Deciphering the Cleveland Sandstone Stratigraphy in Pawnee County, Oklahoma Finds Bypassed Production

Part One of Two

by Connor L. Cain — Master Thesis, Oklahoma State University

(Continued on Page 11)

Abstract

The Cleveland sandstone interval contains a large Middle Pennsylvanian siliciclastic sediment dispersal system that covers a large portion of north-central Oklahoma including the Cherokee Platform, and host numerous oil and gas accumulations. The Cleveland sandstone interval, as used operationally by the petroleum industry, includes the stratigraphic section between the top of the Marmaton Group carbonates, frequently the Oologah Limestone (or “Big Lime”) and the regionally extensive Checkerboard Limestone. Historically, most sandstones occurring in this interval were labeled “Cleveland” without considering their true age or stratigraphic position. Two primary Cleveland sandstone trends transect the study area: Kiefer and Owasso (Krumme, 1981). These sandstone complexes converge and intersect near the Cleveland Field Unit in Pawnee County, Oklahoma, which is operated by Mid-Con Energy. Mid-Con began a drilling program in 2011, followed by a secondary recovery (waterflood) program targeting the Cleveland sandstone. Discrepancies in production within the field prompted this study. One principal hypothesis was that the interaction between the Kiefer and Owasso sandstone complexes contributed to differences in rock properties that had an impact on production rates for wells in the Cleveland Field Unit, however, relating the production discrepancies to differentiated
The following report was prepared by Vice President of National Energy Christopher H. Reed, #2935. The views and opinions expressed are those of the author. Some of the information is available in the public domain.

The underlying theme of this quarter’s article is adaptability and the Independent Earth Scientist. This should be second nature to our group, considering our history and ability to survive the ups and downs in our industry. The biggest recent adaptation has been to the “virtual” or online exchange of information for meetings, classes, and prospect sales.

This year’s Summer NAPE was an entirely “virtual” event. I took the opportunity to adapt and participate, along with several other SIPES members, by showing our prospects online. This involved presenting the prospect in several formats to be inclusive of an executive summary (to not exceed ten slides) and a detailed presentation in a PowerPoint and a YouTube video (to not exceed ten minutes). The cost was less than the usual Exhibitor Booth, but the virtual presentation was time consuming and tedious, particularly to the virtual “newbie.” Although it went on for a couple of weeks, my response was underwhelming to say the least. There were 160 exhibitors, with 400 offerings of prospects and acreage packages presented to 1,500 online attendees. Actual prospects amounted to 234, with Texas having 79, Oklahoma 54, Louisiana 25, and Colorado 13, with the remaining 63 spread over 17 other states.

Simultaneously, in an excellent adaptation to entrepreneurship, the SIPES Houston Chapter led by Jeff Allen and others, launched their first annual Deal Buyers Event via Zoom. This year’s event was by invitation only, targeting buyers and sellers with consistent records for participating, and offering high-quality drilling prospects. Acreage, horizontal and production deals were not allowed. The event for next year will be in person at the Houston Petroleum Club. SIPES members Barry Rava, Mike Jones, Bill Smith, and Ray Blackhall discussed recent successful projects with a Q&A afterward. Other members presented prospects for potential investment. This will become a signature event for the Houston Chapter, and a membership draw. Jeff deserves additional kudos and thanks for his successful recruiting of younger members to the organization.

The Deal Buyers Event was discussed at our recent board of directors meeting in Fort Worth. It was enthusiastically received, and participation was encouraged by other chapters in some form. The duties of the vice president of national energy were expanded to include this sort of activity as business development.

I encourage all members to get with their local chapters, or national, to be a part of the adaptation process of the reinvention of the industry. Three major areas of evangelism that SIPES is best prepared to lead the reformation of the industry are the Three E’s: Ethics, Education, and Entrepreneurship.

We will be looking forward to discussing this at the 2021 Convention in Fredericksburg, Texas.

