region, with Lake Huron now on the verge of exploitation. Offshore development in Lake Erie has been concentrated in two main areas: in the east and underlake extensions of the Clinton-Medina gas fields are being proven; in the west end further biostromic Guelph gas-bearing reefs and extensions, as well as dolomitized Trenton oil and gas production are being sought.

Operating problems may be summarized as follows: relatively high costs of offshore contract drilling, short operating season (6–7 months), weather, disappointing results to-date of drilling based on geophysical surveys (seismic, gravity, magnetic, sparker), and attempts by the fishing industry and by champions of possible lake-pollution to prevent lake-drilling. Also the economics of offshore oil production are an unknown factor which will have to be determined by the type of production encountered.

The favorable marketing conditions in the heavily populated areas surrounding the Great Lakes provide ample incentive for offshore exploratory work. However, because of the problems mentioned, one of the main keys to a profitable natural gas operation has been to minimize drilling development and production costs. Some companies have accomplished this by operating their own offshore towers and by sub-contracting the actual drilling operations.

CHARLES L. DRAKE and MAURICE EWING, Lamont Geological Observatory, Palisades, New York

Structure of Continental Margin of Northeastern North America

During the last 20 years extensive geophysical investigations have been carried out on the emerged and submerged Atlantic coastal plain of the United States. These include over 300 seismic refraction profiles, numerous gravity measurements from both submarines and surface vessels and total intensity magnetic measurements from ships and aircraft.

The geological structure of the area between Newfoundland and Cape Hatteras has been determined in some detail by these measurements. The predominant features are two linear troughs paralleling the edge of the continental shelf and separated by a ridge in the basement. The shelf trough contains up to 18,000 feet of sedimentary material while the outer one contains in excess of 25,000 feet in places.

Comparisons of this structure with the Appalachian Mountain system taken as a whole reveal many interesting parallels. Prior to the Taconic orogeny the Appalachians must have resembled the present continental margin in general characteristics.

The picture south of Cape Hatteras is not as clear. The structure is more complicated and the refraction results are more difficult to interpret due to the presence of calcareous sediments. The Cape Fear arch appears to be the dividing line between the two structural types.

H. F. DUNLAP, J. S. BRADLEY, and T. F. MOORE, Atlantic Refining Company, Dallas, Texas

Marine Seep Detection—New Reconnaissance Exploration Method

Many major oil accumulations of the world are associated with oil or gas seeps. At the least, seeps prove the existence of mobile hydrocarbons in a basin. At the most, and when used with other geological and geophysical data, they can aid in locating exploratory wells.

An effective and inexpensive instrumental technique for locating gas seeps has been developed for use in water-covered areas. If a seep is present, some of the methane dissolves in the water as the gas bubbles rise to the surface. Currents spread this methane-enriched water into a long plume. A boat samples the water continuously, operating over a grid laid out at right angles to the current. The gas dissolved in the water is broken out of solution, and trace concentrations of methane detected using an infrared analyzer. This equipment has detected seeps at distances as great as six miles. A novel system of location using navigational radar is used in carrying out the survey.

Several surveys on marine seeps have been carried out using equipment mounted on various vessels ranging in size from a 14-foot outboard-powered skiff to a coastwise freighter. Under most conditions, the cost of the survey is a few cents per acre. In new basins, the method promises to be of considerable value in localizing areas of interest for more expensive exploration methods.

C. W. DWIGGINS, JR., P. B. LORENZ, and H. N. DUNNING, Bureau of Mines, Bartlesville, Oklahoma

Colloidal Nature of Petroleum

The distribution of nitrogen, sulphur, metals, saturates, and aromatics, among the various molecules and particles in petroleum, is of importance in geochemical speculations on the origin of crude oil. Investigations with the ultracentrifuge are believed to give a truer picture of this distribution, while previous studies have used distillation and precipitation that alter the property being studied. Centrifugation of whole crude oil in a preparative ultracentrifuge at about 80,000 times gravity for 2–5 days gives a gradient in concentration of some constituents in the liquid and a relatively small amount of solid sediment. Examination of the solid by x-ray diffraction permitted identification of kaolinite and sodium chloride among the inorganic constituents and high-molecular-weight waxes among the organic. Most of the asphaltenes remain in the liquid phase and are concentrated in the lower portions of the tube along with nitrogen, sulphur, nickel, and vanadium. Layer analysis of the centrifuged samples leads to a particle diameter distribution curve with a maximum at about 60 Angstroms. Viscosity is considerably affected by asphaltene content and can be used as a measure of separation.

K. O. EMERY, University of Southern California, Los Angeles, California

Dependence of Petroleum Source Materials on Rate of Burial

Organic matter, including parent materials of hydrocarbons and porphyrins, is produced by phytoplankton living in oceanic surface waters in quantities far greater than required for petroleum. Mostly, however, these materials are regenerated in the water and at the bottom, and thus are lost to petroleum. An understanding of petroleum genesis includes knowledge of how they can be preserved.

