formed the most prolific oil-producing reservoirs of those two periods.

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RELATIONSHIPS OF RESERVOIR FLUIDS IN DELAWARE SANDSTONE STRUCTURES AND STRATIGRAPHIC TRAPS

From the axis of the Delaware basin to the western monocline, the upper Delaware sandstone exhibits a regular progression from gas-bearing structures to oil-bearing structures updip, an example of Gussow's migration theory.

Beginning in western Reeves County, Texas, the monocline has trends of clean sandstone encased in very shaly laminated siltstone. These stratigraphic traps contain such perplexing fluid relationships as water above oil, and gas downdip from oil, both in the same correlative electric-log zone. The writer submits that these phenomena are caused by the entrapment of different fluids in lenses within a sandstone body. "Membranes" with various low permeabilities form the boundaries of the "sub-lenses" and control the migration of various fluids.

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DEEP PAYS IN DELAWARE-VAL VERDE BASINS

The Delaware-Val Verde Basins are a continuous elongate northwest-southeast-trending downwarp extending from Eddy County in southeast New Mexico to Edwards and Kinney Counties in Texas. Deep production consists mostly of petroleum condensate and gas containing substantial amounts of carbon dioxide, and is confined primarily to the Ellenburger Group of the Ordovician; the Devonian; the Morrowan, Atokan, and Strawn Series of the Pennsylvanian; and the Wolfcampian Series of the Permian.

Original water salinity distribution in the Ellenburger and Devonian formations appears to have been highly modified by hydrodynamic movement of meteoric waters in the west, southwest, and south parts of the trough. This flushing, extremely active in early Pennsylvanian, late Permo-Pennsylvanian, and Triassic-Jurassic periods, continues in a minor degree to the present time. Charged meteoric water which introduced carbon dioxide to the subsurface had as its major origin the solution of carbonate and bicarbonate components in the exposed rocks of the Ouachita, Marathon, and Diablo Platform areas. The most likely periods of generation were early Pennsylvanian, late Permo-Pennsylvanian, and during the Tertiary igneous disturbance. Forceful emplacement of carbon dioxide and methane may have occurred in the Val Verde Basin throughout early Pennsylvanian and mid-Wolfcampian folding and thrusting in the Ouachita-Marathon region.

Absence of oil production from the deep zones in the Delaware-Val Verde Basins appears to be the result of two major factors. The first is the hydrodynamic flushing of crude accumulations from all but the deeper and larger closures. This scattering of oil occurred coincident with the major periods of hydrodynamic activity. The second factor is that restored maximum overburden, as well as present overburden in many cases, exceeds the gas-condensate conversion point for Delaware-Val Verde Basin oils. These oils, derived from the Simpson, Woodford, and Permo-Pennsylvanian shales, disassociate into gas-condensate and gas below 14,000, 13,000, and 8,000–9,000-foot depths, respectively.

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GEOLOGY OF SUBSURFACE FLUIDS—PROBLEMS AND RESEARCH NEEDS

Oil and gas occupy the pore spaces of sedimentary rocks in petroliferous basins to the extent of the order of 1 part per 100,000; below shallow depths the remainder of the pore space is filled with water. Hence, oil and gas originate, migrate, and become stably trapped in a rock-water environment.

From an initial state of dispersion elementary volumes of oil or gas are driven by physical forces to positions of concentration and entrapment. The direction of these forces is from regions of higher environmental energy for the given fluid to lower-energy regions; and traps for a given fluid are regions of local minimum potential energy.

The search for oil and gas thus reduces itself to a search for regions of minimum potentials for these two fluids. These, in turn, depend on the density and state of motion of the ambient water as well as on the geometrical configuration of the rocks. Petroleum geology, to the extent that it is to become a rational, rather than an empirical science, must therefore ultimately be based on a comprehensive knowledge of the mutual relations of the rock-water-oil (or gas) complex.

Out of such knowledge, it is seen that the conventional horizontal stratification of gas, oil, and water is true only for the special case of hydrostatics. For the general dynamical case, when the water is in motion, traps for gas and those for oil do not coincide. Furthermore, it is possible for such traps to exist in almost any structural position from the crests of anticlines to the troughs of synclinal basins.

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RELATIONSHIPS OF OIL COMPOSITION AND STRATIGRAPHY IN PERMIAN BASIN OF WEST TEXAS AND NEW MEXICO

Analyses of 313 crude oils from Cambrian to Cretaceous formations were studied to correlate the geologic occurrence of these oils with such characteristics as composition by hydrocarbon type (aromatics, naphthenes, and paraffins), content of gasoline and gas oil (determined by distillation and refractometric methods), distillate yields and residuum, sulphur and nitrogen contents, and cloud points.

Five general categories, based on likenesses that may indicate a similar history, include most of the oils, but smaller groupings are also discussed.

AVERAGE VALUES FOR CATEGORIES

Category	*S*	*N*	*N/S*	V_A	V_N	V_P	V_D	*Wax Content*
I	0.16*	0.032	0.21	5.5	7.5	87.0*	84	Med.
II	0.35*	0.059	0.11	8.7	30.3*	61.0	79	High
III	1.77*	0.10	0.057	19.3*	31.4	49.3	73*	High
IV	0.16*	0.125	0.78*	6.1	46.1*	48.0	76	High
V	1.19*	0.140	0.12	6.2*	63.1*	30.7*	63	Low*

S and *N* refer to weight-per cent sulphur and nitrogen; V_A, V_N, V_P to volume-per cent of aromatics, naphthenes, and paraffins, in the gasoline; V_D to volume-per cent total distillate. *Items of particular interest.