GEOLOGY OF THE PROPOSED

WALKER DRAW UNIT

EDDY COUNTY, NEW MEXICO

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LOCATION OF WALKER DRAW UNIT

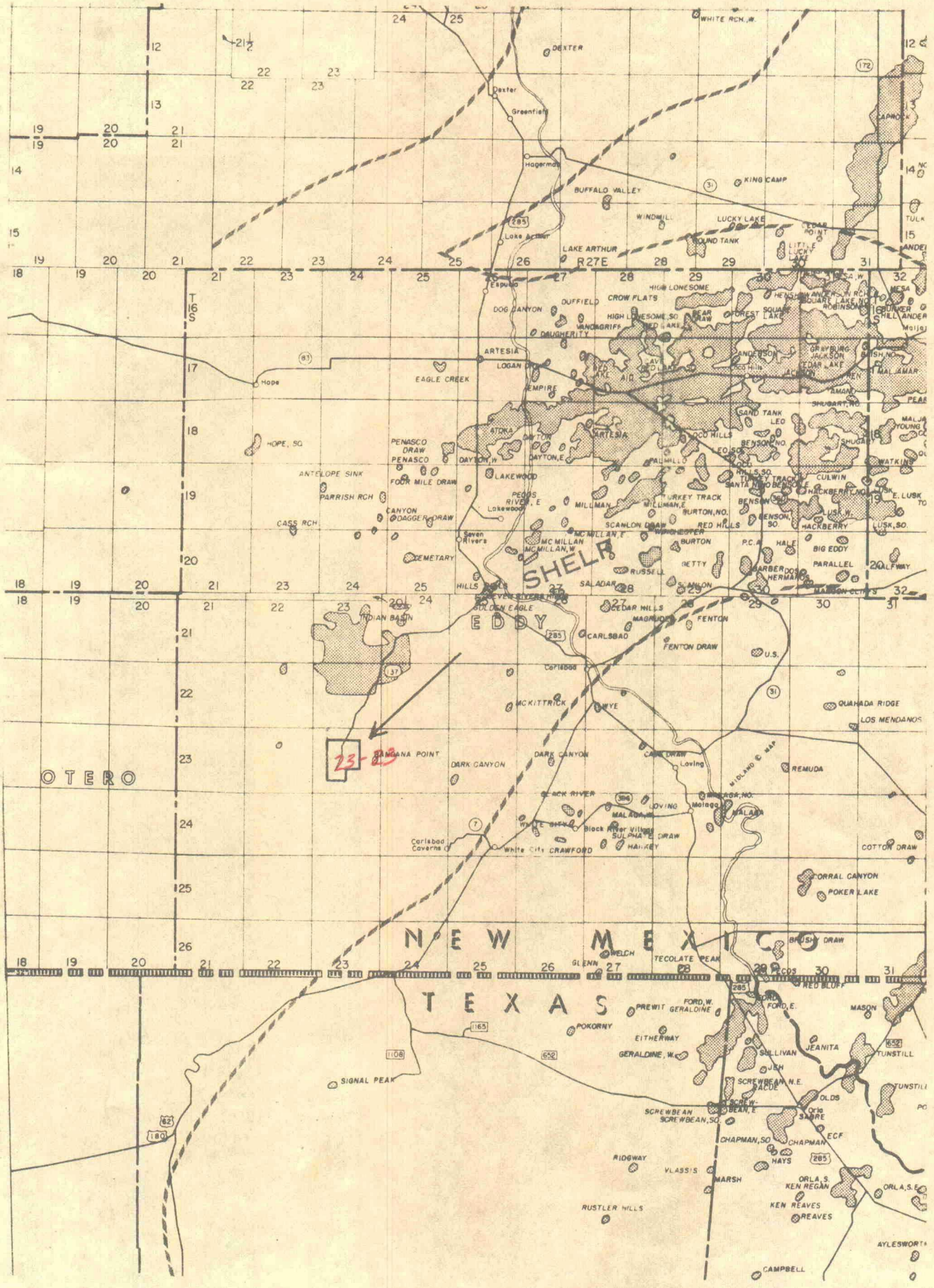

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Fig. 1 Surface Topography of the Walker Draw Unit Area.

