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Abstracts of Papers

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BIOSTRATIGRAPHIC FRAMEWORK OF GRAND BANKS

Paleontologic and palynologic analyses of samples from wells on the Grand Banks of Newfoundland have established the presence of sedimentary rocks ranging in age from Holocene to Devonian. Several unconformities have been recognized, at least one of which is major in terms of areal extent and temporal magnitude. Upper Cretaceous and Tertiary rocks were deposited in environments ranging from middle shelf to slope. Early Cretaceous and Jurassic environments are interpreted as ranging from nonmarine to outer shelf. A graphic technique of compositing all available biostratigraphic data has permitted detailed correlation of wells located in three different basins. The data utilized were derived from analyses of foraminifers, ostracodes, calcareous nannoplankton, dinoflagellates, spores, pollen, and rare megafossils. The foundation for future biostratigraphic work has been established.

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GRAND BANKS REGIONAL GEOLOGY

Geophysical and drilling operations within the area of the Grand Banks have established the existence of thick sedimentary accumulations that include Tertiary, Mesozoic, and Paleozoic formations. An angular unconformity that developed in Early Cretaceous time divides the section into two distinct geologic units. The "upper wedge" is comprised of Tertiary and Cretaceous formations, whereas the "subunconformity basins" contain Jurassic and older formations. The structure of the upper wedge is relatively simple, consisting of regional dip broken locally by salt-dome structures. The subunconformity basins contain a great variety of structural types, including salt domes, salt ridges, and basement-controlled block faults.

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GEOLOGY OF GULF OF MAINE AND ADJACENT LAND AREAS

Seismic reflection, refraction, and magnetic measurements together with bedrock samples obtained with the submersible *Alvin* indicate that the Gulf of Maine has experienced a tectonic history similar to that of coastal New England. The major basement units include the late Precambrian Avalon platform, parts of the Appalachian eugeosyncline, Late Devonian to Middle Pennsylvanian basin and platform structures, and Early Triassic to Jurassic rift structures. The Avalon platform can be traced from the Canadian Maritime provinces to southeastern New England and may represent an ancient subduction zone formed during the early closing of the Atlantic in post-Grenville time. The Taconic and Acadian intrusive rocks of middle-late Paleozoic time also may have resulted from crustal compression during the final stages of closing. At that time the Avalon platform and Appalachian geosyncline were folded, faulted, and welded to the North American craton. Late Paleozoic rift structures apparently formed during the early phase of the opening of the present Atlantic or may have been the result of rotational compression between North America, Africa, and Europe during final closing of the proto-Atlantic. Tensional structures of Triassic age underlie a substantial part of the Gulf of Maine, most being beneath the gulf's many isolated basins. Similar tensional structures can be traced from Newfoundland to Florida and probably resulted from the separation of North America, Africa, and Europe, beginning in the Late Triassic. Mesozoic-Cenozoic igneous activity in northeastern North America also appears to be related to the formation of the present Atlantic basin.

The post-Triassic sedimentary framework of the Gulf of Maine consists of coastal-plain sediments of Late Cretaceous to early Pleistocene age which were deposited on a subsiding basement as the Atlantic widened and deepened with continued spreading. Coastal-plain deposits underlie Georges Bank and isolated topographic highs within the gulf which resisted subsequent removal by stream erosion and glacial activity. Well-defined unconformities beneath Georges Bank are inferred to separate the Upper Cretaceous sediments from the Tertiary and lower Pleistocene sediments and the Tertiary–lower Pleistocene strata from the Pleistocene glacial deposits. Moraine deposits of Pleistocene age mantle the northern slope of Georges Bank and much of the Gulf of Maine. Marine sediments of late Pleistocene to Holocene age are present in the gulf's basins. They are believed to be in part glacial rock flour carried into the basins by melt water and in part sediments winnowed from the moraine deposits on the nearby banks and ledges during the postglacial rise in sea level. The topography of the Gulf of Maine is believed to be the result of fluvial erosion during late Tertiary or early Pleistocene time. Pleistocene glaciation modified but did not alter significantly the preglacial drainage system.

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PALYNOLOGIC ANALYSES OF MESOZOIC–CENOZOIC SEDIMENTS OF GRAND BANKS OF NEWFOUNDLAND

Sediments ranging from Mississippian to Pleistocene age were present in a series of shallow coreholes drilled in 1965 on the Grand Banks of Newfoundland. Palynologic analyses of 110 samples from nine of these coreholes permit the recognition of 16 diagnostic biostratigraphic divisions within the late Mesozoic–Tertiary section. These divisions are defined on their spore, pollen, and/or dinoflagellate and acritarch assemblages. The geologic history and paleoecology can be reconstructed in part from the palynomorph assemblages. Mississippian rocks were recognized in only one of the coreholes (no. 10) and are of marine origin.

