crust, is still uncertain. The central gulf and interior basins subsided after this period of crustal thinning. It was in these basins that the Sigsbee and Louann Salt were deposited. Later, as the basin margins subsided farther, carbonate sediments onlapped and covered these margins, marking 5 km of subsidence by the Cretaceous. Since the Cretaceous, clastics have infilled the northwestern Gulf, causing an additional 3 km of subsidence of the gulf basin, while the central Florida and Yucatan platforms have stabilized above sea level.

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Reservoir Quality in Tertiary Sandstones along Texas Gulf Coast

Three data bases were developed for a regional survey of reservoir quality in Tertiary sandstones along the Texas Gulf Coast.

1. Core analyses from 252 wells (10,900 datum points) are the basis of plots which indicate that porosity and permeability do not simply decrease with depth but commonly increase at depth by development of secondary leached porosity.

2. Point count analyses of 535 thin sections from 169 wells for mineralogy, diagenetic features, and porosity types indicate, within formations, regional mineralogic trends that affect reservoir quality, especially at depth. The average Tertiary sandstone is a moderately sorted, very fine-grained quartzose lithic arkose. Each Tertiary formation shows a similar general diagenetic history; primary porosity is dominant in the shallow subsurface, and secondary leached porosity is dominant in the moderate and deep subsurface.

3. Plots of interval transit time versus depth for 87 acoustic logs indicate general compaction and consolidation histories of complete stratigraphic sections, and they are useful for comparing compaction and consolidation histories among different areas. Both the Wilcox and Frio trends exhibit a general pattern of more rapid compaction and greater degree of consolidation in the lower Texas Gulf Coast than in the upper Texas Gulf Coast.

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Porosity in Giant Gas Field, Ellenburger Formation, Puckett Field, Pecos County, Texas

The Lower Ordovician Puckett field has produced nearly 2.5 Tcf of gas from the Ellenburger Dolomite since the discovery of the field in 1952 by Phillips Petroleum Co. Production is from a depth interval of approximately 12,000 to 15,000 ft (3,600 to 4,500 m), and the estimated ultimate recovery is 3.3 Tcf.

The Ellenburger facies are interpreted to have been deposited in several major environmental settings—subtidal, intertidal-channel belt, and supratidal. Subtidal deposition is represented by burrowed, irregularly laminated mudstones and wackestones and by oolitic grainstones. In the intertidal-channel belt, intraclastic packstones and stromatolitic boundstones accumulated. Laminated mudstones and algal-laminated mudstones were deposited on the supratidal flats in which desiccation produced mud cracks and thin layers of flat-pebble conglomerates. During Ellenburger sedimentation there were many periods of subaerial exposure which resulted in formation of soil zones and karst terranes as deep as 20 ft (6 m). Solution collapse produced thick brecciated zones.

Maximum porosity in the reservoir is 12% and the greatest permeability is 117 md. Porosity originated dominantly from tectonic and karst fractures and karst vugs. The generally low porosity is locally enhanced by intercrystalline, moldic, and interparticle porosity. The greatest porosity and permeability is commonly in the facies of the supratidal and intertidal environments most affected by tectonic fractures and by soil and karst development.

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Error in X-Ray Diffraction Estimates of Dolomite in Carbonate Rocks—Causes and Cures

Three independent errors affect X-ray diffraction estimates of dolomite in pre-Cenozoic carbonate rocks. If calcite:dolomite main-peak [104] ratios are used, each 1% of excess calcium in the dolomite lattice causes a 2% overestimate of the amount of dolomite. Use of the second-intensity [113] ratios avoids the stoichimetry problem, but the [102] quartz peak (2.282A) interferes with the [113] calcite peak (2.282A). Where more than 20% quartz is present, the dolomite proportion in the sample may be seriously underestimated. The third source of error is due to difference between the crystallite size in the standards used to prepare the calibration curves and the crystallite size in the sample unknowns. These three errors can be avoided or corrected; however, point count of stained thin sections, a simple reliable technique, is preferable for analysis in most cemented carbonate rocks.

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Upper Devonian Turbidites of Central and Southern Appalachian Basin—A Prodeltaic Clastic Ramp?

The Brallier Formation (Upper Devonian) of the central Valley and Ridge province is a thick (600 to 900 m) regressive sequence of distal to proximal turbidites composed of interbedded siltstones, olive-gray mudstones and shales, and organic-rich black shales. This sequence is transitional westward to the thinner, distal, Devonian black shale facies. Regional and vertical patterns in sedimentologic features differ from those of most models for turbidite sedimentation.

The uniformity of turbidite bed thickness, implying a triggering mechanism of uniform intensity, and the absence of slump structures in the proximal facies suggest that turbidity currents were initiated by means other than localized mass movement. Storm surges or high river discharges are more likely mechanisms.

The Brallier depositional sequence differs significantly from existing submarine-canyon–fan models in

that it lacks large-scale radial dispersal patterns as well as canyon and channeled inner-fan facies. Rather than radial progradation, characteristic of a large, stable submarine fan, uniform progradation from multiple point sources built a clastic ramp composed of a coalescing series of small, short-lived submarine fans. This uniform progradation is indicated by the disposition of lithofacies and consistent westerly paleocurrent trends.

