RICHTER, C. F., Seismological Laboratory, California Institute of Technology, Pasadena, Calif.

SEISMICITY OF CIRCUM-PACIFIC BELT

The large features of Pacific seismicity, including association of shallow and deep earthquakes with arc structures, almost exclusively shallow earthquakes with block structures, and earthquakes at intermediate depth with volcanic belts, together with distribution in a complicated and branching pattern of narrow zones, are well known.

Broad generalizations about this seismicity and its relation to geologic structures, involving specific interpretations of critical areas, have sometimes been supported by appeals to mapping on an extremely small scale, which allows confounding structures and epicenters perhaps hundreds of miles apart. The briefness of our adequate seismic history on the geologic time scale is often insufficiently considered, and conclusions drawn from present relative lack of seismicity in areas where field evidence, or even historical records, indicate greater activity in the immediate past.

Distribution in depth, even within the crust, is sometimes not considered, and eathquakes are discussed with respect to surface structure as if the latter could be expected to continue vertically down without appreciable dip or other complication in three dimensions.

RIEDEL, WILLIAM R., Scripps Institution of Oceanography, University of California, La Jolla, Calif.

GEOLOGICAL AND GEOPHYSICAL IMPLICATIONS OF MOHOLE PROJECT

The technical success of the experimental drilling phase of the Mohole Project, in 11,700 feet of water, 40 miles east of Guadalupe Island, in March and April, 1961, has provided a new tool for geological and geophysical studies of the ocean floor. Cores were obtained from the 550 feet of Late Tertiary sediments and 44 feet of basalt penetrated there—some of the results of investigations on that material (not available for quotation at the time of preparation of this abstract) will be reported at the March meeting. Samples obtained from the deep crust under ocean basins in later phases of this project may be expected to provide data on changes through time in the amounts and proportions of materials removed from continents (essential for considerations of geochemical balance, and hitherto available only for post-Cretaceous), on the origin of major submarine topographic features, and on biological history during the Lipalian interval. Samples of the mantle should contribute to our understanding of the processes of differentiation of crust, mantle, and core, the evolution and possible mobility of continental and oceanic crusts, and physical properties involved in geomagnetism and other major geophysical phenomena.

ROBINSON, ROBERT B., Sinclair Research, Inc., Tulsa, Okla.

TEXTURAL CLASSIFICATION OF RESERVOIR ROCKS

The porosity of a reservoir rock is best described by the size, shape, and arrangement of the pores comprising this porosity, rather than in terms of gross per cent. It is as important for a petroleum geologist to be able to predict the probable producing characteristics of a reservoir rock as it is for him to know the precise location of a new reservoir. With this in mind, a textural classification of reservoir rocks has been devised to assist well-site geologists in differentiating producing from non-producing zones in a reservoir body. The classification is based on an empiric association between rock textures as viewed on a polished surface and producing characteristics as determined by capillary pressure, porosity, and permeability measurements.

RODDA, PETER U., DIETRICH, JOHN W., AND FISHER, W. L., Bureau of Economic Geology, University of Texas, Austin, Tex.

QUANTITATIVE STUDY OF *ATHLETA PETROSA* STOCK IN EOCENE OF TEXAS

Based on qualitative study of the gastropod genus *Athleta* in the Eocene of Texas, two species are recognized—*Athleta tuomeyi* Conrad, 1853, in the Wilcox Group, and *A. petrosa* (Conrad, 1833) in the Claiborne and Jackson Groups. *A. petrosa* is divided into four successional subspecies and three divergent subspecies.

A statistical study was made of about 1,500 specimens from 49 localities to provide quantitative confirmation of some of the qualitative conclusions. Five parameters were measured: height, maximum width, height of spire, number of columellar folds, and number of spines on the body whorl. A program was prepared for the Control Data Corporation 1604 Computer for the calculation of 20 combinations (sums and ratios) of the parameters of each individual and for the calculation of mean and standard deviation of each parameter and combination by localities. More than half of the combinations appear to be significant.

