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## SOME RECENT SHALLOW PICTURED CLIFFS GAS DISCOVERIES

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### INTRODUCTION

Dugan Production Corporation, a Farmington, New Mexico, based independent, has discovered four shallow, small Pictured Cliffs gas pools in the past seven years. These, in order of their discovery dates, are the WAW Pictured Cliffs, Ojo Pictured Cliffs, NIPP Pictured Cliffs and Potwin Pictured Cliffs pools. This paper will discuss each of these pools in some detail. All of these pools are characterized by small areal extent, thin pay sections, low bottom-hole pressures, and consequently, low recoverable reserves. Only the shallow depth and the independents' adaptability to economical operations make these ventures attractive.

### WAW PICTURED CLIFFS POOL

#### Location

The WAW Pictured Cliffs pool is located approximately 15 miles south of Farmington in parts T. 26 and 27 N., R. 13 W., San Juan County, New Mexico. The limits of the pool have not been completely established at this time.

#### Discovery and History of Development

This pool was discovered by the drilling of the Dugan Production Corp. WAW #1 well located 1500 feet FSL and 950 feet FWL in Section 32, T. 27 N., R. 13W., San Juan County, New Mexico. This well was spudded May 19, 1970, on a "farmout" from Aztec Oil and Gas Company, hence the well name "Wild Aztec Well." A 7-<sup>7</sup>/<sub>8</sub> inch hole was drilled to 14 feet and 5Y2 inch casing run and cemented to surface with 5 sacks of cement; a 4<sup>1</sup>/<sub>4</sub> inch hole was then drilled to a total depth of 1411 feet with water and minimum mud; an electric log was run; and 2-<sup>7</sup>/<sub>8</sub> inch tubing run and cemented for casing. The well was perforated from 1325-1329 feet. This well was sand-water fractured with 10,000 pounds of sand and 360 barrels of water; 1-<sup>1</sup>/<sub>4</sub> inch tubing was set at 1303 feet. The well tested on a one point back pressure test for an AOF of 603 MCFGPD on June 30, 1970, with a 7-day SI pressure of 193 psig.

Because of the remote location of the discovery well from existing gas gathering facilities a contract could not be secured for the sale of gas from the discovery well. In December 1974, Dugan Production Corp. made an application to the Bureau of Land Management to secure a pipeline right-of-way to lay approximately 4 miles of pipeline to tie into the El Paso Natural Gas Company low pressure gathering facility located in the NEA, Section 35, T. 27 N., R. 13 W. This application was granted April 15, 1975, and a 3-inch fiber glass line was laid to connect the WAW #1 and the Notsowaw #1 well located 1850 feet FNL and 1850 feet FEL, Section 32, T. 27 N., R. 13 W., which was completed April 12, 1975. During the remainder of 1975 and 1976, Dugan Production completed 13 additional wells for which more right-of-way was secured and there are now 15 wells operated by Dugan producing into the pipeline system. Two additional wells have been completed in the field by Kirby Exploration, neither of which has gas sales

outlets at this writing, and one well has been completed by Dietrich Exploration Company for which they laid approximately one mile of pipeline. Additional drilling is planned for 1977 by Dugan and other operators.

#### Geology

The WAW Pictured Cliffs pool produces from the uppermost sand development in the Pictured Cliffs Sandstone. In this area the Fruitland coal is less than 15 feet thick to absent in some wells. None of the wells drilled in this field have been cored but log calculations and sample analysis indicate a sandstone with a clay matrix (probably kaolinite) of porosity in the range of 18-24 percent with a rather high, approximately 50 percent, connate water saturation. The main producing sand varies in thickness from 3-15 feet. Some of the wells have been perforated in the massive sand below the main producing horizon but our experience indicates that while some gas may be produced from this zone the water production is greatly increased causing production problems.

There is a structural "nosing" in the southwest portion of the field which may have some bearing on ultimate production but there is no definite gas-water contact in the main producing interval. This field is considered to be a stratigraphic trap with permeability variations controlling producibility.

There are also sands developed within the Fruitland Formation in some wells which will be treated in the future. The New Mexico Oil Conservation Commission has made provisions for granting administrative approval for downhole commingling of Pictured Cliffs and Fruitland formations in this area due to marginal producing characteristics and similar bottom-hole pressures.

