32-N5 and W32-6, are from different delta-front sandstones of the Heebner deltaic complex, which consists of nine stacked prodeltaic-delta front shale-sandstone successions (Fig. 4). W32-N5 is from a tabular cross-bedded sandstone in the lower part of the complex; W32-6 from the base of the fifth deltaic sand-

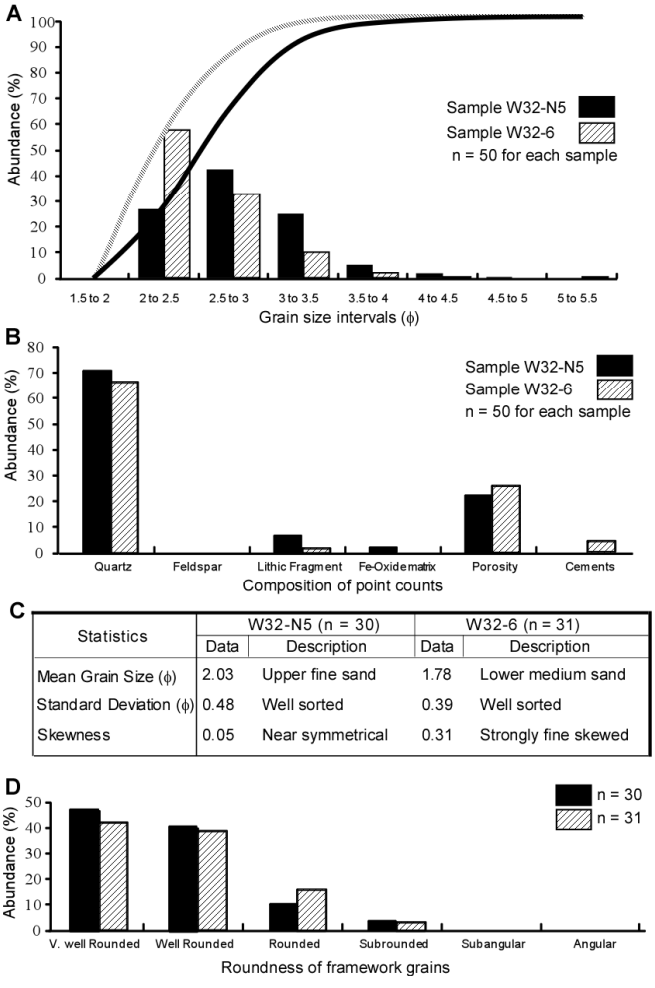
stone. Both samples contain more than 92% quartz and 0% feldspar framework grains and a trace amount of matrix. The lithic grains are shale clasts; and the quartz grains are mostly monocrystalline, commonly fractured, and dominantly in line contact with each other. The QFL ratio of framework grains is $Q_{92}F_0L_8$ for W32-N5 and $Q_{97}F_0L_3$ for W32-6 (Fig. 7B). These samples are classified as quartz arenite. The mean grain size of W32-N5 is upper fine sand, finer than the lower medium sand size of W32-6 (Fig. 7A, C). Both samples are well sorted. Grain-size distribution of W32-N5 is nearly symmetrical and that of W32-6 is strongly fine skewed, containing a

large excess of fine grains. Both samples are dominantly well to well rounded (Fig. 7D). Finally, they are poorly calcite-cemented and very porous (22% porosity for W32-N5 and 26% for W32-6).

Discussions – The pattern that finer-grained W32-N5 underlies coarser-grained W32-6 may reflect the general upward-coarsening trend of a progradational deltaic complex. Coleman and Prior (1982) documented that sediments in the delta front and the lower deltaic plain are reworked by tides and waves and are, in general, better sorted and more rounded than those on the distal delta front. The slightly better sorting of W32-6 in comparison to W32-N5 conforms to the trend. Both samples are dominantly very well to well rounded, suggesting strong reworking. In general both arenites are compositionally and texturally supermature. The quartz grains are probably of a recycled origin from the Ouachita thrust belt to the south, same as those of the underlying Snyderville sandstones (Yang et al., 2003a).

