structures from submersibles in an area normally covered with prograding slope deposits. The concentration of relict shallow-water fossils in deep terrace zones and the rough topography can be confused with nonexistent structural features if not recognized during sampling programs.

S. E. SZASZ, J. H. FANTOZZI, and WILLIAM A. ADENT, State of Calif., State Lands Division, Long Beach Operations, Long Beach, Calif.

DEVELOPMENT OF LONG BEACH UNIT IN OFFSHORE PART OF WILMINGTON FIELD

Development of the Long Beach Unit, which includes most of the offshore part of the Wilmington field, was not begun until 1965. The city of Long Beach is the Unit Operator, directing THUMS Long Beach Company (field contractor) in the performance of day-to-day operations. The State of California oversees economic control through the State Lands Division in its Long Beach Operations office as determined by Chapter 138 (Senate Bill 60) of the State of California Statutes of 1964, First Extra Session. About 5% of the total revenues goes to the State of California for its Parcel II; about 9% is shared by 13,000 owners in the townlot area (downtown Long Beach) covering approximately 8,700 parcels. The remaining 86% is shared by the city of Long Beach and the State of California.

The field is a NW-SE-trending anticline broken by a complex system of mainly transverse faults. The field contains about 70 separate producing reservoirs which, for convenience, have been grouped into eight major zones defined by certain electric-log markers. They range in age from Pliocene to Miocene, and in depth from 2,000 to 8,000 ft. Shifts of the axial plane between fault blocks and with depth, variations in petrophysical characteristics, and large differences between the water tables between reservoirs indicate a complex depositional and postdepositional history. Oil gravity generally increases with depth, and also differs with structural position within the same producing reservoir.

The presently planned 650 wells are being drilled directionally from Pier J in the Long Beach harbor, and from four manmade offshore islands. Esthetic considerations have required extensive landscaping of the nearshore islands and the use of embellished towers which can move on a system of rails.

The general development plan requires a close interplay between geology, reservoir engineering, and economics because of certain unusual situations. At the start of the development, the reservoir pressure was found to be approximately hydrostatic on the south flank but considerably less than hydrostatic on the north flank. The water tables in many, but not all, sandstone members in the upper zones also were found to be less than hydrostatic on the north flank, as would be expected from hydrodynamic considerations. Moreover, free gas is disseminated in the oil zone along the crest and on the north flank in most fault blocks. It is believed that, originally, the reservoirs contained saturated oil with the bubble point at hydrostatic pressure, and that the present situation is attributable to large reservoir withdrawals before 1965, not only from the developed part of the Wilmington field, but also from the Seal Beach and the Long Beach-Signal Hill fields, the aquifer of these fields being in communication even across the Inglewood fault system. If so, the present hydrodynamic gradient is not a natural one but is the result of human intervention.

Exploitation of the field is governed by two major considerations: (1) returning maximum ultimate revenue to the Tidelands Fund. This has required sophisticated well-spacing studies using computerized mathematical modeling of both the production performance and the economics of the Unit; and (2) waterflooding without a primary depletion stage in order to maintain reservoir pressure to avoid any contribution toward ground subsidence. This creates complex problems because of the combining of many sandstone members in the same well bore, and also because faults are only partly sealing.

JUDSON B. HUGHES, JR., J. R. HARRIS, and S. O. PATTERSON, Tetra Tech, Inc., Pasadena Calif.

ADVANCES IN INTERPRETATION OF OFFSHORE SEISMIC DATA

The recent advent of long recording spreads and the development of new programs for digital processing have yielded large quantities of detailed information on seismic velocities along each line of recording. These advances have multiplied the ability of the geophysical interpreter to convert his seismic time data properly to more accurate depth displays for proper integration with geologic data, thus narrowing the gap in interpretation of structure and lithology between the geologist and geophysicist.

In steep dip areas of offshore California, it is imperative that the individual segments of events appearing on seismic time sections be migrated to their proper original positions. This geometric reconstruction can be approximated successfully by the proper use of velocity data in seismic wave-front methods of migration. Two-dimensional plots of seismic depth sections can be produced economically at present; such plots incorporate changing vertical and horizontal velocity data. Various methods of two-dimensional representation of structure are available.

Much greater effort must be devoted to integrated geophysical-geological interpretation of the great masses of seismic data which are being accumulated if management is to realize full return on exploration investments.

M. K. ALBRIGHT, Consultant, La Habra, Calif.

INTERNATIONAL LAW AND TECHNOLOGY FOR SEA FLOOR

The determination of who may own, lease, or explore the ocean floor must be reconciled first to precise means of defining the exact position of boundaries on the ocean floor. Definitions in terms of longitude and latitude at the surface cannot be used to determine on a slope on the sea floor where one company will cease drilling for oil and another will start.

A network of sonic transponders properly positioned on the sea floor by research submarines, guided by highly accurate underwater navigation equipment with X-Y plotters, will provide a 3-dimensional grid for locating fixed installations and tracking vehicles beneath the surface and on the surface. This network of transponders will correspond to "geodetic bench marks" on land.

Such catastrophes as the *Torrey Canyon* tanker, or crowded ports and zero weather conditions at ports, shorelines, or at sea require a new dimension in marine traffic control.