tance, which is nearly the average distance from the earth to the sun. Although some reserve was expressed by the space experts about accepting the new values without further confirmation, the general attitude of the participants was one of confidence.

It was agreed that the conventional values of the constants mentioned and of others, which have been in general use during the past 60 years, are in need of revision, and the executive committee of the International Astronomical Union was requested to appoint a special working group to study the matter and if possible to make specific recommendations to the Union at its next general assembly which will be held at Hamburg in August 1964. The proposed members of the group are D. Brouwer, United States; A. Danjon, France; W. Fricke, Germany; A. A. Mikhailov, U.S.S.R.; and G. A. Wilkins, United Kingdom.

The symposium was the 4th international conference to have been devoted to the system of constants; previous ones were held in 1896, 1911, and 1950, all of them in Paris. L'Observatoire de Paris was the host, and the local arrangements were handled by B. Guinot and J. Kovalevsky. The full proceedings will be published in *Bulletin Astronomique*.

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Petroleum Geology

Deep drilling for oil and gas (to depths of 4500 to 7500 meters, or 15,000 to 25,000 feet) is practical, and large amounts of the world's petroleum resources will be found by exploration at these depths. The world's deep petroleum resources were assessed by Ira H. Cram (Continental Oil Company, New York) at the 48th annual meeting of the American Association of Petroleum Geologists in Houston, Texas, 25–28 March. Cram stated that the greatest volume of sediments in the world's deep hunting grounds occur in two areas, the Gulf Coast province of the United States and the Persian Gulf province of the Near East. He emphasized that there are no serious technological or economic problems that cannot be solved, based on experience gained from the few fields in which oil is now obtained from depths of 4500 to 6500 meters (15,000 to 22,000 feet). We can look forward to hunting for and producing oil and gas from depths of 4500 to 7500 meters, and possibly from 9000 meters (30,000 feet) in the immediate future, as the necessary geologic conditions exist in great quantity throughout many of the world's petroleum provinces.

Carey Croneis (Rice University) in a talk at a general session on geologic researches and scientific manpower stated: "It is a truism, if all too lately recognized, that the more fruitful geological researches today (and tomorrow) depend to an increasing degree on the techniques of the sister sciences and mathematics. So much is this the case that a number of quasigeological 'earth and space science' departments or divisions have been created and others are springing up not only at universities but also in private industrial and governmental research complexes, as well. The pendulum has now swung so far from the geologists per se that these organizations are being staffed to a large degree by non-geologists trained in one of the more fundamental, yet supporting, sciences. The advantages are obvious. The disadvantages, which may be equally great, are as yet only dimly perceived. Despite the paradoxical stigma now attached to the use of the time-honored and appropriately descriptive word 'geology,' the earth science institutes and departments are still chiefly engaged in *geological* researches. In such investigations it is just as short-sighted to expect first-rate results from a staff member who has little or no geological background, as to expect outstanding contributions to stem from the 'geologist' who does not have considerable mastery of at least one of the more basic scientific disciplines. As an additional adverse factor, we see fewer students entering undergraduate geological studies and, if the trend continues, fewer 'genuine' geologists will be available for geological positions in teaching or in industry. In short, the situation feeds on itself. The serious, national problem of scientific and technical manpower inadequacies is also closely involved in the geological research dilemma."

A series of papers on clastic sedimentation contained several significant reports. One on the geologic record of hurricanes by Mahlon M. Ball, Eugene A. Shinn, and Kenneth W. Stockman (Shell Development Company, Houston) was thought-provoking about basic geologic theory, especially with reference to carbonate deposition. The speakers considered a little-thought-of geologic principle, "the principle of catastrophic uniformitarianism." This principle nullifies the previous ideas of many geologists that the geologic record of catastrophic storms is limited. They stated that the passage of hurricane Donna (9–10 September 1960) across south Florida, an area where details of the sea floor before the storm were well known, permitted the recognition of widespread storm effects. The recognition of these storm effects led to the conclusion that a significant part of marine sedimentation records the geologic work of large storms.

Specific effects of the hurricane included formation of large quantities of boulder-size rubble by the action of surf on corals at the Florida platform edge, transportation of all sizes of material away from the open sea toward the platform interior, and stranding of layers of carbonate mud over wide areas of the supratidal flat (above the normal high tide line).

The amount of boulder-size rubble formed by hurricane surf on reefs at the platform edge far exceeded the amount produced by day-to-day processes of coral death and deterioration. Each large storm adds an increment to the building of the rubble accumulations.

The large extent of supratidal flats is due to the ability of storm tides to strand sediment over large areas, the inaccessibility of the flats to processes that could rework their sediment into adjacent marine environments, and the supply of sediments on the flats. The supply is so large that these sediments overwhelm the adjacent marine sediments that compete with them for a place in the geologic record. These factors help explain the existence of large amounts of supratidal sediments in some ancient rocks.

Interesting negative aspects of the hurricane's effects were that mound-type accumulations of muddy sediment were not eroded by storm wave or tidal currents and the sediment-laden waters resulting from the stirring of bottom sediments into suspension by the storm waves and currents did not give rise to effective turbidity currents.

