uplands in the Middle Ordovician sequence indicates the importance of assessing regional geology, geologic history, and tectonics in understanding regional cementation patterns and cementation processes of ancient carbonate platforms.

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Late Mesozoic Carbonate Banks and Reefs Along U.S. Atlantic Margin

A paleoshelf-edge complex of Late Jurassic and Early Cretaceous age rocks observed in seismic profile off the United States east coast probably represents a group of carbonate banks and/or reefs. The paleoshelf-edge lies 10 to 15 km seaward of the present shelf edge in Georges Bank, 20 to 30 km in the Baltimore Canyon trough, 30 to 150 km in the Carolina trough, and 150 to 300 km in the Blake Plateau basin. Refraction studies of the margin observed velocities of about 5 km/sec at depths of 2 to 3 km beneath the outer continental shelf and upper continental slope that correspond to the top of this paleoshelf-edge complex.

Drilling results from COST wells in Georges Bank basin and in Baltimore Canyon trough indicate that a carbonate-evaporite depositional regime was dominant behind the paleoshelf-edge during the Jurassic. Lower Cretaceous algal reef debris has been sampled in Heezen Canyon (Georges Bank slope). DSDP Site 390 also drilled back-reef carbonates of Early Cretaceous age along the seaward edge of the Blake Plateau, and recent submersible dives have recovered Albian-Aptian rudist reefal materials along the Blake Escarpment.

While strong evidence exists for carbonate bank and algal reef deposits all along the paleoshelf edge, the evidence for rudist reefs is presently restricted to the Blake Plateau basin. Erosional retreat of the ancient shelf edge, especially in the Blake Plateau basin, resulted in the removal and breaching of the Lower Cretaceous-Jurassic carbonate bank or reef margin at some locations.

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Sedimentary and Structural Setting, Kuroko Ore Formation, Hokuroku District, Japan

The Kuroko massive sulfides are thought to have formed on the sea bottom during middle Miocene time. The deposits are interstratified with a highly variable sequence of volcaniclastic and detrital sediments, some of the latter bearing foraminifera. Our studies of the paleontological and sedimentological characteristics of the sediments place the following constraints on models of the sedimentologic-tectonic setting before, during, and after ore genesis. (1) Contrary to previously accepted ideas, ore genesis in the Hokuroku district (a 30 by 30 km area) was not contemporaneous and may have spanned as much as 6 million years as is suggested by the planktonic foraminifera. (2) Most previous ideas embodied a shallow-sea origin for the ores, but benthic foraminifera indicate that the ores formed at great depths (about 3,500 m). (3) The district subsided from subaerial to deep submarine during the early Miocene, when the late Paleozoic metamorphic basement was lowered along high angle faults. Rapid subsidence is suggested by thick-bedded, poorly sorted sedimentary breccias and sandstones on the downfaulted blocks. (4) Middle Miocene detrital turbidite muds are common in the district, and a mixing ratio of benthic foraminifera from different depths is used to determine turbidite source areas. (5) Further high angle faulting during the middle Miocene produced a large scale submarine topography which limited the distribution of the muddy turbidites. These fault-generated submarine highs are relatively free from turbidite influence and contain most of the ores.

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A New Philosophy for Petroleum Exploration

Worldwide reserves of oil and gas must be increased substantially within the coming decades to meet critical energy demands as the global transition from fossil fuels to alternate energy sources continues. The easier-to-find supplies have been located and the challenge now is for the petroleum explorationist to focus his efforts toward innovatively searching for the world's remaining deposits of oil and gas.

Petroleum exploration concepts and technology have advanced greatly from the days of random drilling and strict adherence to the anticlinal theory. Surface and subsurface mapping, core drilling, magnetic and gravimetric prospecting, the reflection and refraction seismograph, and computer technology have added to the overall effort. Geologists and geophysicists are encouraged to search for subtle trap accumulations of petroleum, those which are stratigraphic, unconformity-associated, or paleogeomorphic. Remotely sensed data from land satellites and spacecraft are also aiding the explorationist in his search for petroleum.

