regional strike. Each of these deltas consists of local progradational sandstone facies (channel and channel-mouth bars) flanked marginally by extensive sandstone units reworked from channel-mouth bars. Associated prodelta mud facies are moderately thick to thin. High-destructive deltas supported local rather than areally extensive strike-fed systems.

Principal oil and gas reservoirs in high-constructive deltas occur in the progradational delta front sandstones with trends controlled by geometry and distribution of these lobate or elongate sandstone bodies. Vertical stacking of sandstone bodies is common, resulting in multipay fields. Trends within these delta systems are discontinuous along strike, as facies between main prograded lobes consist mostly of muds and tight sands. Attendant growth faulting, salt doming, and mud intrusion cause structural traps. In related barrier bar and strandplain systems trends are regionally persistent with stratigraphic traps. Oil and gas trends in high-destructive deltas are defined by local cuspate-trending coastal barrier sands and downdip progradational channel-mouth bars; principal traps are stratigraphic.

Continental slope systems, making up the distal parts of Gulf basin terrigenous wedges, have been penetrated only in younger units of the basin or in very deep wells. Systems are comparable in scale, composition, and structural association to modern continental slope deposits of the northwestern Gulf. Thick and rapidly deposited delta systems of the Gulf basin mobilized underlying deep-seated salt. Principal flowage was toward the distal front of the prograding systems resulting in distinct diapir fields coextensive with continental slope systems; minor flowage was toward thinner interdeltaic areas. Salt mobilization was a significant control in determination of facies fabric and growth faulting. Younger offlapping units inherited and perpetuated the tectonic grain established by underlying systems.

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FACIES OF CISCO-EQUIVALENT SLOPE DEPOSITION SYSTEMS AND THEIR ROLE IN CONSTRUCTION OF EASTERN SHELF

Uppermost Pennsylvanian rocks of the Eastern shelf, a paleogeographic feature of the eastern flank of the Midland basin, consist of 3 depositional systems. (1) The Cisco fluvial-deltaic system extends across the updip part of the shelf and consists of fluvial to deltaic facies flanked by interdeltaic embayment facies. (2) Downdip, along the margin of the shelf, the Sylvester shelf-edge bank system separates relatively flat-lying shelf units from slope deposits. (3) The Sweetwater slope system is composed of numerous broad, coalescing to restricted wedges of sediment 800 to 1,200 ft thick. The terrigenous wedges are bounded by carbonate aprons that extend upslope into the shelf-edge banks. Sandstone distribution within the slope wedges forms fan-shaped maxima that are elongate perpendicular to the shelf edges and grades from relatively narrow, restricted belts upslope to irregular, broad patches downslope. Principal facies include shelf-margin sandstone, which caps the slope wedges, slope-trough sandstone, which extends through the body of the slope wedge, and distal-slope sandstone. Slope-trough facies include thinly interbedded sandstone and mudstone and medium to thick-bedded, graded sandstone units. Sedimentary structures and textures indicate sporadic deposition, probably by turbidity currents and associated traction carpets, and by subsequent reworking.

The slope system was fed from distal parts of the largest delta distributaries that prograded to the shelf edge, or where tidal or storm currents swept sediment through local breaches in the bank system. Sediment moved downslope by gravity transport mechanisms. The Eastern shelf was constructed by both simultaneous upbuilding (fluvial-deltaic and shelf-edge bank deposition) and outbuilding (slope deposition). Sites of deposition shifted widely across the shelf and slope in response to subtle variations in subsidence and consequent abandonment of active delta lobes.

Petroleum production is limited to lower slope-trough, distal-slope, and shelf-margin sandstones. The small number of fields in the slope system may be the result of (1) low permeability, characteristic of slope sandstones, (2) updip migration of petroleum through slope sandstone facies into facies of other systems, or (3) insufficient drilling.

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ECONOMICS: WITHOUT WHICH—WHAT?

No organization or company with a product to sell can remain in the business of selling that product if the raw materials or parts which make up the product become unavailable. Nor can the company grow if the supply of inventory diminishes in the face of increasing sales ability and demand.

Basic to all such businesses, therefore, is the economics concerned with the availability of inventory, or raw materials. Without raw material for product, there is no business, and without business there can be no need for the economics of running a going concern.

The oil industry, like others, cannot continue to do business long without an adequate and reliable supply of inventory, namely large domestic reserves. Just as great copper reserves in foreign countries are being nationalized by those nations, it is possible that the huge foreign reserves on which the petroleum industry depends for much of its raw crude today may not be available to us someday.

It would be good economics for the domestic petroleum industry to insure its future by giving more consideration to finding domestic reserves. This would ensure a reliable future source of raw materials and would protect this nation from dependence on unreliable crude holdings in foreign countries.

Attainment of raw materials for the future will necessitate the use of economic wisdom in the exploratory search for reserves. For example, (1) exploration money should be used in favorable trends where profitable fields are likely to be found; (2) exploratory tools should be used effectively and efficiently and should supplement, rather than replace, fundamental geology and bold, creative, optimistic geologic thinking; (3) resources should not be placed in jeopardy because of undue risk (expensive drilling programs require partners in many cases); (4) manpower should be used to best advantage, and cooperation between the various disciplines should be stressed; and (5) management should encourage new ideas of exploration, especially those dealing with the search for paleogeomorphic and stratigraphic traps which probably contain the large, undiscovered reserves of the future.

