Some initial results of these studies are as follows: (1) a pre-Devonian polymetamorphic basement complex, including Precambrian granulite facies gneisses, has been located south of the Denali fault; (2) a stratigraphic interval containing approximately 12,000 feet of greywackes, thin limestones, and associated andesitic volcanics has been mapped and dated paleontologically as upper Mississippian and lower Pennsylvanian in age; and (3) a preliminary study of rugose and tabulate corals representative of the *Lonsdaleiidae*, *Cyathopsidae*, *Hapsiphyllidae*, *Favositidae*, and *Auloporidae* has been made and indicates that many forms are as closely related to Asiatic species as to described North American species.

Heretofore, rocks of Pennsylvanian age were believed to be rare or absent in the Alaska Range. Their presence in geosynclinal accumulations will require modification of existing concepts of the depositional history of this region. Additional paleontological study of these northern faunas may further modify and expand our present poor understanding of the paleogeography and faunal realms of the Carboniferous.

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NEARSHORE SANDS OFF SOUTHEASTERN VIRGINIA

In 1961 and 1962, SCUBA divers examined nearshore sands off southeastern Virginia and collected surface samples and 52 short cores, 2 inches in diameter and up to 4 feet long. The samples were analyzed by standard laboratory procedures.

Two relict populations were recognized: (1) a coarse-grained (median about 1.5 phi) brown sand; and (2) a fine-grained (median about 3.3 phi) gray sand. The brown sand exists principally in linear ridges, whereas the gray sand occupies lower areas between ridges. The two sands are found interbedded in layers up to 10 cm. thick in cores taken from the landward side of a nearshore submarine ridge off False Cape. Though both sand populations have been derived from reworking of older Pleistocene deposits, both contain abundant Recent shell debris.

Ripples covered the bottom continuously from just outside the surf zone outward to the outer limit of effective wave action, which varied from a line about 3 miles offshore in water 28 feet deep after a period of calm weather, to a line more than 9 miles offshore in water 71 feet deep after a moderate storm. Long axes of all active ripples measured were parallel to shore in spite of a 90-degree divergence (NE to SE) in direction of wave approach. Farther offshore ripples occur only on submarine ridges.

Differential impregnation of longitudinally cut core surfaces with epoxy cement revealed numerous primary sedimentary structures, chiefly cross-laminae of both normal and oversteepened dip and burrow structures.

Four stations were occupied in the summers before and after the intense storm of March, 1962. Cores collected here illustrate the principle of shelf sedimentation generally attributed to Barrell (1917) but first propounded by H. C. Sorby (1857) that a slow average rate of vertical accretion is combined with evidence of rapid deposition of individual layers.

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ANALYSIS OF THE SEDIMENTS FROM THE SUBSURFACE OF THE BOGRA AREA, BENGAL BASIN, EAST PAKISTAN

The Bengal Basin, located in East Pakistan and neighboring India, contains a stratigraphic section which can best be described as a basin-delta complex. Formations ranging in age from Gondwana (Upper Paleozoic) to Recent have been studied in cuttings and core samples from two dry tests. The samples were described and some were analyzed either mechanically or chemically.

Conclusions are that both the tectonic and the resulting sedimentary environments varied considerably during the deposition of this section. The older sediments deposited prior to the principal Himalayan orogenies were nonmarine. They differ greatly in lithologic character and in thickness. They were influenced by volcanic activity and continental glaciation. The Sylhet limestone (Eocene) can be interpreted as having originated in a fairly uniform marine environment. The growth of the Himalayas initiated a new and significant source of sediments and fluviatile and deltaic agencies of deposition predominated as they do at present.

The Sylhet limestone has yielded gas from several pools and appears to be the most likely, if not the only, possibility for future discoveries of hydrocarbons. However, there may be other marine deposits to the south, closer to or underlying the Bay of Bengal.

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SALT STOCK FAMILIES IN NORTHWESTERN GERMANY

In northern Germany there are more than 200 known salt stocks which are composed of Zechstein salt. Because of favorable geologic conditions, it was possible to reconstruct the historical development of the salt stocks with the aid of reflection seismic surveys. The development of a single salt stock appears to have started with an accumulation of salt, the so-called salt-pillow. At a later stage, the overlying strata broke, allowing the diapir to form. In northern Germany, genetic connections between salt stocks are recognizable. Some of the larger groups of salt stocks are classified as "salt stock families." Such salt stock families consist of a number of salt stocks grouped around the genetically oldest which is said to be the "mother salt stock." The rim synclines of the adjacent salt stocks become younger as their distances from the center increase.

The geological impulse causing the formation of mother salt stocks is supposed to be partly due to tectonics whereas the subsequent wave-front-like growth of the salt stock families took place in a purely halokinetic way, i.e., by the movements of salt under the influence of gravity. The absolute rate of the horizontal wave-front-like flow of the salt over large distances averages about 0.3 mm./year.

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IZA, AN UNUSUAL DIAPIR IN NORTH SPAIN

Interspersed among the gentle fold structures of the Cantabrian Mesozoic basin of northern Spain are at least 12 diapirs with cores of plastic Triassic shales, evaporites, and ophitic igneous rocks exposed at the surface. These occur in an S-shaped belt in a generally east-west direction over a distance of some 130 kilometers (80 miles). The Iza diapir is located in the extreme east portion of the basin at the eastern termination of the diapiric trend.

