

spreading, and plate tectonics help explain these tectonic features of the earth and may help locate additional reserves of petroleum, particularly along the present continental margins.

Differential extension of the lithosphere may result in high temperatures in the upper continental crust concurrent with local accumulations of shallow-water sands, carbonate rocks, euxinic muds, evaporites, and volcanic rocks. Where the lithosphere rifts apart, seawater encroaches and the asthenosphere wells up in the formation of oceanic crust. During continued divergence of the continents, this new crust subsides as it cools and moves away from the rifts, downwarping with it the thinned edges of rifted continental crust. Remnants of tear faults on the rifted continental blocks, and the presence of volcanic rocks and salt diapirs may be clues to petroleum provinces buried beneath the detrital continental rises and/or carbonate platforms that characterize such divergent margins.

Convergence of crustal plate margins (marked by oceanic trenches, linear trends of deep focus earthquakes, volcanic island ridges, and linear mountain chains) results in dominance of detrital over carbonate sedimentation, abrupt facies changes, locally rapid burial of deep water pelagic sediment with thick turbidites, shale diapirs, and layered sediment structures related to drape over differentially uplifted basement blocks, all on the trench side of volcanic island ridges and linear mountains. High temperature may accelerate the generation of petroleum on the continent side of such island ridges and mountains. Strike-slip displacements between adjacent crustal plates, combined with rifting or convergence, may explain other patterns of sedimentation, structure, and geothermal trends related to accumulations of oil and gas.

WILKINSON, COLIN D., Phillips Petroleum Co., Bartlesville, Okla.

EXPLORATION, GEOLOGY, AND POTENTIAL OF THE NORTH SEA

North Sea exploration was triggered by the discovery of the giant Slochteren gas field in northeastern Holland in 1959. Once the international boundary lines on the continental shelf were ratified according to the premises of the Geneva Convention, the stage was set for intense exploration. Initially, exploration activities were concentrated in the southern United Kingdom basin where gas discoveries were made in the Permian Rotliegendes sandstone, underlying the Zechstein evaporites. It was the presence of the evaporites which had a great effect on the course of exploration. They formed an efficient caprock for Permian dolomites and sandstones, but also created seismic velocity problems which confused structural interpretations. Additionally, salt acted as the medium for structural deformation of the younger sediments, a factor which was to prove to be very important in the Northern Tertiary basin, particularly in the Ekofisk area.

After the discovery of the Permian Rotliegendes and Triassic Bunter gas reservoirs in the United Kingdom sector of the North Sea, there followed a series of dry holes which led to a period of discouragement. However, discovery of the Cod gas-condensate field in the Paleocene sands and the Ekofisk oil field in Danian carbonate rock, both in the Northern Tertiary basin, revitalized the exploration drive and opened the possibilities of new reservoirs and an oil province on the north. The Ekofisk discovery was followed by additional discoveries in adjacent blocks, outlining the first giant oil field in northwestern Europe. A development

program is now under way with the ultimate aim of producing 1 million bbl of oil and more than 1 Bcf of gas per day.

A third exploration phase is now developing, following recent discoveries in the far north of the United Kingdom off the coast of Scotland. Oil potential is in Jurassic and perhaps older sandstones. In this area, water depths are nearly 500 ft, and production demands the development of new techniques.

Located in an area of increasing energy demand, North Sea oil production nevertheless is not expected to make a great impression on European energy supply problems. Although the North Sea may produce 3-5 million bbl of oil per day by 1980, by that date Western European oil consumption will have increased between 14 and 30 million bbl per day.

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