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.

HOWARD, W. S., Texas Pacific Oil, Midland, Tex.

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."

JONES, A. V., JR., Albany, Tex.

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.

KLEMENT, KARL, Univ. Texas at El Paso, El Paso, Tex.

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.

LEBLANC, RUFUS J., SR., Shell Devel. Co., Houston, Tex.

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 material on the recent and ancient clastic sediments has appeared during the past 5 years.

Many geologists do not believe that modern clastic deposition is representative of conditions which prevailed during the geoloic past and consequently they seriously question the value of research on recent sediments. Although I agree that several pre-Holocene depositional conditions probably do not exist at the present time, I am convinced that sediment studies of the Holocene have yielded valuable concepts and criteria which could not have been provided by other approaches.

McGOWEN, J. H., Bur. Economic Geology, Univ. Texas, Austin, Tex.

ALLUVIAL FANS AND FAN DELTAS: DEPOSITIONAL MODELS FOR SOME TERRIGENOUS CLASTIC WEDGES

Alluvial fans and fan deltas are constructed by similar processes; both require a highland and adjacent lowland for development. Alluvial fans are associated with interior basins, whereas fan deltas develop along coastlines. A fan delta is an alluvial fan which progrades into a marine body of water.

Modern alluvial fans are present in both arid and humid regions throughout the world, ranging from Arctic to lower latitudes. Geometry and facies are controlled by rate of basin subsidence, source material, and frequency and magnitude of floods. In arid regions, where fans are most common, principal processes include debris-flows, sieve deposition, and fluvial deposition. Processes are intermittent and commonly one is dominant. Debris-flows and sieve deposits are major contributors to the upper ⅓ to ½ of a fan. Sieve deposits are generally confined to the fan apex. Debris-flows, characterized by a heterogeneous mixture of clay- to boulder-size material, extend for considerable distances downfan where they grade to mudflows containing few large clasts. Debris-flows reflect a fine-grained source area. Fluvial processes are dominant on the distal fan.

Humid-region fans, *e.g.*, Kosi River fan of India, are constructed entirely by fluvial processes during large annual floods. Compared to arid-region fans, humid-region fans have a low slope from apex to toe, are large in areal extent, and thin in cross section. Humid-region fans also contain smaller clasts, less fine material in the upper fan, and sediment is better sorted. Source-area vegetation aids in breakdown of rock material into smaller particles than under arid conditions. Erosion is great in humid areas because of intense flooding.

Alluvial fans in closed drainage basins commonly are associated with lakes. Where alluvial fans build into basins with through-flowing streams, braided-stream deposits of the distal fan are interbedded with floodplain deposits.

Fan deltas may be distinguished from alluvial fans only by the nature of related facies. Modern fan deltas develop in areas of high or low rainfall, from deserts to tropical rain forests, and are associated with a wide range of marine depositional environments, *e.g.*, reef-lagoonal to submarine fan association. Types of depositional environments associated with fan deltas are determined by such factors as tidal range, shelf width, and climate.

Fan deltas differ considerably from modern oceanic (high-constructive) deltas which are constructed by continuously flowing, large rivers characterized by a large suspension-load/bed-load ratio. Deltaic plains of oceanic deltas generally are covered by dense vegetation, whereas subaerial parts of fan deltas are virtually barren. Oceanic deltas have ragged lobate or digitate margins indented by interdistributary bays; fan deltas commonly have a smoothly arcuate distal end with no interdistributary bays. Prodelta deposits associated with oceanic deltas are commonly the thickest delta facies; equivalent facies of fan deltas are comparatively thin.

Fan-delta deposits are continually reworked by marine processes. Deposition is sporadic, therefore marine processes are effective in redistributing prodelta sediment. Marine currents redeposit sediment along the distal fan as beaches and associated berms, and within adjacent shallow marine areas as thin sand sheets and local fan-margin islands or spits.

Many ancient clastic-wedge deposits from Precambrian to Pleistocene ages are alluvial-fan systems. Deposits composing these systems become finer in the direction of transport. Lacustrine or fluvial deposits commonly are associated with the finer grained alluvial-fan deposits. Ancient alluvial fans are known from the (1) Precambrian of Texas, (2) Devonian of Norway, (3) Carboniferous of Canada, (4) Permian-Triassic of England, (5) Triassic of the Connecticut Valley, and (6) Pleistocene of California.

Ancient fan deltas have been described as fanglomerates, continental deposits, and tectonic deltas. Subaerial facies have the same character as ancient alluvial fans but are associated with marine facies ranging from turbidites to tidal-flat deposits. Ancient fan deltas occur in the (1) Devonian of New York and Northwest Territories, (2) Pennsylvanian-Permian terrigenous clastics shed off the Ancestral Rockies, Amarillo Mountains, Wichita Mountains, and Arbuckle Mountains, (3) Miocene of Texas and California, and (4) the Pleistocene of Baja California.

Fan deltas and possibly high-destructive deltas prograded shorelines and filled basins during early geologic periods, prior to evolution of terrestrial vegetation. High-destructive deltas are produced by marine reworking of river-borne sediment. Streams associated with high-destructive deltas are characterized by short duration peak discharge which allows sediment deposited at the mouths to be immediately reworked into spits and beach ridges. Lag time between precipitation and runoff was short and the fluvial systems which developed these 2 delta types were either braided streams or coarse-grained meander belts.

NAMY, JEROME N., Baylor Univ., Waco, Tex.

FACIES PATTERNS IN MARBLE FALLS GROUP, SOUTHEAST BURNET COUNTY, TEXAS

Morrowan carbonates and clay of the Marble Falls Group accumulated on part of a broad structural platform, the Texas craton, that was bordered on the east by the Fort Worth basin. A myriad of carbonate facies formed on landward parts of the platform, whereas a relatively thick uniform sequence of dark-gray spiculitic carbonate mudstone accumulated at its seaward margin. As much as 6,000 ft of Mississippian and Pennsylvanian shale and sandstone fill the segment of the Fort Worth basin adjacent to the carbonate platform.

Facies patterns in the Marble Falls Group are closely related to depositional setting. Changes in setting are a consequence of transgression, regression, and accumulation during transgression and regression. The response of facies patterns to changes in setting is recorded in the composition, geometry, and distribution of the facies.