sively deeper into the section until basement rocks were exposed on the highest portion of the Muenster arch.

It is postulated that the Strawn beds, which then covered the platform, furnished the source and seal for the Oil Creek production in the following examples: Ouachita and Arbuckle orogenies (late Pennsylvanian) rejuvenated earlier faulting on the platform, and this faulting partially controls the production.

Exploration is quite attractive, especially for independent operators.

Lease costs are about $10-$15/acre for 1- to 2-year leases except in the Walnut Bend areas where it ranges much higher. Mineral ownership is fairly simple, and 7/8 leases can usually be obtained. The productive areas are not large, hence large lease blocks are unnecessary. Drilling costs are nominal, a 5,000-6,000-foot dry hole costs $20,000-$25,000.

There are classic examples of oil occurrence in subtle stratigraphic traps directly related to an unconformity.

Geology alone will find more of these fields with no dependence on structural closure or geophysics. Careful log correlation is essential; a small fault in the Pennsylvanian section may indicate an untested fault block in the underlying Oil Creek.

The economic incentive is already established in excellent reservoirs. The Oil Creek of North Texas and the other Simpson sandstones of southern Oklahoma offer a fertile hunting ground for truncation prospects.

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February 14, 1966

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"Conquest of the Barranca de Cobre"

The Barranca de Cobre (Copper Canyon) is located in the Sierra Madre Occidental about 200 miles southwest of the city of Chihuahua, Mexico. Copper Canyon was cut by the Urique River in a thick series of volcanic flows of ryolite, trachyte, basalt, tuff, and diorite. The canyon is heavily mineralized with copper and commercial quantities of gold, silver, and optical calcite.

Copper Canyon is part of a system of canyons approximately four times larger in areal extent and up to twice as deep as Grand Canyon. First recorded attempt to explore the Barranca de Cobre was by Robert T. Moore in 1950. His party succeeded in only getting to the bottom of the Barranca de Urique about 15 miles from Copper Canyon before being forced to climb out because of extremely hot weather and heavy rainfall. In 1952, a man named Griffith is believed to have explored about five or six miles of the Cobre before climbing out.

The most recent unsuccessful attempt to conquer the canyon was in October of 1963 when John Cross, a professional river runner from Orem, Utah, led a party of 14 into the head waters of the canyon. Cross's party progressed only about six miles when their heavy rubber boats became trapped between a 50-foot waterfall and a mass of tremendous boulders. This ill-fated attempt received nationwide attention and resulted in a massive rescue operation when two members of the Cross party succeeded in climbing out of the canyon, after having gone five days without food, and reported their companions lost and starving.

The writer, along with Rex Moore, Jr., of Oklahoma City and Bill Wetzel of Duncan, Oklahoma, joined with Cross and seven others in a second try at the canyon in November-December of 1963. By using two-man rubber kayaks, this expedition succeeded in conquering the Barranca de Cobre in its entirety, a distance of about 30 or 40 miles. However, the party was then forced to enter a second unexplored canyon, the Barranca de Urique, in order to find a way out of the maze of deep gorges. After three days of hunger and hardship in trying to climb out, Cross's group finally reached the small hamlet of Franciscan Antonio on the rim, exhausted but elated to be the first to conquer the Barranca de Cobre.

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February 28, 1966

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"Wolfcamp Stratigraphy, Western Delaware Basin"

The major lithologic subdivisions of the "Wolfcamp" strata in the western part of the Delaware basin are described. Also presented is the probable stratigraphic relationship of these strata to equivalent beds present on the Northwestern shelf and in outcrops to the northwest and west.

The term "Wolfcamp" is used as an operational unit and may contain some beds slightly older and/or younger than the lower Permian Wolfcamp Series. The top

of the "Wolfcamp" in the basin is the top of the "3rd Bone Spring Sand" (or Dean) —a regional subsurface marker within the western Delaware basin. On the adjacent platform the "Wolfcamp" is bounded on the top by the Drinkard Sandy Member of the Yeso Formation—a regional subsurface marker on the Northwestern shelf. The base of the "Wolfcamp" commonly is defined by a regional unconformity which overlies rocks ranging in age from Late Pennsylvanian to Precambrian.

"Wolfcamp" strata in the western Delaware basin locally exceed 6000 feet in thickness and are among the least well-known sequences in the basin. These strata are generally dark colored and the carbonates are generally lime packstones, wackestones, and mudstones. The "basinal Wolfcamp" can be subdivided into (1) a lower detrital unit which is quite variable in thickness and lithology, (2) a middle sequence of lime-shale-lime which is somewhat more uniform in thickness and lithology, and (3) the "3rd Bone Spring Sand" which is quite uniform in thickness and lithology. All of these units probably were deposited in a basinal (relatively deep water) environment. Deposits of the lower detrital unit range from conglomerate to feldspathic sandstone to shale and tended to level out the irregular basin floor topography created by Late Pennsylvanian-Early Permian tectonism. Taken as a whole, the "basinal Wolfcamp" records a transition from a period of active tectonism to one of relative stability.

In contrast, "Wolfcamp" strata on the Northwestern shelf are generally light colored, the carbonates are commonly dolostone, and most of the rocks have grain-supported textures. The "shelf Wolfcamp" strata were probably deposited in environments ranging from nonmarine to shallow water marine. The "shelf Wolfcamp" can be subdivided into (1) a lower clastic unit which locally exceeds 2,000 feet in thickness north of the Huapache fault zone, (2) the Abo-Hueco Formations, a thick carbonate tongue grading northwestward into Abo red beds, (3) the lower carbonate-evaporite member of the Yeso Formation, and (4) the Drinkard Sandy Member of the Yeso Formation.

Correlation between "basinal Wolfcamp" and "shelf Wolfcamp" sequences is difficult. Details of the stratigraphic relationships in these sequences are complex and as yet poorly understood. The lower clastic unit of the "shelf Wolfcamp" is similar in age and closely resembles, in lithologic variation (red beds to clean carbonates) and tectonic setting, the Laborcita Formation in the northern Sacramento Mountains. The Abo-Hueco carbonate tongue represents a major marine transgressive-regressive cycle. The lower member of the Yeso represents a similar cycle which terminated in the deposition of the Drinkard.. The Drinkard Sandy Member is believed to represent the remnant of great quantities of very fine sand and silt which were transported across the Northwestern shelf to the Delaware basin where it accumulated as the 3rd Bone Spring Sand.

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March 21, 1966

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"Mathematically Derived Prospects"

The gas and oil search is considered a mathematical problem. The branch of mathematics best suited to the hydrocarbons hunt deals with probability theory and statical analysis. As holes are drilled at random and information is collected from them, it is found that some data may occur within a certain range of probabilities, that is, the process occurs stochastically. By turning to certain probability formulas as found in statistical physics and information theory, the data can be used to configure density patterns or contour maps to obtain ideas as to what percentages of success a series of holes will be expected to have. In some areas, less sophisticated methods can be used effectively in evolving patterns compiled from fixed and random data.

Accurate definition of a discovery or development well can be difficult. When a well is predicted to find hydrocarbons several miles from production it is normally considered as a discovery. But in an area that is geologically and engineering-wise in varying stages of statistical equilibrium, the well might be considered as a verification of prior knowledge and actually a development well. The obvious utility of this information is for an operator to acquire diversified lease blocks before acreage prices soar, and then to optimize a drilling program to verify or gain the most information.

In any statistical argument it is not easy for a single point to be proven. But if evidence in percentages shows an overwhelming regularity when dealing from original