

Tulsa, Oklahoma
December 1, 1936*File with Littlefields
Arbuckle Determinations*Mr. W. E. Wilson,
Building.

Dear Sir:

Weekly Letter No. 48 - 1936
Zone No. 10

Gulf No. 1 Klaus, Sec. 26-14S-19W, Kansas, which found water in the Pennsylvanian conglomerate and penetrated Arbuckle dolomite from 3804-5825', has been described by Dr. Honess. The Arbuckle is pre-Cotter and the pre-Cambrian is estimated to be between 3850-4000'; so that the area is structurally lower, on Arbuckle datum, than is the Ruder area.

The sand production in the offset to the No. 1 Klaus and the recent discovery in 13-15S-20W bring up the problems of stratigraphy in a Central Kansas Uplift area in which it appears that most of the production will be derived from sand reservoirs.

The Central Kansas Uplift has three northwest-southeast trending pre-Pennsylvanian "ribs" or highs; the Russell-Barton-Rice; the Rush; and the Pawnee. The latter is not well enough defined to discuss. The Russell rib has pre-Cambrian in contact with Pennsylvanian in a number of relatively small areas. Production is found in Arbuckle sands which belong in the lower 150' of the section. It is also found in basal Pennsylvanian sands in contact with Arbuckle sands, dolomites, or the pre-Cambrian. In most cases the Pennsylvanian and Arbuckle sands form one reservoir and differentiation is mainly an academic point which may have local economic importance. All sand pools are of the same general type, in that the pre-Pennsylvanian sand paleo-outcrops are small in area because dips are relatively steep.

Much different is the Rush County rib. The central core of pre-Cambrian in contact with Pennsylvanian is at least twenty miles in length and from two to six miles in width. The northwestward extension, as shown by pre-Cotter in contact with Pennsylvanian, goes to the south line of Township 12S-20W, a distance of about fifteen miles. There is little control for the southeastward extension, beyond Twp. 18S-15W. On the northeast flank the Arbuckle dips gently, about 20' to the mile, if the base of the Pennsylvanian is used as a datum. On the southwest flank the control is poor, but the Arbuckle appears to dip about 50' per mile. It is evident that a 50' sand layer of the lower Arbuckle will have a pre-Pennsylvanian paleo-outcrop which is both wide and of considerable linear extent, on the northeast flank and along the northwestward extension of the high. With present control limited to about forty points, the areal limits of the sands are unknown, but the general design or type of pattern is set.

Our knowledge of the Arbuckle of this area has been furthered by an

unusually high percentage of tests which reached the pre-Cambrian. Some seemingly good sample sets are worthless for detail because of excessive cavings. A few wells which penetrated deep into the Arbuckle lack a bottom datum because they did not reach the pre-Cambrian and other sections are difficult to place because upper datum points had been removed by erosion. However, a generalized type section can be made and lateral changes in sand content of the dolomite can be interpreted to some degree. Following are pre-Cotter subdivisions for the area north of Township 21S and west of Range 15W:

Post-Boyce Dolomite - - - - -	60-150'
Boyce sand and sandy dolomite - - - - -	20-80'
Pre-Boyce dolomite . . . - - - - -	0-50'
Weigel Cherty Dolomite) - - - - -	20-100
Pre-Weigel dolomite - - - - -	
Everleigh sand and sandy dolomite - - - - -	20-90'
Basal Sand (Reagan) - - - - -	0-80'
Total pre-Cotter - - - - -	270-320'
Pre-Cambrian	

Basal Sand (Reagan) 0-80'. Commonly medium to coarse, rounded sand. Thin quartzose conglomerate at base. Rarely contains arkose. Usually recrystallized to some degree and in a few cases, quartzitic. Sometimes difficult to distinguish from pre-Cambrian quartzite.

Everleigh sand. 20-90'. Ranges both vertically and laterally from pure sand to dolomite with 20% sand. Thins and becomes pure sand approaching the Rush high, becoming indistinguishable from the upper part of the Basal sand. Both together do not exceed 80' in thickness near the high and it may be that the Basal sand is cut out by overlap. Both sands together have a paleo-outcrop at least two miles wide on the northeast flank and should extend for many miles along or near the axis of the northwest extension of the high.