We envision a prodeltaic setting for the formation of this clastic ramp. In spite of a paucity of modern analogs for such a depositional system, the Brallier Formation and other ancient examples attest to the significance of turbidite sedimentation in deltaic settings.

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Pseudostalactites from Submarine Cave Near Columbus Cay, Belize Barrier-Reef Complex—Evidence of Extensive Submarine Lithification

Numerous inclined projections resembling stalactites but indicating a marine origin occur on the ceiling of a submarine cave in the Belize barrier-reef platform near Columbus Cay (3 km from the outer edge of the barrier reef and 21 km from the mainland). The accreting "pseudostalactites" consist largely of *Vermiliopsis* serpulid tubes and varying amounts of magnesium calcite cement, which is present either as a matrix or as a coating on the upper surfaces of the inclined projections. The opening of the cave is 10 m long and less than 3 m wide; it breaches the roof at a depth of 17 m. A short distance inside and up to at least 40 m from the opening (the limit of our observations), the ceiling is covered by a field of closely packed pseudostalactites more than 30 cm thick. A distinct transition was observed from large club-shaped forms (30 cm wide at the point of maximum development), present about 10 m from the cave opening, to pencil-thin projections at the 40-m limit. Characteristically, the pseudostalactites incline toward the cave opening at about 40 to 60° near the opening and are almost horizontal at the limit of observation. The magnesium calcite cement (15 mole% $MgCO_3$), which commonly constitutes more than half of a pseudostalactite, exhibits the dentate crystals, peloidal textures, and knobby surface relief recognized in submarine cements from other reef areas. These traits and the results of oxygen and carbon-isotope analyses discount any influence of fresh water. Marine planktobacteria associated with the undisturbed surfaces of cement accumulation suggest that bacteria are an active factor in the precipitation of this submarine cement.

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Piper Oil Field

The Piper field lies in UK block 15/17 near the eastern part of the Moray Firth Basin, 125 mi northeast of Aberdeen, Scotland. The field was discovered in December 1972. Five appraisal wells and one exploratory well were drilled in 1973. A steel platform with 36 well slots and space for two drilling rigs was centrally located over the field in 474 ft of water in June 1975, and readied for production drilling by October 1976. Production is from the Upper Jurassic Piper Sandstone, a high-energy, marine sandstone with gross thickness, 177 to 453 ft (56 to 138 m); net sand, 132 to 378 ft (40 to 115 m); net oil sand, 132 to 296 ft (40 to 90 m); average net oil sand, 160 ft (49 m); average porosity 26%; permeabilities 200 to 1,200 md in lower energy bioturbated sands, 2,000 to 10,000 md in higher energy sands. The reservoir is sealed by Kimmeridge shale over most of the field and by Upper Cretaceous marlstones along some fault scarps. The main area of the field, a gently folded fault block dipping 5° northeast and a downthrown northwest-southeast fault block, covers 6,300 acres (2,550 ha.), has a common oil-water contact at 8,512 ft (2,594 m) subsea, and a gross reservoir column 1,300 ft (396 m), which is 7,200 ft (2,195 m) subsea to the oil-water contact. A small accumulation on a parallel fault block on the southwest has a separate oil-water contact at 9,199 ft (2,804 m) subsea. The P1 production well spudded October 10, 1976, established commercial production December 7, 1976 at more than 30,000 B/D, restricted by 5½-in. tubing. The P7 well completed in April 1977 produced more than 50,000 BOPD, restricted by 7-in. tubing. Twenty-four wells have been drilled, four as water injectors to support an active water drive. Production is 300,000 BOPD and recoverable reserves are estimated to be 700 million bbl. Extensive use of seismic data and excellent cooperation by partners in the consortium and the United Kingdom regulatory bodies allowed maximum use of production and new well data to improve subsequent development.

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Environmental and Diagenetic Controls of Carbonate and Evaporite Source Rocks

The organic geochemistry of shale source rocks has been a subject for extensive research during the past 2 decades. Many useful interpretive techniques have been developed for the assessment of hydrocarbon potential of sedimentary basins in which shales are the principal and logical source for petroleum generation. Nevertheless, the present understanding of carbonate and evaporite source rocks remains superficial. The criteria generally employed to assess shale source rocks are inadequate and misleading when applied to carbonate and evaporite basins.

Most misconceptions regarding the hydrocarbon potential of carbonate and evaporite rocks stem from a simplistic notion that organic matter associated with the sediments on well-aerated carbonate shelves and in evaporite-depositing environments is not likely to be preserved. Recent data on organic geochemistry of Holocene carbonate sediments from shallow shelves suggest that (1) organic matter can be preserved in certain environments, and (2) the kerogens produced from degradation of organic matter in carbonate sediments are predominantly sapropelic and therefore much more efficient sources for hydrocarbons than the mixed humic-sapropelic kerogens of shales.

The preservation of organic matter in carbonate and