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THE STORY OF THE PANHANDLE FIELD

The "story" of the Panhandle Field is created by the history of the field. The "story" covers a series of conditions which will apply to any natural gas field or to the total natural gas reserves of the United States.

An economic story is provided in the history of the Panhandle Field. It covers periods of excessive rates of development resulting in a surplus or oversupply. The result was cheap prices and waste. When the demand or market outlets commenced to approach the level of available supply, the price commenced to increase and waste, other than had been curtailed by the action of the Texas Railroad Commission, showed a decline. When the demand exceeded the available supply, the average price immediately went to more desirable and economic levels.

The story demonstrates in a most convincing manner that "price and conservation" are teammates. It also brings out most forcibly that federal regulation will never supplant the law of supply and demand, irrespective of the fact that since the early thirties Washington efforts have been continuous to amend, revise, or disregard the law of supply and demand.

Unhampered competitive efforts to find new gas reserves and further conserve presently known reserves are the best assurance that the consumer can hope for to enjoy a continued full supply of gas at a reasonable price.

If it was possible to convey the lesson which is contained in this story to each and every consumer of natural gas, the oil and gas industry would immediately have the required help to clear up the "federal regulatory fog" with which it is presently shrouded. The consumer, who is, in general

unaware of the threat to his continued supply of natural gas, would come forward to lend his full assistance to clarify the situation.

There is also a pattern lesson to all state regulatory bodies of both producing and consuming states. The producers, the pipe line companies, and industrial users of natural gas will all do well to review the lesson which comes from the history of the Panhandle Field.

So, let us get to the history of the largest known gas field - the Panhandle Field of Texas.

GENERAL DESCRIPTION AND GEOGRAPHICAL LOCATION :

"S P R A W L I N G" - that is a thumbnail description of the Panhandle Field, even in Texas language.

In the motion picture industry, the terminology would be no less than "supercolossal", "stupendous" and "gigantic". To the gas consumer, it is the most important natural gas field that has ever been discovered.

This field derives its name from its geographical location. The natural gas reservoir underlies about 1-1/2 millions of acres of rolling plains, punctuated by numerous small canyons. It is traversed by the Canadian River, usually devoid of water, which forms a broad valley through the area. The surface above the gas reservoir is predominantly ranch country with spotted acreage under cultivation.

The outline of the Proven Area of the Panhandle Field is roughly the shape of a huge shoe with a sloping heel formed by the Potter County Fault. The toe of the shoe ends east of the Town of Shamrock, Texas. The front of the heel is about 30 miles north of Amarillo. The top of the shoe extends northwesterly along a line near the Towns of Pampa and Borger and the top

of the shoe is 12 miles north of Dumas. The extreme back of the shoe is 17 miles west of Dumas. The overall length of the field is approximately 125 miles, while the width varies to a few miles at the so-called toe of the field and to about 50 miles in width at its widest part.

GEOLOGY :

Most geologists agree that in the geologic past, areas now encompassed by the Anadarko Basin and the Palo Duro Basin were one continuous basin. At the end of Mississippian times and into early Pennsylvanian times there occurred an uplifting of the basement along the northwest-southeast trend now identified as the Amarillo Buried Mountains. This uplifting divided the older basin into the present Anadarko Basin to the north and northeast and the Palo Duro Basin to the south.

The Panhandle Field is more closely associated with the Anadarko Basin inasmuch as the origin of the oil and gas appears to have occurred within the area of this basin and accumulation took place on the north and northeast sides of the Amarillo Buried Mountains.

Much weathering and faulting took place along these granite extrusions during Pennsylvanian times, resulting in extensive deposits of granite wash being deposited in both the Anadarko and Palo Duro Basins.

Shallow Permian seas later inundated the entire Anadarko-Palo Duro areas and covered the granite peaks, granite wash and Pennsylvanian sediments with thick deposits of carbonates and evaporites. This Permian carbonate section, the Wolfcamp dolomite, was an erosional surface and was weathered into an ideal reservoir type rock. Later deposition of the thick anhydrite, Wichita-Albany, over the dolomite provided an effective cap for the reservoir.

Accumulation of oil in the Texas Panhandle Field occurs along the north flank of the now buried Amarillo Mountains. Oil occurs in the weathered granites, in the granite wash in arkosic material, marking the transitional between type deposition, and in the dolomite members of the Wolfcamp.

These beds are dipping rather steeply to the north into the Basin and as the beds rise in succession from the water and carry hydrocarbons they are oil bearing from Upper Wolfcamp to Pennsylvanian granite wash downward in reverse order of deposition.