Elgin deltaic sandstone samples

Observations - Two sandstone samples, 262-11 and 262-13, are from the basal two delta-front sandstones of the regressive Elgin Sandstone, respectively. 262-11 is from a tabular cross-bedded sandstone; 262-13 from a plane-bedded one (Fig. 5). The quartz grains are mostly monocrystalline; lithics are shale clast; and matrix is of a trace amount in both samples. Quartz grains are fractured as the samples above, and dominantly in line contact with each other. The QFL ratio of framework grains is $Q_{97}F_0L_3$ for 262-11 and $Q_{100}F_0L_0$ for 262-13 (Fig. 8B). The sandstones are classified as quartz arenites. 262-11 is coarser (upper fine sand) than 262-13 (middle fine sand; Fig. 8A, C). Both samples are well sorted, fine skewed, and



Statistics	W32-N5 (n = 30)		W32-6 (n = 31)	
	Data	Description	Data	Description
Mean Grain Size (ϕ)	2.03	Upper fine sand	1.78	Lower medium sand
Standard Deviation (ϕ)	0.48	Well sorted	0.39	Well sorted
Skewness	0.05	Near symmetrical	0.31	Strongly fine skewed

Figure 7. Petrographic characteristics of samples W32-N5 and W32-6 of Heebner deltaic sandstones. A) Histograms and cumulative curves of grain-size abundance distribution. B) Abundance (%) of mineral types of framework grains and matrix, porosity, and cement. C) Statistical data and description of mean grain size, standard deviation (degree of sorting), and skewness. D) Abundance (%) of degrees of roundness of framework grains.

dominantly well to very well rounded (Fig. 8C, D). They are poorly calcite-cemented and porous (14% porosity for 262-11 and 20% for 262-13).

Discussions – Samples 262-11 and 262-13 have similar mean grain size, degree of sorting, roundness, and skewness. 262-11 is, however, slightly coarser than 262-13, although field observation indicates an overall slightly upward-coarsening trend of the three delta-front complexes. Thus, 262-11 may be located at the coarser part of the delta front, whereas 262-13 at a more peripheral part. Both arenites are compositionally and texturally supermature. The fine quartz grains are likely of the same recycled origin as the other Oread samples discussed above.

Petrographic Comparisons among Fluvial and Deltaic Sandstones

Comparison between Heebner and Elgin deltaic sandstones

Petrographic distinction between the Heebner and Elgin delta-front sandstones is expected, because the former developed during maximum transgression and the latter during early regression (Yang et al., 2003a). Thus, the petrographic data of the two Heebner sandstones are grouped to be compared with the grouped data of the two

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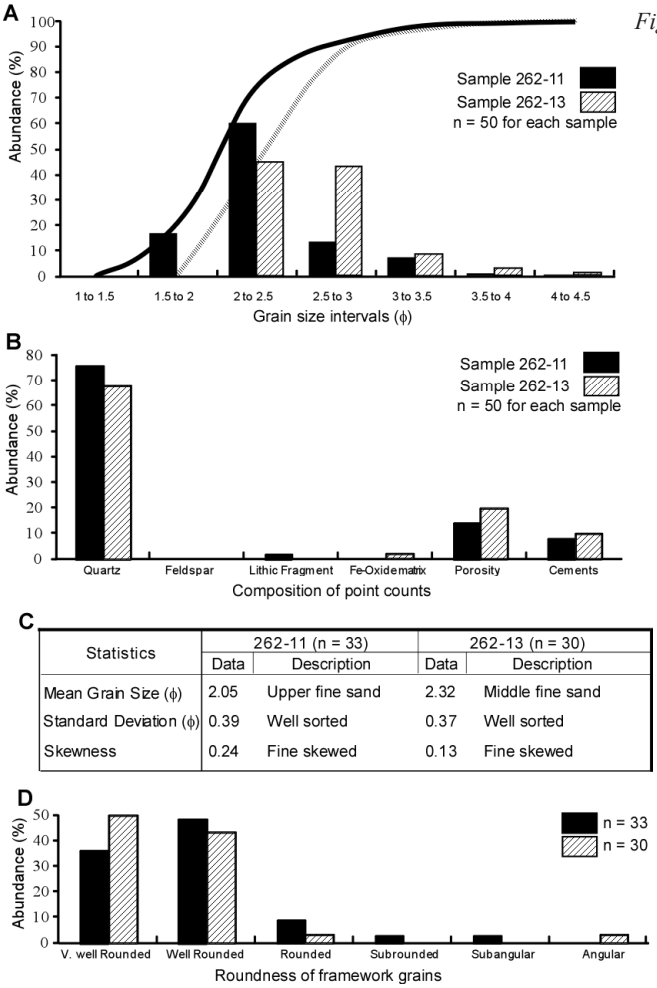


Statistics	262-11 (n = 33)		262-13 (n = 30)	
	Data	Description	Data	Description
Mean Grain Size (ϕ)	2.05	Upper fine sand	2.32	Middle fine sand
Standard Deviation (ϕ)	0.39	Well sorted	0.37	Well sorted
Skewness	0.24	Fine skewed	0.13	Fine skewed

Figure 8. Petrographic characteristics of samples 262-11 and 262-13 of Elgin deltaic sandstones. A) Histograms and cumulative curves of grain-size abundance distribution. B) Abundance (%) of mineral types of framework grains and matrix, porosity, and cement. C) Statistical data and description of mean grain size, standard deviation (degree of sorting), and skewness. D) Abundance (%) of degrees of roundness of framework grains.

