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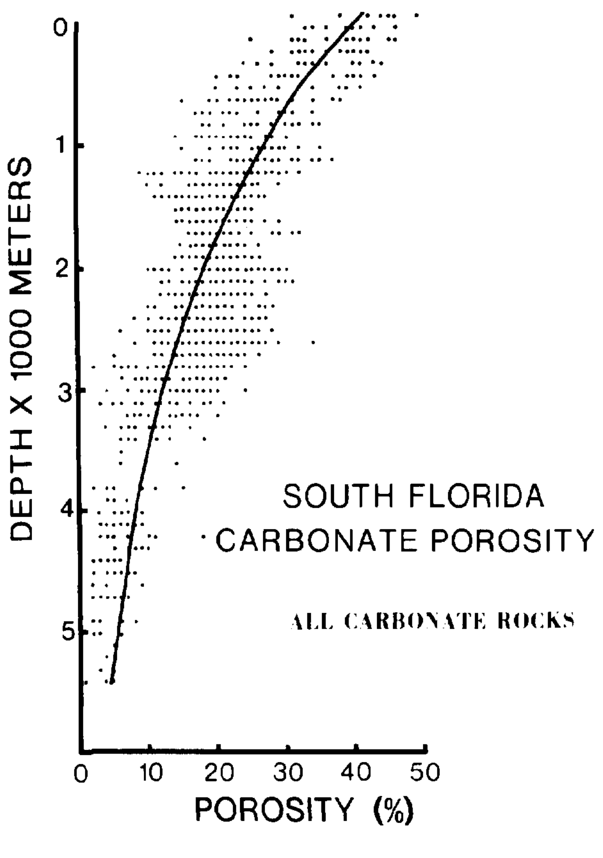
Carbonate Porosity Versus Depth: "Compaction" Curve for South Florida

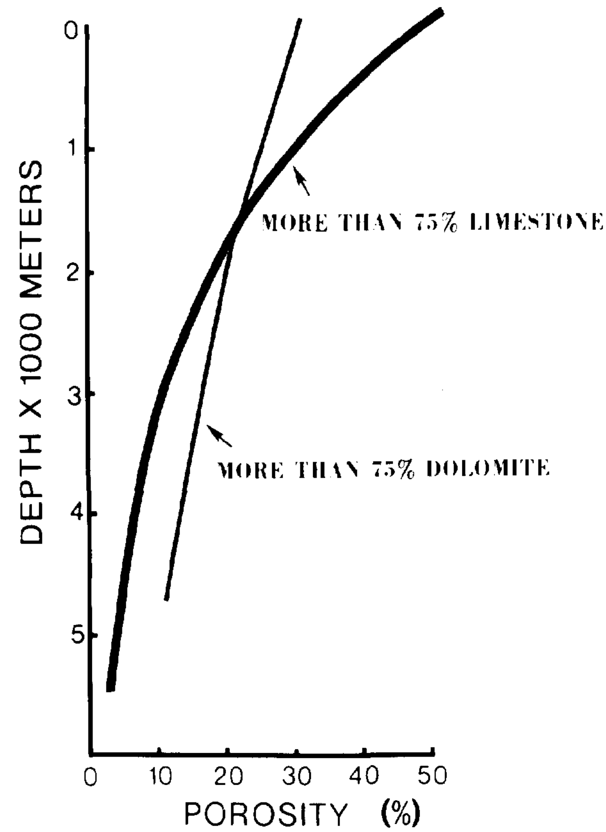
Porosity data from 15 boreholes (0 to 5,500 m) in the South Florida basin show a trend of steadily decreasing porosity with depth (Fig. 1A). This trend is interpreted to result from "compaction" of carbonates in response to overburden pressure. Compaction is used here in a broad sense to include mechanical 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

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.



B

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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

Deep Sea Drilling Program (DSDP). The BSRs at these locations were attributed to the diagenetic alteration of opal-A. This same diagenesis of opal-A to opal-CT is interpreted to be the cause of seismic character changes noted in basins on the Bering Sea shelf. This interpretation implies that limits can be placed on lithologic interpretation of the stratigraphic section in these basins.

Pitfalls in seismic interpretation may be encountered where this reflector intersects other reflectors at an observable angle. The BSR may look like a sequence boundary with prograding clinoforms above it. This would place constraints on a seismic stratigraphic analysis in terms of predicted paleoenvironments and lithologies. Where this reflector crosses an anticlinal structure, it may appear to be a fluid contact and thus a direct hydrocarbon indicator.

Recognition of the presence of this seismic character change is of two-fold importance to explorationists: (1) understanding the geology of the Bering Sea shelf, and (2) avoiding seismic interpretational pitfalls.