Pre-Weigel dolomite and Weigel cherty dolomite. 20-100'. The pre-Weigel is a non-cherty, white, dolomite with about 5% sand. The Weigel is a brown to white dolomite containing from 1-10% chert. In origin the pre-Weigel belongs with the Everleigh and grades up into the Weigel. The Weigel top shows evidence of secondary silicification due to exposure and probably represents an unconformity, suggesting that the Weigel is merely the weathered top of a formation and not a stratigraphic entity. It seems certain that the Rush high was uplifted at the end of Weigel time, for the Weigel and pre-Weigel together thin toward it. It is probable that they are absent adjacent to the high.

Pre-Boyce Dolomite. 0-50'. Purely a lithologic division defined as non-cherty white dolomite containing a residue of less than 15% sand. Thins toward the Rush high, due entirely to increase in sand content. Probably thins toward every ancient high and is now regarded as a highly significant member. Cavings and poor samples render it useless for paleo-geologic interpretation in many holes.

Boyce Sand and Sandy Dolomite. 20-80'. A lithologic division of non-cherty white dolomite containing more than 15% sand. Sometimes develops into coarse

sand 40' in thickness, as in 68-15W. Prominent in the few sections available in Nebraska. Toward the Rush high it thickens and becomes highly sandy but does not develop into pure sand unless close to the high. The top is usually fairly sharp and is marked by coarse sand included in dolomite which is sometimes porous. Contains more feldspar than any other part of the Arbuckle and indicates that pre-Cambrian was exposed in Boyce time, possibly on the Rush high. The interval between the top of the Boyce and the top of the Everleigh is from 110-180'. The pre-Boyce and the Boyce record a period during which seas shallowed and were filled to wave base over high areas, where the top of the Boyce probably marks a time break but no appreciable erosion. On the paleo-outcrop the Boyce is important as a source of sand in early Pennsylvanian time and as a remote possibility as a sand reservoir. The belt of outcrop should be at least three miles wide on the northeast flank of the Rush high and its extension.

Post-Boyce dolomite. 80-180'. Dolomite, white to brown, with some chert, particularly when in contact with Pennsylvanian. Contains considerable included sand in upper part but lower 50' is a low-residue dolomite. It contains the producing zone in the Ruder pool. The Cotter-pre-Cotter contact, at the top of the Post-Boyce, appears as a transition in some areas and as a relatively sharp break in other places. In either case it marks a change from a long period of deposition of a uniform type to a period in which there were rapid changes in the types of dolomites deposited. The Cotter-pre-Cotter contact has never been an entirely satisfactory point regionally as it is based on minor changes in lithology which occur within a zone of major change. The problem is similar to picking the contact in a gradational zone between pure sand and pure shale.

Summary of sand reservoir possibilities in the pre-Cotter. Only the Basal sand and the Everleigh are favorable for reservoirs. Due to the low dip on the northeast flank of the Rush high, the paleo-outcrop must occupy about 70 square miles, in an irregular linear belt adjacent to the pre-Cambrian and along or near the axis of the northwestward extension, from the southeast corner of Township 17S-16W to the center of Township 14S-20W. High spots and truncated edges of this belt may form traps for oil but these conditions are not likely to be found without an overlying mantle of Pennsylvanian sand or sandy conglomerate, which, together with the Arbuckle sand, will form a ramified reservoir system.

The Boyce sandy zone will also cover a considerable area in an irregular belt some distance from the axis of the Rush trend. As pure sand layers are not normal to it, porosity of the dolomite type is more likely. One possibility of sand production from the Boyce is in the residual zone, where the dolomite is dissolved from a partly silicified sandy dolomite, leaving a somewhat porous mass of sand and chert. Such a condition was believed to be present in the Twin No. 1 Copeland, but our No. 1 Klaus, Sec. 26-14-19, offsetting it, showed that the sand is a part of the Pennsylvanian conglomerate. The distinction between residual sand and conglomerate is largely academic, although the residuum should have higher porosity and more continuity.