Elgin sandstones (Fig. 10). The comparison, unexpectedly, indicates that the two delta systems are petrographically similar in composition and texture.

Observations – Sandstones of both deltaic systems contain more than 90% quartz, 0% feldspar framework grains and minimal lithic fragments and matrix (Fig. 10B). The QFL ratio of framework grains is $Q_{95}F_0L_5$ for the Heebner sandstones and $Q_{98}F_0L_2$ for the Elgin sandstones. The Heebner sandstones are slightly finer (a mean size of middle fine sand) than the Elgin sandstones (upper fine sand; Fig. 10A, C). All sandstones are well sorted, fine skewed (Fig. 10C) and contain very well to well rounded grains (Fig. 10D).

Discussions - The strong petrographic similarities between sandstones of the Heebner and Elgin deltaic systems suggest that sea-level changes and oceanic current and wave reworking may not have been the major controls on the petrographic characteristics of the delta-front deposits. The sedimentary processes operating within the individual deltaic environments and the character of sources areas in the Ouachita thrust belt were likely similar during the deposition of the two systems.

The Heebner sandstones have a slightly larger porosity and are less fine-skewed and, thus, better winnowed than the Elgin sandstones. The Elgin may be more compacted. Alternatively, the difference in porosity is caused by textural heterogeneity inherent to delta-front deposits.

Comparison between fluvial and deltaic sandstones

Petrographic distinction between the fluvial and deltaic sandstones is expected. The petrographic data of the two Snyderville sandstones are grouped and compared with the grouped data of the four deltaic sandstones (Fig. 11). The comparison indicates a similarity in composition but a small, yet significant difference in texture between the two groups.

Observations – All the sandstones contain more than 90% quartz, 0% feldspars, and a trace amount of lithics and matrix (Fig. 11B). The QFL ratio of framework grains is $Q_{95}F_0L_5$ for the fluvial sandstones and $Q_{96}F_0L_4$ for the deltaic sandstones. The fluvial samples contain more, albeit small amount, lithic fragments than the deltaic samples. The fluvial sandstones are coarser, much better sorted, and finer skewed than the deltaic sandstones (Fig. 11A, C). The fluvial sand grains are mostly rounded to very well rounded, ranging from angular to very well rounded, whereas deltaic grains are dominantly well to very well rounded (Fig. 11D). Finally, fluvial sandstones have a low average porosity of 2.5%, whereas deltaic sandstones are very porous with a 20.5 % average porosity.

Discussions – The coarser size, much better sorting, a slightly larger amount of shale clasts, and variable roundness of the fluvial sandstones in comparison to deltaic sandstones reflect the shorter sediment transport distance, higher flow velocity, and a local floodplain source of mud chips of the Snyderville fluvial environment. The improved roundness of deltaic sands suggests prolonged transport and reworking by tide, wave, and oceanic currents. The poor sorting of deltaic sands is probably caused by mixing of excessive fine sediments, as indicated by the fine skewness, due to deposition in a relatively low-energy environment and common burrowing as observed in the outcrop. The small porosity of fluvial sandstones can be attributed to pervasive calcite cements, which are less abundant

