Examples are known where several of these various types of porosity are present in a single deposit and influence log analysis in either a negative or positive manner. A nonpermeable chalk or calcisphere porosity carrying high water saturation may produce oil if the fracture fabric or associated intergranular permeability is oil-bearing. Likewise the reverse may be true if nonproducible oil is trapped in the high porosity-low permeability deposits and the more permeable fracture and (or) intergranular porosity is water-bearing.

The presence of these varied porosity fabrics can be recognized in samples and a method of logging and estimating the importance of the different types is suggested. Utilization of well sample data coordinated with realistic log analysis can lead to successful completion in zones which might be overlooked in a cursory log analysis. Examples of these sedimentary types from the Mid-Continent area are discussed and illustrated.

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ORDOVICIAN OIL IN SEDGWICK EMBAYMENT

The Sedgwick embayment occupies approximately 8,000 sq mi in south-central Kansas. The area is bounded on the west and northwest by the Pratt anticline and the Central Kansas uplift. The Nemaha ridge limits the embayment on the east. Late Mississippian and Early Pennsylvanian movements were primarily responsible for the development of the embayment.

The most important reservoir for the Ordovician oil is the Simpson sandstone. Other reservoirs contributing significant recoveries are the Viola and Arbuckle.

Simpson sandstone of the area was laid down by transgressive seas, with locally regressive phases, which invaded from a subsiding basin on the south. Source of the sand was on the north and northeast.

The Sedgwick embayment has undergone two phases of exploratory activity. In the late 1920s and early 1930s the large features were found through core-drilling operations. Subsequent to World War II many new fields were found by subsurface studies and seismic activities.

Fields in the Sedgwick embayment have produced approximately 303,000,000 bbls of oil. Of this total, 108,000,000 bbls, or approximately 30%, has come from Ordovician rocks.

Most of the oil fields of the area which produce from the Ordovician exhibit similar geologic characteristics. Among the more important factors governing Ordovician accumulation are thinning of the Mississippian, existence of adequate reservoir rocks, and Permian structure.

Proper geological application of the known factors which control Ordovician oil accumulation will result in many future Sedgwick embayment discoveries.

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USE OF CLAY MINERALOGY IN DETERMINING SOURCE OF BASIN SANDS

(No abstract submitted.)

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DEPOSITION OF CHESTER SANDSTONES OF MISSISSIPPIAN AGE IN SOUTHWESTERN KANSAS

The Chester Series of the Mississippian System covers all or part of 12 of the counties that comprise extreme southwestern Kansas. The erosional surface on which sediments of Chester age were deposited was an extremely rough one, representing a major unconformity. Significant commercial oil fields have been found in sandstones of Chester age in this area. Commercial oil accumulated in highly lenticular sandstones. This oil accumulation is mainly stratigraphic. Chester sediments change thickness abruptly in the area that was studied. The Chester seas generally were transgressive with several periods of quiescence. Several facies are recognized, including the sandstone facies.

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AN APPLICATION OF DIRECTIONAL FEATURES AND SCALAR PROPERTIES OF SEDIMENTS TO HYDROCARBON EXPLORATION

Ripple marks, cross-bedding, and groove casts are examples of directional features of sediments. Variations in grain size or mineral composition are examples of scalar properties. Although directional features normally are considered to be the domain of the surface geologist, by means of the oriented core and more recently the dipmeter, these features also can be used by the subsurface geologist. Recent literature abounds with reports of new types of scalar properties.

Directional features and scalar properties of sediments are used to determine paleocurrent direction. The integration of paleocurrent data with environmental information yields a paleogeographic map. Prediction of favorable areas for wildcat exploration and the exploitation of wildcat discoveries can then be made from the paleogeographic map.

The Desmoinesian-age Hartshorne Formation of eastern Oklahoma is a shallow but major gas producer within the Arkoma basin. A study in the nature of directional features $\rightarrow$ paleocurrent direction $+$ depositional environment $=$ paleogeographic map is presented. This study indicates that the probable nature of the productive Hartshorne sandstone in the discovery well of the South Pine Hollow field, Pittsburg County, Oklahoma, is a deltaic channel sandstone with a northeast-southwest alignment. This information could have been used to exploit the discovery well.

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CHEROKEE SAND POSSIBILITIES, CENTRAL KANSAS

Cherokee sandstone reservoirs west of, parallel with, and flanking the Central Kansas uplift produce oil primarily from structural traps. Of probable late Cherokee age, these sandstones are the products of the erosion of the nearby positive arch area. Several depositional environments probably are represented, although shallow-water marine conditions from the transgressing Cherokee seas are an obvious influence.

A basinward facies change to dominantly limestone and shale confines the maximum sandstone development within a northwest-southeast trend. This trend generally coincides with the truncated updip limit of the Mississippian, although the sandstones onlap rocks as old as Cambro-Ordovician (Arbuckle) on the pre-Pennsylvanian unconformity surface on which they are deposited.

