the Paleogene California continental margin. Diverse subtropical upper Paleocene-lower Eocene faunas containing *Morozovella* pass upward into temperate middle Eocene ones characterized by diminished diversity, lack of *Morozovella,* and by high dominance values for truncorotaloidid and subbotinid species, thus lending support for the concept of a bipolar middle Eocene cooling interval.

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BIOGENIC AND SEDIMENTARY FEATURES ASSOCIATED WITH JURASSIC CARBONATE TIDAL CHANNEL, WEST PAKISTAN

Exposures of steeply dipping Jurassic limestones in the Surghar Range, West Pakistan, allow detailed observations of various biogenic and sedimentary features. Thin-bedded dolomites, desiccation cracks, scour-and-fill structures, and shallow-water benthonic Foraminifera, within a dominant lithology of pellet carbonate grainstones and mudstones, indicate very shallow carbonate shelf conditions at the time of deposition. Periods of subaerial exposure, and subsequent lithification are indicated by the presence of oriented bivalve borings, both on surfaces which have been desiccated and on one surface which has been corraded by tidal currents. The latter exposure surface contains pebbles of identical lithology within the reticular gullies. Encrusting oysters are common. Submarine cementation of the surfaces is discounted because of the absence of inverted borings, superimposed bored surfaces, and extensively bioturbated sediment.

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ASPECTS OF SUBSURFACE BAHAMIAN DOLOMITES AND INSIGHTS INTO THEIR ORIGIN

A continuous 168-m core was collected on San Salvador in the eastern Bahamas. Dolomite is present in the interval between 35 and 147 m. The dolomite is of 2 basic lithologic types. Those dolomites which are probably supratidal mudstones and show laminations, a poorly developed fauna, a few intraformational clasts, and in places a capping red crust, are termed "stratal" dolomites. These stratal sequences are less than 10 cm thick. Those dolomites which are replacements of grain-supported carbonate sediments or rocks, probably of backreef or lagoonal facies, are termed "massive" dolomites.

Stable isotope analyses show both types of dolomite to have δC^{13} values within the range of Holocene sediments, but to be higher in δO^{18} than either Holocene sediments or Pleistocene limestones. These data indicate the dolomites formed by reaction of host carbonate sediments or rock with Mg-rich hypersaline brines. The stratal sequences were probably dolomitized by upward capillary movement of the fluids, whereas the massive sequences were dolomitized by seepage refluxion. Stratal dolomites seem to be relatively lower in δO^{18} and mol % $MgCO_3$ and more poorly ordered than massive dolomites. This may reflect different efficiencies of the 2 dolomitization processes.

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GEOLOGIC HISTORY OF OCEANIC PLANKTON

In its evolution throughout geologic time, the oceanic microplankton became increasingly diverse in major taxonomic representation and biochemical variety, but fluctuated markedly in species diversity, abundance, size range, morphology, and dominant skeletal composition.

Organic-walled phytoplankton of the Precambrian was locally abundant, specimens relatively large, but diversity low. By Ordovician and Silurian times, phytoplankton varied widely in size and morphology; zooplankton included radiolarians and rare tintinnids. Decreasing suddenly in the Late Devonian, both phyto- and zooplankton were rare in the late Paleozoic.

Slow development of plankton in the Triassic left a meager record of acritarchs, coccolithophorids and radiolarians. Rapid diversification characterized the later Mesozoic; abundant dinoflagellates, tintinnids (calpionellids), and planktonic Foraminifera were added during the Jurassic; siliceous phytoplankton arose in the Cretaceous (diatoms, silicoflagellates, chrysomonads), and radiolarians and coccolithophorids expanded.

Another severe reduction in plankton diversity and abundance closed the Mesozoic, hence most groups are poorly represented in the Danian. Paleocene and Eocene diversification and proliferation of phytoplankton (dinoflagellates, coccolithoporids, diatoms, silicoflagellates, ebridians) and zooplankton (radiolarians, foraminifers and some tintinnids) were accompanied by increased morphologic complexity and greater size range. Although plankton abundance, diversity, and complexity fluctuated in the later Cenozoic, no new higher taxa arose.

At present, abundant plankton indicates high productivity, but diversity may be low. Geologically, this abundance was reflected in rapid accumulation of biogenic sediments (chalks, cherts, diatomites); extensive photosynthetic utilization of CO_2 also may have contributed to the accumulation and preservation of calcareous sediments.

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CONTINUITY OF PLIOCENE TURBIDITE SANDSTONES, VENTURA AREA, CALIFORNIA, WITH APPLICATIONS TO SUPPLEMENTAL RECOVERY

Outcrops of turbidite sandstones of the Pico Formation (upper Pliocene) at Ventura field and vicinity were examined to gain an insight into their continuity.

Two types of reservoir quality sandstones were recognized based on physical and petrophysical properties. Type A sandstones (graded, poorly sorted) have low permeabilities (several hundred millidarcys). Type B sandstones (nongraded, moderately to well sorted) have high permeabilities (several thousand millidarcys).

Three classes of turbidite packages were distinguished based on internal arrangement of sandstone types. All 3 packages contain thin-bedded Type A and B sandstones. A Class I package has, in addition, massive, composite Type A sandstones at the base; a Class II package has the massive, composite Type A sandstones in the middle; and a Class III package has no massive, composite Type A sandstones.

