vember, 1962, at a depth of 1,240 ft. Cumulative production is more than 1,000,000 barrels and initial potentials have ranged up to 665 BOPD. Depth of the standstone ranges from 1,134 to 1,781 ft. and averages less than 1,500 ft. Dry-hole cost averages less than $5,500; completed wells cost $15,000–$20,000, and payout periods can be as short as 4 months. The productive sandstone ranges from 3 to 13 ft. in thickness, has a porosity of 9–24%, and a permeability of 1–872 md. Original bottom-hole pressure was 465 psi.

The producing body is an elongate, northwest-trending marine sandstone accumulation of Niobraran age. It is 25 mi. long and averages 0.5 mi. in width. The sandstone was deposited in erosional troughs formed on the Niobrara-Carlile unconformity. The unconformity rises toward the southwest across the basin. Usually sandstones are found in troughs formed by longshore currents or at the base and seaward edges of cliffs at the unconformity. Detailed isopach mapping shows irregularities along the trough.

Subsequent Laramide folding and faulting and post-Laramide erosion have caused a variety of fluid accumulations within the stratigraphic trap. Zones of fresh water, oil and brackish to salt water, oil, and gas caps occur at different positions along the trend of the sandstone. In Colorado the sandstone dips southeast for 12 mi., from an outcrop elevation of 5,400 ft. to a deep syncline at the Colorado-New Mexico boundary where the oil-water contact is at 3,900 ft. Southeast of the syncline, the sandstone rises 400 ft. in 2½ mi. onto the faulted asymmetrical Blue Hills anticlinal nose and finally descends gradually southeastward into the San Juan basin. A normal fault that divides the sandstone into separate reservoirs is located almost 1 mi. northwest of and essentially parallel with the axis of the plunging Blue Hills anticline. This fault causes the gas-oil contact to be 85 ft. higher on the upthrown (northwestern) side.

34. DONALD I. FOSTER, Consulting geologist, Evergreen, Colorado.

TRAPPING MECHANISMS OF SELECTED FIELDS, CHEROKEE RIDGE, WYOMING AND COLORADO

The Cherokee Ridge is a complex anticlinal arch separating the Washakie basin, Wyoming, from the Sand Wash basin on the south in Colorado. Several fields, primarily gas, are located on the Cherokee Ridge. Exploration has been based primarily on structural "plays" and has proved successful. With present control, it can be demonstrated that at least part of the fields are stratigraphic with only the area and size modified by the structural configuration.

The trapping mechanisms of several fields on the eastern and western ends of Cherokee Ridge are varied and provide templates to guide further exploration.

On the eastern Cherokee Ridge, traps for gas are formed by: (a) structural closure (South Baggs and West Side Canal fields); (b) closure against the downthrown side of a fault (Four Mile Creek field); and (c) porous Lewis and Mesaverde sandstones crossing the Cherokee Ridge (South Baggs and Pole Gulch fields).

On the western end of the Cherokee Ridge, gas accumulations are formed by: (a) structural closure (most fields in some degree); (b) truncation of reservoir sandstones in Lewis and Fox Hills across structural noses (West Hiawatha and Canyon Creek fields); (c) Almond sandstones (uppermost Mesaverde) developed on and across structures (Sugar Loaf, Canyon Creek, and Pioneer fields); and (d) facies change (with possible hydrodynamic reinforcement) in the Trail and Canyon Creek zones of the Mesaverde (Trail and Canyon Creek fields).

35. DONALD O. ASQUITH, Chevron Oil Company, Casper, Wyoming

MESAVERDE AND "ALMY" PRODUCTION, BIRCH CREEK UNIT SUBLETTE COUNTY, WYOMING

Birch Creek field is located on the LaBarge arch in the western Green River basin, and is a part of the Big Piney-LaBarge producing complex. Oil and gas are produced in this area from sediments ranging in age from Jurassic through Paleocene. Of concern here are the trap geometry and source of hydrocarbons of the shallower productive intervals within the Mesaverde and "Almy" Formations.