On top of the buried mountains in areas structurally high, all of these reservoir rocks carry gas. Gas found along the oil contact is sour and becomes progressively sweeter up dip. The gas cap covers roughly the broad area of the apex of the buried mountains.

The presence of hydrocarbons in commercial quantities in rocks older than Pennsylvanian, within the limits of the Texas Panhandle Field, remains to be proven by the drill. This is an unanswered challenge to the operators in this area.

RESERVOIR CHARACTERISTICS :

Three productive zones make up the Panhandle Field reservoir: (1) The Panhandle Lime which is considered as relatively unimportant. (2) The Brown Dolomite which is by far the most important and is a continuous gas producing section. (3) The Granite Wash section which is erratic and which provides only spotted productive areas.

This reservoir, like most limestone reservoirs, is highly variable in both reserve and well potential. Both the porosity and permeability are much higher than is found in the average dolomitic limestone reservoir. The Granite Wash formation ranges from minimum porosity and permeability

to near cavernous conditions and some of the larger wells produce from this formation. The range in open flow potential is from 0 to more than 400,000,000 cubic feet.

The abnormal low reservoir pressure may be labeled as the most disappointing feature of the Panhandle Field. The initial shut-in well head pressures were recorded as 430 psig, or a bottom hole pressure of about 470 psia. Normal reservoir pressure would have been around 1175 psia. The helium field west of Amarillo, related to the Bush Dome, and the John Ray Dome of the Panhandle Field show approximately 700 feet of displacement which has been traced as a fault forming the southern boundary of the west portion of the Panhandle Field. The recorded well head pressure of 720 psig would produce a reservoir pressure of about 778 psia. Normal reservoir pressure would have been around 1457 psia. All of the new fields which have been discovered in Permian and Pre-Permian Age rocks throughout the entire western part of the Anadarko Basin show approximately the same abnormal low reservoir pressures.

It, therefore, appears that during the period of the Rocky Mountain Uplift and perhaps others, and the resultant tilting of the Anadarko Basin, that a spill point was established which caused the lowering of the initial water level some 1450 feet.

The presence of sour gas along the northern area of the field also indicates that gas was once stored at higher pressures and as the pressure was lowered that this gas came out of oil solution and migrated and commingled with gas which did not originally contain hydrogen sulphide.

Source is often a controversial subject. There is evidence that at least a portion of the Panhandle Field gas migrated from the Hugoton Field.

The Hugoton Field pressures are slightly higher but the best evidence is the filtering out of the heavier nitrogen just to the north of the Panhandle-Hugoton bottle neck. The heating value shows a difference of more than 100 BTU per cubic foot and is the direct result of the higher nitrogen content of the Hugoton gas. The thick shales of Pennsylvania Age show a strong methane "kick" when a mud wagon is used while drilling this shale section on wells drilled to Pre-Permian zones in the Hugoton Field.

Should the one time higher reservoir pressure theory be correct, then the up dip area to the west should provide a good hunting ground for undiscovered gas and oil reserves westward to the Las Animas Arch in Colorado.

DEVELOPMENT :

The real romance of oil and gas commences when the drill bit commences to take its bite. But back of the beginning of this action may lie many years of geological study. Then comes the inevitable bargaining for leases and the right to drill. The major sales talk, however, goes to the investor. Risk capital for drilling ventures comes hard.

During 1917 Geologist Dr. Charles N. Gould was successful in conveying his strong conviction that oil and natural gas would be found under what is now the southwestern part of the Panhandle Field. The selection of the drill site was marked by Dr. Gould with a pile of rocks he heaped on Section 65, Block O-18, D. & P. Railway Company Survey. The Amarillo Oil Company was organized the same year for the purpose of exploring the region in the Canadian River brakes for oil and gas. Leases were secured by that company on 40,000 acres of the Masterson Ranch and 16,000 acres of the Bivins Ranch. These leases were obtained at no cost except development and marketing agreements.

The discovery gas well, known as the Hapgood well, was brought in on April 16, 1919, with an open flow of about ten million cubic feet.

On May 2, 1922, the discovery oil well was completed on the Burnett Ranch in Carson County for an initial production of 175 barrels per day.

A history of development is shown in tabular form on this page and on the following page.

During the first twenty years the number of gas wells drilled was far in excess of the number required to supply market demands. This can be found by a comparison of the number of wells and the "Disposition of Production" shown on Page 11 of this paper.

One amazing comparison is shown by the number of oil wells drilled per year. During the "Borger Boom" days, there were 472 wells completed in 1926 and 476 in 1927. Twenty-eight years later in 1955, there was a total of about 1,129 oil wells completed in the Panhandle Field. The total number of producing oil wells was reported as 9,731 with cumulative production of approximately 820 millions of barrels as of January 1, 1956.

