

Hopi Oil Co. #1
NW/4-NE/4 Sec21-Twp15N-R19E 9-7
Navajo County, New Mexico

P-W

County Navajo
Area Holbrook
Lease No. _____

Well Name Hopi Oil Company #1
Location NW NE Sec 21 Twp 15N Range 19E Footage _____
Elev 5985 Gr _____ KB Date _____ Spud _____ Completed _____ Total Depth 2420
Contractor: _____ Abandon _____ Approx. Cost \$ _____
from USGS Dry Lake 7 1/2' guard per JMC

Casing Size	Depth	Cement
_____	_____	_____
_____	_____	_____
_____	_____	_____

Drilled by Rotary _____
Cable Tool _____

Production Horizon _____
Initial Production D&A

REMARKS Supai 465

Redwell 1725

Elec. Logs (1) Sample Log _____
Sample Descr. _____
Applic to Plug _____ Plugging Record _____ Completion Report _____ Sample Set _____
Cores _____

Water well - accepted by _____

Bond Co. & No. _____

Bond Am't \$ _____ Cancelled _____ Date _____ Organization Report _____

Filing Receipt _____ Dated _____ Well Book _____ Plat Book _____

Loc. Plat _____ Dedication _____

PERMIT NUMBER none

Date Issured _____

9-7

County Navajo

Area Holbrook

Lease No. _____

Well Name Hopi Oil Company #1

Location NW NE Sec 21 Twp 15N Range 19E Footage _____

Elev 5985 Gr _____ KB Date _____ Spud _____ Completed _____ Total _____

Contractor: _____ Abandon _____ Depth 2420

Approx. Cost \$ _____

Casing Size _____ Depth _____ Cement _____ Drilled by Rotary _____ Cable Tool _____

Production Horizon _____

Initial Production _____ D&A

REMARKS Supai 465

Redwell 1725

Elec. _____ Sample Log _____

Logs (1) _____ Sample Descrip. _____

Applic _____ Plugging _____ Completion _____ Sample Set _____

to Plug _____ Record _____ Report _____ Cores _____

Water well - accepted by _____

Bond Co. _____

& No. _____ Date _____

Bond Am't \$ _____ Cancelled _____ Organization Report _____

Filing Receipt _____ Dated _____ Well Book _____ Plat Book _____

Loc. Plat _____ Dedication _____

PERMIT NUMBER none Date Issured _____

9-7

LOG OF HOPI OIL COMPANY

NW NE Sec. 21, T. 15 N., R. 19 E., G&SRM
Well 1, drilling ceased prior to 1927.

Patented land - State of Arizona
County Navajo
Field Holbrook area
District Farmington

<u>From</u>	<u>To</u>	<u>Formation</u>
1	465	Cross-bedded Coconino
465	625	Red sandstone
625	679	Sand and lime mixed
679	710	Gray sandstone, water (wind resembling gas)
710	1075	Red salty mixture
1075	1200	Black sandy shale
1200	1285	Salt
1285	1550	Red sandstone and salt
1550	1590	Limestone, hard
1590	1725	Salt and red sandstone
1725	1780	Black lime, very hard
1780	1875	Chunky, pebbly oil sand (no scent and no oil)
1875	1986	Sandstone, salt and mud; no water
1986		Water sand, no water

Formation Tops

0-465	Coconino
465-1986	Supai
TD	1986'

Log of Hopi Oil Co. well from USGSWSP #836-B-

0	465	Coconino sandstone - sandstone, hard, cross-bedded, gray to buff.
		<u>Supai formation</u>
465	625	Sandstone, red
625	697	Limestone, sandy, red
697	710	Sandstone, gray
710	1075	Shale, etc, red.
1075	1200	Shale, sandy, black
1200	1725	Sandstone, red with salt beds. (Limestone 1550-1590) <u>Redwall Limestone</u>
1725	1788	Limestone, very hard, black on blue
1788	1875	Sandstone
1875	2175	Sandstone, red, with salt in upper half
2175	2355	Limestone, red sandy, hard
2355	2400	Sandstone, buff
2400	2420	Limestone, sandy and red sandstone

Another record gives red sand and shale, 2196-2235', and white "lime" 2505-2520'. Possibly base of the Supai was at 1725', but red material occurs in underlying strata.

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Log of Hopi Oil Co. well from U.S.G.S. W.S.P. #836-B-

0	465	Cognino sandstone - sandstone, hard, cross-bedded, gray to buff
		<u>Supai formation</u>
465-	625	Sandstone, red
625	697	Limestone, sandy, red
697	710	Sandstone, gray
710	1075	Shale, etc. red
1075	1200	Shale, sandy, black
1200	1725	Sandstone, red, with salt beds (Limestone 1550 - 1590)
		<u>Redwall limestone</u>
1725	1788	Limestone, very hard, black or blue
1788	1875	Sandstone
1875	2175	Sandstone, red, with salt in upper half
2175	2355	Limestone, red sandy, hard
2355	2400	Sandstone, buff
2400	2420	Limestone, sandy and red sandstone

Another record gives red sand and shale, 2196 - 2235 and white "lime" 2505 - 2520. Possibly base of the Supai was at 1725, but red material occurs in underlying strata.

Mr. Permut

log of Hopi Oil Co. well from USGS WSP #836-B-

0-465 - Coconino sandstone - sandstone hard,
cross-bedded, gray to buff -

Supai formation

465-625

Sandstone, Red

625-697

limestone, sandy, red.

697-710

Sandstone, gray

710-1075

Shale, etc, red.

1075-1200

Shale, sandy, black

1200-~~1725~~

Sandstone, red, with salt beds -

(limestone 1550-1590)

~~1725-1788~~

Redwall ~~formation~~ limestone

1725-1788

limestone, very hard, black on blue

1788-1875

Sandstone

1875-2175

Sandstone, red, with salt in
upper half

2175-2355

limestone, red sandy, hard

2355-2400

Sandstone, buff

2400-2420

limestone, sandy and red sandstone.

Another record gives red sand and shale, 2196-
2235, and white "lime" 2,505-2520. ~~Possibly~~
Possibly base of the Supai was at 1725, but
red material occurs in underlying strata.

the permit

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NW NE,
 Log of HOPI OIL COMPANY - Sec. 21, T. 15 N., R. 19 E., G. & S. R. M.
 Well 1. Drilling ceased prior to 1927.

