

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, PALEO-GEOGRAPHY, 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 (Nahola 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 Moody 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 near-shore 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

due to reworking of the submerged clastic Beaufort Formation cropping out along the western Arctic coast, and to occurrences of drowned headlands consisting of unconsolidated coarse materials.

Spectrochemical analyses indicate that certain elements and clay minerals in bottom sediments are related to nearby geological formations and that the clay minerals are detrital. This indicates past rigorous physical conditions with negligible chemical activity.

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#### THE SALT PLUGS OF SOUTHERN IRAN

The distribution of the south Persian salt plugs has encouraged observers in the past to connect these plugs with diagrammatic lines, suggesting deep-seated linear structural weaknesses. Little has been said about the associated anticlines, particularly as to whether or not they reflect the presence of an extensive, deep-seated salt body.

It is suggested in this paper, that the nature of the prominent 'whale-back' anticlines in the salt-plug region of the southern part of the province of Fars reflects the existence of an incompetent layer of salt at depth. Anomalous swings of strike and possible rim synclines give a characteristic pattern to the salt-plug area. This pattern contrasts strongly with an area in N.W. Iran (Lurestan) which, although having similar 'whale-back' anticlines, lacks anomalies of strike, and shows no surface outcrops of salt.

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#### FLUID-RELEASE MECHANISMS IN COMPACTING MUDROCKS AND THEIR IMPORTANCE IN OIL EXPLORATION

Our current knowledge of clay colloid chemistry and clay mineralogy was applied in an investigation of the mechanisms by which water escapes from muddy sediments. The alteration of montmorillonite to illite after deep burial involves the transfer of large amounts of water from bound positions on montmorillonite to interparticle areas where it has an important bearing on the porosity, permeability, abnormal fluid pressure, and the initial release of hydrocarbons from mudrocks.

In contrast to montmorillonitic deposits, water is compacted out of illitic deposits very soon after burial, before the formation of hydrocarbons comparable to those found in reservoirs. The development of shale source rock requires the initial deposition of a montmorillonitic organic mud, and its subsequent alteration after deep burial to illite. These requirements are of decisive importance in the exploration for oil in new areas.

A considerable reduction in density accompanies the desorption of the last few monomolecular layers of water from montmorillonite during its diagenesis to illite, and the associated volume increase could easily account for the abnormally high fluid pressures so often encountered in drilling operations.

The new compaction theory enables us to give meaningful interpretations to data on the bulk properties of compacting mudrocks.

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#### ENVIRONMENTAL SIGNIFICANCE OF FOSSIL ALGAE

During the past decade, a great deal of interest has

developed in the use of algae as environmental indicators. As a consequence, many fossils have been identified as algae in the published record and used as the basis for environmental interpretation. Some of these fossils may not be algae and others may be algae without environmental significance. This paper is a plea to paleontologists and geologists to be more critical in their identification and utilization of fossil algae. At the present state of our knowledge concerning these fossils, only a few can be used with any confidence for environmental interpretation.

Algae as a group may inhabit almost any environment. For example, coralline algae in the Recent seas range from the equator to the Arctic Ocean and from the intertidal zone to depths of several hundred feet. Too little is known regarding the distribution of modern genera and species to permit us to attach any environmental significance to the fossil forms.

Probably the most misused forms are the algal stromatolites. Structures of varying origins ranging from caliche to diminutive normal marine bioherms have been called algal stromatolites and interpreted as being intertidal in origin. This practice limits the usefulness of algal stromatolites for environmental interpretation.

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#### GEOTECHNICAL ASPECTS OF RECENT MARINE SEDIMENTS, OSLOFJORD, NORWAY

Improved fixed-piston and gravity-type, thin-wall corers designed and built at the Norwegian Geotechnical Institute were used to sample localities selected by a sub-bottom, echo-sounding survey in an integrated geochemical, geological, geophysical, and geotechnical investigation of the Oslofjord. Changes in mass physical properties, particularly grain size and bulk density, were correlated with near-surface acoustic reflections from specific sub-bottom strata. Shear strength of the fine-grained, cohesive sediment was measured in the laboratory using the new Norwegian unconfined compression apparatus and the Swedish fall-cone. The latter instrument is of particular value for the scientific study of the strength of soft, Recent marine sediments because of the small amount of material necessary for a valid test. Natural strength was found to be strongly influenced by the remains of polychaete burrows, the extent of which was demonstrated by radiography. Sediment sensitivities generally were medium to very sensitive, but in a few instances were quick. All material had normal fjord pore-water chlorinities (about 19‰), and the quick character of the clay appeared related to an abnormally high content of calcium carbonate. The sediments were underconsolidated above a depth of approximately one meter.

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#### PRESENT STATUS OF GEOLOGICAL STUDIES IN THE ALASKA RANGE

After more than one-half century of geological study in Alaska, the geology of the Alaska Range remains imperfectly known. This has resulted from emphasis on areas of greater economic potential, such as north of the Brooks Range and Cook Inlet. However, recent geological studies in the eastern Alaska Range by faculty and graduate students at the University of Alaska are now adding substantially to our knowledge of this region.