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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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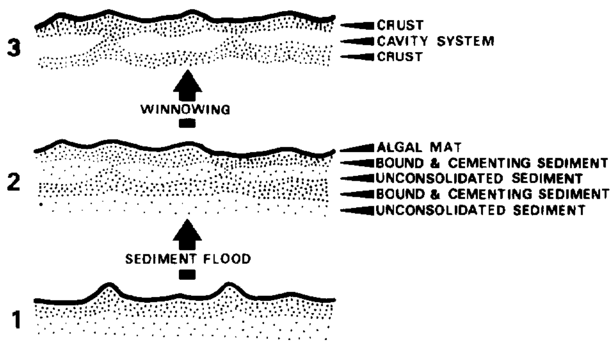
Stromatolitic Framework of Carbonate Mud Mounds



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 conventional base map sources, each of which may show accurate internal spacial distribution, but be inaccurately located relative to the true coordinate geometry of the earth.

Problems ensue when attempts are made to display various data from different sources. Wells, leases, seismic, etc, may not be properly located with respect to each other or with respect to the digital base used.

One solution is to store the digital base in conventional coordinates and locate all other data as offsets to known points in the digital base such as the closest section corner. this is an adaption of the so-called "Legal Description" that is used to locate wells. Pseudo-"Legal Descriptions" can be computer-calculated where not directly available. Boundary data can be treated as a series of connected points that can accurately overlie the digital base map data. Compatibility for all data thus located is achieved regardless of the source or digital base from which the data is acquired. Revisions of the digital base do not require re-registration of other data.

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Terrestrial Influence and Bioturbation Effects on Composition of Organic Matter in Middle Cretaceous Shale and Limestone Sequence near Pueblo, Colorado

Soluble organic matter (chloroform), pyrolytic hydrocarbon yield (Rock-Eval), and carbon isotope ratios of insoluble organic matter were determined on core samples of the Hartland Shale and overlying Bridgecreek Limestone of the Greenhorn Formation. Trends in the organic geochemistry correlate with clay mineral content and sedimentary structures of the sediment, suggesting that (1) terrestrial input and (2) bioturbation are dominant influences on the composition of preserved organic matter.

(1) The Hartland clay shales are organic matter-rich (organic carbon contents 2.3 to 4.5%) but have lower ratios of pyrolytic hydrocarbon yield- and extractable hydrocarbons-to-organic carbon, and lower kerogen $\delta^{13}C$ values (from -27 to -28 ppt) than the Bridgecreek calcareous shales (organic carbon contents 1.8 to 5.4% and $\delta^{13}C$ values from -24.5 to -26.2 ppt. The laminated Hartland shales contain abundant terrestrial detritus (up to 70% quartz, illite, and mixed-layer clays). The laminated to partly bioturbated Bridgecreek shales contain minor terrestrial detritus (less than 20%), indicating a reduction in terrestrial influence on the basin after deposition of the Hartland clay shales.

(2) Within the Bridgecreek member, the types of organic matter preserved in the laminated calcareous shales, partly bioturbated calcareous shales and bioturbated limestones are different, and are thought to result from increasing bioturbation and availability of oxygen in the bottom water. As bioturbation increases, the organic matter remains isotopically constant, but decreases (from about 5 to less than 1%) and is altered chemically as shown by decreasing ratios of pyrolytic hydrocarbon yield- and extractable hydrocarbons-to-organic carbon, and increasing ratios of pyrolytic carbon dioxide to organic carbon.

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Micropaleontologic Analysis of Navarin Basin, Bering Sea, Alaska

Navarin basin, a large structural basin filled in places with more than 12,000 m of sediment, underlies the Bering Sea continental shelf about 100 km from the Koryak coast, U.S.S.R. The shelf in this region is relatively flat with a pronounced shelf-slope break at about 200 m. In contrast, the continental slope is incised by three large canyons.

Little is known about the sediment and microbiota in the Navarin basin province because preveious work in the Bering Sea has been concentrated in the eastern and southern areas. More than 100 gravity cores and grab samples were collected during the summer of 1980 from the basin, adjacent slope, and nearby canyons in water depths ranging from about 80 to 3,300 m. Cores as long as 6 m contain predominantly clastic mud and sand. This preliminary U.S. Geological Survey sampling program is the first attempt in the Navarin province in which the three microorganism groups—diatoms, radiolarians, and foraminifers—are used to obtain paleogeographic information and to establish age-datum planes.

Diatoms, the most abundant micro-organisms in the cores, are useful for defining glacial events and sea level fluctuations, and for establishing depth of deposition. Radiolarians are more abundant in the deeper shelf area, and are used to delineate paleogeographical boundaries and biostratigraphic events in the Navarin province. Calcareous foraminifers are abundant in the cores from even the deepest stations, but diversity is low. Shallow-water benthic foraminifers recovered in deep water indicate downslope movement of sediment. Study of these three micro-organism groups provides a more complete picture of the benthic and planktonic communities and thereby leads to a more accurate paleoecologic interpretation of Navarin basin.

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Melones μ: Clay Controlled, Inclined Oil-Water Contact Reservoir, Orinoco Heavy Oil Belt

The Melones μ reservoir is the topmost petroleum bearing sand of the Melones Field, which is located in the Eastern Venezuela basin, within the Orinoco heavy oil belt.

This huge reservoir contains 1.5 billion bbl of 8.2 to 10.3° API oil in situ. It is a shallow reservoir (1,900 ft or 579 m deep) and has an average thickness of 80 ft (24 m). The unconsolidated sand, with a dip of approximately 1°, contains variable amounts of dispered clay. The μ-sand is a stratigraphic accumulation which has an updip closure controlled by an increase in its clay content. The clastics of this unit were deposited in an alluvial meander belt environment.

Even though the oil-water contact of this giant accumulation is inclined, the reservoir is under hydrostatic conditions. The inclination of the contact is controlled by the sands' clay content. It is postulated that during migration the oil and water had similar densities resulting in the inability of the oil to displace the water except in clay-free areas. The low dip of the strata also did not aid the oil migration.

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Holocene and Ancient Hardgrounds: Petrographic Comparison

Subtle diastems or truncation surfaces in carbonate sequences can go unnoticed during core inspection when mineralized coatings or encrusting fauna are absent. These