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OIL AND GAS SANDS IN THE NORTH HALF OF THE PITTSBURGH QUADRANGLE, PENNA.

By

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This paper summarizes the results of a study to determine the depth, thickness and character of the oil and gas sands encountered in wells drilled in the city of Pittsburgh, and in Plum, Penn, Patton, Wilkins, Braddock, North Versailles, Mifflin, and Baldwin townships in Allegheny County. Although this area has been thoroughly punctured with drill-holes, and the depths to the producing sands have long been well known, little effort has been made to correlate the different sands or to determine how they change in short distances. The author collected and studied all obtainable records of wells drilled in this area and presents here his findings.

To determine the depth of the various sands below the Pittsburgh coal or its horizon, each record was scrutinized, the interval between the top of the well and the horizon of the Pittsburgh coal (most of the wells were started stratigraphically below the Pittsburgh coal) determined by subtracting the elevation at the well mouth from the elevation of the Pittsburgh coal as shown on the structure sheet of the quadrangle, and this interval added to the depths to the sands as recorded by the driller. The intervals were computed for each township, (except Braddock which was treated together with the city of Pittsburgh). Fair averages could not be given for smaller areas, and the townships are large enough to show the change in the average intervals from one to the next.

The following table gives the depths to the various sands, shows where they are usually productive, and indicates their correlation.

Average distance to "sands" and "markers" from base of Pittsburgh coal, in feet, with number of well records used in ().

Sands & other strata encountered & noted by driller.	Township or other area									
	PLUM	PENN-WELLS [illegible]	PENN-OTHER WELLS	WILKINS	PATTON	NORTH VERSAILLES	MIFFLIN	BRADDOCK & PITTSBURGH (CITY)	BALDWIN	Where commonly productive
Upper Freeport Coal	645 (65)	632 (27)	638 (8)	625 (28)	628 (17)	630 (25)	617 (6)	630 (3)	613 (4)	
Upper Kittanng. Coal	766 (4)	765 (1)		758 (2)	742 (9)	747 (8)		735 (1)	739 (12)	
Middle Kittanng Coal	812 (50)	804 (11)	793 (29)	793 (7)	790 (18)	801 (9)	779 (4)	795 (4)	767 (8)	
Lower Kittanng Coal	865 (14)	848 (7)	845 (18)	847 (3)	843 (3)	841 (14)	808 (4)	848 (3)	838 (2)	
Salt Sand	1063 (11)	1045 (3)	1033 (16)	1010 (8)	1032 (9)	1029 (29)	1056 (13)	1041 (7)	1052 (17)	
a Big Lime and b Mauch Chunk red shale	b 1134 (3)	a 1119 (3) b 1125 (2)	b 1114 (5)	a 1160 (1)	a 1109 (1)	a 1174 (18)	a 1156 (15)		1133 (11) b 1140 (1)	
Big Injun sand a Upper split b Lower split	a 1180 (52) b 1312 (44)	1175 (16)	1170 (34)	a 1171 (14) b 1290 (11)	a 1168 (25) b 1338 (10)	a 1197 (36) b 1305 (13)	1184 (24)	a 1181 (9) b 1289 (6)	1159 (35)	
Squaw sand	1549 (31)	1575 (1)	1537 (15)	1519 (9)	1569 (6)	1543 (12)	1551 (7)	1524 (6)	1509 (23)	
Berea sand	1776 (21)	1660 (5)	1786 (23)	1777 (7)	1786 (16)	1782 (12)	1761 (5)	1767 (9)	1761 (37)	Pgh.
Murrysville sd.	1878 (95)	1864 (28)	1875 (40)	1871 (16)	1890 (36)	1897 (47)	1865 (18)	1872 (12)	1826 (33)	Bldwn. N.Ver. Pgh.