Contour Interval 50 feet (from U. S. G. S. Bandana Point Quadrangle - dated 1940)

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INTRODUCTION

The proposed Walker Draw Unit is located approximately twenty miles west-southwest of the City of Carlsbad, New Mexico, and eight miles north of the Carlsbad Caverns. Topographically, the proposed Unit is situated in low relief terrain northwest of the East Hess Hills.

The proposed Unit consists of eleven sections (7,040 acres) of Federal, State and Patented land and is situated entirely within the confines of T-23-S, R-23-E.

The proposed Unit is based entirely on a subsurface stratigraphic trap concept. The principal objective is the uppermost Morrow Sandstone which underlies all of the proposed Unit area. Secondary objectives consist of (1) other Morrow Sandstones (lower in the geologic section) which may or may not be present at any given location within the proposed Unit area, and (2) Atoka Limestones and Sandstones immediately overlying the Morrow section.

We recommend that an initial test be drilled into the Barnett Shale to a total depth of approximately 10,000 feet. It is recommended that the initial test be drilled in the NW/4 of the SE/4 of Section 20, T-23-S, R-23-E.

MORROW STRATIGRAPHY & SEDIMENTATION

The Morrow consists principally of alternating light gray to dark gray shales interbedded with fine to coarse-grained sandstones. Limestone beds ap-

pearing within the Morrow sequence are characterized by being tan to brown in color and oolitic in composition. The anticipated total thickness of the Morrow rocks over the Walker Draw Unit area is 350 feet.

The top of the Morrow sequence is marked by a 40 foot bed of very oolitic limestone which is characterized by little or no porosity and permeability.

Immediately below the above described dense oolitic limestone bed is the Upper Morrow Sandstone which is the principal objective in the proposed Walker Draw Unit area. In Wells numbered 3 and 4 on the stratigraphic cross-section accompanying this report, the Upper Morrow Sandstone consists of very coarse, sub-rounded to sub-angular clear quartz grains that are fairly well sorted and for the most part are unconsolidated. Occasional sand grains are slightly frosted, suggesting abrasion while being transported, but in great preponderance are the glassy clear, conglomeratic quartz grains and small quartz pebbles which infer that deposition occurred fairly close to the source of the material. In the basinward directions to the east and southeast from the proposed Walker Draw Unit area, the Upper Morrow Sandstone grades into fine-grained, silty, dirty, shaley sandstone which is interspersed with thin shale and limestone beds. In the shoreward directions to the west and northwest, it is considered to be absent due to non-deposition. The thickness of the Upper Morrow Sandstone varies from 25 to 30 feet.

The remainder of the Morrow sequence, or that portion from the base of the Upper Morrow Sand to the base of the Morrow clastics (top of the Mississippian

Barnett Shale), may contain one or more sandstone members at any given location. Available well control at this time indicates that these lower sand bodies are discontinuous and of rather poor to unknown reservoir quality.

ATOKA STRATIGRAPHY

Atokan rocks in the Walker Draw area consist mainly of tan to brown, fine to medium crystalline limestones which are occasionally slightly oolitic. Interbedded with the limestones are one or more thin, fine to coarse-grained poorly sorted, consolidated sandstones. Characterized by thin chert beds and chert nodules, the Atoka sequence contains little or no shale. Atoka thickness in the Walker Draw area approaches 250 feet.

One completion attempt from the Atoka has been made in the Walker Draw area. This attempt was made by Humble Oil & Refining Company in their No. 1 Bandana Point (Well No. 7 in the east-west cross-section). This well was completed October 5, 1959, as a shut-in gas well from the interval 9782 to 9796 feet; it was potentialed for an absolute open flow capacity of 1.8 MMCFGD; the well was plugged and abandoned on May 25, 1967.