Bold new ideas are needed to stimulate even bolder exploration. By using the best of past exploration theories, using the tools and ideas of today, and being willing to accept innovative methods the petroleum explorationist can make the crucial decisions called for by today's soaring petroleum energy demands. The philosophy concerning these items is discussed.

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Interpretation of Well Logs at Cerro Prieto Geothermal Field

The Cerro Prieto geothermal field is located 35 mi (56 km) south of Mexicali, Baja California, Mexico. The subsurface geology of Cerro Prieto is typical of a deltaic depositional environment. Logging data from more than 70 wells have been analyzed. A comparison of the data derived from these logs with surface geophysics, mineralogic, and stratigraphic information leads to a model of subsurface fluid flow.

Cross sections have been constructed using the values obtained from resistivity and density logs. The resistivity cross sections are consistent with the model derived from surface dipole-dipole resistivity measurements, lithology, production, and mineralogic characteristics. The density cross sections show good agreement with the location of a self-potential anomaly and the location of micro-earthquake hypocenters.

Interpretation of these well logs leads to estimates of porosity, salinity, temperature, and permeability. High porosities are probably due to secondary dissolution. The salinity distribution shows that relatively fresh water extends from near the surface to depths of 4,000 to 5,000 ft (1,220 to 1,525 m) in the eastern part of the field and to shallower depths in the western part. Water of higher salinity underlies the fresh water. Permeability has been hard to estimate because of conflicting evidence from the well logs.

In the proposed model of hydrothermal flow, hot brines enter the field at 5,000 ft (1,525 m) or more at the eastern part of the field and flow upward and westward through the field.

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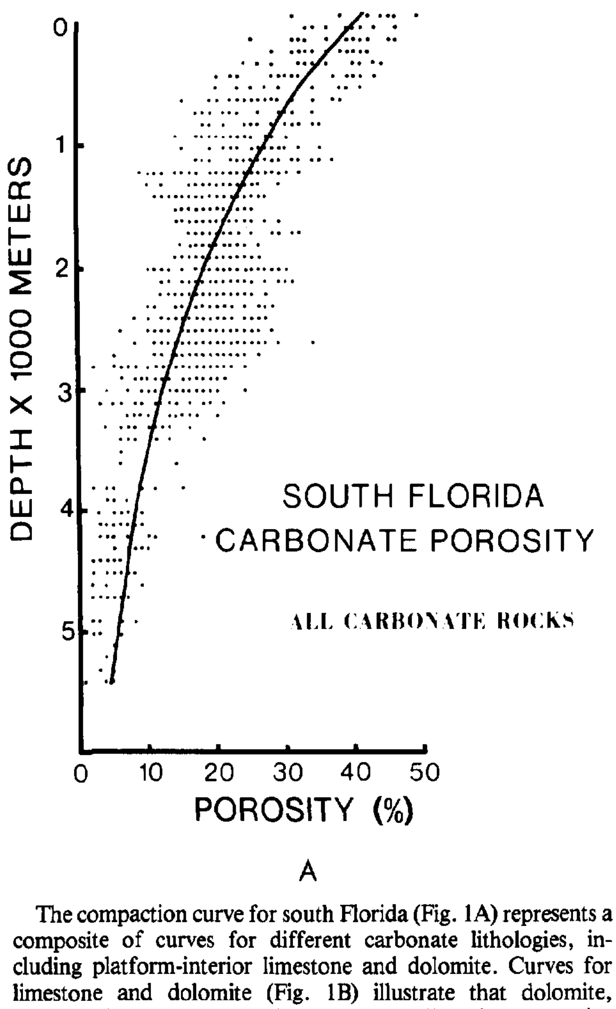
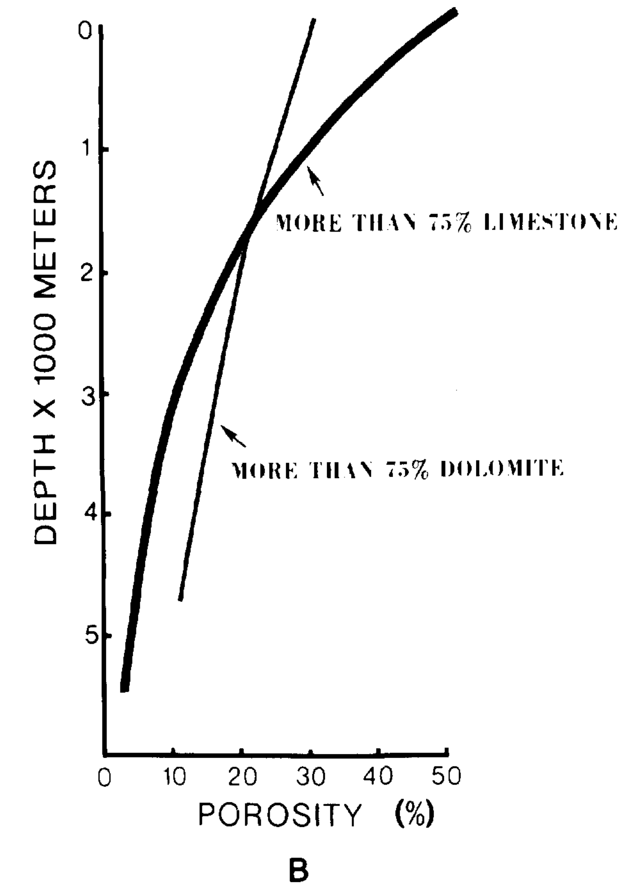
Carbonate Porosity Versus Depth: "Compaction" Curve for South Florida