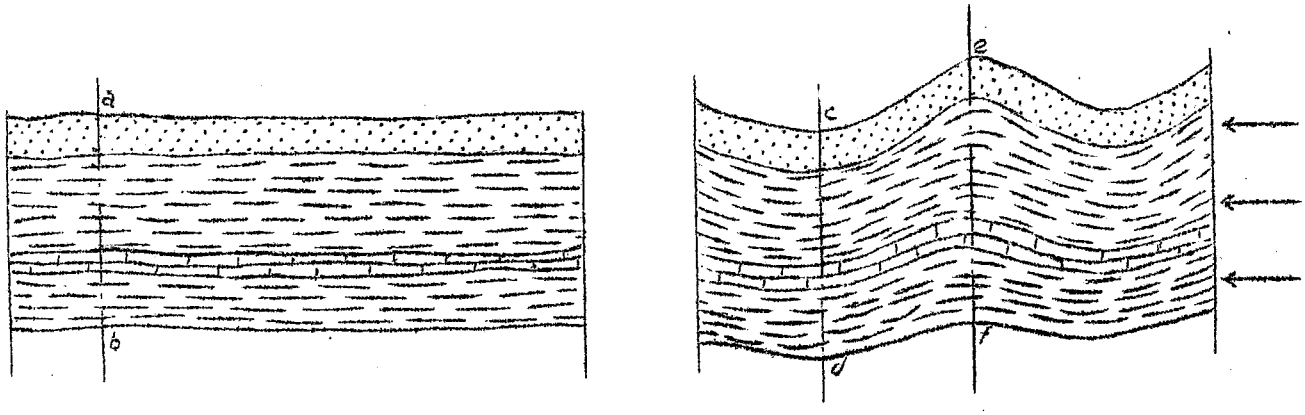
Sands & other strata encountered & noted by driller.	Township or other area									
	PLUM	PENN-WELLS IN 100' OIL POOL	PENN-OTHER WELLS	WILKINS	PATTON	NORTH VERSAILLES	MIFFLIN	BRADDOCK & PITTSBURGH (CITY)	BALDWIN	Where commonly productive
Hundred foot sd. (or Gantz)	2007 (94)	2005 (36)	1999 (41)	2005 (15)	2023 (38)	2040 (47)	1985 (26)	1997 (7)	1960 (31)	Baldwin N. Ver. Plum Patton Penn
Fifty foot sd.							2038 (3)		2017 (13)	
Thirty ft. sd.	2138 (34)	2143 (13)	2133 (39)	2107 (2)	2141 (13)	2148 (10)	2109 (19)	2136 (7)	2102 (33)	
Snee sand	2183 (3)		2173 (17)	2173 (12)	2188 (3)	2217 (15)	2177 (15)		2182 (35)	Penn
Boulder (Gordon Stray) sand	2219 (17)	2210 (11)	2222 (12)	2207 (3)	2239 (10)	2280 (9)	2224 (9)	2216 (4)	2227 (17)	
Third or Gordon sand	2280 (17)	2282 (9)	2278 (22)	2260 (7)	2312 (8)	2336 (19)	2281 (23)	2259 (4) 2309 (4)	2274 (36)	Baldwin
Fourth sand	2345 (41)	2335 (16)	2351 (30)	2338 (15)	2372 (12)	2382 (8)	2354 (26)	2378 (5)	2343 (39)	Penn Wilkins
Fifth sand	2441 (73)	2432 (20)	2425 (37)	2401 (5)	2441 (24)	2448 (23)	2414 (15)	2437 (4)	2458 (17)	Penn Patton Plum Mifflin Baldwin
Sixth sand	2489 (17)	2499 (1)	2490 (1)	2446 (12) 2489 (1)	2492 (19)	2517 (13)	2486 (2)	2485 (1)	2485 (5)	Patton Baldwin
Eliza. sand	2539 (34)	2533 (6)	2554 (6)	2544 (4)	2545 (30)	2581 (28)	2537 (9)	2517 (1)	2542 (4)	Patton Plum N. Ver. Penn

Sand & other strata encountered & noted by driller.	Township or other area									Where commonly productive
	PLUM	PENN-WELLS IN 100' OIL POOL	PENN-OTHER WELLS	WILKINS	PATTON	NORTH VERSAILLES	MIFFLIN	BRADDOCK & PITTSBURGH (CITY)	BALDWIN	
First Speech. sand	3220 (46)	3197 (2)	3153 (2)	3188 (3)	3205 (8)		3203 (2)		3177 (13)	Baldwin Patton Plum
Second Speech. sand	3289 (19)	3233 (2)	3293 (3)		3287 (10)	3326 (22)	3277 (1)	3264 (3)		N. Ver. Patton
Tiona sand	3420 (9)				3417 (4)					
Sheffield sand	3555 (7)	3607 (2)	3575 (1)	3535 (2)	3565 (5)					
Sand	3705 (6)				3766 (5)					
First Bradfrd. sand	3812 (6)	3856 (3)	3791 (2)		3861 (5)		3881 (1)			
Second Bradfrd. sand	3900 (15)				3926 (4)	3946 (3)		3920 (1)		Plum

