debris. In turn, this bioclastic member grades upward into calcarenite composed of particles of limestone. Basal arkose of unit D overlies the calcarenite.

Unit B, insofar as exposed, and unit D show this same sequence of rocks, although there are differences in the proportion of red beds.

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MAGNETISM OF THE EARTH'S CRUST AND THE EARTH'S INTERIOR

Power spectrum analyses of the geomagnetic field over the earth's surface show that the field fluctuations of wave lengths shorter than about a thousand kilometers are connected mostly with the geological structure of the earth's crust. Possible interpretations of the relation between geological structure and the surface geomagnetic anomalies are demonstrated by referring to fairly detailed maps of geology, geomagnetic anomaly, and Bouger anomaly of the gravity field over Japan Islands as well as magnetic properties of various rocks. Special attention is drawn to the absolute importance of natural remanent magnetization of rocks for this kind of interpretation.

It seems likely that geomagnetic anomalies of wave lengths from several hundred kilometers to several thousand kilometers are related to the distribution of continents, to the variation of thickness of the earth's crust, and to the undulation of isothermal surfaces in the earth's upper mantle. Geomagnetic field fluctuations of larger scale seem to be attributable to the electric eddy currents just beneath the surface of the earth's core.

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SOME ASPECTS OF LOWER GODAVARI RIVER AND DELTA SEDIMENTS, INDIA

To study the progressive changes along a river and to delineate sedimentary environments based on variations in the litho- and chemo-facies, 400 recent sediments from the fluvio-marine environment of the Godavari were collected in the pre- and post-flood seasons.

The present river morphology is a manifestation of the bed load material. Higher silt-clay ratios increase the degree of sinuosity and decrease the width/depth ratios of the channels. Decrease in the sinuosity of the river course in the last one hundred years is probably a result of the coarsening in the bed load.

Mean size decreases and coefficient of sorting increases progressively along the river course; skewness changes from positive to negative while kurtosis remains constant. These changes are probably attributable to the decrease in the energy levels downstream.

Heavy mineral percentages are directly proportional to the mean size of the sediments. Heavy minerals indicate a predominantly igneous (acidic) and high-grade metamorphic (khondalite, calc-granulite, and amphibolite) provenance. Few authigenic and rounded zircons are considered secondary. Downstream increase of pyroboles and sillimanite, and decrease of opaques and garnets, is apparently due to sorting based on shape and density.

Delineation of sedimentary environments based on conventional size measures has been partially successful. Similarity in the backwater and marine shoal sediments north of the river confluence indicates that the former was a part of the open sea.

Phosphate, uranium, and iron concentrations were determined in the clay fractions. Phosphate and iron are highest in the marshes. Iron concentration decreases in the backwater and is least in the river channels. Preliminary data show higher uranium content in the upper river.

X-ray analyses show illite, chlorite, and Na-montmorillonite increasing and Ca-Na montmorillonite and kaolinite decreasing from the fluvial to the marine environment. Na-montmorillonite is more predominant in the swamps and illite in the backwater.

The hydrographic data collected are being processed to understand the physico-chemical conditions of deposition.

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DIAPIRIC STRUCTURES IN THE DIABLO RANGE, CALIFORNIA

The Diablo Range is one of the northwest-trending central Coast Ranges of California. It is a complexly-faulted, asymmetrical anticlinorium structurally bounded on the west by the San Andreas fault and on the east by the San Joaquin Valley. Its core consists of the Late Jurassic Franciscan Formation and intruding serpentine. These rocks were formed in an extremely deep and narrow eugeosynclinal trough directly on a simatic base. Younger, flanking rocks, locally overturned, are of Early Cretaceous to late Pliocene age. Core rocks crop out (1) as faulted slivers in the San Andreas fault zone and (2) as piercements along the crest of the principal anticlinal axis.

A major diastrophic episode closed the Jurassic period, broad folding took place late in the Cretaceous, and local uplift occurred in late Miocene time. The piercements transected rocks of the anticlinal crest in late Pliocene and early Pleistocene time.

The diapiric structures are the result of intense compression of a thick sedimentary wedge, accompanied by great vertical movements in a series of intermittent orogenies. Sheared serpentine played an important part in final emplacement. In the broad view, these structures are but detail in the great fault features of western California which developed at the continental margin while faulting, folding, and intrusion took place during thrusting of the simatic sea-floor materials under the sialic edge of the continent.

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VISCOUS PROPERTIES AND CREEP OF SALT

Experiments by Nettleton and others to simulate salt dome formation by means of superposed viscous liquids have clearly demonstrated that gravitational instability provides a physically sufficient explanation of the origin of these structures. In the hydrodynamic theory of stability of a layered sequence, exceedingly high viscous parameters must be used. Very few reliable direct measurements of the viscosity of rocks, obtained in the laboratory under realistic conditions of strain rate, pressure, and temperature, are available. The reason is that creep is a complex phenomenon, part of which is of a transient nature. Most creep rates measured for rocks and cited in the literature refer to transient creep and are probably of little value with regard to a determination of rock viscosity. Only the steady-state creep be-

havior allows such a determination. It is encouraging that a survey of those experiments in which steady-state creep of salt and other rocks was measured reveals viscosity parameters which, when used in hydrodynamic theory, explain in a satisfactory manner the geometry and growth rates of salt structures observed in many areas of the world.

