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TERTIARY CLIMATIC CHANGE IN SAN JOAQUIN BASIN, CALIFORNIA: EVIDENCE FROM SHALLOW-WATER MOLLUSKS[1]

Early and middle Tertiary molluscan faunas of the California Coast Ranges are characterized by taxa now living far south in tropical and subtropical latitudes. Unusually large percentages of warm-water molluscan genera in Eocene and Miocene faunas of the San Joaquin basin reflect episodes during which the climate was substantially warmer than at present. Sharp decreases in warm-water genera and in taxonomic diversity during the middle Oligocene represent an intervening climatic deterioration. Parallel faunal trends occur in other Tertiary basins of the California Coast Ranges.

The post-Oligocene climatic amelioration reached a peak during middle Miocene time; tropical and subtropical genera were nearly four times as abundant as during the Oligocene climatic minimum. Percentages of warm-water genera declined during the late Miocene and dropped sharply during the early Pliocene. The last significantly large element of tropical and subtropical molluscan genera is found in the late Miocene of the San Joaquin basin. By the late Pliocene, molluscan assemblages were of temperate aspect and comparable to those now living at that latitude. The Miocene climatic peak indicated by mollusks is reflected by parallel trends in taxonomic diversity of foraminiferal faunas recently reported by other workers.

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CYCLICITY IN UPPER TERTIARY BASIN-MARGIN DEPOSITS OF CALIFORNIA COAST RANGES

Upper Tertiary marginal-marine sedimentary rocks of California are important reservoirs and have been studied extensively. However, they have been difficult to analyze in detail in terms of reservoir-scale genetic rock units because of the lack of a conceptual and fine stratigraphic framework for paleoecologic analysis and because sedimentation along the tectonically active Pacific Coast was dissimilar to that along the Gulf Coast where our modern depositional models have been largely generated.

Detailed study of Pliocene and Miocene strata of the Coalinga region, integrating both macrofossil and lithologic evidence, indicates that basin-edge sediments were deposited during well-defined transgressive-regressive cycles. The thickness of strata deposited during the cycles and the proportion that was deposited during the transgressive phase of each cycle are proportional to the slope of the surface that was being transgressed. The Pliocene depositional slope in the Kettleman Hills area was very low (many cycles are represented by less than 100 ft of strata), and sedimentation occurred primarily during regression. In the Miocene examples, the depositional slope was greater, the cyclic units are thicker and probably represent longer periods, and much of the deposition occurred during transgression.

Cyclicity in the marginal marine strata provides finer subdivision and more precise correlation than has been possible by use of either fossils or lithology. It also provides the conceptual framework within which genetic rock units can be distinguished at reservoir scale. Positions of shoreline, loci of deltaic deposition, and environmental gradients within the shallow-marine deposits can be discriminated in the Kettleman Hills on layer maps representing subdivisions within individual cycles.

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SUPRATIDAL DOLOSTONES: AN OVEREMPHASIS ON THEIR SIGNIFICANCE IN GEOLOGIC RECORD?

Numerous discoveries of recent dolomite forming primarily in the supratidal zone have prompted analogies with ancient dolostones. Although evidence seems to support most of these contentions, it is likely that overgeneralization has resulted: many dolostones lack definitive evidence of supratidal and/or evaporitic conditions.

Detailed field and laboratory examinations of three dolomitic units in New York (Little Falls, Upper Cambrian; Herkimer, Middle Silurian; Lockport, Middle Silurian) and one in California (Lost Burro, Middle to Upper Devonian) show that the dolomite, all of replacement type, represents original carbonate sediments of variable environmental deposition. These dolostones are not extremely fine grained, as is modern supratidal dolomite; replacement may have begun penecontemporaneously, but generally continued later into diagenesis. Stromatolites, mudcracks, and intraclasts in the Little Falls and Lockport dolostones strongly suggest intertidal to supratidal occurrences; Lost Burro carbonates accumulated in a nearshore, perhaps slightly hypersaline, subtidal environment; Herkimer carbonates apparently formed in a neritic environment of normal salinity.

Several other dolomitic units, cursorily examined, contain evidence (particularly faunal) of not having accumulated in an evaporitic, supratidal setting. In some recent carbonate deposits (*e.g.*, Sugarloaf Key, Florida; Coorang Lagoon, Australia), dolomite formation may not be related directly to high salinities.

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GEOMORPHOLOGY AND SEDIMENTARY CHARACTER OF REDONDO SUBMARINE FAN

(No abstract submitted)

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MAGNETIC GRAIN FABRIC OF SEDIMENTARY ROCKS

It is well known that measurement of magnetic anisotropy indicates the dimensional grain fabric of natural rocks. Although the directional results are easily interpreted, the quantitative descriptive parameters of the magnetic fabric require more care—but they can give valuable information as to the nature of the grain fabric. In direct grain-shape-related magnetic anisotropy, *e.g.*, in magnetite, it is possible to compare magnetic and optical fabric results by using a density function to describe the distribution of the dimensional axes of an aggregate of similar particles. The data are tested with sand deposited at the angle of repose. By using this method to produce a standard depositional

[1] Publication authorized by the Director, U.S. Geological Survey.