In determining the average intervals to the various sands it was found that some of the sands vary widely in their stratigraphic position and others are quite constant. It was expected that the Mauch Chunk red shale and the Catskill red beds would be of great help in making correlations - particularly when the elevation of the well was lacking, or worse, when both the exact location and elevation were unknown. Unfortunately this was not the case. The Mauch Chunk red shale undoubtedly is missing in the stratigraphic section throughout much of the area under discussion and where present is so thin that in many wells the drillers did not notice it. The Catskill red beds almost certainly underlie the whole area, but many drillers do not recognize their value as markers, and in many well records no mention is made of them. It is hoped that in the future drillers will pay more attention to these valuable markers. A third horizon at which red beds occur is below the Squaw sand and above the Berea. Since only a few records note these red beds, they are probably not of wide extent.

It will be noted that many of the intervals for Wilkins township are smaller than the corresponding intervals for nearby townships. This condition is attributable to the fact that the upper half of the Conemaugh formation is thinner here than in any other township in the region studied. On the other hand, the intervals in both Patton and North Versailles townships are greater than the average. Re-checking the figures showed that this phenomenon is not due to mistakes in figuring the intervals; furthermore the same condition has been found farther northeast, and also southwest. A possible explanation is that this thickening of the strata is due to the presence of the Murrysville anticline. The force which created the anticline might have caused a thickening of the strata in a manner similar to that shown in the illustrations of Bailey Willis' article on "The Mechanics of Appalachian Structure."* It will be noted that in a majority of his experiments the increase in thickness due to lateral compression is greatest along the axis of the folds and that this effect is particularly pronounced where most of the material used in the experiment is relatively soft. This latter condition would seem to hold in the region being discussed, as by far the greater part of the stratigraphic column there is composed of shale. Fig. 1 is intended to show the condition of a block of the earth's crust before and after the earth movements which produced the folds of the Appalachian region.

Figure 1



"ab" = "cd" but less than "ef"

The same results can be obtained in an easy manner by exerting lateral pressure on the two edges of a thick, paper-bound book, providing that the greatest lateral movement takes place at the top. Under such conditions (and it seems probable that those conditions existed at the time of the formation of the Appalachian folds) a fold is produced which is thickest at its axis and thicker than the volume when flat.

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*Willis, Bailey, U. S. Geol. Survey, Thirteenth Annual Report, part II, p. 211, 1892.

The thickening of the strata along the Murraysville anticline could also be explained if we assumed that the anticline occupied the approximate position of that part of the Appalachian trough which received the greatest deposit of material eroded from the ancient Appalachian highlands. Until detailed studies have been made of other similar structures, it is thought unwise to hazard an opinion as to the true cause for the phenomenon described.

One other feature of the table which should be explained is the column entitled "Where commonly productive." Nearly all of the sands below the Kittanning coals are productive at some point in the area under discussion; many of the lower sands are productive in several widely spread localities (of very restricted area) not mentioned in this column; the table gives only those areas where the sands are commonly productive. Of course, even in the areas mentioned the sands are dry in some wells.

Description of "sands" and "markers."*

Gas sand. A name that drillers in Mifflin and Baldwin townships, and farther south, apply most frequently to a sand about 750-775 feet below the Pittsburgh coal. The title appears to be quite loosely applied to sands which occur anywhere from 650 to 850 feet below the Pittsburgh coal. The sand is unimportant and in this area never contains more than a puff of gas. Maximum thickness, 80 feet; average, 40 feet.

First Salt sand. A term loosely applied by drillers, chiefly in Baldwin and Mifflin townships, to an unimportant sand. Depth to top of sand from base of Pittsburgh coal, 880 to 980 feet.

Second Salt sand. (simply Salt sand in most townships.) A more definite but relatively unimportant horizon, although it is occasionally productive in Baldwin and Mifflin townships. It becomes increasingly thinner and less important towards the northeast. Salt sand is so called because it commonly contains salt water. Typically it is a white, hard sand; in some places it is split by shale partings. Maximum thickness, 60 feet; average, 40 feet.

Big Lime. An important marker in Baldwin, Mifflin and North Versailles townships. Thins rapidly towards the north. The great thickness (as much as 53 feet) given in some well records is not believed to be one solid bed of limestone, but rather several relatively thin limestone layers interbedded with clay and shale.

Mauch Chunk red shale. Occasionally noted in Penn and Plum townships; apparently lacking elsewhere. Maximum thickness, 40 feet.

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*These descriptions apply only to the area under discussion.

