Production Revival of the Oklahoma City South Wilcox Sand Unit, Oklahoma City Field, Oklahoma and Cleveland Counties, Oklahoma*

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Abstract

The Wilcox Sand of the Oklahoma City Field has produced well over 540 MMBO and 820 BCFG since its discovery on March 26, 1930 by Indian Territory Illuminating Oil Company’s No. 1 Mary Sudik. Of this 540 MMBO, over 60 MMBO has been recovered at the southeast end of the field from the Oklahoma City South Wilcox Sand Unit. After being largely abandoned in 1984, save for one well, the Unit has seen a revival in production in recent years from the recompletion, re-entry and drilling of 33 producing and injection wells. Updating the old geological work by incorporating new interpretation and modern logs has driven the redevelopment of the Unit. At the early stages of this redevelopment, new engineering thought and a modern approach to drilling, completion and production techniques enabled the company to reestablish production. Some of this new production is in areas of the Unit that have not produced since the 1940’s. This revival of production has resulted in an incremental recovery of 2.0 MMBO and 1.5 BCF to date, and incremental future recoverable reserves of 4.1 MMBO and .9 BCFG. Presented here will be an overview of the development, current reservoir conditions, Unit production history and reserves, lessons learned and challenges to drilling in a major metropolitan area.
References Cited


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ACKNOWLEDGEMENTS
(“WE”)

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BOB GILMORE--ENGINEERING
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DALE DREHER--PRODUCTION SUPERINTENDENT
Presenter’s notes: A tribute to the sample catcher. A lot of oilfield technology has been improved, but most of you will notice no difference (maybe the replacement of the wooden bucket with a plastic one).
Presenter’s notes: Portion of Open File Report 5-95 “Geologic Provinces of Oklahoma” showing location of OKC Field and its relation to the Nemaha Fault Zone.
Presenter’s notes: I am going to use several maps from older publications and studies, because the geology at the “field scale” has not changed much. In the OKC Field, there is production from the Pennsylvanian, but the majority of the production has come from Pre-Penn intervals (Arbuckle up through Simpson Group and Viola).
Presenter’s notes: Taking the previous map, and digitizing it as an overlay in GE, we can get an idea of the area covered by the field. Note the capital, Will Rogers World Airport and Tinker AFB. Discovery well - this well was the Indian Territory Illuminating Oil Company (ITIO) OKC No. 1 that “blew in” at 3:15 pm, December 4, 1928. Let’s zoom in and look at a cross section from B-B’.
Presenter’s notes: This is an old cross section from the Geological files that I modified. It is probably from the late 30’s. I could not create a better one. The detailed work that was done from samples alone is amazing. (Presenter’s notes continued on next slide.)
Many of the wells in our inherited Geological Files contain 5 foot (or better) sample descriptions. If you know OKC, this line is from West to East at approximately SE 59th through Valley Brook. This is the north part of the Unit. The red line denotes the Penn Unconformity forming the seal for the Pre-Penn production. I will show references at the end if there is anyone interested in reading the details of the structural development of the field. Slide is meant to show the subcrops of the various units.
Presenter’s notes: The Simpson stratigraphy. The names of the individual units shown on the cross-section are the original names, and are unique to the Field.
Presenter’s notes: The focus of the talk is the Wilcox Sand of the OKC Field. The discovery well for the Wilcox Sand is marked with a red star.
Presenter’s notes: The arc of the original producing area is approximately 12.2 miles in length. The width varies due to differences in the Simpson dip below the Unconformity.
Presenter’s notes: Zooming in on the SE portion of the Wilcox trend, I want to return to the cross section.
Presenter’s notes: The Wilcox discovery well was drilled in the updip wedge of sand as depicted.
Mary Sudik No. 1 blew out at 6:45 am on March 26, 1930. For the first two days the well blew a light-brown colored gas. Estimated oil flow rates were 40,000-60,000 BOPD. Reportedly, the well blew a spray of oil onto the OU campus, 11-1/2 mi. to the south. The well was brought under control at 7:00 pm on April 6, 1930 (11-1/2 days).
Workmen for scale
Presenter’s notes: The red star depicts the location of the Sudik well on a current image. In case anyone is concerned about environmental damage, SJOC owns the surface and the native grass and weeds grow quite well.
Presenter’s notes: This map depicts the fluid contacts at original conditions. Gas caps were at the updip tips of the reservoir, and an original OWC of -5425.
Presenter’s notes: This is the same map as before but with the Unit depicted in blue. It is located on the SE end of the Wilcox producing trend. The Unit was formed by Cities Service, Sinclair, Phillips and Continental. Declaration of Unitization was effective Dec. 1, 1955 with Cities as operator.
Presenter’s notes: At purchase in 1997, the 2165-acre Unit was held by one producing well, OKCSWU #1-5 (in yellow).
Presenter’s notes: Location for the OKCSWU #17-16 typical well. Almost a full Wilcox section. The Wilcox average thickness in the Unit is 226’. 17-16 drilled 457’ from Mary Sudik #1.
Presenter’s notes: This is the typical Wilcox log for the Unit. On the left, I have presented the “as logged” Porosity log using MDEN=2.71, and Neutron MATR=Limestone. The log was recomputed for MDEN=2.65 and MATR=Sandstone. The Wilcox is a uniform body of sand as can be seen. Note the Pe curve. The bottom 20-30’ contains thin streaks of grass-green shale with reported bentonite streaks by the old sample descriptions. Base appears to lie somewhat conformable over a 40-50’ thick “dark-green, greasy shale”. This shale is a good marker when I am lost in the massive Wilcox section.
Generally, Sw analysis is easy, as evidenced by the high Rt and porosity values. Normal scales for resistivity (.2-2000) and porosity (-.10 -- .30). The GOC is an easy pick from Den-Neu crossover, and the OWC pick is based on the point where Rt (AT90) crosses back down below Rxo (AT10).

