ploration. Today, there is no reliable foreign source of oil for this country. Where there is political instability, and even strong Communist dangers, this includes all important foreign oil producing countries, the source of supply to this country and its allies can be sealed off overnight. Even a temporary cut-off of our oil supply would cause serious economic dislocations. Our dependence must be on domestic oil as long as such a source is available.

At the same time, however, a certain volume of imports is needed to relieve the pressure on domestic production and to help adjust to constantly changing conditions in domestic economy. Major importing companies, having tremendous investments made at government behest, should be permitted to import their quotas based on the present mandatory import control. However, imports should supplement, but not supplant domestic production of oil.

Assuming that domestic production and exploration are vital to our national welfare, demand and price of domestic petroleum must remain economically healthy. We must have a constant incentive to find and produce oil; for without that incentive it will be impossible to attract necessary investment capital. In times like the present when crude oil surpluses depress markets and threaten prices, imports should not be permitted to accent this condition. When prices drop, opportunities for profit are fewer, and risk capital finds a more favorable climate outside the expensive business of petroleum exploration.

The backbone of exploration in the United States is the independent. The independent has drilled the most exploratory wells and discovered the majority of our reserves. It is the independent who stabilizes the domestic oil industry by his continued efforts to explore in places and to depths where most large integrated companies probably would not. No act, such as excessive imports, should be permitted to cause the independent to curtail his continued search for new reserves.

ROBERT S. DIETZ, Naval Electronics Lab.

Astroblemes (Meteorite Impact Structures)

EUGENE F. REID, Occidental Petroleum Corporation

Why Explore in Sacramento Valley?

Sacramento Valley exploration and development drilling for natural dry gas fields is setting a brisk pace. Incentives supporting this level of activity are found in geology, economics, and politics.

Geologically, the basin contains a thick section of rocks with favorable reservoir and source characteristics, a portion of which has already been proved productive. A moderately active orogenic history has provided an environment conducive to petroleum traps. Paleocene and Cretaceous portions of the basin are relatively unexplored.

Economically, the most important factor is the competitive position of this domestic gas by virtue of its proximity to an assured expanding market and an ample latitude for future price increases without destroying this position with imported gas and(or) fuel oil. The value of Sacramento Valley gas is slightly more than double the average wellhead price throughout the United States. Average Sacramento drilling, completion and land acquisition costs are very favorable when compared with other areas of the nation.

Politically, the California producer, selling his product within the state, is not subject to Federal regulation of his producing activities or his pricing negotiations. To date, no controls are imposed on his production rate by State authority. The producer can enjoy the benefits of a successful exploration program without artificial restraints.

ROBERT O. PATTERSON, Pacific-Oil Well Logging, Inc.

Field Study of Geological Well Logging at Vernalis

The common practice of using geological well logging only on discovery wells precludes the collection of sufficient data to study the relations between production and well-log curves. The continuing development of the Vernalis gas field is a notable exception, since more than 90% of the wells in this field have been logged.

Optimum operating conditions were maintained by using the same drilling rigs throughout, excellent mud control, "controlled drilling" of the productive horizons, and by de-gassing the mud column prior to penetration of new producing intervals. The curves obtained in this manner were highly definitive of the producing sands.

Examination of the curves of many zones that are comparable from a production standpoint show large variations in amplitude that are apparently due to small changes in the mud weight.

The small effort and expense necessary to standardize as many physical conditions as possible in order to provide optimum well logging conditions appear well justified in the increased reliability of the gas curves. The apparent sensitivity to small changes in mud weight casts doubt on the reliability of many previous well logs made in extra-heavy muds and suggests that care be taken in the future to insure that excessive mud weights do not weaken one of the most reliable tools in the evaluation of gas sands.

SULHI YUNGUL, California Research Corporation

Gravity Prospecting for Reefs: Effects of Sedimentation and Differential Compaction

The classical questions are: "Do reefs create recognizable gravity anomalies?" "If and when they do, then what causes these anomalies?" To find the answers to these questions, first a study of the case histories was made. It indicated that deeply buried, "isolated" organic reefs frequently create recognizable but "mysterious" gravity anomalies, and that there is no evident direct relation between the reef mass and the gravity anomaly. To find out the causes of these anomalies, the field of investigation proved to be so large that this paper could be entitled "a tentative density analysis of the sedimentary subsurface."

The reef mechanism and the depositional processes are such that there is a concentration of sand in the over-reef section. Densities in clay and sand mixtures were investigated in terms of composition and depth of burial. The sand concentration alone is capable of creating shallow positive and deep negative density contrasts sufficient to account for the major part of the gravity anomaly. The gravity effect of a hypothetical reef was calculated. The result was very much like those actually observed. The gravity anomaly depends mainly on what has happened after the reef was buried, and not on the contrast at the reef level.

L. F. IVANHOE, consultant

Bouguer Gravity Map of Alaska

This map is a compilation of all published gravity data. The 20 milligal contours were extrapolated between control points on the basis of the local geology, topography, and known gravity results in similar tectonic areas. Several regions with similar gravity character are apparent, including from north to south the following.