Big Injun sand. An important horizon. A massive sandstone with a minimum thickness of over 200 feet which is usually reported as a single unbroken stratum in Penn, Baldwin and Mifflin townships. Elsewhere it is split by relatively thin shale beds into two or three thick sandstone beds. The sand is usually light colored and of medium hardness. In many places (more particularly in the southwest) it contains a small quantity of gas, and is frequently water-bearing. The importance of the Big Injun sand is more as a marker for the drillers, than for the amount of gas it contains. It is readily recognized by its great thickness.

Squaw sand. A rather persistent and uniform sand occurring at a fairly constant horizon. The sand is usually gray to white, hard and dry. It is economically unimportant. Maximum thickness, 150 feet; average, 70 feet.

Berea sand. The unusually short interval to this sand in the northern part of Penn township determined from drill records, is thought to be due to the disappearance of the true Berea sand. The sand recorded as Berea at about 1630 feet is probably a split of the Squaw. A sand at 1775 feet below the Pittsburgh coal is noted in one well-record and probably represents the true Berea. The sand contains both gas and water in the Duquesne syncline but elsewhere is usually dry or contains water only. Several wells in Penn township got water and small quantities of gas in this sand. The color is variously reported as dark, gray or white. The sand is usually reported as hard and tight. In Baldwin township, where it is most persistent, it averages about 40 feet thick.

Murraysville sand. Although gas is often found in this sand, it frequently is accompanied by water, and wells which start with an initial production of over a million cubic feet are drowned out within a few days or weeks. The formation is usually soft to medium hard, light gray to white in color and ranges in thickness from 60 to 150 feet, averaging slightly over 100 feet. The sand is quite regular in most of the townships but towards the west changes rapidly from a massive sandstone to a sandy shale which is reported by drillers only as slate and shells. The interval to the top of the sand decreases westward and also, but less, to the north. Toward the southwest the sand is apt to be broken and split into two or more parts by shale and limestone beds.

Hundred-foot sand. A prolific sand. Of greatest importance in Plum township where oil has been obtained from it for many years. Contains gas in large quantities in several different localities. It is most regular and thickest (maximum, 145 feet; average, 110 feet) towards the east and northeast. Towards the west the sand is broken and split by shale beds. It commonly is water-bearing, but the water and gas may be separated by a cementing of the sand or a thin shale parting so that by careful drilling a well can be successfully brought in without danger from water. The sand is typically a white, medium-grained to coarse sandstone of moderate hardness. Occasionally it is reported as gray or dark.

Fifty-foot sand. A split of the Hundred-foot sand. See above.

Thirty-foot sand. Relatively unimportant. Recorded as found in only about one out of three wells in Plum, Patton, Penn, Wilkins and North Versailles townships. Towards the west it is more persistent. In Baldwin and Mifflin townships it is locally productive. One or two wells in Patton and Penn townships have also found paying quantities of gas in this sand. It is typically a hard, tight sand which varies considerably in thickness but is usually less than 50 feet. Commonly it is dry.

Catskill red beds. Red shale often occurs close beneath the Thirty-foot sand, but according to the well records at hand, the position of the first red bed is by no means constant. Apparently the first red bed may occur anywhere from 2080 to 2200 feet beneath the Pittsburgh coal. There is a fairly constant increase in the interval to the first red beds from west to east. (See also previous discussion.)

Snee sand. Unimportant. Like the Thirty-foot, it is most persistent in Baldwin and Mifflin townships. It is productive only in the Blackadore Ave. pool just east of the Pittsburgh city limits. Here it attains its maximum thickness (65 feet). Ordinarily the sand is light-colored, hard, dry and less than 30 feet thick.

Boulder (Gordon Stray) sand. A thin, unimportant sand which is usually hard, dry and barren of either oil or gas. It is most persistent in Baldwin township but even there is not recorded in the records of half the wells drilled. This sand and the two just above are so close together that it is difficult to correlate them. The fact that in some areas they unite and in others they disappear, does not make the task any easier. The sand usually is red. Its maximum thickness is about 20 feet.

Third or Gordon sand. Although a more constant horizon than either the Boulder or Snee sands, this sand also is relatively thin and unimportant. It is productive in part of Baldwin township and in a few scattered spots in other townships. Mostly it is barren of both gas and water. The sand apparently is split underneath the city of Pittsburgh and the immediate vicinity. It is usually red and hard. Maximum thickness, 40 feet; average, 16 feet.