(Presenter’s notes continued on next slide)
The Wilcox generally displays an “Annulus” or inversion profile in the different resistivity depths of investigation. Also, there is usually a very short transition zone from high Sw up into oil (good vertical perm). I have used the base of the transition as the OWC in this slide. The “wet” portion of the sand still has good oil shows in the tighter portions.
Presenter’s notes: Present day conditions generally find the Wilcox OWC just below -5200. There are different GOCs encountered within the unit. As development progressed and these contacts were better defined, locations were picked in order to stay in the thickest part of the oil wedge.
Presenter’s notes: This is how it all maps out. Note the different OWCs and GOCs. There appears to be compartmentalization within the Wilcox reservoir. Note the dashed lines marking the approximate boundaries.
Presenter’s notes: Going back to the original Wilcox productive limits, here is how the present day compares to original conditions. OWC has moved up 225’, from -5425 to -5200 (approx).
Presenter’s notes: So…what does this all look like in a production/timeline sense?
Presenter’s notes: Oxy had one well producing on the Unit and began water injection into an updip well. After peaking at a little over 100 BOPD, production went on a 14% decline until SJOC bought the property.
Presenter’s notes: SJOC took over operations from Oxy on 10/1/1997. As I remember, Oxy was selling off properties to raise money to purchase Elk Hills in California. This was the one producing well on the Unit. Simple production flattening due to sound engineering knowledge.
Presenter’s notes: All of this activity is keying off the lone producing well, #1-5.
Presenter’s notes: This recompletion was the first major Unit work performed by SJOC and led us to start thinking about the potential for redevelopment of the Unit. Well originally drilled by OXY in 6/1994 for lower Simpson sand. During drilling, there was lost circulation in the Wilcox. The Wilcox was thought to be depleted, and the zone was never tested.
Presenter’s notes: All of this activity is keying off the lone producing well, #1-5.
Presenter’s notes: From the peak in 2001 through most of 2006, the only major work on the unit was the drilling of OKCSWU #11-4. This well was drilled to test the Wilcox in the southern part of the unit that is separated from the north half by I-240. The prospect was to drill a strike well with the existing production to the north. *(Presenter’s notes continued on next slide.)*
The well turned out to be a dry hole as it was low and below the OWC for the area. During this time, while not on the unit, the Glendale A #9 was drilled. The well was opened in the Lower Simpson and Wilcox. Most of the well’s production is coming from the Wilcox. It had an IP of 25-30 BOPD and the latest well test was 28 BOPD. It has a cum of over 136,000 BBLS.
Activity: 2001-2006
Presenter’s notes: The highlight of this period was the production gain in 11/2006 from running an ESP in the #1-5 well. This increased Unit production by about 50 BOPD. One offset well (Glendale A #10) was drilled, but found the Wilcox eroded off.
Activity: 2006-2009
Presenter’s notes: 2009 was our “Discovery” year. We had a large amount of Unit acreage south of I-240 that had not had a Wilcox producing well for well over 30 years. Some parts of this acreage had not seen production since the 40’s. As we were discussing places to “wildcat”, Fred Stephens “strongly” suggested an offset to “the old Mary Sudik well”, which we did. The Mary Sudik had a cum of over 800,000 BO, so why not try there. We saw the log earlier. (Presenter’s notes continued on next slide.)
We had a good show in a Lower Simpson zone and completed there first. We moved the rig over to #12-16 to drill a well as an updip offset to a well in which Oxy had tried the Wilcox several years earlier. They had deepened a Penn well to the Wilcox, slimhole, and cased with a liner. The sand looked productive on the log, but their swab test could not recover any oil. It turned out that they could not swab below the top of the liner, which was well above the top of the Wilcox. The Wilcox has low bottom hole pressure and will only static a fluid column of about 600’. Swab testing must be done at the perfs. Oxy later plugged the well without making any Wilcox oil. 12-16 found the Wilcox a little thinner than 17-16, but looked productive. We completed in the top of the sand and made a little gas well. Later in the year, we came up the hole in 17-16 and completed in the Wilcox at a sustained rate of over 100 BOPD, and 600 MCFGPD. Immediately after this success, it was determined that 12-16 was actually producing from an Unconformity sand on top of the Wilcox. The well was squeezed and recompleted into the Wilcox. The well initially came in for over 200 BOPD. This was supposed to be a depleted reservoir. It was only pressure depleted; there was a lot of hydrocarbons left. Remapping of the area incorporating the two new wells and the old wells (which were a mile apart), indicated a large oil productive area with a rather large gas cap.
Activity: 2009
Presenter’s notes: Since SJOC took the Unit over, we have drilled 25 producers and two injectors, reentered 4 old wells and recompleted 2 wells. As can be seen from the curve, we have increased production from 50 BOPD at purchase, to 500 BOPD currently.
Presenter’s notes: Bottom Line using 1/1/2017 in-house valuation numbers: For all the new wells drilled, recompleted and reentered on the Unit (inclusive of Glendale #9), the cumulative production has been 2,028,475 bbls. The remaining PDP reserves for these same wells is estimated to be 4,065,642 bbls. Therefore, ultimate production for these wells is calculated to be 6,094,117 bbls. This does not include waterflood reserves as full implementation has yet to begin. Ultimate production for the Unit (inclusive of Glendale #9) is calculated to be 64,590,509 bbls.
WHAT WE HAVE LEARNED