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Reconstruction of Brine Compositions of Ancient Evaporites from Their Mineralogy: Application to Chemistry of Ancient Seawater

Potash evaporites should house the most legible record of ancient water composition available in the geologic column because such deposits represent the end products of evaporation paths sensitive to small variations in initial major ion ratios. The means of accurately predicting these paths are now available. To reconstruct brine compositions we need to identify the most complete sequence of minerals in the deposit and to match it with an appropriate model path (this will give the basic brine type) and to identify the quantitative mineral abundances in *individual sedimentation units* within the deposit (these are directly related to the major ion ratios in the parent brine and allow evaluation of brine composition within close limits).

Undeniably, there are formidable practical difficulties because evaporites are readily altered on burial. If the primary mineral assemblage can be deciphered petrographically, then the procedure is straightforward. The Permian Zechstein 2 of Stassfurt, Germany, illustrates the approach. The Stassfurt potash sequence follows the equilibrium evaporation path predicted for modern seawater at 25°C. This path is very sensitive to initial brine composition; changes in Mg/K_2, Mg/SO_4, and Cl/SO_4 greater than 10 mole % will produce *different* paths. So, if the Stassfurt deposit is marine, then Permian seawater composition must have been similar to modern seawater. Just how similar is shown by the following brine composition reconstructed from the quantitative mineral abundances in meter scale sections of the Stassfurt (mole ratios, modern seawater in parentheses): $Na/Ca \geq 49.8$ (52.3), $Na/K \leq 53.4$ (47.6), $Na/Cl \leq 0.95$ (0.86), $Na/SO_4 \leq 17.3$ (16.7). This implies that differences in mineralogy or elemental geochemistry (e.g., S isotopes) among Permian and post-Permian evaporites cannot be due to changes in seawater composition.

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Influence of Early Cementation on Dolomitization and Compaction in Cambro-Ordovician Carbonates of Central Appalachians

The Cambro-Ordovician platform carbonates of the Great Valley, central Appalachians, are notable for the interlayering of limestones and dolostones with well-preserved primary sedimentary structures. Despite such primary structures there are several observations that demonstrate a secondary origin for much of the dolomite, the most significant being that dolostone-limestone boundaries commonly crosscut bedding planes. The nature of such dolomitization is clearly revealed by certain mottled dolostones in which mudcracks and burrows are haloed by limestone. Stratification can be traced through the 2 to 10-mm wide limestone halos into the dolostone without break. The limestone halos have a peloidal grainstone texture with high minus-cement porosity and unbroken shells whereas the dolostone is a sucrosic mudstone with fragmented shells. We interpret these observations to mean that early cementation around permeable mudcracks and burrows has protected these zones from later compaction and dolomitization. We extend this idea of selective early cementation of permeable sediments to explain why the limestones are invariably grainstones while the dolostones are mudrocks. The idea is supported by the observation that laminae of dolostones are bent around limestone mudcrack halos, ripple lenses, etc, showing that the limestones have acted competently and the dolostones incompetently during compaction.

The timing of this post-early cementation dolomitization is not unequivocal, but it is certainly pre-stylolitization, as demonstrated by dissolution of dolomite rhombs along bedding-plane stylolites. Our observations do not rule out the possibility of a syndepositional origin for at least some dolomite in these rocks (there are dolomites and dolomites!) but they do negate the pressure-solution origin of dolomite advanced by Wanless (1979).

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Geology of Kuparuk River Oil Field, Alaska

The Kuparuk River oil field is located on the Alaskan Arctic North Slope in the Colville-Prudhoe trough some 25 mi (40 km) west of the Prudhoe Bay field. The 23° API crude is similar in type to that in the Prudhoe Bay field. The Kuparuk reservoir, however, is in Early Cretaceous clastics of the Kuparuk River Formation, stratigraphically higher than at Prudhoe. The origin of the oil is believed to be predominantly from the Jurassic Kingak Formation with migration occurring along the basal Cretaceous unconformity.

The dominant trapping mechanism is stratigraphic pinch-out and truncation of the reservoir at an intraformational unconformity along the southern and western flanks of a southeast plunging antiform. Structural dip closure exists along the northern and eastern flanks with a tilted oil-water contact at approximately 6,675 ft (2,034.5 m) subsea. The reservoir sandstones occur within cleaning and coarsening-upward sequences which are interpreted as shallow-marine and sublittoral in origin and deposited as southwesterly trending sand bodies with a provenance to the northeast. Two of the four major lithostratigraphic units mapped exhibit good reservoir characteristics and extend over an area in excess of 200 sq mi (510 sq km).

The cumulative net pay ranges up to 90 ft (27 m) and the estimate of developable oil in place is 4.3 billion stock tank barrels. There is no gas cap.

About 10% of the oil is estimated to be recoverable by primary depletion and it is believed that a further 17% may be recoverable by secondary waterflood. Kuparuk therefore ranks as one of the largest oil fields in the United States. First production is planned for early 1982.