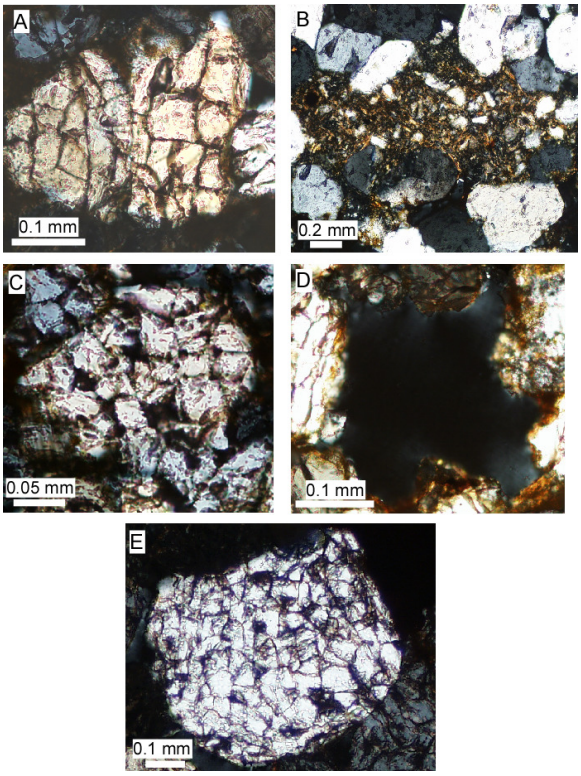
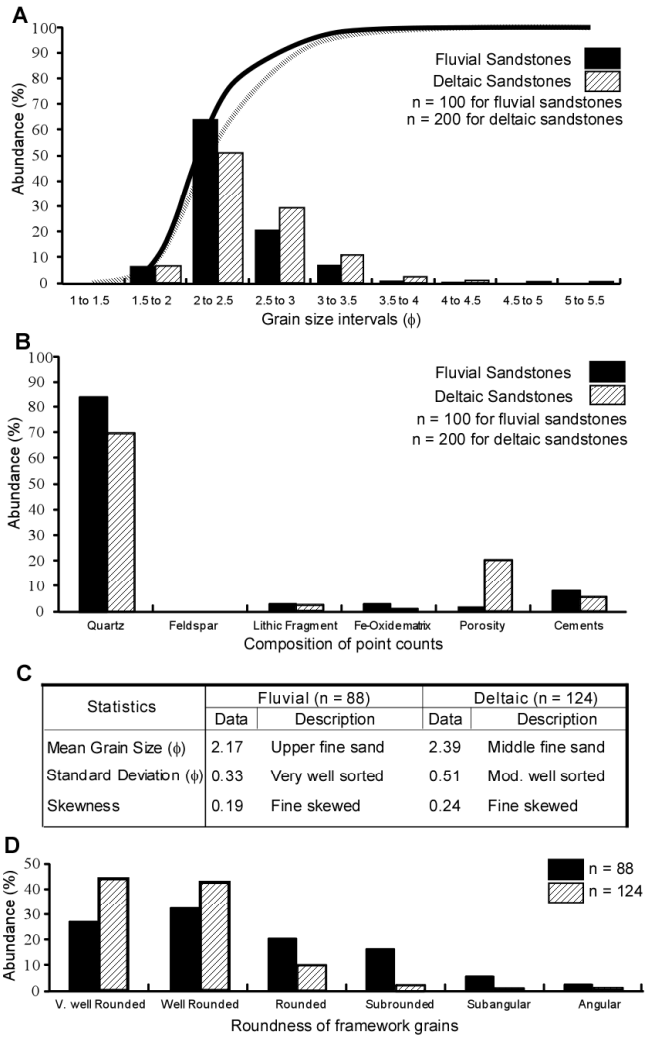


Figure 9. Photomicrographs under polarized light of A) fractured quartz grains in sample 78A-12 of Snyderville point-bar sandstone; B) a highly-contorted silty shale clast in sample 78A-8 of Snyderville point-bar sandstone; C) fractured quartz grain in sample W32-N5 of Heebner delta-front sandstone; D) interparticle porosity (center) in sample W32-6 of Heebner delta-front sandstone; and E) a fractured quartz grain in sample 262-11 of Elgin delta-front sandstone.



C

Statistics	Fluvial (n = 88)		Deltaic (n = 124)	
	Data	Description	Data	Description
Mean Grain Size (ϕ)	2.17	Upper fine sand	2.39	Middle fine sand
Standard Deviation (ϕ)	0.33	Very well sorted	0.51	Mod. well sorted
Skewness	0.19	Fine skewed	0.24	Fine skewed

Figure 10. Petrographic characteristics of Heebner and Elgin deltaic sandstone samples. A) Histograms and cumulative curves of grain-size abundance distribution. B) Abundance (%) of mineral types of framework grains and matrix, porosity, and cement. C) Statistical data and description of mean grain size, standard deviation (degree of sorting), and skewness. D) Abundance (%) of degrees of roundness of framework grains.

in deltaic sandstones. Nevertheless, the generally similar petrographic characteristics between the fluvial and deltaic sandstones are the results of same source area (i.e., Ouachita thrust belt), similar transport distance, similar catchment basin and climate conditions, and deposition separated by a short period of geologic time.

Overall petrographic characteristics of Oread sandstones

The six Oread sandstones of both fluvial and deltaic origins are quartz arenites, containing more than 90% quartz, no feldspars, a trace amount of lithics and matrix (Fig. 12B). The QFL ratio of all the framework grains is $Q_{96}F_0L_4$. They are fine grained, moderately well sorted, strongly fine skewed, and rounded to very well rounded (Fig. 12A, C, D). Thus, the sandstones are petrographically supermature to mature in both composition and texture (Folk, 1951). The high level of maturity is common for sandstones deposited in the epi-continental area (Boggs, 2006). The sediments were derived from recycled sandstones from Ouachita thrust belt, transported over a long (~200 miles) distance to the Cherokee Platform, and deposited on stable low-relief coastal plain and shelf (Fig. 1; Yang et al., 2003a). Finally, the variably calcite-cemented sandstones have moderately large porosity (14.5% on average), especially the deltaic sandstones, and are good potential hydrocarbon reservoir rocks.

