

The Triassic Shinarump conglomerate, the Jurassic Entrada sand, the uppermost Jurassic Morrison(?) sand, the Upper Cretaceous Dakota-Graneros sands, and many other Upper Cretaceous sands intertonguing with the Mancos and Lewis shales have a record of oil and gas shows which has not been fully exploited in 90 per cent of the favorable area.

Exploration frontiers associated with sedimentation exist as overlooked variations in deposition, development, and permeability of the Mesozoic sands. Frontiers associated with structure exist with possibility of fault traps, permeability traps, and hydrodynamic traps on low plunging folds with no apparent surface closure. Closure may exist on these folds in the pre-Cretaceous sediments.

The known lithologic variations of the many possible reservoir beds, when combined with known regional structural anomalies, point to many areas of possible production in the sands with a proved record of shows.

22. ARIZONA, A FRONTIER AREA.

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The state of Arizona is divided into three parts according to its oil and gas possibilities based on present knowledge. This paper gives only a brief mention of the Basin and Range provinces in the southern and western parts of the state and concentrates on the possibilities in the Plateau Province in the northern part.

The major objective formations in the Plateau Province include the Ft. Apache member of the Supai formation (Permian), Hermosa formation (Pennsylvanian) and the Martin formation (Devonian). The presence of a Permian Salt basin in central eastern Arizona may open reef possibilities in the Supai. The Pennsylvanian formations have been disappointing due to the lack of good reservoir beds. Devonian possibilities appear greatest south of the Navajo-Hopi Indian Reservation and in general south and southwest of Holbrook.

The presence of old granite highs and ridges has proved exploration to be dangerous; however, this may be solved by a combination of aerial magnetometer, seismograph, and detailed stratigraphic studies.

23. HYDRODYNAMIC ANALYSES APPLIED TO OIL EXPLORATION AND PROSPECT EVALUATION.

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The common occurrence of hydrodynamic conditions causing tilted oil-water contacts, especially in the Rocky Mountain area, requires the use of new exploration and prospect-evaluation methods. The physical principles of oil entrapment under hydrodynamic conditions are easily understood when explained qualitatively by means of vector-force diagrams. That is, the buoyancy of oil is a vector force acting in a vertical direction, the movement of water in the aquifer produces a vector force acting in a direction approximately parallel with the bedding plane, and the oil-water contact is perpendicular to the vector sum of these two forces. This combination of forces, resulting in a tilted oil-water contact, may (1) cause oil production to extend in the gradient direction beyond the previously assumed limiting contour, (2) force the oil pool away from the highest point of the structure and to the position of minimum potential energy on the flank or nose of the structure, or (3) tilt the oil pool completely out of the structure, leaving it barren of oil production.

When the pertinent forces and structural features are properly scaled, a three-dimensional plastic flow model can be used to study the location and distribution of oil in the structure. In addition, these hydrodynamic scale models can be used to study the effect of local geological factors (faulting, permeability changes, and sand thickness changes) on the hydrodynamic gradient and consequently on the location of the oil pool in the structure.

Electrical and mechanical potentiometric models have been constructed to make regional studies of the potentiometric surface and to evaluate the average hydrodynamic gradient in any specific area of interest. Careful analysis and evaluation of all available data are critical requirements for this study.

It is therefore concluded that in the Rocky Mountain area hydrodynamic gradient analyses must be integrated with structural mapping and stratigraphic studies to properly evaluate all prospects and to find new prospects including nose or flank possibilities on structures previously condemned by dry holes.

24. GEOLOGY OF DISTURBED BELT OF SOUTHEASTERN IDAHO.

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The Disturbed Belt of southeastern Idaho is located on the eastern edge of the Cordilleran geosyncline. The structure and stratigraphy are quite similar to that found along the eastern edge of the Cordilleran geosyncline from Canada to southern Nevada. Oil is being produced from a similar structural environment at Turner Valley and Pincher Creek in Canada.

Southeastern Idaho can be divided roughly into parallel zones of structural shortening. Synclinoria, characterized by long, narrow, asymmetrical doubly plunging folds, are separated by anticlinoria which have over-developed into zones of thrusting and imbricate faulting. Overthrusting and imbricate faulting are uncommon in the synclinoria.