The following is a tabulation of natural gas wells completed in the Panhandle Field by years since the discovery well was drilled:

Year	Number Of Producing Wells	Year	Number Of Producing Wells
1919	1	1929	144
1920	8	1930	169
1921	5	1931	69
1922	5	1932	27
1923	5	1933	24
1924	5	1934	67
1925	15	1935	79
1926	39	1936	156
1927	92	1937	163
1928	140	1938	103

Year	Number Of Producing Wells	Year	Number Of Producing Wells
1939	86	1949	337
1940	92	1950	149
1941	52	1951	108
1942	59	1952	133
1943	56	1953	224
1944	63	1954	151
1945	417	1955	57
1946	136		
1947	174		
1948	135		

Up to January 1, 1956, the total number of 3,745 wells completed as gas producers would have had initial natural potential of more than 75 billion cubic feet, if all would have been completed at virgin pressures. Acidizing and fracturing would have added much more. January 1, 1956, the total potential was in excess of 25 billion cubic feet. This estimate does not include the availability from casinghead wells.

PRODUCTION STATISTICS AND MARKET OUTLETS :

The first market outlet for the Panhandle Field was Amarillo, Texas. Initial deliveries were commenced in 1921. The record of the first five years of deliveries to Amarillo was as shown below in millions of cubic feet:

1921	.345
1922	1.199
1923	2.269
1924	3.568
1925	4.552

This gas was produced from wells located on the Masterson Ranch, with a small volume from Bivins Ranch wells.

In 1926 the first carbon black plant was constructed and by 1930 67.7% of all the carbon black manufactured in the United States was made

from Panhandle Field gas.

A list follows of pipe lines which created market outlets for the Panhandle Field:

1. Cities Service Gas Company
2. Colorado Interstate Gas Company
3. Consolidated Gas Utilities
4. Dozier Gas Company
5. El Paso Natural Gas Company
6. Gray County Gas Company
7. Lela Gas Company
8. Lone Star Gas Company
9. McLean Gas Company
10. Natural Gas Pipe Line Company
11. Panhandle Eastern Pipe Line Company
12. Pioneer Natural Gas Company (Formerly West Texas Gas Co.)
13. Producers Utilities
14. Public Service Corporation
15. Shamrock Gas Company
16. Southwestern Public Service Company
17. Spearman Gas Company
18. Stinnett Municipal Gas Company
19. Texas Gas & Power Company
20. Town of Sunray
21. United Gas Company
22. Wheeler Gas Company

By 1940, 41 carbon black plants were in operation and 42 natural gasoline plants were in use. Approximately 81% of all gas produced was delivered to natural gasoline plants. Natural gasoline amounted to 7.246 millions barrels for 1940.

In December 1955, there were 17 carbon black plants in operation but such plants used 76 billion cubic feet as compared to 294 billion cubic feet in 1940. The price paid per thousand cubic feet in 1955 was from two to fourteen times that which was paid in 1940. More than 96% of all production was delivered to the 30 natural gasoline plants.

The original recoverable reserve of the Panhandle Field is estimated to be in the order of thirty-eight trillion cubic feet to an abandonment pressure of 25 psig at the well head. Straight arithmetic would give a remaining life

of about 19 years. Of course, the annual rate of production of 800 billion cubic feet cannot be legally maintained. It appears that the Panhandle Field experienced its peak production of 901 billion cubic feet. The annual production for 1954 and 1955 averaged about 800 billion cubic feet.

It is predicted that the production rate for the field will decline hereafter at the rate of 4% to 5% each year. There are about 33% of the present wells limited in production rates by the 25% of potential limit established by the State of Texas. A portion of the deficiency occasioned by lower pressures and potentials will be produced from high potential wells located in the better productive areas of the field, and it is probable that well allowables may increase, temporarily, in such areas.

REGULATION :

The Texas Railroad Commission faced a real ordeal when it came to the problem of establishing orderly regulation to a field of such enormous size, particularly when both sweet and sour gas were being produced. The oil production so closely associated with gas horizons caused further complications.

Space will not permit a discussion of the numerous hearings and court house sessions but there were many. It was about 15 years after the first production before flagrant wasteage was curtailed.

Market outlets were limited and it was a practice for long distance pipe lines to produce their gas requirements from company owned leases. This practice established a near feud between independent producers and pipe line purchasers which has never entirely disappeared. It has now been proven that both were and are wrong. Demand establishes price. Without pipe line markets, the supply would still be far in excess of the demand.

On the other hand, the pipe line companies could have shared the market and, by paying the producer a reasonable price, saved trillions of cubic feet of gas.