Conclusions

The sandstones of the Snyderville maximum-regressive fluvial channel fill, Heebner maximum-transgressive delta-front deposits, and Elgin early-regressive delta-front deposits of the Oread cyclothem are all quartz arenites, fine grained, well sorted, rounded, and fine skewed. The sandstones are petrographically mature to supermature in both composition and texture. The petrographic similarities among these sandstones support the previous interpretations of provenance and depositional environments on the basis of field observations. The sandy sediments were probably derived from pre-existing sandstones in the same source area in the Ouachita Mountains, transported over a long distance, and deposited on a stable

epi-continental setting of the Cherokee Platform over a short geologic time span. Minor variabilities in the amount of shale clasts, sorting, skewness, and rounding probably resulted from variations in sedimentary processes, energy conditions, and diagenesis associated with point-bar accretion in fluvial channels, and deltaic progradation, delta-lobe switching, and degrees of wave and current reworking in deltaic environments.

Pennsylvanian sandstones in Kansas and Oklahoma have been the target for petroleum exploration. The moderately porous sandstones of the Oread cyclothem are good potential hydrocarbon reservoir rocks. Deltaic sandstones, in general, have larger porosities than fluvial sandstones, seemingly controlled mainly by the degree of calcite cementation. Common fractures in quartz grains as intra-particle porosity may enhance the overall porosity of the sandstones. Further studies on sandstone cementation are needed to better document the diagenetic history of Oread sandstones.

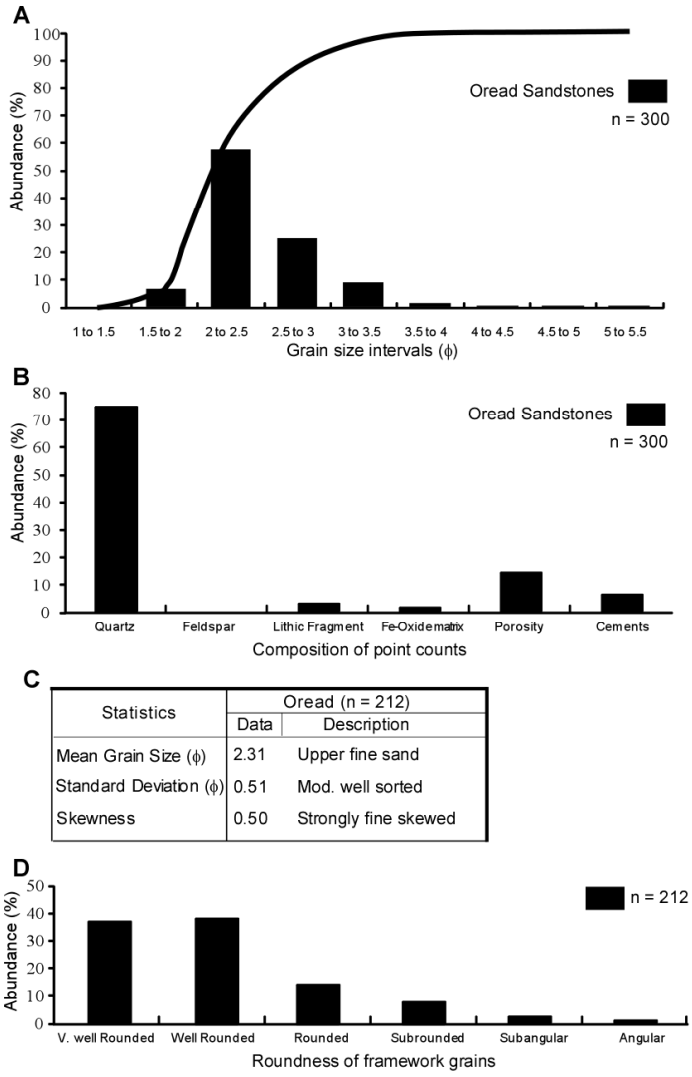


Figure 11. Petrographic characteristics of fluvial and deltaic sandstone samples. A) Histograms and cumulative curves of grain-size abundance distribution. B) Abundance (%) of mineral types of framework grains and matrix, porosity, and cement. C) Statistical data and description of mean grain size, standard deviation (degree of sorting), and skewness. D) Abundance (%) of degrees of roundness of framework grains.

