in the Judith River formation rimrock bounding the higher structural part of the dome have failed to establish production.

To determine the relation of these wells to surface structure, a reconnaissance with the aid of air photos was undertaken during the 1958 field season. An attempt was made to find mappable units in the apparently monotonous Upper Cretaceous sequence cropping out on the central part of the dome. Although lithologic changes in these formations are subtle, it is believed that substantial progress has been made in recognizing the distribution of these rocks. As a result a better understanding of the structural configuration of Porcupine dome has been reached.

From this preliminary work several important exploratory possibilities are suggested.

1. The highest structural point on the dome has not been tested.

2. The most prominent anticlinal axial trend, approximately 36 miles in length, has not been drilled for a distance of 30 miles. Several untested closures are indicated along the trend.

3. The present structure of the dome is essentially the result of Laramide orogeny. Application of hydrodynamic factors, as modified by stratigraphic controls and ensuing time, points to possible areas for oil and/or gas entrapment.

It is concluded that Porcupine dome has not been adequately explored and that its possibilities for hydrocarbon production can be determined only by the drilling of favorably positioned wells.

GEORGE H. MURRY, JR., Consultant, Billings, Montana

Examples of Hydrodynamics in Williston Basin at Poplar and North Tioga Fields

One of the generally accepted inferences with regard to the Williston basin has been that it should be relatively free from hydrodynamic influences. However, a large proportion of the pools in this basin have inclined oil-water contacts and, in some, tilting is an essential feature of the trap. Two excellent examples of such fields are the Poplar pool in northeastern Montana and the North Tioga pool on the north end of the Nesson trend. The reservoir in the Charles formation at Poplar has a readily demonstrable tilt in the oil-water contact of approximately 40 feet per mile north-northeast. At North Tioga a dip of the same order of magnitude, but toward the southeast, is apparent in the water table in the Mission Canyon formation. In both places, log and sample studies show that the tilting can not be ascribed to an "apparent condition" arising from stratigraphic changes. The tilt at Poplar is merely an interesting aberration in an essentially structural accumulation. On the other hand, hydrodynamics is a necessary component of the trap at North Tioga.

JOHN NESBITT, Imperial Oil Limited, Regina, Saskatchewan

Core Examination

The Oxbow-Carnduff field of southeastern Saskatchewan emphasizes the need of detailed lithological studies in evaluating a reservoir. A critical comparison of routine core analysis and detailed core studies in the field shows that a substantial percentage of the reservoir unit, which has porosity and permeability above a reasonable lower cut-off, is ineffective and unstained. The effective pay within the unit is determined not only by its porosity and permeability but also by the grain size of the carbonate. This example points out the need of full use of core examination in conjunction with core analysis in the evaluation of a reservoir.

V. E. PETERSON, Equity Oil Company, Salt Lake City, Utah

Structural Control Related to Stratigraphic Traps, Piceance Creek Basin, Colorado

Few if any accumulations of petroleum classified as being of stratigraphic origin are totally independent of structural control. In a consideration of the stratigraphic potential of a basin, therefore, it is prerequisite that due consideration be given to at least the principal structural deformations that have occurred within the basin during and since the deposition of the most prospective formations.

Scrutiny of thickness variations in the sediments the Piceance Creek basin reveals that the basic tectonic framework controlling the present configuration of the basin was in evidence at least as early as the oldest Cretaceous sediments represented in the basin. Stronger border components, such as the Uncompahgre arch, the White River uplift, and possibly the Douglas Creek arch are identifiable as positive structural elements during earlier periods, and were periodically active in influencing the nature of deposition within the Piceance Creek basin from Cretaceous through Eocene time.

With the exception of a few features deep within the basin, where data is not available or is inconclusive, thickness variations within the Mancos shale section indicate either early or continued phases in the structural development of all of the principal components forming the tectonic framework of the present basin. The Danforth Hills anticline on the northeastern side of the basin is revealed as an active positive area during Mancos time. The Douglas Creek arch is clearly defined by a relatively thin Mancos shale section.

Thickness variations of the later Cretaceous sediments (Mesaverde) indicate continued structural development of the basin similar to Mancos time, though of a greater magnitude.