The stratigraphic interval from Pennsylvanian to the

Aptian inclusive was not present in any of the stratigraphic tests. The oldest Early Cretaceous sediments of late Albian age are of continental origin. The Cenomanian-Turonian marked the onset of marine deposition which was relatively continuous throughout the Late Cretaceous and Tertiary. A climatic cooling first recognized in the early Miocene extended into the Pleistocene. Comparison is made with the data from the Pan Am IOE Tors Cove and Pan Am IOE Grand Falls wells drilled in 1966. The age determinations on 212 samples from 20 of the shallow coreholes have assisted greatly in the construction of a geologic subcrop map of the Grand Banks region.

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Baffin Bay

Baffin Bay is a small ocean basin. This has been shown by seismic refraction studies. The depth to mantle beneath the central part of the basin is approximately 10 km, consisting of 2 km of water, 4 km of sediment and 4 km of oceanic crust, with the oceanic crust thickening toward Greenland. Sediments thicken northward and beneath the northern margin, east of Lancaster Sound, and are 6–7 km thick. The margin of the ocean basin can be delineated by gravity measurements, and the change in gravity is accompanied by change in magnetic-field-anomaly characteristics and change in structural style in sediments. Sediment-filled grabenlike structures occupy Melville Bay and Lancaster Sound, and smaller sedimentary basins are present in the southern part of Nares Straits and in Jones Sound. Extensions of the Tertiary igneous rocks of West Greenland and eastern Baffin Island are found offshore. Oceanic "basement" at the southern end of Baffin Bay rises to the surface on the northern side of Davis Strait. This sill is Icelandic in character, and may have been a site of a mantle plume which was at least in part responsible for the opening of the Bay.

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Preliminary Report on U.S. Geological Survey Geophysical Studies of Atlantic Outer Continental Shelf

Regional geologic and geophysical studies are being conducted by the U.S. Geological Survey to determine the structural framework of the area from Cape Hatteras to the northeastern edge of Georges Bank to assess the petroleum potential of the northeastern Atlantic outer continental shelf. Preliminary interpretations of geophysical data integrating gravity and magnetic data from the U.S. Naval Oceanographic Office with seismic surveys, suggest that the linear ridge reported by Drake and others in 1959 is deeper and farther west than previously suspected. Although it is not observed under the seaward extension of the Norfolk arch, it can be traced from the south side of the Baltimore Canyon area northeastward toward the eastern edge of Georges Bank. This ridge seems to form the eastward edge of a Mesozoic trough in the Baltimore Canyon area in which more than 10 km of relatively undisturbed post-Paleozoic sediments accumulated. The types of structures mapped are in general agreement with the sedimentary, structural models hypothesized for the Baltimore Canyon area by Kraft *et al.* in 1971. More than 8 km of sediments are present beneath the continental shelf on Georges Bank. On the basis of the preliminary regional geophysical studies, thick sedimentary sections and structural traps favorable for the accumulation of petroleum appear to exist under the Atlantic continental shelf off the northeastern part of the United States.

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Structural Framework of Continental Margin of Eastern North America

A reference surface is defined as the top of seismic layers of velocity greater than 4.5 km/sec, and referred to as "basement." The configuration of this surface is a series of basins, linear arches, and escarpments which have controlled the thickness and facies distribution of the lower velocity Cenozoic and later Mesozoic sediments.

Velocities within basement cluster in two groups, less than and greater than about 5.6 km/sec. High-velocity basement can be equated accurately with crystalline bedrock only in some nearshore areas of the inner shelf. Lower Cretaceous carbonates in the Bahamas–Blake Plateau area and very possibly farther north have velocities in this range, and obscure the underlying crystalline bedrock. High-velocity basement under the continental rise between the Scotian Shelf and the Carolinas has velocities mostly in the range of oceanic layer 3. Few measurements are in the range of normal upper continental crust.

Low-velocity basement represents a great range of lithologies and ages, including low-grade metamorphic rocks, Mississippian strata, early Paleozoic platform cover, Early Cretaceous/Jurassic sediments, and layer 2 of the ocean basin.

Between the Blake Plateau and the Scotian Shelf, a broad basement arch underlying the outer shelf and a secondary, more subdued, arch beneath the upper continental rise are formed on low-velocity basement. A large gravity high is associated with self-edge arch, but is not solely caused by it. Basement underlying the secondary arch, and seaward of it, has velocities characteristic of layer 2, but is much thicker and may be a mixture of clastic, evaporite, carbonate, and lava rocks which has subsided several kilometers since the region was the shallow margin to a young rift ocean. North of the New England seamounts the secondary arch appears to underlie the "ridge complex" observed by seismic profiler, which in turn follows the magnetic "slope anomaly."

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Stratigraphy of Continental Shelf, Offshore Nova Scotia

A formal stratigraphic scheme has been proposed for the Cenozoic and Mesozoic sediments of the continental shelf, offshore Nova Scotia. The stratigraphy is based primarily on subsurface information from approximately 30 offshore wells and supplemented by an extensive seismic grid.

The oldest recognized stratigraphic unit is salt, possibly of Early Jurassic age. The salt unit thickens into several subbasins where it is overlain conformably by a variable sequence of dolomite, anhydrite, limestone, and shale. Poorly sorted, feldspathic clastic sedimentary rocks disconformably overlie the evaporite section