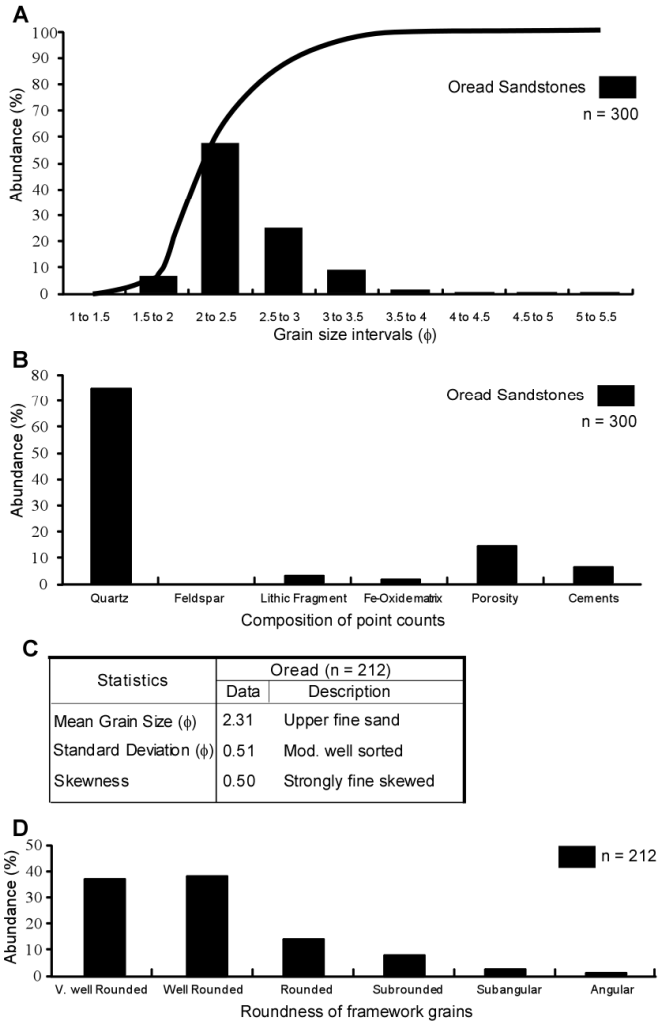


Figure 12. Petrographic characteristics of the Oread sandstone samples. A) Histogram and cumulative curve of grain-size abundance distribution. B) Abundance (%) of mineral types of framework grains and matrix, porosity, and cement. C) Statistical data and description of mean grain size, standard deviation (degree of sorting), and skewness. D) Abundance (%) of degrees of roundness of framework grains.

Acknowledgement

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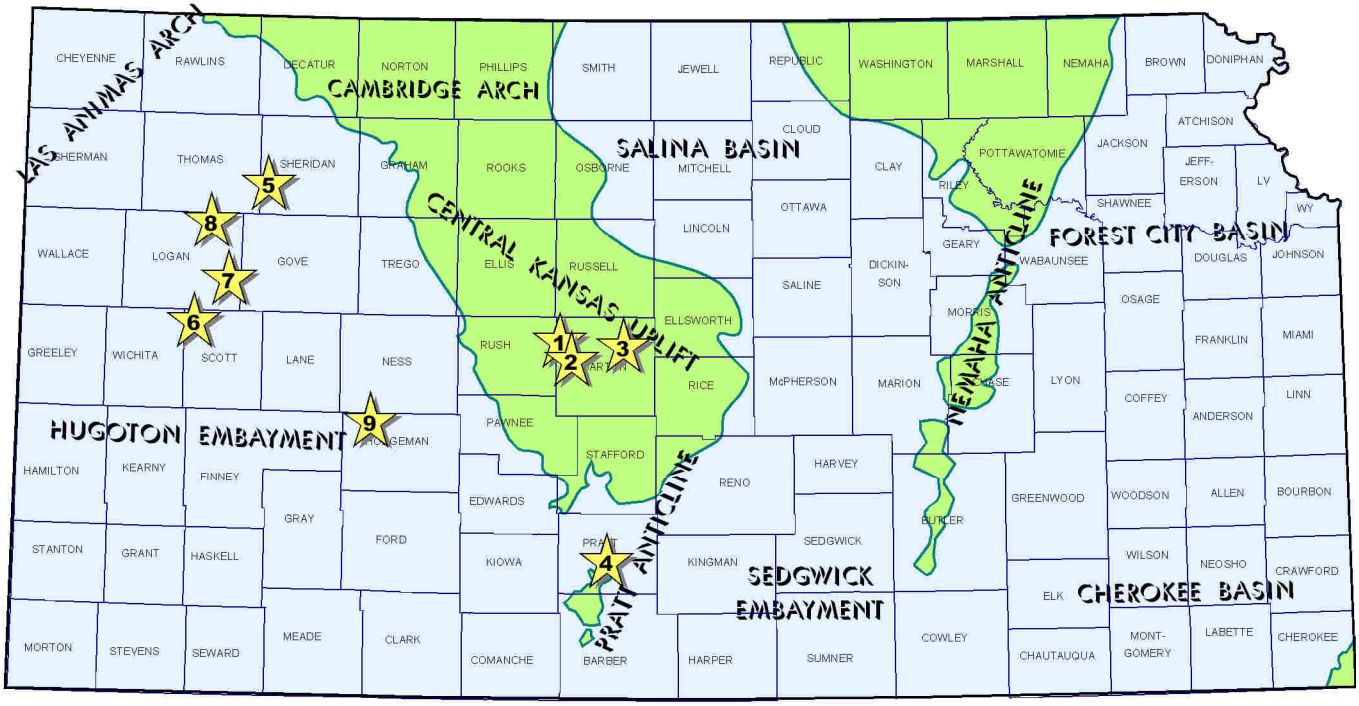
Exploration Highlights

