rine and nonmarine paleontologic stratigraphies and geochronologies of the Miocene.

Part 2—*Marine vertebrates* by Lawrence G. Barnes.

Emphasis on faunal studies and intensified fossil collecting have shown that marine vertebrates in Miocene strata of the West Coast of North America are useful in paleontologic correlation and in geochronology. Mammals, sharks, and bony fishes, in that order, are probably the most useful groups for correlation and chronology; birds and turtles are less useful at present because they are less well studied. Associations of marine vertebrate fossils with terrestrial mammals and marine invertebrates at several localities have permitted correlations between land-mammal "ages" and marine ages. There are three major chapters in the evolutionary history of marine vertebrates in the West Coast Miocene. These are termed *early, middle,* and *late* and are roughly equivalent to "Vaqueros," "Temblor," and "Santa Margarita" ages respectively. Early Miocene faunas are characterized by archaic mammals (eurhinodelphid dolphins, squalodonts, early sea lions) and birds, and mixed types of sharks. Middle Miocene faunas are characterized by relict archaic mammals (eurhinodelphids, squalodonts, primitive sea lions), some highly specialized mammals (desmatophocine sea lions, desmostylians), and the earliest ancestors of living groups (modernized dolphins, cetotheres). Middle Miocene fishes are tropical, the birds are related to modern taxa, and the sharks are noticeably different from early Miocene species. Late Miocene faunas closely resemble middle Miocene faunas, with similar sharks and birds, but usually lack most of the archaic mammals and turtles and show increased numbers of modernized mammals (dolphins, baleen whales, modern sea lions). Transitions between these three major marine faunas of the Miocene are rarely found.

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HISTORY OF SEISMIC EXPLORATION-SANTA BARBARA CHANNEL

The Santa Barbara Channel is 50 mi northwest of Los Angeles, and represents the offshore part of the Ventura basin, which covers an area of approximately 70 mi in length and 25 mi in width. Structurally, the basin is characterized by sharply folded, highly faulted anticlines, some of which are offshore extensions of onshore producing trends. The basin contains up to 40,000 ft of Tertiary sediments, with production from Pliocene through Eocene reservoirs.

The history of Humble's geophysical activity in the Santa Barbara Channel spans the period from early 1948, when the first reconnaissance lines were shot, through the 1969 digital CDP program. During this period, Humble compiled approximately 10,000 mi of seismic data. All of the data accumulated through 1967 was incorporated into a regional interpretation of the Santa Barbara Channel in preparation for the Federal lease sale in February 1968. Later surveys continued to improve data quality and velocity control for prospect evaluation on Humble leases.

Early seismic surveys, 1948-1953, used dynamite or black powder as an energy source and were recorded on paper records. An "L" spread cable configuration was commonly used, which enabled the geophysicist to resolve a true strike and dip at each shot point. These seismic events were laboriously hand picked, plotted, and migrated. Interpretation of the deep structure was greatly limited on these data by lack of penetration and a severe multiple problem. The near surface structures could be defined and resulted in the discovery of several fields on State offshore leases.

The development of CDP shooting techniques, first used by Humble in 1964 in the Santa Barbara Channel, gave the first insight into the deep structural complexity. Attenuation of multiple energy was possible and greatly needed velocity information could be obtained. Regulations limiting the amount of dynamite which could be used, were the greatest incentive for industry to change to non-dynamite sources. Air gun, gas exploder, and Aquapulse became the principal sources used. Data quality continues to be enhanced by improvements in the energy source, shooting technique, and data processing.

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PALYNOLOGY OF MONTESANO FORMATION (UPPER MIOCENE) OF WESTERN WASHINGTON

Plant microfossils from the Montesano Formation have been studied qualitatively and quantitatively in the type section along the Middle Fork of the Wishkah River. The age of the Montesano Formation has been established independently by Foraminifera as Late Miocene (Mohnian-Delmontian).

Over 100 species of palynomorphs have been recognized from the Montesano Formation with the following taxa most common: *Pinus, Picea, Pseudotsuga, Tsuga,* Taxodiaceae, Cupressaceae, Taxaceae, *Alnus, Betula, Carya, Castanea, Pterocarya, Quercus, Salix,* Compositae, and *Ulmus-Zelkova, Fagus, Juglans.* This assemblage indicates that in late Miocene time elements of the Eastern deciduous forest and coastal plain provinces co-existed with elements of the Cordilleran forest province.

The major floristic difference between the Montesano Formation and the overlying Pliocene-Pleistocene sequence is the disappearance of elements of the Eastern deciduous forest and coastal plain provinces in the younger rocks. Also *Artemisia,* which is absent in the Montesano Formation, becomes an important element in the younger flora. The underlying Astoria Formation, of early to middle Miocene age, is similar floristically to the Montesano Formation with the major differences being an almost complete lack of Compositae as well as the absence of *Polygonum californicum* in the Astoria Formation.

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FUTURE PETROLEUM POSSIBILITIES OF LOS ANGELES BASIN

The Los Angeles basin is an old and prolific petroleum-producing area, which should produce another 2 billion bbl of oil in the next 20 years. Estimates of ultimate recoverable oil range from 8 to 10 billion bbl, and 1-2 billion bbl of this oil is still undiscovered.

Exploration and production operations are difficult to initiate because of continually increasing governmental restrictions. Oil and gas potential is still geologically good. Three areas are unexplored: the center of the basin, the southeastern end, and the San Gabriel Valley.

Upper Miocene and lower Pliocene rocks are the most prospective for future discoveries and particularly the Soquel sandstones of the Miocene. New accumulations should be expected from both structural and stratigraphic traps.

The most important tool for finding new reserves is good data. We could improve the data situation by a general release of well information and the publication of more measured stratigraphic sections. Because geophysical work is severely restricted, we must use all available tools and investigate all new tools.

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ZEMORRIAN AND SAUCESIAN (OLIGO-MIOCENE) FORAMINIFERAL SEQUENCES IN SUBSURFACE, SOUTHWESTERN SAN JOAQUIN VALLEY, CALIFORNIA

Exceptional foraminiferal sequences of Zemorrian and Saucesian (Oligocene-Miocene) age occur in the subsurface of