Those thirsting for some numbers: On 9/29/20, the WTI closed at $39/BO with natural gas at $2.40/MMBTU. The disparity of parity ($ ratio of gas: oil) is starting to close to 1/16th from a past five-year average of 1/25th. This will be discussed in the future, and member input is encouraged. Contact chris@creedex.com. The feedback on the last article was appreciated and will be put to use.

Hot off the press — recent “U.S. Oil and Gas: Providing Energy Security and Supporting Our Quality of Life,” link as follows:


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If you haven’t already taken a look at the website, please do so. Katie has done an excellent job of transitioning our information from the old website to the new one. But the website is for you. Let us know if you need other information to be included on the new website, or if you can’t find something.

Be sure to read Chris Reed’s column about some new business ideas in the works too.

As we move forward to the 2021 Annual Convention, we are looking at ways to make this convention even more accessible.

Yes, change is in the air, and we are experiencing some extraordinary events, but there are positive changes that are emerging from these times. I love to see the ingenuity of solutions that are developing to address various issues. There are new ways to engage with colleagues, friends, and family for meetings, advice, social, and spiritual connections. Shopping and eating out have changed, but again, there are different opportunities to engage in those activities too.

Convention News

Remember to mark your calendars for the 2021 Annual Convention. The convention will be held June 7-10, in Fredericksburg, Texas. This is an excellent, convenient location with a lot of attractions. Great talks, an interesting and fun post-convention field trip, and several optional day tours have been planned.

In September, you should have received a letter and order form for sponsorship and advertising opportunities for this convention. If you supported us for 2020 — THANK YOU! Your contribution will be recognized for 2021 also, at no additional cost. If you choose to support us again for 2021, you will be specifically recognized in all printed materials. Of course, your support is invaluable to the well-being of SIPES.

National Dues and SIPES Cornerstone Group

You will soon receive your membership renewal notice for the 2021 year. Please return this form at your earliest convenience. Also note this year there is an additional question regarding your other professional affiliations.

Dues are the main source of income for SIPES. Cornerstone contributions are our next largest source of income. Cornerstone was founded in 1994 as a voluntary contribution plan, to provide financial stability to SIPES. 2020 brought the crises of the COVID-19 pandemic and the associated drop in oil prices. These two factors have affected our other main sources of income – our annual convention and NAPE. Given this loss of revenue, we are concerned that income for 2021 will be short for our minimum budget projections. However, with your renewed dues and generous support through the Cornerstone Group, we are confident that our budget will be met. Thank you for your contributions to Cornerstone in the past, and thank you for your continued support for 2021.

As Independent Earth Scientists, creativity and ingenuity are second nature to us. It will be interesting to hear about the creative solutions that have caught your attention and the ones you have implemented yourself.

Until next time.

Dawn S. Bissell
**DALLAS**

The Dallas Chapter held a virtual meeting in September featuring two lawyers, Charles Sartain and Rusty Tucker, both of Gray Reed, speaking on the topic “My Operator is Making Money and I’m Not. What Can I Do?” Hopefully, you have never had this thought before, but our Zoom meeting was well attended and featured an extensive Q&A period, so clearly a chord was struck!

After discussing the scenario in which operating costs (and COPAS overhead) exceed revenues, leaving the non-operators in the red, the speakers laid out seven options for non-ops. Some of these options include suing for breach of JOA, top leasing, attempting to remove operator, proposing to plug the wells, amending overhead, conducting an audit, discontinuing to pay, or offering to sell. Each option was presented in detail, along with relevant case law, exploring the arguments for and against.

Protections for operators are formidable, and costs for legal action can be likewise unappealing. The unsurprising answer is that there is no simple path, but there are some ideas worth thinking about.

Our chapter is also pleased to announce a new member to SIPES, Odilia Barman, #3569. Odilia is a geologist with many years of experience as a petrophysicist at the Venezuela national oil company PDVSA. She currently works as a consultant in Dallas, and we are proud to finally have her as a full member.

We plan to have several more virtual meetings luncheons through the fall, and we look forward to resuming our in-person meetings with great anticipation.

