several meters to more than 18 meters was raised from the ocean floor between Panama and Antofagasta, Chile. Sediment types represented in the cores are silty and sandy lutite of terrigenous origin, globigerina ooze, and red clay. A variety of bottom environments was sampled, including those from the continental slope and rise, trenches and marginal basins, and the Carnegie and Nasca ridges.

Shear strength was measured aboard ship with a Swedish Fall Cone Penetrometer at 20-cm. intervals down the length of the core immediately after extrusion from the core pipe. Bulk and dry density, moisture content, porosity, and particle-size distribution were determined for each lithologic unit represented in the core. These data are correlated with bottom and sub-bottom reflecting horizons identified on the records of the precision echo sounder.

The data indicate that strong acoustic reflectivity is obtained at the boundary between a lithologic unit of low shear strength and an underlying layer of relatively high shear strength. Zones of high shear strength are characterized by lower moisture content and porosity, and by an increase in the coarse size fraction. Layers of volcanic ash and layers of manganese oxide were identified as strong reflecting horizons. At least one reflecting layer identified in the cores could be identified for several hundred miles, and other reflecting horizons for shorter distances. A layer of volcanic ash just a few centimeters thick was sufficient to provide a strong reflecting horizon.

Although the porosity of the sediment differed from core to core, there was no significant decrease in the porosity or moisture content with increasing depth below the bottom in a single core. This suggests that little if any compaction of the sediment has occurred within the zone that was sampled. However, in several cores there was a gradual increase in shear strength with depth.

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Porosity Changes During Lithification from Unconsolidated Carbonate Sediment to Consolidated Limestone

As carbonate sediments are lithified to limestone, two major porosity changes commonly occur. First, interstitial pore space is partly or, less commonly, totally obliterated as the grains are bound together; second, moldic porosity usually is developed. In sediments devoid of $CaCO_3$ mud, porosity development tends to be more pronounced than porosity elimination; yet preliminary studies indicate that, where $CaCO_3$-mud matrix is found, the moldic pore space is more likely to be retained. Moldic porosity is formed by the dissolution of aragonitic grains which are abundant in shallow-water marine sediments, but is not formed at the expense of grains composed of the two types of calcite (high-magnesian and low-magnesian). Aragonite and both types of calcite are synthesized predominantly by organisms. Because different biologic groups selectively synthesize carbonate material of either aragonite or one of the two types of calcite, a predictable relation exists between biological activity and the tendency to form moldic porosity.

The tendency for aragonitic grains to develop porosity is variable. Shell material is more strongly affected by dissolution and consequent moldic porosity development than are the more finely crystalline oöids, which may resist dissolution. Yet, oöids are more likely to form moldic ("oömoldic") porosity than are pelletal and cryptocrystalline grains. Where the process of diagenesis continues, the newly created pore spaces are occluded by drusy calcite mosaic.

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Nannofossils from Upper Cretaceous of Texas

Eight samples from the Upper Cretaceous of the northwestern Gulf Coast were studied intensively by electron and light microscopy. The samples, ranging in age from Eaglefordian to Navarroan, yielded 93 species, of which 35 are new. All are assignable to 31 genera, of which four are new. Most of the species and genera fit readily and naturally into a small number of higher taxa. Forms are distinguished primarily on the basis of gross morphology and secondarily on variations visible only by using crossed nicols on a light microscope or an electron microscope. Reworking of specimens is common with the result that a reliable zonation must be based on the entire assemblage including relative abundance of all species.

The Eaglefordian sample is characterized by two elliptical, placolith-like species related to the genus *Coccolithus*, which is rare or absent in younger deposits. *Arkhangelskiella*, *Cribrosphaerella*, *Marthasterites*, and *Micula*, four typical Upper Cretaceous genera, are lacking. The middle part of the Austin Chalk is marked by the first occurrence of *Lucianorhabdus cayeuxi* Deflandre, *Micula decussata* Vekshina, and a new species of *Zygodiscus*. The first occurrence of *Cretarhabdus? decorus* (Deflandre) and abundant specimens of *Microrhabdulus* mark the upper part of the Taylor Marl. The late Navarroan is distinguished by the appearance of *Lithraphidites quadratus* Bramlette and Martini and a new genus apparently related to *Arkhangelskiella*. *Lucianorhabdus cayeuxi* Deflandre and several new species common to both the Austin Chalk and Taylor Marl are absent.

Many of the species appear to have notably restricted stratigraphic ranges and wide geographic distribution. Nannofossils, therefore, are a good criterion for refined zonation and intercontinental correlation.

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Foraminiferal Species Diversity Distributions, Eastern Gulf of Mexico

Species diversity is a mathematical expression of the internal variability of biotic communities. It is a relative measure of the degree of concentration of species within an assemblage. Diversities have been calculated for each of more than 400 death accumulation-samples of benthonic Foraminifera from the eastern Gulf of Mexico. Diversities were calculated for each sample, based on previously published population data, using the reciprocal of Simpson's (1949) modification of Yule's (1944) statistic,

$$\frac{N(N-1)}{\text{Diversity}\sum_{i=1}^{K} n_i(n_i-1)},$$

where N is the total number of individuals counted, n_i is the number of species of the i-th species, and K is the number of species.