These economic practices, combined with greatly increased domestic exploration and drilling, will satisfy the basic economic need of the petroleum industry which, simply, is a reliable, adequate, and continuous source of raw materials through new, large, domestic reserves.

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LET'S GET THE LAST DROP

The growing demand for petroleum resources, and the ever-increasing economic pressure to produce these resources at minimum cost, create a formidable challenge in the coming decade to look hard at currently used economic guidelines and success rates so that the petroleum industry as a whole may emerge from the 1970s in the strongest position it has ever enjoyed. Much has been said and written in the past decade about methods of calculating economic parameters for evaluating both wildcat and development wells, but the industry has missed perhaps the most significant aspect of the economic approach, that of improving the chances for success by more efficient drainage of reservoirs. Most currently used systems are based on results, empirically derived, from past performance. These by necessity normally include some rather broad assumptions. It is the purpose of this paper to direct attention to some ways in which our basic approach to the actual search for hydrocarbons might be altered to achieve the desired economic return by increasing the per well recovery.

Although there will undoubtedly be vast improvement in technique in the coming 10 years, the technology is already at hand which, if properly applied, should produce some rather dramatic results in the relatively near future enabling us more efficiently to drain "the last drop."

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PROSPECTING FOR OIL AND GAS IN MATURE AREA

The writer has had much experience in looking for oil in west-central Texas, a mature area of oil and gas development. The advantages of the west-central Texas area include ready markets, easily accessible locations, and fairly cheap leases. The west-central area is a good place to explore for hydrocarbons, particularly good for the independent company or individual.

Geologists can prepare themselves to become independent businessmen, and there are ways in which they might better cooperate with other segments of the industry to make exploration for petroleum not only easier but also more profitable.

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GENETIC CLASSIFICATION OF POROSITY FORMATION AND DESTRUCTION IN CARBONATE ROCKS

For a proper evaluation of the reservoir potentialities of carbonate rocks the exact causes of porosity formation and destruction need to be known. Such a genetic approach to a classification has to be practical enough to be applicable at the well site, yet sophisticated enough to allow meaningful interpretations. All old attempts at classification of porosity have been either descriptive or insufficiently accurate. For example, the term "leaching" is meaningless, unless it is specified if it pertains to subaerial leaching, or leaching accompanying recrystallization, or leaching resulting from dolomitization. An attempt is made herein to propose a genetic classification which has been tested in its applicability, both at the well site and in the laboratory.

There are basically 2 types of porosity—primary and secondary. Primary porosity developments were formed at time of deposition prior to diagenetic alterations of the sediment. Secondary porosity formations are introduced after deposition by early or late or even post-diagenetic activity.

Primary porosity may be subdivided into intergrain and intragrain porosity.

Secondary porosity formation may represent the following types: (1) subaerial leaching of the grains (moldic porosity) or the carbonate mud matrix; (2) recrystallization porosity, based primarily on (a) leaching accompanying the recrystallization process, (b) rearrangement of the crystal fabric (interstitial porosity), and (c) preservation of primary porosity by fast diagenetic hardening; (3) dolomitization porosity, based primarily on (a) leaching resulting from the dolomitization process, (b) volume reduction caused by a slight density difference between calcite and dolomite, (c) preservation of the primary porosity by fast diagenetic hardening, and (d) interstitial porosity created by dolomitization and subsequent recrystallization; (4) fracture porosity, either by itself or further enlarged by subsequent leaching.

Partial or complete porosity destructions in carbonates result primarily from (a) fibrous calcite wall linings, (b) sparry calcite precipitation, (c) sparry dolomite precipitation, (d) anhydrite and gypsum infills, (e) infilling by other evaporites, (f) infill by clay, silt, or sand, (g) infill by carbonate mud, (h) infill by isolated dolomite rhombohedra, and (i) collapse of the former depositional fabric.

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RÉSUMÉ OF SIGNIFICANT STUDIES OF CLASTIC SEDIMENTATION

Research on recent clastic sedimentation conducted by the petroleum industry, universities, and government agencies during the past 2 decades represents one of the most significant advances in the fields of stratigraphy and sedimentology. This research effort has provided geologists with conceptual models of eolian, alluvial, deltaic, coastal interdeltaic, and marine sedimentation. It has led to a better understanding of the depositional processes and related sedimentary sequences which characterize each model. Concepts and criteria necessary to interpret the origin and distribution of ancient sedimentary facies have been reasonably well established.

An analysis of the literature of recent sediments reveals that over 500 papers are now available for study, however the amount of research on processes and sequences associated with each depositional model has not been uniform. Emphasis has been primarily on deltaic, interdeltaic, and alluvial (meandering stream) environments. Considerably less research has been done on the higher energy alluvial-fan and braided-stream types of alluvial sedimentation and the normal marine (nonturbidite) environments.

The literature on depositional environments of ancient clastics, which now consists of over 600 papers, demonstrates quite clearly that results of modern sedimentation research have been applied to the study of older rocks on a very broad scale. An analysis of this literature reveals that about 50% of the published ma-