The end of Cretaceous time in the Piceance Creek basin is marked by broad uplift and local folding, followed by a period of erosion. Flank structures of the basin were extensively eroded and peneplaned before being covered by later sediments. Basal members of the overlying Paleocene sediments usually contain conglomerates of a diversified origin.

Paleocene sediments in the basin are similar to the Mesaverde section. They range in thickness from a few feet on the edge of the basin to more than 3,000 feet in the deep basin, and indicate active structural growth of the basin during this period.

Growth of the basin continued to be active during Wasatch time. Thickness variations of this section indicate that structural deformation was mainly on a broad basis; previously prominent local features within the basin had only slight influence on the thickness of the Wasatch sediments.

Continued growth of the basin is clearly evident in the thickness variations of the Green River sediments. In contrast to the Wasatch period, however, the local structural features within the basin were again active and are expressed in thickness and facies changes.

The present great structural relief of the Piceance Creek basin is mainly the result of tectonic activity following the deposition of the Green River sediments, the last consolidated sediments found in the basin.

The most favorable stratigraphic-type reservoirs within the present economic reach of the drill in the Piceance Creek basin are of Cretaceous and later age. The nearly constant structural deformation of these sediments since their deposition along established patterns has maintained favorable conditions for the accumulation of petroleum in stratigraphic-type traps on the flanks of the basin.

Significant deposits of gas and some oil have been found in stratigraphic traps in widely scattered areas of the basin. Some accumulations appear to have had strong local structural influence; others can have been influenced only by broad structural movements. Apparent economic productive potentials have been measured from nearly all Cretaceous and post-Cretaceous formational units represented in the basin.

M. Dane Picard, American Stratigraphic Company, Durango, Colorado

White Mesa Field, Environmental Trap, Paradox Basin, Utah

It has been said in the White Mesa field, "Every well is a wildcat." The present study indicates the situation is, perhaps, not entirely uncertain.

Located on the southern flank of the Paradox basin, the field (with one exception) produces from the Desert Creek zone of Pennsylvanian (Cherokee) age. To December 1, 1958, there were 48 oil wells.

Structurally the area can be divided into two units. The southeastern part strikes N. 30° W. to N. 90° E. (averaging N. 30–70° E.), and dips gently west and north at 60–115 feet per mile. It appears probable that this part is the west and north flanks of an anticline located east and southeast of present wells. In the northwestern part of the field, a small area of closure is present. This part trends northwest-southeast, and is related to the Ratherford field northwest of White Mesa. It is separated from the southeastern part of White Mesa by a narrow syncline opening (?) northeast.

Production in the field is from vuggy, bioclastic limestone, secondary dolomite and oölitic limestone.

The Desert Creek zone ranges from 137 to 207 feet in thickness. It is characterized by three centers of thickening: one in the northwest, one in the northeast, and one in the south part of the field.

Stratigraphically the field is an area of rapid lateral and vertical lithologic change. The lithofacies pattern can be divided into three units: high carbonate (limestone-dolomite versus evaporite more than 79%) rocks on the northern margin, similar high carbonate-versus evaporite rocks trending north-south, subsidiary to the northern unit, and a restricted lithofacies (increased evaporite) bordering the northern margin and surrounding the north-south-trending carbonate lithofacies. Because of these variations oil has been environmentally trapped. The specific change most instrumental in entrapment, is the transition from deposits of a shallow, well oxygenated, agitated, marine environment to deposits of a deeper-water, relatively quiet, restricted, marine environment. The latter might be called "lagoonal."

Many wells in White Mesa produce from rocks deposited in the restricted environment; eleven dry holes have found a slightly greater environmental restriction and were not productive due to negligible permeability.

In origin White Mesa and the related fields (Aneth, McElmo Creek, Ratherford) have been called a "reef complex." The writer believes the term biostromal complex to be more descriptive of Desert Creek zone stratigraphy in the area.

R. D. Ramsey, The Atlantic Refining Company, Billings, Montana

Stratigraphy of Amsden Formation in Wolf Springs-Delphia Area, Central Montana

The Amsden formation thins progressively northward by pre-Piper truncation. This can be dem-