Surface evidence and seismic work plus the data from four wells drilled on the Iza structure have outlined this unusual diapir. Most diapirs in northern Spain are expressed on the surface as nearly circular depressions

representing the intrusive mass. The surrounding beds dip away from the central depression, often very steeply, to form a series of cuestas. In contrast, the Iza diapir is a buried wall or ridge of plastic rock at least five kilometers (three miles) long by less than 1.5 kilometers (one mile) wide intruded into a sedimentary section over 4,410 meters (14,470 feet) thick. Only the uppermost tip is exposed at the surface in a belt of indistinct outcrops up to 30 meters (98 feet) wide. One of the wells drilled on the structure encountered an inverted block of Upper Cretaceous sandstone above Paleocene carbonates, apparently incorporated into the diapir.

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SALT DEPOSITS AND STRUCTURE OF THE MARITIME PROVINCES OF CANADA

Aeromagnetic, gravity, and seismic surveys in the Maritime Provinces of Canada have provided extensive new information bearing on (1) the geometry of the depositional basins, (2) the distribution and shape of the major salt masses, and (3) the sub-salt structure.

The basins and uplifts exhibit a striking geometrical relationship of east- and northeast-trending elements that strongly suggest a shear pattern. This pattern was developed during the Acadian and possibly earlier orogenies. Large crustal blocks, bounded by faults, appear to have tilted and shifted, with rapid erosion and deposition during Mississippian and Pennsylvanian times creating large prisms of sediments which differ greatly in shape, size, and sedimentary facies.

Widespread deposits of rock salt, gypsum, and anhydrite exist in the Windsor Group (Upper Mississippian) in all the Maritime basins. The saline facies is interbedded and interfingered with thin limestones, red and grey shale, and coarse red clastics, and in a few places lies directly on the basement rocks. In the anticlines, notably those of northern Nova Scotia, western Cape Breton, and southern New Brunswick, the rock salt thickened greatly in the axial region of the folds and in places pushed through the overlying rocks to the surface. This sequence of thickening of the salt within the folds followed by diapirism is similar to that of the salt anticlines of the Paradox Basin and South Persia. Little is known about the original depositional thicknesses of the saline facies, but gravity data indicate wide differences in the amount of rock salt along the axes of the major anticlines. This may indicate the original pattern of salt deposition.

A thick section of sandstone and shale, plentiful oil shows, a basin-wide seal afforded by the evaporite section, and the large structural traps provided by the major anticlines combine to make the sub-salt Horton Group (Lower Mississippian) rocks a prime target for oil and gas exploration in these largely untested basins.

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GEOSYNCLINAL FILLING: SOME STRATIGRAPHIC-STRUCTURAL RELATIONSHIPS

A geosyncline does not develop by mere crustal sag but rather by movement along faults. Contemporaneous faults are known to have been active during development of the large Ouachita and Gulf Coast geosynclines and development of the small but active Los Angeles, Hanna, and Ardmore basins, which are tectonically similar.

The sedimentary fill of tectonically similar geosynclines, however, may be quite different. The Los Angeles Basin along the continental margin received thick turbidite deposits before it was filled to shelf depths. During its rapid subsidence, the Hanna Basin within the landlocked western interior filled with alluvial deposits. The Ardmore Basin during the late Paleozoic received shallow marine and coastal (paralic) sediments. Disharmonic folds involving the thick, ductile Springer-Goddard Shale indicate the influence of rock type in forming local structural features.

While the Springer Shale was being deposited in the Ardmore Basin, turbidites were being deposited along the length of the Ouachita geosyncline. After water depths shoaled, shallow marine beds of the Atokan were deposited. The over-all regressive sequence of the Tertiary in the Gulf Coast geosyncline has resulted in paralic sediments overlying ductile, offshore, and "deep-water" shales. This relation may have been the cause of structures formed independently of salt tectonics. Such features are thought to be analogous to those failures recognized causing failures in foundation engineering and to the Recent mudlumps of the Mississippi River.

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SOME OIL OCCURRENCES IN THE TAR SPRINGS (MISSISSIPPIAN) DELTA, ILLINOIS

The Tar Springs Sandstone along the southwestern flank of the Illinois basin is one of a series of Mississippian Chester clastic formations comprising a major deltaic complex. The Tar Springs was deposited in a slowly subsiding, intracratonic basin by a major river system, the Michigan River system of D. H. Swann.

The Tar Springs deltaic deposits are the principal reservoir in the 9-mile-long, 1–3-mile-wide producing trend formed by the Benton, Orient, and West Frankfort fields in south-central Franklin County. In this north-south oriented trend, the Tar Springs Sandstone is at an average depth of 2,050 feet and lies between two widespread, shallow marine, impermeable limestones. The reservoir is made up of very fine-grained to fine-grained sandstone laid down in overlapping and coalescing fan-shaped buildups and in lenticular bodies. Individual sand buildups are partially separated vertically and laterally from one another by impermeable siltstone and shale. The sandstone was probably deposited by shifting distributary channels. The siltstone and shale are probably quiet water, interdistributary deposits.

Oil accumulations in the Benton-Orient-West Frankfort trend are primarily structurally controlled; however, stratigraphic variations influence the over-all distribution of hydrocarbons. All the Tar Springs accumulations lie on a broad, north-south trending anticline of moderate closure. Local folding and warping of the anticline combined with lateral and vertical facies change from sandstone to shale determine the size, shape, and position of the oil pools.

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DISTRIBUTION OF HYDROCARBONS IN SOUTH LOUISIANA BY TYPES OF TRAPS

Hydrocarbons in Frio and younger sediments in South Louisiana, both onshore and offshore, are associated with six types of structural or combination structural-stratigraphic traps: salt domes; circular or elongate