THE BISTI AREA, SAN JUAN COUNTY, NEW MEXICO

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The Bisti area in central San Juan County, New Mexico, is on the south flank of the San Juan Basin. Production is from the Gallup sandstones and siltstones, Mesaverde group of Upper Cretaceous age. Accumulation of oil and gas in the Bisti area is controlled by stratigraphic entrapment without structural closure.

HISTORY OF DISCOVERY AND DEVELOPMENT

The discovery well in the area was the El Paso Natural Gas Company's Kelly State No. 1 in Section 16, T-25N, R-12W. This well was drilled to a total depth of 5285 feet and completed from the Gallup sandstone at 4760-4842 feet on October 7, 1955, for an initial potential of 180 barrels of 39° gravity oil per day. The Gallup producing trend is at least 29 miles long and 2 miles wide. Further extension to the southeast is probable. The proven productive area is approximately 47,000 acres. Within the Bisti area (Figure 3) there are 114 oil wells, 12 gas wells, and 23 dry holes as of July 1, 1957. The oil wells have been completed for potentials flowing from 100 to 700 barrels per day. Although some wells have produced small amounts of brackish water, no active water drive is indicated and primary reservoir energy is considered to be solution-gas drive. Three wells have been completed as gas wells from the Gallup sand indicating the presence of a small gas cap in the southeastern part of the area. Sand-oil fracture treatment has been necessary to establish production in most wells. Wells are at present restricted to 14 barrels of oil per day because of limited local refining capacities and lack of pipeline outlet. For a short period during the Suez crisis, average production was 49 barrels of oil per day per well. Cumulative production to January 1, 1957, was 426,348 barrels.

LOCAL STRATIGRAPHY

The Gallup sandstone in the Bisti area appears on electric logs as three distinct units (Figure 5 - Section B-B'): (1) an upper sandstone which marks the top of the Gallup section (lower 120 feet of Zone "J"); it consists of black shales and dense, non-productive resistive sandstones; the section averages 120 feet in thickness; (2) a middle sandstone (upper 70 feet of Zone "K"), with an average thickness of 35 feet, is the upper and principal producing zone; it consists of a light gray, medium-grained, clean, well-sorted sandstone; (3) a lower productive zone (lower 100 feet of one "K"), 100 feet thick, which is characteristically a silty, fine-grained sandstone with irregular, dark gray, micaceous shale inclusions and partings. In the Bisti field (T-25N, R-12W) the average net thickness of saturated oil

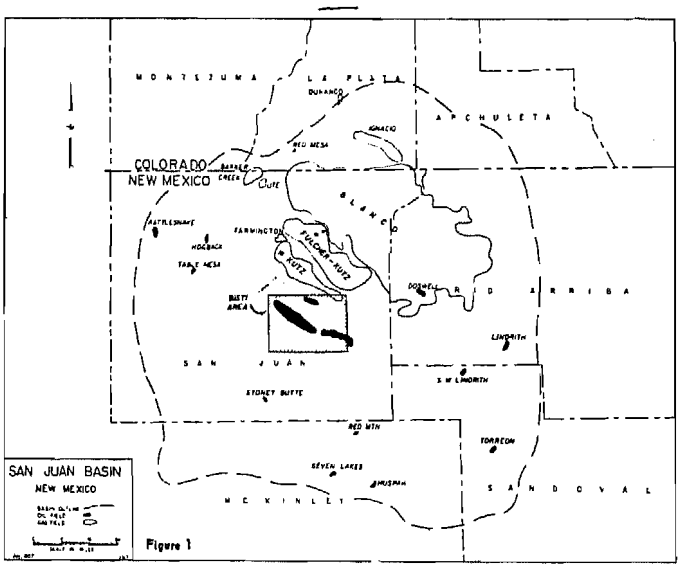


Figure 1

sand is 15 feet for the upper producing zone and 10 feet for the lower zone. In the Carson area (T-25N, R-11W) the average net sand thickness is 20 feet for the upper zone. Both zones are considered part of the same reservoir. Core analyses indicate that the upper producing zone has a porosity range of 5 to 20 per cent and a permeability range from 0.4 millidarcys to 387 millidarcys with an average of 100 millidarcys. In the Bisti field the upper zone is generally one sandstone bench but in the Carson area two sandstone benches are present (Figure 4). The sandstone benches coalesce in Section 7, T-25N, R-11W.