RESERVOIR
Low bottom-hole pressure. Wells will only static a 600’ column of fluid.
OWC has risen from 5425’ subsea to approximately 5200’ subsea.
Originally there were small gas caps at the tip of the reservoir that seem to have expanded.
The reservoir is compartmentalized as evidenced by differing OWCs and GOCs.
There is currently waterflood response around existing injection wells. Future plans will call for conversion of existing producers to injectors.
Cities Service/Oxy initial injection pattern was for downdip injection into the aquifer. This idea was a failure. Later injection into the productive portion of the reservoir proved successful.

DRILLING
Low bottom-hole pressure necessitates the need for LCM. We use at least a 5-10# system.
After numerous stuck drill pipe problems, switching to HWDP solved these issues.
WHAT WE HAVE LEARNED

DRILLING (cont.)

PDC bits have advanced ROP in the Wilcox. Tricone bits used to take 10-15 min/ft.

With the advent of Pason we control ROP to a max of 2 min/ft. It will drill faster.
Pason also allows for ROP control to aid in the collection of usable quality samples.
Pick directional service people wisely. Scrutinize positional data. If possible, run a second party directional survey. We run a survey tool on all open-hole log jobs.
Wells drilled without aid of directional equipment do tend to walk up dip (175'). Well spots on the map are not BHL.

Mud properties are critical, especially when directional drilling.

PRODUCTION

Rat-hole below the perfs is crucial. The Wilcox produces large amounts of formation sand. Due to the low BHP, swabbing below the perfs has been beneficial to clean up the wells before production. It is advantageous to pump these wells below the perfs.
WHAT WE HAVE LEARNED

PRODUCTION (cont.)

Production rate typically increases after a period of time. It seems that the formation “cleans up”.

In this field, you are going to handle water. Don’t skimp on infrastructure.