The Upper Cretaceous Mesaverde and upper Hilliard Formations together form a typical regressive sequence of, from northwest to southeast, lagoonal coal-bearing siltstone and thin sandstone, a littoral sandstone complex, and marine siltstone and shale. Uplift along the LaBarge arch during the Late Cretaceous or very early Paleocene resulted in the erosion of a portion of this sequence and an unknown thickness of Late Cretaceous rocks. A combination of the truncated edge of the upturned littoral sandstone complex in conjunction with lateral permeability changes and the gentle structure of the LaBarge arch forms the traps within the Mesaverde.

The Paleocene sequence, assigned to the "Almy" Formation by operators in the area, is composed of clastic sediments derived from two separate and distinct source areas. An upper sequence, consisting of conglomerate, varicolored shale, and siltstone, was derived from a sedimentary terrane probably in the rising thrust belt on the west. This sequence is characterized by pebbles and cobbles of limestone and quartzite and would be better assigned to the Chappo Member of the Wasatch Formation. The major (or lower) part of the Paleocene rocks at Birch Creek was derived from a granitic source on the east, probably in the vicinity of the Wind River Mountains, and is characterized by abundant mica and feldspar. The Paleocene forms a regressive lacustrine sequence of the following facies: (1) lacustrine shale; (2) marginal lacustrine sandstone; (3) paludal shale, siltstone, and thin sandstone; and (4) variegated mudstone and thick sandstone, probably deposited in a fluvial environment. A more logical formation assignment of this latter sequence would be to the Fort Union Formation.

Significant oil production and the major part of the gas production from the Paleocene at Birch Creek and surrounding fields are from reservoirs within the marginal lacustrine sandstone facies. Traps result from the updip and lateral pinchout of individual sandstones into lacustrine shale along the eastern flank and crest of the LaBarge arch. Structural modification of this basic trapping mechanism is present at some nearby fields such as LaBarge.

The close association of significant oil product and the greater portion of the gas production with the Paleocene lacustrine shale body strongly suggests that this shale is the source of the hydrocarbons produced from these reservoirs. The close association of production from the Mesaverde with the unconformity and the overlying shale body, the lack of a distinct difference between oils from Cretaceous and Paleocene reservoirs, and the lack of significant production from areas where shale is absent or poorly developed suggest that the source of hydrocarbons produced from these

Cretaceous reservoirs also may be the Paleocene lacustrine shale rather than the underlying Cretaceous marine shales and siltstones.

36. ROBERT E. COVINGTON, Caldwell and Covington, Vernal, Utah, AND RALPH L. McDONALD, Consulting Geologist, Golden, Colorado

