Drilling on the continental shelf of the Central Beaufort Sea has led to significant oil and gas discoveries. There is considerable optimism that the region may encompass a new oil basin. Hydrocarbons are present in Eocene and Oligocene strata. The environment of deposition, established by paleontology and seismic facies analysis, is deep marine. Reservoirs are considered to be sand, transported by turbidity currents and deposited as deep-sea fans. The resulting accumulations are constructional in that they form large mounds and are readily identified on seismic sections taken parallel with the sedimentary strike of the deposits. Traps are stratigraphic where closure is the result of deposition, and structural where shale swells have arched the sand layers. Timing of the latter may play a significant role in the migration and final concentration of hydrocarbons. Marine shales form an effective seal.

The first conventional cores of the reservoirs were cut during the 1981 drilling season. At Koakoak O-22, several oil-bearing sands were recovered. Porosities averaged 29% and permeabilities ranged from 61 to 2,500 md with an average of 1,000 md. The fine to medium-grained sands are friable with very little clay matrix.

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Evidence of Cross-Formational Flow Above Healdton Oil Field, Carter County, Oklahoma

An anticlinal trap is the locus of deep-water discharge with hydrocarbons being retained while the water is transmitted vertically through the sediments. The change in the sense of water movement from lateral to vertical at the apex of the anticline is accompanied by temperature- and salinity-gradient changes. Because of this, it might be possible to outline an oil field by an analysis of these gradients over an anticline.

To test this hypothesis, Healdton anticline, Carter County, Oklahoma, a textbook example of an anticline, was selected for study. This paper examines by an analysis of the salinity and geothermal gradients in the shallow beds the probability of cross-formational flow through the anticline. A large amount of data is available from electric logs of wells drilled in Carter County. Using the spontaneous potential curve and a modified computer program, formation-water resistivities were calculated and these resistivities were converted into total dissolved solids (salinity) based on empirical data from the study area. It is anticipated that contour maps of salinity and geothermal gradients will show the outline of the Healdton oil field.

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Tectonics and Sedimentation Along Continental Margin of Western India, Pakistan, and Adjacent Arabian Sea

The Chagos-Laccadive Ridge and its northern extension, the Lakshmi Ridge (CLLR), trending parallel with the coastline in the deep eastern Arabian Sea, is a continental fragment (with crustal thickness >20 km). Sea-floor spreading-type magnetic anomalies are absent and crustal thickness is about 16 km in the region east of CLLR. West of the ridge, magnetic anomalies, from 5 to 28 on the magnetic time scale, are present and the crustal thickness is 11.5 km. The magnetic anomalies, crustal thickness, and considerations of land geology suggest that most of the sedimentary basins in the region east of the ridge were initiated during the rifting stage in the Late Cretaceous, whereas those in the western region evolved during sea-floor spreading since 64 m.y. ago. The NNW-SSE and to some extent northeast-southwest and ENE-WSW basement trends, as well as associated horsts, grabens, and growth faults in the eastern region, formed as a result of reactivation of the ancient Precambrian trends observed on the Indian shield during and after rifting, and have determined the shapes, extents, and tectonic styles of the sedimentary basins there. The acoustic structure of sediments suggests that a basal sedimentary layer with a velocity of 4.0 to 4.3 km/sec is present in the region east of CLLR, but is absent west of it. This sediment layer, believed to be composed of clastics, volcaniclastics, and limestone, was probably deposited during the rifting stage. The seismic layers and the velocity structure (1.9 to 3.5 km/sec) of the overlying sediments are similar both east and west of the CLLR and suggest similar influences on sedimentary evolution in both the eastern and western regions during sea-floor spreading. However, sea-level changes during the Cenozoic in conjunction with tectonics resulted in several unconformities in the shelf sedimentary sequences. By about Oligocene and Miocene times, with the closure of Tethys Sea and the uplift of Himalayas, terrigenous sediments from the Himalayas became important for the northern margin and initiated the Indus deep-sea fan.

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Estimation of Paleo-Pore Pressure and Time of Hydrocarbon Expulsion—Computerized Simulation Model

A geological simulation model of generation and expulsion of hydrocarbon can be a useful tool in hydrocarbon exploration. The advantage of the model is to realize different environments in which hydrocarbon accumulations form under various geologic conditions.

A geologic cross section of an area is divided into a series of vertical columns, which are sectioned into rectangular cells. The model simulates the various geologic processes during basin development: (1) burial compaction of sediments, (2) history of temperature estimated from thermal conductivity and heat flow, (3) $R_O$ (vitrinite reflectance) value calculated by Lopatin's method, and (4) the amount of generated hydrocarbon as a function of generation potential and of transformation ratio represented by $R_O$. Increase of pore pressure is assumed to be caused by (1) increase of overburden, (2) increase of volume of free water resulted by clay dehydration, (3) aquathermal expansion of water, and (4) expansion of fluid phase by hydrocarbon generation. Residual pore pressure in each step of geologic time in the model is calculated by Rubey-Hubbert's equation:

$$P_A = kT + (P_O - kT) \cdot e^{-t/T}$$

where $P_A$ = residual abnormal pressure, $P_O$ = initial abnormal pressure, k = ratio of pressure increase, t = duration, and T = relaxation constant. T is a function of permeability that is derived from porosity and grain size. The amount of hydrocarbon expelled is calculated from residual abnormal pore pressure as a function of relative permeability and viscosity of fluids. Direction and time of hydrocarbon migration can be interpreted from spatial distributions of paleo-pore pressure and of hydrocarbon expelled from source rocks for each geologic time.

The model is applied to the Niigata sedimentary basin of the coastal region of the Sea of Japan. Regional differentiation of time of hydrocarbon accumulation in the basin is observed. Upward hydrocarbon migration across the strata is also implied at culminations of the trapping structures.

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