Patented land - State of Arizona
 County - Navajo
 Field - Holbrook Area
 District - Farmington

<u>From</u>	<u>To</u>	<u>Formation</u>
1	465	Cross-bedded Coconino Coconino
465	625	Red sandstone
625	679	Sand and lime mixed
679	710	Gray sandstone, water (wind resembling gas)
710	1075	Red salty mixture
1075	1200	Black sandy shale
1200	1285	Salt
1285	1550	Red sandstone and salt
1550	1590	Limestone, hard
1590	1725	Salt and red sandstone
1725	1780	Black lime, very hard
1780	1875	Chunky, pebbly oil sand (so scent and no oil)
1875	1986	Sandstone, salt and mud; no water
1986		Water sand, no water.

~~(in Supai at bottom of hole. Dist.)~~

~~TD~~ Formation tops

0 - 465 Coconino
465 - 1986 Supai
TD 1986.

No permit

Log of HOPI OIL COMPANY - NW $\frac{1}{4}$ NE $\frac{1}{4}$, Sec. 21, T. 15 N., R. 19 E.,
 G. & S.R.M. Well 1. Drilling
 ceased prior to 1927.

Patented land - State of Arizona
 County - Navajo
 Field - Holbrook Area
 District - Farmington

<u>From</u>	<u>To</u>	<u>Formation</u>
1	465	Gross-bedded Coconino
465	625	Red sandstone
625	679	Sand and lime mixed
679	710	Gray sandstone, water (wind resembling gas)
710	1075	Red salty mixture
1075	1200	Black sandy shale
1200	1285	Salt
1285	1550	Red sandstone and salt
1550	1590	Limestone, hard
1590	1725	Salt and red sandstone
1725	1780	Black lime, very hard
1780	1875	Chunky, pebbly oil sand (no scent and no oil)
1875	1986	Sandstone, salt and mud; no water
1986		Water sand, no water.

Formation

0 - 465 Coconino
 465 - 1986 Supai

TD 1986

McCormick

Holbrook Oil Company. The well sunk by this company on the southern flank of the Holbrook monocline, about ten miles northwest of the Adamana hole, in Sec. 23, Township 15 N., Range 18 E, 21 miles southwest of Holbrook, was drilled to a depth of 2,400 feet in 1922.

The Jerome-Navajo Drilling Company. (Organized in 1924 to continue the Holbrook well). This company drilled to a depth of 3,775 feet in 1925. Traces of gas and oil were reported at that depth.

Hopi Oil Company. The well of this company, about half way between the Holbrook and Adamana holes, was carried down 2,500 feet. A few showings of gas were reported. This hole is in Sec. 21, Township 15 N., Range 19 E., about twenty miles southwest of Holbrook. The lower Paleozoic beds were not tested.

Great Basin Oil Company. This company, promoted by E. S. Taylor, sank its well in 1925 and 1926, considerably north of the Holbrook monocline, five miles southwest of Holbrook on a doubtful structure. The hole was carried down to a depth of 4,675 feet, and was drilled to within a few hundred feet of the base of the Paleozoic section. Traces of oil were reported at about 1,700 feet and again from 4,245 to the bottom of the hole.

Conclusion. The Holbrook monoclinial fold is a major structural feature of the region which extends in a southeasterly direction from between Clear and Chevelon creeks, south of the railroad to about eleven miles east of Snowflake, a distance of fifty miles. This structure has been tested only in one limited part, covering a distance on the strike of about 12 miles, and there by only two holes. At the points tested, definite traces of gas and oil were found at various horizons. The results achieved, although disappointing, are, notwithstanding, inconclusive.

ZUNI AREA

In this area, about twenty miles northeast of Holbrook, there exists a very gentle synclinal trough with minor crinklins, a structure not favorable for oil accumulation.

Oil Prospecting: One hole was put down by the *Zuni Oil Company* in Sec. 6, Township 19 N., Range 24 E., 22 miles northeast of Holbrook. The well was drilled over 1,000 feet deep and it was reported that a trace of oil was found at 950 feet. The hole started in Triassic and penetrated only the top Paleozoic sandstones.

LUPTON STRUCTURE

This structure, on the southern end of the Defiance Uplift, is a

Arizona Bureau of Mines Bulletin 130, 1931

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RECORD OF ADAMANA BORE HOLE, SEC. 4, T. 14, R. 20,
SOUTHWEST OF HOLBROOK, ARIZONA

Feet	Material	Formation
0- 60	Red shale	Moenkopi
60- 80	Limestone, yellow, very sandy	Kaibab
80- 394	Sandstone, yellow	Coconino
394- 439	Shale, white	
439- 549	Sandstone, mostly buff, some reddish	
549- 680	Sandstone, white	
680- 692	"Limestone", hard	Supai
692- 855	Red shale, some gypsum and salt	
855-1040	Shale, brown	
1040-1050	Lime, blue	
1050-1090	Shale, brown, and salt	Redwall
1090-1745	Shale, blue and brown, salt	
1745-1950	Limestone, blue	
1950-2040	Sandstone and salt	Redwall
2040-2150	Shale, brown	
2150-2345	Limestone, some shale	

This record was to the end of January, 1921. A year later the depth was 350 feet greater, and soft, brown beds were being penetrated. In February, 1923, the depth was about 3,000 feet and the material was black shale. The Supai formation appears to be about 1,065 feet thick in this hole, but there is some uncertainty as to its lower limit.

RECORD OF HOPI BORING, IN SEC. 21, T. 15 N., R. 19 E.,
SOUTHWEST OF HOLBROOK, ARIZONA

Feet	Material	Formation
0- 465	Sandstone, hard, cross-bedded, gray to buff	Coconino
465- 625	Sandstone, red	Supai
629- 697	Limestone, sandy, red	
697- 710	Sandstone, gray	
710-1075	Shale, etc., red	
1075-1200	Sandy shale, black	Redwall
1200-1725	Sandstone, red, with salt beds, (limestone, 1550-1590 feet)	
1725-1788	Limestone, very hard, black on blue	
1788-1875	Sandstone	Redwall
1875-2175	Red sandstone with salt in upper half	
2175-2355	Limestone, red, sandy, hard	
2355-2400	Sandstone, buff	
2400-2420	Sandy limestone and sandstone, red	

Another record gives red sand and shale 2196 to 2235 feet, lime and shale, 2235 to 2505 feet, and white "lime," 2505 to 2520 feet. Possibly the base of the Supai was at 1725 feet, but red material occurs in underlying strata.

