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. gerontica, 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 neoecology and from statistical analyses of palynological assemblages. The environmental factors generally sought are physiography, hydrography, temperature, moisture, and substrate. Their determination involves an analysis of fossil origin, preservation, identification, association, relative abundance, and successional occurrence. Palynological fossils in a deposit are commonly derived from more than one ecology and are transported to the place of burial by gravity, wind, water, or some organic vehicle. The lithofacies in which the fossils occur are indicative of the environment of preservation and, in many cases, of the physiographic-hydrographic relations. Identifications of palynomorphs can be made at the phyla level and are valid paleoecological indicators but, with narrower taxonomic recognition, the fossils become increasingly useful in environmental studies. Specific determinations and natural-affinity associations give the best paleoecological criteria for the recognition of distinct environments. Consistent association of certain palynomorph species may be indicative of certain ecological conditions, and their relative abundance can indicate the stage of regional or local environmental development. Relative abundance, however, must not be construed as indicating the absolute abundance of the parent plant or animal from which the palynomorphs were derived. The abundance of individual fossils observed may be governed by the number of spores, pollen, statoblasts, etc. produced by the parent organism, manner and distance of transport to the place of burial, type of preservation, diagenesis of the sediments, and techniques of recovery from the rock for study. Successional stages of palynological assemblages in a stratigraphic section are related to many factors and, where these are recognized, the successional stages can indicate environmental conditions not otherwise apparent.

Pleistocene paleoecological studies give clues to techniques that may be used in Tertiary and Upper Mesozoic investigations. This is especially true if the fossils have recognizable natural affinities. When dealing with Paleozoic and Lower Mesozoic palynomorphs there are problems of organic evolution. These make environmental determinations difficult, and more empirical ecological techniques are required than with the younger fossils. Although the resulting environmental conclusions are mainly hypothetical, this information has been found useful in biostratigraphic studies.

WORNARDT, W. W., California Academy of Sciences, San Francisco, Calif.

Stratigraphic Distribution of Diatom Floras in Type Monterey Formation and in "Sisquoc" Formation of Santa Maria District, California

The upper member of the typical Monterey Formation near Del Monte and Monterey, California, bears a distinctive diatom flora of at least 288 species. Most of these diatoms are bottom-dwelling forms; only a few are sessile. This flora is of Delmontian (late Miocene) age.

In the "Sisquoc" Formation along Harris Grade near Lompoc, Santa Maria District, three diatom floras may be distinguished: all are younger than the Delmontian flora of the upper typical Monterey, but only about 150 species occur. Pelagic forms are most numerous in the older and middle of these "Sisquoc" floras whereas bottom-dwellers, both free and attached, increase upward through the sequence, being most common in the youngest of the floras.

All four of these distinctive diatom floras have been found over an extensive area in the California Coast Ranges. They occur from Monterey in the north to Taft in south-central California and to Santa Barbara in the southwestern part of the state.

WRAY, JOHN L., The Ohio Oil Company, Denver Research Center, Littleton, Colo.

Palynology of Paleozoic Rocks of Libya

Marine sediments were deposited in western Libya during most of Paleozoic time. The resulting rock section consists of a thick sequence of detrital rocks, largely dark gray shales and sandstones, ranging in age from Cambrian to Permian. A high proportion of the fine-grained rocks in all of the Paleozoic systems contain spores, pollen, hystrichospheres, and (or) chitinozoans.

Various hystrichospheres occur in most of the marine Paleozoic rocks. Although some hystrichospheres are stratigraphically significant throughout the Paleozoic, they are particularly important in the Cambro-Ordovician section, where pollen and spores are absent. Chitinozoans are found most commonly in Silurian and Devonian strata.

The earliest occurrence in Libya of spores of vascular plants is in rocks of Early Silurian age. The Silurian microflora is dominated by smooth trilete spores. Spores constitute less than 10 per cent of the total palynological assemblage in the lower part of the Silurian, but generally comprise a larger proportion of the total assemblage in upper Silurian rocks; the remainder of the population is composed primarily of hystrichospheres.

An abundant and diverse microflora is encountered in Devonian rocks. This assemblage is characterized by trilete spores with a variety of sculpturing and ornamentation. Smooth, spinose, and reticulate spores are common, as are zonate and monosaccate spores. Trilete spores with radiating ridges are also found.

The Carboniferous microfloral assemblage is distinguished by spores with an equatorial flange, triangular zonate spores with distal spines, trilete reticulate spores, and monosaccate forms.

The frequent occurrence and excellent preservation of these palynological assemblages, commonly where other fossils are rare or absent, permit zonation and correlation of Paleozoic strata in Libya. These rocks also provide a source of material that can contribute to an over-all understanding of the stratigraphic ranges, evolution, and phylogeny of spores, pollen, and certain groups of microplankton during Paleozoic time.

Representative microfossil assemblages are illustrated together with range charts showing the stratigraphic distribution of the more common and diagnostic forms.