Michael Adams
Chairman

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**FORT WORTH**

The Fort Worth Chapter of SIPES opened it’s fall season in September with an excellent program presented by Robin Vasicek, #2354, entitled “Operating and Living with Stripper Wells.”

The total crude oil production in Texas is approximately 3.5 million barrels per day. With roughly 10% of that total being stripper production or wells producing less than 10 barrels per day, September’s lecture was both timely and informative. Robin offered his personal insight into how to purchase, manage and optimize stripper production. In 1993, Robin and his father started Bessero Oil Company as a consulting firm in Midland, Texas. Robin immediately began noticing the pitfalls that the operating companies he was consulting for were running into with the new wells they were drilling, which included poor reservoir quality, geologic and geophysical busts, completion errors, limited reservoir size and lack of reservoir pressure, price fluctuations in crude oil and natural gas and mechanical problems. With this information at his disposal, Robin decided he would like to have some production of his own, and that opportunity presented itself in 1998. He bought his first well making eight barrels of oil per day. The well was producing under a packer because the well had a hole in the casing, but he was officially in the oil business. He immediately started looking for additional low cost, low risk producing wells, and quickly decided that he would limit his search to well packages of ten wells or less, because the process of reviewing the well files, analyzing the wellbore configuration and inspecting the condition of the field equipment was taking approximately one to two weeks per well, and trying to buy larger packages of wells was taking too long to evaluate. He also realized early on that it is imperative that you are your own operator so that you are the one making the decisions on when and where money is being spent. Some of the other critical factors that he realized, included never buying a lease with less than a 75% net revenue interest, acquiring a large enough interest in the well package to keep your interest piqued, and any well making less than three barrels of oil per day is almost impossible to make profitable. He also realized that it is especially important to know and develop good relations with the managers and pushers at the various service companies you are using to service your wells. You must have a good roustabout crew with a well maintained pulling unit that can be on location quickly when needed; you need a good roustabout crew.

(Continued)
Hot oiler to deal with your paraffin problems; you need a company with salt water disposal and kill trucks that you can rely on; and you need a good chemical man because he can help you get your oil sold when it gets turned down by your gatherer. Robin stressed the importance of concise recordkeeping and documenting the details of the workover and repair of each well. His experience has taught him that in order to have lasting effects on the decline of a particular well, one can slow down the pumping unit which will invariably cause less wear and tear on the equipment, as well as the tubulars, or use a timer or pump-off controller to regulate the pumping of the well. Changing the stroke length of the pumping unit and getting the pump to work more efficiently by changing the bottom hole configuration can also have lasting effects on production decline, and it’s never a bad idea to buy production on the edge of a waterflood.

Robin Vasicek grew up the son of an independent petroleum engineer. At the age of 13 he was installing flowlines in west Texas. Robin graduated with a B.S. in petroleum engineering from The University of Texas at Austin in 1979. Out of school he went to work for Mobil Producing Texas and New Mexico, in Hobbs, New Mexico, as a production engineer in charge of the Vacuum Abo and San Andres water floods, the Square Lakes Flood, the EK Queen Flood and other Mobil wells and fields in southeastern New Mexico. In 1982, he was recruited by Mewbourne Oil Company as a field engineer to handle drilling, completion, and production operations in southeastern New Mexico and west Texas. In 1986, he transferred to the Texas Panhandle, where Mewbourne Oil Company provided on the ground production training by working alongside the company pumper and mechanics. In 1987, he moved back to Midland to help manage Mewbourne Oil Company’s west Texas production operations. In 1989, he joined the Mewbourne acquisition team providing reservoir studies and expert witness testimony before both the Texas Railroad Commission and New Mexico Oil Conservation Division. In 1993, he formed Bessero Oil Company as a consulting business with his father, where they drilled, completed, and managed numerous wells for multiple clients across west Texas. In 1998, he joined with two silent partners to form QP, Inc. and began purchasing and operating marginal, low cost, producing wells in west Texas.