In recent years many writers have presented various measures dealing with the relative concentration or variety of species in biologic communities. The results of these studies suggest a high degree of order in community structure. This order is expressed by a regular arrangement of population elements into a definite hierarchal pattern characterized by dominants in association with a progressively diminishing number of subsidiary species. In populations of high diversity, differences between the numerical census of dominant and subsidiary species is low. Low-diversity populations have low variety, and census differences between dominants and subsidiaries are great. Various explanations have been proposed to account for these differences as well as the order in biotic communities. The responsible agents have been most frequently characterized as being the results of adjustments caused by intra- and interspecific competition, successional development, and trophic relationships. The writer believes that these processes are important ultimately only when the ecologically defining factors within the environment are limited to little variation.

Foraminiferal diversity distributions in the eastern Gulf of Mexico are offered to support the contention that population complexity is primarily a function of variability in environmental conditions. Maximum diversity is confined to the continental slopes, and isodiversity contours from the edge of the shelf seaward follow bathymetric contours. Isodiversities on the continental shelf are variable and register bottom topography and the net effect of prevailing current and wave forces.

Statistical error plotted for the calculated species diversities is below 10 per cent. Because population variety is limited by the degree of variability in the mechanical and non-mechanical ecologic factors characterizing the environment, diversity plotted in relation to depth alone shows no correlation.

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Early Diagenesis and Mass Properties of Siliceous Oozes

Three piston cores, 22–26 m. long were taken in a relatively undisturbed condition during 1964 in the southern Pacific Ocean in about 5,200 meters of water by the U.S.N.S. *Eltanin*. All were of approximately the same siliceous-ooze lithology. Shear-strength (cohesion) measurements were made at those depths in all of the cores where samples were taken for measurement of water content, texture, mineralogy, and geochemistry. Similar measurements were made on a 6-m. core of calcareous ooze from 4,000 m. of water for comparison. Statistical analysis of 13 variables of the grouped data from the long cores shows that 41.60 per cent of the variation in cohesion is accounted for by the following, in order of their relative importance as ranked in multiple regression: depth in core (20.88%), $CaCO_3$ content (9.0%), silt content (3.07%), water content (5.16%), sand content (1.62%), and sorting (1.87%). In the calcareous ooze, core cohesion varies only as depth (63.91%) and the ratio chlorite: illite (24.19%). All cores show a decrease in water content and an increase in cohesion with depth. The siliceous ooze shows a progressive degeneration in its matted texture with depth, which is attributed to the solution of opaline tests and an attendant growth of the following authigenic minerals, as identified by X-ray diffraction: K-feldspar (microcline, orthoclase, and anorthoclase); Na-feldspar (albite and oligoclase); quartz; amphibole; phillipsite; clinoptilolite; dahlite (?); and wilkeite(?) and montmorillonite.

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Local and Interregional Distribution of Late Paleozoic Cephalopods

Despite the ability of cephalopods to move freely through the sea, their geographic distribution patterns tend to be restricted. Many genera but few species were widely distributed in the past. In fact, it is by means of distribution patterns at the generic level that most interregional correlations based on cephalopods are made.

Carboniferous ammonoids common to strata on both sides of the Atlantic Ocean in the Northern Hemisphere include: *Protocanites lyoni* (Meek and Worthen) in the late Kinderhookian and late Tournaisian; *Goniatites crenistria* Phillips in the late Meramecan and late Viséan; *G. granosus* Portlock and *Neoglyphioceras subcirculare* (Miller) in the early Chesterian and late Viséan; *Eumorphoceras bisulcatum* Girty, *Anthracoceras paucilobum* (Phillips), and *Delepinoceras bressoni* Ruzhentsev in the late Chesterian and early Namurian; *Branneroceras branneri* (Smith) in the Morrowan, middle Namurian, and Bashkirian; and *Politoceras politum* (Shumard) in the Desmoinesian and Westphalian C. These few species constitute the principal "pegs" on which the correlation framework is hung. Apparent lack of species common to both sides of the Atlantic in Late Pennsylvanian and Permian deposits may result from more complicated sutures, which make differentiation in these ammonoids easier to establish.

Nautiloids generally tend to have greater stratigraphic ranges than ammonoids, but some were just as restricted stratigraphically and equally distributed geographically as some ammonoids. A few coleoids also had moderately extensive geographic ranges.

Factors that probably influenced cephalopod distribution include swimming and feeding habits, reproduction, buoyancy, sea-water properties (pH, salinity, other chemical features of the sea water, and prevailing currents), physical barriers, and type of bottom.

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Physical Techniques of Correlation Applied to Upper Ordovician Rocks of Southeastern Indiana[1]

For more than 60 years, formations of Late Ordovician age in southeastern Indiana have been identified on the basis of the contained fossils. Unpredictable variability of the rocks has been given as the reason that lithologic criteria were not used. It is true that individual beds are not persistent laterally, but groups of beds can be traced by using electric and other geophysical logs, quantitative insoluble-residue logs, and

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