By John H. Morrison, III
Independent Oil & Gas Service



(1) Samuel Gary Jr and Associates, Denver (CO), reports three new oil discoveries in **Barton** County. First, the No. 1-18 Stos Etal, located in the SE/4 of section 18- T17s- R15W, has been completed for 15 barrels of oil and 10 barrels of water per day. The new Stos South pool discovery well is producing crude from Arbuckle perforations placed at a depth of 3560 to 3565 feet. Pay zone was treated with 400 gallons of cleanup acid. Rotary total depth was obtained by VAL Energy rig at 3680 feet. The new reserves were discovered over one mile southeast of abandoned production in the Stos field (1972 - 1981), where both the Lansing -Kansas City and Arbuckle zones were once productive. Gary's new field lies five miles northwest of Olmitz, Kansas.

(2) In the NW/4 of section 19- T17s- R15W, Samuel Gary's No. 1-19 Stos & Stos is producing an unknown amount of oil from the Arbuckle formation. The well explored over one mile southwest of the Stos field (see above), near the **Rush** County line. Operator bottomed the well at a total depth of 3773 feet. Production depth is being held confidential. The new Stos Southwest field is located almost six miles northwest of Olmitz, Kansas.

(3) Samuel Gary has discovered Arbuckle oil deposits, and subsequent new pay source, at a stepout test northeast of the Boor Southwest field. The No. 1-16 Prosser is finalized for 10 barrels of oil and 20 barrels of water per day. The infield discovery is producing oil from perforated depth between 3346 to 3349 feet. Top of the Arbuckle was found to be 3339 (1365 kb). Southwind Drilling tools drilled the well to a total depth of 3470 feet. The Boor Southwest field had previously given up Lansing-Kansas City oil since its discovery in 1985 by Thunderbird Drilling.

(4) Dunne Equities Operating, Wichita (KS), has successfully re-entered and washed down the No. 1-12 Newlin in **Pratt** County and is producing 35 Mcf natural gas, one-half barrel of oil and 95 barrels of water per day. The wildcat well, spotted in the NE/4 of section 12- T28s- R13W, nearly one and one-quarter miles north of the Konold oil and gas field, is producing from the Mississippian formation through perforations shot from 4230 to 4253 feet. The well was originally drilled by Phelps Dodge Fuel Development Corp. to a total depth of 4605 feet in 1984 with shows noted in the productive zone. The new field has been named Pratt Lake. site is located about one and three-quarters miles southeast of Pratt, Kansas.

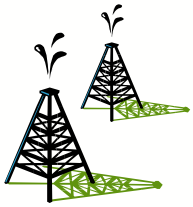
(5) McCoy Petroleum Corp., Wichita (KS), has discovered Lansing-Kansas City oil deposits over four miles west of the W.C.C. oil field (Toronto and LKC oil) in **Sheridan** County. The No. 1-23 Lager A is on pump making an undisclosed amount of crude in the SW/4 of section 23- T9s- R30W, about twelve miles southwest of Hoxie, Kansas. The wildcat well was drilled to 4650 feet total depth by Murfin Drilling Company. The field has been named Lager.

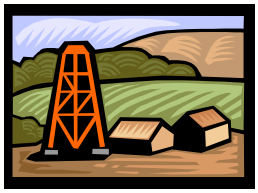
(6) Shakespeare Oil Company, Salem (IL), has discovered oil deposits in the Marmaton and Cherokee groups at their Radnor No. 1-14, located in the SW/4 of section 14- T16s- R34W, **Scott** County. The Radnor pool opener was put on pump in October for an undisclosed potential. Operator drilled the wildcat well to a total depth of 4950 feet using H D Drilling tools. The new unnamed field lies nearly eleven miles southeast of nearest established production in the Christy Canyon field, which produces oil from the Lansing-Kansas City and Cherokee formations. The Radnor lease is located about eighteen miles northwest of Manning, Kansas.