Lower part
good zone
in Ruder
pool.
upper part
poor
the Taylor
Embrey
23-1-19

Other pre-Pennsylvanian sands. The Miller-Purcell, in two wells in Township 17S-20W and 17S-19W, on the southwest flank, shows considerable sand interbedded with green shale and dolomite. It does not appear to be a favorable reservoir but not enough is known to evaluate it. The Kinderhook may have a sand facies overlapping the Uplift from the southwest, as it shows a tendency to become sandy on approaching the high. Production possibilities in the Kinderhook are remote.

Pennsylvanian sand conditions. During various stages of the Pennsylvanian submergence of the Central Kansas Uplift the Russell rib was the highest and the surface had a general slope to the southwest, toward and across the Rush high. In the dolomite areas the sea found a mantle of residuum which was the result of a long period of solution during which underground drainage was dominant. This residuum was reworked but little as it was coarse in texture and partially indurated by clay and secondary silica. On the sand and pre-Cambrian areas, pre-submergence drainage must have been more normal and mechanical erosion must have been active, for these areas are worn down to approximately the same level as the dolomite terrain. The sandy debris, already sorted to some extent by land wash, was easily reworked by the advancing sea but was not transported for any great distance, for sand outcrops are commonly overlain by sandy conglomerates. Thus, the areas in which sands and pre-Cambrian rocks outcrop are mantled by bedded and roughly sorted Pennsylvanian conglomerates and sands. On present control it appears that this area covers about 300 square miles, the equivalent of between eight and nine townships. Whole townships in which the sand mantle should be present are: 13S-20W, 14S-20W, 15S-20W, 16S-20W, and 16S-19W. Townships partially covered are: 14S-21W, 15S-21W, 14S-19W, 15S-19W, 16S-18W, 16S-17W, 16S-16W, 17S-19W, 17S-18W, 16S-15W, and 16S-17W. It is probable that there are considerable areas along the axis of the Rush high which have little or no conglomerate for the reason that they were local topographic highs. In thickness the conglomerate zone ranges from 0-100'. The porosity, so far as seen, is highly variable both vertically and laterally. The assumption is that most of the sand and debris is marine. However, it is not a thoroughly sorted sheet deposit, but a series of locally derived lenses which suggest that the sea had more material available than it could handily sort. It suggests that the land surface was so flat that a slight rise in sea level inundated a large area. There is also a suggestion that in part the sands and conglomerates may be fluvial.

Pennsylvanian conglomerate

Differentiation between reworked Pennsylvanian and the underlying Arbuckle sand in place is not easy in some wells. Cores can be determined, both from the bedding and appearance of the sand and by heavy minerals. Heavy minerals cannot be used with cuttings for the more varied suite of minerals is in the Pennsylvanian, which commonly caves enough to mask the simpler suite of the Ordovician. When Pennsylvanian and Arbuckle sands, in contact, are so similar in type, it is probable that together they form a single reservoir. Differentiation may be important for both local and regional development, but details of occurrence, from location to location, will be impossible to predict.

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The best sand, that is, the cleanest and best-sorted, seems to lie near the top of the conglomerate in some wells, but there is no general rule as to the occurrence of porosity within the conglomerate. The most logical datum for contouring the conglomerate is the highest occurrence of sand or detrital chert. This will not do for local development, where the top of porosity should be used. Isopachs of the conglomerate should be of help, but will be difficult to make for no two workers will agree on the Pennsylvanian-Ordovician contacts in every well in the area. Detail study of the lower 200' of the Pennsylvanian might help to locate topographic highs along which might be found beach and bar deposits.

Present production. There are three producing areas at present, two of which are one-well pools; the Twin No. 1 Copeland, Sec. 26-14S-19W, the Bradley No. 1 Wann, Sec. 13-15S-20W, and the Otis gas field.

The Twin No. 1 Copeland, 26-14S-19W, is producing from 9' of coarse, well-sorted sand, which, in our No. 1 Klaus, was the upper part of a conglomerate 80' in thickness.

The Bradley No. 1 Wann, 13-15S-20W, is producing from 4' of quartzose sand which appears to be Ordovician but which may be the upper part of the Pennsylvanian conglomerate. In 12-15S-20W, 87' of sandy beds, in part Pennsylvanian and in part Ordovician, were found above the pre-Cambrian.

