

mopolitan aspect and more intense provincialism. The biogeographic changes appear related to changing ocean basin configuration and initiation of the breakup of the circum-equatorial Tethys.

In the present preliminary phase of investigation firm conclusions cannot be drawn, but the convergence of such diverse approaches encourages the interpretation that ridge activity caused mid-Cretaceous biogeographic changes.

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APPLICATION OF OIL CORRELATION AND SOURCE-ROCK DATA TO EXPLORATION IN WILLISTON BASIN

Most Williston basin oils belong to one of two basic types: (1) a lower Paleozoic type believed to have originated in Winnipeg shales and found predominantly in Ordovician and Silurian reservoirs, and (2) a Mississippian type expelled primarily from Bakken shales and produced mostly from Madison reservoirs. The two types are isolated vertically by evaporites but commonly are mixed beyond the evaporite limits in basin margin areas.

Both oil types can be related to their source facies. Lithofacies maps of these source sequences, when combined with diagenesis determinations, provide source-area definition. The time of expulsion and volume of expelled oil from each source can be calculated. Paleostucture maps and carrier-bed isopachs indicate the direction and extent of secondary migration, both horizontally and vertically from the source area. Ultimately, the subsurface distribution of each oil type is predicted, to define high-grade areas in which to concentrate exploration activity.

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DISCRIMINATION FUNCTION ANALYSIS AND BAYESIAN CLASSIFICATION APPROACH TO MUDDY SANDSTONE EXPLORATION, WYOMING

Stratigraphically trapped petroleum deposits occurring in the Muddy Formation of Campbell County, Wyoming, were studied by using discriminant function analysis followed by Bayesian classification analysis. The data used in this study were obtained from over 600 productive and nonproductive wells in a 720-sq mi area.

A total of 15 quantitative measures (variables) of lithology, porosity, and salinity were computed from the S.P., gamma ray, and density logs from each well. Discriminant and Bayesian classification analyses were used to compute discriminant and probability maps. Discriminant-scores maps were made by two methods: (1) using the total data set of both productive and nonproductive wells, and (2) using only the nonproductive wells. The second type of map more closely simulates the exploration situation.

A map showing probability of oil occurrence was constructed by first partitioning the study area into 64 cells of 9 sq mi each, and then establishing a control area and a test area. In the control area the cells were divided into productive and nonproductive subsets; a discriminant function then was computed. The discriminant function derived from the control area was used as the input for a Bayesian classification procedure to compute probabilities of petroleum occurrence in the test area. The predictions made by the statistical analyses are compared to the actual production in the test area.

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NORTH SEA BASINAL AREA, EUROPE—IMPORTANT OIL AND GAS PROVINCE

The North Sea covers the offshore part of a major sedimentary basin which extends from Norway, Scotland, and Denmark across northern Germany and the Netherlands into eastern England.

Information gained from exploration efforts over the last 10 years shows that the North Sea covers several smaller sedimentary and structural basins of different geologic ages, but for descriptive purposes these can be divided into southern and northern areas. The rocks range in age from Paleozoic to Tertiary and consist of sandstone, shale, carbonate rock, and evaporite. The most important reservoir rocks are the Lower Permian sandstones of the Rotliegendes Formation, the Upper Permian dolomites of the Zechstein Formation, the Triassic sandstone of the Bunter Formation, the Maestrichtian-Danian chalk, and Paleocene and Eocene sandstones. Significant shows of hydrocarbons have been found in 9 formations. The main source rocks are Carboniferous coal measures, Mesozoic shale and carbonates, and Tertiary shale and carbonates. The significant traps are folds and fault blocks associated with salt movement and basement faulting.

Exploration activity received its initial impetus in 1959 from the discovery of a major gas field, Schlochteren, onshore in northern Netherlands. In the early 1960s the passing of legislation favorable for the acquisition of exploration acreage offshore added further stimulus to the exploration pace. The majority of this activity was concentrated initially in the southern area, and resulted in the discovery of the first offshore commercial gas field at West Sole in 1965. This discovery was followed rapidly by other gas discoveries in the United Kingdom and the Netherlands culminating in the Leman Bank field, a major gas field by world standards. Interest and activity lagged, however, in the northern area despite reported small oil and gas discoveries in Denmark, and the discovery in 1968 of the Cod gas-condensate field in Norway. In late 1969, oil production was established at the Ekofisk field in Norway. With this discovery and subsequent confirmation as a major field, exploratory interest has shifted to the north.

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BIOMERIZATION: ECOLOGIC THEORY OF PROVINCIAL DIFFERENTIATION WITH EXAMPLES FROM MODERN AND FOSSIL BIOTAS

Modern biotic provinces are centers of endemism surrounded by zones of coincidence of broad-ranged species. Provinces form coherent units of association above the community level. Superimposed ranges are used to construct a surface contoured for provincial diversity. Provincial boundaries overlap. Frequencies of provincial components along boundaries vary from season to season. Relict provinces survive in these zones.

Biomeres, as chronologic provincial units, are transgressive and regressive, and exhibit complex intertonguing in boundary regions. Faunal and floral zonal sequences are replicable within the biomere, but are complicated by inversion and recurrence along boundaries. These anomalies are useful in locating boundary zones.

Provinciality is due to homeostasis of the ecosystem and is proportional to diversity. Terrestrial biota is more provincial than marine biota.

A biomere appears as a pioneer biota under new conditions. It differentiates about centers of habitat di-