margin or reef flat and the seaward, more steeply inclined upper slope or marginal escarpment.

The carbonate margins fronting detached platforms and attached shelves can be grouped as either open (Campeche, West Florida) or rimmed (Bahamas, Belize, Great Barrier Reef). Insular margin fringing/barrier reefs (New Guinea, Tahiti) and atolls (Eniwetok, Bikini) form a third major group. The shelf-slope boundary within these highly variable margins spans from shallow, abrupt, and distinct to deep, broad, and dimly defined.

The regional geologic setting, basement structure, and tectonic history are the primary controls determining carbonate buildup type and hence the general nature and location of the shelf break.

Once established, carbonate buildups are profoundly influenced by the available physical-energy flux. Where winds and waves are dominantly unidirectional, the margins of carbonate buildups acquire significant windward and leeward characteristics. Where the tidal range is elevated, tidal currents control sedimentation. Acting in conjunction with tectonic movement and the physical processes are geo- and glacio-eustatic-induced sea-level fluctuations. Other important factors influencing the carbonate shelf break are antecedent topography, fluvial-terrigenous sediment input, and oceanic circulation/upwelling.

The dominance of reefs and sand bodies at the carbonate shelf-slope boundary produces rocks with initially high porosities/permeabilities which may form good reservoir rocks. This boundary is also sensitive to climate change and sea-level fluctuation and therefore may contain detailed data on the geologic history of the entire carbonate buildup.

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## Mineral Reactions in Shale Diagenesis

Compaction and lithification of muds (composed of normal terrestrial weathering minerals) into shales involves a major mineralogic change that has been followed in many sedimentary basins throughout the world. Unstable mineral components, such as potassium feldspar and mica, begin to decompose at temperatures around 60°C and the released chemical components react with dioctahedral smectite to produce mixed-layer illite/smectite, chlorite, and quartz. The extent of the reaction is highly dependent on temperature and time.

This diagenetic reaction may influence the rate at which liquid hydrocarbons are generated because the surface electrical charge of smectite—and therefore its efficiency as a catalyst—increases during the reaction. In addition, dehydration of smectite on its conversion to illite can lead to overpressuring of pore fluids that may be involved in migration of liquid hydrocarbons from the shale to reservoir rocks. The timing of liquid hydrocarbon and new pore-water generation, and overpressuring caused by smectite dehydration may be critical to the production potential of a sedimentary basin.

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## Faunal Zonation of Cenomanian (Middle Cretaceous) Rudist Reef, Paso del Rio, Colima, Mexico

The Cenomanian (Middle Cretaceous) rudist reef at Paso del Rio, Colima, is the only reef known to contain *Immanitas,* a recumbent, caprinid rudist. Within the reef, four units are discernible. At the base is a siliciclastic-poor wackestone with upright caprinids. This grades upward into a silty, caprinid-Immanitine-radiolitid wackestone/packstone with caprinid and radillitid zones at the top. Overlying this unit is an argillaceous, Immanitine packstone. The reef is capped by a silty packstone (debris bed) containing *Immanitas.*

This reef represents a single cycle of framework evolution with a constructive and a destructive phase. The constructive phase is represented by the caprinid wackestone and the silty, caprinid-Immanitine-radiolitid wackestone/packstone. The caprinid and radiolitid zones at the top of the latter unit comprise the climax communities. The destructive phase is initiated by the reestablishment of *Immanitas* in the argillaceous, Immanitine packstone. The termination of the reef is evidenced by the debris bed, a silty, *Immanitas* packstone.

This zonation is somewhat similar to the zonation of Cretaceous rudist frameworks in the Caribbean reported by others with the following exceptions: (1) upright rudists at Paso del Rio are predominantly caprinids, whereas those in the Caribbean are predominantly radiolitids; (2) recumbent rudists at Paso del Rio are the caprinid *Immanitas,* whereas those in the Caribbean are the caprinid *Titanosarcolites* and the radiolitid *Biradiolites;* and (3) the two separate types of framework evolution described in the Caribbean are combined at Palso del Rio.

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## Surface Geochemical Prospecting—Pro and Con

In the 40 years since surface geochemical prospecting was first developed, extensive studies have been made by major oil company research laboratories, academic institutions and geochemical service companies both in the United States and abroad. Despite this wealth of data, there are still conflicting opinions as to the value of surface prospecting in finding oil and gas.

There is ample evidence that many petroleum accumulations leak hydrocarbons to the surface via faults, fractures, unconformities, intrusions, and highly permeable sediments. Migration can occur in a wide range of concentrations from the visible to the invisible, as a discrete hydrocarbon phase or in solution. These migration mechanisms follow erratic pathways upward causing surface anomalies that may have prospecting value when combined with conventional geological and geophysical exploration methods plus an understanding of the ground-water flow regime. Upward migration is most likely in tectonically active areas, and least likely in quiet areas, especially where there are widespread barriers to migration such as evaporites.

The interpretations of these anomalies are best used in a regional sense since there is no known mechanism that will cause a subsurface pool to be outlined at the surface. Furthermore, the mixing of upward migrating hydrocarbons with near-surface generated hydrocarbons confuses the detailed local interpretations. Even regional evaluations can be risky since some areas with valid surface shows are studded with dry holes. Nevertheless, when no subsurface cuttings are available, surface prospecting can indicate, under favorable conditions, if an area is alive or dead with respect to hydrocarbons.

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