Several shoreline trends are recognizable in the upper Muddy. They are progressively younger eastward and reflect the overall west to east transgression. These trends were controlled by the remnant Skull Creek topography and changing conditions of sediment supply.

Production from the Muddy Formation is principally stratigraphic, however, in places structure is important in localization of accumulations.

Lower Muddy production is restricted to updip channel boundaries and is localized by structural noses and updip channel reentrants. Upper Muddy production is controlled chiefly by porosity development and lateral facies changes.

Exploration for Muddy sandstone reservoirs is accomplished best by the use of an isopach of the total Muddy Formation. This map shows the configuration of the Skull Creek channels and therefore the distribution of the lower Muddy sandstone bodies. It is also helpful in predicting the orientation of the upper Muddy shoreline trends where they were related to remnant Skull Creek highs and by showing an increased Muddy thickness due to sand buildups in nonchannel areas. As the sand geometry is complex, abrupt stratigraphic changes are common. Electric log maps combined with zonal sandstone isopachs provide a means of visualizing these abrupt changes in sand geometry and also aid in the interpretation of depositional environments.

Exploration must be focused on the location of primary stratigraphic traps which have not been altered strongly by later structural movements. The ubiquitous presence of clay-filled porosity has eliminated large areas as nonproductive. It is believed that the clay fill largely is diagenetic and occurred subsequent to primary oil accumulation. The lower percentage of clay fill in the oil-filled primary traps suggests that the presence of the oil inhibited clay diagenesis.

In the last 3 years nearly 3,000 wells have been drilled in the study and search for Muddy oil. Each year new fields of significant size have been discovered. Abrupt stratigraphic changes require detailed stratigraphic work and, most important of all, courage to use the drill as an exploration tool.

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STATISTICAL METHODS OF PETROLEUM EXPLORATION IN PART OF DENVER BASIN, COLORADO

Pattern drilling, based on the hypothesis that any field with dimensions larger than the area between pattern wells certainly would be discovered, is tested in a sample area on the east flank of the Denver basin ("fairway" trend area) and compared with effectiveness of actual drilling. This test might be described as a combination of random and geologic-lead drilling. The pattern selected "discovers" 1.16×10^8 bbl of oil actually produced as of January 1, 1969. This quantity includes produced oil only and does not include estimates of reserves or total ultimate production. The pattern-drilling system yields 123,400 bbl/well of oil actually produced in the sample area (including dry holes). Actual drilling in the area has led to production of 1.53×10^8 bbl of oil or 66,500 bbl/well.

It is concluded that, in the sample area at least, pattern drilling could have been more economical than drilling according to geologic leads, promotional deals, and leasing arrangements, as has occurred in the area.

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REEVALUATION OF USE OF GLAUCONITE FOR RADIOMETRIC STRATIGRAPHIC DATING

(No abstract submitted)

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STRATIGRAPHY OF BLACK SHALE FACIES OF GREEN RIVER FORMATION (EOCENE), UINTA BASIN, UTAH

In the Uinta basin, Utah, the black-shale facies of the Green River Formation (Eocene) is divided into 5 rock units: 4 lacustrine units designated by the letters A-D, and a fluvial unit, the Wasatch tongue of the black-shale facies. The Wasatch tongue occupies the same stratigraphic position as unit C. Unit A contains the oldest lacustrine rocks of the black-shale facies, and is transgressive on the underlying fluvial Wasatch Formation (Paleocene-Eocene). All of the lacustrine units contain black fine-grained clastic rocks. Units B and D contain more carbonate rocks than do other units. Units B and D are also the most extensive of the lacustrine units. Units A, B, and C range in thickness from 100 to 300 ft, whereas the Wasatch tongue is 100–400 ft thick. Unit D has the greatest thickness range, from about 100 to 500 ft.

Rocks contained in the 4 lacustrine units vary in composition depending upon where they were deposited in relation to the center of the basin. The central lake environment of deposition produced mostly dark-gray to black, fine-grained clastic rocks and finely crystalline, brown to dark-brown carbonate rocks. The total clastic content of the lacustrine rocks and their model grain size increase toward the peripheries of the depositional basin and sandstone and siltstone become more abundant. Near the edges of the basin carbonate rocks are more saccharoidal in texture and contain larger amounts of silt- and sand-sized grains, oolite, pisolite, and shell fragments.

The depositional axis trends east-west and the depositional center of the lacustrine units is south of Duchesne, Utah, except for unit D where the center is farther south. Well control is sparse in the western part of the Uinta basin.

Lake Uinta was initiated by the coalescing of several small freshwater lakes on a broad alluvial plain. Downwarping led to the formation of the first moderately deep Green River Lake and the deposition of the black fine clastics and other rocks in unit A. The lake was thermally or chemically stratified, which is suggested by the preserved organic material and the presence of pyrite and salt crystals. As the lake transgressed over the fluvial sediments and became larger, the sediments of unit B were deposited. Unit B contains abundant carbonate rocks that were deposited over the entire lake, but particularly in the shallower part where the temperature was highest. A change in climate and/or increasing downwarping caused the lake to diminish its total area and unit C was deposited. During the deposition of unit C, the fluvial sediments of the Wasatch tongue of the black-shale facies were deposited along the southern part of the basin. The lake then transgressed back across the fluvial sediments and deposited unit D. The dominant rock types of unit D are very similar to those of unit B, indicating a similar environment of deposition.

Much of the oil and gas production in the Green