Radiocarbon age determinations at several depths in cores from basins off southern California show that the rate of deposition of total sediment varies from 8 to 125 $mg/cm^2/year$. Highest rates occur in basins close to shore where rates are similar to those for the now-filled Los Angeles and Ventura basins during the Pliocene epoch; the grain size, content of calcium carbonate, and interruption by turbidity currents also are similar. Most of the sediment is detrital silt and clay from the mainland. Organic matter is diluted by this detrital sediment so that it forms a lower percentage of total sediment in nearshore than in offshore basins. Even though hydrocarbons and porphyrins are also diluted by detrital sediments in nearshore basins, both are much more abundant (constituting a higher percentage of total sediment) in nearshore than in offshore basins. Thus, it is evident that both hydrocarbons and porphyrins are more easily oxidized than is total organic matter and that their preservation is greatly enhanced by rapid burial which removes them from contact with the oxidizing overlying water. Comparison with estimated ultimate petroleum recovery from Los Angeles basin shows that far more organic matter, hydrocarbons, and porphyrins were produced and deposited in the basin sediments than were required to form the petroleum. Nevertheless, present production of petroleum from Los Angeles basin is at a rate that appears to be about 150,000 times greater than its rate of formation.

J. GORDON ERDMAN and WILLIAM E. HANSON, Mellon Institute, Pittsburgh, Pennsylvania

Sources and Modes of Genesis of Nitrogen and Sulphur Compounds in Crude Oils

Nitrogen and sulphur compounds are present in all crude oils and, in some instances, may represent the major portion of the crude. While many sulphur compounds in crude oils have been identified, or the structure of the sulphur-containing group determined, relatively little is known concerning the structures of the nitrogen-containing compounds. Organic nitrogen is present in abundance in plant and animal detritus accumulating in aquatic sediments. From current knowledge of the structures of nitrogen compounds formed by plants and animals and conditions for post-depositional degradation, predictions can be made concerning the type of nitrogen compounds likely to be present in crude oils. It is improbable, however, that the quantity and variety of sulphur compounds present in many crude oils could have been derived entirely from organo-sulphur compounds contained in the living source material. While derivatives of sulphur compounds synthesized by plants and animals may be present in crude oils, a larger portion of the sulphur compounds appearing in the crude must be formed after incorporation of the organic source material into the bottom sediments. Mechanisms proposed for the geochemical synthesis comprise reactions of plant—or animal-produced unsaturates and oxygen-nitrogen heterocyclics with sulphur or hydrogen sulphide formed by bacterial reduction of sulphate ion.

HAROLD N. FISK, Humble Oil & Refining Company, Houston, Texas

Bar-Finger Sands of Mississippi Delta

Elongate, lenticular sand bodies, termed bar fingers, characterize the Mississippi birdfoot delta sedimentary complex. They underlie the 15–20-mile-long principal distributaries or passes of the river which radiate from Head of Passes, and have formed in response to long continued distributary-mouth-bar deposition. These sand bodies attain a thickness of more than 250 feet and a width of as much as 5 miles. Their thickness results in part from subsidence brought about by compaction of underlying clays, and the width beneath a given pass is comparable to that of the actively forming distributary-mouth bar. The sand bodies comprise beds of well sorted, fine to very fine sand or silt and occasional thin layers of clay and silty clay. Diagnostic features are numerous cross-bedded thin layers in which the principal elements dip gulfward, laminae composed of root and wood fragments, sand-size grains of lignite, and an absence of faunas. The bar-finger sands grade downward into delta-front silty clays which rest upon deeper marine prodelta clay deposits. Laterally they interfinger with extensive thick clay sections which accumulated in delta-front, bay, and marsh environments. The sands are transitional with overlying natural-levee, marsh, and bay deposits. Locally, the bar fingers have been disturbed by the upward movement of clays from underlying deposits to form mud lumps.

Bar fingers are distinguished from other sand bodies in the Recent deposits of the Mississippi deltaic plain by their greater thickness and their pattern of distribution. Their ancient counterparts have been recognized in the Pennsylvanian Booch sands of Oklahoma. Abnormally thick sand masses present locally within the Eocene Wilcox and Sparta formations of Louisiana may also be deltaic bar-finger sands.

PETER T. FLAWN, Bureau of Economic Geology, University of Texas, Austin, Texas

A.A.P.G. Basement Project

The Basement Rock project of the A.A.P.G. was initiated in the fall of 1956; it is supported from the Research Fund. The Basement Project Committee, organized on a geographic basis, is currently compiling a basement map of North America between 24° and 60° N. Latitudes. This map will consist of two parts: (1) a map showing basement wells with code number, outcrops of basement rocks differentiated as to age and gross lithology, and contours on the basement surface and (2) a geologic and structural map of the basement. Preliminary copy for (1) is nearly complete. This map will be published through the cooperation of the U. S. Geological Survey and will be accompanied by a text giving basic data for all wells.

Basement studies are important in regional evaluations. Knowledge of basement geology and structural grain aids in interpretation of geophysical data. Movements along basement structures produce structures in younger basin rocks which can be prospected more effectively if the basement control is recognized. Basement topography controls the facies of overlying sedimentary rocks. A regional knowledge of basement terranes is valuable in determining source of sediments and direction of transport. In areas where basement rocks are not "granite," thousands of unnecessary feet of hole have been drilled into metasedimentary and volcanic rocks. In some areas fractured basement rocks are reservoirs.

Petrographic methods, supported by geophysical and other information, can, within the limits of well control, establish (a) major lithologic and tectonic features such as orogenic belts, volcanic terranes, plutonic terranes, and fault zones and (b) tectonic divisions within concealed orogenic belts, such as allocthonous plates, belts characterized by different type and degree of metamorphism, and zones of igneous activity.

WALLACE W. HAGAN, Kentucky Geological Survey, Lexington, Kentucky

Oil Exploration in Green County, Kentucky, and Adjacent Areas