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* New lecturers and subjects.
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NATURAL GAS: OIL'S PRINCIPAL COMPETITOR

Petroleum gases and liquids, often occurring together, are found in the same types of traps by the same exploratory methods and are exploited and produced in the same manner. Moreover, all crude oil contains some natural gas, but nearly 75% of all natural gases are not associated with crude oil in the reservoir. The two phases of petroleum are highly competitive.

There are important differences in the physics and chemistry of natural gases and crude oil. Natural gases are a mixture of various organic compounds, usually accompanied by smaller amounts of inorganic elements and compounds. Natural gases of commerce are petroleum natural gases, although helium and hydrogen sulfide—also natural gases—may be valuable components. Even carbon dioxide, also a natural gas, finds markets. Physically, natural gases are highly mobile, difficult to contain, and are soluble in both crude oil and water, particularly under pressure.

Chemically, there are marked differences between petroleum natural gases and crude oil. Methane is the simplest, most ubiquitous and principal component of petroleum natural gases. It is often accompanied by much smaller quantities of heavier hydrocarbons. Natural gases are alkanes: paraffinic, saturated, straight chain hydrocarbons. The division between petroleum natural gases and the somewhat more complex, heavier alkanes occurring with them as vapors, is between propane and butane. Butane and heavier paraffinic hydrocarbons can be found both as normal, saturated straight chain or as isomers: saturated, branched chain hydrocarbon compounds. The substantial chemical differences between the simple compounds of petroleum gases and the far more complex crude oils suggest somewhat different modes of origin. An early and multiple origin for methane seems probable, inasmuch as substantial quantities are found in youngest Holocene sediments in swamps and glacial drift, and it is present as part of the atmosphere of several of the planets.

The vastly different physical and chemical characteristics of petroleum gases and crude oil have a great bearing on economics of exploring for, developing and producing them. The phenomenal growth in production of natural gas and in its use as a form of primary energy has been a major factor in the declining growth in the need for crude oil. The two substances are directly competitive for space heating, for domestic uses, and for generation of electricity. Liquefied petroleum gases ("natural gasolines") and lease condensate have further supplanted crude oil. Production of petroleum natural gases, wet, increased from 4,423 trillion BTU in 1945 to 20,121 trillion BTU in 1967, and in 1967 amounted to 36.4% (excluding lease condensate) of production of primary energy, compared to 32.6% for crude oil (including lease condensate). Moreover, according to Winger *et al.*, dry natural gas yields less than 4¢ of every dollar of income from a representative group of companies, the financial characteristics of which have been studied for years by the Chase Manhattan Bank. Although natural gas liquids and lease condensate add somewhat to this amount, natural gas is a much less attractive exploration objective than crude oil.

Most natural gases have been found as a result of the search for crude oil. Under present economic conditions, natural gases alone are not attractive exploration objectives in most areas of the United States. Hence, as demand has continued to accelerate, drilling of gas wells has declined sharply, and ratio of annual production to annual additions to reserves has declined to a dangerous point. Unless this trend is reversed, the next few years may see a shortage of available natural gases—although none exists in nature—simply because of lack of incentive to search for and develop natural gases in the quantities which will be needed.

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NEW GLOBAL TECTONICS RELATED TO WEST COAST STRUCTURE

The current evidence, patterns, and history of sea-floor spreading in the northeast Pacific; the character and history of the San Andreas system of deformation; and some geologic implications of their relations to a worldwide tectonic scheme are reviewed.

The NE-trending East Pacific rise enters the Gulf of California from the Pacific Ocean. The essentially contemporaneous and parallel Gordo and Juan de Fuca ridges lie off the coasts of northern California and Oregon. According to the New Global Tectonics, the SE-trending San Andreas zone is a transform fault which connects these two segments of the World Rift system. Furthermore, according to the rigid-plate concept, the adjoining oceanic and continental blocks are moving northwest and southeast away from the oceanic ridges, and past each other along the San Andreas. On the other hand, according to the new concepts, part of the sea-floor magnetic pattern and the northeast Pacific fracture zones (transform faults) indicate an earlier (10–30 m.y. ago) north-south oceanic ridge trend accompanied by east-west crustal extension. However, since the present crustal dynamics typified by the San Andreas system of deformation has been operative for a much longer time (at least 80 and possible for more than 135 m.y.), some doubt is cast on the interpretation of the San Andreas as a geologically young transform fault. These and other contrasting geophysical data and interpretations from the oceans tested against geologic data and interpretations from