Early in 1925 the Taylor-Fuller boring penetrated arkosic sandstone 3685-3870 feet, limestone 3870-3994 and red and brown hard sandstone 3994-4112 feet, possibly strata of the Apache group which outcrop on Canyon Creek 60 miles southwest.

The Holbrook boring (No. 1) about three miles west of the Hopi hole is reported to have entered red shale at 511 feet, which continued to 935 feet, interrupted by limestone from 680 to 692 feet and by gypsum at intervals from 692 to 865 feet and some salt from 855 to 935 feet. Apparently there are local salt basins in Permian and Pennsylvanian strata in this region.

The westernmost bore hole, which is at the Black Canyon claim in Section 20, T. 16, R. 17, was sunk 476 feet with diamond drill. The cores were nearly all light colored sandstone (Coconino). Some layers were found to contain considerable calcium carbonate and a few thin layers of shale were penetrated. The mesa at this place is capped by the thin Kaibab limestone, the upper part very sandy. A boring for water at Winslow had reached a depth of 965 feet late in 1924 all in Coconino sandstone below 100 feet. The overlying Kaibab was thin.

The thinning of the Kaibab limestone in the plateau south of Holbrook is an interesting feature which has been described in considerable detail on a previous page. It results in the disappearance of the formation at Holbrook, although its thin edge is well characterized a short distance south of that place and near Winslow and Snowflake. It is absent in the basin northeast of Holbrook and in the Defiance uplift where the Moenkopi formation, and to the northward the Shinarump conglomerate, lies on the Coconino sandstone.

As shown in Plate 52, the dome of the Holbrook region trends northwest and finally flattens out in the monocline southeast of Winslow. It is broad and flat to the southeast along the Little Colorado River, which cuts a canyon across it, mostly with walls of Coconino sandstone, from near Snowflake to Holbrook. Woodruff Butte consists of Moenkopi, Chinle, and Shinarump beds in a shallow basin, capped by basalt (See Pl. 60a.) Possibly the vent from which this latter rock came is in the butte. Just east of Taylor there is a small local dome in which the Coconino sandstone is revealed overlain by yellow sandy Kaibab limestone only a few feet thick.

The Sinks are on the south slope of the large dome, about 10 miles northwest of Snowflake. There are 30 or 40 of them, ranging from a few yards to 100 yards in diameter, in an area about a mile in length, and all near or on the steep dip to the south. Most of them expose sandstone of Coconino aspect (see Pl. 60b), overlain by Kaibab limestone, here 20 or 30 feet thick. Undoubtedly this sandstone is underlain by a limestone member which has been removed in places by solution in underground waters passing into the valley of Dry Lake to the southward.

This latter valley is a syncline filled with Moenkopi formation, as shown in the cross section (Fig. 28), which extends nearly to Cheylon Canyon. In the center of the basin, southwest of the Sinks, are two buttes capped by Shinarump conglomerate.

The Moenkopi extends far up the slopes south of Dry Lake Valley, and on an irregular surface of this formation and in places overlapping on to the Kaibab limestone, is the cap of Upper Cretaceous strata which

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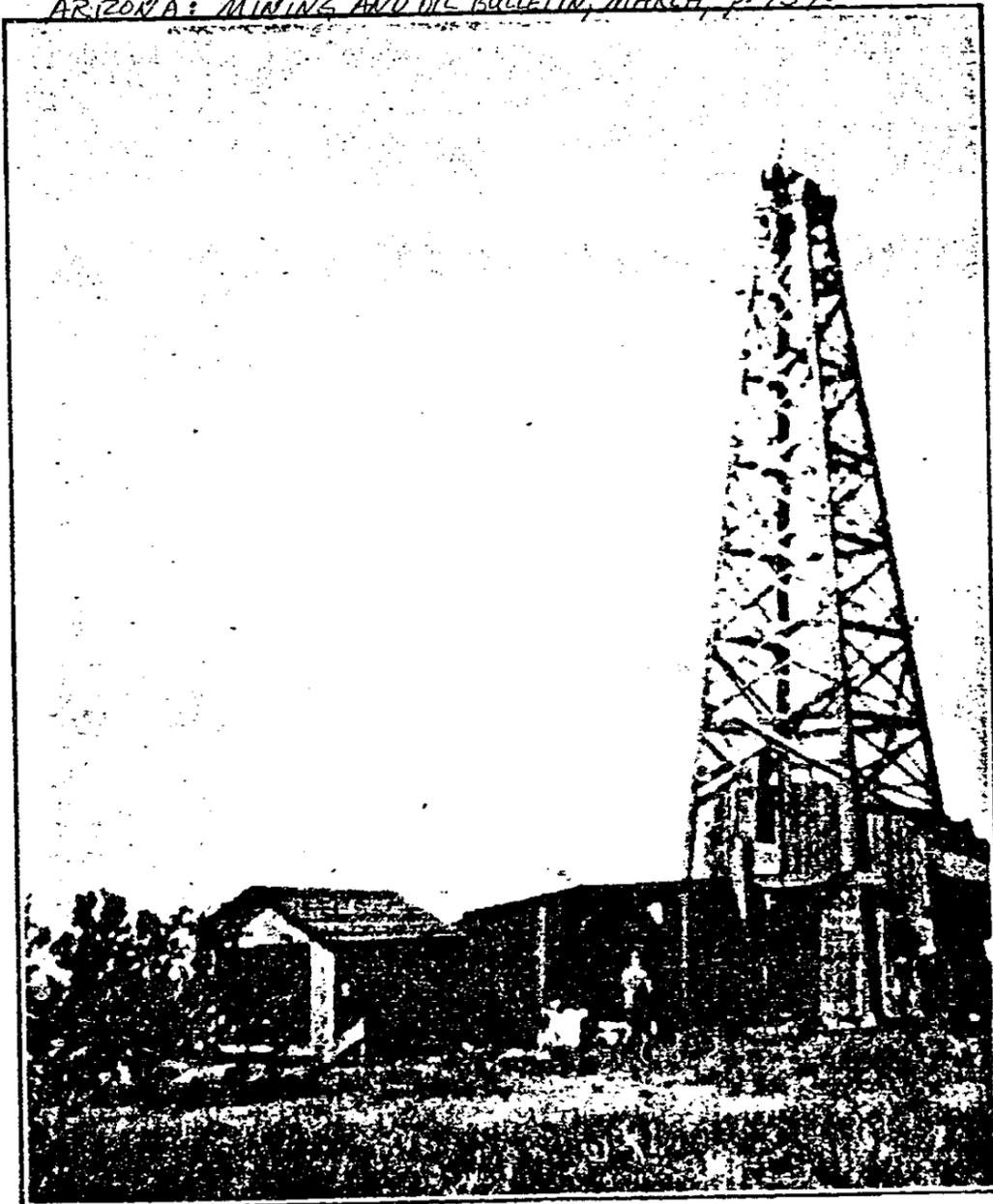
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largely as a result of lack of funds due to the
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also due to the fact that some of the locations
are not the most favorable ones for testing out
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been consumed in getting to a depth of 2500
feet is fully accounted for by these circum-
stances.