#### Drilling and Completion Practices

As already discussed, the discovery well was sand-water fractured but it has subsequently been learned that fracturing does not greatly enhance producibility from these wells. Dugan Production now spuds a 7<sup>7</sup>/<sub>8</sub> inch hole and sets one joint of 5<sup>1</sup>/<sub>2</sub> inch casing cemented to surface. A 4<sup>3</sup>/<sub>4</sub> inch hole is then drilled with water or minimum mud to a total depth of approximately 125 feet into the Pictured Cliffs Sandstone. An electric log or induction electrical log is then run to total depth, and 2<sup>7</sup>/<sub>8</sub> inch tubing is run for production casing and cemented with a lightweight cement slurry with lost circulation material to avoid formation damage. The drilling rig is then released and after waiting at least 48 hours a swabbing unit is moved in. A gamma-ray correlation and collar log is run, and the 2<sup>7</sup>/<sub>8</sub> inch casing is swabbed down to within 300-400 feet of the interval to be perforated. After perforating with 2<sup>1</sup>/<sub>8</sub> inch glass jet charges of selected intervals, the casing is swabbed down. If commercial production is indicated at this point 1<sup>1</sup>/<sub>4</sub> inch tubing is run and the well completed ready for production. If natural production is not indicated or of very slight amount, a small job of 250 gallons of 15 percent regular HC1 acid followed by enough water to displace the acid into the formation is performed. The well is then swabbed

in and tubing run. Other operators, of course, use different techniques and casing and tubing programs.

This field is located in an area of relatively flat terrain making it possible to use truck-mounted "shot hole" rigs and requires a minimum of road and location building.

#### Production History and Indicated. Reserves

First production from the WAW Pictured Cliffs pool was May 1975. From that time until late March 1976 only two wells were producing. At this writing there are 16 wells producing. The cumulative production to March 1, 1977, has been 378,657 MCF of gas with production averaging 33,000 MCF per month. These wells are producing into El Paso Natural Gas Company's low pressure gathering system which was originally designed to gather casing head gas from the Bisti and Gallegos-Gallup oil fields. The average line pressure at the sales meter is 35-40 psig but due to friction in the gathering system laid by Dugan Production the average wellhead pressure runs from 70-90 psig.

As the field is defined at this time, and with only a limited production history, we believe that no more than 15 percent of the recoverable reserves have been produced making total reserves for the presently outlined field to be 2,500,000 to 3,000,000 MCF. Only the advent of the new gas price makes this venture economical; however, we believe a fair return will ultimately be realized.

### OW PICTURED CLIFFS POOL

#### Location

The Ojo Pictured Cliffs pool is located in Sections 25, 26, 35 and 36 of T. 28 N., R. 15 W., San Juan County, New Mexico. This is approximately 10 miles south of Fruitland and within 5 miles of the Pictured Cliffs outcrop to the west.

#### Discovery and History of Development

The discovery well for this pool, the Dugan Production Corp. Pet Inc. #2, was spudded February 9, 1971. Dugan Production had previously laid approximately 6<sup>1</sup>/<sub>4</sub> miles of 4-inch pipeline to gather gas from two Gallup wells and one Dakota well which did not have sufficient reserves to interest gas purchasers of the area. These three wells were approaching their economic limits and new reserves were needed to make the pipeline project an economical success. Through the study of mechanical well logs in the area run by other operators on deeper wells it was decided to drill a Pictured Cliffs test in the NE<sup>1</sup>/<sub>4</sub> of Section 36, T. 28 N., R. 15 W. The Pet Inc. #2 well was drilled with mud to a total depth of 848 feet, 2<sup>7</sup>/<sub>8</sub> inch tubing was run for casing, and the Pictured Cliffs Sandstone perforated from 767-772 feet. The well was sand-water fractured with 10,000 pounds of sand and 370 barrels of fresh water. The discovery well was tested on a one point back pressure test for an AOF of 130 MCFGPD with a 7-day SI pressure of 123 psig.