A distinct separation of *A. tuomeyi* is shown in several significant computations. Mixtures of successional and divergent subspecies of *A. petrosa* are apparent. Within the successional subspecies, there is a rapid change in measured and significant computed values from the Reklaw subspecies to the Weches subspecies, very little change from the Weches subspecies to the Cook Mountain subspecies, and a rapid change from the Cook Mountain subspecies to the Jackson subspecies. Geographic variation generally is insignificant.

ROEHL, P. O., Shell Oil Company, Denver, Colo.

OIL-BEARING ANALOGS OF MODERN CALCAREOUS SEDIMENTARY FABRICS IN LOW-ENERGY ENVIRONMENT

Examples are presented of reservoir rocks taken from Stony Mountain (Ordovician) and Interlake (Silurian) producing formations in several oil fields situated on the Cedar Creek anticline, southwestern Williston basin. In lower Paleozoic time the basin was dominantly covered by epeiric seas in which were deposited shallow-water, intertidal, and supratidal carbonates of distinctive facies and fabric. These deposits are now dolomite in which intercrystalline porosity predominates. However, the delineation and extent of the latter is strictly controlled by original facies fabrics, the character of which is favorably comparable with modern tidal-flat and low-profile supratidal deposits reported for Florida and the Bahama Islands.

A generalized working model of facies relationships is presented showing the proposed environment of deposition and some of the kinds of fabrics in which producible oil has been found. Most of the important oil-bearing fabrics suggest combined organic and inorganic processes in zones of low hydrokinetic potential, viz., pelleted and laminated muds and silts; burrowed, bored, and reworked muds and silts; algal mats and stromatolites; flat-pebble conglomerates; and endogenic and (or) solution breccias. Leaching of fossils and anhydrite in certain cases has accentuated and improved pore structure.

ROSENFELD, MELVIN A., Pure Oil Company Research Center, Crystal Lake, Ill.

GEOLOGY REACHES COMPUTER AGE

That geology, at least in some areas, has reached the computer age is evidenced in the symposium we are holding at this time. The five symposium papers describe a variety of today's computer applications in geology and exploration. This paper attempts to provide a background of computer information as a framework for the other papers.

In this symposium we are using the word "computer" in its broadest sense to include the actual general-purpose electronic digital computer, its associated data processing equipment such as key punches, sorters, tabulators, and reproducers, and also specialized data-gathering input and graphical output equipment. Actually we are considering whole "systems." Much of geological work may be done on associated machines other than the actual computer.

The electronic computer itself is the core of any system; it is one of the most dramatic and significant developments of our time. Capable of performing arithmetical and logical operations at extremely high speeds and of storing vast quantities of data, the computer provides geologists with opportunities to solve problems unapproachable a decade ago.

It is estimated that there are 10,000 digital computers installed and in use today. Oil companies are well equipped and, in most cases, their computers are available for exploration work. Service bureaus and consultants provide computers and programming help for use of smaller companies and individuals. No geologist is very far from a computer today. These devices are easy to use and should present no learning problems greater than the use of any new exploration technique or equipment.

The computer is not a magic black box; it is thoroughly understandable. We may consider it simply an extension of part of the human mind just as we consider the geology hammer an extension of the hand, the microscope an extension of the eye and the seismograph an extension of the ear. Fear or resentment of the computer decreases as familiarity increases.

There have been raised in some quarters, however, real moral issues involving the dehumanizing effect of computers. These have been in particular reference to military work and should not be of concern in geology.

ROSS, CHARLES A., Illinois State Geological Survey, Urbana, Ill.
SABINS, FLOYD F., JR., California Research Corporation, La Habra, Calif.