Jim West
Secretary

### IN MEMORIAM

We regret to note the passing of the following members:

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<td>Wichita</td>
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<td>Charles H. Andrews</td>
<td>#1852</td>
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<td>July 10, 2020</td>
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<td>Jack P. Martin</td>
<td>#246</td>
<td>Lafayette</td>
<td>Louisiana</td>
<td>September 4, 2020</td>
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<tr>
<td>Gerald S. Pitts</td>
<td>#1075</td>
<td>Midland</td>
<td>Texas</td>
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HOUSTON
The Houston Chapter Board of Directors meetings occurred via audio, GoToMeeting, or Zoom for the three months of July, August, and September of 2020.

The Houston Chapter did not have lunch meetings in July or August due to COVID-19. However, our chapter did hold a virtual Zoom fireside chat with Arthur E. Berman, #3062, for our September meeting. The focus of the talk was to discuss the current oil and gas markets; industry issues; the history, current and future of prices; the future of resource plays; and where do we go from here. Jeff Allen, the Houston Chapter newsletter chairman, and Mark Hamzat O. Erogbogbo, a Houston Chapter sponsorship/hospitality committee member, and Godswill Nwankwo, the Houston Chapter web chairman were commentators and asked important questions for Mr. Berman to answer.

Mr. Berman has been a consistent and accurate voice for our industry for decades. He is a working petroleum geologist. Mr. Berman has a B.A. in history from Amherst College, and an M.S. in geology from the Colorado School of Mines. Mr. Berman loves to unravel the complex factors in the oil and gas industry that drive the markets and prices. He looks at everything, but comparative inventory is the cornerstone of his approach. The Houston Chapter event with Arthur Berman was a virtual Zoom talk that lasted approximately one hour and ten minutes. There were 80 Zoom attendees registered for this meeting. Please review the YouTube video of “SIPES Houston Event with Arthur Berman on Sep 17, 2020.” Mr. Berman also has a website - www.arberman.com.

Steve Smith
Secretary
LAFAYETTE

The Lafayette Chapter does not hold any meetings during the summer, so our first meeting of the third quarter was originally planned for September 9. That meeting was canceled due to the high number of COVID-19 cases in Lafayette at that time. Our local chapter decided to wait until the end of the month in the hopes that the virus numbers improved. This did indeed happen and so our substitute meeting was scheduled for the GeoGulf 2020 (70th Annual GCAGS Convention) Awards Banquet. Our old friend and SIPES member Frank W. Harrison, Jr., #209, received the Don R. Boyd Medal for his lifetime contributions to Gulf Coast geology and his leadership in the AAPG, GCAGS and Lafayette Geological Society. Our hats go off to Frank for this well-deserved honor, and also to GCAGS Convention Chair Dr. James Willis, and former SIPES Lafayette Chapter Chair Travis Helms (GCAGS President), for organizing and putting on a live geology conference (the only one around) which was well attended and had an excellent technical program. Travis and James are blazing a trail in the new normal of living with the virus!

On a sad note, our only centenarian Lafayette Chapter member, Jack P. Martin, #246, passed away on September 4. He would have been 101 years old on October 16. Jack was a fine example of the Greatest Generation that came before us. Growing up as the son of a mining engineer on the banks of the Rogue River in Gold Hill, Oregon, he was destined to be a geologist. He graduated in geology from Oregon State University, where he was a member of Theta Chi Fraternity, and did post graduate studies at the University of Washington. As with most men of that generation, World War II came along, and Jack volunteered by joining the Army Air Corps. He served in the Pacific as a navigator-bombardier flying over 60 something missions in a B-25. After the war, he married Jane Anderson in 1945 and went to work for Shell Oil Company. After exploring for oil in Texas, New Mexico, and Mississippi, he ended up in Lake Charles, Louisiana, and finally in Lafayette, from which he never left. Jack left Shell Oil Company to become an independent geologist and as with most things that he did, he was good at it! He teamed up with his friend and geologist, Frank W. Harrison, Jr. (this year’s Boyd Medal winner), for many years, with many discoveries and adventures happening along the way. Jack was also a pillar of the community. He served in leadership positions on many boards, including as the SIPES Lafayette Chapter Chairman from 1971-73. He was also a man of faith and was an active member of the First United Methodist Church. Jack was always direct and spoke his mind, which was sharp until the end. He WILL be missed!