In a symposium on cyclic sedimentation several speakers stressed the idea that many transgressions and regressions (advances and retreats, respectively) of the ocean as recorded in geologic time are not related to eustatic changes in sea level but are due to the shifting of the deltas of major river systems and

the attendant river deposits and offshore deposits associated with the deltas. Eustatic changes in sea level are real changes in sea level; they are not relative changes due to uplift or subsidence of a coastal area. In the past many geologists and most physiographers and geographers have emphasized that transgressions or regressions were due to true changes in sea level caused by extensive periods of glaciation and nonglaciation. From new studies of both recent and ancient sediments geologists now conclude that there are fewer real changes in sea level and that the shifting ocean boundaries on the edges of or across portions of a continental land mass are due to differential uplift and subsidence and further that many of these "ups and downs" are connected "chicken and egg" fashion with major delta systems. The influence of this shifting of delta systems was also stressed in the analyses of cyclically recurring sequences of rocks particularly in the Pennsylvanian age which contributed vast amounts of sediments throughout the United States. These sequences of sediments (cyclothems) have been studied in great detail in the Illinois and Appalachian basin areas, and they can be explained by shifting continental and marine depositional facies, delta, and river patterns without "yo-yo-ing" sea level.

A paper on the West Bastian Bay field by Clyde A. Brooke and Parker S. Turner (Pan American Petroleum Corporation, Houston, Tex., and New Orleans, La.) stressed the sedimentary and structural patterns that occur when local uplifting and faulting occur over a growing deep-seated salt dome. Brooke and Turner stated that the large, domal structure at West Bastian Bay field, central Plaquemines Parish, Louisiana, is a deep-seated salt dome. A large, normal fault which strikes east-west and dips south, and which was contemporaneous with the upward push of the salt, traverses the dome and controls accumulation of oil and gas in multiple upper Miocene sands. At the time of maximum growth along this Bastian Bay fault, sediment was deposited approximately three times faster in the downthrown block where most of the hydrocarbon accumulation occurs. The relative thickness of sediments shows that domal uplift, deposition of upper Miocene and younger beds, and movement along Bastian Bay fault were contemporaneous. Reliable electric log correlations together with paleontological data from well samples in the field area afford excellent data for a detailed study of contemporaneous normal faulting, a type of faulting common to Miocene sediments of the Gulf Coast and important to exploration for oil and gas. Microfaunal and lithologic data obtained from conventional cores through oil and gas productive strata show that the 'R' and 'S' sands were deposited predominantly in nonmarine environments. These sands in turn are separated by dense homogeneous gray-black shales, deposited in marine environments similar to those existing on the modern continental shelf. Production has been established in 20 sands ranging in depth from 2644 to 4664 meters (8677 to 15,305 feet).

Doyle T. Graves (Union Oil Development Corporation, Sydney, Australia) reported on the geologic significance of the Moonie Oil Field discovery, Queensland, Australia. Graves stated that the discovery of the first commercial oil field on the continent of Australia has caused a reappraisal of the petroleum prospecting potential of all its sedimentary basins. This discovery marks the beginning of an oil-producing industry and has caused many preconceived ideas to be discarded. Geologically, Moonie is most significant for its contribution to the understanding of the structural and sedimentary history of the Surat Basin as related to the accumulation of petroleum. The oil field is an accumulation on a large regional plunging nose with a relatively small local closure of 45.7 meters (150 feet). Immediately below the producing sands is a major angular unconformity, and the pre-unconformity structure is the steeply dipping flank of a complexly thrust-faulted regional anticline. Thick sequences of rock are missing on this steep, faulted anticlinal flank below the unconformity.

Geophysical papers stressed the importance of generation of sound waves for seismic surveying by means of vibrators, impact devices, or weight drops rather than by the conventional means of explosions in a shot hole. By the use of these techniques, coupled with electronic tape recording, reinforcement of useful seismic energy can be achieved. It is now possible to obtain fair quality seismic reflections from sedimentary beds in many deep basin areas. In many parts of the Gulf Coast province of the United States reliable seismic reflections from below 3600 to 4500 meters (12,000 to 15,000 feet) were impossible to obtain prior to the advent of the impact wave generation devices in which

a series of many drop patterns are recorded along a linear seismic spread. This allows "stacking" of the reflected sound waves and the enhancement of usable reflections. Good results at depths of 4500 to 7500 meters (15,000 to 25,000 feet) are being obtained.

The meeting, attended by 4600 registrants, was held in conjunction with the Society of Economic Paleontologists and Mineralogists and the Midwestern Societies of Exploration Geophysicists.

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Optical Masers

An international symposium on optical masers conducted by the Polytechnic Institute of Brooklyn in New York (16–18 April) not only provided a review of research, but also a forum for discussion of major problem areas and findings of interest to engineers, chemists, and physicists. The meeting was a comprehensive integration of the physics and technology bearing directly on the discovery, theory, and application of maser phenomena at optical and infrared frequencies.

N. Bloembergen (Harvard) presented a review of some theoretical problems in quantum electronics. He noted that although the fundamental problems of the interaction between electromagnetic radiation and matter are well understood, the advent of lasers has necessitated a more careful study of both quantum-mechanical and classical aspects of this interaction. Many well-known concepts from the realm of radio and microwaves have to be adapted to the optical region. Quantitative differences occur because several spatial modes are involved and quantum aspects, such as the uncertainty relations between amplitude and phase of the electromagnetic modes, are more prominent. Therefore, coherence, fluctuations, information, and channel capacity in optical fields are being studied with renewed vigor.

Nonlinear electromagnetic properties of materials at optical frequencies provide another illustration of the extension of well-known classical and quantum theories. It is possible to give quantum-mechanical expressions for linear and nonlinear complex susceptibilities with positive or negative imaginary parts. These may be incorporated