STRATIGRAPHIC AND STRUCTURAL CONTROLS OF BITUMINOUS SANDSTONE DEPOSITS OF UTAH

The bituminous sandstones of Utah contain very significant reserves of oil which can add substantially to overall United States oil reserves. An understanding of the origin of the bitumen, the nature of the reservoir rock, and the mechanics of emplacement will lead to a more intelligent exploration program and to a more efficient development of the deposits. All of the bituminous sandstone deposits of commercial importance are located in the eastern half of the State of Utah. The largest of these is the Sunnyside deposit located in Carbon County. Next in order of importance are the deposits of the Asphalt Ridge area, the Whiterocks area, the Peor Springs deposits, and the bituminous sandstones of the Green River Desert. The reserves of these areas are much greater than previously estimated. The deposits in the Sunnyside—Peor Springs areas are stratigraphically controlled, occurring on a north-dipping monocline where the highly organic Green River Formation intertongues with the fluvial beds of the Wasatch Formation. Bitumen at Asphalt Ridge is contained in sandstone and conglomerate of the Eocene (?) Duchesne River Formation and in the basal sandstones of the Cretaceous Mesaverde Formation. In the former, bitumen beds saturation is related to unconformities and to faulting. In the latter, the saturation is related directly to progressive overlap and truncation, combined with structural folding. A Cretaceous source for the saturation in the basal Mesaverde beds is now proposed in view of new data rather than a Tertiary origin as interpreted previously. The accumulation of bitumen in the Navajo Sandstone of Jurassic age in the Whiterocks area, previously believed to have been primarily the result of stratigraphic controls and of Tertiary origin, is postulated to be of Paleozoic origin and the result, primarily, of strong structural control. The localization of bitumen in the Tertiary beds of the Chapita Wells—Dragon—Rainbow—Pariette Bench areas of the Uinta basin is related directly to good porosity and permeability within a reservoir associated with relatively strong structural controls, including both fracturing and faulting. It is proposed that the high pour-point, high wax crude oil of the Red Wash—Walker Hollow—Wonsits—Brennan Bottoms—River Junction—Pariette Bench—Monument Butte oil fields represents the original, "first-phase" oil. The "second-phase" oil is represented by original entrapped oil which escaped upward when faulting and subsequent fracturing of the reservoir took place. The oil moved into the porous and permeable sandstones cut by the fractures and faults and, during erosion, the lighter fractions escaped. Because of the viscosity of the crude when the larger fracture systems opened, only a relatively small percentage of oil was able to move into the sandstone reservoirs. The greater volume was left in the fractures which remained open and, with more complete oxidation and subsequent induration, formed the many exotic hydrocarbons of the basin such as gilsonite, elaterite, wurtzilite, ozocerite, tabbeyite, and others. The difference in chemical composition is intimately associated with the source beds as stated in the literature; however, the mechanics of emplacement have heretofore never been explained adequately. The localization of bitumen in the Moenkopi, Kaibab, and the White Rim Formations of the Green River Desert area in central Utah is related directly both to structural and stratigraphic controls. Local entrapment of oil in post-Laramide structures was probably controlled by regional hydrodynamics, because a fairly well-defined asphalt-water contact is present. Furthermore, the best saturations occur on well-defined structural features. The origin of the oil undoubtedly was the Permian Kaibab Limestone or, where it is missing, the basal marine facies of the Moenkopi Formation. There are other areas of lesser importance where the relationship between the controlling parameters of structure and stratigraphy can be established.

37. JERALD ALLIGER AND GILBERT THOMAS, Geophoto Services, Inc., Denver, Colorado

COMPREHENSIVE SURFACE MAPPING IN WILLISTON BASIN

The systematic surface structure-mapping procedure of the Montana part of the Williston basin is comprehensive and consists of three phases: planning, data-gathering, and integration. The final product is a morpho-tectonic map that combines the physiographic data of an area with the geologic data in a regionally consistent interpretation. Applied to the Williston basin, this comprehensive method has been successful in defining positive and negative trends within the tectonic framework of such well-known features as Cedar Creek anticline, Freedom dome, Weldon fault, and Blood Creek syncline. In the course of defining the local features, a tectonic theory was gradually evolved for the Williston basin suggesting that the local structural trends within the basin are the result of reactivation of a pre-existing set of basement zones of weakness oriented most commonly at approximately N. 45° E., N. 70° E., N. 45° E., and N. 75° W. Some areas display also a N. 20° W. trend. Paleozoic reactivation of the trends is suggested by geomorphic data and by subtle deflections in the trend of surface structures or by alignment of positive features to form culmination. The Laramide reactivation, concentrated along the northwest-oriented trends, dominates the present surface structure and appears to have been superimposed on the older structures.

15TH ANNUAL MEETING OF GULF COAST ASSOCIATION OF GEOLOGICAL SOCIETIES

Houston, Texas, October 27–30, 1965

The Fifteenth Annual Meeting of the Gulf Coast Association of Geological Societies and the Gulf Coast Section of the Society of Economic Paleontologists and Mineralogists will be held jointly with a Regional Meeting of The American Association of Petroleum Geologists from October 27–30, 1965, in Houston, Texas. The convention hotel will be the Shamrock Hilton which will be the scene of the registration, technical