Stay healthy and safe everyone!

King Munson
Chairman

MIDLAND

No luncheon meetings were held in July or August. At our September meeting, Mella McEwen gave a talk entitled “Energy companies find new ways to find operating cash.”

"Cash-strapped energy companies are increasingly turning to an old-fashioned strategy to boost cash flow. Called factoring, it is the practice of selling invoices to a third party for cash, giving that third party the right to collect what is owed. But now a new wrinkle is developing, called managed accounts payable. It is essentially reverse factoring," said Barry Morehead, president of Bold Business Capital. “MAP or reverse factoring is used by 100 percent of Fortune 100 companies,” he told SIPES members at our monthly luncheon. He said it has evolved over the last couple of years to meet the needs of the oil and gas industry. “Service companies may do $1 million in work for an operator each month, and typically do not get paid for that work for 30 to 45 days - or longer,” he said. “Service companies struggle to (Continued)
do the work when they haven’t gotten paid for the work they did the last two months,” he said. “Our company can give them cash for the jobs they’ve done, less a discount fee.”

What differentiates MAP from traditional factoring is that it lets the service provider decide how quickly they want to get paid, and the discount fee is set depending on that time length. “After receiving the invoice and determining if the vendor is willing to accept a discount fee and how quickly it wants to be paid, Bold then coordinates the payment,” Morehead said. “In return, those discounts boost the operator’s bottom line, turning its accounts payable into a profit center,” he said. “Not only does it receive a discount on what it purchases, but streamlining its accounts payable operations reduces overhead costs and even headcount,” he said. “Working capital management is the biggest benefit — more cash on hand, more liquidity,” Morehead said. Companies like his are taking a higher risk than traditional banks and offering additional services. He told his audience that his background is in banking — working for federally insured banks in alternative lending. “I understand the need from the entrepreneur’s side to get cash,” he said. “A bank won’t lend to small businesses that need cash because they’re growing too rapidly to qualify or they’re too young to get that prime interest rate.”

George Friesen
Secretary

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Michael A. Oestmann, #3291 — Tall City Exploration
Carol M. Shiels, #3007 & R. David Shiels, #3171 — Shiels Engineering, Inc.
D. Craig Smith, #3124 — Midland, Texas

**Silver — $500**
Louis C. Bortz, #1698 — Flagg Diamond Corporation
John C. Kinard, #1303 — Denver, Colorado

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Save the Date for the SIPES 2021 Convention in Fredericksburg, Texas!
More information coming soon!
sandstones from the Kiefer or Owasso sandstone complex was not possible due to the complexities of these valleys. In order to test this hypothesis and evaluate the impact of the Kiefer and Owasso deposition on reservoir quality, detailed analyses of the stratigraphic framework, regional distribution, depositional lithotypes, and reservoir characteristics of the Kiefer, Owasso, and other Cleveland sandstones were completed. Findings of this study show that the Owasso sandstone complex occurs below the Nuyaka Creek Shale and is Marmaton aged, whereas the Kiefer sandstone complex is true Cleveland and, in many cases, fills a valley that eroded through the Nuyaka Creek Shale. Another key finding is that Marmaton carbonate paleotopography influenced Owasso complex distribution, but not the Kiefer, which in some cases appears to fill a deeply incised valley that eroded to the top and possibly removed Marmaton carbonate.

