and Devonian support the concept of two intrabasin platforms: one in southwestern Michigan (Allegan) and the other in southeastern Michigan (St. Clair). A generalized depocenter lies directly northwest of Saginaw Bay. There were important deviations from this depocenter, particularly during the Ordovician and Middle Devonian.

The major northwest-trending folds in the central part of the Michigan basin were generated during Late Mississippian or Early Pennsylvanian time, and are probably the result of the regeneration of dominantly vertical movements along basement faults.

Major petroleum production in Michigan is from (1) Ordovician dolomitized fault zones; (2) Silurian pinnacle reefs; and (3) Devonian anticlinal traps with marked variations in porosity.

Future possibilities lie primarily with the discovery of additional dolomitized fault zones in Ordovician carbonate rocks or in Devonian stratigraphic traps. Cambrian production is a possibility, but there is inadequate control to define its potential.

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Accretional Shoreline Processes at Tidal Inlets Along South Carolina Coast

The greatest shoreline changes of barrier islands along the South Carolina coast occur in the vicinity of tidal inlets. Depositional processes at these inlets can be categorized as those associated with (1) migrating inlets, (2) stable inlets, and (3) inlets whose main ebb channels breach new positions through their ebb-tidal deltas.

At migrating inlets, curved beach ridges are added to the updrift island while the downdrift island erodes. These processes occur most commonly at shallow inlets whose main ebb channels do not scour into the marine or lagoonal muds underlying the barrier-island sands. Shoreline breachings during storms are also important at inlets with histories of rapid migrations.

Stable inlets have deeper main ebb channels which are entrenched in resistant clays. Morphologic changes associated with these inlets are predominantly the result of wave processes. The coalescing of wave-built swash bars in the outer part of the ebb-tidal delta and the subsequent landward migration of these bar complexes can cause inlets to have either a downdrift or updrift offset, or a straight configuration.

The well-developed ebb-tidal deltas of the South Carolina inlets normally have a single main ebb channel and two or more marginal flood channels. The dominant northeast wave approach causes southerly longshore transport of sand along most of the South Carolina coast and a preferential addition of sediment to the north side of the ebb-tidal delta, which results in a southerly migration of the outer part of the main ebb channel. Because the southerly course is longer and less efficient than a straight course through the ebb-tidal delta, the main channel eventually breaches a new position through a northern marginal flood channel. The accumulation of sand which flanked the old channel is transported landward and accretes to the downdrift beach.

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Giant Field Discoveries, 1967-77—An Overview

In this symposium a giant oil field is defined as one containing 100 million bbl or more of oil. Exceptions are those oil fields in the Middle East, North Africa, and eastern USSR where 500 million bbl, or more, are considered giants. Giant gas fields contain 1 Tcf, or more, except in the Middle East, North Africa, and eastern USSR where 3 Tcf, or more, are required.

During the 11-year period since the last AAPG symposium on giant fields (held in Oklahoma City in 1968), approximately 280 giant oil and gas fields have been found. These fields contain an estimated recoverable reserve of roughly 120 billion bbl of oil and 900 Tcf of gas. These fields account for about 60% of world oil and gas discovered during the period.

The 280 giant fields are distributed as follows: United States and Canada, 40; Latin America, 40: Europe, including western USSR, 55; Africa, 40 (8 north Africa; 32 other Africa); Far East, including China, 40; Eastern Russia, 30; and Middle East, 35.

With respect to numbers of giant fields being found, no decline in rate of discovery can be observed. Outside the United States and Canada, the discovery rate is increasing. However, the average size of giant discoveries is in marked decline, as is the discovery rate in barrels and cubic feet per year in total.

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Pictured Cliffs Sandstone—Upper Cretaceous Distributary-Channel, Delta-Front, and Beach-Bar Deposits, Southwestern San Juan Basin, New Mexico

The Upper Cretaceous Pictured Cliffs Sandstone in the Bisti-Burnham area in southwestern San Juan basin, New Mexico, contains distributary-channel, delta-front, and beach-bar deposits. The distributary-channel deposit is a basally erosional, festooned, convoluted, and rippled sandstone. The delta-front deposits include distributary-mouth-bar sandstone, distal-bar sandstone, siltstone, shale, and intervening contorted sandstone. The distributary-mouth-bar sandstone is subparallel laminated, rippled, and festooned. The distal-bar sandstone is subparallel laminated and rippled. The intermediate contorted sandstone contains fold and ball-and-pillow structures. The distributary-channel and delta-front sandstones are very fine to fine grained, quartz poor (39%), and sparsely burrowed by *Ophiomorpha*.

The beach-bar deposits include shoreface-beach sandstone, siltstone, and shale, and tidal-channel and washover sandstones. Lower-shoreface deposits include parallel-laminated, rippled sandstone and bioturbated shale and siltstone. Middle-shoreface sandstone consists of a subparallel-laminated, rippled, and locally burrowed lower part, and a planar-cross-bedded and commonly burrowed upper part. Upper-shoreface–beach deposits consist of planar-cross-bedded, sparsely burrowed sandstone and lenticular, festooned, rippled, burrowed sandstone grading upward into subparallel-laminated, festooned, burrowed sandstone. The shoreface-beach deposits are dissected by bidirectionally festooned and planar-cross-bedded tidal-channel sandstone and festooned, burrowed washover sandstone. The beach-bar sandstones are very fine to medium grained, quartz rich (54%), and commonly burrowed by *Ophiomorpha.*

Differentiation of Pictured Cliffs Sandstone depositional environments led to recognition of deltaic and back-barrier coal deposits of the overlying Fruitland Formation.

