and to a lesser extent in the reef-slope facies. Zoned dolomite cements are, in contrast, the major cement type in the reef-margin and reef-slope facies; a basinal source for dolomite-precipitating fluids is indicated. It is suggested that the composition of basin-derived pore waters was controlled by temperature-dependent clay mineral reactions as a function of progressive burial.

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Miocene Deep-Sea Benthic Foraminiferal Faunal Changes in Pacific

Miocene deep-sea benthic foraminifera, analyzed from numerous Pacific DSDP sites, are found to respond to climatically induced oceanic variations by: (1) changes in depth distribution with time; (2) changes in species proportion within assemblages; and (3) becoming extinct. Because benthic species are long-ranging, many species occurring today were present in the Miocene and provide a basis for studying Miocene paleo-oceanographic changes. Analyses of δO^{18} and δC^{13} compositions of benthic foraminifera which record fluctuations in paleotemperatures and in the marine HCO_3 pool reveal major changes between the early and late Miocene.

Shifts in benthic foraminiferal populations and isotopic compositions during the Miocene imply the following water mass changes: (1) early Miocene deep waters appear to have been warmer with older, light δC^{13}; and (2) a sharp middle Miocene increase in δO^{18} which we interpret to be a major bottom water cooling concomitant with Antarctic glacial buildup and thickening of the Antarctic bottom waters, restructuring the Miocene ocean and increasing the equatorial thermal gradient. Benthic fauna species dominance, species assemblage, and water depth indicate that by the late Miocene, both modern benthic foraminiferal assemblages and modern oceanographic conditions were approached. Intensification of the oxygen minimum zone in the late Miocene is supported by the dominance of *Uvigerina* fauna in the west Pacific.

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Algae, Carbonate Facies, and Petroleum Geology

Algae have been a significant part of carbonate deposition for much of the earth's sedimentary history. They are all important in some circumstances. In recent years the growing understanding of calcareous algae has become increasingly relevant to petroleum geology.

Marine calcareous algae have been the source of vast quantities of carbonate sediment, principally muds and sands, on continental shelves and in the deep ocean basins. Encrusting calcareous algae have created rigid frameworks and are important elements in Mesozoic and Cenozoic reefs. Noncalcareous filamentous algae have been influential in stabilizing fine-grained carbonate sediment, thereby forming distinctive sedimentary laminated structures.

The ecologic requirements of benthic calcareous algae have been used with success in the interpretation of environments in which ancient carbonate sediments accumulated. Drawing upon detailed studies of modern ecosystems, definitive depth-distribution patterns of living coralline algae have been established that have value in determining Cenozoic paleobathymetry.

Rapid evolutionary changes undergone by calcareous planktonic aglae, together with their abundance and widespread distribution, have led to their extensive use in stratigraphy. Coccolithophorids provide the basis for a remarkable high-resolution biostratigraphy in Mesozoic and Cenozoic marine sediments. Zones with time spans averaging one million years (minimums of a few hundred thousand years) have been established for the Cenozoic era.

Although the remains of calcareous algae are the major grain constituents in some carbonate reservoir rocks and associated facies, their principal uses are in establishing fine-scale stratigraphic frameworks, interpreting paleoenvironments, and understanding the diagenetic history of reservoir facies. Fossil algae, often considered an obscure field of knowledge, are assuming a more pragmatic position in petroleum geology.

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Late Neogene and Recent Bathyal Foraminifera of Mediterranean

Multivariate statistical analyses of recent deep-water benthic foraminifera of the Mediterranean reveal a bathymetric and geographic distribution that can be ascribed to water-mass distribution and bottom topography. Three bathyal zones were detected: upper (500 to 1,300 m), intermediate (1,300 to 2,800 m), and lower (> 2,800 m). The eastern Mediterranean (Ionian and Levantine Basins) displays significantly fewer species, fewer individuals, and shows lower species equitability than does the western Mediterranean. The Holocene foraminiferal distribution patterns provide a framework against which late Miocene and Pliocene foraminiferal dynamics were evaluated.

The late Miocene (Messinian) salinity crises eliminated bathyal faunas from the Mediterranean. Pliocene foraminifera which repopulated the Mediterranean (1) are remarkably similar to pre-Messinian faunas of the middle upper Miocene Mediterranean sediments; (2) appear in the sedimentary record very soon after initiation of Pliocene sedimentation and attain population stability within 0.5 million years; (3) were derived predominantly from the Atlantic Ocean; and (4) migrated across the Mediterranean from the west to east. Population differences between the eastern and western Mediterranean faunas suggest the presence of Pliocene sills, especially in the Sicilian area. The geographic differences between Pliocene population structures were less significant than they are today. This phenomenon can be explained by Pleistocene tectonism which further restricted water circulation.

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Petrophysical Engineer's View of Reservoir Delineation

From imperfect measurements of a few physical properties representing a tiny fraction of the reservoir, significant interpretations are made by geologists, engineers, and geophysicists. As the geophysicist begins to focus more on field delineation rather than broad exploration, it becomes even more important to understand the potential as well as limitations of borehole measurements.

Basic physical measurements in the borehole provide far more information than the usual reservoir parameters such as porosity, fluid type, and saturation. Log responses such as self potential, natural radioactivity, resistivity, acoustic travel time, and density also provide invaluable clues to lithology,