south of the hinge-line, contains a thick Miocene-Eocene section deposited in a saucer-shape basin unconformably overlying Upper Cretaceous sediments. Production in the Rio Vista basin is predominantly from "blanket" type Eocene sands on structural anomalies. North of the Sacramento hinge-line, the majority of the gas production, which is firmly established over this broad area, is stratigraphically entrapped in erratic lenticular Upper Cretaceous sands.

It is anticipated that extensive Upper Cretaceous production present north of the Sacramento hinge-line will be found in the Rio Vista basin and the Northern San Joaquin Valley. The economic depth limit for testing the Cretaceous will be effectively lowered as the intrinsic value of gas increases.

TOWE, K. M., AND HAY, W. W., University of Illinois, Urbana, Ill.

SUBMICRONIC STRUCTURE OF FOSSIL COCCOLITHOPHORIDS

Electron photomicrographs of replicated surfaces of fossil Coccolithophorids reveal a wealth of minute structural detail. The complex nature of large coccoliths has been suspected from features which can be seen in a light microscope. However, most of the minute structures are visible only in the electron microscope.

Discoliths consist of about 100 radially arranged peripherally branching platelets, each about 1/5 micron wide. Rhabdoliths are extremely complex. The "basal plate" is in reality made up of about 50 wedge-shape platelets arranged in an imbricate fashion. The stem also appears to be made of thin imbricate platelets. *Coccolithites gammation* possesses a complex circular ridge surrounding the central pore. About nine widely spaced shallow grooves, which may represent sutures, are present on the distal surface of this species. The margin is finely dentate, the individual denticles being only about 1/40 micron across. Broken edges of pentaliths of *Braarudosphaera* show an apparent laminar structure; however, no traces of fine structure have yet been observed on the surface of the pentaliths.

Discoasterids appear to be much more coarsely constructed than coccoliths, confirming observations made with the light microscope.

Analysis of submicronic structure will be of major importance in establishing a genetic classification of the Coccolithophorids and related nannoplankton.

TSCHUDY, ROBERT H., U. S. Geological Survey, Federal Center, Denver, Colo.

PALYNOLOGY AND TIME-STRATIGRAPHIC DETERMINATIONS

The determination of time horizons is difficult because of the comparatively slight amount of information collected to date; because many palynomorph-bearing sediments are devoid of other fossils which may permit accurate dating; and because many lithologic strata are known to transgress time.

Complications to accurate dating involve recognition of following facts.

1. There are no finite boundaries based on evolution of plants alone. Unless an unconformity is present all horizons involve more or less gradual change.
2. Sediments may be carried into a basin from different directions, resulting in a mixing of suites of palynomorphs from dissimilar floral provinces.
3. River transport may carry a suite of fossils different from those by air transport from the same floral province as well as from a different province.
4. Circulation (coriolus or other currents) can reorient and partially re-distribute fossils after they have arrived within a basin of deposition.

At the present time, the general boundaries (world-wide) such as the Mio-Oligocene, Pennsylvanian-Permian, and Mississippian-Devonian are recognized. Absolute determination has yet to be made, in most instances. Such boundaries are largely theoretical and have to be established and extended as each new fossil province is studied. However, time lines, within an individual depositional basin, can be established palynologically, with reliability and confidence. If palynomorphs are present in sediments of a basin, time-stratigraphic determinations can be made and correlations established.

VALENTINE, GRANT M., Shell Oil Company, Seattle, Wash.

RECENT PETROLEUM DEVELOPMENTS IN OREGON AND WASHINGTON

There are five exploration basins in Oregon and Washington, two west and three east of the Cascade Mountains. Exploration has been cyclic; much of the exploration during the high period of the last cycle (1955–1957) was concentrated in the eastern basins.

During 1961, exploration emphasis swung to the offshore parts of the western basins where five companies conducted marine geophysical operations in Washington and Oregon, and a sixth in Canadian waters adjacent to Washington; in addition, offshore aeromagnetic surveys were conducted.