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Ancestral Delta Lobe of Santee River Near Charleston, South Carolina

The Santee River of North Carolina and South Carolina emptied into the sea 75 km west of its modern mouth when the shoreline was 15 to 21 m above present sea level in early Pleistocene time. For a short time, the river deposited a fluviomarine delta lobe (volume 5 cu km) that covered 400 sq km near Summerville, South Carolina, 35 km northwest of Charleston. The Summerville lobe was abandoned before the late Pleistocene, and the sea has not covered the area since then. The original wave-constructed ridge-and-swale topography is still visible; drill holes have revealed the subsurface lithofacies relationships. In the modern Santee delta and the chenier plain of Louisiana, similar topography and patterns of lithofacies reflect alternating dominance of flood-plain deposition and shoreface redistribution.

Paleontology, paleomagnetic stratigraphy, and sediment mineralogy contribute to the age determination of the Summerville lobe. On the basis of fossil pollen and invertebrates identified by U.S. Geological Survey paleontologists, the Summerville lobe deposits are tentatively believed to be equivalent in age to the Waccamaw Formation (late Pliocene and early Pleistocene) of northern South Carolina. Surficial heavy- and light-mineral suites are more mature, and thus older, than paleontologically dated late Pleistocene shoreline deposits nearby. Less weathered mineral suites below the water table in the Summerville lobe reflect the Piedmont (Santee River) source of the sediment. Preliminary paleomagnetic data are compatible with this age determination.

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Oceanic Crust

The model presented is based on the interpretation of marine geophysical data, studies of dredged rocks, theoretical modeling, geologic investigations of ophiolite complexes on the continents, and results of deep-sea crustal drilling by JOIDES/IPOD.

Along the axis of the midoceanic ridge system a zone of upwelling asthenosphere extends from the base of the lithosphere at 50 to 70 km to the base of the oceanic crust. Within this prism, which narrows upward, adiabatic decompression of asthenospheric material results in partial melting, forming basaltic melt. The basaltic liquid coalesces into pockets of magma at shallow depths, forming magma chambers typically located a few kilometers beneath seafloor and centered beneath the axis of the ridge crest. Crystal fractionation takes place within these chambers, but generally never evolves too far because of the periodic addition of fresh magma from below and loss of magma to the seafloor. Profound complications exist, however, because several primitive magma types have been clearly defined which cannot be related to each other by crystal fractionation in shallow, crustal magma chambers, but must reflect different mantle compositions and/or melting processes. Either several zones of melting and magma ascent in the asthenosphere or a compositionally heterogeneous mantle is implied. Furthermore, drilling results demonstrate that distinct magma types occur in units of variable thickness (50 to 200 m), implying generation and fractionation of distinct batches of magma. This suggests that magma generation and emplacement is an episodic rather than a steady-state process, and argues for the coexistence of several magma chambers of restricted size, rather than a single, large, continuous magma chamber. In time, cooling of the magma chamber leads to a lower oceanic crust composed of gabbroic rocks and cumulates. The plutonic foundation of the oceanic crust is overlain by an assemblage of sheeted dikes which are capped by a chaotic extrusive carapace of pillow basalts, massive and thin flows, sills, and intercalated sediments. Seawater percolates down through the brittle carapace of the oceanic crust along permeable pathways, reacts with the hot rock at depth, and leads to metamorphism of the lower crust. Furthermore, the high thermal gradients at the ridge crest lead to the development of convective circulation of seawater through the shallow intrusive and extrusive lid of the crust, causing widespread low-temperature alteration. The water is heated and leaches material from the rocks; these dissolved constituents are either deposited along voids within the crust or are deposited on the seafloor as metallic sulfides, manganese and iron oxides, or metal-enriched sediments.

This model is still a working hypothesis, and much of it is based on circumstantial evidence. The model will change as a function of the evolving, accreting-plate-margin mosaic.

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Geology of Southeast Georgia Embayment

Computer-generated lithology-porosity calculations based on corrected sonic, density neutron, and gamma-ray logs can aid greatly in interpreting the rock record. Percentage shale calculations averaged over uniform intervals show one-to-one correlation with environmental interpretations derived from micropaleontologic data for Upper Cretaceous rocks in the COST GE-1 well. For the marine section percentage quartz parallels percent shale and both follow the general trend of transgressions and regressions suggested by P. Vail et al.

The transgressive pulses at the GE-1 site are quite similar to those at the B-2 site. The depositional sequence is similar at the two sites, with both containing Upper Cretaceous shelf carbonates, Lower Cretaceous nonmarine clastics, and a decreasing rate of deposition with time.

Lower Cretaceous Albian anhydrite present at GE-1 is absent at B-2. Conversely Lower Cretaceous coal,