thickens to the southeast, although not as much as expected. The average thickness in the Valley and Ridge province is about 17,000 feet and the greatest thicknesses are in the southern part, indicating that the basement surface plunges in that direction.

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Summary of Geology of Atlantic Coastal Plain Province

The emerged part of the Atlantic Coastal Plain is underlain chiefly by Cretaceous and Tertiary sediments above the basement rocks. Some deep beds may be of Jurassic age, and thin deposits of Quaternary age blanket coastal areas. In aggregate, the sediments thicken as a wedge toward the coast; at extreme tips of southern New Jersey and eastern North Carolina they are about 10,000 feet thick, and in southern Florida they are thicker than 15,000 feet.

Predominantly marine sands and clays characterize the entire sedimentary sequence north of North Carolina, as well as the Cretaceous sequence north of Florida. Near-surface calcareous rocks of Eocene age extend from North Carolina through Florida. Pre-Pleistocene rocks of Florida are largely carbonates.

The basement underlying the eastward- and southeastward-dipping homoclinal beds consists chiefly of crystalline rocks and to a lesser extent Paleozoic and Triassic sedimentary rocks. The basement is a shallow platform beneath the updip portion of the Coastal Plain, but in southern New Jersey and eastern North Carolina the slope steepens where the platform adjoins the western border of a north-trending trough. The Peninsular arch of Florida and the Cape Fear arch of North Carolina are two northwest-trending positive elements. An embayment in southeastern Georgia lies between them.

Common tendencies include: (1) downdip change in many formations from coarse clastic to fine clastic to carbonate facies, (2) downdip thickening of beds, (3) downdip increase in number of beds, (4) lack of consolidation of sand and clay except at great depth, and (5) decreasing porosity and permeability with depth in coastal areas.

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Deep Drilling Project

The AMSOC Committee of the National Academy of Sciences-National Research Council has determined that it is both feasible and desirable to drill a hole through the earth's crust for the main purpose of obtaining as much sample as possible of the mantle. The hole must be drilled in either the Pacific or Atlantic Ocean basin where the crust is thin enough to be penetrated. Detailed surveys have been carried out in the area north of San Juan, Puerto Rico, on the rise north of the Puerto Rican trench. The survey area covers about 5 square degrees. In the Pacific a smaller area 50 miles southwest of Guadalupe Island has been surveyed. One of these sites will be chosen for drilling to the mantle. The project will be carried out in 3 phases: Phase I will consist of modifying a drilling barge for deep-water operation. As many test holes as the project can afford will be drilled. Several complete sedimentary core sections will be obtained which will yield information on coring methods in unconsolidated sediments, as well as paleontological, mineralogical, and structural knowledge of deep-sea sediments, which never before has been obtained. The preliminary holes will go to depths of 18,000 feet and in some places it is expected that the second layer will be penetrated. Phase II will begin with the application of the engineering data found in phase I to the design of a new drilling barge. The new barge will be constructed and moved into place. Phase III encompasses the actual drilling of the deep mantle hole, the scientific direction of the work, field analysis of the results, and later laboratory analysis.

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Lower Silurian and Cambro-Ordovician Sedimentation of Northern Appalachian Basin

Subsurface studies in the Northern Appalachian basin reveal several different histories of sedimentation (Cambro-Ordovician and Lower Silurian). Too few wells have been drilled to the Precambrian to reveal anything but very regional data on the Cambrian sediments. The Cambrian thickness varies from 13,000 feet on the outcrop in south-central Pennsylvania to 900 feet in northeastern Ohio and 0 feet in southwestern Ontario. The section is predominantly dolomite and sandstone. The Upper Cambrian isopach map shows a probable regional high in northeastern Ohio. This high seems to trend north-south. Two regional unconformities have been detected within this section.

Middle-Ordovician sedimentation marked a time of emergence with the Adirondack-Tazwell axis in the center of the basin forming a structural and facies barrier separating for the first time the Appalachian basin into two distinct basins of deposition. On the northwest flank of the Allegheny synclinorium, the Crawford arch came into existence along with the Olean embayment and Erie trough (Chatham Sag extension). Unlike the more pronounced Adirondack-Tazwell feature, the Crawford arch did not act as a facies barrier. The Middle Ordovician sediments encountered so far are argillaceous limestones. The exception to this being the dolomitized productive areas on the Findlay arch.

Upper Ordovician sedimentation shows regional east to west thinning with occasional interruptions across local highs. These sediments are predominantly shales with occasional layers of siltstones or sands. The subsequent Lower Silurian deposits also show regional thinning eastward with local variations. Lower Silurian production appears to be confined to within the 200–400-foot isopach interval. Variations within this isopach interval are critical as to the quality of production to be found. Detailed study reveals the productive sand bodies are deltaic rather than offshore bars or shoestring sands.