Due to the low initial potential and low formation pressure of the discovery well no additional development was done until June of 1972. During 1972 five additional wells were drilled of which four were completed as small gas wells. During August of 1973 gathering lines were laid and a 2-stage compressor installed to gather gas from wells #2, #3, #5, #6 and #7 and compress to a line pressure of approximately 250 psig. In 1975 two additional wells, the #2R and #9, were drilled and completed, and the #8 well was drilled and plugged and

abandoned. Additional drilling is planned in 1977 to completely develop this four-section lease.

#### Geology

The Ojo Pictured Cliffs field produces from the uppermost lens of the Pictured Cliffs Sandstone. There has been only one electric log run on a producing well in the field, that being the discovery well, the Pet Inc. #2. The very limited information from this log, samples from other producing wells and logs on the few deeper tests in the area indicate the productive lens pinches out to the west and most probably to the east leaving only the massive lower sand which, where it has been tested, is water productive. The structural relief from the eastern most producing well to the west side of the field shows 80 feet of east dip. There is no structural anomaly indicated in this field.

#### Drilling and Completion Practices

After the drilling, completion and testing of the discovery well it was determined that for this pool to be an economical venture, drilling cost would have to be kept to an absolute minimum. The technique used in subsequent wells has been to set one joint of 5<sup>1</sup>/<sub>4</sub> inch casing for surface pipe cemented to surface, and drill a 4<sup>1</sup>/<sub>4</sub> inch hole with air through the producing sand but not into the water bearing main bench. If gas production is indicated, 2<sup>1</sup>/<sub>4</sub> inch line pipe is run for production casing with an open hole packer set above the indicated producing interval with the pipe below the packer torch-slotted. Cement is then placed above the packer. Drilling and completing these wells is normally accomplished in 8-10 hours below the surface casing. By utilizing drilling rigs of the "shot hole" variety and used equipment wherever possible, well cost can be kept quite minimal.

#### Production History and Indicated Reserves

Total production from the field as of April 1, 1977, has been 319,196 MCF of gas. No attempt has been made to estimate reserves due to a lack of reservoir information but pressure draw-down versus cumulative production would indicate recoverable reserves on the order of 1,500,000 MCF for this vary marginal pool.

### NIPP PICTURED CLIFFS POOL

#### Location

The NIPP Pictured Cliffs gas pool is located approximately 25 miles south of Farmington and includes parts of T. 25 and 26 N., R. 12 W.; and T. 26 N., R. 13 W., with most of the wells located in T. 26 N., R. 12 W., San Juan County, New Mexico.

#### Discovery and History of Development

The Dugan Production Corp. Chaco Plant #1 is the discovery well of the NIPP Pictured Cliffs pool. This well, located 790 feet FSL and 1830 feet FEL in Section 17, T. 26 N., R. 13 W., was spudded March 20, 1975. A 7<sup>7</sup>/<sub>8</sub> inch hole was drilled to 40 feet and 5<sup>1</sup>/<sub>4</sub> inch surface casing run and cemented to surface. A 4<sup>3</sup>/<sub>4</sub> inch hole was then drilled to a total depth of 1230 feet with minimum mud. An attempt to run an induction electrical log with a 3<sup>7</sup>/<sub>8</sub> inch OD tool was unsuccessful so a "slim hole" gamma-ray neutron log was run, and 2<sup>7</sup>/<sub>8</sub> inch tubing run and cemented for production casing. The well was perforated from 1143-1149 feet with 10 holes, 1<sup>1</sup>/<sub>4</sub> inch tubing was then run and the hole jetted down with

air; while blowing the hole at 800 feet the well kicked off. The 1<sup>1</sup>/<sub>4</sub> inch tubing was landed at 1153 feet and the well completed naturally. The well was initially potentiated for an AOF of 218 MCFGPD with a 7-day SI pressure of 186 psig. Later, after this well had produced for approximately one year, an additional 3 feet of sand was perforated and production substantially increased. Since the discovery well was drilled a fairly continuous drilling program by Dugan Production Corp., Jerome P. McHugh, Kirby Exploration, Nixon Development Corporation, and Merrion & Bayless has been carried out. There are presently 20 wells producing in the field and 10 more in various stages of drilling and completion. It appears that the east side of the field has been fairly well defined with the north end being the most active at this time.