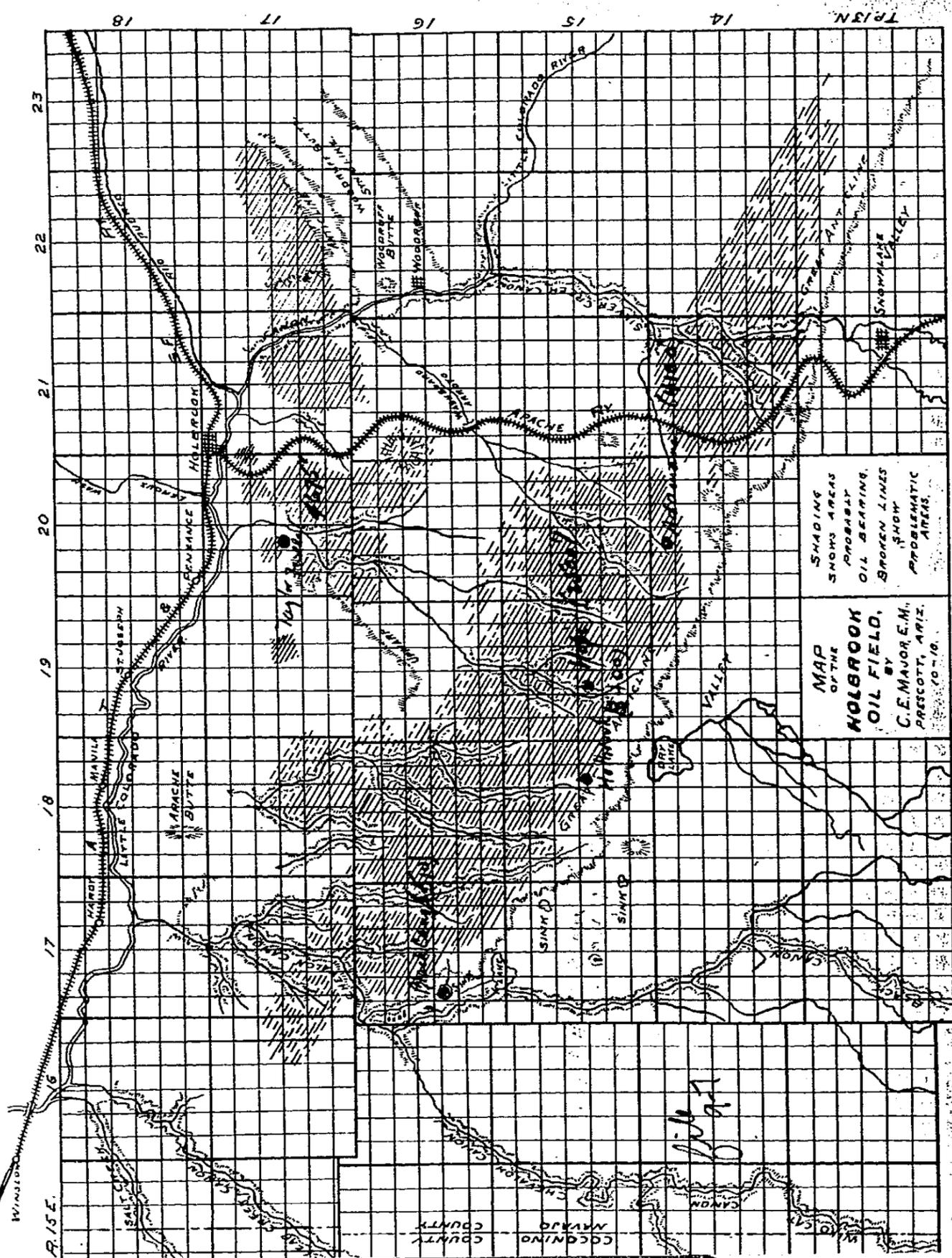
*IN: HAGER DORSEY, 1922, OIL POSSIBILITIES-HOLBROOK AREA -
ARIZONA: MINING AND OIL BULLETIN, MARCH 7, 1929.*



HOPI WELL, HOLBROOK, ARIZONA.

4, Township
miles south of

CONCLUSION.



Petroleum

Geology and Oil Prospects

of

Holbrook District

Arizona

by

Harry R. Johnson
Union Oil Building
Los Angeles,

August 18, 1919

file 9-7

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Introduction

In view of activity toward oil development near Holbrook, Arizona, which, in addition to arousing intense local interest, is now commanding the attention of outside operators, a review of the conditions found there will be presented, including present development, status of lands, and the indications and possibilities regarding oil.

Location and Topography

The town of Holbrook, about 900 population, is situated on the Santa Fe Railroad, 60 miles from the eastern border of the State. Two banks, several wholesale and retail merchandise establishments, two newspapers and half a dozen hotels make it headquarters of the ranching and Indian reservation interests, and lately, for oil development work in that section. It is on the Ocean-to-Ocean Highway, and dirt roads into the surrounding country are fairly well kept up. Winslow, Arizona, 33 miles west of Holbrook (population 2000) may also be considered within the oil development area.

The Little Colorado River flows intermittently thru both Holbrook and Winslow, the wells 300 feet deep and reservoirs formed by damming creeks form the water supplies of the towns. A sparse growth of scrub timber, found on the hills south of Holbrook, is a source of fuel for drilling, and coal is brought in from New Mexico. The elevation of Holbrook is 5,080 ft; that of Winslow is 4,850 ft.

