nel," delayed definition of the West Thornton gas field for four years until further development drilling was undertaken in April of this year. Since this time five additional wells have been completed in the Midland pool.

S. R. SILVERMAN, California Research Corporation

Critical Review of Contemporary Theories of Petroleum Origin

The present status of chemical, geological, and biological information on the origin of petroleum strongly favors the theory of organic (or biogenic origin over that of inorganic origin. There is no general agreement, however, on the mechanism or mechanisms by which biologic products become petroleum. Among the various hypotheses offered to explain this conversion, two have received most attention and occupy the forefront of present-day theories of petroleum origin. One, which may be designated as the "Direct-Accumulation" hypothesis, contends that petroleum consists of a selective accumulation of relatively unchanged organic compounds produced by living organisms. Opposed to this explanation are the so-called "Transformationists" who believe that biologic source materials must undergo marked chemical transformations, under the influences of temperature, pressure, and lithologic environment, before they are converted into petroleum. A critical review of available chemical and geologic information on petroleum and other organic materials in ancient and modern sediments suggests that chemical transformations play an important role in petroleum formation.

JOHN W. GROESCH, Union Oil Company of California

Economics of Marketing

The Pacific Coast market today is highly competitive. Price wars have been with us so long that depressed prices seem normal. Marketing margins are low. Refiners margins are seriously depressed. Eastern oil companies are seeking Pacific Coast outlets for their product. This contrasts with the stable Pacific Coast market of 10 years ago.

The turning point came at about the time of the Korean War. With the big Middle East oil strikes, productive capacity exceeded consumption. Combined with a surplus of tankers, a shift from production orientation to marketing was inevitable. Concurrently, petroleum companies have been seeeking greater efficiency in all phases of their operation.

For the next 20 years, California continues to have the greatest growth prospects in our market. Following 1980, a similar expansion is expected for the Pacific Northwest. Marketing prospects are virtually unlimited.

RICHARD R. THORUP, consulting geologist

King City Oil Field, Monterey County, California

The King City oil field, also referred to as the San Bernabe oil field, is 20 miles northwest of the San Ardo oil field, and 6 miles south of the town of King City, Monterey County, California. The field was discovered in December, 1959, the discovery well being the Thomas Doud Estate No. 2, which produced 16° gravity oil at the rate of 76 b/d net oil cutting 16% from a depth of 2,000 feet. The No. 3 was also completed in December, 1959, with an I.P. of 531 b/d cutting 0.1%. The No. 4 was completed in June, 1960, as a gas well indicating the possibility of a gas cap in the field. Cumulative production through September, 1960, is 43,000 bbls. of net oil and 10,000 bbls. of water. The producing sand is middle Miocene in age with a total thickness of 330 feet, about 150 feet of which is oil saturated. Porosity averages 23% and permeabilities have been found as high as 2,100 millidarcys. Accumulation is believed to be due to a combination of structure and stratigraphy. The discovery well was located primarily on the basis of field and subsurface geology.

EUGENE M. SHOEMAKER, U. S. Geological Survey, Menlo Park, California.

Interplanetary Correlation of Geologic Time

Asteroid impact has produced a significant number of medium and large craters on the earth in comparatively recent geologic time, and the rate of impact can be interpreted to have remained fairly steady for at least the last half-billion years. By extrapolation of this rate, the age of major stratigraphic units on the moon may be estimated from the number and distribution of superimposed primary impact craters. With appropriate modification, the same principle should be applicable to Mars when detailed photographs become available for photogeologic mapping.

A second potential method of interplanetary correlation depends on the actual transport of impact debris from other planets to the earth, where the debris becomes incorporated in the terrestrial stratigraphic record. Some rock debris is ejected at escape velocity by asteroid impact on the Moon and probably also on Mars; part of the lunar ejecta must land on earth and a very small fraction of Martian ejecta is probably also swept up by Earth. Some tektites are probably formed by ablation of ejects thrown into orbit around the earth. It may be possible to identify the craters from which ejecta are derived at some advanced stage of lunar and planetary exploration and thus tie the age of these craters directly to the terrestrial time scale. A ray crater in the size range from Aristarchus to Tycho is the probable source of the ejecta from which the australites and associated Pleistocene tektites were formed.

GORDON R. BELL, Gulf Oil Corporation of California

Trends in Geological Society Membership in Oil Industry of California

Membership in the Pacific Section of the American Association of Petroleum Geologists has declined 18.8% from its all-time high of 1,362 members in 1956. The rate of decline appears to have leveled off during the year 1959–60. During the 15 years prior to 1956, the Pacific Section grew rapidly from 247 members in 1941. This rate of growth was at least equal to the phenomenal growth rate experienced by national A.A.P.G. The present analysis shows the trends of Pacific Section membership throughout California during the 9-year period 1951–1960. Trends by areas corresponding with those of local geological societies and oil-compnay operations are shown. Statistics used are obtained from membership lists, newsletter mailing lists, and five Pacific Section directories published to date.