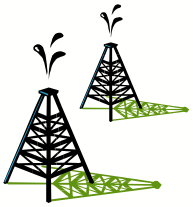
(7) Ritchie Exploration, Wichita (KS), has established the new Bridges oil field in eastern **Logan** County. The No. 1 Bridges 24-CD, spotted in the SW/4 of section 24- T14s- R32W, is on pump at an undisclosed rate with pay coming from perforations in the Cherokee and Morrow formations. Rotary total depth was obtained at 4660 feet. Discovery site is located one and one-half miles west of the Thies Ranch field (Lansing-Kansas City oil) and is nearly twenty miles southeast of Russell Springs, Kansas.

(8) McCoy Petroleum Corp., Wichita (KS), is producing an unknown amount of oil from the Lansing-Kansas City and Cherokee zones at the No. 1-3 Karlin Trust A in **Logan** County. The wildcat well was drilled to a total depth of 4760 feet by Murfin Drilling rig. Production commenced in October at site located in the NW/4 of section 3- T11s- R33W, about two miles northeast of Monument, Kansas. The new Karlin field lies three-quarters mile northeast of producing wells in the Cook Northwest oil field with similar pays.

(9) American Warrior, Garden City (KS), has successfully completed its No. 1-3 Borger in **Hodgeman** County to open the new Almquist Southeast (Mississippian oil) field fourteen miles northwest of Jetmore, Kansas. The wildcat well was drilled to a total depth of 4552 feet at site selected in the NE/4 of section 3- T21s- R25W. Closest established production can be found nearly three-quarters mile northwest of the oil strike in the Almquist field, which has produced Mississippian oil since 1978. Daily production is unknown.







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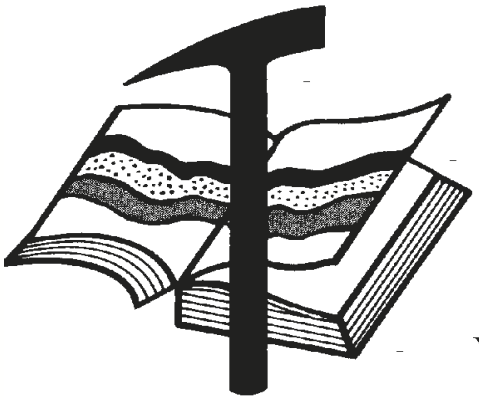

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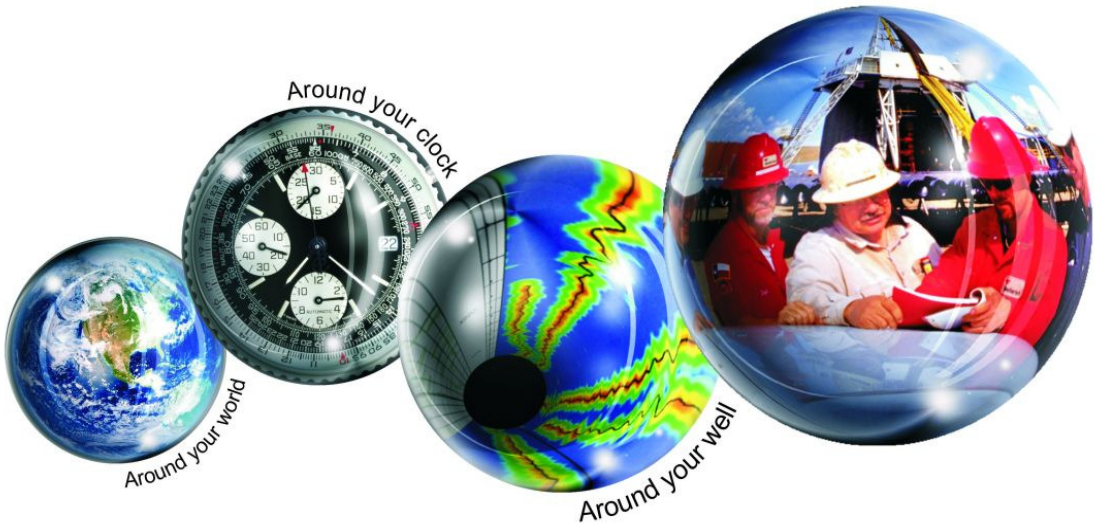

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