Figure 1. County map of Oklahoma with regional study area outlined in red. Location of the Cleveland Field Unit is denoted with a blue circle.
Figure 2. Paleogeography of the Late Pennsylvanian showing the major features during the time of Cleveland sandstone deposition. Oklahoma is outlined in black and the study area is outlined in red. Modified from Algeo and Heckel (2008).
Figure 3. Stratigraphic column and typical log of the Cleveland sandstone interval and underlying marker beds from the Cleveland Field Unit, Pawnee County, Oklahoma.
Cleveland Field Unit Petroleum Geology

The Cleveland Field Unit covers 1,760 acres in T21N, R08E, Pawnee County, Oklahoma. This area was unitized in 2011 by RDT Properties (now Mid-Con Energy) of Tulsa, Oklahoma. In the same year, an infill drilling program was initiated by Mid-Con, which resulted in 52 wells drilled to date. The Cleveland Field Unit primarily produces from the Cleveland sandstone (76 active Cleveland sandstone wells); however, oil is produced from the Osage Layton sandstone, Layton Sandstone, Lower Skinner Sandstone, and Bartlesville Sandstone in co-mingled wells.

The Cleveland Field Unit is located on a structural high, well defined by a structural contour map of the Checkerboard Limestone. The structural dome has two prominent high points located within the field, one in the northwest and one in the southeast (Figure 4). The field contains multiple faults that are inferred from missing sections on wireline logs. These fault cuts occur at various depths within the field, with the most prominent fault cutting through the Cleveland sandstone on the western edge of the unit boundary. This fault is located on the western flank of the structural high in the northwest portion of the field.

Other significant features in Cleveland Field include a significant change in the thickness of the Marmaton Group carbonates in the western half of the field. Wireline logs from the JL Miller Lease show a significant thickening of the upper carbonate unit (“Big Lime”). The “Big Lime” is not present in other portions of the field or to the south, southeast, or east; however, in the western half of Cleveland Field, the limestone reaches thicknesses of 80 feet. This thick limestone interval results in the Cleveland sandstone lying directly above it without the normal marine shale found in the rest of the field.

(Continued)
The Nuyaka Creek Shale is only observed in the far northeast and southwest corners of the Cleveland Field Unit. The field contains over 100 wells with gamma-ray and porosity logs surveys over the Cleveland sandstone interval and the Nuyaka Creek Shale is not present in any of these wells. In the majority of the field and surrounding area, Cleveland sandstone accumulations are undifferentiated with none of the stratigraphic markers recorded in wireline logs or present in cores.

Based on cross section correlations and mapping, the Kiefer and Owasso sandstone complexes converge near the Cleveland Field Unit; this results in sandstone thicknesses averaging 200 feet across the unit. Based on wireline log correlations, the Owasso sandstone complex enters the Cleveland Field Unit from the northeast and trends diagonally across the field toward the southwest. Additionally, the Kiefer sandstone complex extends across Cleveland Field from the southeast and continues to the northwest (Figure 5). In previous investigations of the Cleveland sandstone in Cleveland Field Unit, the sandstone interval was not divided into Kiefer and Owasso sandstone complex; however, petrophysical analysis was performed, and the Cleveland sandstone was divided into four depositional events (Roddy, 2014; Roddy et al., 2018).

Sandstone thickness across the field is fairly consistent with the majority of the wells in the field containing over 100 feet of greater than 10% porosity sandstone. The area with the thinnest gross sandstone is the west-southwest corner, where some wells contain only 50-60 feet. Given the consistent thickness across the field, there are considerable changes in the nature of the sandstone bodies. The majority of the wells in the northern half and southwestern corner of the field contain more sandstone in the lower portion of the interval. There are defined sandstone bodies that make up the basal part of the Cleveland sandstone and are in contact with the underlying marine shale. In contrast, the southern half minus the southeast contains less developed sandstone bodies and instead has intervals of interlaminated to interbedded sandstone and shale (Figure 6). The underlying marine shales are overlain unconformably by the interbedded sandstone and shale intervals. The position of the Cleveland sandstone is consistent across the field. In areas with less developed “lower” Cleveland sandstone, the interbedded sandstones and shales display lower porosity and higher gamma-ray.

The upper 50-75 feet of the Cleveland sandstone displays the highest permeability and cleanest sandstone on the gamma-ray log (Figure 7). Based on the earliest well completion records, this
CLEVELAND SANDSTONE CONTINUED

Figure 7. Above: Permeability and porosity data graphed from the Van Eman #16 showing the change in relative permeability over the sandstone interval. Below: Cross section of the cored wells in Cleveland Field with gamma-ray and permeability curves plotted. Blue lines represent core plug derived permeability, and red lines indicate permeability from minipermeameter.