Topography

The Holbrook district is situated on the plateau province of Arizona, at the south border of the Navajo County which extends with little variation in topography north 175 miles into Utah. The surface is cut by occasional deep canons, due to the swift torrential streams. As a rule, the region is a prairie country, with scattered buttes, the remnants of lava flows or erosional features. To some extent the topography conforms with the bedding, comprising a gently rolling surface that follows the barely perceptible bend of the hard sandstone strata beneath. The plateau country, from the Utah border to 90 miles south of Holbrook, maintains an elevation between 4800 and 6000 feet throughout.

Maps and Photography

The accompanying composite map will serve to indicate the geographic, topographic and geologic conditions of this district. The stratigraphy is based on Herbert E. Gregory's U.S.G.S. Professional Paper, 93, long accepted as a standard on the geology of the Navajo County. The structural geology, as mapped, is the result of the writer's investigations made in a general way only, and not detailed. The accompanying photographs show the general appearance of the country, and the position from which each was taken is indicated on the map.

Development and Operations to Date

The Aztec Land and Cattle Company have been in possession for a number of years, of nearly a million acres of land in this district, formerly owned by the Santa Fe Railroad. A portion of this land has recently been leased by the Hopi Oil Company of Holbrook, and in October of 1918, a well was started on their property in Sec. 21, T. 15 N., R. 19 E., at the end of July 1919, a depth of 2050 ft. had been reached with no showing except a slight color at about 425 ft. (This showing appears in the oil wells drilled so far and in water wells, and will be commented on later.) The Wind River Oil Co., of Wyoming is drilling this well for the Hopi Oil Company on a participating interest basis.

9-6 The Holbrook Oil Company, with close to 60,000 acres of patented and leased land, is drilling a well on Sec. 23, T. 15 N., R. 18 E., now 100 ft. and waiting for tools.

9-7 The Adamana Oil & Land Company, with 40,000 acres, has reached a depth of 1060 ft. on Sec. 4, T. 14 N., R. 20 E., drilling.

9-9 The Black Canyon Oil Company (McCloskey interests of Holbrook) with 50,000 acres has drilled to 500 ft. with a core drill on Sec. 20, T. 16 N., R. 17 E., seventeen miles southerly from Winslow.

The Apache Oil & Development Company has a location in Sec. 7, T. 16 N., R. 21 E.; the Holbrook Oil Co. a location in Sec. 22, T. 17 N., R. 21 E.; the Lone Star Oil Co. a location in Sec. 6, T. 19 N., R. 23 E.; the Zuni Oil Co. a location in Sec. 6, T. 19 N., R. 24 E.

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Other Arizona companies organized to secure leases include the Winslow Oil Co., Cheylon Oil Co., Home Oil Co., Klatawa Oil Co., Holbrook Investment Co., Winslow Mutual Oil Association, and Shamrock Oil & Development Co., all of whom contemplate putting down rigs eventually and are at present offering leases or shares on the market in any size blocks. The land is thoroughly taken up to the extent of some 1100 square miles.

Geologist representing the Carter Oil Co., Commonwealth Oil Co., Allen Oil Co. (of Oklahoma) Union Oil Co., of California, Standard Oil Co. of California and Sinclair Oil Co., have visited the district in the past, it is reported.

Results Obtained by Drilling

The progress of the Hopi Oil Co., well in Sec. 21-15-19 is being watched with interest by all parties concerned in the Holbrook field. The depth of the oil bearing horizon (if one should exist) is purely speculative, inasmuch as there is no criterion in the way of drilled wells to guide the prospectors. At a depth of 2050 ft. the Hopi drill has passed the horizon that carried oil in the San Juan Oil field, 160 miles to the north, where wells of

Small production (5 to 15 bbls. per day) were secured at depths ranging from 300 to 750 ft. The Hopi well is drilling with standard tools in an open hole, encountering alternate sandstone and lime, with very little shale. At 1950 ft. very little water had been encountered, tho at 2025 ft. the drill penetrated a "saturated water sand." This is considered significant from the standpoint that it indicates the possible presence of sufficient underground water to assist in the accumulation of oil, a point which will be touched upon later in this report.

The other drilling wells in the locality have not reached sufficient depth to add to the knowledge of underground conditions. However, the Adamana in Sec. 4-14-20 encountered a 50 ft. bed of impure salt at a depth of 650 ft., which was not noted in the Hopi well. Similar salt deposits were noted in water wells near Winslow and elsewhere.

With the test wells now drilling, a rea fifty miles long and some fifteen miles wide will be proven up, provided the wells are carried to sufficient depth. The broad form of folding found in this territory does not sharply segregate the district into likely and unlikely territory as in California or Wyoming fields, though the anticlines and synclines are sufficiently well developed as to make each a separate drilling possibility.

Geology and Structure

The Navajo Country of Arizona comprises a well recognized geographical and geological unit. It includes a gently rolling plateau area that extends roughly from the Utah border south thru Arizona 190 miles or 50 miles south of the Santa Fe Railroad and Holbrook; and from the Colorado and Little Colorado Rivers on the west to the Continental Divide (approximating Gallup, New Mexico) on the east. The general elevation of the surface of this plateau is between 4800 and 6000 ft.

Throughout this plateau the sedimentary strata (of Mesozoic and Paleozoic age) extend without perceptible break and with little warping except at the boundaries of the region. The slight warping on a broad scale, has placed the bed in the form of a geo-syncline extending southerly from the San Juan River (and oil fields) in Utah to Holbrook, though making a long general slope upward to and south of Holbrook. Along a line situated fifteen miles south of Holbrook this upward slope terminates and the beds bend over in an anticlinal fold that is barely perceptible, and assume a dip toward the south. The gentle folding is on such a large scale that many smaller anticlinal and synclinal folds are encountered as one traverses the district. Thus the "great anticline" or "Holbrook structure," as the major anticlinal (or doming) fold has come to be known, is the location selected for prospecting by the Holbrook interests. The minor folds take the form of partly-closing domes on the flanks of the major structure, or anticlines and synclines whose trend has apparently little conformance with the trend of the major anticlinal axis. The location of many of the minor folds, both anticlinal and synclinal, have been selected by the various operators as suitable

locations for drilling, which accounts for the wide dispersion of test wells in the district.