(1) Arctic coastal region
(2) Brooks Range isostatic minimum
(3) Central Alaska region of low gravity relief
(4) Southeastern Alaska region of large complex gravity anomalies due to local isostatic and geological adjustments
(5) Bristol Bay positive area
(6) Aleutian Islands maximum
(7) Aleutian Trench minimum

Proper recognition of the types of large gravity anomalies to be expected in each region will greatly improve the interpretations of gravity meter surveys run in local areas for petroleum exploration.

F. J. HORTIG, State Lands Commission

California Offshore Oil—Present and Future

The base for report of the status of present development of offshore oil and for prediction of future developments is contained primarily in the past history of California offshore development, starting with the first tideland well drilled in 1896. Current annual (1959) production from State-leased offshore lands is 15 million bbls. from Orange, Ventura, and Santa Barbara counties. In addition, production has been developed from offshore lands granted by the State to municipalities at Newport Beach, Long Beach, and Redondo Beach.

Five leases, comprising 19,200 acres, are under exploration development in Santa Barbara County. Potential lease offers are under review by the State Lands Commission in both Santa Barbara and Ventura counties. Submarine seismic and geological (core drilling) surveys are being continued over the majority of the Southern California offshore area extending seaward to the Channel Islands. Exploration and technological developments in drilling and production indicate that the maximum California offshore development will be achieved in the future.

JOHN C. HAZZARD, Union Oil Company of California

Bioherms in Middle Devonian of Northeastern Spanish Sahara, Northwest Africa

Two groups of Middle Devonian (Eifelian) bioherms, here defined as the Gor Loutad and the Gor Morehba reef areas, have been recognized east and southeast of Semara, a village about 160 km. east-southeast of El Aaiun. The Gor Loutad reef area (Lat. 26°45′ N.; Long. 10°45′ W.) which was seen only from the air, comprises about 20 biohermal mounds and ridges distributed in a narrow northeast-southwest trending belt. To the southwest is the Gor Morehba reef area (Lat. 26°30′ N.; Long. 11°25′ W.) which was visited on the ground.

The Gor Morehba reefs are expressed topographically as an elongate area of low hills trending northeast-southwest for approximately 52 km.; the width of the belt ranges from 10 to 15 km. This area comprises more than 15 elongate reef ridges and elliptical to circular reef mounds. The ridges are as much as 5–6 km. in length and 1 km. in width; the mounds have an average maximum diameter of 1–2 km. Topographically, these reefs stand as much as 100 meters above present drainage levels.

The reef-forming limestone averages less than 30 meters in thickness and the total thickness of section affected in any way by the reefing is about 100 meters. Flank dips on the ridges are as much as 20° while dips on the flanks of the mounds are as great as 50°; such dips are in contrast with the average 2° regional dip of the Devonian section. The core of the reef mounds and ridges is a massive light gray limestone made up of broken fragments of coral, calcareous algae, and clastic limestone. It is overlain by, and grades down the flanks into, well bedded dark gray limestone which in turn passes into the shaly limestones and calcareous shales of the inter-reef areas.

Well exposed sections of the ridges and mounds suggest that the pattern of reef development was partly controlled by submarine channeling prior to deposition of the reefs. The inter-channel ridges and more isolated "highs" became the loci for growth of carbonate-secreting organisms. Such limestone (or reef) growth continued for a relatively short time until the influx of clastic material filled the inter-reef areas and eventually passed over the centers of reef development. Locally, initial dips exposed in the overlying clastic section reflect the underlying reef pattern.

STANLEY J. LASTER and FREEMAN GILBERT, Geophysical Service, Inc.

Line Source Problem for Solid-Solid Interface

This paper deals with the elastic waves propagated along an interface between two solid elastic half-spaces (Cagniard's problem). Classically it has been shown that interface (Stoneley) waves should exist only for those limited values of the elastic parameters of the two solids for which the Stoneley pole is real and lies on the sheet of integration. Solutions for the similar, but algebraically simpler, Lamb's problem indicate that interface waves may also be associated with complex poles not on the sheet of integration. Exact solutions are presented for Cagniard's problem for a large number of materials, lying both inside and outside the classical existence diagram. These seismograms support the conclusion that attenuated Stoneley waves can be propagated at the interface of almost any two solid materials. Additional information on critical refraction phenomena is also presented.

JOHN SILCOX, Standard Oil Company of California

General Geology and Development of West Thornton and Walnut Grove Gas Fields Sacramento Valley, California

The West Thornton and Walnut Grove gas fields occupy a position astride the east-west–trending Thornton arch which extends from Lodi to Rio Vista and is one of the major structural features of the Sacramento Valley gas province. Production along this trend was first established in 1943 at the Thornton and Lodi fields which are areas of anticlinal closure. Down plunge to the west, additional production was subsequently developed in 1956 and 1958 with discoveries at West Thornton and Walnut Grove respectively.

The productive section at the West Thornton and Walnut Grove fields includes the Domengine and Midland sands of Eocene age, Paleocene Martinez sands, and Cretaceous Winters-Millar sands. Gas accumulation in these intervals is controlled by a combination of faulting and stratigraphic changes on the plunge of the Thornton arch. Cretaceous production of the Thornton arch was first established at Walnut Grove from the Winters-millar sands in the Brazos Locke Unit No. 1 well in 1959. Three wells are presently productive from this interval. Erratic sand distribution in the lower Eocene Meganos sediments, attributable to either rapid facies changes or channel development similar to the "Markley Chan-