It is suggested that the upper producing zone of the Bisti and Carson areas consists of a series of *en echelon* offshore sandbar deposits. The evidence for this is: (1) the great length of the sand bodies in comparison to their width; (2) the convex upward profile of the deposits; (3) the clean, well-sorted nature of the sand. Longitudinally, these sandbars appear to be partly separated by constrictions in the width of the sand deposition and by areas of reduced permeability.

In the western part of T-26N, R-11W, production has been found from a zone which is apparently a stratigraphic equivalent of the Upper Gallup zone. In this area the Gallup consists of thinly laminated, intercalated sandstones and shales. The shales are black and appear to have much vertical fracturing. The sand is fine- to medium-grained and low in permeability. All wells in this area require heavy fracture treatments before producing. It is possible that

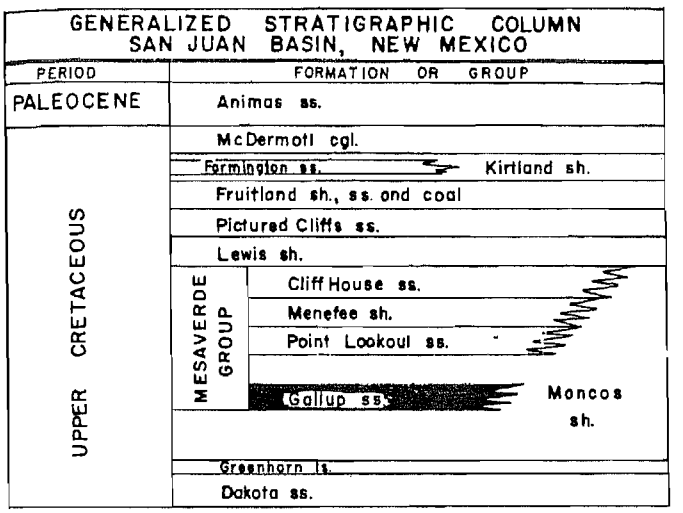
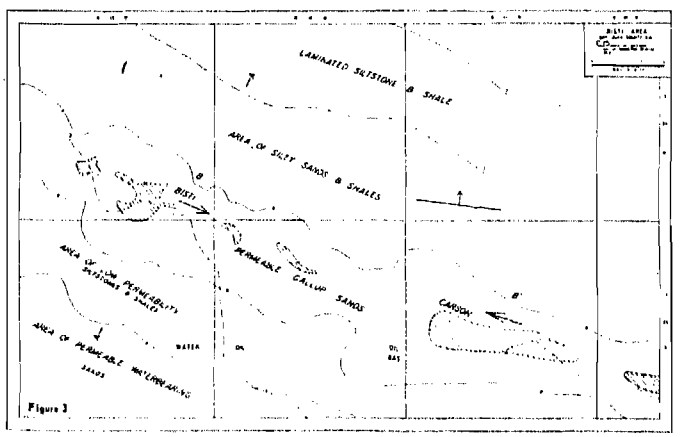


FIGURE 2

this production will more or less parallel the Bisti-Carson productive trends.

Figure 3 is a diagrammatic map of the area based upon a study of effective sand values determined from self-potential, induction and micrologs. This map illustrates: (1) the persistent northwest-southeast trend of maximum sandstone development; (2) areas of reduced sandstone values suggesting tidal inlets; (3) a more abrupt gradation from sandstone to shale on the northeast or seaward side of the field as compared with the southwest side — all consistent with an offshore sandbar concept.

