suitable for cores cut in formations where bedding is not visible. Drawbacks are encountered in highly fractured formations. Highly fractured cores are most effectively oriented at the surface provided that the bedding is visible or that other directional core parameters, such as paleomagnetic properties, can be measured.

The fold fracture classification presented differentiates between fracture systems associated with folds that result from horizontal compressive stress systems and those that result from vertical diapiric uplift. Each type of fold is characterized by two dominant fracture patterns. Fracture patterns 1 and 2 occur in association with compressive folds, and fracture patterns P and R are associated with diapiric structures. Potentially, each fracture pattern consists of an extension and two conjugate shear fractures. All four fracture patterns result from stresses generated during the folding process. Fracture patterns 2, P, and R result from extension parallel to the bedding, and are best developed where bed curvature is greatest.

Analysis of core-measured fracture patterns is best effected by plotting the poles to the fractures, with bedding plane orientation, on a stereographic projection. The fracture patterns distinguished can then be projected to other parts of the structure or to adjacent structures. Areas of maximum fracture potential can be distinguished by calculation of both cross-sectional and planar bed curvature.

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San Andres and Grayburg Oil Plays in Permian Basin—Past Performance and Prediction for the Future

Crude oil production in Texas totals more than 47 billion bbl; however, the rate of production has been declining since 1972. The most rapid decline was 6% in 1979, but subsequent decline rates have diminished to 2.5% in 1983. Production of second-crop oil (attributable to infill drilling and enhanced recovery methods) from Permian basin reservoirs has been responsible for a large part of this improvement. Second-crop oil will likely be instrumental in arresting the rate of production decline for the state.

Production from San Andres and Grayburg reservoirs played a major role in establishing the Permian basin as a premier oil province in Texas and the United States. Since the first commercial production at Westbrook field, Mitchell County, in 1921, these reservoirs have accounted for more than 40% of the oil produced from the Permian basin and more than 15% of the oil produced in Texas. Researchers at the Bureau of Economic Geology have subdivided these reservoirs into several plays on the basis of geographic association and similarities in depositional controls, trapping styles, and drive mechanisms. The reservoirs consist of dolomitized carbonates interpreted as restricted-shelf deposits on the northern and eastern shelves of the Midland basin and restricted-platform carbonates on the Ozona platform, Yates area, and the Central Basin platform. The San Andres and Grayburg exhibits widespread reservoir heterogeneity owing to complex depositional and diagenetic facies relationships. This internal complexity, along with a less efficient solution-gas drive, accounts for the large volume of unrecovered movable oil. Innovative infill-drilling programs based on geologic concepts of facies-controlled reservoir development provide an opportunity for further reserve growth as well as increased production.

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Integration of Seismic and Well Log Data Using Vertical Seismic Profile

Use of the vertical seismic profile (VSP) as the link between surface seismic data and advanced log evaluations makes it possible to calibrate seismic sections in terms of subsurface petrophysical parameters.

A step-by-step procedure of (1) tying a surface seismic section to the borehole measurements via the VSP, (2) reprocessing the seismic section, and (3) propagating log information outward from the well using the calibrated seismic section is practical. In fact, if a VSP is run in the discovery well in a field, this procedure can be followed to obtain information about where to drill the first development well. If vertical seismic profiles are run in each subsequent development well, a continually updated reservoir description can be used to guide the development of the field.

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Stratigraphic Dipmeter Interpretation—Fort Worth Basin Submarine Slope Systems

Submarine slope systems pose several exploitation problems. Previous dipmeter interpretation techniques using the standard dipmeter with CLUSTER processing are highly successful in fluvial to deltaic sequences, but lack of accuracy in the anastomosing depositional environment associated with submarine slope systems. Both the delineation of individual depositional units and the precise trend determination of each are essential for optimum exploitation. A new interpretation technique has been devised to provide accurate and consistent answers to these problems. The technique involves the use of multiple logging passes and detailed stratigraphic correlation to provide a paleocurrent and depositional analysis.

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Middle Atokan to Early Missourian (Pennsylvanian) Conodonts, Fort Worth Basin and Concho Platform, Central Texas

Middle and Upper Pennsylvanian strata in the Colorado River Valley and Llano area south of Brownwood, Texas, have not been extensively studied, and little is known regarding their precise correlation. Conodont faunas have been recovered from many units, particularly Smithwick Shale (Atokan), lower Strawn Group (Atokan-Desmoinesian), upper Strawn Group (Desmoinesian-Missourian), and lower Canyon Group (Missourian). Conodonts permit more refined correlation of this important sequence with Mid-Continent and Appalachian series than has previously been possible. In addition, age relationships of stratigraphic units places constraints on developmental models for the Fort Worth basin and adjacent Concho platform.

The Smithwick conodont fauna is indicative of a middle to late Atokan age. Diagnostic species are *Neognathodus atokaensis, N. bothrops, Neogondolella clarki, N.* n. sp. A, and *Idiognathoides* spp. Approximately the lower one-half of the lower Strawn Group is latest Atokan based on occurrences of *Idiognathoides* spp. The appearance of *Gondolella laevis* and advanced neognathodids distinguish the early Desmoinesian portion of the lower Strawn Group. *Neognathodus roundyi, N. dilatus,* terminal neognathodids, *Gondolella bella,* and *G. magna* are typical conodonts of middle to late Desmoinesian strata of upper Strawn Group. Missourian conodont faunas are relatively depauperate, and seemingly have less value for precise correlation than older Desmoinesian and Atokan faunas.

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Truncated Devonian and Fusselman Fields and Their Relationship to Permian Basin Reserves

The Permian System accounts for a majority of oil produced in the Permian Basin. However, the Devonian rocks and Silurian Fusselman rocks are excellent producing zones. These produce on both structure and truncation, but this paper deals with truncated aspects only.

It appears that production in these fields is the result of an updip pinch-out of the formation along with lateral closure to trap the hydrocarbons. Lateral closure must be by faulting and/or reentrants along either or both sides of the pinch-out. When a prospect exhibits all these features, production should be assured.

The truncated Fusselman along the Eastern shelf produces both from dolomite and limestone ranging in depth from 8,000 to 11,000 ft. It is believed that both the overlying Woodford Shale and underlying Sylvan Shale act as source rock and seal.

When exploring for the truncated Devonian in southern Crane and northern Pecos Counties, Texas, a third requisite is required: tripolitic chert. This unique rock appears to be the result of subaerial erosion. The tripolitic chert is usually found in downthrown fault blocks or grabens which are present along the flank of the "Old Fort Stockton high." These faults appear to be adjustment features which formed as a result of movement along and around this positive area.