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Petroleum Possibilities of Peten Basin, Guatemala

The Peten area of Guatemala was intermittently occupied by a marine basin from the late Paleozoic through the Cenozoic. The oldest sediments in the basin probably represent deep-water deposition in Pennsylvanian time. Emergence of the area, in the Permian resulted in the deposition of limestones, dolomites, sandstones, and siltstones. Total emergence by the end of the Permian continued through the Triassic and most of Jurassic. Upper Jurassic encroachment by the western sea resulted in deposition of red sandstones and conglomerates that lensed out on the positive eastern portion of the area. Resubmergence in the Lower Cretaceous accompanied by east-west faulting divided the area into a deeper southern structural element and a northern platform. Carbonate deposition was almost continuous for the southern element throughout the Cretaceous although embayments contemporaneous with the first stages of submergence resulted in local evaporite development. An extensive evaporite basin existed during the Lower Cretaceous in the shallower and stiller seas of the northern platform. Continued submergence in Middle and Upper Cretaceous resulted in the carbonate covering of the evaporite sequences. Continued deepening and turbidity during the Eocene resulted in the deposition of silty limestones, siltstones, and shales. A general re-emergence at the end of the Eocene is marked by localized occurrences of Oligocene and Miocene limestones and clastic sediments.

The Maya mountains are a positive element that remained static following the late Permian-Triassic emergence. Between the Maya mountains and the northern platform of the Peten lies the Chuquibul embayment, and area that may be of importance for the stratigraphic accumulation of oil.

The basin is buttressed southward by the Santa Cruz Mountains, and east-west Paleozoic range. In front of the mountains lies the Alta Verapaz thrust zone, the effect of Tertiary forces, terminating in an arcuate front extending across the southern portion of the Peten basin.

The southeast end of the Bartlett Deep is represented by Lake Izabel within the basin, and the shore areas of this trough have been filled with a great thickness of Upper Cenozoic sediments.

Oil impregnated rocks, in outcrop and in well cuttings have been found throughout the Cretaceous section and further accumulation is considered likely in the Jurassic redbeds and Permian limestones.

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Pre-Matawan Cretaceous Sediments

The record of the post-Jurassic transgression which caused the formation of the northern Atlantic Coastal Plain begins with the Potomac group, non-marine sediments of early Cretaceous age. Lithologically similar non-marine and transitional sediments of early late Cretaceous age, the Raritan and Magothy formations, overlie the Potomac group. The lithologic similarity of the several formations, and disagreement as to the significance of their contained plant fossils, which are the major means of dating the exposed deposits, have caused some recent confusion in their stratigraphic interpretation.

Recent laboratory and field studies show that heavy minerals are useful for local correlation, and permit the following conclusions.

1. A considerable wedge of Lower Cretaceous sediments is present in the shallow subsurface of southern New Jersey, and was derived principally from the crystalline Piedmont of Pennsylvania and Delaware.

2. During Raritan time the Piedmont was covered by Cretaceous sediments and the materials which make up the Raritan formation were supplied from older sedimentary terranes northwest of the Coastal Plain except in the northern New Jersey-Long Island area which received sediments derived from crystalline rocks exposed in southern New York and New England. Similar conditions prevailed during the deposition of the Magothy formation, but during Magothy time, the Cretaceous sediments were stripped from the Piedmont and it again became a site of active erosion.

3. The Potomac group and the Raritan formations are dominantly fluvial sediments at the outcrop and in the shallow subsurface, but marine facies of the Raritan are present only a few miles downdip from the outcrop areas. No marine Lower Cretaceous has been reported from the northern Atlantic Coastal Plain.The Magothy formation is transitional marine at the outcrop.

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Laboratory Experiments on Form and Structure of Offshore Bars and Beaches

Beaches and bars have been formed during experiments conducted in a 45-foot wave tank at the Sedimentation Laboratory of the U. S. Geological Survey in Denver. By changing one variable at a time, factors responsible for major differences in primary structure and in shape of sand body have been determined. These factors are: depth of water, intensity of wave action, and supply of sand. Stages in the development of the bars and beaches were marked with dark layers of magnetite and cross sections were preserved on masonite boards coated with liquid rubber, thus making a record of cross-stratification patterns and sand-body shapes.

Offshore bars develop at the point of wave break. Where this occurs in very shallow water an emergent bar commonly forms; where it is in somewhat deeper water a submarine bar is built; where still deeper no bar develops. Increase in intensity of waves tends to build a bar forward toward, and even onto the beach. Weaker waves build upward to form barriers with lagoons to shoreward. Abundant sand furnished on the seaward side of a developing bar, simultating conditions developed by some longshore currents, causes gently sloping, seaward-dipping beds to form. In contrast, shoreward-dipping strata of steeper angle are characteristic of bars developed where the sand supply is limited.

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Geochemical Investigations of Athabasca Oil Sands

Analyses were performed to evaluate the organic composition and the mineral content of the McMurray oil sands in northeastern Alberta, Canada. The samples came from the Abasand Quarry near McMurray and from three bore holes, drilled along a southwest-northeast cross section in the Fort MacKay and Bitumount area.

The bitumen content is related to the particle size of the rock. Impregnation is not restricted to one particular sediment type in the McMurray formation. For example, sandstone zones in the Bitumount core were found to contain as much as 17 per cent organic material soluble in methylene chloride; the bitumen content of the shale layers is lower. The elementary composition of the organic material was found to be uniform throughout the entire 246-foot section of the McMurray formation in the core. An organic sulphur content of approximately 5 per cent extends throughout the core. The aromatic character of the bitumen was shown by spectroscopic methods of analysis. The bitumen con-