The dark gray shaly inclusions that occur within the lower producing zone of the Gallup sandstone indicate a strandline of a land mass of low relief with contamination by shoreward lagoonal deposits. Field development has followed the northwest-southeast trend of the strandline. Extension of production northwest appears to be limited by the occurrence of water and by reduction in the permeability of the sandstone in both producing zones. The southeast productive extent of the strandline is undefined and the writers believe that it could extend another 5 to 10 miles beyond the area mapped. The Gallup gas and oil production, 4 to 6 miles north of the Bisti field, appears to be a separate reservoir or reservoirs from the Bisti-Carson production. On the southwest edge of the Bisti field the Gallup sandstone contains oil and brackish water and further south contains fresh water. The inferred line of water-oil contact is shown on Figure 3. A north-south diagrammatic cross-section A-A' (Figure 4) shows the general stratigraphic relationships and fluid content of the Gallup sandstone in the Bisti area.



STRUCTURE

Contours on the top of the Gallup sandstone in the Bisti area show a gentle north dip of 75 feet to the mile. Oil accumulation appears to be independent of both regional dip and local minor noses and re-entrants.

HYDRODYNAMIC ACTION

Study of samples and electrical logs of the Gallup sandstone in the southwest part of the San Juan Basin suggests the presence of a porous aquifer fed at the upturned edges of the outcrop. This is directly supported by the quantities of fresh water found in several recent Gallup tests drilled on the north flank of the Zuni uplift and the flow of fresh water (chlorides 305 parts per million) encountered in the Lion Oil Company's Chaco No. 1, Section 20, T-24N, R-13W, 9 miles south of the Bisti field. Northward and toward a considerably less permeable facies of the Gallup the Magnolia Petroleum Company's Postelle Federal No. 1, Section 28, T-25N, R-13W, yielded slightly brackish water with a chloride count of 6,600 parts per million; fluid of approximately this value is found admixed with oil in the southwest edge of the strandline that defines the Bisti area. It was noted that this slightly brackish water was found upstructure from clean oil-producing sands of the field (Figure 3). This could result in one of two ways: (1) selective action of two fluids whereby water would be restricted as the wetting phase to the least permeable rock and the oil permitted to accumulate in the relatively more permeable facies regardless of structural position; (2) some degree of hydrodynamic flow which would tilt the water-oil interface toward the northwest and also explain the downdip transition from fresh to brackish water in the Bisti area.

Outcrop elevations on the Gallup sandstone progressing north from the Zuni uplift to the most northern surface exposure, in the vicinity of the Hogback field, show a total drop of 2,000 feet or an average of 20 feet to the mile. Although this rate of fall is less than the 35 feet per mile northwest component of the north dip found in the Bisti field, the differential pressure effect is generally in the same direction as the strike of the strandline and could contribute to the apparent tilt of the water-oil interface.

From the evidence that the Gallup sandstone was deposited under marine conditions, it appears reasonable to as-