By the use of these statistics, it is possible to show that while the number of members has changed, the percentage distribution of Pacific Section members in each of the Los Angeles, San Joaquin Valley, Coastal, and Northern California operational areas over the past 9 years has remained fairly constant, but that members outside of California have increased from 4% to about 15% of the total organization. A study of the percentage distribution of members by organizational affiliation shows that between 40 and 50% of the members worked

for 15 major oil companies over most of this period, while 15 independent oil companies employed an average of 7%. All oil companies together accounted for 75% of the total membership in all areas.

Membership trends in California alone for each year bear a resemblance to exploration activity over the period analyzed. The peak year in California's drilling record for exploratory holes completed and footage drilled corresponds closely with the high point in Pacific Section membership.

Membership figures used in this analysis consist of the total number of active and subscriber members. Only paid members could be counted inasmuch as all available lists include only this group. A check was made against the geographical roster of the national A.A.P.G. March *Bulletin* for each year to find the relation between national and Pacific Section members.

CHARLES C. BATES, Advanced Research Projects Agency

Vela Uniform—Nation's Quest for Better Detection of Underground Nuclear Explosions

Negotiations between the USSR, United Kingdom, and the United States have been in progress since 1958 in an effort to achieve a treaty for cessation of nuclear weapons testing under an effective control system. To support these negotiations, the President announced in May, 1960, a major expansion of the present research and development program, VELA UNIFORM, directed by the Advanced Research Projects Agency. The program's goal is to provide a markedly improved capability in detecting and identifying underground nuclear explosions during the coming two years. Starting as a $10,000,000 effort in the fiscal year just past, spending during the present year is at the rate of about $66,000,000, making the project the largest terrestrial science effort underway within the U. S. at the present time.

The Advanced Research Projects Agency, with the technical assistance of the Air Force's Technical Applications Center, is employing several approaches for rapidly improving the state of the art in subsurface nuclear test detection. These include a several-fold expansion of the effort going into basic seismological research; procurement of instruments for a world-wide seismic research program; development of improved seismic instruments; construction and operation of prototype seismic detection stations; and an experimental program of underground explosions encompassing both high explosive and, where necessary, nuclear explosions. Already in the program are such government agencies as the Department of Defense, Atomic Energy Commission, Department of Commerce, and Department of Interior, as well as universities and private organizations, both profit and non-profit. Provision has been made for investigation of all aspects of improvement considered feasible. To this end, unsolicited proposals bearing on such improvement from both profit and non-profit organizations, domestic and foreign, are invited. Outstanding unsolved problems include development of a better global knowledge of the layering of the earth's crust, a need for improved instrumentation and data analysis capable of markedly improving signal-to-noise relationships, improvement of techniques for distinguishing at great distances the differences between earthquake and explosion-induced seismic signals, and the providing of on-site inspection techniques that are much more rapid and economical than those existing today.

CHARLES B. OFFICER, Marine Geophysical Services Corporation

Petroleum Exploration with Gas Exploder and Sparker Offshore California

Petroleum exploration with the Gas Exploder and Sparker has been conducted over a number of offshore and inland water-covered areas of interest throughout the world. One of these areas which has received considerable attention has been offshore California.

A description of both the Gas Exploder and Sparker equipments and methods of operation is given; illustrative records of each are shown and discussed. The results are presented in the form of a geologic cross section. The structural configuration is shown in detail. In general offshore California, both the configuration of anticlines and the strike and dip of fault planes can be mapped.

The Gas Exploder obtains continuous reflections down to depths of 3,000–4,000 ft. The seismic source for the Gas Exploder is the underwater explosion of a mixture of propane and oxygen in an open cylinder.

The Sparker obtains continuous reflections down to depths of 600–800 ft. The sound source for the Sparker is the underwater detonation of a 10,000-volt spark discharge. The Sparker shows more detail of the structural configuration down to 600–800 ft. than the Gas Exploder.

Both the Gas Exploder and the Sparker can be operated at the same time on the same survey. Several of the more recent surveys have been conducted in this manner.

CARL H. SAVIT, Western Geophysical Company of America

Solving the Singing Record

Extensive theoretical study and experimentation reveal that theoretical models do not approximate actual singing situations to better than the first order. Measurements of singing amplitudes, however, indicate that, in many cases, attenuation of singing must be of the order of 40 db in order to produce a useful record. Based on these observations, a system was designed using cascaded frequency-domain filters and empirically determined parameters to remove the singing-complex from tape-recorded data. Application of this system to singing records from various areas of both the eastern and western hemispheres has been spectacularly successful.

WENDELL H. RUSSELL, Baroid Division, National Lead Company

Quantitative Mud Analysis for Hydrocarbons

Prior to recent developments, results obtained by mud-analysis logging have been qualitative not quantitative. The magnitude of gas shows obtained was not necessarily an accurate reflection of the concentration of gas entrained in the drilling mud. Nor could one safely assume that similar concentrations of gas in different mud samples would yield readings of similar magnitude.

The analytical method employed in determining the type and concentration of hydrocarbon gases in the drilling mud was the weak point in early mud logging. The gas chromatograph, incorporated in present equipment, has overcome the analytical problem. The remaining obstacle to precise mud analysis has been that of extracting all the hydrocarbon gases from the drilling mud for analysis. With the development of equipment