(Continued)
interval was the primary interval produced when the field was discovered. In the earliest wells drilled in the field (1904-1915), completion reports claim the upper interval produced significant volumes of gas (the highest being initial potential test of 5 million cubic feet in the Miller #1) and also produced large volumes of oil. The discovery well for the field, the Uncle Bill #1, flowed 250 barrels of oil a day after being stimulated ("shot") with nitroglycerin. Cleveland sandstone core reports are available from 4 wells cored during the 1960s (Mullendore & Berry #31, Mullendore & Berry #34, Booher #29, and LM Jones #46). The reports from the Mullendore & Berry #31 and #34 indicate only slight odor in the upper 50 feet with low oil saturations (4-5%). Underlying this zone, both cores reported strong odor-bearing sandstones with notes of bleeding oil and greater oil saturations. In both wells, the upper sandstone contains higher porosities and permeabilities (14-20% porosity and 3-100 millidarcies), compared to the lower sandstone with 10-14% porosity and <1 to 5 millidarcies (from core reports). Another interesting observation from the M&B #31 and #34 is the change in the resistivity curve from the wireline logs. The upper interval has resistivity values that average 25 ohm·m. The lower sandstone decreases to 5-10 ohm·m. This is in contrast to the Booher #29 wireline log that has less than 5 ohm·m over the upper sandstone interval and increases in the lower zone. Core reports from the Booher #29 indicate no shows in the upper sandstone and bleeding oil in the lower sandstone.

Data for the older cored wells (1960s) are from wells in the southern half of the field and show a consistent trend of higher permeability and swept sandstone at the top of the core and higher oil saturations in the lower quality rock toward the base of the overall interval. Recent core analyses from 2 wells in the southern portion of the field indicate similar results to the cores cut in the 1960s. The highest porosities and permeabilities are located in the upper sandstone bodies and contain a lower oil saturation than the lower permeability sandstones found near the base of the interval. These lower intervals are highly laminated sandstones and shales. The wells from the northern half of the field still show higher permeabilities in the upper 40-50 feet; however, multiple sandstone bodies are present in the middle to lower interval that contain good oil saturation and have not been swept by early development. These sandstone bodies are the primary target for the recent development of the Cleveland Field Unit.

(Continued)
Oil and gas production from the Cleveland sandstone within the field is inconsistent. The north half of the field produces approximately 90% of the oil for the entire field (Figure 9). The sandstone quality and thickness do not change significantly from the north to the south, however, the southern portion of the field exhibits lower resistivity values on average. Multiple re completions were attempted in the southern half of the field, and none has resulted in the oil production rates that wells in the north are achieving. Wells in the northern half of the Cleveland Field Unit average 30 BOPD with the best wells making over 100 BOPD. In contrast, wells from the southern half of the field average 5 BOPD or less with the highest volumes coming from other reservoirs in the field. Initial hypotheses for this discrepancy included structural changes in the Cleveland sandstone that resulted in a more significant gas cap in the south, a more homogeneous sandstone interval overall that resulted in fewer stratigraphic traps and allowed for better vertical permeability and migration of oil, and production that is tied to the sandstone complex being produced (Owasso in the north and Kiefer in the south).

Article to be continued in the next SIPES Quarterly issue.

Figure 9. Production bubble map of daily Cleveland sandstone production overlying the Checkerboard Limestone structure map. Larger bubbles indicate higher production. Contour interval for Checkerboard Limestone = 20 ft.
WELCOME NEW MEMBERS

In accordance with the SIPES Constitution, By-Laws and Code of Ethics, the following list includes new members who have been unanimously approved by the SIPES Membership Committee during the last quarter. These members have completed the 30-day waiting period and we welcome them as new members of the Society.

Gregg S. Alletag, National Membership Committee

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Adopted by the SIPES Board of Directors
September 21, 1996