FUSULINID ASSEMBLAGES FROM LATE PENNSYLVANIAN AND EARLY PERMIAN OF SOUTHEASTERN ARIZONA

The varied fusulinid faunas of the late Pennsylvanian (Virgilian) and early Permian (Wolfcampian) parts of the Naco Group and the Earp Formation can be divided into five assemblage zones. The lowest zone is characterized by *Triticites cullomensis* and occurs in early Virgilian strata disconformably overlying middle Desmoinesian beds. This early Virgilian sequence is overlain by a zone of middle to late Virgilian fusulinids, *Triticites ventricosus sacramentoensis* and *T.* cf. *T. plummeri*, that occurs in the uppermost beds of the Horquilla Limestone and ranges into the lower 20–235 feet of the Earp Formation. From the fusulinid distribution and the transitional lithologic features it appears that the top of the Horquilla Limestone and the base of the Earp intertongue laterally.

The succeeding 540 feet of the Earp Formation contain a fusulinid assemblage of *Triticites* and *Schwagerina* characteristic of the Bursum Formation of New Mexico, the Admire Group of Kansas, and Pueblo Formation of north-central Texas. Of particular interest is the nearly complete transition from *Triticites* into *Schwagerina* in the lower part of the Earp Formation. Overlying these beds are 1,200 feet of limestone and shale having a *Pseudoschwagerina* and *Triticites* assemblage closely similar to that from the Neal Ranch Formation (early Wolfcampian) of the Glass Mountains, Texas. The succeeding 300 feet of limestone beneath the red shale and cross-bedded sandstone at the top of the Earp Formation have *Pseudoschwagerina* and advanced species of *Schwagerina* that bear similarity to the fusulinid fauna from the Lenox Hills Formation (late Wolfcampian), Glass Mountains, Texas.

ROTHWELL, W. T., JR., Richfield Oil Corporation, Long Beach, Calif.

IMPORTANT FACTORS FOR MICROPALEONTOLOGIC INVESTIGATION IN PETROLEUM GEOLOGY

Three factors are vital in successful paleontologic investigations in petroleum geology. These are: (1) collection of the fossil groups by paleontologists with knowledge of the total fauna, its ecologic associations, and lithologies in which preservation is best; (2) processing of samples in laboratories closely supervised by paleontologists to insure effective recovery of fossils of each group; (3) accumulation and evaluation of data employing the whole spectrum of fossil and mineral content of the sediment, gathered by geologically and paleontologically trained personnel.

Diagrams and charts are presented showing (a) the fossils commonly used in petroleum geology grouped into surface and subsurface categories; (b) the environmental, lithologic, and bathymetric interrelations that affect the use of important fossil groups in stratigraphy; and finally (c) a procedure is suggested for paleontologic investigation, and reporting of data in petroleum exploration.

SABINS, FLOYD F., JR., California Research Corporation, La Habra, Calif.

STRATIGRAPHY, PETROGRAPHY, AND PALEOECOLOGY OF BISTI STRATIGRAPHIC TRAP, SAN JUAN BASIN

Bisti field produces from bar sands of the Gallup Sandstone (Upper Cretaceous), which consists of the following units. The non-productive Main Gallup Sandstone is a regressive sandstone that grades downward and laterally into marine Mancos Shale. The Main Gallup Sandstone contains the offshore sand facies and the beach sand facies. Overlying the offshore sand facies are three productive bar sands with a distinctive low SP interval at their base. The bars have flat bases, convex tops, and form a complex more than 30 miles long, 3 miles wide, and 40 feet thick. Seaward (northeastward) the bar sands grade into the fine-grained fore-bar facies. Landward (southwestward) they grade into the back-bar facies. Overlying the entire Gallup Sandstone is the "Upper" Mancos Shale.

The beach sand facies is medium-grained sandstone that lacks glauconite and primary dolomite grains. The offshore sand facies is very fine-grained sandstone with abundant primary dolomite grains. The low SP interval consists of sandy shale. The bar sands consist of sub-