The consumer is the ultimate largest loser when low field prices are being paid. However, all three - the consumer, producer, and pipe line company - owe a profund vote of thanks to the commissioners who carried on the fight to stop waste.

PRICE AND CONSERVATION :

Following the efforts of the Railroad Commission through the 30's to achieve better utilization of the Panhandle Field gas, one of the most potent conservation agents known made his appearance.

This agent is "P R I C E".

It is only necessary to follow the comparison of gas disposition and the amount paid for such gas to obtain the indisputable answer that price is our best agent for conservation, as is shown in the following table:

DISPOSITION OF PANHANDLE FIELD GAS
AS RELATED TO PRICE

Volumes Expressed in Percentage

Period	Highest Offered Price ¢ Per MCF	Pipe Line Percent	Carbon Black Percent	Misc. Uses and Waste Percent
To 1931	3.93	9,11	12.74	78.15
1931-1935	3.19	19.23	21.00	59.77
1941-1945	6.03	51.01	36.79	12.20
1946-1950	8.64	59.30	30.73	9.97
1951-1955	14.01	75.62	14.16	10.22

See Page 13 for volumes by years.

It is not meant to infer that uses of natural gas other than domestic use constitute waste. On the contrary, gas used for cooking and heating may constitute severe waste.

Conservation is the inverse of waste.

Waste is usually classified as either Physical Waste or Economic Waste.

Physical Waste is the difference between the volume of gas originally contained in the reservoir and the volume which is ultimately made available to the consumer.

Economic Waste is the difference between the gross heat energy input and the net heat energy realized which can be best utilized for the economy of our country.

SUMMARY :

The story of the Panhandle Field is one of "supply and demand", "price and conservation".

Does not the history of the field tell a most convincing story?

Note - The accuracy of the statistics shown in this paper cannot be guaranteed but the information for development rates and volumes produced has been obtained from the best sources available.

INCLUDING EAST FIELD, WEST SWEET AND SOUR FIELD
CASINGHEAD GAS AND THE DISPOSITION OF GAS

	Total Production MMCF	Pipe Line Deliveries MMCF	Carbon Black Plant Deliveries MMCF	Other Uses And Unaccounted For MMCF	Blown To Air MMCF
1926 & Prior Yrs.	276 993	17 605	1 890	60 098	197 400
1927	565 601	9 881	11 280	311 840	232 600
1928	597 788	44 755	43 020	346 513	163 500
1929	700 447	94 898	136 374	323 375	145 800
1930	690 253	90 887	168 104	308 662	122 600
1931	558 735	96 880	120 387	275 168	66 300
1932	467 943	108 781	118 591	207 631	32 940
1933	538 757	115 952	125 000	126 255	171 550
1934	866 440	154 053	150 000	248 141	314 246
1935	893 721	163 952	184 516	235 972	309 281
1936	618 607	201 765	225 076	126 988	64 778
1937	670 252	235 932	287 592	129 874	16 854
1938	614 462	230 308	266 882	103 636	13 636
1939	636 822	248 908	290 306	88 176	9 432
1940	670 435	263 781	293 843	107 158	5 653
1941	683 196	281 251	289 189	108 801	3 955
1942	680 840	319 022	264 723	93 071	4 024
1943	700 932	359 246	245 374	91 577	4 735
1944	800 175	463 008	263 007	70 425	3 735
1945	857 322	476 212	307 253	71 530	2 327
1946	836 813	436 501	312 478	86 736	1 098
1947	830 722	444 821	304 060	81 292	549
1948	879 615	513 990	287 438	77 832	355
1949	883 816	559 655	221 031	102 753	377
1950	871 331	596 365	197 026	77 563	377
1951	900 770	614 958	203 901	81 796	115
1952	890 410	654 499	150 830	84 955	126
1953	817 532	639 030	94 341	84 020	141
1954	797 435	638 479	71 243	87 462	251
1955	806 063	638 452	76 105	91 294	212
Total -	21 604 228	9 713 827	5 710 860	4 290 594	1 888 947

ACKNOWLEDGMENTS :

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The files and records kept by R. C. Kay, C. E. Weymouth and H. W. McCue of the Columbian Fuel Corporation, furnished valuable early history information.

Estimates of production and disposition of natural gas compiled by Victor Cotner and H. E. Crum, later published in Volume 17, No. 8, August 1933, by the American Association of Petroleum Geologists on the "Occurrence of Natural Gas in Amarillo District, Texas", helped to furnish source material.

In addition to those mentioned above, thanks are in order to the hundreds who have invested risk capital and the thousands of employees who have caused the Panhandle Field to make history.