A.E.C., is program chairman; ADDISON YOUNG, Phillips Petroleum Company, is editor, and L. E. GNAGY, 1400 Wilco Building, is chairman of the housing committee. Applications for room reservations should be mailed before January 1 to the S.W.F.G.S. Housing Bureau, Chamber of Commerce, Midland, Texas.

Convention headquarters hotel is the Scharbauer and registration headquarters is across the street in the Midland Mart Building. The technical program will be presented at the Yucca Theater.

M. RAY THOMASSON, president of the Southwestern Federation, will open the sessions with the theme, The Geology of Fluids. On the second morning, J. C. SPROULE, president of A.A.P.G., will discuss Certification and Registration of the A.A.P.G.

The entertainment committee is arranging plenty of diversion from start to finish.

SPEAKERS AND ABSTRACTS

DRESCHER, WILLIAM J., Engineer, U. S. Geological Survey, Madison, Wisconsin

HYDROLOGIC CONSIDERATIONS IN DEEP-WELL DISPOSAL OF RADIOACTIVE LIQUID WASTES

Disposal of radioactive liquid wastes through deep wells may be categorized as containment or confinement. Containment means the placement of wastes under conditions that preclude their movement out of a definable zone. Confinement means the placement of wastes in a zone where movement may take place under restricted conditions that can be controlled or monitored.

Disposal of liquid wastes on a continuing basis by containment probably is not practical except for small quantities and may be possible in only a few areas. It is probable, therefore, that any deep disposal of radioactive liquid wastes will be by confinement of wastes in certain geologic zones through which they will move at measured rates.

Hydrologic principles applied to the available data indicate that there is circulation of fluids in almost all sediments. Movement of fluids tends to be restricted in the basal parts of sedimentary basins, but any assumption that wastes introduced into a basin would not eventually move out of the basin or to the near-surface formations should be carefully scrutinized. Introduction of wastes into an anomalously low-pressure zone should not be considered safe unless the reason for the low pressure can be explained.

Data necessary to define the hydrodynamics of fluids injected through deep wells will be expensive to obtain, and many of them will have to be collected for each particular disposal site. Geochemical factors may influence greatly the movement of radioactive material in deep formations. A system of monitoring, and possibly removal, is a prime requisite of deep-well disposal of radioactive wastes. Initial disposal activities necessarily will be on an experimental basis pending the results of such monitoring.

ERDMAN, J. GORDON, Senior Fellow, Mellon Institute, Pittsburgh, Pennsylvania

PETROLEUM: ITS ORIGIN IN THE EARTH

The gas-liquid-solid mixture which we know as producible petroleum represents only a small proportion of all fossil organics including coals, oil shales, natural asphalts, etc. In past ages, as today, plant and animal detritus was deposited and preserved in fine-grained sediments in environments ranging from fresh-water swamps to marine slopes and basins. Why do only certain of these environments favor the genesis of accumulable oil? What are the controlling ecological and chemical factors? By what mechanisms do the constituents of petroleum migrate into the reservoir? To what extent does fractionation occur during migration? Does chemical alteration occur during migration and after accumulation in the reservoir? Today, answers to these questions are being sought in many laboratories throughout the world.

Living organisms do not generate, as part of their life processes, many of the hydrocarbons and other chemical compounds characteristic of petroleum. Further, the components are not in thermodynamic equilibrium under earth conditions and, hence, independent of the structure of the source material. The nature of the source material derived from living organisms and its quantitative variation as a function of environment is being determined through study of Recent sediments. Changes in composition with age and depth of burial are being observed and the mechanisms of the reactions elucidated. Good progress has been made toward recognizing the sources for constituents of petroleum ranging from the hydrocarbon gases to the asphaltic residues. In several instances reactions involved in their genesis have been duplicated.

Fractionation of the organic matter begins with deposition and continues throughout subsequent geologic time. Physical processes are interrelated with the chemical and the two must be considered together.

No satisfactory mechanism has been proposed for the migration of petroleum out of the fine-grained source rocks into the reservoir. Mechanisms involving oil as a separate phase, as a soapy colloid, or as a solution in water, all seem to fail under experimental scrutiny.

GIBSON, GEORGE R., Geological Consultant, Midland, Texas

OCCURRENCE OF OIL AND GAS IN SOUTHWESTERN REGION—GEOLOGIC FRAMEWORK

A structural relationship exists in several areas in the Southwestern region between rock types in the Precambrian and Paleozoic structural trends. The Ouachita geosynclinal belt on the south and east of the Texas Craton which underlies the Southwestern region was the dominant structural feature during the Paleozoic and probably exercised indirect control over all intracratonic structures. Most of the early and middle Paleozoic oil and gas reservoirs are associated with unconformable surfaces. These reservoirs were formed by weathering of the unconformity surface particularly where pre-unconformity folded and faulted structures existed.

Four Paleozoic continent-wide interregional unconformities are present. The approximate dates of the regressional maxima represented are: (1) very late Precambrian, (2) early Middle Ordovician, (3) early Middle Devonian and (4) post-Mississippian. In addition, many regional unconformities are present, the most important in relation to the source, migration, and accumulation of oil and gas being that between the Permian and Pennsylvanian. This regional unconformity is composed of local unconformities associated with structurally positive areas. Early and middle Paleozoic hydrocarbon source beds were probably organic-rich sediments overlying the unconformities. Late Paleozoic Pennsylvanian and Permian sediments were by far the most abundant source of hydrocarbons in the reservoirs in the middle and early Paleozoic formations. Within the Pennsylvanian and the Permian, unconformities are important; however, their importance is overshadowed by lithofacies phenomena in the form of reefs which

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

GRAUTEN, WILLIAM F., Consulting Geologist and Oil Operator, Midland, Texas

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.

HOLMQUEST, HAROLD J., Senior Exploration Geologist, Mobil Oil Company, Midland, Texas

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.

HUBBERT, M. KING, Shell Development Company, Houston, Texas

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.

JONES, T. S., Geologist, Union Oil Company of California, Midland, Texas

SMITH, H. M., Research Scientist, Bartlesville Petroleum Research Center, Bureau of Mines, U. S. Department of the Interior, Bartlesville, Oklahoma In conjunction with WEST TEXAS GEOLOGICAL SOCIETY RESEARCH COMMITTEE

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.