stratification is regular, parallel, and continuous. Tidal flats are characterized by very thick channel cross-beds, thin irregular beds containing organism burrows and trails, and shale-pebble conglomerate. Beach deposits consist of tabular to wedge-shape bundles of thin, regular, parallel to subparallel to laminae. Surf-zone deposits contain low-angle cross-beds in tabular to irregular, relatively continuous sets 1 ft. thick or less.

30. R. E. SWENSON, Chevron Oil Company, Billings, Montana

TRAP MECHANICS IN NISKU IN NORTHEASTERN MONTANA

The Upper Devonian Nisku Formation became a productive unit for the first time in late 1960, when the Tule Creek field was discovered in northeastern Montana. Since then 6 additional Nisku fields have been discovered within a 10-mi. radius of Tule Creek. Even-textured, saccharoidal dolomite, which has 50 ft. of net pay, is productive of 40°-47° API oil at these 7 fields.

Data from closely spaced wells amply demonstrate that structural closure is the basic trapping mechanism for oil in the Nisku. Various interpretations have been advanced regarding the type and degree of influence of stratigraphic factors in these accumulations. Current information indicates that primary stratigraphic variations do impose a semi-regional control on the entrapment of oil in the Nisku, but are less important in individual traps.

Steep-sided, flat-topped structures, which typically are less than 1 sq. mi. in area, control the limits of Nisku fields. The writer suggests that the structures are not the products of normal tectonics. Instead, it can be demonstrated, both theoretically and by deep-well data, that the structures are "sedimentary structures" resulting from multiple-stage solution of the Lower Devonian Elk Point salt beds.

The present-day solutional zero edge of the Elk Point salt beds is east of and downdip from the Nisku fields. The writer suggests that an original thickness of 50–100 ft. of salt was present in the Tule Creek area, and that the original depositional edge of the salt was farther west.

31. GRAHAM S. CAMPBELL, Consulting geologist, Salt Lake City, Utah

DOUGLAS CREEK TREND, CASE HISTORY, UINTA BASIN, UTAH

The 75-mi.-long productive fairway of the Douglas Creek Member of the Green River Formation yields 7 million bbls. of oil and 1 Bcf. of gas annually, largely from two fields. It was not until 13 yrs. after discovery that geologists recognized the broad extent and stratigraphic nature of the accumulation along this trend. A more determined and subjective examination of the specific pay unit, ignoring shows in other Green River members, would have resulted in a much earlier definition of the trend.

Subsidence during Douglas Creek time, transverse to usual northwest-striking Green River stratigraphic trends, caused a temporary but significant shift in shore alignment. The Douglas Creek lake-margin sandstone bodies, which are more "marine" than deltaic in character, trend southwestward.

Recent definitive studies to understand the Douglas Creek trend should hasten new and substantial discoveries along it.

32. A. V. ROBERTSON COE, District geologist, Husky Oil Company, Cody, Wyoming

PITCHFORK OIL FIELD, PARK COUNTY, WYOMING

The Pitchfork oil field, discovered in 1930, is on a steeply dipping, surface-anticlinal structure along the west flank of the Big Horn basin, Park County, Wyoming. The discovery well was completed at a total depth of 3,903 ft. in the Tensleep Sandstone. Field production today is primarily from the Tensleep, though a small amount of production is from the Permian Phosphoria Formation. One well was drilled in 1962 to test older formations, and reached a total depth of 7,766 ft. in the Precambrian.

The original oil found in the discovery well was 18° API. Because of the lack of demand for such oil, poor transportation, and low prices, the well was shut in until 1944. Development since 1944 has been sporadic.

The Tensleep is 250–275 ft. thick, and consists of porous, very fine- to fine-grained, heavily oil-saturated sandstone bodies separated by tight, slightly oil-saturated sandy dolomite and dolomite lenses. Within this active water-drive field, there is 130–150 ft. of net pay having permeability in excess of 25 md. and porosity in excess of 10%. As many as 5–6 zones in the field are characterized by such values. However, as development progressed, it became apparent that "pods" of oil were not being drained effectively by updip wells because of the irregular permeability and porosity.

High water cuts are found in low-permeability sandstone beds where the highly viscous oil is bypassed, and in high-permeability fractured zones where communication is established early with downdip, higher water saturations.

The upper part of the Phosphoria Formation contributes 15–20 b/d of oil from 3 dually completed wells. The 30 ft. of crystalline, vuggy, fossiliferous, heavy-oil-saturated Phosphoria dolomite has a porosity range of 14 to 23%, but low permeability reduces the effectiveness of the water drive and results in low fluid recovery.

Development drilling continues within the Pitchfork Unit in the oil-water transition zone because the economic productive limits are undefined.

As of January 1, 1966, 37 wells were producing at the rate of 103,000 bbls. of oil per month from 720 acres on a 23-acre-spacing pattern. Cumulative production to January 1, 1966, was 8,600,000 bbls. of oil and 30,000,000 bbls. of water.

33. JERRY L. BRANCH, Consulting geologist, Shelby, Montana

GENERAL DRILLING HISTORY AND NEW DEVELOPMENTS IN NORTHWESTERN MONTANA

Northwestern Montana is geologically complex, and this complexity is fully reflected in the diversity of type and location of oil and gas accumulations. As a result, the oil and gas history of this area has been one of continual development of new and changing geological ideas.

Until 1963, drilling was concentrated primarily in and around old productive areas associated directly with the Sweetgrass arch. Subsequently, new discoveries essentially were extensions to already productive Cretaceous Cutbank sandstone and Madison carbonate reservoirs in the Cutbank, Kevin-Sunburst, and Pondera fields.