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PLANKTONIC FORAMINIFERA, PALEOECOLOGY, PALEOGEOGRAPHY, AND CORRELATION

Studies of the species composition of Paleocene and early Eocene planktonic foraminiferal faunas from selected sections in the Atlantic and Gulf Coastal Plains, Trinidad, and South India show that recognizable faunal differences occur in a longitudinal direction as well as in a latitudinal direction. These data indicate that it is possible to identify and delineate paleo-faunal provinces.

These studies also show that the stratigraphic ranges of planktonic foraminiferal species may differ along lines of latitude and longitude. This raises questions concerning the use of these fossils for detailed intercontinental and regional correlations. There is no one standard section that shows world-wide faunal sequences. The local stratigraphic range (*teilzone* of Arkell) of a species is most important and useful for stratigraphic work. The planktonic foraminiferal sequences of each stratigraphic section simply reflect the pattern of faunal changes that occurred on a local or regional basis.

Analysis of the species composition of fossil planktonic foraminiferal faunas and the stratigraphic ranges of species from many local sections can lead to important data on faunal migration and species dispersal. A more detailed understanding of the evolutionary history and of the intercontinental correlative value of fossil planktonic Foraminifera will result from such studies.

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FAUNAL ZONES OF THE PALEOCENE AND EOCENE GEOLOGIC SECTION ALONG CHATTAHOOCHEE RIVER, ALABAMA

The stratigraphic interval from the top of the Upper Cretaceous Providence Sand to the bottom of the upper Eocene Ocala Limestone, extending 49 miles along the Chattahoochee River, was studied and sampled. The section, more than 600 feet thick, can be correlated with the standard section in central and western Alabama by means of fossil zones. Each of the eight formations studied contains beds with distinctive guide fossils.

The Paleocene Series is represented by a limestone facies that contains a more poorly preserved fauna than the equivalent argillaceous facies of western Alabama. The upper Paleocene (Naheola Formation) is absent in eastern Alabama. The lower Eocene Series is lithologically and faunally similar to its equivalent farther west. The middle Eocene Series is more calcareous than in western Alabama. The lower Lisbon (Winona equivalent) and the Gosport Sand are absent. The upper Eocene Series is represented by a limestone facies of the Moodys Branch Formation and Yazoo Clay of western Alabama.

Foraminiferal zones established for the geologic section on the Chattahoochee River conform closely to the macrofossil zones.

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RECENT PEAT DIAPIRS IN THE NETHERLANDS: A COMPARISON WITH GULF COAST SALT STRUCTURES

Several peat diapirs, three to four feet high, were observed in Recent sediments of the Flevoland. The peat was deposited approximately 7,000 years ago on an eroded Pleistocene surface. Four to six feet of sediments which overlie the peat include, beginning with the oldest, *Unio* Clay, Young Peat, *Cardium* Clay, and Almere and Zuiderzee deposits. On the flanks of several elongate Pleistocene sand ridges, diapiric folds and related structures, similar to Gulf Coast structures, exist in the Recent deposits. The structures most like those of the Gulf Coast are down-to-the-basin normal faults, rim synclines, and, in one case, a central graben. These diapiric folds exist where the dip of the onlapping Recent sediments increases along the sand ridge flanks. The folds probably resulted from peat flowage down the sand ridge slopes.

The time of diapirism can be dated as about 1,000–1,500 A.D., because the overlying Zuiderzee deposits (1,600 A.D.) usually are not involved.

Although these small-scale diapirs resemble some Gulf Coast salt domes, they differ in two principal ways: (1) a shorter time for formation (500 years maximum) and (2) a negligible sedimentary overburden (four–six feet) when diapirism occurred. Nevertheless, the Flevoland diapirs suggest a possible mechanism of origin for salt diapirs on buried basement topography early in the history of the Gulf Coast geosyncline.

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SEDIMENTATION IN ARCTIC WATERS

Bottom studies involving physiography, sedimentation, and paleontology indicated that there was pre-Pleistocene fluvial erosion when the land stood higher relative to sea level, followed by modification of trunk systems by valley glaciers, then submergence of much of the archipelago, and finally emergence. Tertiary headlands are still submerged more than 400 meters. Following these physiographic and crustal events, Arctic sedimentation occurred.

Sediments from lake, river, delta, protected bay, channel, and ocean environments were studied. River and delta environments were selected as classical depositional sites, and others were interpreted from this norm. In fluvial deposits, a direct relationship of decrease in size of detritus with distance of transport occurs together with reduction in percentage, mean size, and number of heavy mineral species. Where river gradients lower abruptly, sedimentary particles decrease immediately from gravel to sand and silt. In deltas, decrease in size is exponential with distance of transport, and deposits consist chiefly of silt and mud. There, contours on lithofacies maps protrude seaward over bathymetric contours indicating prograding of clastic sediments due to marine regression or relative crustal uplift.

Offshore, no progressive variation in texture exists, due to occurrences of ice-rafted material and lack of sufficient currents. Where currents exist, as in mid-channel areas, sediments are better sorted. Thus, anomalous distributions of sediments arise wherein nearshore deposits in channel areas consist of fine material, but in mid-channel areas they are coarser. Occurrences of coarse marine sands off seaward tips of islands are