Thick, composite Type A sandstones have good lateral continuity because they are amalgamated. Type B sandstones have poorer lateral continuity because of lack of communication with other sandstones.

Observations on a single turbidite package over a lateral distance of 1,000 ft indicate that 80% of the Type A sandstone is continuous for this distance, whereas only 10% of the Type B sandstone is continuous. Factors for lateral continuity with distance multiplied by kh (millidarcy-feet) give a measure of the kh which may be expected to be in connection between wells various distances apart. At a distance of 500 ft from an injection well, only 60–80% of the total kh of the injection well may be in connection with a producing well, in the direction of depositional strike (north-south). In the depositional dip direction (east-west) this value may be 80–100%.

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EXPERIMENTAL CEMENTATION OF CARBONATE SANDS

The processes of vadose and phreatic diagenesis in carbonate rocks have been simulated in the laboratory by using CO_2 charged water to leach a "source bed" of carbonate sand. Precipitation of carbonate cement in a second sand body, above and below an artificial water table, was induced by CO_2 evasion. Aragonite and high-Mg calcite (predominantly the latter) were leached from the source bed, and low-Mg calcite was precipitated as cement in the second sand unit. More cement was produced in the "vadose" zone than in the "phreatic" zone.

The petrography of the cement is similar to that observed in cemented eolianites in Bermuda. Petrographic evidence suggests that cementation proceeds in 3 stages: (1) intragranular calcite cement forms drusy cavity fillings in the original voids of skeletal fragments; (2) rim cementation, consisting of fine-grained spar calcite; and (3) intergranular fine-grained calcite spar filling the original pore space in the skeletal sediment.

Mass transfer calculations show that the laboratory cementation process is consistent with soil P_{CO_2}, rainfall, and cementation rates on Bermuda.

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SUNDA BASIN—IMPORTANT NEW INDONESIAN OIL PROVINCE

The Sunda basin is one of the Tertiary ideogeosynclines bordering the stable Sundaland. Twenty-one prospects have been drilled since offshore exploration started in late 1968 with oil and/or gas being discovered in 52% of these ventures.

A north-south horst and graben framework on a rugged Late Cretaceous surface governed erosion, deposition, and tectonic growth throughout the Tertiary in all but the northeastern extremities of the basin.

Volcanic and fluvial rocks constitute initial sedimentary deposits. Quantity of sediment influx was primarily responsible for differential sinking of graben blocks during early basin development and resulted in thick deltaic deposits during early Miocene. Downwarp of the backdeep continued with sea invasion through island passages in the geanticline on the south. High tectonic blocks prevented segments of the basin from being invaded during early basin development. With continued denudation and downwarp, Miocene transgression expanded over the Sunda basin. Local high areas persisted, but trangression continued dominant.

As basin segments filled, a nearby flat depositional surface developed. Slight lowering of sea level resulted in regional regression, followed by major transgression in post mid-Miocene time. Late in this second transgressive period, most disconnected ideogeosynclines became one regional geosyncline surrounding the Sundaland. Final regional regression occurred in late Miocene, culminating in complete emergence during Pleistocene. Worldwide melting of Pleistocene ice caused a resubmergence of the basin to present marine conditions.

Production has been established in principal intervals producing in Sumatra. Major new pays have been established in Oligocene volcanic tuffs and in Oligocene (?)-Miocene sandstones of the Talang Akar. Possible commercial shows have been found in Miocene Batu Radja transgressive limestone and in weathered basement rocks. Major oil production is indicated from Air Benakat sandstone bodies. Gas production has been established in the Parigi Limestone.

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UNIQUELY ROUNDED DESICCATION COLUMNS NEAR EUPHRATES RIVER, NORTHWESTERN IRAQ—PRODUCED BY PROLONGED EROSION IN ARID CLIMATE

During a reconnaissance in northwestern Iraq distinctive, much eroded, polygonal mudstone desiccation columns averaging 2 ft in diameter and ranging in height from 2 to 4 ft were seen in the bed of a wadi 200 yd upstream from its intersection with the Euphrates River between the villages of Haditha and Ana. These columns were unique because of their well-rounded upper terminations and because of their discreteness, emphasized by enlarged bounding fractures which ranged in width from 3 to 6 in. The key to the origin of such columns must lie in prolonged preservation and exposure—perhaps over a period of several years—to erosion, largely by weathering (including spheroidal weathering) and by wind and perhaps to a lesser extent by water.

At this locality the blanket of sediment in which the desiccation columns developed was deposited during floodstage of the Euphrates. If this same height of flood was not reached again for several years and if the columns were not destroyed by local rainfall or wadi flow, prolonged erosion would result. Regionally, rainfall averages only about 4 in. per year, but local areas may receive little or no rainfall for extended periods.

Thus if preserved in ancient rock such extremely eroded and rounded columns, or the casts produced by filling of their bounding fractures, would be suggestive of a more arid environment than is indicated by many occurrences of "ordinary" mudcracks or mudcrack casts and associated columns with noneroded planar or only slightly curvilinear upper surfaces.

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TIME STRATIGRAPHY FROM SEISMIC DATA

The seismic reflection process expresses the interbedding of sediments as a pattern of seismic cycles which