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Planktonic Calibration of Provincial Miocene Stages of California

Age assignments and correlations of Miocene marine strata in California are usually made with reference to a sequence of benthic foraminiferal stages. During the past decade refined calcareous and siliceous planktonic microfossil biochronologies have been developed that provide a means for calibrating the California provincial stages to international standards while also testing the chronostratigraphic reliability of correlations derived by equating stage diagnostic benthic foraminifer assemblages in different areas. Diatoms are particularly useful for dating the upper, silica-rich part of the Monterey Formation whereas calcareous nannofossils are useful for dating the lower part of the Monterey Formation and older Miocene units.

Data from type sections show that the base of the Saucesian Stage is near the Oligocene-Miocene boundary of international usage, the base of the Relizian Stage falls at the base or in the lower part of the early Miocene *Helicosphaera ampliaperta* Zone (nannofossil), and the Luisian Stage essentially coincides with the middle Miocene *Sphenolithus heteromorphus* Zone (nannofossil) and the *Denticulopsis lauta* Zone to Subzone a of the *Denticulopsis hustedtii—D. lauta* Zone (diatom). The top of the type Mohnian Stage is within the latest Miocene to early Pliocene *Nitzschia reinholdii* Zone (diatom), whereas the type section of the Delmontian Stage is within Subzones b and c of the middle Miocene *Denticulopsis hustedtii-D. lauta* Zone. The type Delmontian is therefore equivalent to the lower Mohnian of most California sections.

Compilation of data from throughout California indicates some overlap in time of benthic foraminifer assemblages diagnostic of the Zemorrian and Saucesian Stages and of the Relizian and Luisian Stages. The transition from Luisian to Mohnian benthic foraminifer assemblages, however, consistently occurs near the top of the *Sphenolithus heteromorphus* Zone and within Subzone a of the *Denticulopsis hustedtii-D. lauta* Zone.

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Focused Migration of Gas and Oil

Gas and oil migrate from the site of thermal generation to the site of final entrapment. The direction of this migration is controlled by the basin geometry in existence during the time of migration, while the length of the migration path is controlled by the available permeability of void channels or natural fractures. Gas and oil generally migrate in directions normal to the regional pressure contours, thus normal to regional structural contours. Focusing of migration paths results from certain favorable geometric parameters connected with basin configurations. Major migration paths, and hence preferred areas of hydrocarbon entrapment, are predictable to a large degree. Migration focusing is not a theoretical concept but rather a valid explanation of numerous observations is most basins of the world. Examples are given from such different geologic settins as the Middle Magdalena basin and Lower Magdalena basin, Colombia (oil), northwest Germany (gas), and the Gippsland basin, Australia (gas and oil).

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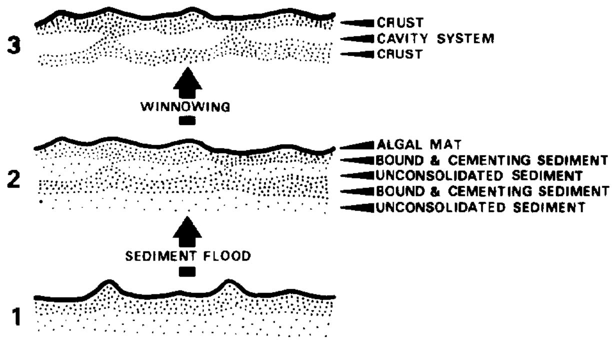
Stromatolitic Framework of Carbonate Mud Mounds



Mud mounds are an important Phanerozoic reef type generally formed in deep water on carbonate shelf-to-basin slopes. They commonly contain spar-filled depositional cavities (stromatactis) but lack abundant metazoan framebuilders. Mud mounds are flanked by steeply dipping bioclastic grainstones and commonly attained widths and depositional relief of hundreds of meters. They may occur as basal zones in many metazoan-constructed reefs.

Stromatactoid mud mounds are composed of a succession of submarine-cemented crusts separated by cavities that developed in intercalated, unlithified mud. Crusts from mud mounds of all ages show strong similarities to thrombolites (unlaminated stromatolites) which occur in many Phanerozoic shallow-water reefs; both are largely composed of micrite, cemented on the sea floor, contain fenestral fabric and cryptalgal microstructure, and their depositional surfaces are rugose, not burrowed, encrusted, or bored. Both thrombolite and crust morphologies are probably related to environmental factors: thrombolites in shallow-water reefs are columnar and branching whereas crusts in deeper water are more tabular. Irregular sediment loading and distribution of algal mats probably caused rugose depositional surfaces. Stromatolitic lamination, although not commonly developed in the subtidal zone, occasionally occurs and corroborates a cryptalgal origin.

It is proposed that mud mounds accumulated from successive floodlike episodes of sedimentation off carbonate shelves. Rapid sedimentation at the onset of each flood smothered the living algal mat which re-established itself as sedimentation began to subside. Winnowing between sediment floods washed out unbound sediment and promoted synsedimentary cementation of resulting stromatactis and algal-bound crusts.

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Digital Base Maps—Dealing with Registration Problem

Most large petroleum exploration companies are assembling digital files of exploration data that can be accessed routinely to produce operating base maps. These data include site data (wells, seismic, pipelines, etc) and boundary data (leases, political subdivisions). To associate these data with a ground reference system, survey details (such as section, township, and range) have been digitally captured for computer-generated display.

In the past all this information was stored as conventional coordinates, such as latitude and longitude. This information comes mostly from a variety of sources lacking detail or having inaccurate detail for determining correct conventional coordinates. In any geographic area there may be a number of con-