### Geology

The NIPP Pictured Cliffs pool produces from thin sand lenses above a more massive and more easily traceable unit in the Pictured Cliffs Sandstone. Upon studying logs in the Bisti and Gallegos-Gallup fields it was noticed in many of these wells an anomalous higher resistivity occurred in some of these lenses. This prompted the drilling of the discovery well after an acreage position was established.

We believe this field to be a stratigraphic trap. The producing sands are thin and discontinuous from well to well occupying an interval from the base of the Fruitland coal which, in this field, is approximately 20 feet thick, to the top of a massive water bearing sand. This interval varies from 15-30 feet. In some wells there are two distinct sands and in some cases only one sand which has resistivity on the log of greater than 10 ohms. There have been no structural anomalies encountered in the development of this field that would indicate structure having a part in this gas entrapment. Permeability differences in these producing sands vary significantly causing the producibility range from 20-500 MCFGPD. This permeability difference is very hard to determine from log analysis or sample examination so if any resistivity is shown on the log, casing is normally run and the well tested.

The trend of this field, as presently defined, is more north-south than the normally trending northwest by southeast configuration of Pictured Cliffs pools in the San Juan Basin. There is continued drilling, particularly on the north end of the pool, and some indication that this pool and the WAW pool may join.

### Drilling and Completion Practices

The techniques used by Dugan Production for drilling and completing wells in the NIPP field are exactly the same as those used in the WAW field. Mention should be made of the fact that some of the wells drilled in this field have been foam fractured. These simulation jobs have not been very successful; as in every case water production has been increased with very little increase in gas production. Wells completed naturally or stimulated with small acid jobs normally make very small amounts of water.

### Production History and Indicated Reserves

The major advantage that this field has over the two fields previously discussed is the close proximity of the existing low pressure gathering system which makes compression and the laying of a costly gathering system unnecessary. There are presently 21 wells producing in this field with 9 wells waiting on pipeline connection and 4 more wells waiting on completion. First production in this field was in December 1975 and cumulative production as of March 1, 1977, has been 458,752 MCF of gas. Production from this field is presently averaging 3000 MCFGPD.

The NIPP pool presently encompasses approximately eight sections. Due to the lenticular nature of the pay sands, a lack of reservoir information, and limited production history, reserves are difficult to determine. We believe ultimate recoverable gas from this field as it now stands will be on the order of 5,000,000 MCF to 7,500,000 MCF.

### POTWIN PICTURED CLIFFS POOL

#### Location

The Potwin Pictured Cliffs field is located in Sections 15 and 16 of T. 24 N., R. 8 W., San Juan County, New Mexico, which is approximately 35 miles southeast of Farmington.

#### Discovery and History of Development

The discovery well for this pool is the Mountain #1 located 1650 feet FSL and 1650 feet FEL in Section 15, T. 24 N., R. 8 W. This well was drilled as a Chacra prospect with a total depth of 3040 feet, 2<sup>7</sup>/<sub>8</sub> inch tubing was run for casing, and the Chacra zone perforated and sand-water fractured. When this zone proved to be unproductive the well was plugged back to 2850 feet and the Pictured Cliffs perforated from 2030-2039 feet. The casing was then swabbed down and the well made an estimated 250 MCF naturally with no water. The well was subsequently foam fractured using 113,500 SCF of nitrogen, 84 barrels of water, and 15,000 pounds of sand; 1<sup>1</sup>/<sub>4</sub> inch tubing was run and set at 2031 feet; and the well potentiated May 7, 1976, on a four point back pressure test for an AOF of 1100 MCFGPD with a 10-day SI pressure of 574 psig. There have been five additional wells drilled in this field with only two being successful completions.

This field is located approximately three miles from the nearest pipeline and to this date sufficient reserves have not been indicated to get a gas connection.

### CONCLUSION

The gas reserves from the fields discussed in this paper will not make any significant contribution to solving the domestic natural gas shortage. These discoveries do point out that there are significant undeveloped reserves at relatively shallow depths in the San Juan Basin which can be economically produced under a realistic price structure and with prudent operations.