GEOLOGICAL HISTORY

At the time of Morrow clastic deposition, the Walker Draw area was a stable, shallow embayment which received a remarkably uniform thickness of sediments. The Upper Morrow Sandstone is visualized as an arcuate off-shore bar, closed to the west and north by non-deposition and effectively disappearing to the

east and southeast into a limestone-shale-sandstone facies. The source of the Morrow sediments was the Pedernal land mass to the west and northwest. Transport distance was probably rather short, as indicated by the presence of an abundance of conglomeratic, pebbly, glass-clear quartz grains.

At the beginning of Atoka time, the erosion channels which provided the access route for the Morrow clastics were sealed off and Atoka deposition was confined mainly to shallow water limestones. Clastic deposition through the old, or possibly new, channels was renewed one or more times for short periods during the Atoka period, as indicated by the appearance of occasional thin sandstones in the sequence.

Folding at the close of Pennsylvanian time resulted in the south-plunging structural nose which is seen in the subsurface in the Walker Draw area today. After deformation by folding the shelf area was tilted to the east-southeast as a result of the subsidence of the Delaware Basin.

DRILL STEM TEST AND ELECTRIC LOG INTERPRETATION

SHELL-WAGONTIRE NO. 1

The Morrow gas pay zone in the Shell-Wagontire No. 1 (Sec. 17, T-23-S, R-23-E) from 9684' to 9708' contains 24' of net gas pay sand having a weighted average porosity of 11% and a water saturation of 40%.

On a conventional drill stem test from 9492' to 9692' (including only 8' of the net pay), a gas flow rate of 1,550 MCF per day was recorded at the end of

a four hour drill stem test. Initial and final shut in pressures were 3740 and 3535 respectively. Extrapolation of the pressure build up data indicated a static reservoir pressure of 3830 psig on both shut in tests.

A subsequent straddle packer test from 9682' to 9743' bracketing the entire pay section after reaching total depth resulted in a stabilized gas flow rate of 1,250 MCF/day at a surface pressure of 110 psig on a 3/4" choke. Initial and final shut in pressures were 3820 and 3684 respectively. These extrapolate to 3835 psig and 3880 psig respectively.

Permeability calculations from these data indicate a range from 0.5 md. to 0.2 md., with the higher value being recorded on the earlier test. The reduced permeability indicated from the straddle test and the lower flow rate are believed to be due to the massive skin damage known to result from exposure of Morrow sands to fresh water base drilling fluids. At the time this well was drilled (1964) there were no known successful methods of stimulating a Morrow pay sand. In fact, stimulation attempts in this area generally resulted in a decrease in productivity.

In 1967, some three years after abandonment of this well, successful fracturing techniques using gelled articifial brine solutions duplicating the Morrow zone water salinity were applied. In 1970, super thickened brine solutions have been even more successful. These fracture treatments have yielded gas flow rates three-fold to twenty-fold over the drill stem test flow rates. The larger

increases being in those wells with severe skin damage.

Analysis of the drill stem test of the Shell-Wagontire No. 1 and the results of recent fracturing techniques suggest that this well should be expected to produce at a CAOF of approximately 4,000 MCF/day by NMOCC testing procedures after a fracturing treatment.

CAROLINE HUNT SANDS - J. R. JOYCE NO. 1

The Caroline Hunt Sands - J. R. Joyce No. 1 (Sec. 28, T-23-S, R-23-E) located 1.75 miles southeast of the Shell-Wagontire No. 1 encountered the same Morrow sand at 9494' to 9525' that produced gas in the Shell well. This zone was not drill stem tested, but has a very striking correlation to the gas zone in the Shell-Wagontire No. 1 and is 182' structurally higher. Analysis of the well logs shows 29' of net sand having a weighted average porosity of 8% and a water saturation of 48%. While the sand in this well shows a slightly higher water saturation than that found in the Shell-Wagontire No. 1, it is believed due to the lower average porosity since the well is structurally higher.

By the analogy of the electric and sonic logs, it appears that gas productivity equal to that expected from analysis of the drill stem test in the Shell-Wagontire No. 1 can be expected from the Caroline Hunt Sands - J. R. Joyce No. 1 after it is stimulated by a fracture treatment.