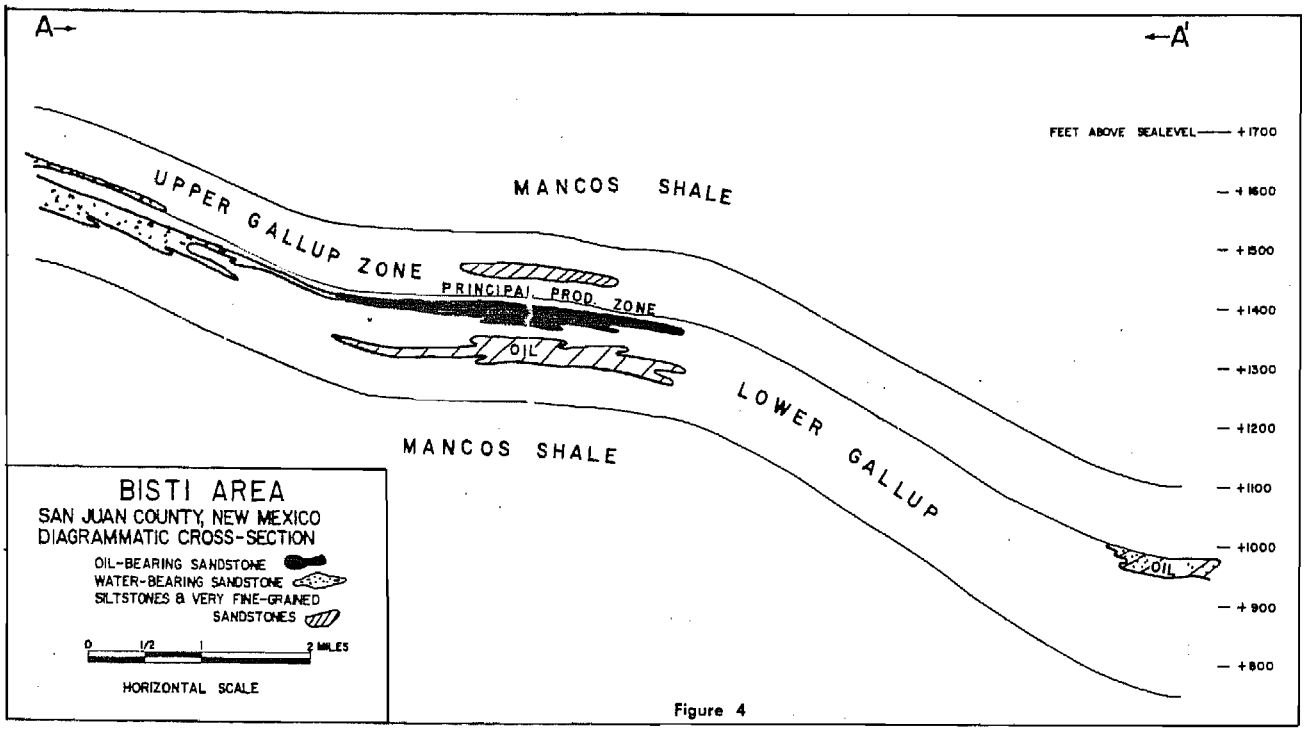


Figure 4

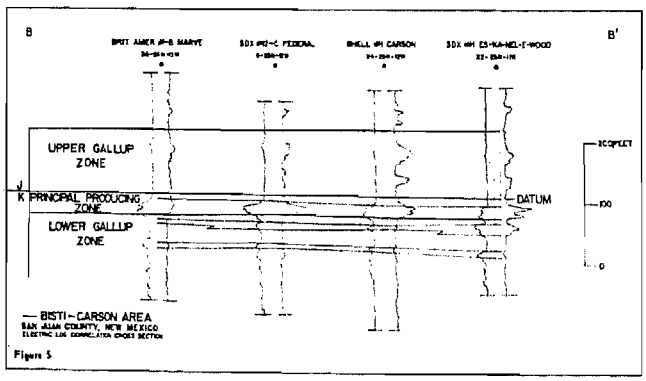


Figure 5

sume that marine waters with typical salinity (chlorides at least 20,000 parts per million) were also present in some degree at the time of oil accumulation. The brackish water encountered on the southwest side of the field would then represent the diluting effect of limited hydrodynamic action updip to the field.

SUMMARY

1. Oil accumulation in the Bisti area is found in stratigraphic traps developed on a strandline proximate to the basinward limits of the Upper Cretaceous Gallup sandstone..

2. Transverse and probably lateral facies change from relatively permeable sandstone to impermeable siltstones, and silty carbonaceous shales provide entrapment in the Bisti area.

3. The principal producing zone in the Bisti-Carson area resembles a sandbar deposit both in form and composition.

4. Oil production is primarily controlled by permeability development in the Gallup sandstone.

5. Limited hydrodynamic action is suggested.

REFERENCES

For complete bibliography see following article:
Tomkins, J. Q., "Bisti Oil Field, San Juan County, New Mexico." Bulletin of the American Association of Petroleum Geologists, Vol. 41, No. 5, May 1957.