Limited isopach data indicate that southeastern Idaho, from southwest to northeast, contains rocks of basinal, marginal, and foreland thicknesses. Generally, the lithofacies maps tend to confirm these relationships.

Five unsuccessful wildcat wells have been drilled in the province which covers 4,000 square miles. Four of the five wells were drilled on anticlines located in the synclinoria, and one was drilled in the imbricate area. Although results to date have been somewhat discouraging, the area has not been completely tested. None of the wells have penetrated the Paleozoic section beneath the Mississippian-Madison limestone, and numerous large folds, offering multiple objectives, have not been tested.

25. WASATCH PLATEAU REVIEW, CENTRAL UTAH.

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The Wasatch Plateau is an elevated tract in central Utah, having a north-south length of 60 miles and a width of 20 miles. It is not a separate or unique geologic feature, but rather a segment of the long transition belt between the Great Basin and the Colorado Plateau.

Rocks capping the plateau are Tertiary Eocene and uppermost Cretaceous in age. The Mesozoic section is about 12,000 feet thick, thickening and becoming more clastic toward the west. The Paleozoic rock thickness is probably comparable with that of the Mesozoic. The Ferron and Dakota sands of Cretaceous age are gas-productive on the plateau.

The Wasatch monocline constitutes a very distinctive topographic and structural boundary between the plateau and Sanpete Valley on the west. Except for normal fault-block tilting and/or slumping, the plateau top is almost flat. Little, if any, actual bending of the strata is evident except on the monocline. A north-south fault system of Tertiary age is predominant throughout the plateau. Although there is probably a deep-seated fault beneath the Wasatch monocline, many of the smaller faults on the Wasatch Plateau and in Sanpete Valley may be due to movement and solution of salt-bearing beds in the underlying Jurassic rocks.

Structural and stratigraphic evidence tends to shift the Great Basin-Colorado Plateau boundary westward from previously assigned positions. This would increase the area of potential oil-bearing post-Paleozoic rocks considerably.

It is suggested that the Paunsaugunt and Wasatch plateaus were parts of the same province through Wasatch time, and that the Paunsaugunt, 100 miles south, offers the same excellent Cretaceous oil and gas possibilities as those offered by the Wasatch Plateau.

26. GAS AND OIL OPERATIONS IN UINTA BASIN OF UTAH.

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The Uinta basin of Utah is going into its 5th year of oil production. To date there is one field, Red Wash, of importance with nearly 8,000 acres proven and 24 producing wells which yield around 5,000 barrels daily. Most of the production is choked down until transportation can take care of the situation.

Nearly 100 holes have been drilled, resulting in the discovery of five oil fields, two possible oil fields, and two gas fields. The discovery rate is 7 out of 70 or one producer, or potential producer, out of 10 tests. With the 8,000 square miles in the basin, the average dry-hole density is one hole to 110 square miles. However, with the proximity of dry holes to the nearby fields, the ratio is more nearly one to 400. There are nearly 20 square miles of proved area, or one square mile proved to 400 unproved.

Nearly all the fields are due to stratigraphic traps so that the situation for new discoveries is unique in that new fields should be of the same type.

The south rim of the basin has two gas fields in the Wasatch and in the Mesaverde beds. Conditions there are similar to those in the San Juan basin. It is possible that a major gas area may be developed on the south rim of the basin.

Drilling and operating costs are high in the basin due to transportation, and to the oil carrying high proportions of wax, 20-50%, with pour points of 90°-110°.

When drilling costs are reduced and when there is a solution to the handling of the oil, the Uinta basin should be an important producer with numerous new gas and oil fields.

27. GAS PROSPECTS OF NORTHEASTERN UTAH AND NORTHWESTERN COLORADO.

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Recent gas discoveries in the Greater Uinta basin of northeastern Utah and northwestern Colorado, in rocks of Jurassic, Cretaceous, and Tertiary age, together with the prospect of a market outlet, have centered interest on the area as a potential future gas reserve.

Commercial gas discoveries to date have been widely scattered in the following formations: Entrada, Morrison, Dakota, Mesaverde, Wasatch, and Green River. However, these discoveries indicate the following problems which must be solved in future exploration and development before sizable reserves of natural gas are definitely established:

- (1) Questionable reflection of surface structural features at depth.
- (2) Abrupt lateral porosity and permeability variations.
- (3) Deposition of sands sufficiently developed to provide appreciable reserves.