The Otis area, in 18S-16W, was not included in the above discussion, as it is on the southeast flank of the high, where dips are somewhat steeper. Gas production is found in Pennsylvanian sand and conglomerate on pre-Cambrian granite, on pre-Cambrian quartzite, and on Ordovician sand. Some oil production is found in Pennsylvanian lying on Ordovician sand. The reservoir is a complex of Pennsylvanian sand lying across the truncated pre-Cambrian, the Basal and Everleigh sands (Reagan), and some of the pre-Cotter dolomites.

The production possibilities of the sand area on the Rush high are largely unknown. The most intensive prospecting has been along the crest of the pre-Cambrian paleo-outcrop, where there is little conglomerate. Balanced against the lenticular, somewhat irregular, nature of the Pennsylvanian sandy conglomerate is the possibility of finding a trap in which as much as fifty feet of Basal sand of the Arbuckle might be present. No one test is conclusive for any considerable area as production will not necessarily coincide with any one structural datum.

The northeast flank of the Rush high, on present structural position appears to be nearly level. The northeast one-half of Township 18S-19W is to the northeast of the axis of the Rush high and should contain areas of paleo-outcrop of the Basal and Everleigh sands, as well as a Pennsylvanian sand mantle. It happens to be in line with the Ruder-Shutts-Bemis trend, and might have a possibility of post-Mississippian fold crossing the Rush high. This area seems to be the most favorable, but in general, all of the area covered by Pennsylvanian sandy conglomerate appears more attractive for scattered small pools than do most

Mr. W. B. Wilson
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dolomite areas of the same size.

Very truly yours,

(Signed) MAX LITTLEFIELD

ML:LAP

Wichita, Kansas,
March 31, 1937.

Dr. Max Littlefield,
303 North Cincinnati,
Tulsa, Oklahoma.

Dear Max:

You will recall that we have had considerable difficulty in our correlations in T.14S., R.19W. between Twin Drilling, No. 1 Copeland and our Gulf, No. 1 Klaus, both in Section 26.

Last year Vickers completed its No. 1 Kraus, SW/c NW Sec. 22, T.14S., R.19W., as a 259-barrel well in pre-Cotter sandy dolomite. Carmody's correlations are as follows:

3670 feet	Base Kansas City
3716 feet	Top Pennsylvanian basal conglomerate
3732 feet	Top Siliceous lime
3740 feet	Total depth
	Pay - 3735 to 3737 feet

This week Bridgeport drilled in its No. 1 Kraus, NE/c SE Sec. 21, T.14S., R.19W., as the southwest diagonal offset, and found, according to Carmody:

3685 feet	Base Kansas City
3732 feet	Top Pennsylvanian basal conglomerate
3752 feet	Total depth, probably still in sand of Pennsylvanian basal conglomerate age

However, this test filled 1800 feet with oil from 3748 to 3752 feet and will probably make a small well in this zone.

Based on your subareal map, Vickers-Kraus is almost at the contact of the Boyce sandy dolomite. Carmody is not at all certain whether the last 4 feet of sand in the Bridgeport test belongs to the Siliceous lime, but since it did not have either weathered and leached dolomite or residual green clay (both of which were present in the Vickers test), he is inclined to believe that the Bridgeport test is still in Pennsylvanian at its total depth.

Bridgeport is anxious to get a little more information as to whether or not there is any possibility that the present producing horizons of these two offset wells may or may not be the same, and if not, whether it would be wise to deepen their test a few feet into the horizon of the Vickers-Kraus.

We are this afternoon sending you by parcel post samples on Bridgeport, No. 1 Kraus from 3673 to 3752 feet. Samples on the Vickers test should be in your office, although our index does not indicate that they have been sent. However, they were examined sometime ago and we cannot now find them in our files.

Dr. Max Littlefield, Page No. 2, 3-31-37.

We have had and are having quite a few operations with Bridgeport and I would consider it a favor if you would write me within the next few days and let me have the benefit of the detailed correlations on these two wells, and also what chances you think there may be relative to deepening the Bridgeport test. Naturally I will only pass on to Bridgeport such information as we would ordinarily make available to them and the detailed information would not be passed on.