Fourth sand. Gas has been obtained from this sand in paying quantities in every township included in this study. In two of them (Patton and Plum) however, only one or two wells got more than a show of gas. In the western part of the area under discussion, the sand is usually described as white and of medium hardness. Elsewhere it is red and apt to be hard. It varies in thickness from 0 to 50 feet, averaging about 30 feet. The stratigraphic position is fairly constant within township limits. This and all lower sands are usually free of water except where it has been let in by abandoned and improperly plugged wells.

Fifth sand. Although productive over a smaller area than the Fourth sand, this sand undoubtedly has produced more gas than any sand above it save perhaps the Hundred-foot. In both Penn and Plum townships it is the chief producing (gas) sand. It is more regular

than the Fourth sand and averages about 5 feet thicker. It is usually found just below the Catskill red beds although occasionally a red bed is reported below it. Where productive the sand is open, light colored and of medium hardness. Elsewhere it is hard and gray. Like many of the sands already described, it thins and disappears towards the west.

Sixth sand. As shown by the table, this sand is not persistent except in Plum, Patton and N. Versailles townships. It is not important even there. Usually it is thin (less than 30 feet) and it may range in color from dark to white. In Plum and Patton townships it occasionally contains "shows" of oil.

Elizabeth sand. This sand is also most persistent in Plum, Patton and North Versailles townships and attains its greatest importance along the Murraysville anticline. In the western townships usually it is either missing or very thin. Its color ranges from dark to white, and the texture from fine and hard, to medium and moderately soft. It occasionally contains small "shows" of oil and in Patton township one small pool was developed. In the latter township it attains a maximum thickness of 40 feet, but averages only 18 feet.

Between the Elizabeth and First Speechley sands there is no sand of sufficient importance or persistence to warrant describing it. Such sands as are reported are usually thin and dark-colored. No production has been reported from any of them.

First Speechley sand. This sand has a typical chocolate color, usually, and where productive is of medium hardness. Considerable oil, as well as gas, has been obtained from it in Plum township where it is quite regular in its occurrence and is of maximum thickness (30 feet) and importance. Lesser quantities of gas have been obtained from it in Patton and Baldwin townships. Except in Plum township the sand is apt to be irregular. It thins rapidly towards the south and west and in many places is missing.

Second Speechley sand. This sand is of chief importance along the Murrysville anticline. In North Versailles and Patton townships it is one of the chief producing sands. South of the area under discussion a very prolific pool was developed in this sand near McKeesport. In North Versailles township it attains a maximum thickness of about 50 feet. The gas is usually found near the bottom of the sand. Where it is productive the sand is dark and medium grained. Where dry it may be light-colored or white. The interval to the sand is fairly constant within small areas but decreases gradually towards the west. It also is less persistent in that direction.

Between the Second Speechley and the Bradford group of sands is a thick series of vari-colored shales with occasional unimportant and non-persistent sand strata.

Bradford sands. The sands of this group are quite irregular, their thickness and stratigraphic position changing considerably within short distances. They are most persistent and have been found

to contain gas only in the eastern part of the area under discussion. In that district they vary in thickness from 0 to 80 feet, the average thickness being about 30 feet. Where productive they are dark-colored, open-grained and fairly soft. Toward the west they thin rapidly and disappear. The deepest producing horizon yet found in any well in this area is that encountered by the T. W. Phillips Gas & Oil Co. No. 2 well on the Thos. E. Mallissee farm in Plum township. Gas is obtained in this well at a depth of 3980 feet below the Pittsburgh coal. Deeper drilling so far has failed to find gas in lower sands. This is no proof that a lower producing horizon might not be found, as only a few wells have reached a depth of 4000 feet below the coal.

Conclusion. It will be noticed that in the above descriptions continual reference was made to the thinning of the sands in a westerly direction. This tendency is quite marked. Provided the original supply of gas was the same in all parts of the area under consideration, the greater percentage of sand towards the east would certainly provide increased opportunity for the storage of the gas and a generalization might safely be hazarded that the opportunity of tapping new gas pools is best in that direction.

In conclusion the author expresses the hope that this paper will be useful to operators and drillers in the district discussed. The correlations made are based on all the data at present available and are correct within the area studied. Anyone who finds an apparent error or disagrees with the figures or statements is invited to communicate with the author.

Drillers should not accept the table incorporated in this report as representative of every hole. It cannot be, and is meant to be used only as a guide. In drilling a well, all coals, red beds, sands and limestones should be recorded, regardless of whether they fit in with the table.