Sandstones at nearly all levels in the interval produce. Correlation of individual sandstones can be accomplished only on a limited scale, indicating the lenticular nature of the section. Intraformational limestones are not widely persistent.

Pennsylvanian and Permian movements were most important in forming the producing structures. How-

ever, except on the pronounced structural trends, producing fields have no particular pattern where the underlying rocks are of Mississippian age. In a thinner updip interval are what commonly are called "conglomerate sands." These also are productive and appear to be a product of the same transgression and as such are genetically related.

More than 5,000,000 bbls of oil has been produced from Cherokee sandstone pools. Additional reserves found during the past 2 years should increase the oil already produced by 30%. More prospecting will discover additional structural traps and furnish further control for the search for stratigraphic traps—a search which should not be neglected.

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DEPOSITIONAL ENVIRONMENT OF SPIRO SANDS IN ARKOMA BASIN

Isopachous maps, electric-log cross sections, and Kodachrome slides of the Sprio Sands in Wilburton, Kinta, and Milton-Cartersville fields are used to illustrate the writer's interpretation of the depositional environment of these sandstones in the Arkoma basin.

At least three sandstones, differing genetically and in age, have been termed the Spiro Sand in the Arkoma basin.

In the Wilburton field, the Spiro Sand appears to be a marine facies of the Wapanucka Limestone and possibly is Morrowan in age.

Such characteristics, as geometry of the sandstone bodies, sedimentary structures, composition, nature of the boundaries, and other features, lead the writer to believe that, in the Kinta and Milton-Cartersville areas, the Spiro Sands were deposited in an environment likely to have channel, as well as transgressive, unconformity sandstone deposits.

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APPLICATION OF TREND ANALYSIS TO PRE-MORROW SURFACE, SOUTHEASTERN HUGOTON EMBAYMENT AREA

Trend analysis is a technique used to distinguish between trends, such as regional dip or thickening, which may influence a whole region that is the object of study, and small-scale effects (anomalies) which are influential locally. Because oil and gas fields are in almost every place associated with anomalies or departures from the regional trend, whether governed by structural, thickness, or lithologic factors, trend analysis should prove to be an important prospecting tool.

The electronic computer has permitted the application of trend analysis and numerous other techniques to large areas by the oil industry. A procedure involving the computer has obvious advantages in that it provides a degree of rigor that more elementary methods lack, and reduces considerably the amount of time involved in computation.

Application of the technique to the pre-Morrow surface in the southeastern part of the Hugoton embayment, using few control wells, reveals objectively the combined topographic and structural relief that existed before Pennsylvanian deposition. With few exceptions, Morrow sandstones, and hence production, are found to be related empirically to the flanks of structures or in depressions.

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GEOPHYSICAL EVIDENCE OF UNTAPPED OR INSUFFICIENTLY EXPLORED PARTS OF STRATIGRAPHIC SECTIONS

Beginning with the development of the seismic-reflection method of geophysical profiling about 1930, blanket-type surveys were begun in which a crew (or crews) was placed in a prospective area with the assignment to "map the subsurface." The survey progressed section by section, township by township, and county by county, mapping regional features as well as local detail. The objective was to be there first and to acquire acreage on interesting structures. Those organizations without the financial ability to carry on such programs, or who were late in arriving in the area, learned early that acreage acquisition in an active area even without geophysical or geological information was good protective strategy. Those organizations which acquired strong land positions so often obtained positions of power that land acquisition and the land departments who created this position became dominant factors in the industry.

About 1950, so much of the acreage in recognized oil provinces was leased that little incentive remained for conducting blanket or regional-type surveys. Because of the lack of available acreage and other economic factors, geophysical prospecting degenerated into individual prospect analysis. This forced change in exploration philosophy has been a large contributing factor to the decrease in geophysical activity.

Unfortunately, the instrumentation and techniques used in the blanket-survey era were inadequate for some areas and some exploration problems. Many of the improvements in seismic-instrumentation and seismic-prospecting techniques have been made possible by developments in government-sponsored research and these improvements were developed too late to be applied to the blanket survey.

The quality of analyses of the untested producing potential of some of the important basins of the Mid-Continent area depends on the quality of regional studies and regional information. The cost of obtaining this type of data is great and beyond the financial resources of the average company. Recognition of this problem has led to the formation of exploration combines of one type or another for the express purpose of acquiring quality data of regional type. Even though surveys of this nature are scarce, and data available to a limited number of people and organizations, the impact of these studies on new discoveries is considerable and will become much more of a factor in the immediate future. Geophysical "evidence" is rapidly being accumulated which eventually will lead to the discovery of new producing trends and to the redrawing of regional maps.

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BASIS FOR RED FORK SANDSTONE EXPLORATION IN NORTHWEST OKLAHOMA

The Red Fork Sandstone produces oil and gas in a large area of north-central Oklahoma. There are indications that several oil fields comparable with the Burbank field (½ billion bbls) can be found in northwestern Oklahoma during the next few years by using available well control for detailed reconstruction of the depositional environments of the Red Fork Sandstone.