The San Juan oil field, with its known oil measures, has been used by geologists as a criterion at Holbrook, as far as possible, though, as mentioned previously, the measures containing oil at San Juan have been pierced by the drill at Holbrook, and have proved unproductive. The geologic section at Holbrook may be given as follows:

Era	Period	Series	Group	Formation	Thickness (Estimated)	Description	
Mesozoic	Triassic			Chinle	1000 Plus	Gray, purplish shale.	
				Shinarump	5-20	Heavy conglomerate	
				De Chelly	0-20	Red sandstone	
			Permian		Moenkopie	100-300	Red shale and sandstone
Paleozoic	Carboniferous		Aubrey	Kaibab	0-60	Limestone	
				Coconino	300	Gray & white cross-bedded sandstone	
			Pennsylvanian	Supai	1500	Sandstones & limestones (oil bearing at San Juan)	
			Mississippian		Redwall	500 (?)	Limestone
			Cambrian		Tonto	900 plus (?)	Shales and sandstones
Proterozoic	Pre-Cambrian			Unkarchuar	5000 plus (?)	Shales, sandstones, quartzite, limestone, Granites, gne. schists.	

The surface rock in the vicinity of Holbrook is the Moenkopie. Toward Winslow the Moenkopie is entirely eroded away, exposing the Kaibab Limestone, which is there only 8 ft. in thickness. The Coconino sandstone is exposed in the walls of Cheylon and Clear Creek Canons, southeast of Winslow. There the walls stand 100 ft. above the waters which have been dammed up to form reservoirs.

Thus the wells drilled thus far penetrate a lower portion of the Moenkopie; may or may not encounter the Kaibab limestone, according to their location (as the Kaibab does not underlie all this region;) and pass into the Supai Lower Pennsylvanian, the thickness of which is unknown here, but judging from distant outcrops, will probably be upwards of 1500 ft. This formation is oil bearing in the San Juan oil field (known there as the Goodridge sands of the Aubrey group.) The lower portion of the Supai is the objective of the drillers at Holbrook. The well of the Hopi Company as has been mentioned previously, has passed the upper members of the Supai and at 2050 ft. (August 1, 1919) should have reached the lowermost members, and has not yet encountered the oil. The well will be carried down into the Redwall lime if necessary, it is understood.

Beneath the Redwall limestone there is encountered in other parts of Arizona (Grand Canon section) a tremendous thickness of Cambrian and Pre-Cambrian sedimentaries that lie on the primitive granites and schists, the thickness, or even presence of which beneath the Holbrook area is unknown, and their possibilities as a source of petroleum is highly improbable.

As regards lava flows in this vicinity, remnants of basaltic flow rock are still to be found at no great distance, notably at Goodruff Butte, 10 miles southeast of Holbrook, where a resistant basaltic cap rests on the chert shales. Other basaltic remnants occur in large masses 25 miles north of Holbrook. Twin Buttes, 18 miles north of Holbrook, are of intrusive origin.

The plateau region in general has been the scene of intrusive action thru-out Triassic, Tertiary and even recent ages, the region 75 miles southeast of Holbrook (near Springerville) and 40 miles west of Winslow (San Francisco Mountain volcanic field) being notable examples of fresh volcanic activity, with unusually perfect cinder cones and lava flows. The particular region about Holbrook and Winslow, however, has not been subjected to volcanic action (though the general detrimental effect of neighboring intrusive activity on the accumulation of petroleum should not be overlooked.)

Faulting does not occur to any perceptible extent in the Holbrook area. The maximum dips encountered are $3\ 10/2$ on the flanks of the smaller folds; the general dip of the beds toward the north on the north portion of the major anticline is $10/2$, and the same toward the south.

Emphasis must be placed here upon the importance of under-

ground water as a factor influencing the accumulation of petroleum. A sufficient supply of underground waters, constituting a hydrostatic head, will tend to accumulate the oil in porous beds under an impervious shale or limestone cap in the top or apex of the anticlines and domes, due to the higher specific gravity of the water. Lack of water will allow the oil to settle in the synclines. In most oil fields the oil is found in the anticlines, where it is impounded by waters bearing it up from beneath. At the San Juan Oil Field, however, the oil is recovered from the synclines due to the absence of a hydrostatic head of water. In this case, the deep-cut canyons of the San Juan River and its tributaries have apparently drained the oil bearing strata of water, leaving the oil to settle in a general way in the synclines.

At Holbrook the feature of deep-cut canyons is not encountered; but it is possible in this region, where there is no higher land within forty miles, and where the stratification (level, resistant, compact beds) is conducive to quick run-off of surface waters, and where a general condition of aridity exists, that there may be the lack of underground waters necessary to the anticlinal accumulation of oil.

On this hypothesis the location of the Adamana Oil Co. well, Sec. 4-14-20, has been made on a syncline. In this connection also the logging of a "saturated water sand" in the Hopi Co. Well, Sec. 21-15-19, at 2025 ft. is significant, as mentioned previously, in that it gives an indication as to what may be expected of water conditions, and is considered in a favorable light by those who have selected anticlinal locations for their prospect rigs. The relative value of anticlinal locations for the accumulation of oil could only be determined by the drill, should oil be discovered in this section. The anticlinal position would be preferred by the writer if guided by choice of location alone.

Surface Indications of Oil

As pointed out previously, the San Juan oil field, 160 miles north of Holbrook, is the most closely related point of oil production; and the oil measures there do extend south to Holbrook and are within reach of the drill there but have so far proven barren. Drilling commenced at San Juan in 1910, the wells being small producers of high grade oil.

The Seven Lakes oil field, 60 miles north of Gallup, New Mexico, 125 miles northeast of Holbrook, supports a number of 5 to 20 barrel wells. The oil is high grade, with reported high gasoline and lubricating stock contents, and the field, like the San Juan field, the far from transportation, is at present being exploited for further development. The oil horizon at Seven Lakes is evidently the Dakota sandstone, a Cretaceous member and much higher stratigraphically than the Holbrook area.

An oil seep is reliably reported to the writer to be found in Canyon de Chelly, 95 miles northeast of Holbrook (half way to San Juan) and another in Cibola Canon, 106 miles south of Holbrook.