Onshore exploration consisted of seismic operations on Whidbey Island in Washington, and a gravity survey in the Willamette Valley of Oregon. Eleven dry, new-field wildcats totalling 45,000 feet, all located in the Western Columbia Basin of Washington, were drilled during 1961.

During 1961, legislation was passed in Oregon which provides for the leasing of offshore State lands.

VAN DEN BOLD, W. A., Louisiana State University, Baton Rouge, La.

PROGRESS REPORT ON LATE TERTIARY AND QUATERNARY OSTRACOD FAUNAS OF CARIBBEAN

The lower Miocene ostracod fauna of the Caribbean area (the Gulf Coast, Central America, northern South America, the Antilles, and the Bahamas can be divided into four units: Gulf Coast, the "*ashermani*"-fauna (*Hulingsina*, *Actinocythereis*, *Protocytheretta*); Central Caribbean, the "*antillea*"-fauna (*Loxoconcha antillea*, *Hemicythere antillea*, *Costa* spp.); northern South American, the "*navis*"-fauna (*Cativella*, *Caudites*, *Basslerites*, *Pellucistoma*), and the more wide-spread "*deformis*"-fauna (*Aurila*, *Hermanites*, *Jugosocythereis*). These are all shallow-water assemblages. The "*ashermani*"-fauna spread to the south during Miocene time whereas the "*antillea*"-and "*navis*"-fauna moved northward to effect a mixing of the faunas in the Cuban and Guatemalan latitudes. The "*ashermani*"-fauna did not extend far south of these, and in the Quaternary withdrew northward. The "southern" faunas spread farther north, with the "*antillea*" element reaching Florida in the upper Miocene, and later withdrawing. The "*navis*"-fauna extended to the Carolinas, and at present dominates the entire region.

Relative movements of these faunas are governed by many factors, including currents, temperature, water-depth, salinity, and bottom sediment among others, but to date sufficient evidence is unavailable for determination of the controlling factor.

VANDERHOOF, V. L., Santa Barbara Museum of Natural History, Santa Barbara, Calif.

CALIFORNIA EARTHQUAKES—PICTORIAL REVIEW

Selected photographs show damage in three historic earthquakes: San Francisco, 1906; Santa Barbara, 1925; Imperial Valley, 1940. Relative value of building materials and techniques in resisting large earthquakes are evident from the pictures.

WAGNER, FRED J., Jersey Production Research Company, Tulsa, Okla.

MACHINE DIGITIZING AND PROCESSING OF GEOLOGICAL DATA OBTAINED FROM WELL LOGS

Integration of electronic machines for the efficient recording, computing, and plotting of exploration data has reduced the time, cost, and number of errors inherent in the manipulation of data.

The data processing system discussed encompasses all the phases of data recording, computing, and plotting. However, data recording still limits the machine approach because most manual methods are too slow and prone to error.

Jersey Production Research Company has developed and put into operation a digitizer, which is a desk-sized instrument designed to transfer basic stratigraphic data and their respective depths from well log overlays to punch cards. This unit has been incorporated into the machine system for processing geological data. The use of the digitizer reduces by one-half the time necessary for data tabulation, and increases the accuracy and efficiency of machine processing. The digitizer allows for the preservation of vertical positions (depths) for a maximum of 40 variables on one overlay. These variables, including lithologic features, oil shows, and (or) fluid contents, porosity ranges, and formation tops, are computed and plotted prior to the preparation of stratigraphic maps.

A specially designed computer program provides the necessary link between the digitizer and the IBM 650; it processes the data and computes thicknesses, subsea depths, ratios, and percentages in a form suitable for machine plotting of exploration maps. For subsequent studies involving correlation changes, the basic geological data, which are stored on cards, can be retrieved and reworked without retabulation.

The final step in the machine system is cross-sectioning, plotting, and contouring the computed data for visual presentation.

