Reaction rates for a wide variety of reactions involving carbonate phases and aqueous solutions have been investigated by monitoring pH changes as the reactions proceed. Rate constants are available for the escape of CO_2 from solution, for the dissolution of a wide range of calcium and calcium-magnesium carbonate minerals, and for growth rates of aragonite and calcite. Preliminary studies of nucleation energy and nucleation induction time have been carried out, but these studies have limited applicability to natural systems where abundant nuclei already are available. In certain cases where carbonate deposition is assumed to occur, tetracycline marking techniques have been employed to test the validity of the kinetic models.

On the basis of the experimental results, kinetic theory allows the following predictions: (1) in the presence of organisms, surface waters will appear oversaturated with respect to both CO_2 and dissolved carbonates during daylight hours; (2) the composition of a solution in contact with mixed carbonate phases will be determined by the more rapid of the simultaneous dissolution and precipitation reactions, with dissolution generally being the controlling process; and (3) in the absence of a continuing supply of metastable phases, equilibration will be approached more rapidly by the removal of metastable phases (either by solution or by replacement) and much more slowly by interstitial carbonate precipitation. Each of these observations is supported by field evidence.

The observations made suggest the need for caution when applying the results of field study of modern carbonate environments to the interpretation of ancient carbonate rocks.

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Early Post-Depositional Preservation of Paleosalinity, a Mathematical Approach

Early alteration of interstitial water can appreciably hasten sediment diagenesis; this is especially true for calcareous deposits. Thus, from a theoretical standpoint, it is of interest to determine if "original" interstitial water can be preserved as a paleosalinity in areas where post-depositional bottom-water salinity changes characteristically take place, *e.g.*, coastal swamps and deltas.

A model based on the coastal mangrove swamps of southwest Florida, an area where marine swamps recently have replaced fresh-water swamps, was constructed and an equation derived to evaluate the effect of long-term and short-term salinity variations in swamp water on the salinity of water entrapped in the 1–3 meters of sediment underlying the swamps. The model considers ionic diffusion in a homogeneous sediment column overlying an impervious basement and underlying swamp water that seasonally (short term) fluctuates in salinity and that systematically decreases or increases in mean water salinity over periods measured in years (long term).

The model predicts that, in areas where the bottom water has an annual sinusoidal-salinity fluctuation with an amplitude of 35 ‰ (parts per mil), the interstitial water will be affected significantly (more than 0.2 ‰) in the upper 35 cm. of the underlying sediment. This prediction is borne out by field data. If the mean water salinity about which the short-term fluctuations take place is increased or decreased, most of the effect of the drift in the mean is transmitted to the bottom of the sediment column within a few hundred years. Normal sedimentation rates in the swamps have little effect on the rate at which the interstitial water is modified.

Preservation of paleosalinities in the coastal swamps of southwest Florida, or in similar environments, evidently requires special condition, *e.g.*, a recent change in mean bottom-water salinity combined with rapid deposition of sediment. Deposition of sediment isolates underlying deposits from diffusion contact with the changed bottom water.

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Diagenesis and Geochemistry of Sediments in Marine Environment

Diagenetic alterations were induced in sediments in a model representing a shallow-marine shelf by injecting synthetic sea water under partial pressure of carbon dioxide. The sediments from the model were then removed and studied under the petrographic microscope. The study included (1) the interrelation of the chemistry of the interstitial fluid and the mineralogy of sediments, (2) the factors controlling the formation of silica and calcite cements, (3) the processes responsible for transforming sediments into hard rocks, and (4) the sequence of these processes.

The precipitation of silica and calcium carbonate as cements in the model sediments was detected under the petrographic microscope and is shown on photomicrographs. The petrographic analyses indicate that during early diagenesis cements formed in intergranular space only. The calcite cement crystallizes as small fibrous crystals around the grains extending into the pore space and subsequently results in rim cement. Silica cement is formed simultaneously both as overgrowths and in optical continuity around sand grains.

The silica and calcite precipitated as cements in the model seem to be derived from the interaction of clays and sea water. Geochemical environments for such reactions and environments which enhance the cementation of sediments were interpreted from the studies.

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Outline of Geology of Niger Delta

The coastal sedimentary basin of Nigeria has been the scene of three depositional cycles. The first started in middle Cretaceous time with a marine incursion and was terminated by a mild folding phase during Santonian time. The second began with the growth of a proto-Niger delta during Late Cretaceous time and ended in a major Paleocene marine transgression. The third cycle, lasting from Eocene to Recent, was the continuous growth of the main Niger delta.

A new three-fold lithostratigraphic subdivision is introduced for the Eocene-Recent Niger delta subsurface, comprised of an upper sandy unit called the Benin Formation, an intervening unit of alternating sandstone and shale named the Agbada Formation, and a lower shaly unit called the Akata Formation. These three units extend throughout the delta and each ranges in age from early Tertiary to Recent. A separate member of the Benin Formation is distinguished in the Port Harcourt area. The Afam Member is interpreted as an ancient valley fill formed in Miocene sediments. Subsurface structures are interpreted