The writer personally visited an oil seep, or group of seeps on Clear Creek, 7 miles southeast of Winslow. The seeps occur at the edge of the water in a reservoir formed by damming the steep walled gorge of Clear Creek, and can be reached only by boat (or, as in the writer's case by swimming.) A thin stream of brown oil exudes with water from crevices in the Coconino sandstone and spreads upon the surface of the reservoir. It is believed that this oil occurs at the base of the Coconino sandstone and is floated out by the waters of the reservoir, penetrating the surrounding strata. Considerable gas, with unmistakable petrolific odor, bubbles thru the water. There is no evidence of faulting that would allow this oil to reach the surface here from great depths.

A similar seep is reported in the gorge of Cheylon Fork, also dammed up, 13 miles southeast of Winslow and 21 miles west of Holbrook.

In connection with these seeps on Clear Creek and Cheylon Fork are indications of oil in the form of colors and globules, with some gas, creditably reported and known for some years, to be found in various water wells drilled to depths of 300 to 500 ft. near Holbrook. Further, as mentioned previously in this report, the Hopi well reported a showing of colors and gas at 425 ft, which corresponds with the horizon of the Coconino sandstone. Hence the Coconino sandstone seems to be a member that contains oil in very small quantities, though has evidently been explored thoroughly without having proved productive.

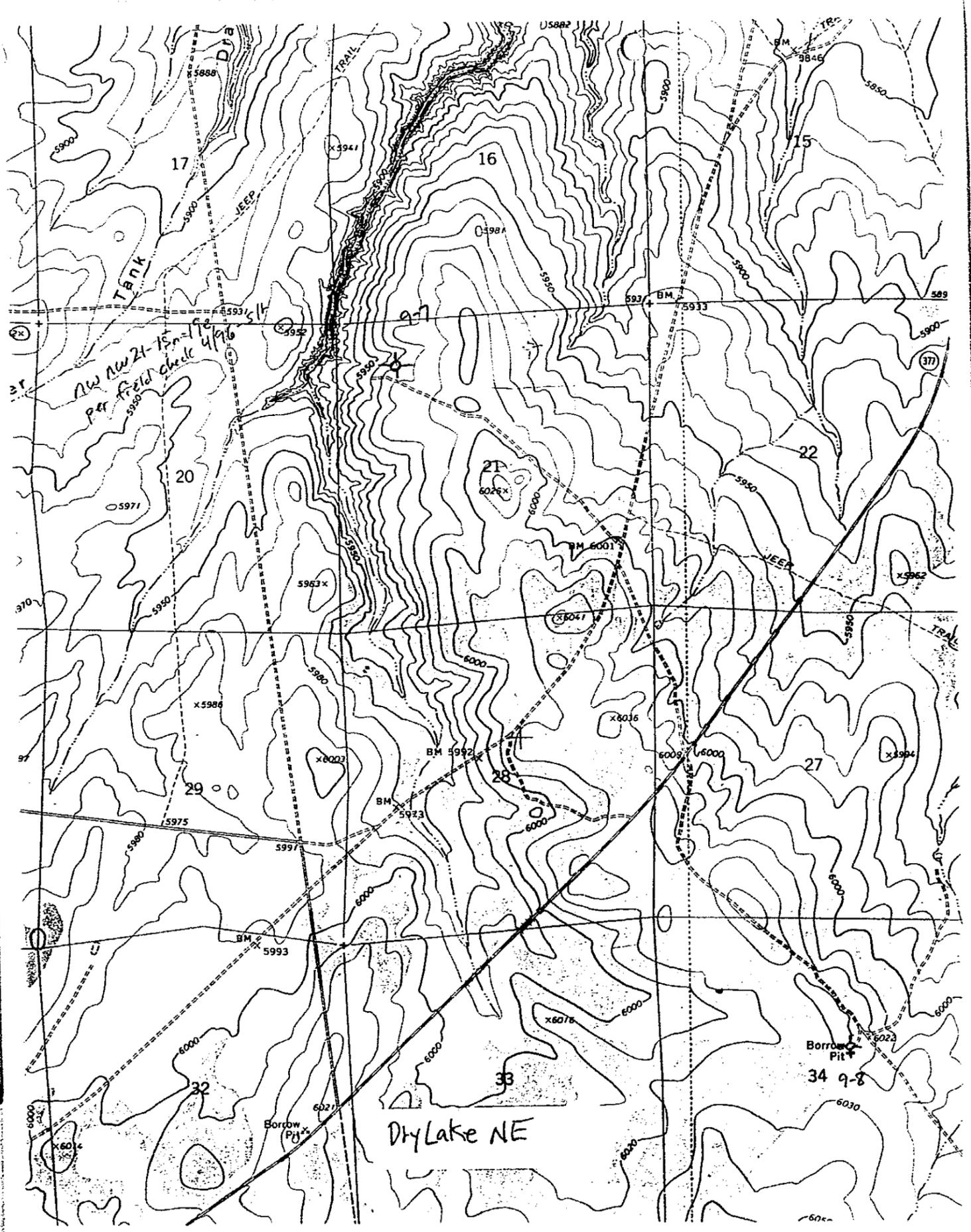
Conclusions Concerning Possibilities

The foregoing more or less detailed description of the geological and structural features of the Holbrook district will serve to indicate that if oil were present in the deep-lying sediments of the Navajo Country, the Holbrook major anticline, as well as a number of the minor folds accompanying it, would offer some promise of accumulation. However, the fact that the sand measures above the Cambrian have been prospected without results, especially the Pennsylvanian series (Coconino sandstone) that showed some surface indications of oil at shallow depth; the nature of the sedimentary rocks, lacking in carbonaceous or diatomaceous shales throughout; the questionable presence of underground hydrostatic pressure; the adverse conditions created by (geologically) recent igneous activity in the general region; the knowledge that such oil is produced in New Mexico and Utah is derived from horizons above those in which Holbrook interest are now drilling, and that the Mississippian beds where exposed in this region are known to have shown no evidences of petroleum; together with the fact that all the wells in the New Mexico and Utah fields have scarcely produced oil in commercial quantities, makes the Holbrook area, in the writer's opinion, an unpromising one, where the possibility of securing petroleum is extremely unlikely.