Savings in time and cost can not be estimated accurately, but they are more than sufficient to make geological data processing practical. The chief benefit of machine processing of exploration data is that it provides the geologist with data quality and several courses of investigation previously considered infeasible.

WAINES, R. H., University of California, Berkeley, Calif.

DEVONIAN CALCAREOUS FORAMINIFERA FROM ARROW CANYON RANGE, CLARK COUNTY, NEV.

Calcareous foraminifera determined from thin-section studies of samples from a sequence of Devonian limestones in the Arrow Canyon Range of southern Nevada are assigned to three genera. These are: *Eonodosaria* Lipina, well represented from 575 feet to 765 feet below the top of the system; *Tikhinella* Bykova, found sporadically between 575 feet and 805 feet; a third, possibly new, genus, sparsely represented from 430 feet to 805 feet.

Representatives of these genera compare favorably with forms confined to limestones of late Frasnian age (Devonian) in the Russian platform, western Russia. The eonodosarians, in addition, are similar to forms of probable late Frasnian age from Kwang-si Province, south-central China.

On the basis of the similarity of the Nevada fossils to those from Russia and China, a late Frasnian age is suggested for a part of the Devonian limestone sequence in the Arrow Canyon Range.

WILLIAMS, THOMAS E., Southern Methodist University, Dallas, Tex.

BIOSTRATIGRAPHY OF LOWER PERMIAN HUECO GROUP, HUECO MOUNTAINS, TEXAS

On the geologic map of the Hueco Mountains, Texas King *et al.* (1945) recognized three "divisions" of the Hueco Limestone: a lower light gray limestone, 500 feet thick (including a Powwow Member); a middle dark gray limestone, about 250 feet thick; and an upper light gray limestone, 800 feet thick including 180 feet of redbeds (Deer Mountain Red Shale Member). The term "division" has no standing in the stratigraphic code; yet the divisions of King can not simply revert to member status; members may not contain members. Furthermore they can be and have been mapped throughout the range; each is lithologically distinctive and amazingly uniform. Therefore, it is proposed that the lower, middle, and upper divisions be elevated to formation rank, and the Powwow and Deer Mountain units be retained as members. Accordingly the Hueco Limestone is renamed the Hueco Group.

The formations of the Hueco Group contain distinctly different assemblages of fusulinid species. The lower, the middle, and most of the upper formation are within the "zone of Pseudoschwagerina" (Wolfcampian Series). The Wolfcamp-Leonard boundary, marked by the appearance of a *Schwagerina crassitectoria-S. franklinensis* fauna, falls within the upper formation about 80 feet above the last appearance of *Pseudoschwagerina*. The composition of the fusulinid faunas of the Hueco Group is as follows (in ascending order): Powwow Member—*Pseudoschwagerina beedei*, *Schwagerina bellula*, *S. huecoensis*, *Triticites powwowensis;* lower formation—*Monodiexodina linearis*, *Pseudoschwagerina beedei*, *P. texana*, *P. uddeni*, *Schwagerina bellula*, *S. emaciata*, *S. huecoensis*, and *S. knighti;* middle formation—*Schwagerina eolata*, *S. neolata;* upper formation—*Pseudoschwagerina convexa*, *P. grontica*, *P. texana*, *P. uddeni*, *Schwagerina diversiformis*, and *S. nelsoni; Schwagerina crassitectoria* and *S. franklinensis*. No fusulinids were found in the Deer Mountain Member. Facies control of fauna is strikingly demonstrated in the occurrence of a typical Wolfcampian assemblage in the lower formation, its replacement by the specialized *Schwagerina eolata-S. neolata* assemblage in the middle formation, and its reappearance in the upper formation.

WILSON, L. R., University of Oklahoma, Norman, Okla.

PALYNOLOGY AND DETERMINATION OF ANCIENT ENVIRONMENTS

Determination of ancient environments by the palynological approach utilizes principles derived from