Porosity data from 15 boreholes (0 to 5,500 m) in the South Florida basin show a trend of steadily decreasing porosity with depth (Fig. 1A). This trend is interpreted to result from "compaction" of carbonates in response to overburden pressure. Compaction is used here in a broad sense to include mechanical and chemical compaction, the latter encompassing carbonate dissolution and reprecipitation as burial cement (solution-transfer of Bathurst). Factors which contribute to the scatter about the trend include variations in depositional environment, diagenetic history, pore-fluid composition, pressure, age, geothermal gradient, and experimental error.



A



B

The compaction curve for south Florida (Fig. 1A) represents a composite of curves for different carbonate lithologies, including platform-interior limestone and dolomite. Curves for limestone and dolomite (Fig. 1B) illustrate that dolomite, although less porous than limestone at shallow depths, retains more porosity than limestone during burial, and is more porous than limestone below 2,000 m. Below 4,500 m, porosity greater than 5% occurs primarily in dolomites, an observation commonly made for the deeper parts of Paleozoic sedimentary basins.

If porosity reduction were due to cement derived from dissolution at the surface or from outside the basin, the curve (Fig. 1A) would simply be a record of increasing cementation with depth. This would require the removal of between 1,000 and 1,500 m of carbonate rock from somewhere within the section or from carbonates outside the basin. It seems more likely that the cement is locally derived. If mass transfer of carbonate is limited to a local scale, then the curve is a true compaction curve.

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Anomalous Seismic Character—Bering Sea

Seismic data collected within basins along the outer Bering Sea shelf often exhibit a distinct change in seismic character between 1.0 and 2.0 sec two-way time. This change appears on seismic sections as a reflector or as an increase or decrease in amplitude. The feature is of regional extent.

This seismic character change is a manifestation of what has been called in other basins a bottom simulating reflector (BSR). BSRs are reflectors that are (1) subparallel with sea-floor topography, (2) discordant with stratigraphy where the sea floor dictates, and (3) do not demonstrate the characteristics of a multiple.

Two causes of BSRs are generally accepted. One involves an ice-like mixture of water and gas, termed "gas hydrate," in which gas molecules are trapped within a framework of water molecules. The other cause involves the diagenetic alteration of biogenic opal-A to opal-CT in diatomaceous sediments.

BSRs were penetrated at three locations in the Bering Sea in water depths greater than 6,000 ft (1,829 m) on Leg 19 of the