The section of country fifty miles east of Holbrook presents a better appearance for the accumulation of petroleum than that at

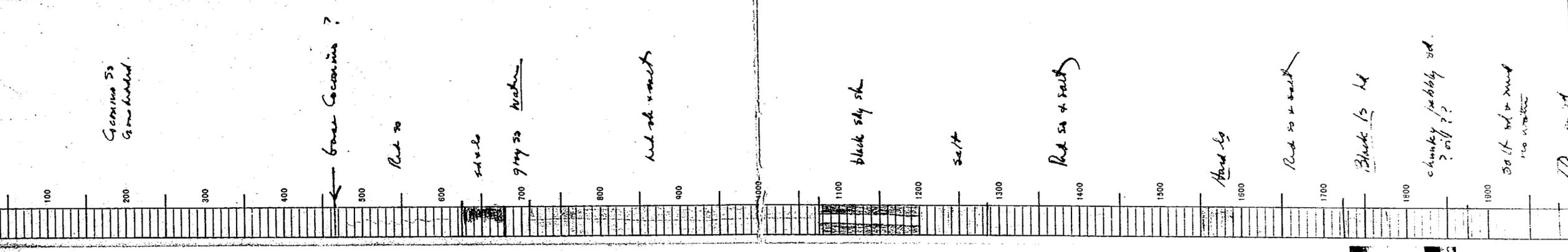
Holbrook. Anticlinal structures of more pronounced folding are evident, and the area is more worthy of prospecting. However conditions that govern the accumulation of oil at Holbrook will apply also to this region. The land in the vicinity of Houck on the Santa Fe Railroad, has not been located for oil possibilities and should any oil be encountered in the drilling activities near Holbrook, this territory should command the attention of operators.

Los Angeles, California.
August 18, 1919.



N.W. NE		NAVAJO Co. 2	
T. 15 N., R. 19 E., S. 8 & 9		COMPANY NO.	
COMMENCED	19	COMPLETED	19
REMARKS: <i>(Signature)</i>			

3 1/2" X Coconino



LOG OF HOPI OIL COMPANY

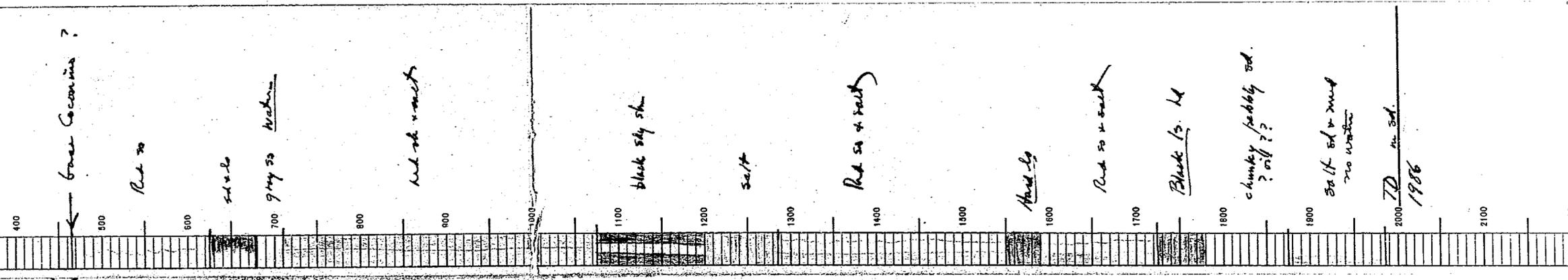
FROM 1 165
TO 465 625 679 710

NW NE Sec. 21, T. 15 N., R. 19 E., S. 8 & 9
Well 1, drilling ceased prior to 1921.

Patented land - State of Arizona
Navajo area
Holbrook
County
Farming
District

Formation

- Cross-bedded Coconino
- Red sandstone mixed
- Sand and lime mixed
- Gray sandstone
- Red salty mixture
- sandy shale
- (wind resembling gas)



Green Cocconino ?

Red ss

shale

9' to 30' Washin

red sh matrix

black silty sh

salt

Red ss + salt

Hard ls

Red ss + salt

Black ls. M

chunky pebbly sd.
? oil ??

salt sd + mud
no water

ID in sd.
1986

68SRM
NW NE Sec. 21, T. 15 N., R. 19 E., prior to 1921.
Well 1, drilling ceased

Patented land - State of Arizona
County Navajo
Field Holbrook area
District Farmington

Formation

Cross-bedded Coconino
Red sandstone
Sand and lime mixed (wind resembling gas)
Gray sandstone, water
Red silty mixture
Red sandy shale

LOG OF HOPI OIL COMPANY

From	To
1465	465
1625	625
1679	679
1710	710

LOG OF HOPI OIL COMPANY

NW NE Sec. 21, T. 15 N., R. 19 E., G&SRM
Well 1, drilling ceased prior to 1927.

Patented land - State of Arizona
County Navajo
Field Holbrook area
District Farmington

<u>From</u>	<u>To</u>	<u>Formation</u>
1	465	Cross-bedded Coconino
465	625	Red sandstone
625	679	Sand and lime mixed
679	710	Gray sandstone, water (wind resembling gas)
710	1075	Red salty mixture
1075	1200	Black sandy shale
1200	1285	Salt
1285	1550	Red sandstone and salt
1550	1590	Limestone, hard
1590	1725	Salt and red sandstone
1725	1780	Black lime, very hard
1780	1875	Chunky, pebbly oil sand (no scent and no oil)
1875	1986	Sandstone, salt and mud; no water
1986		Water sand, no water

Formation Tops

0-465	Coconino
465-1986	Supai
TD	1986'

Log of Hopi Oil Co. well from USGSWSP #836-B-

0	465	Coconino sandstone - sandstone, hard, cross-bedded, gray to buff.
		<u>Supai formation</u>
465	625	Sandstone, red
625	697	Limestone, sandy, red
697	710	Sandstone, gray
710	1075	Shale, etc, red.
1075	1200	Shale, sandy, black
1200	1725	Sandstone, red with salt beds. (Limestone 1550-1590)
		<u>Redwall Limestone</u>
1725	1788	Limestone, very hard, black on blue
1788	1875	Sandstone
1875	2175	Sandstone, red, with salt in upper half
2175	2355	Limestone, red sandy, hard
2355	2400	Sandstone, buff
2400	2420	Limestone, sandy and red sandstone

Another record gives red sand and shale, 2196-2235', and white "lime" 2505-2520'. Possibly base of the Supai was at 1725', but red material occurs in underlying strata.

LOG OF HOPI OIL COMPANY

NW NE Sec. 21, T. 15 N., R. 19 E., G&SRM
Well 1, drilling ceased prior to 1927.

Patented land - State of Arizona
County Navajo
Field Holbrook area
District Farmington

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