Very truly yours,

Anthony Folger

Anthony Folger

AF:AS

August, 1936.

Twin Drilling Co. #1 Copeland,
NE NE SW, 26-14S-19W,
Elevation 2082'

plotted

Rotary to total depth.

Pennsylvanian conglomerate 3701-3704?

3701-3704 Clay shale with included sand grains. (core)

Questionable Arbuckle Top 3704' Penetration 6' Sub-sea, minus 1622'
3704-3710 Medium to coarse sand, with included chert and
shale fragments. (Core)

There are three correlation possibilities:

1. Arbuckle. Boyce sand. Equivalent to 3610-3630' in Palmer #3 Ruder, 17-15S-18W, in which the top of the basal sand is 3735'
2. Arbuckle residuum. A sand which is the result of the solution of a sandy dolomite, leaving a highly porous residual sand in place. If so, it is probable that the top of the Arbuckle will be stratigraphically below that in the Ruder pool.
3. Reworked Pennsylvanian conglomerate. Locally derived sand reworked in ~~sandy~~ into a conglomerate.

Of these three possibilities either #1 or #2 appears most probable. Map as Pre-Cotter, Boyce sand member, with a question mark. If this is right it should be about 100' to the top of the basal sand.

It does not seem probable that the sand from 3704-3710' is basal Arbuckle sand or Everleigh sand.

7
April, 1937.

P.C.?

Vickers #1 Kraus,
SW SW NW, 22-14S-19W,
Elevation 2124'

Pennsylvanian conglomerate 3716-3732'
3716-3732 Clay shales, stained cherts, and some sand.

Arbuckle or Arbuckle residuum Top 3732' Penetration 8' Sub-sea, 1608'
3732-3740 Sand, medium to coarse, in part consolidated; with
considerable quartzose chert. The abundance of
oolitic chert suggests residuum. This is probably
residuum of the Pre-Cotter of Boyce or slightly
younger edge.

December, 1936.

Gulf #1 Klaus,
SW SW NE, 26-14S-19W,
Elevation 2095'

PC.

Rotary to total depth.

Pennsylvanian conglomerate 3776-3804'

3776-3780 Sandstone grading down into cherty conglomerate.

Chert pebbles well-worn. Porous in base.

Contains salt water. Cored, recovered 3'.

3780-3804 Rotary cutting show considerable chert. Attempts to core at 3780-82' and 3798' were failures due to the formation being hard and rough. Probably a chert conglomerate.

Ordovician	Top 3804'	Penetration 19'	Sub-sea, minus 1709'
Arbuckle	" "	" "	" " " "

3804-3823 Dolomite, white to brown, fine to medium. Cored.
Core cuts show residue of less than 1%.
This is Pre-Boyce dolomite.

The Pre-Cambrian top is estimated to be between 3950-4000'

The Pennsylvanian sand from 3776-3780' appears similar to that producing in the Twin Drilling Co #1 Copeland, the southwest offset, which penetrated 6', from 3704-3710'. In August, 1936, this latter well was reported by me as producing from questionable Arbuckle, Boyce sand member. It now appears that this is wrong and that the producing zone is Pennsylvanian conglomerate. The degree of dip between the two wells, five degrees, is striking. The producing well found the top of the sand at -1622' and the #1 Klaus at -1681'.

24442
28442
Tulsa, Oklahoma,
April 2, 1937.

Mr. Anthony Folger,
Wichita, Kansas.

Dear Sir:

Samples on Vickers #1 Kraus, 22-14S-19W, to 3740' were in our file and were examined, along with those from the Bridgeport #1 Kraus.

I agree with Carmody that the Vickers well is in Arbuckle, probably in a partially cemented residual zone which is in place and would be continuous to dolomite below. In the Bridgeport well the sand from 3745-3752' is either Penn. conglomerate or residuum in place, probably the former. I would expect this material to lie on cemented residuum which would in turn lie on dolomite. *check ??*

The Penn. conglomerate, the Arbuckle residuum, and the dolomite would be expected to be either in vertical or lateral contact with each other, forming a unit reservoir. Deepening of the Bridgeport test might find additional porosity containing either oil or water. I see no reason to expect to tap a separate reservoir by deepening.

Very truly yours,

Max